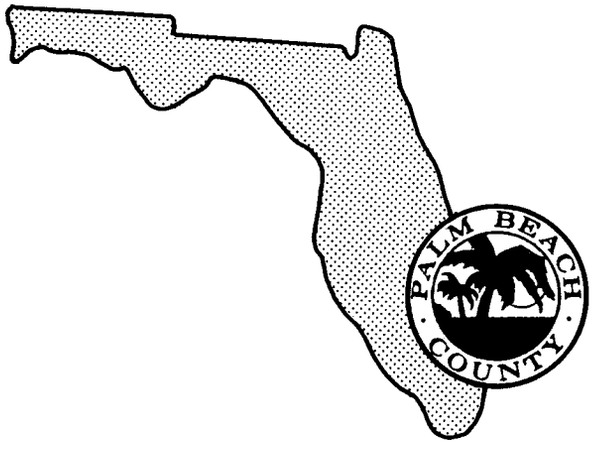
Volume I
Engineering Report on the

DRILLING AND TESTING OF THE INJECTION AND MONITOR WELLS FOR SYSTEM 9

Palm Beach County
Water Utilities Department



CH2M HILL

January 1986

ENGINEERING REPORT

ON THE

DRILLING AND TESTING

OF THE INJECTION AND MONITORING WELLS

FOR PALM BEACH COUNTY SYSTEM NO. 9 NORTH

Prepared for

PALM BEACH COUNTY
WATER UTILITIES DEPARTMENT
PALM BEACH COUNTY, FLORIDA

Prepared by

CH2M HILL
350 Fairway Drive
Suite 210
Deerfield Beach, Florida 33441

JANUARY 1986

FC18009.B2

tmSTS1/050

Engineers
Planners
Economists
Scientists

February 18, 1986

FC18009.B2

Mr. Robert Weisman, P.E.
Administrator
Palm Beach County
Water Utilities Department
P. O. Box 16097
West Palm Beach, Florida 33416

RE: Drilling and Testing of Injection and Monitoring Wells for the System 9 North Wastewater Treatment Plant

Dear Mr. Weisman:

It is with great satisfaction that we submit to you this engineering report covering the construction of the System 9 project. This report documents the data collected during the construction and testing of the wells and is prepared in accordance with specific condition No. 8 of the Construction and Testing Permit No. UC 50-092095 issued by the Florida Department of Environmental Regulation (FDER) February 25, 1986. Copies of the Construction Permit and its provisos are included in the Appendix of this report.

We are pleased to note that the project was successfully completed within the restrictive timeframe specified by the Amended Consent Order OGC No. 83-0728 and that the FDER has waived impending fines that accrued prior to completion of the project.

Such an achievement has been possible due to the personal interest and assistance of the Utilities staff, the efficient performance by the Contractor, the cooperation of the FDER Technical Advisory Committee, and the dedication of our staff assigned to this project.

CH2M HILL Southeast Florida Office Hillsboro Executive Center North 350 Drive, Suite 210
Deerfield Beach, Florida 33441 Palm Beach Co. 305.395.3800
Broward Co. 305.426.4008

We would like to extend our personal thanks to Mr. Lawton McCall. His assistance has been invaluable in the prosecution of this work.

Very truly yours,

Sean T. Skehan

Sean T. Skehan
Resident Geologist

Thomas M. McCormick

Thomas M. McCormick
Project Manager

J. I. Garcia-Bengochea

J. I. Garcia-Bengochea, P.E.
Project Administrator

tmTMC2/063
Enclosure
cc: Richard J. Bedard, P.E./Area Office Manager/CH2M HILL

gnCM47/d.2001

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November 18, 1986

FC18009.F0

South Florida Water
Management District
P.O. Box V
West Palm Beach, Florida 33402

Attention: Bruce Adams

Subject: Construction Cost Estimate for Reclaimed Water Delivery Station, PBCWUD System No. 9

Per your request, we have prepared an estimate of the cost to construct the reclaimed water delivery stations for PBCWUD System No. 9. The components of the delivery station, shown in Attachment A, include pipe, fittings, valves, a flowmeter, a remote telemetry unit, and appurtenances. The construction cost estimate is $23,500 for the station, as shown in Attachment B. In addition to this cost, the User would be responsible for construction of piping upstream and downstream of the delivery station, and other costs as outlined in Section 8 of the "Water Reclamation Study for System No. 9."

It is our understanding that this information is your final requirement for acceptance of the above-referenced study. If we can be of any further assistance, please call me at 737-6665.

Sincerely,

Stephen H. Riley

Stephen H. Riley, P.E.
Project Manager

bcrSHR3/002

Attachments

cc: C. L. McCall/PBCWUD
T. McCormick/CH2M HILL

CH2M HILL Southeast Florida Office Hillsboro Executive Center North 550 Fairway Drive, Suite 205
Deerfield Beach, Florida 33441 Palm Beach Co. 305.737.6665
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Attachment B

PBCWUD System No. 9 Water Reclamation Study
CH2M HILL No. FC18009.F0

CONSTRUCTION COST ESTIMATE
FOR RECLAIMED WATER DELIVERY STATION

Item	Quantity	Unit	Unit Cost	Total
12-inch Ductile Iron Pipe, Flanged	60	foot	$ 40	$ 2,400
Fittings				
12-inch, 90°, Flanged	6	each	350	2,100
12-inch Tee, Flanged	2	each	600	1,200
Valves				
12-inch Gate	2	each	600	1,200
12-inch Gate with Actuator	1	each	3,300	3,300
Flowmeter	1	each	1,300	1,300
RTU	1	each	4,000	4,000
Allowance (fence, concrete pad, pipe supports, etc.)	1	each	2,000	2,000
SUBTOTAL				$17,500
Add 34 Percent for Electrical, Instrumentation, Site Work, Painting, Mobilization, Insurance, Bonds, Contingency				6,000
TOTAL				$23,500

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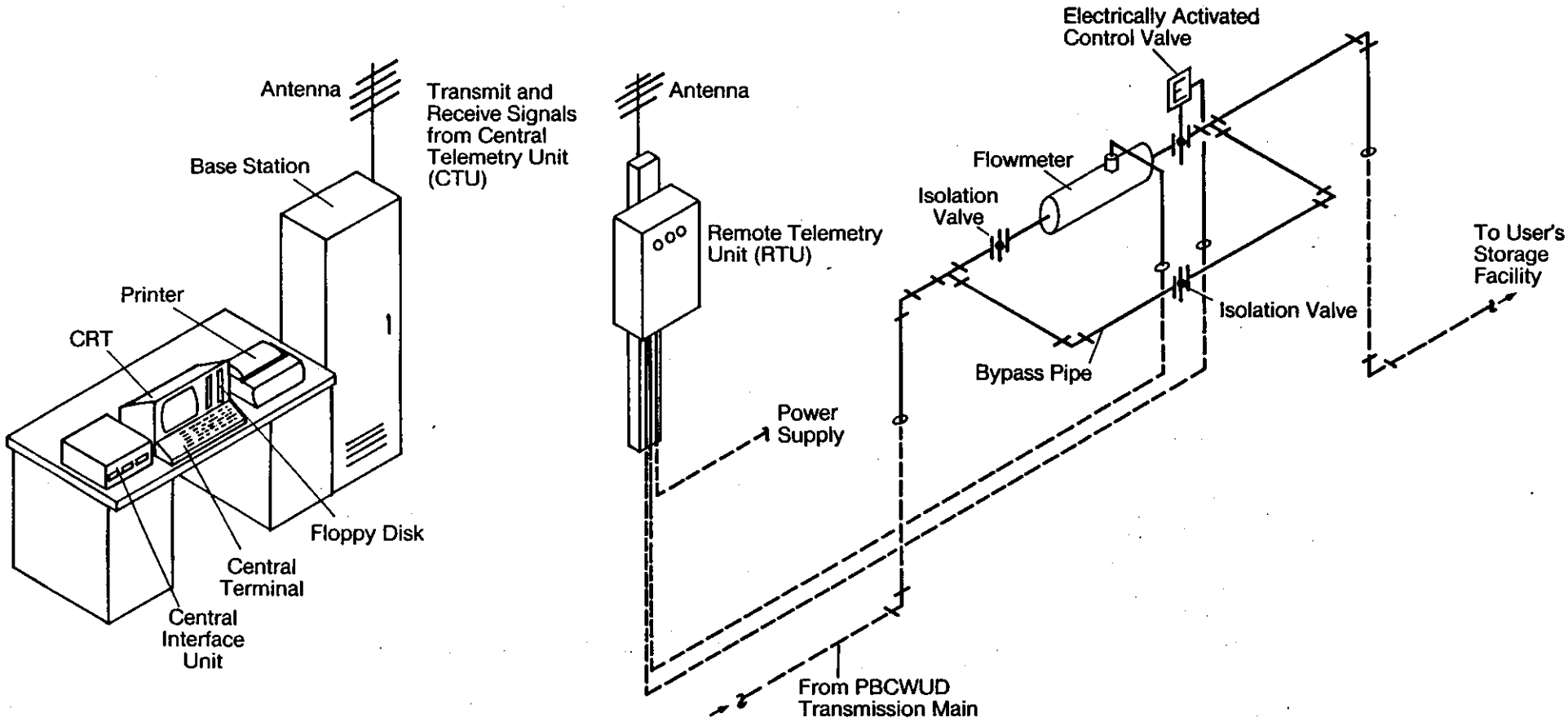

Central Telemetry Unit **Remote Telemetry Unit** **Delivery Station**

FIGURE 6-1.
Remote Telemetry Facilities.

"ATTACHMENT A"

CONTENTS

TABLES

FIGURES

Section 1
INTRODUCTION

SCOPE

The scope of work for Palm Beach County's Water Utilities Department (PBCWUD) System No. 9 included the construction of a 24-inch injection well, an effluent transfer pump station, a dual-zone monitor well, an injection well pump station, and a 24-inch-diameter transmission line to pipe effluent from System No. 9's south plant to the north plant for disposal into the deep injection well. CH2M HILL served as the prime consulting engineer and engineer of record through the entire project.

The existing system of discharging the treated effluent to percolation ponds at the south plant and into a lake system at the north plant will be phased out but maintained for emergency discharge upon the completion of the injection facilities. The effluent will then be disposed of into the salt water "Boulder Zone" through the injection well. Disposal through golf course irrigation is an alternative to be implemented as soon as contractual agreements are reached among the parties.

Layne Atlantic, Inc. of Orlando, Florida was selected as contractor for the construction of the injection and dual-zone monitor wells. Southeast Underground, Inc. of Cape Coral, Florida was selected as the contractor to install the 24-inch transmission line and construct the pump station. This report describes the construction of the injection and dual-zone monitor wells.

Under construction permit No. UC 50-092095 as granted by the Department of Environmental Regulation (DER) to PBCWUD, construction began in March 1985. Construction on both wells

was completed in November 1985. The permit, included in Appendix A, contains specific conditions relating to the site, design parameters and specific construction criteria; including equipment, testing and monitoring requirements.

ACKNOWLEDGEMENTS

The DER Technical Advisory Committee (TAC) coordinated the actions of local, State and Federal agencies which included the DER (state and local), South Florida Water Management District (SFWMD), PBC Health Department, and the United States Geological Survey (USGS). Periodically, TAC meetings were held to fully inform its members of the project progress and to review current data collected. Summaries of these TAC meetings are included in Appendix B.

This project and the completion of it would not have been possible without the continuous communication and cooperation between all parties involved.

Those individuals who played a role in this project were:

PBCWUD: Mr. William Bryant, Former Administrator and Mr. Robert Weisman, Present Administrator of Water Utilities Department; Mr. Tom Thornton, Director of Utility Engineering Division; and Mr. Lawton McCall, C.I.P. Coordinator.

DER: Mr. Roy Duke, Jr., Manager South Florida District; Mr. John Guidry, Former Chairman, Mr. Don White, Present Chairman TAC; Mr. Scott Seyfried, Hydrologist, West Palm Beach; Mr. Richard Deuerling, Environmental Specialist, Tallahassee.

SFWMD: Dr. Leslie A. Wedderburn, Deputy Director, Resource Control Department; Mr. David Butler, Hydrologist.

USGS: Mr. Michael Meritt, Hydrologist.

LAYNE ATLANTIC CO.:

Messrs. Bill Neely, Project Administrator; Ralph Palmer, Project Superintendent; Russ Carlin, Field Superintendent.

CH2M HILL:

Dr. J.I. Garcia-Bengochea, Project Director; Messrs. Gary Fries, Project Manager; Tom McCormick, Project Manager/DIW; William Rice and Sean Skehan, Geologists.

Section 2
WELL CONSTRUCTION

LOCATION

The injection and dual-zone monitor wells are located at the north plant of PBCWUD System No. 9. This treatment plant is located adjacent to State Road 7 approximately two miles north of Glades Road in the Northwest ¼ of Section 7, Township 47 South, Range 42 East. Figure 2-1 shows the location of both the north and south plants of System No. 9.

SITE PREPARATION

Construction of the deep injection system at the north plant of System No. 9 began in February 1985 with clearing of the site, figure 2-2 shows a site plan with the location of the wells and injection system piping. After clearing the site the drilling pad location was graded and compacted with crushed limestone. The pad was constructed with a mat of reinforcing steel and a single monolithic concrete pour. The design of the 80- x 120-foot pad with a six-inch curb was calculated to support the load of the drilling rig with the various suspended casing loads and to contain drilling fluid and saltwater produced during well construction.

DRILLING METHODS AND DATA COLLECTION

Drilling of the injection well began in March 1985 and was completed in October 1985 with a Wilson 7500 rotary drilling rig. The Wilson has a rated hook load of 450,000 lbs. A Gardner Denver 3000 with a rated hook load of 200,000 lbs. was used to drill the dual-zone monitor well in September and October 1985. Two methods of rotary drilling, standard mud circulation, and reverse air circulation, were utilized

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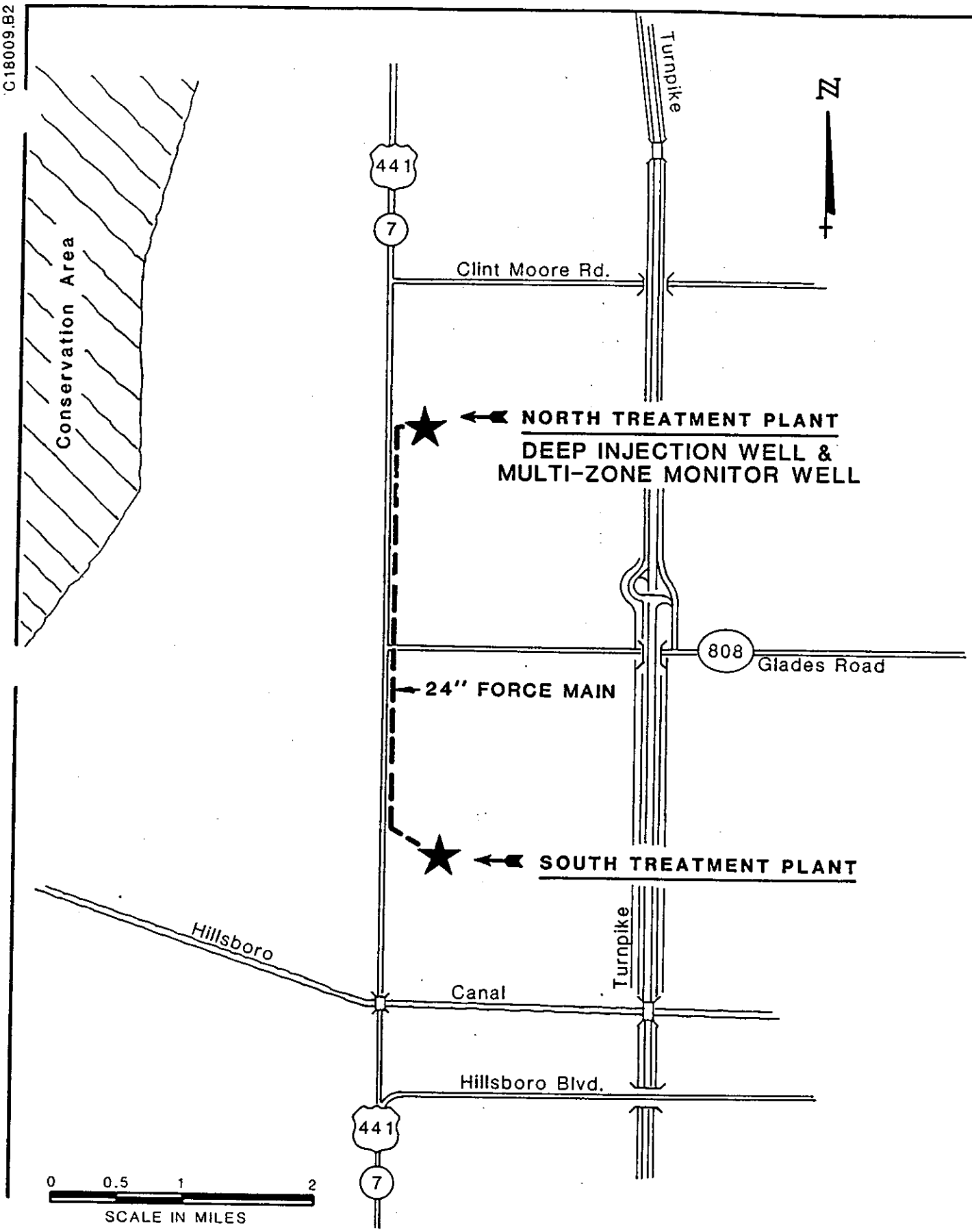

FIGURE 2-1

Location of Palm Beach County System No. 9

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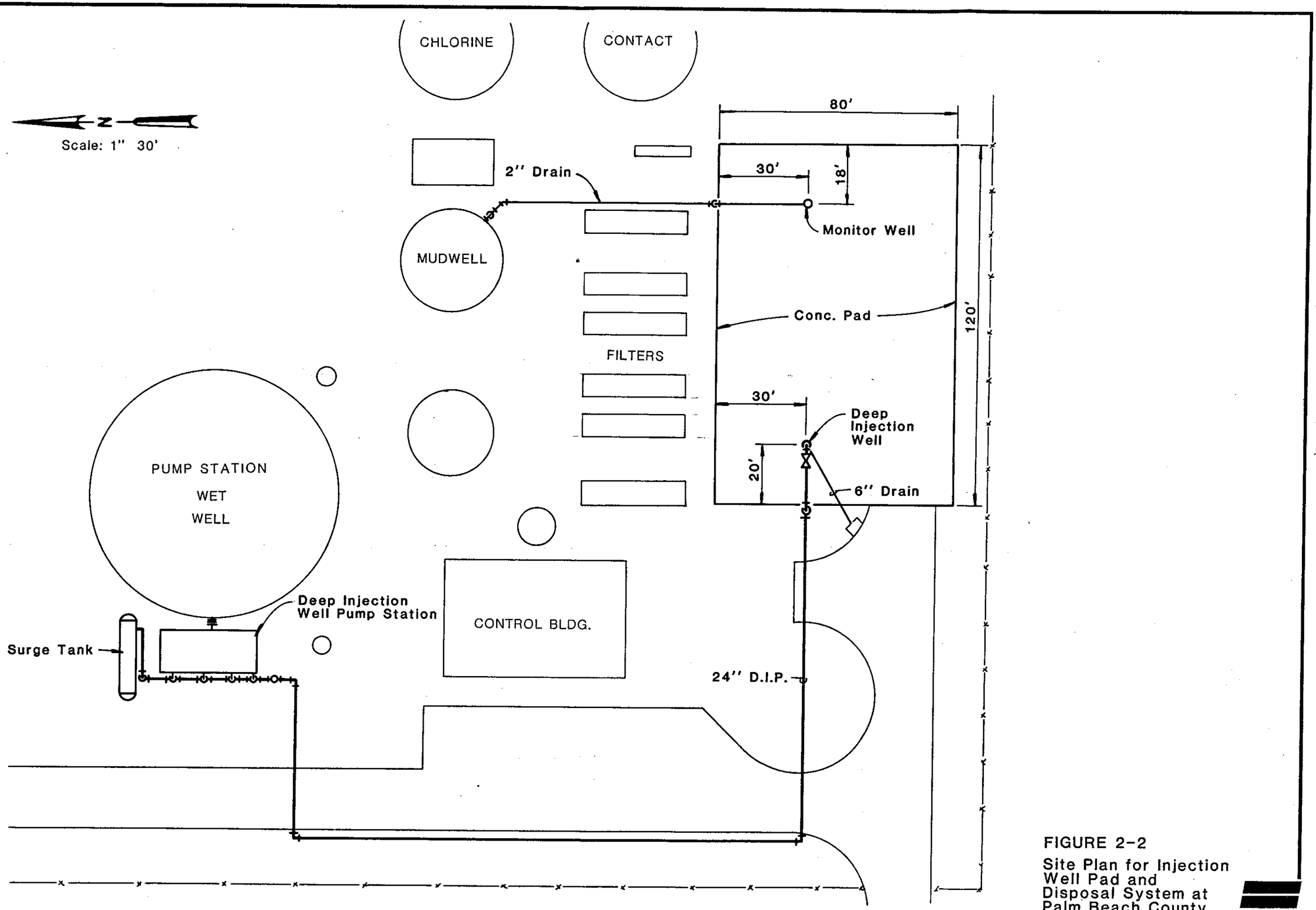

FIGURE 2-2

Site Plan for Injection Well Pad and Disposal System at Palm Beach County System No. 9

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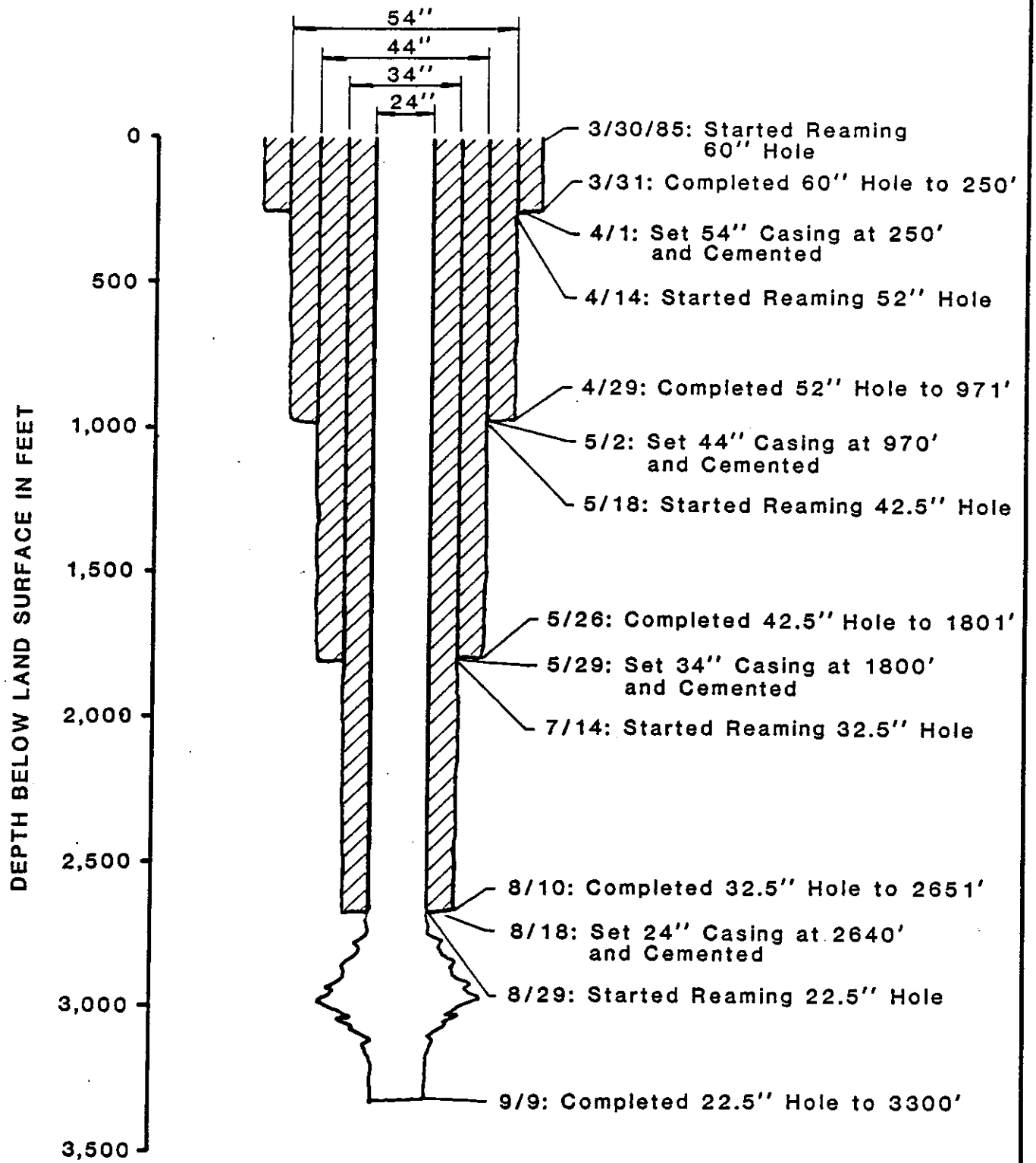

FIGURE 2-3
Completion Diagram
for Injection Well
at Palm Beach County
System No. 9

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to drill both wells. Mud circulation was used to remove formation cuttings down to approximately 1,000 feet and the reverse air circulation method was used below this depth to remove formation cuttings and take formation water samples.

The pilot holes for the injection and monitor wells were drilled in stages to anticipated casing setting depths with formation samples being collected at 10-foot intervals. Water samples were taken at 30-foot intervals while drilling on reverse air and were analyzed for temperature, conductivity and chlorides. Core samples were also taken at various depths between 1,800 to 2,700 feet to obtain undisturbed representation of the formations. Samples were then selected from each interval and sent to an independent laboratory for analysis.

The drilling schedule and casing setting depths were designed to meet the particular characteristics of the geologic and hydrogeologic features of southeast Florida. Geophysical logs were run on the pilot holes to aid in the interpretive analysis of the formation samples. Casing setting depths were then selected, the pilot hole reamed to the selected depth, and casings set and cemented. At PBCWUD System No. 9, four concentric steel casings were used in the construction of the injection wells; 54, 44, 34, and 24-inch diameter. Table 2-1 summarizes the drilling and the geophysical logging at the injection well.

The 54-inch casing for IW-1 was set and cemented from a depth of 250 feet to land surface. This casing was set through the surficial Biscayne aquifer and into the upper Hawthorn formation to prevent possible contamination to the Biscayne aquifer. This protected southeast Florida's primary source of potable fresh water during subsequent drilling operations.

Table 2-1
SUMMARY OF DRILLING AND GEOPHYSICAL LOGGING
FOR THE INJECTION WELL AT
PALM BEACH COUNTY SYSTEM NO. 9

Depth Drilled (feet)	Hole Diameter (inches)	Date Completed	Logs Run	Remarks and/or Section Drilled
280	17½	3/29	Single point electric, gamma ray, caliper	Logs of pilot hole to determine 54" casing setting
250	60	3/31	--	Completed 60" reamed hole for 54" casing
1,023	17½	4/12	Long and short normal electric, spontaneous potential, gamma ray, caliper	Logs of pilot hole to determine 44" casing setting
971	52	4/29	--	Completed 52" reamed hole for 44" casing
1,850	17½	5/17	Long and short normal electric, spontaneous potential, single point electric, gamma ray, caliper, fluid resistivity, temperature	Logs of pilot hole to determine 34" casing setting
1,800	42½	5/26	Caliper log	Completed 42½" reamed hole for 34" casing
1,768	34	5/30	Temperature	Log run to determine cement fillup in 34" annulus
3,300	17½	7/6,8	Long and short normal electric, spontaneous potential, gamma ray, caliper, temperature, fluid resistivity	Logs of pilot hole to determine 24" casing setting
3,300	17½	7/10,11,12	Flow meter (static), flowmeter (injection)*, fluid resistivity (static)	Logs run to determine flow and water quality characteristics of the pilot hole and water quality
2,651	32½	8/10	Caliper	Log run to determine hole diameter prior to setting 24" casing and for cement calculations
2,543	24	8/19	Temperature	Log run to determine cement fillup in 24" annulus

Table 2-1 (Continued)

Depth Drilled (feet)	Hole Diameter (inches)	Date Completed	Logs Run	Remarks and/or Section Drilled
3,301	22½	9/10	Long and short normal electric, spontaneous potential, gamma ray, caliper fluid resistivity, temperature	Logs performed on the 22½" reamed hole to establish background log data on completed injection well
3,301	22½	9/11	Fluid resistivity, temperature, flow meter	Logs performed during injection test of 22½" reamed hole
2,640	22½	10/19	Cement bond log	Log run to check cement bond to 24" casing
3,301	22½	10/21	T.V. survey**	Final T.V. survey was run to establish a visual background profile for the completed well

Note: *Difficulty with geophysical logging equipment.

**T.V. survey review can be found in Appendix F.

Copies of geophysical logs can be found in Volum II of this report.

The 44-inch casing was installed to a depth of 980 feet and cemented back to land surface; through the Hawthorn formation and into the upper Floridan aquifer. This casing served as a construction casing sealing off the clays and soft limestones of the Hawthorn and Tampa formations to protect the integrity of the confining beds and to prevent interference during reverse air drilling below 1,000 feet.

The 34-inch casing was installed to a depth of 1,800 feet and cemented back to land surface. This casing is used to control the artesian flows of the upper Floridan aquifer system during construction. Two artesian zones in this interval are used as monitors in the dual-zone monitor well constructed as part of this project.

The 24-inch casing is the conductor casing for the effluent at the injection well. This casing was installed and cemented at a depth of 2640 feet, the base of the first competent confining interval above the injection zone. Table 2-2 summarizes the casing depths and the type and quantity of cement used for cementing the injection well. Figures 2-3 and 2-4 show injection well and injection well head completion diagrams, respectively.

DUAL-ZONE MONITOR WELL CONSTRUCTION

At PBCWUD System No. 9 a dual-zone monitor well was constructed with the same drilling techniques as the injection well but with an open circulation system instead of a closed system. This was made possible by having the completed injection well available to dispose of the fluids produced while drilling through the artesian zones of the upper Floridan aquifer. The two monitor zones located in the upper Floridan aquifer above the confining beds of the injection zone will be used to monitor for any upward

Table 2-2
CASING SETTING DEPTHS
TYPES AND QUANTITIES OF CEMENT USED FOR THE INJECTION WELL AT
PALM BEACH COUNTY SYSTEM No. 9

Casing Diameter		Casing Wall Thickness	Casing Depth Below Pad	Type of	Amount of Cement	
External	Internal	(inches)	(feet)	Cement	(sks)	Remarks
54"	53"	.500	250	12%	460	Cemented in 1 stage
				Neat	342	
44"	43"	.500	970	12%	1701	Cemented in 2 stages
				Neat	565	(1 primary and 1 tremie)
34"	33"	.500	1,800	12%	3183	Cemented in 3 stages
				Neat	523	(1 primary and 2 tremie)
24"	23"	.500	2,640	12%	4031	Cemented in 14
				4%	1884	stages (1 primary
				2%	583	and 13 tremie)
				Neat	704	
				Thixotropic	250	

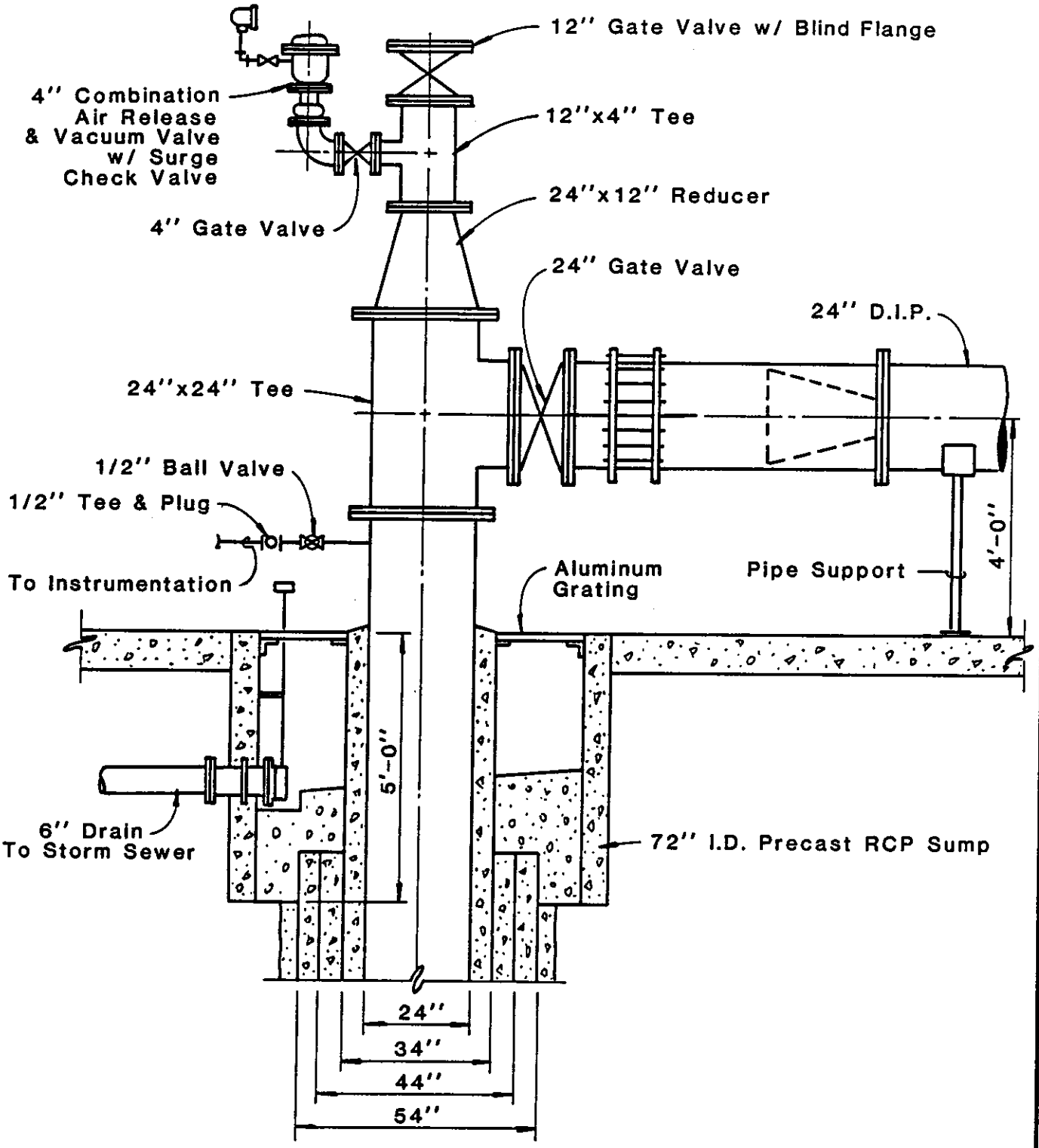

FIGURE 2-4

Completion Diagram for Injection Well Head at Palm Beach County System No. 9

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migration of injected effluent. Figures 2-5 and 2-6 show the monitor well completion and monitor well head completion diagrams, respectively. Table 2-3 summarizes the drilling and the geophysical logs performed during construction of the monitor well.

The casing setting depths for the monitor well were the same as those used for the upper three casings of the injection well. A 24-inch casing was set through the Biscayne aquifer, a 16-inch casing was installed through the Hawthorn and Tampa formations and into the upper Floridan aquifer, and a 6-inch casing was installed to 1,699 feet into an interval immediately above the 10,000-TDS interface. Table 2-4 summarizes the monitor well casing settings and the type and quantities of cement used.

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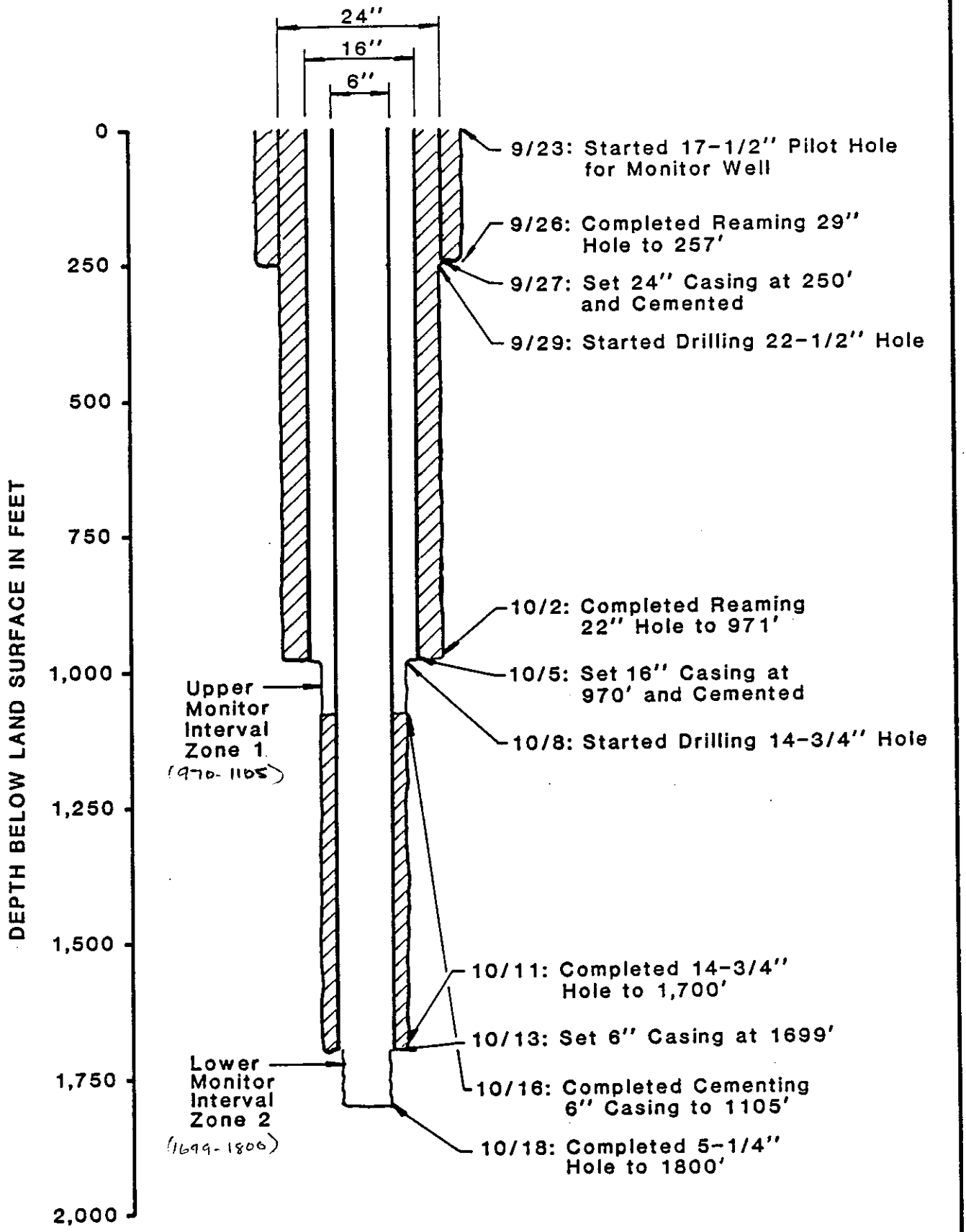

FIGURE 2-5

Completion Diagram of Dual-Zone Monitor Well at Palm Beach County System No. 9

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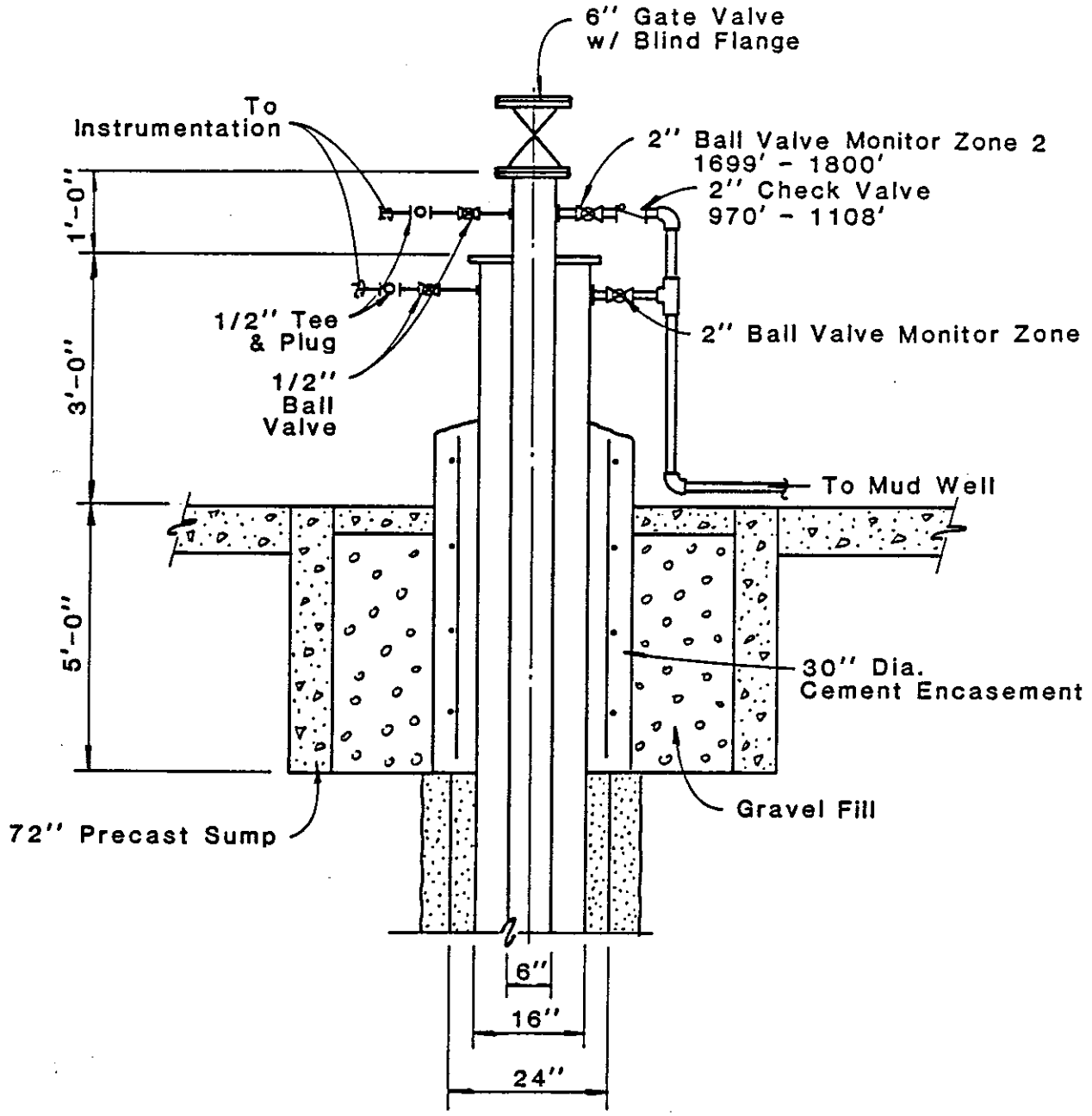

FIGURE 2-6
Completion Diagram for
Dual-Zone Monitor Well Head
at Palm Beach County
System No. 9

Table 2-3
SUMMARY OF DRILLING AND GEOPHYSICAL LOGGING
FOR THE DUAL-ZONE MONITOR WELL AT
PALM BEACH COUNTY SYSTEM NO. 9

Depth Drilled (feet)	Hole Diameter (inches)	Date Completed	Logs Run	Remarks
257	29	9/26	--	Reamed hole for 24" casing
971	22½	10/3	Long and short normal electric with spontaneous potential, gamma ray, caliper	Logs for reamed hole to determine 16" casing setting
1,705	14-3/4	10/12	Long and short normal electric with spontaneous potential, gamma ray, caliper, temperature, fluid resistivity, flow meter	Drilled hole for 6" casing, full suite of logs performed to define >10,000 TDS water
1,700	6" casing	10/14	Temperature	Log run to determine cement fill up
1,700	6" casing	10/20	Cement bond log	Long run to check cement bond to 6" casing
1,800	5¼	10/21	Long and short normal electric with spontaneous potential, gamma ray, caliper, temperature, fluid resistivity, grab sample at 1,790	Logs run on completed well to establish a background profile for the completed well and to determine water quality at the bottom of the well
1,800	5¼	10/21	T.V. survey*	The T.V. survey was run to establish a background profile for the completed well

Note: *T. V. survey review can be found in Appendix F.

Copies of geophysical logs can be found in Volume II of this report.

Table 2-4
CASING SETTING DEPTHS
TYPES AND QUANTITIES OF CEMENT
USED FOR THE DUAL-ZONE MONITOR WELL AT
PALM BEACH COUNTY SYSTEM NO. 9

Diameter (inches)		Casing Wall Thickness (inches)	Casing Setting Depth (feet)	Type of Cement	Amount of Cement (sks)	Remarks
External	Internal					
24	23	.5	250	12% Bentonite Neat	196 617	Cemented in 3 stages (1 pressure and 2 tremie)
16	15.25	.375	970	12% Bentonite Neat	492 100	Cemented in 1 stage with returns to surface
6.625	5.761	.432	1,700	2% Bentonite Neat	857 160	Cemented in 4 stages (1 pressure and 3 tremie) to 1105 feet below land surface

Section 3
GEOPHYSICAL LOGGING, STRATIGRAPHY, WATER QUALTY
AND HYDROLOGIC TESTING

GEOPHYSICAL LOGGING

Geophysical logs are used to identify and collect specific data from underground geologic structures. Geophysical logs were performed on all the pilot hole intervals and were then used to correlate the formation samples, taken while drilling, to determine formation boundaries and to obtain other necessary in-situ borehole data. This data was then used to determine optimum casing setting depths.

Geophysical logs were run during the injection test to obtain data on the completed well in order to help define fluid loss zones and to provide a basis for comparison for future investigations on the well.

STRATIGRAPHY

A stratigraphic profile of the injection and monitor wells at Palm Beach County WWTP No. 9 was derived by correlating the formation samples with the geophysical logs run on the pilot hole. Figure 3-1 generalizes the diverse strata of limestones, calcareous clays, phosphatic sands and dolomites found at the site. The detailed lithologic log of the wells can be found in Appendix C.

The primary constituents indentified during the drilling of the pilot hole to 210 feet were sandy limestones, calcareous phosphatic sandstones, coquinoid and shelly sands. These constituents exemplify recent deposits through the Pleistocene and are referred to as the Anastasia formation in the Florida Bureau of Geology Report of Investigations No. 17, Biscayne Aquifer of Dade and Broward Counties, Fla., 1958 by Melvin C. Schroeder, Howard Klein and Nevin Hoy, USGS. The

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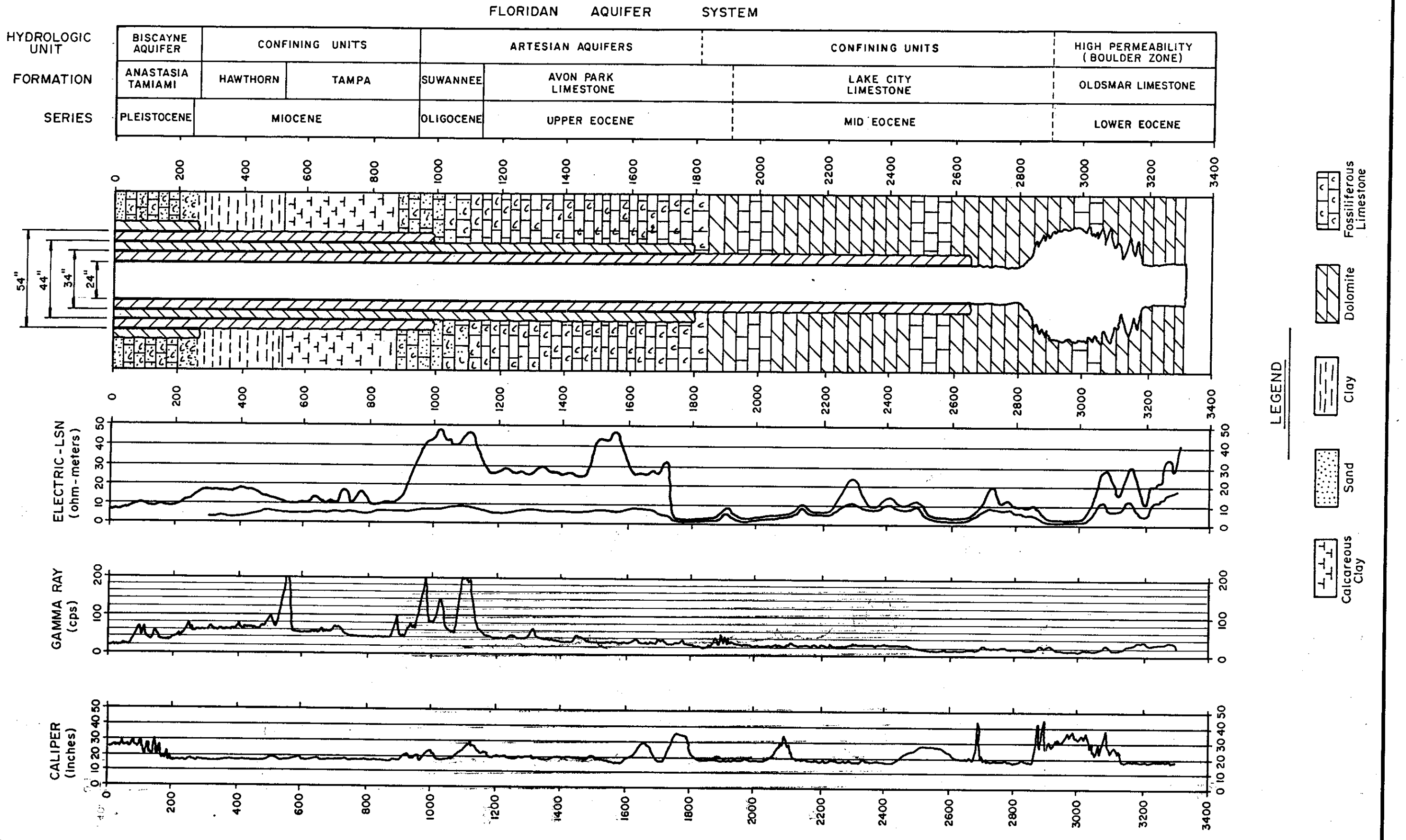

FIGURE 3-1
Generalized Lithologic Detail For Injection Well
At Palm Beach County System No. 9

Anastasia formation represents the primary component of the Biscayne aquifer in this area.

The natural gamma ray log indicated an average of 30 to 50 counts per second (cps) through this interval. From 210 to 244 feet the gamma ray response is in the 50 to 70-cps range which correlates to the appearance of olive gray clay and shell in the drill cutting samples. This interval represents the transitional Tamiami formation of the Upper Miocene series. The Miocene series then extends down to approximately 952 feet and is divided into the Hawthorn and Tampa formations. The Hawthorn formation extends to 552 feet and is typified lithologically by dense plastic olive green clay with some interbedded shell. A high gamma ray peak (greater than 200 cps) defines the bottom of the Hawthorn and the start of the Tampa. The Tampa formation extends from approximately 552 feet to 952 feet and is characterized by a lithologic color change to a yellowish gray calcareous clay with the occurrence of some interbedded siltstone, chert and shell. The gamma ray count rate ranges from 40 to 60 cps throughout most of this interval.

The characteristic clays found in the Miocene series represent a substantial confining unit of very low permeability separating the Biscayne aquifer from the artesian Floridan aquifers.

At 952 feet the gamma ray response makes a sharp shift toward higher counts. This shift correlates to the fossilifereous and arenaceous phosphatic limestones found in the drilling cutting samples. The Long-Short Normal Electric log also indicates this formation change with a shift to higher resistance; a feature typical of erosional unconformities and water-producing limestones. This interval, the Suwannee formation of the Oligocene series, extends to approximately 1,126 feet. The Suwannee is a geologic formation of the

upper Floridan aquifer system and characteristically exhibits high permeability and artesian pressure. The upper-most zone of this artesian aquifer was selected for monitoring of the upper Floridan aquifer.

Below 1,136 feet and extending down to 1,870 feet the lithology consists of a yellowish gray, soft, biomicritic limestone typical of the Avon Park formation of the Upper Eocene Series. The gamma ray count rate remained at a fairly constant rate of 20 cps through this interval but shifts to higher counts with 55 cps peaks between 1,870 feet and 1,940 feet. This relates to a change in lithology from limestone to dolomite. This change could relate to the fine to medium crystalline dolomite bed forming the base of the Avon Park Limestone and overlying the Lake City Limestone as described by Chih Shan Chen in Florida Geological Bulletin No. 45, The Regional Lithostratigraphic Analysis of Paleocene and Eocene Rocks of Florida, 1965. The Avon Park-Lake City formation boundary can be more closely determined through an in-depth paleontologic study of the formation samples. The Lake City limestone, of the Mid Eocene, is comprised of light to dark brown interbedded carbonaceous dolomites, dolomites and fossiliferous limestones which extend to the top of the Oldsmar limestone at approximately 2,910 feet. The gamma ray log maintains a relatively constant rate of approximately 15 to 30 cps through this interval.

In general, the Avon Park and Lake City formations are considered a confining unit separating the upper and mid Eocene from the lower Eocene series. The caliper log below 2,910 feet indicates a highly fractured and cavernous formation down to 3,130 feet, indicative of the Oldsmar Limestone of the lower Eocene Series. This cavernous formation, also known as the "Boulder Zone," is characterized by a hard, fine to coarsely crystalline dolomite formation that is highly transmissive.

Below 3,130 feet and down to 3,300 feet the formation is more massive and displays fewer cavernous features.

A complete file of the geophysical logs run at Palm Beach County System No. 9 can be found in Volume III of this report.

CORES AND ANALYSIS

Core samples were taken at various depths between 1,800 and 2,700 feet while drilling the pilot hole. The cores were taken with a 5¼-inch Christiansen Diamond Bit and a 20-foot 4-inch barrel. The cores were first examined and described and then wrapped to minimize fluid loss prior to permeability and porosity analysis. Tuscolussa Testing Laboratories (T.T.L.), Inc. was selected to analyze the core samples. Six core intervals were found to have suitable samples for both permeability and porosity analysis.

Permeability as described in Applied Hydrogeology by C.W. Fetter, Jr., Charles E. Merrill Publishing Company, 1980, is of two types, primary and secondary. Primary permeability relates to the characteristic openings in the rock as it is formed and secondary permeability relates to openings created after the rock was formed. The core intervals tested were comprised of limestones and dolomites which are sedimentary rocks with a chemical and biochemical origin. Typically, the low primary permeability of limestone and dolomite is due to an intergrown crystalline structure. The permeability and porosity results from T.T.L., Inc., as seen in Table 3-1, indicate low values for the limestones and very low values for the dolomites. The low values seen for the limestone cores can also be related to the generally low resistivity values seen on the long and short normal electric log through the 1,800- to 2,700-foot interval. This interval, although interbedded with some high resistivity dolomites,

Table 3-1
CORE PERMEABILITY AND POROSITY TEST DATA FOR
PALM BEACH COUNTY SYSTEM NO. 9

Core and Section	Core Interval (ft - depth)	Description	Direction	Permeability Coefficient "K" (cm/sec)	Porosity (%)
Core 1, 1	1891 - 1891.75	Limestone	Vertical	4×10^{-5}	--
4	1893 - 1895	Limestone	Vertical	2×10^{-6}	23
4	" "	Limestone	Horizontal	2×10^{-5}	--
7	" - 1897.58	Dolomite	Vertical	2×10^{-5}	4
7	" "	Dolomite	Horizontal	3×10^{-8}	--
Core 2, 1	2015 - 2015.58	Limestone	Vertical	5×10^{-6}	29
8	2019.05 - 2019.72	Dolomite	Vertical	2×10^{-5}	30
8		Dolomite	Horizontal	5×10^{-6}	--
13	2023.44 - 2024	Dolomite	Vertical	3×10^{-10}	6
13	" "	Dolomite	Horizontal	2×10^{-7}	--
Core 4, 1	2370 - 2370.02	Dolomite	--	--	1
9	2374.7 - 2375.5	Dolomite	Vertical	2×10^{-9}	--
10	2375.5 - 2376	Dolomite	Vertical	2×10^{-10}	1
Core 5, 3	2505.55 - 2505.8	Limestone	Vertical	4×10^{-9}	--
24	2510.61 - 2510.96	Limestone	--	--	27
Core 6, 1	2516 - 2516.55	Limestone	--	2×10^{-5}	--
3	2517.4 - 2518.05	Limestone	Vertical	1×10^{-5}	--
5	2518.30 - 2518.73	Limestone	Vertical	1×10^{-5}	--
12	2520.42 - 2520.79	Limestone	Vertical	7×10^{-7}	--
Core 8, 3	2590.53 - 2590.88	Limestone	Vertical	5×10^{-6}	--
8	2592.42 - 2592.87	Limestone	Vertical	2×10^{-5}	--
9	2591.54 - 2591.79	Limestone	Vertical	3×10^{-5}	--
13	2594.16 - 2594.70	Limestone	--	--	29

Note: Analytical data from Tuscalosa Testing Laboratory can be found in Appendix G.

is generally considered to have low permeability and is defined as an aquitard. However, since the samples must be made small enough to be analyzed in the laboratory they exhibit little, if any, secondary effects of fracturing and channeling that can be common to hard dolomite.

WATER QUALITY

As previously mentioned, reverse air circulation drilling was utilized below approximately 1,000 feet to remove formation cuttings and to take water samples. Water samples were taken at 30-foot intervals in both the injection and dual-zone monitor wells to obtain a depth versus quality (chlorides and conductivity) profile of the borehole. The injection well was drilled on a closed circulation system which was necessary to avoid discharge of salt water to surficial waters. Because of closed circulation, a truly representative formation water sample was not always possible due to mixing of waters within the borehole and the use of brine as a weighting fluid while drilling through the artesian zones of the upper Floridan aquifer. However, the water quality data was useful in determining the general water quality trends of the injection well. Figure 3-2 shows the results of the water quality analyses for the reverse air samples collected during the injection well drilling.

Drilling of the monitor well below 1,000 feet was performed with open circulation in order to collect more representative formation water samples. Fluid developed during the drilling was injected into the completed injection well. Figure 3-3 shows the water quality data plotted versus depth and indicates a sharp increase in chlorides at approximately 1,775 feet. This data is further corroborated by samples taken from 1,790 feet with the geophysical logger's depth

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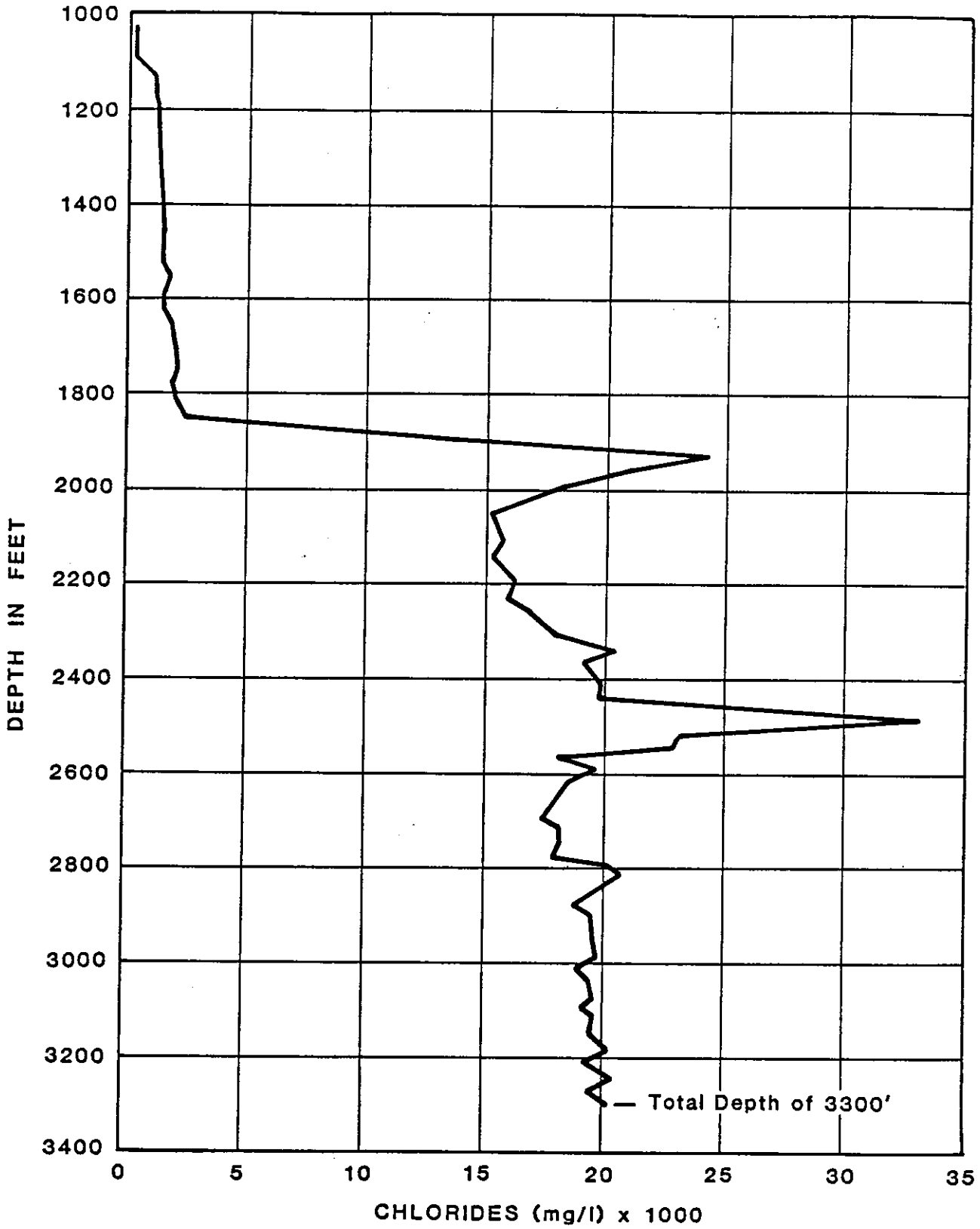

FIGURE 3-2

Water Quality Data From Pilot Hole Drilling For Injection Well At Palm Beach County System No. 9

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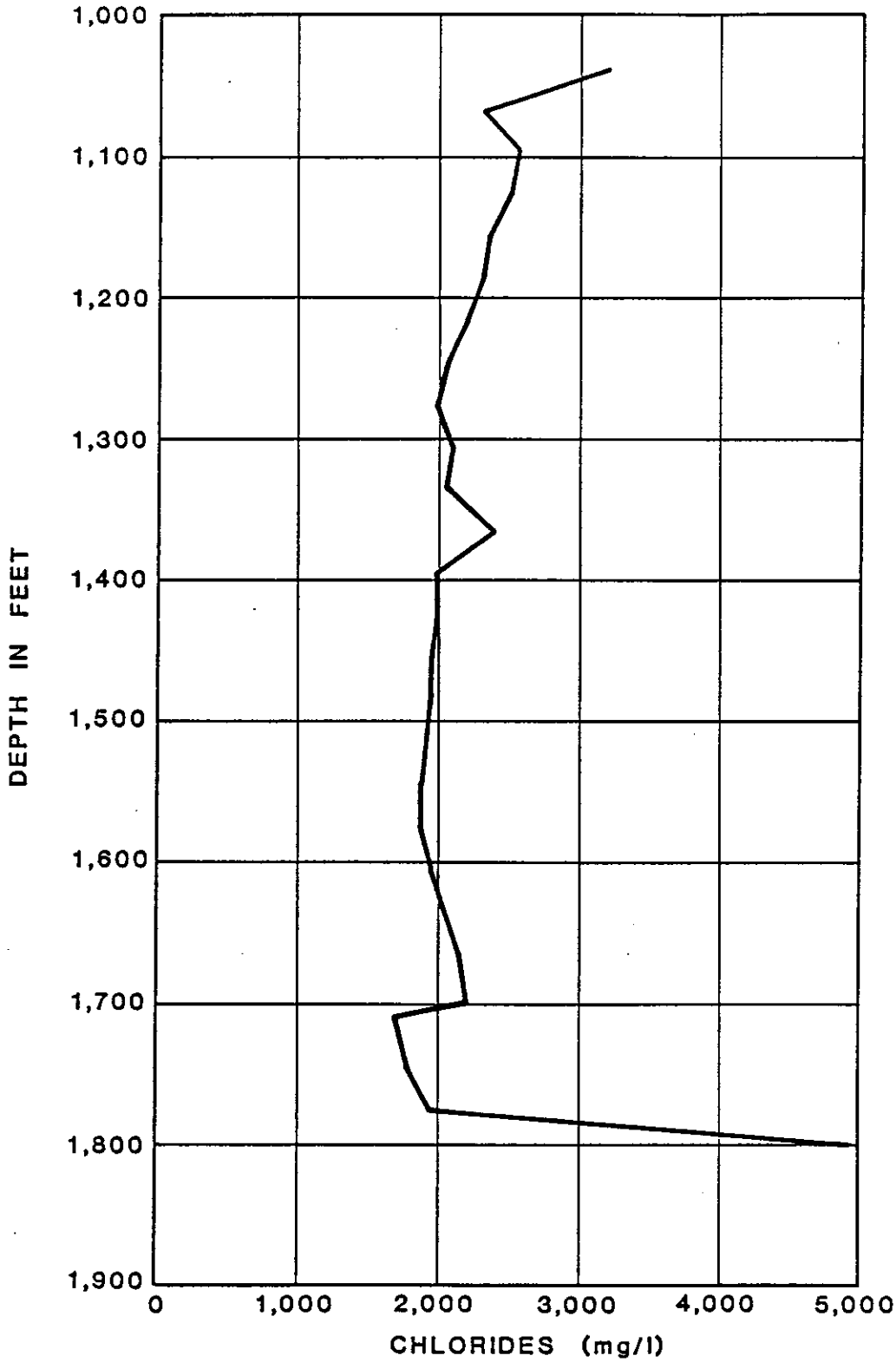

FIGURE 3-3

Water Quality While Drilling
(Open Circulation)
The Multi-Zone Monitor Well At
Palm Beach County System No. 9

sampler while the well was backflowing. It appears that the lower monitor zone (Zone 2) intersects the desired 10,000-TDS interface. The field chloride and conductivity data for the injection, dual-zone and shallow site monitor wells, can be found in Appendix D.

HYDROLOGIC TESTING

An injection test was performed on the completed well for a period of eight hours. The test utilized the canal adjacent to the north end of the north plant of System No. 9 as a fresh water supply. A flowmeter with totalizing capabilities was installed in the pipeline to measure the flow rate and a 100-psi Heise gauge was installed on the wellhead to measure injection pressures. Initially the injection rate was maintained at approximately 4,500 gpm while running geophysical logs. Upon completion of the geophysical logging, the injection was stepped up at several intervals to a final injection rate of approximately 10,000 gpm. A maximum injection pressure of 35.2 psi at 10,000 gpm indicated a very transmissive injection zone. Table 3-2 summarizes the injection data from the various steps and the field data can be found in Appendix E.

The geophysical logs run during the injection test included flowmeter, temperature and fluid resistivity. The flowmeter log indicated that at a rate of approximately 4,500 gpm, 100 percent of the injected water was lost to the borehole by 2,900 feet in depth. Several minor fluid loss zones are present between 2,640 and 2,730 feet but the largest percentage (80 percent) of fluid exits the hole between 2,730 and 2,900 feet. The temperature and fluid resistivity logs also indicate an interface at 2,900 feet where both the temperature and fluid resistivity make sharp deflections to the left. This interface represents the loss of the warm, fresh water to the Boulder Zone and the cold salt waters

Table 3-2
INJECTION TEST DATA FOR INJECTION WELL AT
PALM BEACH COUNTY SYSTEM NO. 9

Step	Time Pumped	Approximate GPM (1,000 gal)	Stabilized PSI	Remarks
1	5 Hours	4.25 - 4.50	27.4	Low rate for geo-physical logging.
2	1 Hour	6.5 - 6.7	29.7	
3	1 Hour	8.3 - 8.5	32.6	
4	1 Hour	9.8 - 10.0	35.2	The injection test was completed after 8 hours.
			23.40	Stabilized recovery pressure after one hour.

Injection Test Performed 9/11 on the completed 24-inch Diameter Injection Well

of the Boulder Zone. The graphically produced logs in Figure 3-4 represent the data from those logs mentioned.

An additional detail seen in the temperature log of the Boulder Zone is the inverted temperature gradient. This inverted gradient represents a geologic anomaly found at the PBCWUD System No. 9 and at other southeast Florida injection wells. This anomaly is characterized by a decrease in temperature with depth from the lower Floridan aquifer to the Boulder Zone. This temperature decrease is caused by heat transfer from the waters in the Boulder Zone within the continental shelf to those in the Florida Straits, which near the bottom of the straits show temperatures of 40° to 45°F. At the Palm Beach County site, the bottom hole water temperature was measured at 61°F.

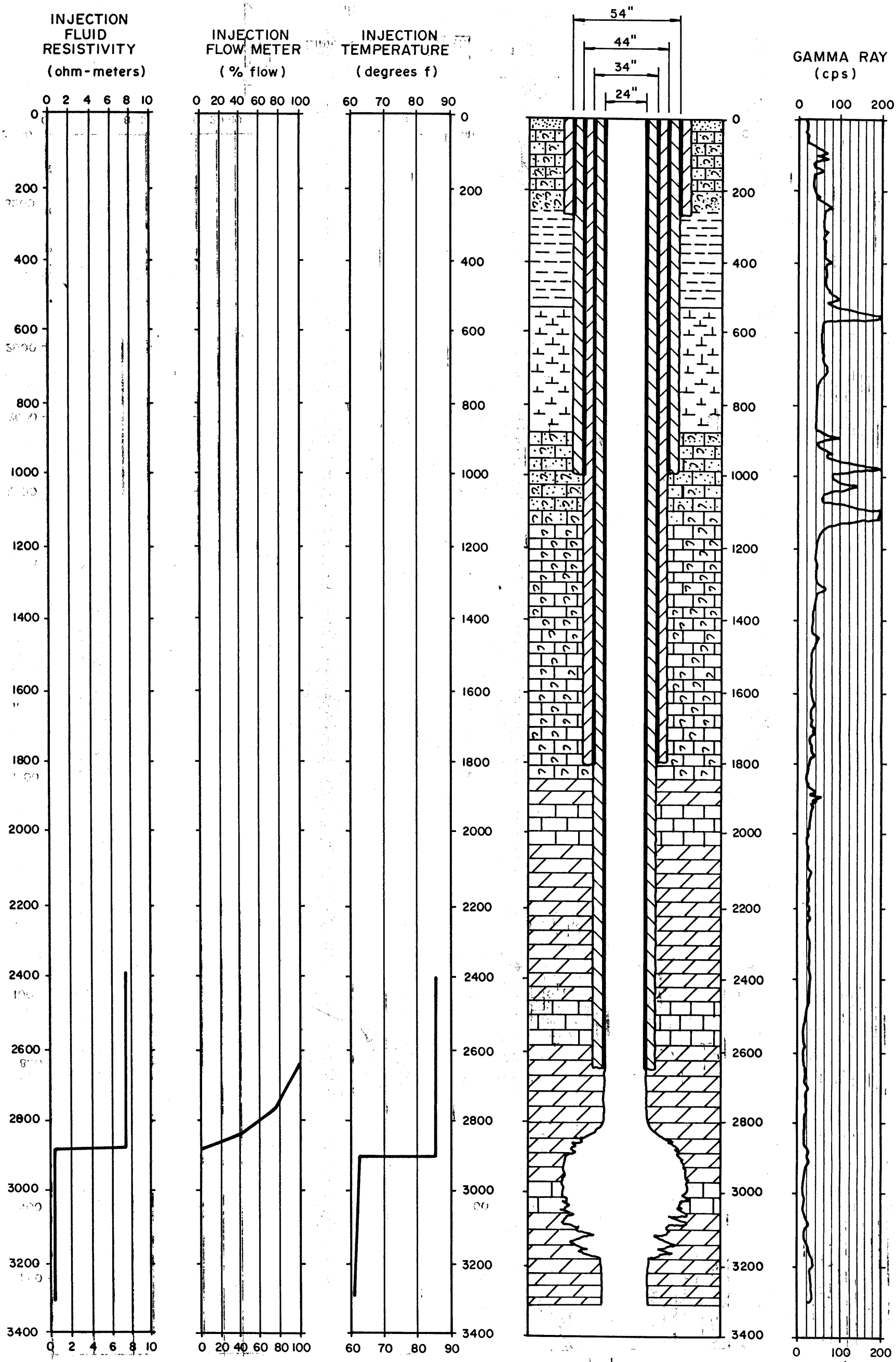

FIGURE 3-4
Summary Of Geophysical Logs Run
During Final Injection Test
At Palm Beach County System No. 9

CH2MHILL

Section 4
MONITORING PROGRAM

BACKGROUND DATA

Two types of background data were collected in conjunction with construction of the injection and monitor wells:

1. Weekly samplings from each of two existing surficial monitor wells located adjacent to the construction pad. These wells were sampled throughout the entire construction period.

2. Sampling of the dual-zone monitor well after completion of construction.

Samples from the two shallow monitor wells (MW No. 1 - 18.6 feet deep and MW No. 2 - 20.1 feet deep), were analyzed for conductivity and chlorides. These wells were used to monitor against any saltwater contamination that might result from the construction activities. Figure 4-1, a plot of the weekly chloride data, shows a low, relatively stable chloride background throughout the construction period.

Upon completion of the dual-zone monitor well, each monitor zone was developed for approximately 20 hours to remove drilling fluids and produce natural formation water. The two zones were then sampled and analyzed for the following parameters:

Na	pH
Sulfate	Temperature
Chlorides	Electric Conductance
Alkalinity	TDS
Fecal Coliform	TOC

Table 4-1 shows the analytical data from background water quality samples taken, from Zones 1 and 2 of the Floridan Aquifer Monitor Well, between 10/22/85 and 1/2/86.

Zone 1 (970 to 1105 feet) and Zone 2 (1699 to 1800 feet) analytical data indicates that the earlier samples were still affected by the drilling operation. Additional development was initiated and continued with further water quality samples also being taken. The final three sample periods (from 12/13/85 to 1/2/86) indicates relative stable water quality for each zone.

Zone 1 background pressures have been between 8.50 on 11/15/85 and 9.25 on 1/2/86 and Zone 2 pressures have been between 6.75 and 7.50 for the same dates. These differences are most likely attributed to the combined effects of the continued development of the monitor zones and seasonal variation in the water levels of the Floridan aquifer. Long term monitoring will better define the seasonal fluctuations for this system.

OPERATIONAL MONITORING

The parameters included in the operational monitoring program include: injection well flow rates and pressures, water quality of injected effluent and monitor well pressures and water quality. Table 4-2 details the recommended parameters, equipment, and frequency of sampling. A sampling and monitoring program is provided in the Operation and Maintenance Manual for this project.

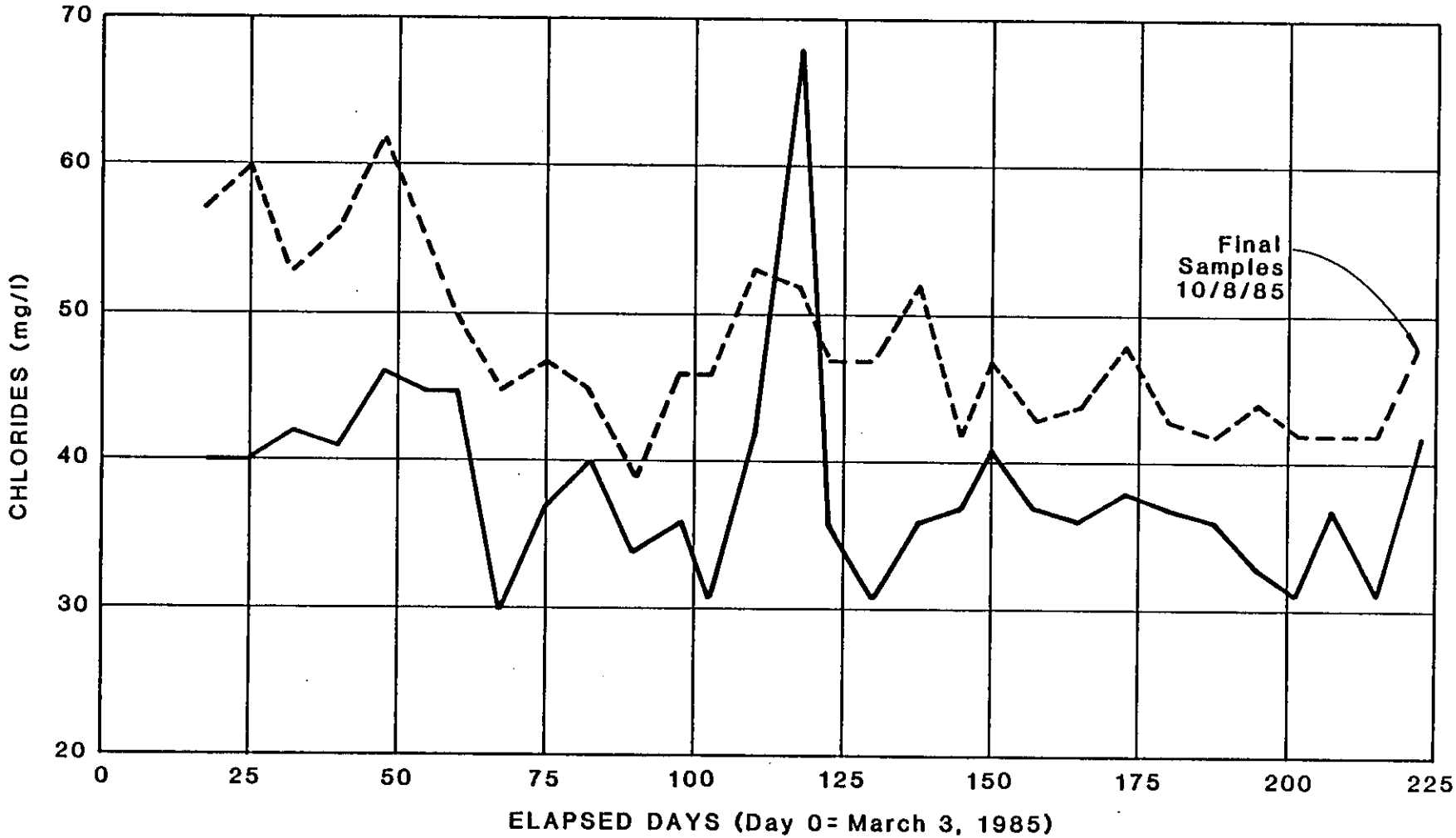

FIGURE 4-1

Chloride Concentration For Shallow Monitor Wells During Construction of Injection Well at Palm Beach County System No. 9

Table 4-1
Selected Water Quality Parameter
Background Sampling Program

Zone 1
16' Annulus - 970' to 1105'

Parameters	10/22	10/25	11/5	11/12	12/13	12/16	1/2	1/20
pH, pH Units	7.25	7.30	7.45	7.60	7.50	7.35	7.30	7.25
Total Alkalinity	131	80	103	110	108	124	128	147
Chlorides	3,760	13,300	17,290	15,680	2,720	2.260	1,520	2,980
Sp. Conductance	10,200	31,200	*525	*540	16,200	14,200	9,870	9,210
Sodium	1,922	8,570	6,020	5,200	2,850	2,430	1,490	1,620
Total Dissolved Solids	6,915	23,200	9,900	9,010	9,250	7,930	5,730	5,600
Sulfate	420	405	22,100	20,200	560	600	620	580
Total Organic Carbon	1.54	3.88	<1.00	18.9	1.55	3.57	2.23	3.50

Zone 2 - 1700' to 1800'	10/22	10/25	11/5	11/12	12/13	12/16	12/18	--
pH, pH Units	7.05	7.45	7.30	7.45	7.40	7.35	6.70	
Total Alkalinity	134	136	130	134	122	119	117	
Chlorides	4,850	3,760	6,316	6,330	2,450	2,500	2,020	
Sp. Conductance	12,200	10,100	*438	*370	14,700	15,400	15,000	
Sodium	2,580	1,961	1,790	1,840	2,270	2,340	2,370	
Total Dissolved Solids	9,000	7,350	3,660	3,760	8,830	9,050	8,880	
Sulfate	530	475	884	*8,890	560	540	560	
Total Organic Carbon	3.33	2.06	2.03	<1.00	<1.00	1.41	3.31	

*Data in question
Laboratory Analysis Sheets can be found in Appendix H

Table 4-2
RECOMMENDED OPERATIONAL MONITORING PROGRAM FOR INJECTION AND MONITORING WELLS AT PALM BEACH COUNTY SYSTEM NO. 9

Parameter	Equipment or Procedure	Frequency
Injection Flow Rate	12-inch diameter dial, circular chart, variable flow recorder, (0 to 15 mgd)	Continuous
Injection Pressure	12-inch diameter dial, circular chart, variable 3 pen pressure recorder (0 to 60 psi)	Continuous
Pressure in the Upper Monitoring Zone 1 (980'-1,105')	Same recorder used	Continuous
Pressure in the Lower Monitoring Zone 2 (1,699'-1,800')	Same recorder used	Continuous
Water Quality of Injected Fluid:		
Specific Conductance Chloride Concentration Suspended Solids Temperature	Sample at wellhead	Weekly
Water Quality of Upper and Lower Monitoring Zones:	Sample after flowing zones	Monthly
Specific Conductance Chloride Concentration Temperature Fecal Coliform BOD_5		
Specific Injectivity Test	As per O & M Manual	Quarterly
Mechanical Integrity Test		As specifed in Operating Permit

Section 5
SUMMARY

The construction project for Palm Beach County Water Utilities Department System No. 9 involved the modification of the effluent discharge systems of both the north and south plants. This work involved the construction of a 24-inch-diameter injection well, a dual-zone monitoring well, an injection well pump station, and a surge control system at the north plant. It also included an effluent transfer pump station at the south plant and a 24-inch-diameter effluent transfer line between the plants. Construction of the injection well commenced in March 1985 and was completed in October 1985; monitor well construction started in October and was completed in November of 1985.

The implementation of deep well injection will end the discharge of treated effluent to percolation ponds and lakes. Plans call for the treated effluent to be used for golf course irrigation and the injection well used to dispose of excess effluent, as soon as agreements can be formalized among the parties.

The effluent at PBCWUD System No. 9 will be injected into the "Boulder Zone", approximately 2,700 to 3,300 feet below land surface. The Boulder Zone at System No. 9 is a highly fractured dolomite that corresponds to similar intervals at other injection well locations in southeastern Florida.

The hydrologic testing performed indicate a very transmissive injection zone. Injection pressures during testing did not exceed 35.2 psi at the maximum injection rate of 10,000 gpm and would not exceed 40 psi at the design maximum rate of 10,500.

APPENDIX A

DER CONSTRUCTION PERMIT

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

SOUTHEAST FLORIDA
DISTRICT

P.O. BOX 3858
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33402-3858

PERMITTEE:
Mr. William A. Bryan, Administrator
Water Utilities Department
Post Office Box 16097
West Palm Beach, Florida 33402

I.D. NUMBER: 5050P50006
PERMIT/CERTIFICATION NUMBER: UC 50-092095
DATE OF ISSUE: February 25, 1985
EXPIRATION DATE: February 25, 1986
COUNTY: Palm Beach
LATITUDE/LONGITUDE: 26°23'33"N/80°12'12"W
SECTION/TOWNSHIP/RANGE:
PROJECT: Palm Beach County Class I Injection Well Construction and Testing Permit (System 9)

This permit is issued under the provisions of Chapter 403, Florida Statutes, and Florida Administrative Code Rule 17-28. The above named permittee is hereby authorized to perform the work or operate the facility shown on the application and approved drawing(s), plans, and other documents attached hereto or on file with Department and made a part hereof and specifically described as follows:

TO CONSTRUCT: One 24-inch Class I Test/Injection Well, 3,200 feet deep, with a monitoring well located a distance of approximately 100 feet east from the injection well. The well will be used for testing and future disposal of treated wastewater effluent and will have a maximum injection capacity of 10,500 GPM.

IN ACCORDANCE WITH: Application for Permit to Construct a Class I Injection Well System submitted to this agency on Department of Environmental Regulation Form 17-1.209(9) dated August 31, 1984, contract documents prepared by CH_2M Hill December 1982, as amended.

SUBJECT TO: General Conditions 1-15 and Specific Conditions 1-10.

DER Form 17-1.201(5)
Effective November 30, 1982

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

SOUTHEAST FLORIDA
DISTRICT

P.O. BOX 3858
3301 GUN CLUB ROAD
WEST PALM BEACH, FLORIDA 33402-3858

February 25 , 1985

Broward County
UC - Palm Beach County Class I
Injection Well Construction and
Testing Permit (System 9)

Mr. William A. Bryan, Administrator
Water Utilities Department
Post Office Box 16097
West Palm Beach, Florida 33402

Dear Mr. Bryan:

Attached is Permit No. UC 50-092095, to construct one 24-inch Test/Injection Wells. Should you object to the issuance of this permit or the specific conditions of the permit, you have a right to petition for a hearing pursuant to the provisions of Section 120.57, Florida Statutes. The petition must be filed within fourteen (14) days from receipt of this letter. The petition must comply with the requirements of Section 17-103.155 and Rule 28-5.201, Florida Administrative Code, (copies attached), and be filed pursuant to Rule 17-103.155(1) in the Office of General Counsel of the Department of Environmental Regulation at 2600 Blair Stone Road, Tallahassee, Florida 32301. Petitions which are not filed in accordance with the above provisions are subject to dismissal by the Department. In the event a formal hearing is conducted pursuant to Section 120.57(1), all parties shall have an opportunity to respond, to present evidence and argument on all issues involved, to conduct cross-examination of witnesses and submit rebuttal evidence, to submit proposed findings of facts and orders, to file exceptions to any order or hearing officer's recommended order, and to be represented by counsel. If an informal hearing is requested, the agency, in accordance with its rules of procedure, will provide affected persons or parties or their counsel an opportunity, at a convenient time and place, to present to the agency or hearing officer, written or oral evidence in opposition to the agency's action or refusal to act, or a written statement challenging the grounds upon which the agency has chosen to justify its action or inaction, pursuant to Section 120.57(2), Florida Statutes.

Sincerely,

John A. Guidry, Chairman
UIC Technical Advisory Committee

cc: DER, Tallahassee, ATTN: Groundwater
SFWMD, ATTN: Resource Control
PBCHD, ATTN: Groundwater
USEPA Region IV, ATTN: Groundwater
CH_2M Hill, ATTN: Dr. Garcia

JAG:my/5

Enclosure

DER Form 17-1.201(7)
Effective June 1, 1984

RULES OF THE ADMINISTRATIVE COMMISSION
MODEL RULES OF PROCEDURE
CHAPTER 28-5
DECISION DETERMINING SUBSTANTIAL INTERESTS

PART II
FORMAL PROCEEDINGS

28-5.201 Initiation of Formal Proceedings.

(1) Initiation of formal proceedings shall be made by petition to the agency responsible for rendering final agency action. The term petition as used herein includes any application or other document which expresses a request for formal proceedings. Each petition should be printed, typewritten or otherwise duplicated in legible form on white paper of standard legal size. Unless printed, the impression shall be on one side of the paper only and lines shall be double-spaced and indented.

(2) All petitions filed under these rules should contain:

(a) The name and address of each agency affected and each agency's file or identification number, if known;

(b) The name and address of the petitioner or petitioners, and an explanation of how his/her substantial interests will be affected by the agency determination;

(c) A statement of when and how petitioner received notice of the agency decision or intent to render a decision;

(d) A statement of all disputed issues of material fact. If there are none, the petition must so indicate;

(e) A concise statement of the ultimate facts alleged, as well as the rules and statutes which entitle the petitioner to relief;

(f) A demand for relief to which the petitioner deems himself entitled; and

(f) Other information which the petitioner contends is material.

****

A petition may be denied if the petitioner does not state adequately a material factual allegation, such as a substantial interest in the agency determination, or if the petition is untimely. (Section 28-5.201(3)(a), FAC)

DER Form 17-1.201(7)
Effective November 30, 1982

PERMITTEE:

I.D. Number:
Permit/Certification Number:
Date of Issue:
Expiration Date:

GENERAL CONDITIONS:

1. The terms, conditions, requirements, limitations, and restrictions set forth herein are "Permit Conditions" and as such are binding upon the permittee and enforceable pursuant to the authority of Sections 403.161, 403.727, or 403.859 through 403.861, Florida Statutes. The permittee is hereby placed on notice that the department will review this permit periodically and may initiate enforcement action for any violation of the "Permit Conditions" by the permittee, its agents, employees, servants or representatives.

2. This permit is valid only for the specific processes and operations applied for and indicated in the approved drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit may constitute grounds for revocation and enforcement action by the department.

3. As provided in Subsections 403.087(6) and 403.722(5), Florida Statutes, the issuance of this permit does not convey any vested rights or any exclusive privileges. Nor does it authorize any injury to public or private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations. This permit does not constitute a waiver of or approval of any other department permit that may be required for other aspects of the total project which are not addressed in the permit.

4. This permit conveys no title to land or water, does not constitute state recognition or acknowledgement of title, and does not constitute authority for the use of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the state. Only the Trustees of the Internal Improvement Trust Fund may express state opinion as to title.

5. This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, nt or aquatic life or property and penalties therefor caused by the construction or operation of this permitted rce, nor does it allow the permittee to cause pollution in contravention of Florida Statutes and department .ies, unless specifically authorized by an order from the department.

6. The permittee shall at all times properly operate and maintain the facility and systems of treatment and control (and related appurtenances) that are installed or used by the permittee to achieve compliance with the conditions of this permit, as required by department rules. This provision includes the operation of backup or auxiliary facilities or similar systems when necessary to achieve compliance with the conditions of the permit and when required by department rules.

7. The permittee, by accepting this permit, specifically agrees to allow authorized department personnel, upon presentation of credentials or other documents as may be required by law, access to the premises, at reasonable times, where the permitted activity is located or conducted for the purpose of:

   a. Having access to and copying any records that must be kept under the conditions of the permit;

   b. Inspecting the facility, equipment, practices, or operations regulated or required under this permit; and

   c. Sampling or monitoring any substances or parameters at any location reasonably necessary to assure compliance with this permit or department rules.

   Reasonable time may depend on the nature of the concern being investigated.

8. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately notify and provide the department with the following information:

   a. a description of and cause of non-compliance; and

b. the period of noncompliance, including exact dates and times; or, if not corrected, the anticipated time the non-compliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the non-compliance.

The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the department for penalties or revocation of this permit.

9. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source, which are submitted to the department, may be used by the department as evidence in any enforcement case arising under the Florida Statutes or department rules, except where such use is proscribed by Sections 403.73 and 403.111, Florida Statutes.

10. The permittee agrees to comply with changes in department rules and Florida Statutes after a reasonable time for compliance, provided however, the permittee does not waive any other rights granted by Florida Statutes or department rules.

11. This permit is transferable only upon department approval in accordance with Florida Administrative Code Rules 17-4.12 and 17-30.30, as applicable. The permittee shall be liable for any non-compliance of the permitted activity until the transfer is approved by the department.

12. This permit is required to be kept at the work site of the permitted activity during the entire period of construction or operation.

13. This permit also constitutes:

( ) Determination of Best Available Control Technology (BACT)
( ) Determination of Prevention of Significant Deterioration (PSD)
( ) Certification of Compliance with State Water Quality Standards (Section 401, PL 92-500)
( ) Compliance with New Source Performance Standards

14. The permittee shall comply with the following monitoring and record keeping requirements:

a. Upon request, the permittee shall furnish all records and plans required under department rules. The retention period for all records will be extended automatically, unless otherwise stipulated by the department, during the course of any unresolved enforcement action.

b. The permittee shall retain at the facility or other location designated by this permit records of all monitoring information (including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation), copies of all reports required by this permit, and records of all data used to complete the application for this permit. The time period of retention shall be at least three years from the date of the sample, measurement, report or application unless otherwise specified by department rule.

c. Records of monitoring information shall include:

- the date, exact place, and time of sampling or measurements;
- the person responsible for performing the sampling or measurements;
- the date(s) analyses were performed;
- the person responsible for performing the analyses;
- the analytical techniques or methods used; and
- the results of such analyses.

15. When requested by the department, the permittee shall within a reasonable time furnish any information required by law which is needed to determine compliance with the permit. If the permittee becomes aware that relevant facts were not submitted or were incorrect in the permit application or in any report to the department, such facts or information shall be submitted or corrected promptly.

PERMITTEE:
Mr. William A. Bryan,
Administrator

I.D. Number: 5050P50006
Permit/Certification Number: UC 50-092095
Date of Issue: February 25, 1985
Expiration Date: February 25, 1986

SPECIFIC CONDITIONS:

1. This permit approval is based upon evaluation of the data contained in the application and the plans and specifications submitted in support of the application. Any changes in the plans and technical specifications, except as provided elsewhere in this permit, must be approved by the Department before being implemented.

2. This project shall be closely monitored by the Department with the assistance of the Technical Advisory Committee consisting of professional representatives of the following agencies:

Department of Environmental Regulation, Tallahassee and West Palm Beach, Florida;
U.S. Environmental Protection Agency, Atlanta, Georgia;
South Florida Water Management District, West Palm Beach, Florida;
Palm Beach County Health Department, West Palm Beach, Florida.

These agencies shall be provided copies of all correspondence relative to this permit and the project and, unless specifically designated otherwise, all agencies shall be provided copies of all reports, schedules, analyses, geophysical logs, surveys, video television surveys, test reports and progress reports required by the Department in this permit and/or the specifications. Unclear copies of geophysical logs or the video television surveys will not be accepted by the agencies.

3. During the construction period allowed by this permit daily progress reports shall be submitted to the Department and the Technical Advisory Committee each week. The reporting period shall run Friday through Thursday and reports shall be mailed Friday of each week. The report shall include but is not limited to the following:

A. Description of daily footage drilled by diameter of bit or size of hole opener or reamer being used;
B. Description of formation and depth encountered;
C. Notification of collection of drill cuttings every ten (10) feet or at every change in formation;
D. Description of any construction problems that develop and their status;
E. Detailed description of the standard deviation survey when performed.

4. The cementing program shall be submitted by the engineer at least fifteen (15) days prior to the date the cementing is scheduled and approval must be received before cementing begins. The format for the estimate shall be submitted at the first scheduled meeting with the TAC.

PERMITTEE:
Mr. William A. Bryan,
Administrator

I.D. Number: 5050P50006
Permit/Certification Number: UC 50-092095
Date of Issue: February 25, 1985
Expiration Date: February 25, 1986

SPECIFIC CONDITIONS CONTINUED:

5. The permittee and/or the engineer shall schedule progress review meetings with the TAC for the purpose of reviewing the results of tests, geophysical logging, drilling records, and construction problems. The initial meeting will be held prior to construction start-up but after the contractor has been selected. Scheduling of future meetings shall be scheduled for the purpose of selecting final setting depths for the 34" and 24" casings.

6. A professional engineer, registered pursuant to Chapter 471, Florida Statutes (F.S.) must be retained throughout the construction period. On-site monitoring of the construction operation shall be provided by a professional engineer or qualified geologist. The Department must be notified immediately of any change in engineer or geologist.

7. If any problems develop that may seriously hinder compliance with this permit, construction progress or good construction practice the Department shall be notified immediately. The Department may require a written report describing in detail what problems have occurred, the remedial measures applied to assure compliance and the measures taken to prevent recurrence of the problem.

8. After completion of construction a final report shall be submitted to the Department and the TAC. The report shall document and discuss all testing results, chemical and physical analyses of water samples, geophysical logs, and the results of pressure monitoring. To the extent possible the transmissivity of the injection zone and the maximum capacity within safe and economical pressure limits, shall be estimated.

9. The Department shall require operational testing demonstrating that the well can absorb the design and peak daily flows that are expected over the next five years, prior to granting approval for operation of the well.

PERMITTEE:
Mr. William A. Bryan,
Administrator

I.D. Number: 5050P50006
Permit/Certification Number: UC 50-092095
Date of Issue: February 25, 1985
Expiration Date: February 25, 1986

SPECIFIC CONDITIONS:

10. During this construction period the permittee shall prepare or shall have the engineer prepare an operation and maintenance manual including emergency procedures for the use of operations, maintenance personnel, technicians, laboratory personnel and others, as appropriate. The manual shall include but is not limited to:

A. Instructions for the safe and reliable operation of the injection system.

B. Description and/or drawings of the basic engineering design of the continuous flow measuring/monitoring equipment.

C. Sampling and monitoring procedures.

D. Emergency procedures for handling abnormal events.

E. Shut down and start up procedures.

F. Preventive maintenance schedule.

G. Schedules and procedures for calibration of monitoring instruments.

H. Standardized test procedures for performing the specific injectivity test.

Issued this 25th day of February, 1985

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

Roy M Duke

Roy M. Duke
District Manager

JAG

DER Form 17-1.201(5)
Effective November 30, 1982

APPENDIX B

TAC MEETING SUMMARIES

SUMMARY OF MEETING

DATE:	November 19, 1984
SUBJECT:	Palm Beach County System 9 (N) DIW Review of Contract Specifications
LOCATION:	Department of Environmental Regulation 3301 Gun Club Road West Palm Beach, Florida
ATTENDING:	John Guidry/DER West Palm Beach Richard Deuerling/DER Tallahassee Paul Feldman/DER West Palm Beach Woody Board/DER West Palm Beach Leslie Wedderburn/SFWMD David Butler/SFWMD Fred Meyer/USGS Miami Lawton McCall/PBCWUD West Palm Beach J.I. Garcia-Bengochea/CH2M HILL Gainesville Phil Waller/CH2M HILL Tampa Jerry Foess/CH2M HILL Boca Raton Thomas McCormick/CH2M HILL Boca Raton
COPY TO:	Frank Garguilo/PBC Health Department
PROJECT NO.:	FC18009.A0
PREPARED BY:	Thomas M. McCormick

The meeting was opened at 1:30 P.M. by John Guidry with a request for more detail on the pump station proposed for construction at the North Plant.

Tom McCormick replied that both the pump station and monitoring instrumentation for the injection well were included in the Contract being prepared for the construction of the pipeline interconnect between the North and South Plants. The data that had been forwarded to DER was in the form of an in-house technical memorandum. Detailed plan sheets for the pump station and the monitoring instrumentation are close

to completion and will be presented for review within the week.

David Butler requested clarification of the proposed water reuse aspect of the project.

Dr. Garcia-Bengochea reviewed the pertinent aspects of the reuse project including golf course irrigation, the wetlands recharge project, continuation of the use of the current percolation ponds at the South Plant, and use of the existing Century Village lakes system at the North Plant.

Leslie Wedderburn noted the requirement for provisions for both emergency and temporary discharge systems and asked how these requirements would be met following completion of the construction of the deep well.

The question was related to a possible catastrophic failure of the deep well injection system at the North Plant. In the unlikely event of such an occurrence the operators will have several options available.

At the North Plant, the three 1.2 MG temporary storage tanks will provide immediate emergency storage. In addition, the existing Century Village lakes system is to remain in service and could serve as either an emergency or a temporary discharge system for treated effluent from the plant. Once the wetlands project is in service, the North Plant operators will have the option of increasing the flow to the wetlands or diverting flow south to the golf course irrigation systems.

Operators at the South Plant will be able to utilize the existing percolation ponds as both emergency or temporary discharge systems. The South Plant will also have the option of increasing flow to golf course irrigation systems and the wetlands reuse project.

All parties agreed that the question of both temporary and emergency discharge systems appeared to be adequately addressed by the multiple options available to the operators.

The TAC then addressed a list of comments submitted by David Butler (copy attached).

1. The subject of shallow aquifer monitor wells was discussed and it was determined that the two existing shallow aquifer monitors will be sufficient. Background data will be gathered and then daily monitoring of the wells will commence with the arrival of bulk salt at the site, or with the first penetration of formations containing brackish waters.

2. There are no known water supply wells in the immediate vicinity of the drilling project, but the points raised are addressed in the Contract Documents.

3. The question of the use of salt for head control during the setting of the surface casing was discussed. It was noted that the contract specifications called for mud drilling to a depth of

1000 feet, and that under the conditions likely to be encountered, the use of salt would be unnecessary. It was agreed that the use of salt as weight material would be restricted to those formations below 1000 feet in depth.

4. The proposed 200 foot depth for the surface casing was questioned. Tom McCormick pointed out that the 200 foot depth was given as an approximate number for bidding purposes and that the actual setting depth of the casing would be determined from litho samples and geophysical data gathered during the drilling of the pilot hole. The actual setting depth for this casing on the Margate Well IW-2 was 230 feet, with the base of the Biscayne Aquifer appearing at 210 feet at that location. Leslie Wedderburn said that he felt that the 200 feet depth was inadequate and that the bottom of the Shallow Aquifer could be substantially deeper at this location. CH2M HILL agreed to insert 300 feet in the Contract Documents as the approximate number to be used for bidding purposes. The actual setting depth for the casing will be based on the data gathered during drilling of the pilot hole, and the casing will be set at least 20 feet into the top of the confining bed.

5. The Contract Documents do require a one-hour pressure test at 100 psi for the final casing string.

6. This question cannot adequately be addressed under currently accepted drilling standards. The air reverse method of drilling specified for this contract is the most accurate, practical method currently available for securing representative water quality samples, but as long as salt is used as a weight control material there can be no guarantee that the weighted cap is not decaying and mixing with the formation waters being samples. Past experience has shown this method to be of sufficient accuracy to positively identify regions of differing water quality.

7. The water quality parameters will be recorded as requested with the exception of sodium. Sodium is being deleted due to the difficulty of performing accurate field analysis.

8. It is CH2M HILL standard procedure to request a temporary use permit from SFWMD before commencing an injection test.

9. The issue of temporary discharge is addressed in the notes above.

Following resolution of the points raised by SFWMD, Dr. Garcia-Bengochea thanked David Butler for his comments and proceeded to explain CH2M HILL's reasons for structuring the proposal with three alternate formats for the monitoring system. The primary purpose is to gather cost data so that

the Engineer may make an accurate relative value recommendation to the Palm Beach County Water Utility Department.

Fred Meyer asked if the proposed Resident Observer schedule of 10 hours per day meant that CH2M HILL would man the site only 10 hours a day, and questioned the rest of the TAC committee about their intended requirement of 24-hour per day observation.

Tom McCormick stated that while CH2M HILL's schedule called for 10 hours of resident observation per day, the actual practice is that during any critical stage of operations, the project representative is on site around the clock. During normal drilling operations the project representative is at the site 10 hours a day and on call nearby for the remaining 14 hours.

After discussion, the members of the TAC committee agreed that the proposed resident observer schedule would be acceptable for this project.

The meeting on Palm Beach County System 9 (N) was adjourned at 3:15 P.M.

SUMMARY OF MEETING

CH2M HILL

DATE: September 20, 1985

LOCATION: Department of Environmental Regulation
3301 Gun Club Road
West Palm Beach, Florida

SUBJECT: Meeting, 1:30 P.M. September 19, 1985
Palm Beach County System 9 (N)
Deep Injection Well and Proposed Water Reclamation System
Discussion of DER Operating Permit Requirements

ATTENDING: Lawton McCall/PBC Water Utilities Department
James Shamblin/PBC Water Utilities Department
Kim Hanes/PBC Water Utilities Department
Woody Board/DER, West Palm Beach
Al Mueller/DER, West Palm Beach
Thomas M. McCormick/CH2M HILL, Deerfield Beach
Stephen Riley/CH2M HILL, Deerfield Beach

COPIES TO: Thomas Thornton/PBC Water Utilities Department
J.I. Garcia-Bengochea/CH2M HILL, Gainesville
Jerry Foess/CH2M HILL, Deerfield Beach

PROJECT NO.: FC18009.B2

PREPARED BY: Tom McCormick/CH2M HILL, Deerfield Beach

The meeting was called to clarify the permitting requirements of DER with regard to the System 9 treatment plants.

At the start of the meeting, Roy Duke entered and briefly commented that the paperwork procedure at the end of the project is to be as follows:

1. Certification of the Engineer of Record of the Completion of Construction in Accordance with the Plans and Specifications of the Injection Well and Monitor Well.

2. Certification of the Engineer of Record of the Completion of Construction in Accordance with the Plans and Specifications of the Effluent Pumping and Transmission System.

3. Three months for data collection on the injection system.

4. Operating permit application submittals.

Lawton McCall asked DER how many operating permits would be required.

After discussion, Woody Board determined that three operating permits would be required, one for each plant, and one for the injection system. Fees for the permits are $100 each for the plant operating permits, and $800 for the injection well operating permit.

The following points were addressed in the discussion:

The System 9 (S) plant operating permit is to include the effluent transfer line to the discharge point at the System 9 (N) plant injection pump station wet well.

The System 9 (S) plant is to produce only a high-level secondary effluent (filtration and high-level disinfection), meeting or exceeding the DER standards for slow rate land application.

At the System 9 (S) plant the existing percolation ponds are to be allowed to dry for maintenance purposes. The pond system is to remain on stand-by status as the plant emergency discharge system. No modifications to the existing effluent pumps at the System 9 (S) plant are proposed. In the event of a shut-down of either the injection well system or the new effluent transfer system, high-level secondary effluent will be pumped by the existing effluent pumps to the percolation ponds.

At this time no reduction in treatment level is proposed under any of the operating scenarios at the System 9 (S) plant.

The System 9 (S) plant operator will be on-call on a 24-hour basis, but the plant is to be manned in accordance with the current schedule calling for 16 hours per day.

Control of the effluent distribution system will be centered in the Operator's room at the System 9 (N) plant. Distribution points along the effluent transmission main will be equipped with valves controlled by remote telemetry.

The System 9 (N) plant is to be manned by an operator on a 24-hour basis. In the event of a shut-down of the injection well or the injection pump station, the North plant operator will notify the South plant operator by telephone or radio. If the shut-down occurs when there is no operator on shift at the South plant, the North plant operator will ensure that 'on-call' personnel check the South plant emergency discharge functions.

The System 9 (N) plant will have the option of producing either secondary effluent for injection into the well, high-level secondary effluent for reuse by spray irrigation, or discharge to the existing lake system.

Until the reuse of effluent for spray irrigation commences, the high-level secondary effluent from the effluent transfer line will be mixed with the secondary effluent from the System 9 (N) plant and disposed of by injection.

At the System 9 (N) plant, discharge to the existing lake system is to occur only when the injection well system cannot be utilized. Discharge to the lake system through the filters can occur only when the flow to the injection pump station wet well is valved off. To provide further assurance that inadvertent discharge to the lake system does not occur, the influent valves on the filters can be closed.

The System 9 (N) plant operating permit is to address operations scenarios and procedures for effluent disposal.

The injection well operating permit is to address functions of the injection well from the injection station wet well to the injection zone.

Irrigation water for the System 9 (N) yard will be drawn from the new effluent transfer line.

Total Suspended Solids (TSS) monitoring of high-level secondary effluent will be required for both plants. The preferred method is through the use of automatic turbidity measuring equipment. Turbidity values can be correlated to TSS values by running lab tests. The requirements for monitoring and sampling of effluent quality is to be addressed in the reuse plan currently being prepared.

An effluent flow diagram is to be prepared showing the effluent disposal options for each plant.

Text on operation and maintenance of the new effluent pumping and transmission systems will be incorporated into the Injection Well O&M Manual.

Certification of Completion of the new pumping systems can be delivered up to 30 days after the system is placed in operation. This allows time to debug the system.

SUMMARY OF MEETING

CH2MHILL

DATE: August 23, 1985

LOCATION: Department of Environmental Regulation
3301 Gun Club Road
West Palm Beach, Florida

SUBJECT: Meeting, 1:30 P.M., August 22, 1985
Palm Beach County System 9 (N)
Deep Injection Well
Discussion of Job Progress and Consent Order Requirements

ATTENDING: Thomas Thornton/PBC Water Utilities Department
Lawton McCall/PBC Water Utilities Department
Roy Duke/DER, West Palm Beach
Richard Reese/DER, West Palm Beach
Eric Medina/DER, West Palm Beach
Paul Ezatoff/DER, Tallahassee
Thomas M. McCormick/CH2M HILL, Deerfield Beach
Gary Fries/CH2M HILL, Deerfield Beach

PROJECT NO.: FC18009.B2

COPIES TO: Robert Weisman/PBC Water Utilities Department
J.I. Garcia-Bengochea/CH2M HILL, Gainesville
Jerry Foess/CH2M HILL, Deerfield Beach

PREPARED BY: Tom McCormick/CH2M HILL, Deerfield Beach

Tom McCormick stated that the purpose of the meeting was to review the status of the Palm Beach County System 9 (N) Injection Well and to review and confirm for Tom Thornton DER's position with respect to the fines that are accruing under Amended COnsent Order 06C No. 83-0728.

Roy Duke reiterated DER's position that the key date to be met is the November 27th date noted in the revised Consent Order dated February 14, 1985. In order for the County to avoid imposition of the accrued fines, DER requires that a complete operating permit application for both the well and

the System (N) treatment plant be submitted on or before November 27, 1985.

Roy recommended that both the Engineer and the County meet with the appropriate representatives of DER to ascertain exactly what documentation would be required for the respective permit applications. It is his intent that the applications meet DER standards for completeness. If there is any delay in the presentation of documentation (a revised O&M manual was mentioned) that is to accompany the permit application, DER will make a decision concerning the completeness of the submittal.

Gary Fries advised DER that the delays on the drilling project were causing the Utility to accrue engineering costs in addition to the fines imposed by DER and that it was the intent of the Utility to recover those costs through the assessment of liquidated damages against the drilling contractor. It is important that DER recognize that the funds designated in the contract to defray accumulated fines will not be assessed against the contractor unless those fines are in fact assessed against the County.

Tom McCormick estimated that the contractor is approximately 6-weeks behind schedule at this time. The injection well should be complete by October 1, 1985 with the pump-station contractor able to initiate testing of his pumps by that date.

Roy inquired as to whether the contractor could place the monitor well rig on the drilling pad without moving the

Wilson. The size of the Wilson and the size of the drilling pad make this impossible. The contractor will have to demobilize the Wilson before starting construction of the monitor well. The monitor well rig will be arranged on the pad so that the pump-station contractor can gain access to the injection wellhead.

Cementing of the 24-inch casing is currently underway. There has been some difficulty cementing through 2365 feet in depth. This is the depth at which a 3-degree temperature shift was noted during pilot hole logging and there is some feature, either a fracture, a cavity, or flow which is absorbing cement. At this time 50 sacks of thixatropic cement have been placed yielding 6 feet of fill, and a second cement order has been issued for another 50 sacks of thixatropic cement proceeded by 50 sacks of 12% gel cement.

CH2M HILL

MEETING SUMMARY

SUBJECT:	TAC Meeting, 10:00 A.M., February 26, 1985 Palm Beach County System 9 (N) Deep Injection Well Preconstruction Meeting
DATE:	February 26, 1985
LOCATION:	Department of Environmental Regulation 3301 Gun Club Road West Palm Beach, Florida
PROJECT NO.:	FC18009.B2
ATTENDEES:	David Butler/SFWMD John A. Guidry/DER Scott Seyfried/DER Lawton McCall/PBCWUD John Olaynick/PBCWUD Tom McCormick/CH2M HILL Bill Rice/CH2M HILL Sean Skehan/CH2M HILL Ralph Palmer/Layne Atlantic Bill Neeley/Layne Atlantic Ralph Belfor/Glades of Boca Lago Joseph Vitelli/President of West Boca Council
PREPARED BY:	Sean T. Skehan/CH2M HILL

John Guidry, Chairman of the Technical Advisor Committee (TAC), opened the public hearing by distributing copies of the construction permit and requesting questions from the parties in attendance. Discussion was to be limited to the construction of the deep injection and monitoring wells. Layne-Atlantic when questioned about the disposal of salt water and formation cuttings stated that clean formation cuttings would be disposed of at the county land fill and or other DER approved locations. It was recommended to dispose of salt water at other deep injection well sites rather than disposal at Port Everglades. While drilling on reverse air and using salt in drilling fluids, an accurate account of the salt used and on site must be kept throughout the period of construction in the daily reports. Salt that is stored on site must be kept covered and on the pad at all time.

Joe Vitelli wondered if the deep injection well system would relieve the flooding of local community lakes during periods of excessive rainfall. In response, Tom McCormick said that the system would reduce the occurrence of overflow conditions as a result of diversion of plant effluent into the injection well. The diversion effluent will decrease the loading of lake system, however, flooding may still occur from natural causes during periods of excessive rainfall.

Ralph Belfor asked how the pipeline construction was going to coincide with the construction of the deep injection wells and Lawton McCall stated that projected completion dates are 8/29 for the injection and monitor wells, 9/29 for the pipeline, and 10/85 for over all completion. At this point there were no further questions and the public hearing was concluded.

Tom McCormick then opened the TAC meeting with an introduction of himself as the project manager and Sean Skehan and Bill Rice as Resident Geologists. Notice to proceed for site preparation was given 2/12, mobilization of equipment could proceed from 2/26. The pad construction was started on 2/12 and completion of mobilization is expected by 3/10.

John Guidry stated that there had been recent questions concerning the standardization of concrete drilling pads for deep injection wells. After some general discussion several items were brought up and generally agreed upon that control the construction of the pads. They are:

1. The pads should not be standardized because of the variability of drilling rigs in use in deep well construction. The design of the drilling pad should be tailored to the drilling rig to be used.

2. Permanent concrete pads are effective and necessary because they will provide a stable and durable working surface that also protects adjoining areas from potential contamination and are available for future use when working on or around the well. Other materials such as asphalt or plastic liners are more susceptible to damage during the construction process.

The construction schedule as proposed by Layne Atlantic dates that deep injection well construction will proceed as follows:

Set 54" casing	3/24
Set 44" casing	4/14
Set 34" casing	5/5
Set 24" casing	6/2
Testing	6/30
Complete	7/14

Monitor Well

Set 24" casing	8/4
Set 16" casing	8/18
Set 6" casing	8/25
Complete	8/29

The TAC meetings are to be held prior to the settings of the 34" and 24" casing on the deep injection well and prior to setting the 6" casing on the monitor well. The TAC requests that the geophysical logs be submitted at least one week before the TAC meetings to allow time for review.

The wells are to be drilled in accordance with the AWWA drilling standards. Mud circulation will be used while drilling through the unconsolidated formations, approximately 1000 feet in depth. Air reverse circulation will be used below 1000 feet. Sure Shot deviation surveys will be taken every 90 feet while drilling and a continual plot of the results will be made. In the event that a elevation survey shows a deviation from true vertical of greater than one degree, the Contractor will correct the condition and rerun the survey.

David Butler questioned whether a sure shot device would detect a cumulative deviation.

Tom McCormick replied that the sure shot tool would indeed detect a cumulative deviation from true vertical. When run, the device aligns itself within the drill collar above the bit assembly and an internal plumb bob compares the alignment of the tool and by inference the alignment of the drill collar, to true vertical.

John Guidry noted that on a recent drilling project a question had arisen about the tracking of the pilot hole and that the

driller requested the use of an innovative method for determining a "wipe-out" of the pilot hole. This method involves the filling of the pilot hole with a black sand and monitoring the cutting returns. Should the sand not appear in the cuttings, then it would be assumed that the pilot hole had deviated from the reamed bore.

The meeting continued with a review of the drilling procedures to be followed by Layne-Atlantic. Reaming is to be done with staged bits, the lead bit being the same size as or smaller than the pilot bit.

Salt will be used to control artesian flow zones while drilling and a blowout preventer will be installed on the wellhead while drilling below the 1000 feet depth. The casings will be installed, at the engineers discretion, to the approximate depths stated in the specifications. Dowell Schlumberger will be Layne-Atlantic's cementing subcontractor and while cementing, Layne will maintain 100 psi on the well head. This pressure will be maintained constant during the cement set times, (approximately 8 hours).

Geophysical logging will be performed by CH2M HILL.

CH2M HILL will submit a weekly construction report to the TAC members and establish a weekly sampling program on the two existing shallow monitor wells. The two shallow monitor wells are to be protected by Layne so that they are not damaged during construction.

Layne will use sound control blankets to reduce equipment noise. Ralph Palmer did note that while running casing the brakes on the rig would be noisy and such noise is very hard to reduce. Joseph Vitelli thought that most of the homeowners would not object but that the people closest to the lake would be impacted most by the noise. He invited Tom McCormick to attend a West Boca Council meeting to be held on the second Wednesday in May to advise residents on the progress of construction.

No other items were brought before the TAC committee for discussion and the meeting was adjourned at 11:45 A.M.

SUMMARY OF MEETING

CH2M HILL

DATE:	July 12, 1985
LOCATION:	Department of Environmental Regulation 3301 Gun Club Road West Palm Beach, Florida
SUBJECT:	TAC Meeting, 1:00 P.M., July 9, 1985 Palm Beach County System 9 (N) Deep Injection Well Report on Preliminary Injection Test and Selection of Setting Depth for 24-inch Casing
ATTENDING:	Lawton McCall/PBC Water Utilities Department Roy Duke/DER, West Palm Beach Scott Seyfried/DER, West Palm Beach Richard Deuerling, Jr./DER, Tallahassee Patrick G. Smith/DER, Tallahassee David Sample/EPA-Region IV Ron Lane/PBC Health Department David Butler/SFWMD Michael L. Merritt/USGS, Miami Jerry Foess/CH2M HILL, Deerfield Beach William Neely/Layne-Atlantic, Orlando Ralph Palmer/Layne-Atlantic, Orlando
COPIES:	Robert Weisman/PBC Water Utilities Department Leslie Wedderburn/SFWMD, West Palm Beach J.I. Garcia-Bengochea/CH2M HILL, Gainesville
PROJECT NO.:	FC18009.B2
PREPARED BY:	Tom McCormick/CH2M HILL, Deerfield Beach

Roy Duke called the meeting to order at 1:00 P.M.

Tom McCormick commented on the number of new members attending the meeting and introductions were made around the table.

The meeting then commenced with an invitation for comments or questions concerning the Summary from the previous meeting on February 26, 1985. There were no comments and Tom McCormick noted that a meeting of the Technical Advisory Committee had been proposed for the selection of the setting depth for the 34-inch casing, but as there had been no deviation from the proposed setting depth of 1800 feet,

John Guidry, TAC Chairman at that time, had decided that the matter could be handled by phone.

Mike Merritt questioned the selection of the 1800 foot setting depth and its relationship to the 10,000 TDS depth in the Floridan Aquifer. He noted that the accuracy of the conductivity and chloride measurements made on the drilling fluid samples was obscured by the Contractor's practice of adding salt to the drilling fluid.

Tom McCormick agreed that the data was indeed affected by the salts, and that the 10,000-TDS interface had not yet been positively identified at this site. He explained that there is a bit of a catch-22 in the drilling process. Given the sensitivity of the Surficial Aquifer and the restrictions upon disposal of drilling fluids, the well cannot be drilled with open circulation. The 1800-foot depth was selected as being well below the 10,000-TDS interface based upon a consideration of the water quality data, geophysical logging performed on the pilot hole, consideration of data from other wells in the area, and a knowledge of the general hydrology of the Floridan Aquifer.

Mike Merritt asked if it would be possible to drill with open circulation and store the fluids onsite for re-injection at a later date. Tom McCormick pointed out that the quantity of the fluids made this impractical and that the artesian nature of the Floridan Aquifer could quickly overwhelm any given storage capacity.

Roy Duke stated that this was a problem recognized by the TAC Committee and that unless there was disposal source available for the developed fluids, it was accepted practice to drill the injection well on closed circuit using salt as weight material for artesian flow control. Accurate identification of the 10,000-TDS interface was normally made during the drilling of the monitor well, when the developed fluids can be disposed by injection into the completed injection well.

It was also noted that the 34-inch diameter casing is a work casing installed primarily to allow the Contractor to complete the injection well to the injection zone without having to deal with the artesian flows of the Floridan Aquifer. Both the 34-inch and 24-inch casings are fully cemented, and upon

completion of the well the integrity of the confining zones is fully restored.

Richard Deuerling asked what depth was proposed for the lower monitor zone of the monitor well. Tom McCormick replied that a depth of 1650 feet had been proposed based on prior experience, but that the actual depth of the monitor zones would be determined during the drilling of the monitor well. Richard Deuerling stated that it is the intention of DER that the lower monitor zone be below the 10,000-TDS interface.

Tom McCormick then reviewed the current status of the project. The Contractor is approximately 3-weeks behind his proposed construction schedule due to the extremely hard drilling encountered and the difficulty experienced in retrieving core samples.

Eleven coring attempts have produced a good quantity of cored material, but only five of the attempts produced sections suitable for vertical permeability testing utilizing the standard testing machines. CH2M HILL is investigating other options for testing the smaller sections.

Representative core samples were made available for inspection by TAC members.

Core sections will be tested for vertical permeability, horizontal permeability and total porosity.

A casing setting depth of between 2630 and 2640 was recommended for the 24-inch diameter casing. This places the final casing 20 to 30 feet into the calcitic dolomite underlying the lower aquitard, the tan biomicritic limestone occurring between 2480 and 2620 feet below land surface.

The TAC Committee approved the proposed setting depth pending confirmation of the low transmissivity of the lower aquitard during the injection test scheduled for Friday.

Mike Merritt questioned the proposed injection testing technique and asked if it would be possible to install a plug above the injection zone before starting the test, and thereby gather more accurate data about the relative transmissivities of the confining beds. Tom McCormick agreed that more accurate data on the lower Floridan Aquifer could

be gathered in such a test, but the expense of installing a plug and running such a test could easily exceed $50,000 and that given the time constraints facing this Contractor, such a requirement would not be appropriate on this project.

Roy Duke commented that information of that kind is normally gathered by packer testing of discrete zones, and that several packer tests have been run with the results available in the literature. Such testing had not been proposed on this project but might be considered as a requirement on other projects if the need for information was substantial.

There was further discussion of the Contractor's completion schedule and Roy Duke stated that the completion schedule outlined in the consent order was still in force. Penalties will continue to be assessed but will not be imposed if construction is completed within the time frame detailed within the amended consent order.

Tom McCormick asked for clarification on DER's concept of "completion" of the well. Roy Duke said that the intent of the consent order was to bring a halt to discharge violations, and that when the well began receiving effluent and the discharge violations were corrected for both North and South plants, that would be the point at which he considered the construction complete and the requirements of the consent order fulfilled. Delays in purely administrative functions, such as the application and receipt of the operating permit would not result in the imposition of fines.

The meeting was then adjourned.

APPENDIX C

LITHOLOGIC LOGS

INJECTION WELL

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION
WELL COMPLETION REPORT

TYPE OF WORK: [X] New Construction [ ] Repair [ ] Deepening [ ] Plugging [ ] Other:

PERMIT NUMBER: UC 50-092095

WELL NUMBER: WEST PALM BEACH #1

TYPE OF WELL: [ ] Water Well [ ] Test Well [ ] Recharge [ ] Drainage [X] Waste Disposal [ ] Observation [ ] Other

USE: [ ] Domestic [ ] Irrigation [ ] Industrial [ ] Livestock [ ] Public Supply [X] Other: DISPOSAL OF TREATED EFFLUENT

OWNER: PALM BEACH COUNTY
Last Name / First Name / Initial
P O BOX 1609
Number / Street
WEST PALM BEACH FLORIDA
City / State
305 [ ] [ ] [ ] [ ] 33402
Area Code / Phone Number / Zip Code

WELL LOCATION:
¼ ¼ ¼ of Section [ ]
[ ] [ ] (N-S) [ ] [ ] (E-W)
Township / Range
Latitude 26 Deg. 43 Min. 33 Sec. N
Longitude 80 Deg. 12 Min. 12 Sec. W
Locate in Section

SYSTEM 9
Number / Street/Road
STATE ROAD 7
Lot No. / Subdivision
WEST OF BOCA RATON PALM BEACH
City / County

OWNER WELL NUMBER OR NAME: WEST #1

DRILL METHOD: [X] Rotary [ ] Cable Tool [ ] Jet [ ] Auger [ ] Other:

SKETCH LOCATION OF WELL in relation to local landmarks, giving distance and direction from nearest town, road, or other reference point.

North ↑

(SEE ATTACHED MAPS)

SHEET 1 OF 4

GEOPHYSICAL LOGS: Type: VARIOUS By: Schlumberger

SURFACE CASING, CASING, AND LINER MATERIAL:

Steel Dia. (In.) Black	Galv.	S. Steel	Steel Wt. (lb./ft.)	Dia. (In.) PVC	Other†	From (Ft.)	To (Ft.)	Schedule No.	Joints*
54			286			0	250		W
44			232			0	970		W

† Describe Material:
* TC = Threaded and Coupled, TCW = Threaded, Coupled, and Welded, W = Welded, B = Bonded (PVC), O = Other:

GROUT: [ ] None [ ] Neat Cement [ ] Other:

Type and Percent of Additives and Grout Volume or Number of 94 lb. Sacks

	From (Ft.)	To (Ft.)
460 SACKS 12% JEL, 242 SK NEAT	0	250
1,701 " " " , 265 " "	0	970

FINISH: [ ] Open Hole [ ] Perforated or Slotted Casing [ ] Gravel Pack [ ] Sandpoint or Screen Attached to Well Casing [ ] Sandpoint or Screen Telescoped with Packer Inside Casing (Packer Material:)

Sandpoint/Screen Material	Dia. (In.)	Slot Size (In.)	From (Ft.)	To (Ft.)

[ ] Other Finish:

QUALITY TEST: [ ] None [ ] Bacteria ____ Date [ ] Chemical ____ Date
By: [ ] Health Dept. [ ] USGS [ ] Other
[ ] Clear [ ] Colored [ ] Sulphur [ ] Salty [ ] Iron [ ] Other
Conductance (Micromhos) [ ] [ ] [ ] [ ] [ ] Chloride [ ] [ ] [ ] ppm
Hardness [ ] [ ] [ ] [ ] ppm as calcium carbonate pH [ ] [ ] Temp [ ] [ ] °F
Well Disinfected: [ ] No [ ] Yes (Date)

WELL TEST, by: [ ] Natural Flow [ ] [ ] [ ] [ ] G.P.M. [ ] Airlift
[ ] Bailer [ ] Permanent Pump [ ] Test Pump [ ] None
Discharge Measured By: [ ] Bailer [ ] Estimated [ ] Current Meter
[ ] Orifice [ ] Trajectory [ ] Venturi [ ] Volumetric [ ] Other

Measured Static Water Level [ ] + [ ] - [ ] [ ] [ ] Ft.
Measured Pumping Water Level [ ] + [ ] - [ ] [ ] [ ] Ft.
After [ ] [ ] [ ] Hours At [ ] [ ] [ ] [ ] G.P.M.
Specific Capacity [ ] [ ] [ ] [ ] G.P.M./Ft. of Drawdown
Measuring Pt. (Describe):
Which is [ ] [ ] [ ] Ft. [ ] Above [ ] Below Land Surface
Elevation of Measuring Pt. = [ ] [ ] [ ] Ft. [ ] Above [ ] Below MSL

WELL EQUIPMENT: [ ] Open [ ] Capped [ ] Valved [ ] Permanent Pump [ ] Temporary Pump
Type Pump: [ ] Centrifugal [ ] Cylinder [ ] Jet [ ] Submersible [ ] Turbine [ ] Other:
Power: [ ] Diesel [ ] Electric [ ] Gasoline [ ] Other:
Horsepower [ ] [ ] [ ] [ ] Capacity [ ] [ ] [ ] [ ] [ ] G.P.M.
Intake/Injection Depth [ ] [ ] [ ] [ ] Ft.

WELL LOG

Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.

Bore Hole (In.)	Casing Size (In.)	Depth (Ft.) From	To	
60	54	0	10	NO SAMPLE
"	"	10	20	SANDSTONE & SHELL BEDS
"	"	20	30	YELLOW TO GRAY SANDSTONE
"	"	30	40	SAME
"	"	40	50	SANDSTONE & SHELL BEDS
"	"	50	80	SANDSTONE, CALCAREOUS CEMENT
"	"	80	160	SANDSTONE, GRAY & BLK SPECS
"	"	160	190	SANDSTONE, YELLOWISH GRAY
"	"	190	200	CLAYEY SANDSTONE
"	"	200	210	SAME, WITH SHELL BED
"	"	210	230	SANDY CLAY, LIGHT OLIVE GR
"	"	230	240	SAME, SHELL BED NEAR BASE
"	"	240	250	CLAY, GR. OLIVE, PLASTIC.
52	AA	250	280	SAME
"	"	280	380	CLAY, GR. OLIVE PLASTIC, STICKY
"	"	380	400	SANDSTONE, GRAY, PHOSPHATIC
"	"	400	450	GR. CLAY, PLASTIC, STICKY
"	"	450	460	SANDSTONE, GRAY
"	"	460	690	GR. OLIVE CLAY
"	"	690	730	CLAY, SANDY, YELLOW GRAY
"	"	730	740	SILTSTONE/SHELL BEDS.
"	"	740	750	SAME
"	"	750	810	YELLOWISH GRAY CLAY
"	"	810	930	CLAY, PALE OLIVE, CHALK
"	"	930	970	" " FOSSILIFEROUS, SHELLS
CONTINUED →				CONTINUE →

Total Depth [ ] [ ] [ ] [ ] Ft. Producing Zone Material: [ ] Sand [ ] Shell [ ] Broken Shell [ ] Limestone [ ] Other:
Top of Producing Zone [ ] [ ] [ ] [ ] Ft., Bottom of Producing Zone [ ] [ ] [ ] [ ] Ft.
[ ] Drill Cuttings Sent to Bureau of Geology

[ ] [ ] [ ]
License No. / Contractor Signature / Position
Completion Date [ ] [ ] [ ] [ ] [ ] [ ] / Driller Signature

DER Form PERM 13-10 (Oct 77)

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

WELL COMPLETION REPORT

TYPE OF WORK: [X] New Construction [ ] Repair [ ] Deepening [ ] Plugging [ ] Other:

PERMIT NUMBER: UC 50 - 092095

WELL NUMBER: INJECTION #1

TYPE OF WELL: [ ] Water Well [ ] Test Well [ ] Recharge [ ] Drainage [X] Waste Disposal [ ] Observation [ ] Other

USE: [ ] Domestic [ ] Irrigation [ ] Industrial [ ] Livestock [ ] Public Supply [ ] Other:

OWNER: Last Name | First Name | Initial

Number | Street

City | State

Area Code | Phone Number | Zip Code

WELL LOCATION: ¼ ¼ ¼ of Section

Township [N-S] Range [E-W]

Latitude Deg. Min. Sec. N

Longitude Deg. Min. Sec. W

Locate in Section

Number | Street/Road

Lot No. | Subdivision

City | County

SKETCH LOCATION OF WELL in relation to local landmarks, giving distance and direction from nearest town, road, or other reference point.

North

OWNER WELL NUMBER OR NAME:

DRILL METHOD: [ ] Rotary [ ] Cable Tool [ ] Jet [ ] Auger [ ] Other:

SURFACE CASING, CASING, AND LINER MATERIAL:

Steel Dia. (In.) Black	Galv.	S. Steel	Steel Wt. (lb./ft.)	Dia. (In.) PVC	Other†	From (Ft.)	To (Ft.)	Schedule No.	Joints*
24			179			0	1801		W

† Describe Material:

* TC = Threaded and Coupled, TCW = Threaded, Coupled, and Welded, W = Welded, B = Bonded (PVC), O = Other:

GROUT: [ ] None [ ] Neat Cement [ ] Other:

Type and Percent of Additives and Grout Volume or Number of 94 lb. Sacks

	From (Ft.)	To (Ft.)
208 SACKS 12% Jel, 523 SKS NEAT	0	1801

FINISH: [ ] Open Hole [ ] Perforated or Slotted Casing [ ] Gravel Pack [ ] Sandpoint or Screen Attached to Well Casing [ ] Sandpoint or Screen Telescoped with Packer Inside Casing (Packer Material:)

Sandpoint/Screen Material	Dia. (In.)	Slot Size (In.)	From (Ft.)	To (Ft.)

[ ] Other Finish:

QUALITY TEST: [ ] None [ ] Bacteria Date [ ] Chemical Date

By: [ ] Health Dept. [ ] USGS [ ] Other

[ ] Clear [ ] Colored [ ] Sulphur [ ] Salty [ ] Iron [ ] Other

Conductance (Micromhos) Chloride ppm

Hardness ppm as calcium carbonate pH Temp °F

Well Disinfected: [ ] No [ ] Yes (Date)

WELL TEST, by: [ ] Natural Flow G.P.M. [ ] Airlift [ ] Bailer [ ] Permanent Pump [ ] Test Pump [ ] None

Discharge Measured By: [ ] Bailer [ ] Estimated [ ] Current Meter [ ] Orifice [ ] Trajectory [ ] Venturi [ ] Volumetric [ ] Other

Measured Static Water Level + - Ft.

Measured Pumping Water Level + - Ft.

After Hours At G.P.M.

Specific Capacity G.P.M./Ft. of Drawdown

Measuring Pt. (Describe):

Which is Ft. [ ] Above [ ] Below Land Surface

Elevation of Measuring Pt. = Ft. [ ] Above [ ] Below MSL

WELL EQUIPMENT: [ ] Open [ ] Capped [ ] Valved [ ] Permanent Pump [ ] Temporary Pump

Type Pump: [ ] Centrifugal [ ] Cylinder [ ] Jet [ ] Submersible [ ] Turbine [ ] Other:

Power: [ ] Diesel [ ] Electric [ ] Gasoline [ ] Other:

Horsepower Capacity G.P.M.

Intake/Injection Depth Ft.

DER Form PERM 13-10 (Oct 77)

SHEET 2 OF 4

GEOPHYSICAL LOGS: Type: By:

WELL LOG

Bore Hole (In.)	Casing Size (In.)	Depth (Ft.) From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
42	34	970	1020	Sandy Limestone olive Gray
"	"	1020	1090	SAME, White & Gray
"	"	1090	1190	yellow, Gray Sandy Limest
"	"	1190	1260	White Limestone
"	"	1260	1500	yellowish gray Limestone
"	"	1500	1510	AS ABOVE with Dolomite
"	"	1510	1520	Dolomite, hard, pale yellow
"	"	1520	1540	SOFT to hard Limestone
"	"	1540	1560	hard, dark Dolomite
"	"	1560	1620	yellow gray Limestone with dolo
"	"	1620	1630	AS ABOVE but no Dolomite
"	"	1630	1650	yellow gn. LS. & dolomite
"	"	1650	1660	as above, but no dolomite
"	"	1660	1670	yellow gray Limestone
"	"	1670	1680	Light Gray Limestone
"	"	1680	1700	pale orange crumbly LS.
"	"	1700	1710	chalky white Limestone
"	"	1710	1730	yellowish gray Limestone
"	"	1730	1740	AS ABOVE, but sticky clay like
"	"	1740	1770	medium Gray Limestone
"	"	1770	1790	white chalky Limestone
"	"	1790	1801	yellow gray Fine Lime
32	24	1801	1850	yellow gray Lime, Fossils
"	"	1850	1870	AS ABOVE
"	"	1870	1891	Dolomite, TAN & BROWN
CONTINUED				CONTINUED

Total Depth Ft. Producing Zone Material: [ ] Sand [ ] Shell [ ] Broken Shell [ ] Limestone [ ] Other:

Top of Producing Zone Ft., Bottom of Producing Zone Ft.

[ ] Drill Cuttings Sent to Bureau of Geology

License No. Contractor Signature Position

Completion Date Driller Signature

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

WELL COMPLETION REPORT

TYPE OF WORK: [X] New Construction [ ] Repair [ ] Deepening [ ] Plugging [ ] Other:

PERMIT NUMBER: UC-50-09 2095

WELL NUMBER: IW JEC T F W #1

TYPE OF WELL: [ ] Water Well [ ] Test Well [ ] Recharge [ ] Drainage [ ] Waste Disposal [ ] Observation [ ] Other

USE: [ ] Domestic [ ] Irrigation [ ] Industrial [ ] Livestock [ ] Public Supply [ ] Other:

OWNER: Last Name / First Name / Initial

Number / Street

City / State

Area Code / Phone Number / Zip Code

WELL LOCATION:

¼ ¼ ¼ of Section

Township (N-S) Range (E-W)

Latitude Deg. Min. Sec. N

Longitude Deg. Min. Sec. W

Locate in Section

Number / Street/Road

Lot No. / Subdivision

City / County

OWNER WELL NUMBER OR NAME:

DRILL METHOD: [ ] Rotary [ ] Cable Tool [ ] Jet [ ] Auger [ ] Other:

SURFACE CASING, CASING, AND LINER MATERIAL:

Steel Dia. (In.) Black	Galv.	S. Steel	Steel Wt. (lb./ft.)	Dia. (In.) PVC	Other†	From (Ft.)	To (Ft.)	Schedule No.	Joints*
24			125.49			0	2640		W

† Describe Material:

* TC = Threaded and Coupled, TCW = Threaded, Coupled, and Welded, W = Welded, B = Bonded (PVC), O = Other:

GROUT: [ ] None [ ] Neat Cement [ ] Other:

Type and Percent of Additives and Grout Volume or Number of 94 lb. Sacks

	From (Ft.)	To (Ft.)
704 SACKS NEAT 583 SACKS 2%		
1884 SACKS 4% 40:30:12% 250 4th hr.	0	2640

FINISH: [ ] Open Hole [ ] Perforated or Slotted Casing [ ] Gravel Pack [ ] Sandpoint or Screen Attached to Well Casing [ ] Sandpoint or Screen Telescoped with Packer Inside Casing (Packer Material:)

Sandpoint/Screen Material	Dia. (In.)	Slot Size (In.)	From (Ft.)	To (Ft.)

[ ] Other Finish:

QUALITY TEST: [ ] None [ ] Bacteria Date [ ] Chemical Date

By: [ ] Health Dept. [ ] USGS [ ] Other

[ ] Clear [ ] Colored [ ] Sulphur [ ] Salty [ ] Iron [ ] Other

Conductance (Micromhos) Chloride ppm

Hardness ppm as calcium carbonate pH Temp °F

Well Disinfected: [ ] No [ ] Yes (Date)

WELL TEST, by: [ ] Natural Flow G.P.M. [ ] Airlift [ ] Bailer [ ] Permanent Pump [ ] Test Pump [ ] None

Discharge Measured By: [ ] Bailer [ ] Estimated [ ] Current Meter [ ] Orifice [ ] Trajectory [ ] Venturi [ ] Volumetric [ ] Other

Measured Static Water Level + - Ft.

Measured Pumping Water Level + - Ft.

After Hours At G.P.M.

Specific Capacity G.P.M./Ft. of Drawdown

Measuring Pt. (Describe):

Which is Ft. [ ] Above [ ] Below Land Surface

Elevation of Measuring Pt. = Ft. [ ] Above [ ] Below MSL

WELL EQUIPMENT: [ ] Open [ ] Capped [ ] Valved [ ] Permanent Pump [ ] Temporary Pump

Type Pump: [ ] Centrifugal [ ] Cylinder [ ] Jet [ ] Submersible [ ] Turbine [ ] Other:

Power: [ ] Diesel [ ] Electric [ ] Gasoline [ ] Other:

Horsepower Capacity G.P.M.

Intake/Injection Depth Ft.

DER Form PERM 13-10 (Oct 77)

SKETCH LOCATION OF WELL in relation to local landmarks, giving distance and direction from nearest town, road, or other reference point.

North ↑

SHEET 3 OF 4

GEOPHYSICAL LOGS: Type: By:

WELL LOG

Bore Hole (In.)	Casing Size (In.)	Depth (Ft.) From	To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
32	24	1891	1901	(Cored) Dolomite & Lime
"	"	1901	1910	Pale Orange L.S. & Dolomite
"	"	1910	1920	NO SAMPLE
"	"	1920	1990	Dolomite & Dolomitic Limestone
"	"	1990	2040	PINK & TAN Dolomitic Lime
"	"	2040	2090	DARK BROWN Dolomite
"	"	2090	2190	yellow to gray Limestone
"	"	2190	2200	HARD yellow gray Limestone
"	"	2200	2280	HARD Calcitic Dolomite
"	"	2280	2350	Calcitic Dolomite, yellow & Gray
"	"	2350	2360	Dolomite, Blk & Brown
"	"	2360	2380	calcitic dolomite, pale yellow
"	"	2380	2390	yellow gray Limestone
"	"	2390	2440	crystalline dolomite YELLO BROWN
"	"	2440	2520	dolomitic Limestone, brownish
"	"	2520	2580	Pale orange Limestone
"	"	2580	2610	AS ABOVE
"	"	2610	2690	yellowish brown dolomite
22	—	2640	2900	AS ABOVE
"		2900	2930	AS ABOVE
"		2930	2960	Pale Orange Lime & dolomite
"		2960	3000	HARD Light brown dolomite
"		3000	3010	SOFT Chalky Limestone
"		3010	3020	Med. Hd. TAN Dolomite
"		3025	3040	PALE ORANGE LIMESTONE
CONTINUED		—	CONTINUED	

Total Depth Ft. Producing Zone Material: [ ] Sand [ ] Shell [ ] Broken Shell [ ] Limestone [ ] Other:

Top of Producing Zone Ft., Bottom of Producing Zone Ft.

[ ] Drill Cuttings Sent to Bureau of Geology

License No. Contractor Signature Position

Completion Date Driller Signature

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

WELL COMPLETION REPORT

TYPE OF WORK: [X] New Construction [ ] Repair [ ] Deepening [ ] Plugging [ ] Other:

PERMIT NUMBER: IC-50-092095

WELL NUMBER MIECHLOWAY

TYPE OF WELL: [ ] Water Well [ ] Test Well [ ] Recharge [ ] Drainage [ ] Waste Disposal [ ] Observation [ ] Other

USE: [ ] Domestic [ ] Irrigation [ ] Industrial [ ] Livestock [ ] Public Supply [ ] Other:

OWNER: Last Name / First Name / Initial

Number / Street

City / State

Area Code / Phone Number / Zip Code

WELL LOCATION:

¼ ¼ ¼ of Section

Township (N-S) Range (E-W)

Latitude Deg. Min. Sec. N

Longitude Deg. Min. Sec. W

Locate in Section

Number / Street/Road

Lot No. / Subdivision

City / County

SKETCH LOCATION OF WELL in relation to local landmarks, giving distance and direction from nearest town, road, or other reference point.

North ↑

OWNER WELL NUMBER OR NAME:

DRILL METHOD: [ ] Rotary [ ] Cable Tool [ ] Jet [ ] Auger [ ] Other:

SURFACE CASING, CASING, AND LINER MATERIAL:

Steel Dia. (In.) Black	Steel Dia. (In.) Galv.	Steel Dia. (In.) S. Steel	Steel Wt. (lb./ft.)	Dia. (In.) PVC	Dia. (In.) Other†	From (Ft.)	To (Ft.)	Schedule No.	Joints*

† Describe Material:

* TC = Threaded and Coupled, TCW = Threaded, Coupled, and Welded, W = Welded, B = Bonded (PVC), O = Other:

GROUT: [ ] None [ ] Neat Cement [ ] Other:

Type and Percent of Additives and Grout Volume or Number of 94 lb. Sacks

	From (Ft.)	To (Ft.)

FINISH: [ ] Open Hole [ ] Perforated or Slotted Casing [ ] Gravel Pack [ ] Sandpoint or Screen Attached to Well Casing [ ] Sandpoint or Screen Telescoped with Packer Inside Casing (Packer Material:)

Sandpoint/Screen Material	Dia. (In.)	Slot Size (In.)	From (Ft.)	To (Ft.)

[ ] Other Finish:

QUALITY TEST: [ ] None [ ] Bacteria Date [ ] Chemical Date

By: [ ] Health Dept. [ ] USGS [ ] Other

[ ] Clear [ ] Colored [ ] Sulphur [ ] Salty [ ] Iron [ ] Other

Conductance (Micromhos) Chloride ppm

Hardness ppm as calcium carbonate pH Temp °F

Well Disinfected: [ ] No [ ] Yes (Date)

WELL TEST, by: [ ] Natural Flow G.P.M. [ ] Airlift [ ] Bailer [ ] Permanent Pump [ ] Test Pump [ ] None

Discharge Measured By: [ ] Bailer [ ] Estimated [ ] Current Meter [ ] Orifice [ ] Trajectory [ ] Venturi [ ] Volumetric [ ] Other

Measured Static Water Level + − Ft.

Measured Pumping Water Level + − Ft.

After Hours At G.P.M.

Specific Capacity G.P.M./Ft. of Drawdown

Measuring Pt. (Describe):

Which is Ft. [ ] Above [ ] Below Land Surface

Elevation of Measuring Pt. = Ft. [ ] Above [ ] Below MSL

WELL EQUIPMENT: [ ] Open [ ] Capped [ ] Valved [ ] Permanent Pump [ ] Temporary Pump

Type Pump: [ ] Centrifugal [ ] Cylinder [ ] Jet [ ] Submersible [ ] Turbine [ ] Other:

Power: [ ] Diesel [ ] Electric [ ] Gasoline [ ] Other:

Horsepower Capacity G.P.M.

Intake/Injection Depth Ft.

DER Form PERM 13-10 (Oct 77)

SHEET 4 OF 4

GEOPHYSICAL LOGS: Type: By:

WELL LOG

Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.

Bore Hole (In.)	Casing Size (In.)	Depth (Ft.) From	Depth (Ft.) To	
22	—	3040	3140	HARD DARK BROWN DOLOMITE
11		3140	3150	PALE CRANLE LIMESTONE
11		3150	3160	Pale yellowish Br. Dolomite
11		3160	3180	Lt. Gray + Black Dolomite
11		3180	3200	Lt. Pale yellowish Br. Dolomite
11		3200	3240	yellow to Brown Dolomite
11		3240	3070	Hd. Dk yellow Br, Dolomite
11		3070	3130	Hd. PALE BROWN DOLOMITE
11		3130	3140	DARK yellowish Br. Dolomite
11		3140	3150	Limestone part DOLOMETIZED
11		3150	3160	Dolomite + Pale Orange Lt.
11		3160	3180	Lt. Gray + Black Dolomite
11		3180	3200	Lt. BROWN Dolomite + Limestone
11		3200	3210	Dk. yellow Brown DOLOMITE
11		3210	3230	PALE BROWN DOLOMITE
11		3230	3260	HARD BROWN DOLOMITE
11		3260	3280	LT. BROWNISH GRAY DOLOMITE
11		3280	3290	HARD, BROWN & PINK DOLOMITE
11		3290	3300	HARD LT. BR. PALE DOLOMITE

Total Depth 3300 Ft. Producing Zone Material: [ ] Sand [ ] Shell [ ] Broken Shell [ ] Limestone [X] Other: DOLOMITE

Top of Producing Zone 2640 Ft., Bottom of Producing Zone 3300 Ft.

[ ] Drill Cuttings Sent to Bureau of Geology

2302 H. Christian DeLaigne - ATLANTIC Geologist
License No. / Contractor Signature / Position

12 / 79 M. SORDAN, S. UNDERWOOD
Completion Date / Driller Signature

R. CALLIN, PUSHER

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	OBSERVER's DESCRIPTION	INITIALS
3/23	0	10	No Sample	WJR
"	10	20	Coquina/calcareous sandstone 50/50, coquina mostly very pale orange (10 YR 8/2), sandstone yellowish gray (5 Y 7/2) fine	"
"	20	30	Coquina/ calcareous sandstone 50/50, sandstone lightly gray (N7) to yellowish gray (5 Y 7/2), very fine, coquina very pale orange	"
"	30	40	Calcareous sandstone 60%, light gray (N7) to yellowish gray (5 Y 7/2), very fine, poorly sorted, coquina 40% very pale orange (10 YR 8/2)	"
"	40	50	Calcareous sandstone 60%/coquina 40%, grayish orange (10 YR 7/4), sandstone very fine to fine grained, poorly Sorted	"
"	50	60	Same, except calcareous sandstone, fine - medium, grained	"
"	60	70	Calcareous sandstone 70%/coquina 30%, grayish orange (10 YR 7/4), sandstone very fine to course grained	"
"	70	80	Same	"
"	80	90	Calcareous sandstone, light gray (N7), fine to very course grained, grades into limestone on some pieces of sample, phosphatic	"
"	90	100	Sandy limestone, phosphatic, sand graines fine to coarse, light gray (N7), hard, shell fragments, black phosphatic particles.	"
"	100	110	Same	"
"	110	120	Same	
"	120	130	Calcareous sandstone, light gray (N7), fine to course grained, black phosphatic particles.	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
8/23	130	140	Calcareous sandstone, light gray (N7) to light olive gray (5 Y 5/2), interbeds of very pale orange (10 YR 8/2) to pale yellowish orange (10 YR 8/6) shell, fine grained sandstone	WJR
"	140	150	Same	"
"	150	160	Arenaceous limestone, phosphatic numerous shells, worm burrows, coral and barnacle fragments, yellowish gray (5 Y 7/2)	"
"	160	170	Same	"
"	170	180	Same	
"	180	190	Same	"
"	190	200	Calcareous clayey sandstone, yellowish gray (5 Y 7/2), fine grained, numerous shell fragments	"
"	200	210	Same	"
"	210	220	Calcareous clayey sandstone, light olive gray (5Y 5/2), fine grained, numerous shells	"
"	220	230	Sandy clay, light olive gray (5 Y 5/2)	"
"	230	240	Same, some shells	"
"	240	250	Clay, grayish olive, plastic, grayish olive (10 Y 4/2)	"
"	250	260	Same	"
"	260	270	Same	"
"	270	280	Same	"
'10	280	290	Same	"
"	290	300	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
4/10	300	310	Same	WJR
"	310	320	Same	"
"	320	330	Same	"
"	330	340	Same	"
"	340	350	Same	"
"	350	360	Same	"
"	360	370	Same	"
"	370	380	Same	"
"	380	390	Sandstone, light olive gray (10 Y 5/4), black phosphatic particles, shell fragments, fine grained	"
"	390	400	Same	"
"	400	410	Same	"
"	410	420	Clay, grayish olive (10 Y 4/2), plastic	"
"	420	430	Same	"
"	430	440	Clay, grayish olive (10 Y 4/2) with some interbeds of siltstone/mudstone light olive gray (5 Y 5/2)	"
"	440	450	Same with some shell fragments	"
"	450	460	Sandstone, light olive gray (5 Y 5/2), black phosphate particles, very fine to fine grained	
"	460	470	Clay, grayish olive green, (5 YR 3/2)	"
"	470	480	Same	"
"	480	490	Same with some shell fragments	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
4/10	490	500	Same	WJR
"	500	510	Same	"
"	510	520	Same	"
"	520	530	Same	"
"	530	540	Same	"
"	540	550	Same with some interbeds of mudstone, some shell fragments	"
"	550	560	Clay, grayish yellow green (5 GY 7/2) to grayish olive green (5 GY) with interbeds of calcareous siltstone	"
"	560	570	Same	"
"	570	580	Same with some black phosphate pebbles	"
"	580	590	Same	"
"	590	600	Same	"
"	600	610	Same	"
"	610	620	Same	"
"	620	630	Same	"
"	630	640	Same	"
"	640	650	Same	"
"	650	660	Same	"
"	660	670	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
4/10	670	680	Same	WJR
"	680	690	Same	"
"	690	700	Clay, sandy, yellowish gray (5 Y 7/2) small interbeds of calcareous mudstone/siltstone	"
"	700	710	Same	"
"	710	720	Same	"
"	720	730	Same	"
"	730	740	Siltstone with shell beds, yellowish gray (5 Y 7/2), calcareous, black phosphate particles	"
"	740	750	Same	"
"	750	760	Clay, yellowish gray (5 Y 7/2), silty, shell fragments	"
"	760	770	Clay, yellowish gray (5 Y 7/2), silty, shell fragments calcareous	"
"	770	780	Clay, calcareous, yellowish gray (5 Y 7/2) to pale olive (10 Y 6/2)	"
4/12	780	790	Same	"
"	790	800	Same	"
"	800	810	Same	"
"	810	820	Clay, calcareous pale olive (10 Y 6/2), with nodules of chart, dark grayish olive (10 Y 4/2) to white (N9)	
	820	830	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
4/12	830	840	Same	WJR
"	840	850	Same	"
"	850	860	Same	"
"	860	870	Same	"
"	870	880	Same	"
"	880	890	Same	"
"	890	900	Same	"
"	900	910	Same	"
"	910	920	Same	"
"	920	930	Clay, pale olive (10 Y 4/2), interbedded with fossilferous limestone, yellowish gray (5 Y 7/2), shell fragments	"
"	930	940	Same	"
"	940	950	Same	"
"	950	960	Same	"
5/9	960	970	Same	"
"	970	980	Arenaceous limestone, light olive gray (5 Y 5/2), contains very fine quartz sand and phosphate particles (tan brown & black) with some shell	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
5/9	980	990	Same	WJR
"	990	1000	Same	"
"	1000	1010	Same	"
"	1010	1020	Same	"
"	1020	1030	Arenaceous limestone, quartz and phosphatic sands (tan to black), very fine to course, subangular and rounded, fossil molds and some shell, worm tube casts, white (N9) to light olive gray (5 Y 6/1), crumbly	STS
"	1030	1040	Same	"
"	1040	1050	Same	"
"	1050	1060	Same	"
"	1060	1070	Same	"
"	1070	1080	Same	"
"	1080	1090	Same	"
"	1090	1100	Arenaceous limestone, quartz and phosphatic sands (tan to black) medium grained, well sorted, rounded, fossil shells and molds, mostly yellowish gray (5 Y 7/2) to light olive gray (5 Y 5/2), crumbly	"
"	1100	1110	As above but white (N9) to light olive gray (5 Y 5/2), fossils, bryzoans & shell fragments, echinoid spines	"
"	1110	1120	Grainstone, fine to coarse grained, rounded to angular, mostly quartz, sparse dark phosphatic grains, interbedded, shell fragments dark yellowish brown (10 YR 4/2) 10%, white 10% (N9), crumbly	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
5/10	1120	1130	Same	STS
"	1130	1140	Limestone, biomicritic, with some sparry replacement, yellowish gray (5 Y 7/2), loosely consolidated, crumbly, fossils: dictyconus	"
"	1140	1150	Same	"
"	1150	1160	Same	"
"	1160	1170	Same	"
	1170	1180	Same	"
"	1180	1190	Same	"
"	1190	1200	Limestone, biomicritic, well consolidated, hard, white (N-9), shell fragments	"
"	1200	1210	Same	"
"	1210	1220	Same	"
"	1220	1230	Same	"
"	1230	1240	Same	"
"	1240	1250	Same	"
"	1250	1260	Same	"
"	1260	1270	Limestone, biomicritic, some sparry replacement, yellowish gray (5 Y 7/2), loosely consolidated, crumbly, fossils: dictyconus, globergerina, sparse oolites; clayey matrix, very porous	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
5/11	1270	1280	Same	STS
"	1280	1290	Same	"
"	1290	1300	Same	"
"	1300	1310	Same	"
"	1310	1320	Same, oolites more abundant	"
"	1320	1330	Same	"
'	1330	1340	Limestone, biomicritic, some sparry replacement, yellowish gray (5 Y 7/2), primarily consolidated & crumbly, some hard streaks, microfossilan, dictyconus, oolites, clayey matrix & very porous	"
"	1340	1350	Same	"
"	1350	1360	Same	"
"	1360	1370	Same	"
"	1370	1380	Same	"
"	1380	1390	Same	"
"	1390	1400	Same	"
"	1400	1410	Same	"
"	1410	1420	Same	"
"	1420	1430	Same	"
"	1430	1440	Same	"
"	1440	1450	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
5/12	1450	1460	Same	STS
"	1460	1470	Same	"
"	1470	1480	Same	"
"	1480	1490	Same	"
"	1490	1500	Same	"
"	1500	1510	Same as above with a hard dolomite, pale yellowish brown (10 YR 6/2), fine grained	"
"	1510	1520	Dolomite, hard, fine grained, pale yellowish brown (10 Y 6/2)	"
"	1520	1530	Limestone, biomicritic, soft, microfossilan, yellowish gray (10 Y 6/2), with a hard limestone, pinkish gray (5 YR 8/1), very fine grained	"
"	1530	1540	Same	"
5/13	1540	1550	Dolomite, hard, fine crystalline structure, dark yellowish brown (10 YR 4/2)	"
"	1550	1560	Dolomite, hard, fine crystalline, grayish black (N2), carbonate matrix (very fine), some vugs, has some fossil remains that are white & chalky	"
"	1560	1570	Limestone, biomicritic, microfossilan, yellowish gray (5 Y 7/2), very porous, loosely consolidated, crumbly, interbedded with some dolomite, hard, pale yellowish brown (10 Y 6/2)	"
"	1570	1580	Same	"
"	1580	1590	Same	"
'	1590	1600	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
5/13	1600	1610	Same	STS
"	1610	1620	Same	"
"	1620	1630	Same as above but no dolomite	"
"	1630	1640	Same	"
"	1640	1650	Same	"
"	1650	1660	Same	WJR
'	1660	1670	Limestone, biomicritic, yellowish gray (5 Y 7/2), calcareous clay, light gray (N-7) to medium light gray (N6), fossils - dictyoconus	"
"	1670	1680	Limestone, biomicritic, medium light gray (N-6) to very light gray (N8), hard, vuggy, fossils-dictyoconus and foraminifera	"
"	1680	1690	Limestone, intramicritic, (Packstone), very pale orange (10 YR 8/6), soft, crumbly, fossils, dictyoconus, very fine calcilutite	"
"	1690	1700	Limestone, intramicritic-fossiliferous (Packstone), pale yellowish brown (10 YR 6/2), soft, crumbly, very fine calcilutite	"
"	1700	1710	Limestone, biomicritic (chalky), white (N-9) soft	"
5/17	1710	1720	Limestone, biomicritic, yellowish gray (5 Y 7/2), with a microcrystalline, intramicritic limestone, (Packstone), Fossils: Dictyoconus; Miliolio foraminifera	"
"	1720	1730	Same	"
"	1730	1740	Limestone, intramicritic, packed, fine grained, yellowish gray (5 Y 8/1), very soft	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
5/17	1740	1750	Limestone, micritic, pinkish gray (5 YR 8/1), very finely crystalline, hard with calcareous clay, yellowish gray (5 Y 7/2)	WJR
"	1750	1760	Limestone, biosparite, medium light gray (N6), fine grained, interparticle porosity; fossils: Dictyoconus, Miliolid foramanifera	"
"	1760	1770	Same	"
"	1770	1780	Limestone, biomicritic, white (N9), micro-crystalline hard, vuggy, chalky fossils: Dictyoconus	"
"	1780	1790	Same	"
"	1790	1800	Same	"
"	1800	1810	Same	"
"	1810	1820	Limestone, biomicritic, (Wackstone), yellowish gray (5 Y 7/2) fossils: Foraminifera & Dictyoconus	"
"	1820	1830	Same	"
"	1830	1840	Same	"
"	1840	1850	Same, with no Dictyoconus	"
6/6	1850	1860	Same, with no Dictyoconus	WJR
"	1860	1870	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/6	1870	1880	Dolomite, medium crystalline, moderate brown (5 Y 4/4)	WJR
"	1880	1890	Dolomite, fine to medium crystalline, moderate brown (5 YR 3/4), micritic limestone, very light gray (N8), soft	"
"	1890	1900	1891 - 1901 Cored. See Core Lithology Log	"
"	1900	1910	Limestone, biomicritic, very pale orange 10 YR 8/2, some dolomitization, fossils: Dictyoconus, coral fragments. Dolomite, medium crystalline, dark yellowish brown (10 YR 4/2)	"
"	1910	1920	No Sample	
"	1920	1930	Dolomitic limestone, fine-medium crystalline, vuggy, dark yellowish brown (10 YR 4/2), fossil casts	"
"	1930	1940	Dolomite, grayish brown (5 YR 3/2), finely crystalline, slightly vuggy	"
"	1940	1950	Dolomite, moderate brown (5 YR 3/4), very fine crystalline	"
"	1950	1960	Dolomite, brownish gray (5 YR 4/1), vuggy, vugs filled with light colored calcium carbonate, very finely crystalline	"
"	1960	1970	Dolomite, dark yellowish brown (10 YR 4/2), medium crystalline intercrystalline & vuggy porosity (20-30%). Vugs filled with light colored limestone, fossils: Dictyconus	"
"	1970	1980	Dolomite, dark yellowish brown (10 YR 4/2), fine to medium crystalline, vuggy porosity 10 - 15%	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/6	1980	1990	Limestone, biomicrite, pinkish gray (5 YR 8/1), soft, partially dolomitized, fossils: dictyconus; some soft dolomite, dark yellowish brown, (10 YR 4/2)	WJR
"	1990	2000	Same	"
"	2000	2010	Same	"
"	2010	2020	Dolomite, pale, yellowish brown (10 YR 6/2), very fine crystalline, very uniform, compact, very few vugs, dense	"
	2020	2030	Same	"
"	2030	2040	Same	"
"	2040	2050	Dolomite, dark yellowish brown (10 YR 4/2), finely crystalline, some vugs	"
"	2050	2060	Dolomite, hard, dark yellowish brown (10 YR 4/2); some limestone, yellowish gray (5 Y 8/1) with phosphate & quartz	"
"	2060	2070	Dolomite, dark yellowish brown (10 YR 4/2), very finely to finely crystalline, some vugs.	"
"	2070	2080	Same	"
"	2080	2090	Same	STS
"	2090	2100	Limestone, biomicrite, soft, yellowish gray (5 Y 8/1); with Dolomite, hard, medium to coarse crystalline, dark yellowish brown (10 YR 4/2)	"
"	2100	2110	Same	"
"	2110	2120	Calcitic dolomite, hard, very finely crystalline, some vugs, dark yellowish brown (10 YR 4/2)	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/6	2120	2130	Same	STS
"	2130	2140	Same	"
"	2140	2150	Same	"
"	2150	2160	Calcitic dolomite, hard, pale yellowish brown (10 YR 8/2), weak HCI response, some molded fossilization	"
"	2160	2170	Same	"
"	2170	2180	Same	"
"	2180	2190	Same	"
"	2190	2200	Limestone, hard, fossilized, yellowish gray (5 Y 7/2), vuggy to channeled porosity	"
"	2200	2210	Calcitic dolomite, hard, very finely crystalline, pale yellowish brown (10 YR 6/2), weak HCI response	"
"	2210	2220	Same	"
"	2220	2230	Calcitic dolomite, hard, fine crystalline, dark yellowish brown (10 YR 4/2), some vugs, weak HCI response	"
"	2230	2240	Same	"
"	2240	2250	Same	"
"	2250	2260	Same	"
"	2260	2270	Same	"
"	2270	2280	Same	"
'	2280	2290	Mudstone, medium light gray (N6), fine crystalline (medium calcilutite), soft	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

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DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/6	2290	2300	Limestone, dismicrite, very finely crystalline, hard, fractured and vuggy	WJR
"	2300	2310	Calcitic dolomite, dark yellowish brown (10 YR 4/2) to moderate brown (5 YR 2/4), fine crystalline, vuggy, hard	"
"	2310	2320	Calcitic dolomite, pale yellowish brown (10 YR 6/2), very finely crystalline, hard	"
"	2320	2330	Same	"
"	2330	2340	Same with some vugs lined with crystalline dolomite	"
"	2340	2350	Calcitic dolomite, very pale orange (10 YR 8/2) to pale yellow brown (10 YR 6/2), some dark mottling, very fine grained, vuggy	"
"	2350	2360	Dolomite, black (N1) to dark yellowish brown (10 YR 4/2), fine to medium crystalline, vuggy, hard	"
"	2360	2370	Calcitic dolomite, light pale yellow brown (10 YR 6/2), very finely crystallized	"
"	2370	2380	Same as above with some intrasparitic limestone, vigorous HCI response	STS
"	2380	2390	Limestone, micrite, very fine grained, hard, yellowish gray (5 Y 7/2), vigorous HCI response	"
"	2390	2400	Dolomite, medium crystalline, sucrosic, vugular, dark yellowish brown (10 YR 4/2), hard to crumbly	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/6	2400	2410	Dolomite, fine crystalline, hard, some crystalline lined vugs, grayish brown (5 YR 3/2)	STS
"	2410	2420	Same	"
"	2420	2430	Same	"
"	2430	2440	Same	"
"	2440	2450	Dolomitic, fine to medium rhombic crystalline development, sucrosic, crumbly to hard, moderate yellowish brown (10 YR 5/4)	"
"	2450	2460	Dolomite, fine to medium crystalline, crystalline lined vugs, hard, grayish brown (5 YR 3/2)	"
"	2460	2470	Same	"
"	2470	2480	Dolomitic limestone, good medium crystalline development, sucrosic, some HCI response, grayish brown (5 YR 3/2), hard	"
"	2480	2490	Limestone, bio-pelmicrite, moderately soft, lime-mud matrix, very pale orange (10 YR 8/2) pellets & abundant fossils, gastrapod and mollusk castes, vigorous HCI response	"
"	2490	2500	Same	"
"	2500	2510	Same	"
"	2510	2520	Same	"
"	2520	2530	Same	"
"	2530	2540	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/6	2540	2550	Same	STS
"	2550	2560	Same	"
"	2560	2570	Same	"
"	2570	2580	Same	"
"	2580	2590	Same	"
"	2590	2600	Same	"
"	2600	2610	Same	"
"	2610	2620	Dolomite, moderately yellowish brown (10 YR 5/4) to dark yellowish brown (10 YR 4/2), medium crystalline, sucrosic, vuggy & inter crystalline porosity, hard	"
"	2620	2630	Same	"
"	2630	2640	Same	"
"	2640	2650	Same	"
"	2650	2660	Same	"
6/26	2660	2670	Dolomite, fine to medium crystalline sucrosic development, moderate yellowish brown (10 YR 5/4), vuggy	WJR
"	2670	2680	Same	"
"	2680	2690	No Sample	"
"	2690	2700	Same	"
"	2700	2710	Same	"
"	2710	2720	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/26	2720	2730	Same as above but dark yellowish brown (10 YR 4/7)	WJR
"	2730	2740	Same	"
"	2740	2750	Same	"
"	2750	2760	Same as above but moderate yellowish brown (10 YR 5/4)	"
"	2760	2770	Same	"
"	2770	2780	Same	"
"	2780	2790	Same	"
"	2790	2800	Same	"
"	2800	2810	Same	"
"	2810	2820	Same	"
"	2820	2830	Same	"
"	2830	2840	Same	"
"	2840	2850	Same	"
"	2850	2860	Dolomite, fine to medium crystalline, moderate yellowish brown (10 YR 5/4) to dark yellowish brown (10 YR 4/2), vuggy, sucrosic in places	"
"	2860	2870	Same	"
"	2870	2880	Same	"
"	2880	2890	Same	"
"	2890	2900	Same	"
	2900	2910	Dolomite, fine crystalline, pale yellowish brown (10 YR 6/2), vuggy, vugs filled with medium rhombic crystals	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/29	2910	2920	Dolomite, fine crystalline, moderate yellowish brown (10 YR 5/4) to dark yellowish brown (10 YR 4/2), vuggy, sucrosic in places	WJR
"	2920	2930	Dolomite, fine crystalline, vuggy, glauconitic, vuggy, moderate yellowish brown (10 YR 5/4)	"
"	2930	2940	Limestone, biomicrite, in spots grades into bio-intramicrite, soft, very pale orange (10 YR 8/2), fossils: Worm tubes, coral fragments, foraminifera	"
"	2940	2950	Same as above with dolomite, fine to medium crystalline structure, sucrosic, loose to slightly packed, some evidence of lime matrix, grayish orange (10 YR 7/4), hard	STS
"	2950	2960	Same as above	"
"	2960	2970	Dolomite, massive to sucrosic, carbonate matrix, hard, light brown (5 YR 6/4) to dusky yellowish brown (10 YR 2/2), intercrystalline to vuggy porosity	"
"	2970	2980	Same	"
"	2980	2990	Same	"
"	2990	3000	Same	"
"	3000	3010	Limestone, biomicrite, very pale orange (10 YR 8/2), soft, calcitic crystal development, chalky-lime matrix	"
"	3010	3020	Dolomite, hard, moderate yellowish brown (10 YR 5/4) to dusky yellowish brown (10 YR 2/2), medium crystalline, a packed sucrosic development, vuggy porosity	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
6/29	3020	3030	Limestone, biomicrite, very pale orange (10 YR 8/2), soft & chalky	STS
"	3030	3040	Same	"
"	3040	3050	Dolomite, hard, pale yellowish brown (10 YR 4/2), sucrosic, moderately packed, vuggy	"
"	3050	3060	Same	"
"	3060	3070	Same	
"	3070	3080	Dolomite, hard, pale yellowish brown (10 YR 6/2), massive to sucrosic & vuggy; some limestone, soft, pale orange (10 YR 8/2) biomicritic	"
"	3080	3090	Same	"
"	3090	3100	Same	"
"	3100	3110	Same	"
"	3110	3120	Same	"
"	3120	3130	Same	"
7/5	3130	3140	Dolomite, dark yellowish brown (10 YR 4/2), medium crystalline, intercrystalline porosity,	WJR
"	3140	3150	Limestone, very pale orange (10 YR 8/2), dismicrite-intramicrite, dolomitization of the limestone evident; dolomite, pale yellowish brown to dark brown (10 YR 4/2 - 6/2)	"
"	3150	3160	Dolomite, pale yellowish brown (10 YR 6/2): fine to medium crystalline limestone, very pale orange (10 YR 8/2), intramicrite	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
7/5	3160	3170	Dolomite, light gray (N-7) & black (N-1), fine to medium crystalline, hard, dense, also pale yellow, to dark yellowish brown dolomite (10 YR 6/2 & 4/2), banded & mottled	WJR
"	3170	3180	Same	"
"	3180	3190	Dolomite, fine crystalline, light pale yellowish brown (10 YR 6/2); limestone, very pale orange (10 YR 8/2), intramicrite, soft fossils: Echinoderm (sand dollar)	"
"	3190	3200	Same	"
"	3200	3210	Dolomite, pale to dark yellowish brown (10 YR 4/2-6/2), finely crystalline, some sucrosic texture, hard, dense	"
"	3210	3220	Same	"
"	3220	3230	Same	"
7/6	3230	3240	Same	"
"	3240	3250	Dolomite, light pale yellowish brown (10 YR 6/2), finely crystalline, hard, dense, small vugs lined with dolomite crystals, some evidence of original limestone texture.	"
"	3250	3260	Same	"
"	3260	3270	Dolomite, light brownish gray (5 YR 6/1), hard, finely crystalline, fractures & vugs; some medium crystalline, dusky yellowish brown dolomite (10 YR 6/2)	"
"	3270	3280	Same	"

Client: Palm Beach County Water Utilities Department
Project No: FC18009.B3

Well Number: IW-1

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
7/6	3280	3290	Dolomite, pale yellowish brown (10 YR 6/2), fine to very fine crystalline, vuggy, fractured and hard	WJR
"	3290	3300	Same	"

STS/503

DUAL-ZONE MONITOR

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

WELL COMPLETION REPORT

TYPE OF WORK: [X] New Construction [ ] Repair [ ] Deepening [ ] Plugging [ ] Other:

PERMIT NUMBER: UC 50-092095

WELL NUMBER: MONITOR #1

OWNER: PALM BEACH COUNTY [ ]
Last Name First Name Initial

P.O. BOX 16097
Number Street

WEST PALM BEACH FLORIDA
City State

305 [ ] [ ] [ ] [ ] 33416
Area Code Phone Number Zip Code

TYPE OF WELL: [ ] Water Well [ ] Test Well [ ] Recharge [ ] Drainage [ ] Waste Disposal [ ] Observation [X] Other MONITOR

USE: [ ] Domestic [ ] Irrigation [ ] Industrial [ ] Livestock [ ] Public Supply [X] Other: MONITOR

WELL LOCATION:

¼ ¼ ¼ of Section [ ]

[ ] [ ] (N-S) [ ] [ ] (E-W)
Township Range

Latitude 26 Deg. 43 Min. 33 Sec. N

Longitude 80 Deg. 12 Min. 12 Sec. W

Locate in Section

SR 7 FM #
Number Street/Road

STATE ROAD 7
Lot No. Subdivision

WEST OF BOCA RATON PALM BEACH
City County

OWNER WELL NUMBER OR NAME: MONITOR #1

SKETCH LOCATION OF WELL in relation to local landmarks, giving distance and direction from nearest town, road, or other reference point.

North

SHEET 1 OF 1

DRILL METHOD: [X] Rotary [ ] Cable Tool [ ] Jet [ ] Auger [ ] Other:

GEOPHYSICAL LOGS: Type: VARIOUS By: SCHLUMBERGER CHEMHILL

SURFACE CASING, CASING, AND LINER MATERIAL:

Steel Dia. (In.) Black	Steel Dia. (In.) Galv.	Steel Dia. (In.) S. Steel	Steel Wt. (lb./ft.)	Dia. (In.) PVC	Dia. (In.) Other†	From (Ft.)	To (Ft.)	Schedule No.	Joints*
24			125.49			0	250		W
16			62.58			0	970		W
6			28.57			0	1700		W

† Describe Material:

* TC = Threaded and Coupled, TCW = Threaded, Coupled, and Welded, W = Welded, B = Bonded (PVC), O = Other:

GROUT: [ ] None [X] Neat Cement [X] Other: GEL(S)

Type and Percent of Additives and Grout Volume or Number of 94 lb. Sacks

	From (Ft.)	To (Ft.)
617 SACKS NEAT 196 SKS 12%	0	250
492 SACKS ~~NEAT~~ 12%, 102 NEAT	0	970

FINISH: [ ] Open Hole [ ] Perforated or Slotted Casing [ ] Gravel Pack [ ] Sandpoint or Screen Attached to Well Casing [ ] Sandpoint or Screen Telescoped with Packer Inside Casing (Packer Material:)

Sandpoint/Screen Material	Dia. (In.)	Slot Size (In.)	From (Ft.)	To (Ft.)

[ ] Other Finish:

QUALITY TEST: [ ] None [ ] Bacteria Date [ ] Chemical Date

By: [ ] Health Dept. [ ] USGS [ ] Other

[ ] Clear [ ] Colored [ ] Sulphur [ ] Salty [ ] Iron [ ] Other

Conductance (Micromhos) Chloride ppm

Hardness ppm as calcium carbonate pH Temp °F

Well Disinfected: [ ] No [ ] Yes (Date)

WELL TEST, by: [ ] Natural Flow G.P.M. [ ] Airlift [ ] Bailer [ ] Permanent Pump [ ] Test Pump [ ] None

Discharge Measured By: [ ] Bailer [ ] Estimated [ ] Current Meter [ ] Orifice [ ] Trajectory [ ] Venturi [ ] Volumetric [ ] Other

Measured Static Water Level [ ] + [ ] - Ft.

Measured Pumping Water Level [ ] + [ ] - Ft.

After Hours At G.P.M.

Specific Capacity G.P.M./Ft. of Drawdown

Measuring Pt. (Describe):

Which is Ft. [ ] Above [ ] Below Land Surface

Elevation of Measuring Pt. = Ft. [ ] Above [ ] Below MSL

WELL EQUIPMENT: [ ] Open [ ] Capped [ ] Valved [ ] Permanent Pump [ ] Temporary Pump

Type Pump: [ ] Centrifugal [ ] Cylinder [ ] Jet [ ] Submersible [ ] Turbine [ ] Other:

Power: [ ] Diesel [ ] Electric [ ] Gasoline [ ] Other:

Horsepower Capacity G.P.M.

Intake/Injection Depth Ft.

WELL LOG

Bore Hole (In.)	Casing Size (In.)	Depth (Ft.) From	Depth (Ft.) To	Examine cuttings at 20 ft. or smaller intervals and at changes. Give color, grain-size and type of material. Note any cavities. Indicate producing zones. Attach additional sheets if necessary.
29	24	0	20	Light Gray SAND
"	"	20	100	SANDSTONE & Shell
"	"	100	140	CALCAREOUS SANDSTONE
"	"	140	210	SANDY Light Gray Limestone
"	"	210	250	Lt. Olive Gray Clay & Shell
22	16	250	550	Gray, olive, PLASTIC Clay
"	"	550	690	Gray Clay, stks of Lime.
"	"	690	730	SANDY yellow clay
"	"	730	740	SILTSTONE & Shell
"	"	740	750	SAME AS above
"	"	750	880	Yellowish Gray Clay
"	"	880	950	Lt. Olive Clay W. cheat
"	"	950	970	Pale olive Sdy. clay
15	6	970	1010	SANDY, Gray Limestone
"	6	1010	1090	White & Gray Limestone
"	"	1090	1190	Gray & yellow Limestone
"	"	1190	1260	White Limestone
"	"	1260	1510	yellow & gray L.S., some Dolo-
"	"	1510	1520	HARD yellow DOLOMITE
		1520	1540	HARD L.S. w/ Soft stks.
		1540	1620	CR. L.S. & DARK DOLOMITE
		1620	1680	Yellow, Gray L.S. & Dolomite
		1680	1700	ORANGE L.S.
		1700	1740	yellow, gummy L.S.
		1740	1770	Med. to Gray L.S.
		1770	1800	White chalky L.S.

Total Depth 1800 Ft. Producing Zone Material: [ ] Sand [ ] Shell [ ] Broken Shell [ ] Limestone [ ] Other: N.A.

Top of Producing Zone N/A Ft., Bottom of Producing Zone N/A Ft.

[X] Drill Cuttings Sent to Bureau of Geology

2304 A.T. Chitty for Layne-Atlantic Co. Eng.
License No. Contractor Signature Position

10 15 85 S. WADE WOOD, M. SORDAN
Completion Date Driller Signature

DER Form PERM 13-10 (Oct 77)

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	OBSERVER's DESCRIPTION	INITIALS
9/25	0	10	Quartz sand, very light gray (N-8), f-medium grained sub-anuglar to slightly rounded, 1-2% shell fragments	WJR
"	10	20	Same as above	"
"	20	30	Shell beds/sandstone; 40%/60%, shell mostly coquina, very pale orange (10 yr 8/2). Sandstone fine grained, calcareous cement	"
"	30	40	Same as above	"
"	40	50	Same as above	"
"	50	60	Same as above except, 80% sand/20% shell	"
"	60	70	Calcareous sandstone, very light gray (N8) f-medium grained, 5-10% shell	"
"	70	80	Same as above	"
"	80	90	Calcareous sandstone, medium gray to medium dark gray (N5-N4), fine to medium grained, fine grained, black phosphate grains	"
"	90	100	Same as above	"
"	100	110	Same as above	"
"	110	120	Same as above	
"	120	130	Same as above except some small, medium gray limestone lenses	"
9/26	130	140	Same as above	"
"	140	150	Arenaceous limestone, light gray (N7) quartz grains, black phosphate grains, some shell fragments	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
9/26	150	160	Same as above	WJR
"	160	170	Same as above	"
"	170	180	Arenaceous, limestone, yellowish gray (5Y 7/2), sandy, phosphatic, shell fragments	"
"	180	190	Same as above	"
"	190	200	Arenaceous limestone, yellowish gray (5Y 7/2) numerous shells, phosphate grains	"
"	200	210	Same as above	"
"	210	220	Clay and shell, yellowish gray (5Y 7/2) to light olive gray (5Y 5/2), the clay is light olive gray	"
"	220	230	Same as above	"
"	230	240	Same as above	"
"	240	250	Same as above	"
10/2	250	260	Mudstone, medium light gray, phosphatic	"
"	260	270	Clay, grayish olive (10y 4/2), sandy, yellowish gray shell fragments (5y 8/4)	"
"	270	280	Same as above, no shell	"
"	280	290	Same as above	"
"	290	300	Same as above	"
"	300	310	Same as above	"
"	310	320	Clay, grayish olive green (5GY 3/2)	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/2	320	330	Same as above	WJR
"	330	340	Same as above	"
"	340	350	Same as above	"
"	350	360	Same as above	"
"	360	370	Same as above	"
"	370	380	Same as above	"
"	380	390	Clay; grayish olive green (5GY 3/2)	"
"	390	400	Same as above	"
"	400	410	Same as above	"
"	410	420	Same as above	"
"	420	430	Same as above	"
"	430	440	Same as above	"
"	440	450	Same as above	"
"	450	460	Same as above	"
"	460	470	Same as above	"
"	470	480	Same as above	"
"	480	490	Same as above	"
"	490	500	Same as above	"
"	500	510	Same as above	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/2	510	520	Same as above	WJR
"	520	530	Same as above	"
"	530	540	Same as above	"
"	540	550	Same as above	"
"	550	560	Clay; grayish yellow green (5GY 7/2)	"
"	560	570	Same as above	"
"	570	580	Same as above	"
"	580	590	Clay; grayish yellow green (5GY 7/2)	"
"	590	600	Clay; dusky yellow green (5GY 5/2), calcareous	"
"	600	610	Same as above	"
"	610	620	Same as above	"
"	620	630	Same as above	"
"	630	640	Calcareous clay; grayish yellow green (5GY 7/2)	"
"	640	650	Same as above	"
"	650	660	Same as above	"
"	660	670	Same as above	"
"	670	680	Same as above	"
"	680	690	Same as above	"
"	690	700	Same as above	"
	700	710	Calcareous clay grayish yellow green (5GY 7/2), interbedded with yellowish gray limestone (5Y 8/1)	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/2	710	720	Same as above	WJR
"	720	730	Same as above	"
"	730	740	Same as above	"
"	740	750	Same as above	"
"	750	760	Same as above	"
"	760	770	Same as above	"
"	770	780	Calcareous clay, grayish yellow green (5GY 7/2), interbedded with yellowish gray limestone (5Y 8/1)	"
"	780	790	Clay; dusky yellow green (5GY 5/2)	"
"	790	800	Same as above	"
"	800	810	Same as above with shell	"
"	810	820	Calcareous clay; grayish yellow green (5GY 7/2), interbedded with limestone	"
"	820	830	Same as above	"
"	830	840	Same as above, no limestone	"
"	840	850	Calcareous clay; pale olive (10Y 6/2) some grayish olive chert (10Y 4/2)	"
"	850	860	Same as above, no chert	"
"	860	870	Same as above, no chert	"
"	870	880	Same as above	"
"	880	890	Same as above	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/2	890	900	Same as above	WJR
"	900	910	Same as above	"
"	910	920	Calcareous clay interbedded with thin limestone lenses, clay-pale olive (1Y 6/2), limestone yellowish gray (5Y 7/2)	"
"	920	930	Same as above	"
"	930	940	Same as above	"
"	940	950	Same as above	"
"	950	960	Same as above	"
10/10	960	970	Calcareous clay, pale olive (10Y 6/2), with limestone interbeds, yellow gray, (5Y 7/2)	"
"	970	980	Arenaceous limestone, light olive gray (5Y 5/2) silty, very fine sand with phosphate grains, very little reaction to 10% HCL	"
"	980	990	Same as above	"
"	990	1000	Same as above	"
"	1000	1010	Limestone and arenaceous limestone interbedded, yellowish gray (5Y 7/2), very fine sand, with tan to black phosphate; fossils, shell, worm tubes, dictyconus	"
"	1010	1020	Same as above	"
"	1020	1030	Same as above	"
"	1030	1040	Limestone, very light gray (N8) to light gray (N7) sandy, phosphatic, fossils: shell casts, shells echnoid spines	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/10	1040	1050	Same as above	WJR
"	1050	1060	Same as above	"
"	1060	1070	Same as above	"
"	1070	1080	Same as above	"
"	1080	1090	Same as above	"
"	1090	1100	Same as above	"
"	1100	1110	Same as above	"
"	1110	1120	Same as above	"
"	1120	1130	Same as above, but with medium dark calcareous siltstone, dark gray (N4)	STS
10/11	1130	1140	Limestone, very pale orange (10YR 8/2) (grainstone) fine to course particles, fossils: echnoid spines, foraminifera, dictyconus	"
"	1140	1150	Same as above	"
"	1150	1160	Limestone (grainstone) very pale orange (10YR 8/2) fine to course grained; fossils: echnoid spines, forminifera	"
"	1160	1170	Same as above	"
"	1170	1180	Same as above	"
"	1180	1190	Same as above, some yellowish gray (5Y 7/2), biomicritic limestone	"
"	1190	1200	Same as above	"
"	1200	1210	Same as above	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/11	1210	1220	Same as above	STS
"	1220	1230	Biomicritic limestone; white (N7) fossils dictyconus, forminifera	"
"	1230	1240	Same as above	"
"	1240	1250	Same as above, yellowish gray (5Y 8/1)	"
"	1250	1260	Same as above	"
"	1260	1270	Limestone, (Packstone) yellowish gray (5Y 8/1) dictyconus	WJR
"	1270	1280	Same as above	"
"	1280	1290	Same as above, also light gray biomicritic limestone	"
"	1290	1300	Same as above	"
"	1300	1310	Same as above	"
"	1310	1320	Biomicritic limestone, yellowish gray (5YR 8/1) fossils: Dictyconus, miliolid forminifera	"
10/23	1320	1330	Biomicritic limestone, some sparry replacement, yellowish gray (5Y 7/2), loosely consolidated crumbly, very porous, fossils: dictyconus, ooilites, forams	STS
"	1330	1340	Same as above	"
"	1340	1350	Same as above	"
"	1350	1360	Same as above	"
"	1360	1370	Same as above	"
"	1370	1380	Same as above	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/23	1380	1390	Same as above	STS
"	1390	1400	Same as above	"
"	1400	1410	Same as above	"
"	1410	1420	Same as above	"
"	1420	1430	Same as above	"
"	1430	1440	Same as above	"
"	1440	1450	Same as above	"
"	1450	1460	Same as above	"
"	1460	1470	Same as above	"
"	1470	1480	Same as above	"
"	1480	1490	Same as above	"
"	1490	1500	Same as above	"
"	1500	1510	Same as above with a hard dolomite, pale yellowish brown (10YR 6/2), fine grained	"
"	1510	1520	Same as above	"
"	1520	1530	Same as above	"
"	1530	1540	Same as above	"
"	1540	1550	Same as above but (10YR 4/2)	"
"	1550	1560	Dolomite, hard fine crystalline, some response to HCl, grayish black (N2), interbedded with a soft biomicritic limestone, pale yellowish brown (10YR 6/2), crumbly	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/23	1560	1570	Same as above	STS
"	1570	1580	Same as above	"
"	1580	1590	Same as above	"
"	1590	1600	Same as above	"
"	1600	1610	Same as above	"
"	1610	1620	Same as above	"
"	1620	1630	Same as above but no dolomite	"
"	1630	1640	Biomicritic limestone, soft, crumbly, loosley consolidated, yellowish gray (5Y 7/2), fossils: miliolid foraminifera, dictyconus	"
"	1640	1650	Same as above	"
"	1650	1660	Same as above	"
"	1660	1670	Same as above	"
"	1670	1680	Same as above	"
"	1680	1690	Same as above	"
"	1690	1700	Same as above	"
"	1700	1710	Same as above	"
"	1710	1720	Same as above	"
"	1720	1730	Same as above	"
"	1730	1740	Same as above	"
'	1740	1750	Same as above	"

Client: Palm Beach County Water Utilities Department
System No. 9
Project No: FC18009.B3

Well Number: Monitor Well

GEOLOGIC DATA

DATE	DEPTH INTERVAL (ft) FROM	TO	DESCRIPTION	OBSERVER's INITIALS
10/23	1750	1760	Same as above	STS
"	1760	1770	Same as above	"
"	1770	1780	Fossiliferous limestone, hard, medium light gray (N6), fine grained	"
"	1780	1790	Same as above	"
"	1790	1800	Same as above	"

APPENDIX D

INJECTION AND MONITORING WELLS WATER QUALITY DATA

INJECTION WELL

CH2M HILL

Page No.: 1

Client: Palm Beach County System #9

Well No.: IW-1

Project No.: EC 18009.B3

WATER QUALITY DATA FROM Pilot Hole Drilling

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (μmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
5/9/85	10:30Am	1022	22°	4860	400		STS
5/9/85	2:00P.m	1054	22°	4811	400		"
5/10/85	8:25Am	1114	22°	4030	450		"
"		1145	22°	6090	1100		"
"	4:30PM	1173	22°	5470	1050		"
"	8:00PM	1203	22°	5270	1100		"
5/11/85	12:50Am	1234	22°	4750	1050		"
"	5:10 A.m	1264	22°	5070	1150		"
"	8:30AM	1292	22°	5200	1150		"
"	12:30PM	1326	22°	4980	1150		"
"	2:48PM	1364	22°	5760	1300		"
"	9:30 PM	1383	22°	5440	1200		STS
5/12/85	9:00Am	1450	22°	5880	1399		WJK
"	2:00PM	1470	22°	5690	1399		"
"	3:30PM	1533	22°	5490	1349		"
5/13/85	12:45AM	1563	22°	6710	1649		"
5/14/85	8:00AM	1594	22°	5540	1449		"
"	12:30Am	1625	22°	5680	1449		"
"	1:10am	1654	22°	7180	1999		"

CH2M HILL

Client: PALM BEACH COUNTY SYSTEM # 9

Well No.: IW-1

Project No.: EC 18009.B3

WATER QUALITY DATA FROM Pilot Hole Drilling

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (μmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
5/16/85	1:05 P.M	1743	21.5°	7220	2099		WJR
5/16/85	11:15 P.M	1770	26°	6580	1849		"
5-17-85	5:30 AM	1804	23°	6990	1949		"
5-17-85	1:00 PM	1850	27°	8660	2499		"
6/5/85	1:00 PM	1890	29°	39,500	13,595	SALT ADDED TO DRILLING FLUID.	"
6/6/85	7:25 A.M	1924	31.5°	60,700	24,142	"	"
6/6/85	2:10 PM	1954	32°	54,600	29993	"	"
6/6/85	9:30 P.M	1984	29°	46,200	18294	"	"
6/9/85	12:30 AM	2065	24.5	43,900	15195	"	"
6/9/85	4:05 PM	2105	25	45,700	15495	"	STS
6/10/85	8:00 AM	2136	25	45,000	15195	"	STS
6/11/85	3:00 AM	2190	25	46,700	16294	"	STS
6/11/85	11:30 AM	2225	24	44,200	15795	"	STS
6/11/85	10:00 PM	2255	24	47,300	17144	"	STS
6/12/85	5:30 AM	2285	23	47,100	17794	"	WJR
6/13/85	11:30 P.M	2315	23	53,000	20,243	"	"
6/14/85	6:00 P.M	2347	32°	48,500	18,844	"	"
6/16/85	9:00 P.M.	2404	23.5°	50,900	19,993	"	"
6/17/85	9:30 AM	2437	31°	50,400	19993	"	"
6/17/85	7:00 PM	2447	29°	54,200	22,078	"	"

CH2M HILL

Client: PALM BEACH COUNTY SYSTEM #9

Well No.: IW-1

Project No.: EC 18009.B3

WATER QUALITY DATA FROM PILOT HOLE DRILLING

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (µmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
6/19/85	5:45Am	2494	21.5	56,500	23,192	SALT ADDED TO DRILLING FLUID.	WJR
6/19/85	8:00 PM	2525	21.5	55,000	22,543	"	"
6/19/85	11:40PM	2555	21.5	49,100	18,044	"	"
6/20/85	2:00Am	2580	22.5	49,800	19,693	"	"
6/21/85	5:00PM	2615	22.5	49,300	18,444	"	"
6/22/85	11:00AM	2645	26	47,500	17,744	"	"
6/22/85	8:55PM	2675	23.5	46,500	17,294	"	"
6/24/85	9:30P.M.	2705	23.5	48,700	18,344	"	"
6/25/85	9:30Am	2735	24.0	47,900	18,244	"	"
6/25/85	8:45PM	2766	24.0	48,500	17,894	"	"
6/26/85	2:00PM	2795	22.5	50,600	20243	"	"
6/26/85	7:45P.M	2824	23	50,400	20443	"	"
6/27/85	6:25Am	2855	22	50,100	19,843	"	"
6/27/85	—	2885	22.5	49,600	18844	"	"
6/28/85	—	2916	27.5	50,000	19,494	"	"
6/29/85	2:00PM	2947	20	51,100	19,444	"	"
6/29/85	6:00PM	2976	24	50,400	19843	"	"
6/29/85	10:30PM	3006	24	51,100	18,994	"	"
6/30/85	3:20Am	3036	24	50,300	19493	"	"
6/30/85	6:00AM	3066	24.5	50,400	17593	"	"

CH2M HILL

Page No.: 4

Client: Palm Beach County System #9

Well No.: IW-1

Project No.: FC 12007.B3

WATER QUALITY DATA FROM PILOT HOLE DRILLING

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (µmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
6/30/85	6:00PM	3096	24	50,300	19,244	SALT ADDED TO DRILLING FLUID	WJK
7/1/85	5:00PM	3126	24	50,800	19,743	"	"
7/2/85	1:46PM	3156	22	50,700	19,344	"	"
7/3/85	8:45AM	3186	22.5	50,700	20,293	"	"
7/4/85	6:00AM	3216	22.5	50,400	19,344	"	"
7/4/85	10:00AM	3246	22.5	50,500	20,442	"	"
7/6/85	1:00PM	3276	22.5	50,600	19,793	"	"
7/7/85	11:00AM	3300	21.0	50,900	20,343	"	"

DUAL-ZONE MONITOR

CH2M HILL

Page No.: 1

Client: Palm Beach County System #9

Well No.: Dual Zone Monitor

Project No.: FC 18009.B3

WATER QUALITY DATA FROM PILOT HOLE DRILLING

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (μmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
10-8-85	6:00 P.M	1,037	27°	12710	3,199	CHANGED DRILLING FLUID TURNED WELL OVER 3 TIMES SWITCHED TO REVERSE AIR	WJK
10-9-85	9:30AM	1,067	25°	8,140	2,299	SALT PILLOW BEING USED ON TOP OF WATER COLUMN TO HELP CONTROL FLOW.	"
10-10-85	3:30 AM	1095	25°	8,940	2549		"
10-10-85	6:00AM	1126	31.5	8,260	2499		"
10-10-85	10:45AM	1156	24°	8,390	2349		"
10-10-85	11:30AM	1186	32°	8,310	2299		"
10-10-85	1:00 P.m	1216	33°	7910	2199		"
10-10-85	3:50P.m	1246	33°	7300	2049		"
10-10-85	5:45PM	1277	25°	7100	1999		"
10-10-85	6:45P.M	1306	25°	7340	2099		"
10-10-85	7:46PM	1335	25°	7270	2049		"
10-10-85	10:30PM	1365	25°	8180	2399		"
10-10-85	12:00PM	1395	25°	7150	1999		"
10-11-85	1:05AM	1425	25°	7130	1999		"
10-11-85	2:20AM	1455	25°	6980	1949		"
10-11-85	3:25AM	1482	25°	6860	1949		"
10-11-85	8:30AM	1545	25°	6800	1899		"
10-11-85	1:45P.m	1576	25°	6860	1899		"
10-11-85	5:22P.m	1606	23°	6990	1949		"

CH2M HILL

Page No.: 2

Client: Palm Beach County System #9

Well No.: Dual Zone Monitor

Project No.: FC 18009.B3

WATER QUALITY DATA FROM PILOT HOLE DRILLING

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (μmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
10/11/85	8:30 PM	1667'	24°C	7540	2149		WJR
10/12/85	10:00PM	1700	24°C	7660	2199		"
10/18/85		1711		6150	1699	Sample from drill string	TM
"		1742		6200	1769	" " " "	
"		1774		6600	1919	" " " "	
10/19/85		1800		14,220	4918	Sample from drill string circulate off bottom	
"	6:00AM	1800		14,120	4900	As above	
"	8:30AM	1800		14,100	5018	As above	
"	11:00AM	"		14,430	4918	As above	
"	1:00PM	"		14,300	5,138	As above	
"	3:00PM	"		14,435	5,248	As above	TM
10/20/85	9:00AM	1700		8,600	3,000	From 6" casing at surface	TM
"	10:00AM	"		8,420	2982	As above	TM
"	3:00PM	"		8,610	3099	As above	TM

SHALLOW MONITOR NO. 1

CH2M HILL

Page No.: 1

Client: Palm Beach County System #9

Well No.: 1
Shallow Monitor

Project No.: FC 18009.B3

WATER QUALITY DATA FROM Monitor Well 16.8'

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (µmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
1/11/84	?	45.0			71	PALM BEACH COUNTY SAMPLE	J.R
4/18/84	11:00 AM	"			71	"	D.S.
7/18/84	9:00 AM	"			60	"	J.R.
10/10/84	9:00 A.M	"			59	"	J.R.
1/15/85	10:00 A.M	"		760	26	"	J.R.
3/18/85	11:00 AM	"	23.5°	667	57	CH2M HILL SAMPLES STARTED WITH THIS SAMPLE	WJR
3/25/85	10:30 A.M	"	24.9	655	60	RECALIBRATED METER	WJR
4/3/85	10:00 AM	"	24.0	619	53	COMPENSATED CONDUCTIVITY VALUES	WJR/SS
4/10/85	9:30 AM	"	23.5	612	56		WJR/SS
4/17/85	2:00 PM	"	25.0	560	62		WJR
4/24/85	8:15 AM	"	25.0	705	55		"
5/1/85	4:00 P.M	"	25.0	694	50		"
5/8/85	2:30 P.M	"	25.5	690	45		STS
5/15/85	2:45 PM	"	28.0	695	47		WJR
5/24/85	9:15 AM	"	25.5	722	45		WJR
5/29/85	8:50 AM	"	25.0	723	39		WJR
6/5/85	8:30 AM	"	24.5	722	46		WJR
6/12/85	7:15 AM	"	24.0	742	46		WJR
6/19/85	7:30 AM	"	24.5	734	53		WJR
6/26/85	7:30 AM	"	24.0	751	52		WJR

CH2M HILL

Page No.: 1

Client: Palm Beach County System # 9

Well No.: 2 Shallow Monitor

Project No.: FC 18009.B.3

WATER QUALITY DATA FROM Monitor Well 20.1'

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (µmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
1/11/84	—	16.0	—	—	44	PALM BEACH COUNTY SAMPLE	J.R
4/18/84	11:00 AM	"			44	"	D.S
7/18/84	9:00 AM	"			28	"	J.R.
10/10/84	9:00 AM	"			31	"	JR
1/15/85	10:00 AM	"		640	28	"	JR
3/18/85	11:00 AM	"	23.5	690	40	CH2M HILL SAMPLES START WITH THIS SAMPLE	DJR
3/25/85	10:30 AM	"	24.9	667	40		"
4/3/85	10:05 AM	"	23.5	669	42	RECALIBRATED METER COMPENSATED CONDUCTIVITY VALUES	"
4/10/85	9:45 AM	"	23.5	691	41		"
4/17/85	2:15 AM	"	25.0	706	46		"
4/24/85	8:30 AM	"	25.0	909	45		"
5/1/85	4:15 PM	"	25.0	935	45		"
5/8/85	2:35 PM	"	26.0	971	30		"
5/14/85	2:50 PM	"	26.0	1000	37		"
5/24/85	9:20 AM	"	24.5	1050	40		"
5/29/85	8:58 AM	"	24.0	1075	34		"
6/5/85	8:15 AM	"	24.0	1057	36		"
6/12/85	7:30 AM	"	24.0	1025	31		"
6/19/85	7:45 AM	"	24.5	985	42		"

CH2M HILL

Page No.: 7

Client: Palm Beach County System #9

Well No.: 1

Project No.: EC 18CC9.B3

WATER QUALITY DATA FROM Monitor Well

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (μmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
7-3-85	7:30 AM	45.0'	24.0	758	47		WJR
7-10-85	7:10 AM	45.0	25.5	764	47		WJR
7-17-85	7:15 AM	45.0	24.0	767	52		WJR
7-24-85	7:10 AM	45.0	24.5	766	42	HEAVY RAIN.	WJR
7-31-85	7:15 AM	45.0	24.5	774	47		WJR
8-7-85	7:10 AM	45.0	24.0	772	43		WJR
8-14-85	7:40 AM	45.0	24.0	776	44		WJR
8-22-85	9:00 AM	45.0	25	784	48		WJR
8-28-85	10:15 A.M.	45.0	26.5	788	43		WJR
9-4-85	8:15 AM	45.0	25°	796	42		WJR
9-11-85	7:20 AM	45	24.5°	796	44		WJR
9-19-85	9:00 AM	45	24.5	795	42		WJR
9-26-85	7:15 A.M.	45	24.5	802	42		WJR
10-2-85	7:10 PM	45.	25°	801	42		WJR
10-9-85	7:15 AM	45	25	801	48		WJR

SHALLOW MONITOR NO. 2

CH2M HILL

Page No.: 1

Client: Palm Beach County System # 9

Well No.: 2 Shallow Monitor

Project No.: FC 180094.B3

WATER QUALITY DATA FROM Monitor Well 20.1'

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (µmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
1/11/84	—	15.0	—	—	44	PALM BEACH COUNTY SAMPLE	J.R
4/18/84	11:00 AM	"			44	"	D.S
7/18/84	9:00 AM	"			28	"	J.R.
10/10/84	9:00 AM	"			31	"	JR
1/15/85	10:00 AM	"		640	28	"	JR
3/18/85	11:00 A.M	"	23.5	690	40	CH2M HILL SAMPLES START WITH THIS SAMPLE	JR
3/25/85	10:30 AM	"	24.9	667	40		"
4/3/85	10:05 AM	"	23.5	669	42	RECALIBRATED METER COMPENSATED CONDUCTIVITY VALUES	"
4/10/85	9:45 A.M	"	23.5	691	41		"
4/17/85	2:15 AM	"	25.0	706	46		"
4/24/85	8:30 A.M	"	25.0	909	45		"
5/1/85	4:15 P.M	"	25.0	935	45		"
5/8/85	2:35 P.M	"	26.0	971	30		"
5/14/85	2:50 P.M	"	26.0	1000	37		"
5/24/85	9:20 AM	"	24.5	1050	40		"
5/29/85	8:58 AM	"	24.0	1075	34		"
6/5/85	8:15 AM	"	24.0	1057	36		"
6/12/85	7:30 AM	"	24.0	1025	31		"
6/19/85	7:45 AM	"	24.5	985	42		"

CH2M HILL

Page No.: 2

Client: PALM BEACH COUNTY SYSTEM # 9

Well No.: 2

Project No.: FC 18007.B3

WATER QUALITY DATA FROM MONITOR WELL

Date	Time	Depth (ft)	Temperature (°C)	Specific Conductance (µmhos/cm)	Chloride (mg/l)	Remarks	Observer's Initials
7-3-85	7:45 AM	15.0'	24.0	973	36		WJC
7-10-85	7:20 AM	15.0	25.5	992	31		WJC
7-17-85	7:30 AM	15.0	24.0	979	36		WJC
7-24-85	7:20 AM	15.0	25.0	972	36.7		WJC
7-31-85	7:25 AM	15.0	26.0	996	41		WJC
8-7-85	7:20 AM	15.0	24.5	963	37		WJC
8-14-85	7:45	15	24.5	966	36		WJC
8-22-85	9:15	15	25.5	944	38		WJC
8-28-85	10:30	15	25.0	928	37		WJC
9-4-85	10:25	15	25.5°	912	36		WJC
9-11-85	7:30	15	25.0°	905	33		WJC
9-19-85	9:15	15	24.5	893	31		WJC
9-25-85	7:15 AM	15	25.5	918	37		WJC
10-2-85	7:20 AM	15	2610	905	31		WJC
10-9-85	7:20 AM	15	2610	915	42		WJC

APPENDIX E

INJECTION TEST DATA

FINAL INJECTION TEST

CH2M HILL

SUBJECT Alpha Beach Co. Injection Test
TD 3300'
Final Test

BY VMC DATE 7-13-85
SHEET NO. 1 OF 8
PROJECT NO. FC18009 B3

Injection Well
MONITOR POINT ELEVATION 25.6'

Time	Pressure PSI	×1000 GPM flow rate	×10,000 GALLONS flow total	NOTES
TIME INTERVAL = 30 SEC				START TEST 10:33 PM
00:00:00	3.0	0000	4313	PROPOSED RATE 4500 GPM
00:00:30	8.5	5.5	4314.0	PULL FLUID SAMPLE #1
00:01:00	9.0	5.2	4314.2	T°C 29
00:01:30	9.8	4.5	4314.4	
00:02:00	10.5	4.2	4314.6	
00:02:30	13.0	4.2	4314.8	
00:03:00	13.0	4.2	4315.1	
00:03:30	15.0	4.2	4315.3	
00:04:00	15.5	4.2	4315.5	
00:04:30	17.0	4.2	4315.7	
00:05:00	18.0	4.2	4315.9	
TIME INTERVAL = 1 min				
00:06:00	20.0	3.9	4316.3	
00:07:00	22.2	3.9	4316.7	
00:08:00	25.0	4.0	4317.1	
00:09:00	25.6	4.0	4317.5	
00:10:00	25.5	4.4	4318.0	Pull Fluid Sample #2
TIME INTERVAL = 2 min				T°C 29
00:12:00	26.7	4.4	4318.9	
00:14:00	26.7	4.5	4319.8	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — TD 3300' — Final Test

BY TMSC DATE 9-13-85

SHEET NO. 2 OF 8

PROJECT NO. PC 18009.83

Injection Well

MONITOR POINT ELEVATION 25.6'

TIME	PRESSURE PSI	FLOW RATE GPM	FLOW TOTAL GALLONS	NOTES
00·16·00	26.7	4.2	4320.6	
00·18·00	26.7	4.2	4321.5	
00·20·00	26.7	4.25	4322.5	
TIME INTERVAL 5 MIN				
00·25·00	26.7	4.2	4324.6	
00·30·00	26.7	4.3	4326.9	
TIME INTERVAL = 10 MIN				PULL FLUID SAMPLE #3 T°C 29
00·40·00	26.7	4.2	4331.1	
00·50·00	26.7	4.25	4335.5	
01·00·00	26.8	4.2	4339.8	PULL FLUID SAMPLE #4 T°C 29
01·10·00	26.8	4.2	4344.18	
01·20·00	26.8	4.2	4348.5	
01·30·00	26.8	4.2	4352.5	
01·40·00	26.8	4.25	4357.2	
01·50·00	26.9	4.25	4361.5	
TIME INTERVAL = 20 MIN				PULL FLUID SAMPLE #5 T°C 29
02·00·00	26.9	4.25	4367.6	
02·20·00	27.0	4.25	4376.0	THROTTLE DOWN PUMPS - CHANGE TO T°FIBRE 12:56 START PUMP 1:36 AM SIP = 22.6 PSI PULL FLUID SAMPLE #6 T°C 29
02·40·00	27.1	4.2	4386.0	
03·00·00	27.1	4.25	4394.5	
03·20·00	27.1	4.2	4403.9	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — TD 3300' — Final Test

BY JMSC DATE 1-13-85

SHEET NO. 3 OF 8

PROJECT NO. EC18009.03

INJection Well

MONITOR POINT ELEVATION 25.6'

Time	Pressure PSI	flow rate GPM	flow total GALLONS	Notes
03·40·00	27.1	4.2	4412.4	Pull Fluid Sample #7 T°C 29
04·00·00	27.4	4.25	4412.8	STOP PUMP AT 2.50 AM SIP 22.8 PSI INSERT RESISTIVITY TOOL START PUMP AT 3:23 AM
04·20·00	27.4	4.5	4421.8	
04·40·00	27.4	4.5	4429.0	
05·00·00	27.4	4.4	4438.0	Pull Fluid Sample = 8 T°C 29
				STOP PUMP AT 4:34 AM REMOVE RESISTIVITY PROBE START PUMP 5.29 AM SIP 23.6 PSI
INTERVAL = 30 SEC		STEP #2		
00·00·00	29.7	0.00	4446.3	
05·00·30	31.0	4.6	4446.7	
05·01·00	30.0	5.3	4447.2	
05·01·30	29.5	6.8	4447.4	
05·02·00	29.7	6.5	4447.7	
05 02·30	29.7	6.5	4448.1	
05 03·00	29.7	6.5	4448.3	
05·03·30	29.8	6.5	4448.7	
05·04·00	29.8	6.4	4449.1	
05·04·30	29.7	6.5	4449.4	
05·05·00	29.7	6.5	4449.8	
Time INTERVAL = 1 min				
05·06·00	29.8	6.5	4450.3	
05·07·00	29.8	6.5	4451.0	

SUBJECT Palm Beach Co. Injection Test
TD 3300'
Final Test

BY TMEC DATE 9-13-85
SHEET NO. 4 OF 8
PROJECT NO. FC18009.83

Injection Well
MONITOR POINT ELEVATION 25.6'

Time	Pressure PSI	Flow rate GPM	Flow total GALLONS	Notes
05:08:00	29.7	6.5	4451.7	
05:09:00	29.7	6.5	4452.3	
05:10:00	29.7	6.5	4453.0	
TIME INTERVAL = 2 min				
05:12:00	29.8	6.5	4454.3	
05:14:00	29.7	6.5	4455.5	
05:16:00	29.8	6.5	4457.0	
05:18:00	29.7	6.5	4458.3	
05:20:00	29.7	6.5	4459.6	
TIME INTERVAL = 5 min				
05:25:00	29.7	6.5	4463.0	
05:30:00	29.7	6.3	4466.2	
TIME INTERVAL = 10 min				
05:40:00	29.7	6.5	4473.8	
05:50:00	29.7	6.5	4479.3	
06:00:00	29.7	6.7	4486.0	
		STEP #3		
00:00:00	29.7	8.5	4487.4	
06:00:30	35.0	8.7	4488.0	
06:01:00	33.3	8.8	4488.3	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — TD 3300' — Final Test

BY TMC DATE 1-13-8

SHEET NO. 5 OF 8

PROJECT NO. FC18609.B3

Injection Well

MONITOR POINT ELEVATION 25.6'

TIME	Pressure PSI	flow rate GPM	flow total GALLONS	NOTES
06:01:30	33.4	8.8	4488.3	
06:02:00	33.3	8.8	4488.7	
06:02:30	33.3	8.9	4489.2	
06:03:00	33.3	8.9	4489.7	
06:03:30	33.3	8.9	4490.2	
06:04:00	32.4	8.4	4490.6	
06:04:30	31.5	7.8	4491.0	
06:05:00	32.9	8.2	4491.4	
TIME INTERVAL = 1 MIN				
06:06:00	32.6	8.3	4492.3	
06:07:00	32.6	8.5	4493.1	
06:08:00	32.6	8.3	4494.8	
06:09:00	32.6	8.3	4495.8	
06:10:00	32.6	8.5	4495.6	
TIME INTERVAL = 2 MIN				
06:12:00	32.6	8.4	4497.3	
06:14:00	32.6	8.3	4499.1	
06:16:00	32.6	—	—	* MISSED READING
06:18:00	32.6	8.3	4502.4	
06:20:00	32.6	8.7	4504.2	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — TD 3300' — Final Test

BY SMSC DATE 9-13-85

SHEET NO. 6 OF 8

PROJECT NO. FC 18009.83

Injection Well

Monitor point elevation 25.6'

Time	Pressure PSI	flow rate 1000 GPM	flow total 10,000 GALLONS	Notes
Time Interval =5 min				
06:25:00	32.6	8.4	4508.5	
06:30:00	32.6	8.3	4512.7	
Time Interval =10 min				
06:40:00	32.6	8.5	4521.3	
06:50:00	32.6	8.3	4529.9	
07:00:00	32.6	8.3	4538.6	
		STEP #4		
00:00:00	32.6	10.0	4539.6	
07:00:30	36.5	10.0	4540.1	
07:01:00	35.5	10.0	4540.6	
07:01:30	35.5	10.0	4541.2	
07:02:00	35.4	10.0	4541.5	
07:02:30	35.5	10.0	4541.8	
07:03:00	35.4	10.0	4542.1	
07:03:30	35.4	10.0	4542.8	
07:04:00	35.4	9.9	4543.1	
07:04:30	35.4	10.0	4543.7	
07:05:00	35.4	9.9	4544.1	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test
TD 3300'
Final Test

BY JM'C DATE 9-13-85
SHEET NO. 7 OF 8
PROJECT NO. FC/8009.B3

Injection Well
Monitor point elevation 25.6'

Time	Pressure PSI	Flow rate GPM	Flow Total Gallons	Notes
Time Interval = 1 min				
07.06.00	35.8	9.0	4545.1	
07.07.00	35.4	10.0	4546.2	
07.08.00	35.3	9.9	4547.2	
07.09.00	35.4	10.0	4548.1	
07.10.00	35.3	9.9	4549.2	
Time Interval = 2 min				
07.12.00	35.3	9.9	4551.1	
07.14.00	35.3	9.9	4553.1	
07.16.00	35.2	9.9	4555.2	
07.18.00	35.2	9.9	4557.2	
07.20.00	35.2	9.9	4559.2	
Time Interval = 5 min				
07.25.00	35.2			
07.30.00	35.2	10.0		
Time Interval = 10 min				
07.40.00	35.2	9.9	4579.3	
07.50.00	35.2	9.8	4589.4	
08.00.00	35.2	9.8	4599.4	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test
TD 3300'
Final Test

BY _____ DATE 9/13/85
SHEET NO. 8 OF 8
PROJECT NO. _____

Injection Well
Monitor point elevation 25.6'

Time	Pressure PSI	Flow rate GPM	Flow total GALLONS	Notes
		Well shut in at		
00.00	25.50			
00.01	23.80			
00.02	23.60			
00.03	23.55			
00.04	23.53			
00.05	23.46			
00.10	23.40			
00.15	23.32			
00.30	23.15			
00.40	23.20			
00.50	23.30			
01.00	23.40			

PRELIMINARY INJECTION TEST

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — Preliminary Injection Test on Pilot Hole

BY SMcC DATE 7/11

SHEET NO. 1 OF 9

PROJECT NO. FC 18009.B3

Injection Well

Monitor point elevation 25.6

Time	Pressure psi	Flow rate x1000 GPM	Flow total x 10,000 gallons	Notes
Interval = 30 sec				START TEST: 1:00 PM 7/11/85
00.00.00	10.2 psi *	-0-	4120.4	Full fluid samples 1 & 2 T° 31°C Sp. Gr.
00.00.30	11.7	3.8		* Residual pressure from previous night's testing of injection system-
00.01.00	12.5	3.8	4120.7	
00.01.30	14.4	5.5	4120.8	
00.02.00	13.9	5.0	4121.0	
00.02.30	14.4	5.0	4121.4	
00.03.00	14.1	4.5	4121.6	
00.03.30	14.7	4.2	4121.8	
00.04.00	14.8	4.3	4122.1	
00.04.30	14.8	4.25	4122.3	
00.05.00	14.8	4.25	4122.6	
Interval = 1 min				
00.06.00	14.8	4.36	4123.8	
00.07.00	14.9	4.30	4124.4	
00.08.00	14.9	4.30	4124.8	
00.09.00	15.0	4.30	4125.2	
00.10.00	15.0	4.30	4125.7	Pulled Fluid Sample # 3 T° 31°C Sp Gr
Interval = 2 min				
00.12.00	15.1	4.25	4126	
00.14.00	15.2	4.25	—	Missed totalizer reading

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — Preliminary Injection Test

BY _____ DATE 7/11

SHEET NO. 2 OF 9

PROJECT NO. PC18009.83

Injection Well

Monitor Point Elevation _____

Time	Pressure PSI	Flow Rate GPM	Flow Total Gallons	Notes
00·16·00	15.3	4.3	4126.8	
00·18·00	15.4	4.25	4128.6	
00·20·00	15.5	4.25	4129.5	
Interval = 5 min				
00·25·00	15.6	4.25	4131.7	
00·30·00	15.6	4.25	4133.95	
Interval = 10 min				
00·40·00	15.7	4.25	4138.0	
00·50·00	15.8	4.25	4142.7	
01·00·00	15.8	4.25	4146.5	
01·10·00	15.8	4.25	4150.85	
01·20·00	15.8	4.25	4155.5	
01·30·00	15.9	4.3	4159.5	
01·40·00	15.9	4.3	4163.9	
01·50·00	16.0	—	—	missed readings
02·00·00	———	4.20	4173.5	missed pressure reading
02·20·00	16.0	4.30	4182.2	
02·40·00	16.0	4.25	—	reading in error
03·00·00	16.0	4.25	4198.3	
03·20·00			4206.5	* Injection Test halted to free flowmeter Tool.
03·40·00				

CH2M HILL

SUBJECT Palm Beach Co. Injection Test
Preliminary Injection Test

BY JMsC DATE 7/11/85
SHEET NO. 3 OF 9
PROJECT NO. FC18029.B3

Injection Well
Monitor point elevation _____

Time	Pressure PSI	Flow rate GPM	Flow total GALLONS	Notes
				Residual Pressure After bleed off during tool retrieval
00:00:00	8.7	5.00	4206.2	Restart injection test at:
00:00:30	10.5	5.20	4206.6	
00:01:00	10.1	4.50	4206.9	
00:01:30	10.1			missed reading
00:02:00	10.9	4.25	4207.2	
00:02:30	11.3	4.25	4207.4	
00:03:00	12.0	4.25	4207.6	
00:03:30	12.4	4.30	4207.8	
00:04:00	12.7	4.25	4208.0	
00:04:30	13.1	4.25	4208.3	
00:05:00	13.7	4.25	4208.6	
Interval = 1 min				
00:06:00	14.5	4.25	4208.9	
00:07:00	15.8	4.25	4209.3	
00:08:00	15.9	4.25	4209.8	
00:09:00	16.1	4.25	4210.2	
00:10:00	16.1	4.25	4210.7	
Interval = 2 min	———	———	———	
00:12:00	16.1	4.25	4211.7	
00:14:00	16.0	4.30	4212.5	
00:16:00	16.0	4.30	4213.4	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — Preliminary Injection Test

BY JMSC DATE 7/11/85

SHEET NO. 4 OF 9

PROJECT NO. FC18009.B3

Injection Well

Monitor point elevation

Time	Pressure PSI	Flow rate GPM	Flow total Gallons	Notes
00:18:00	16.1	4.30	4214.2	
00:20:00	16.1	4.30	4214.7	
Interval = 5 min				
00:25:00	16.1	4.50	4217.4	
00:30:00	16.1	4.25	4219.5	
				Step 2 Proposed rate 6500 GPM
00:33:30	17.3	6.50	4220.8	
00:34:00	17.3	6.50	4221.1	
00:34 30	17.3			Missed readings
00:35:00	17.3	6.40	4222.1	
00:35:30	17.3	6.50	4222.3	
00:36 00	17.3	6.50	4222.7	
00:36:30	17.3	6.70	4223.0	
00:37 00	17.3	6.50	4223.3	
00:37:30	17.4	6.70	4223.6	
00:38:00	17.4	6.70	4224.0	
Interval = 1 minute				
00 39:00	17.3	6.70	4224.6	
00:40:00	17.3	6.50	4225.3	
00:41:00	17.3	6.5	4226.0	
00:42:00	17.3	6.5	4226.6	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test
Preliminary Injection Test

BY TMC DATE 7/11

SHEET NO. 5 OF 9

PROJECT NO. FC 18009.B3

Injection Well

MONITOR POINT ELEVATION _____

Time	Pressure PSI	Flow rate 1000 GPM	Flow total 10,000 GALLONS	Notes
00:43:00	17.3	6.50	4237.3	
INTERVAL = 2 min	———	———	———	
00:45:00	17.4	6.70	4238.7	Pull Fluid Sample 1A
				T° = 31°C Sp Gr =
00:47:00	17.4	6.50	4230.0	
00:49:00	17.4	6.40	4231.4	
00:51:00	17.3	6.50	4233.6	
00:53:00	17.3	6.50	4234.0	
INTERVAL = 5 min	———	———	———	
00:58:00	17.3	6.50	4236.7	
01:03:00	17.4	6.50	4240.0	
				STEP 3
				PROPOSED RATE 8500 GPM
INTERVAL = 30 SEC				
01:10:00	19.4	7.4	4241.4	
01:10:30	19.5	8.5	4242.1	
01:11:00	19.6	8.5	4242.3	
01:11:30	19.5	8.5	4243.6	
01:12:00	19.6	8.5	4243.3	
01:12:30	19.6	8.5	4243.7	
01:13:00	19.6	8.5	4244.2	
01:13:30	19.5	8.5	4244.6	
01:14:00	19.5	8.5	4244.9	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test
Preliminary Injection Test

BY _____ DATE 7/11/85
SHEET NO. 6 OF 9
PROJECT NO. FC 18009.83

Injection Well
Monitor point elevation _____

Time	Pressure PSI	Flow rate GPM	Flow total GALLONS	Notes
01:14:30	19.5	8.50	4245.4	
01:15:00	19.5	8.60	4245.7	
Interval = 1 minute	—	—	—	
01:16:00	19.5	8.50	4246.6	
01:17:00	19.6	8.50	4247.8	
01:18:00	19.6	8.50	4248.5	
01:19:00	19.6	8.50	4249.3	
01:20:00	19.6	8.50	4250.2	
Interval = 2 minutes	—	—	—	
01:22:00	19.6	8.50	4251.9	
01:24:00	19.7	8.50	4253.7	
01:26:00	19.7	8.50	4255.5	
01:28:00	19.7	8.60	4257.3	
01:30:00	19.7	8.50	4258.8	
Interval = 5 minutes	—	—	—	
01:35:00	19.7	8.50	4263.3	
01:40:00	19.7	8.50	4267.5	Water sample # 2 A T° 31°C Sp Gr
				Step 3
Interval = 30 sec				Proposed rate 10,500 GPM
01:42:00	21.0	10.40	4269.5	
01:42:30	21.5	10.40	4269.9	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test — Preliminary Injection Test
BY JMSC DATE 7/11/85
SHEET NO. 7 OF 9
PROJECT NO. FC18009.B3

Injection Well
MONITOR POINT ELEVATION _____

Time	Pressure PSI	Flow rate GPM	Flow total GALLONS	Notes
01·43·00	21.5	10.40	4270.4	
01·43·30	22.0	10.30	4270.4	
01·44·00	22.0	10.40	4270.9	
01·44·30	22.0	10.30	4271.4	
01·45·00	21.8	10.50	4272.0	
01·45·30	22.0	10.30	4272.7	
01·46·00	21.8	10.30	4273.1	
01·46·30	22.0	10.30	4273.6	
01·47·00	21.8	10.50	4274.0	
INTERVAL = 1 MINUTE	———	———	———	
01·48·00	21.8	10.40	4275.1	
01·49·00	22.0	10.30	4276.2	
01·50·00	21.8	10.10	4277.2	
01·51·00	22.0	10.00	4278.3	
01·52·00	21.8	10.20	4279.3	
INTERVAL = 2 MINUTES	———	———	———	
01·54·00	21.8	10.30	4281.3	
01·56·00	22.0	10.40	4283.4	
01·58·00	21.9	10.50	4285.5	
02·00·00	21.9	10.30	4287.7	
02·02·00	21.9	10.50	4290.2	

CH2M HILL

SUBJECT Palm Beach Co. Injection Test
Preliminary Injection Test

BY _____ DATE 7/1L

SHEET NO. 8 OF 9

PROJECT NO. FC 18069.B3

Injection Well

MONITOR POINT ELEVATION _____

Time	Pressure PSI	Flow rate GPM	Flow total GALLONS	Notes
INTERVAL = 5 minutes	21.9	10.20	4295.1	
02.07.00	21.9	10.20	4300.2	Pull Fluid Sample 3A T° 31°C Spgr
02.12.00				
———	———	———	———	
				Pump stoped down Valve closed at
INTERVAL = 30 sec				
00.00.30	14.40			
00.01.30	14.30			
00.02.00	14.25			
00.02.30	14.25			
00.03.00	14.25			
00.03.30	14.25			
00.04.00	14.20			
00.04.30	14.20			
00.05.00	14.20			
INTERVAL = 1 min	———	———	———	
00.06.00	14.20			
00.07.00	14.20			
00.08.00	14.20			
00.09.00	14.20			
00.10.00	14.18			

CH2M HILL

SUBJECT Palm Beach Co. Injection Test
Preliminary Injection Test

BY _____ DATE 7/11

SHEET NO. 9 OF 9

PROJECT NO. FC 18009.B3

Injection Well

Monitor point elevation _____

Time	Pressure PSI	Flow rate GPM	Flow total Gallons	Notes
Interval = 5 min				
00:15:00	14.10			
00:20:00	14.00			
00:25:00	13.90			
00:30:00	13.90			
Interval = 10 min				
00:40:00	13.20			
00:50:00	13.20			
00:60:00	13.10			

APPENDIX F

T.V. SURVEY REVIEWS

INJECTION WELL

CH2M
HILL

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Deep Injection Well Project

Well: System No. 9 IW-1

Survey By: Deep Venture
Box 329-B, Perry, Florida

Survey Date: 9/13/85 Total Depth: 3300'

Witnessed By: Stacey Hill
Tom McCormick

Reviewed By: Sean T. Skehan Date: 12/5/85

Remarks: Black and White

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
		0	110	Intro
18	37	110	164	Casing joint
37	55	164	185	Joint or ring
55	78	185	223	Casing joint
78	118	223	287	Casing joint
118	158	287	351	As above
158	198	351	416	As above
198	238	416	475	As above
238	278	475	528	As above
278	318	528	579	As above
318	358	579	628	As above
358	399	628	680	As above
399	439	680	729	As above
439	479	729	779	As above

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: System No. 9 IW-1 Date: 9/13/85 Total Depth: 3300'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
479	519	779	830	Casing joint
519	559	830	882	As above
559	599	882	931	As above
599	640	931	1007	Picture becoming cloudy, 631 waited for water to clear up, casing joint
640	680	1007	1061	Casing joint - clear picture
680	721	1061	1117	As above
721	761	1117	1167	As above
761	801	1167	1217	As above
801	841	1217	1267	As above
841	881	1267	1317	As above
881	922	1317	1367	As above
922	962	1367	1415	As above
962	1002	1415	1462	As above
1002	1042	1462	1510	As above
1042	1083	1510	1557	As above
1083	1123	1557	1603	As above
1123	1163	1603	1650	As above
1163	1203	1650	1693	As above
1203	1243	1693	1736	As above
1243	1283	1736	1778	As above

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: System No. 9 IW-1 Date: 9/13/85 Total Depth: 3300'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
1283	1324	1778	1819	Casing joint, clear picture
1324	1364	1819	1860	As above
1364	1405	1860	1901	As above
1405	1445	1901	1942	As above
1445	1485	1942	1982	As above
1485	1525	1982	2023	As above
1525	1565	2023	2065	As above
1565	1606	2065	2106	As above
1606	1645	1217	2146	As above
1645	1685	2146	2177	As above
1685	1726	2177	2210	As above
1726	1765	2210	2241	As above
1765	1806	2241	2273	As above
1806	1846	2273	2306	As above
1846	1886	2306	2339	As above
1886	1926	2339	2371	As above
1926	1967	2371	2402	As above
1967	2007	2402	2434	As above
2007	2047	2434	2476	As above
2047	2087	2476	2499	As above

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: System No. 9 IW-1 Date: 9/13/85 Total Depth: 3300'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
2087	2127	2499	2531	Casing joint, clear picture
2127	2167	2531	2565	As above
2167	2208	2565	2597	As above
2208	2244	2597	2626	As above
2244	2282	2626	2656	As above
2282	2322	2656	2689	As above
2322	2362	2869	2722	As above
2362	2402	2722	2755	As above
2402	2442	2755	2789	As above
2242	2483	2789	2822	As above
2483	2523	2822	2855	As above
2523	2563	2855	2889	As above
2563	2603	2889	2922	As above, cement on the wall
2603	2637	2922	2952	As above, windows for cementing
2637	2641	2952	2956	Casing ends
2641	2642	2956	2958	Going into open hole
2642	2650	2958	2966	Open hole, borehole pocketed with small cavities
2650	2660	2966	2975	Large cavity and fracture
2660	2670	2975	2984	Smooth bore with small cavities on borehole wall
2670	2680	2984	2993	One large cavity, some vertical fracturing and smooth bore with cavities

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: System No. 9 IW-1 Date: 9/13/85 Total Depth: 3300'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
2680	2690	2993	3002	Small cavities on borehole
2690	2700	3002	3011	Mostly smooth bore and some cavities
2700	2710	3011	3020	As above
2710	2720	3020	3029	As above, water becoming cloudy
2720	2730	3029	3040	Picture cloudy, appears to be some water movement upward
2730	2740	3040	3054	As above but clearing
2740	2750	3054	3064	Large cavities extending horizontally and vertical fractures, clear picture
2750	2760	3064	3074	As above
2760	2770	3074	3083	Bore becomes smoother with some small cavities, some vertical fractures
2770	2780	3083	3093	As above
2780	2790	3093	3103	As above, some small boulders
2790	2800	3103	3113	As above
2800	2810	3113	3123	As above with large vertical fracture
2810	2820	3123	3132	Large horizontal cavities and vertical fractures, some boulders
2820	2830	3132	3142	As above
2830	2840	3142	3151	As above with some smooth bore
2840	2850	3151	3161	As above
2850	2860	3161	3171	As above
2860	2870	3171	3181	As above
2870	2880	3181	3216	As above 2875 - caliper arm

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: System No. 9 IW-1 Date: 9/13/85 Total Depth: 3300'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
2880	2890	3216	3230	Large vertical fractures and horizontal cavities, large boulders
2890	2900	3230	3241	As above
2900	2910	3241	3253	As above, 2906 very large cavity
2910	2920	3253	3267	As above, very large horizontal cavity
2920	2930	3267	3280	Very large cavity, picture becomes dark, camera hangs to one side
2930	2940	3280	3294	As above, proceeding slow
2940	2950	3294	3309	As above
2950	2960	3309	3323	As above
2960	2970	3323	3338	As above
2970	2980	3338	3353	As above
2980	2990	3353	3367	As above
2990	3000	3367	3381	As above
3000	3010	3381	3396	As above
3010	3020	3396	3410	As above
3020	3030	3410	3424	As above
3030	3040	3424	3439	As above
3040	3050	3439	3454	As above
3050	3060	3454	3468	Complete borehole can be seen again - 3056 large boulders, fractures and cavities
3060	3070	3468	3480	As above, appears to be two holes offset from each other
3070	3080	3480	3493	As above

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: System No. 9 IW-1 Date: 9/13/85 Total Depth: 3300'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
3080	3090	3493	3505	Borehole appears to be oval, side hole cavities, vertical fractures
3090	3100	3505	3517	As above
3100	3110	3517	3530	As above,
3110	3120	3530	3542	Borehole becomes smoother with small side wall cavities
3120	3130	3542	3554	As above, several larger horizontal cavities
3130	3140	3554	3567	Borehole becomes smoother, formation mottling at 3134, some small cavities and fractures
3140	3150	3567	3579	As above, distinct formation mottling
3150	3160	3579	3591	As above
3160	3170	3591	3601	As above
3170	3180	3601	3612	Large cavity at 3176 with formation change at 3178, some small cavities and fractures
3180	3190	3612	3622	As above, with horizontal cavities starting at 3184
3190	3200	3622	3632	Smooth bore with crystalline lined fractures
3200	3210	3632	3641	As above, with large cavities
3210	3220	3641	3651	As above
3220	3230	3651	3660	As above
3230	3240	3660	3669	Mostly smooth bore, some filled fractures and several small cavities
3240	3250	3669	3679	As above
3250	3260	3679	3689	As above
3260	3270	3689	3698	As above
3270	3280	3698	3708	As above

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: System No. 9 IW-1 Date: 9/13/85 Total Depth: 3300'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
3280	3290	3708	3719	Mostly smooth bore with crystalline filled vertical fractures, small cavities
3290	3300	3719	3728	As above, total depth 3300', large cavity near bottom, gravel filled bottom

DUAL-ZONE MONITOR

CH2M
HILL

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: Multi-zone Monitor

Survey By: Deep Venture Video Logging

Survey Date: 10/21/85 Total Depth: 1804'

Witnessed By: Tom McCormick
Jim Hayden

Reviewed By: Sean T. Skehan Date: 12/3/85

Remarks:

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
		0	79	Blank Tape
0	2	79	240	Well head "T", camera in casing
2	18	240	316	Casing joint
18	60	316	446	Casing joint
60	99	446	558	As above
99	139	558	700	As above
139	180	700	780	As above
180	220	780	948	As above
220	260	948	1038	As above
260	301	948	1150	As above
301	339	1150	1218	As above
339	380	1218	1346	As above
380	389	1346	1375	As above
389	420	1375	1436	Casing joint

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: Multi-zone Monitor Date: 10/21/85 Total Depth: 1804'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
1022	1062	2657	2729	Casing joint
1062	1102	2729	2809	As above
1102	1127	2809	2861	As above
1127	1143	2861	2894	As above
1143	1182	2894	2984	As above
1182	1215	2984	3051	As above
1215	1223	3051	3074	As above
1223	1251	3074	3143	As above
1251	1263	3143	3172	As above
1263	1303	3172	3257	As above
1303	1343	3257	3362	As above
1343	1383	3362	3442	As above
1383	1423	3442	3512	As above
1423	1463	3512	3584	As above
1463	1490	3584	3627	As above
1490	1503	3627	3657	As above
1503	1544	3657	3756	As above
1544	1584	3756	3826	As above
1584	1624	3826	3905	As above
1624	1664	3905	3962	As above

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: Multi-zone Monitor Date: 10/21/85 Total Depth: 1804'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
420	451	1436	1494	Casing Joint
451	461	1494	1523	As above
461	482	1523	1574	As above
482	501	1574	1609	As above
501	541	1609	1695	As above
541	581	1695	1774	As above
581	604	1774	1806	As above
604	621	1806	1846	As above
621	635	1846	1881	As above
635	661	1881	1944	As above
661	701	1944	2005	As above
701	727	2005	2063	As above
727	741	2063	2096	As above
741	782	2096	2157	As above
782	822	2157	2261	As above
822	862	2261	2346	As above
862	902	2346	2429	As above
902	942	2429	2500	As above
942	982	2500	2590	As above
982	1022	2590	2657	As above

RECORD OF UNDERWATER TV SURVEY

Project: Palm Beach County Water Utilities System No. 9 Injection Well Project

Well: Multi-zone Monitor Date: 10/21/85 Total Depth: 1804'

Depth in Feet		Reel Counter		OBSERVATIONS
From	To	From	To	
1664	1698	3962	4040	Cement windows 2' off bottom
1702			4058	Out of casing, open hole
1702	1720	4058	4111	Open hole, limestone, small cavities up hole flow
1720	1730	4111	4140	Smooth borehole
1730	1740	4140	4156	Smooth bore with some small cavities
1740	1750	4156	4174	As above
1750	1760	4174	4206	As above
1760	1770	4206	4250	As above with some larger cavities continued uphole flow
1770	1780	4250	4279	As above
1780	1790	4279	4303	As above
1790	1794	4303	4331	Up hole flow discontinues, no flow
1794	1804	4331	4352	Total depth, no flow, some small cavities

APPENDIX G

CORE ANALYTICAL DATA

TTL, Inc. A SERVICE ORGANIZATION

ENVIRONMENTAL • GEOLOGICAL • MINERALOGICAL • GEOTECHNICAL

September 30, 1985

Mr. Thomas M. McCormick
CH2M Hill
Post Office Box 2468
Boca Raton, Florida 33427

RE: Permeability and Porosity Testing

Dear Mr. McCormick:

TTL has completed the permeability and porosity tests on the core samples you sent in August. The procedures and the results for those tests are as follows:

PERMEABILITY

1. We prepared a cylindrical sample with the top and bottom surfaces perpendicular to the sides. We used three (3) inch diameter cores, trimming the top and bottom surfaces.

2. The sample was encased in a cylindrical, latex membrane with porous stones and blocks on the top and bottom. The encased sample was set in a triaxial cell and a confining pressure was applied around it.

3. The permeant was then forced through the sample with a differential head. We used a permeant of approximately 35,000 tds as requested.

4. Each sample was first allowed to saturate. After sufficient time and flow occurred to assure saturation, the permeability readings were started. Readings were taken at periodic intervals for about three (3) to twenty four (24) hours and the permeability coefficient was calculated for each interval. When the calculated coefficients became stable, the test was considered complete. Our calculations are base on the equation.

$$K = \frac{Q}{iA}$$

Where: k = Permeability Coefficient (cm/sec)
Q = Flow Rate (cm^3/sec)
i = Hydraulic Gradient (cm/cm)
A = Sample Area (cm^2)

SAMPLE PERMEABILITY CALCULATION

Assume Ht = 2 1/2"
Diameter = 4"

Permeant head = 20" mercury
Mercury specific gravity = 13.667
Steady state water flow = 80 ml in 30 minutes

Q = (80 cc) − (30 min) (60 sec/min) = 0.0444 cc/sec
i = (20 in) (13.667) − (2.5 in) = 109.3 in/in
A = (/4) (4 in)^2 (6.452 cm^2/in^2) = 81.1 cm^2

$$k = \frac{Q}{iA} = \frac{0.0444 \text{ cc/sec}}{109.3 \text{ in/in} \times 81.1 \text{ cm}^2} = 5.0 \times 10^{-6} \text{ cm/sec}$$

POROSITY

After disassembling the permeability apparatus the saturated samples were weighed in water (Buoyant Wt.), weighed in Air (SSD Wt.), and then dryed and weighed in the air again (Dry Wt.). A small volume of the dry sample was then taken and its specific gravity determined using the Kerosene Displacement Method. Our porosity calculations are based on the following equation:

Porosity = Volume of voids/Total sample volume

Where:

Total Sample Volume - (SSD Wt.) - (Buoyant Wt.)
Apparent Volume of solids = (Dry Wt.) - (Buoyant Wt.)

True Volume of solids = (Dry Wt.)/(Specific Gravity)
Volume of Voids = Total Sample Volume - True Volume of Solids

If you have any questions, please call us.

Sincerely,

TTL, Inc.

H. Dean McClure

H. Dean McClure
Civil Engineer

James C. Bambarger

James C. Bambarger, P.E.
Ala. Reg. No. 11289

HDM/JCB/jlc-6

Attachment: Table

TTL, Inc. A SERVICE ORGANIZATION
ENVIRONMENTAL • GEOLOGICAL • MINERALOGICAL • GEOTECHNICAL

PERMEABILITY DATA FOR CH2M HILL

September 30, 1985

Core Sample	Direction	Description	Permeability Coefficient "K" (cm/sec)
C1-1	Vertical	Limestone	4×10^{-5}
C1-4	Vertical	Limestone	2×10^{-6}
C1-4	Horizontal	Limestone	2×10^{-5}
C1-7	Vertical	Dolomite	2×10^{-10}
C1-7	Horizontal	Dolomite	3×10^{-8}
C2-1	Vertical	Limestone	5×10^{-6}
C2-8	Vertical	Dolomite	2×10^{-5}
C2-8	Horizontal	Dolomite	5×10^{-6}
C2-13	Vertical	Dolomite	3×10^{-10}
C2-13	Horizontal	Dolomite	2×10^{-7}
C4-9	Vertical	Dolomite	2×10^{-9}
C4-10	Vertical	Dolomite	2×10^{-10}
C5-3	Vertical	Limestone	4×10^{-6}
C6-1	Vertical	Limestone	2×10^{-5}
C6-3	Vertical	Limestone	1×10^{-5}
C6-5	Vertical	Limestone	1×10^{-5}
C6-12	Vertical	Limestone	7×10^{-7}
C8-3	Vertical	Limestone	5×10^{-6}
C8-8	Vertical	Limestone	2×10^{-5}
C8-9	Vertical	Limestone	3×10^{-5}

MAIN OFFICE: 3516 Greensboro Avenue • P.O. Box 1094 • Tuscaloosa, Alabama 35403 • Telephone 205/345-0816
BRANCH OFFICE: 409 N. Court St., Suite 6 • P.O. Box 1754 • Florence, Alabama 35630 • Telephone 205/767-0691

POROSITY DATA FOR CH2M HILL

September 30, 1985

Core Sample	Description	Porosity (%)
C1-4	Limestone	23
C1-7	Dolomite	4
C2-1	Limestone	29
C2-3	Dolomite	6
C2-8	Dolomite	30
C4-1	Dolomite	1
C4-10	Dolomite	1
C5-24	Limestone	27
C8-13	Limestone	29

APPENDIX H

LABORATORY ANALYSES FOR DUAL-ZONE MONITOR WELL BACKGROUND SAMPLES

ENVIRONMENTAL LABORATORIES
7201 N.W. Eleventh Place
P.O. Drawer 1647
Gainesville, Florida 32602
904/377-2442

REPORT OF ANALYSIS

Sample No. 28770-28775

Lab ID No. 82112

Client PALM BEACH COUNTY

Project No. FC18009.B9

Attention Sean Skeehan

Received 11/1/85

Address Deerfield Beach Office

Reported 12/3/85

Description of Sample:

Six water samples collected by Sean Skeehan during the period of 10/22/85 through 10/25/85

Description	(Zone 1) Sample# 28770 A-1 Collected 10/25/85	(Zone 2) Sample# 28771 B-1 Collected 10/25/85	(Zone 1) Sample# 28772 A-2 Collected 10/25/85	(Zone 2) Sample# 28773 B-2 Collected 10/25/85	(Depth Sample) Sample# 28774 C-1 Collected 10/22/85	(Surface Artesian Sample) Sample# 28775 D-1 Collected 10/22/85
pH, pH Units	7.30	7.20	7.30	7.45	7.05	7.25
Total Alkalinity	46	141	80	136	134	131
Chloride	59	3,510	13,300	3,760	4,850	3,760
Specific Conductance	262	9,030	31,200	10,100	12,200	10,200
Sodium	19.7	1,685	8,570	1,961	2,580	1,922
Total Dissolved Solids	214	6,177	23,200	7,350	9,000	6,915
Sulfate	17	420	405	475	530	420
Total Organic Carbon	7.17	2.14	3.88	2.06	3.33	1.54

NOTE: All values reported in mg/L as substance unless otherwise indicated.

Respectfully submitted,

Thomas C. Erwin

Laboratory Supervisor

ENVIRONMENTAL LABORATORIES
7201 N.W. Eleventh Place
P.O. Drawer 1647
Gainesville, Florida 32602
904/377-2442

Sample No. 29883-29888

Lab ID No. 82112

REPORT OF ANALYSIS

Client PALM BEACH COUNTY — Project No. FC18009.B9

Attention SEAN SKEEHAN — Received 1/3/86

Address DEERFIELD BEACH OFFICE — Reported 1/15/86

Description of Sample:

SIX SAMPLES RECEIVED FROM PALM BEACH COUNTY INJECTION WELL PROJECT

Description	Sample# 29883 Zone 1 75° F Coll. 12/13/85 @ 0830	Sample# 29884 Zone 2 75.8° F Coll. 12/13/85 @ 0830	Sample# 29885 Zone 1 74.1° F Coll. 12/16/85 @ 0830	Sample# 29886 Zone 2 73.2° F Coll. 12/16/85 @ 1645	Sample# 29887 Zone 2 73.1° F Coll. 12/18/85 @ 0800	Sample# 29888 Zone 1 76.2° F Coll. 1/2/86 @ 1150
pH, pH Units	7.50	7.40	7.35	7.35	6.70	7.30
Total Alkalinity, as $CaCO_3$	108	122	124	119	117	128
Chloride	2,720	2,450	2,260	2,500	2,020	1,520
Specific Conductance, µmhos/cm	16,200	14,700	14,200	15,400	15,000	9,870
Sodium	2,850	2,270	2,430	2,340	2,370	1,490
Sulfate	560	560	600	540	560	620
Total Dissolved Solids	9,250	8,830	7,930	9,050	8,880	5,730
Total Organic Carbon	1.55	< 1.00	3.57	1.41	3.31	2.23

NOTE: All values reported in mg/L as substance unless otherwise indicated.

Respectfully submitted,

Laboratory Supervisor

CH2M HILL

ENVIRONMENTAL LABORATORIES
7201 N.W. Eleventh Place
P.O. Drawer 1647
Gainesville, Florida 32602
904/377-2442

Sample No. 28962-28965

Lab ID No. 82112

REPORT OF ANALYSIS

Client PALM BEACH COUNTY — Project No. FC18009.B9

Attention Sean Skeehan, Deerfield Beach Office — Received 11/13/85

Address Deerfield Beach Office — Reported 12/2/85

Description of Sample:

Four water samples collected on 11/5/85 and 11/12/85 by Sean Skeehan

Description	Sample#28962 BC#9 Coll. 11/5/85 @ 0930 (Zone 2)	Sample#28963 BC#9 Coll. 11/5/85 @ 1300 (Zone 1)	Sample#28964 BC#9 Coll. 11/12/85 @ 1050 (Zone 1)	Sample#28965 BC#9 Coll. 11/12/85 @ 1130 (Zone 2)
Temperature, °C	25.0	25.5	25.5	25.5
Pressure, P.S.I.	8.50	5.25	5.30	8.50
pH, pH Units	7.30	7.45	7.60	7.45
Total Alkalinity, as $CaCO_3$	130	103	110	134
Total Dissolved Solids	6,316	17,290	15,680	6,330
Sulfate	438	525	540	370
Sodium	1,790	6,020	5,200	1,840
Chloride	3,660	9,900	9,010	3,760
Specific Conductance, micromhos/cm	884	22,100	20,200	8,890
Total Organic Carbon	2.03	< 1.00	18.9	< 1.00

NOTE: All values reported in mg/L as substance unless otherwise indicated.

Respectfully submitted,

Laboratory Supervisor

SUMMARY OF MEETING

DATE: August 15, 1988

SUBJECT: Technical Advisory Committee (TAC) Meeting, 1:00 p.m., August 9, 1988, UIC Permit Application UO-112903 for Palm Beach County WWTP System 9(N) Injection Well System

LOCATION: Florida Department of Environmental Regulation 1900 Congress Boulevard West Palm Beach, Florida

ATTENDING: Donald B. White/DER/WPB
Peggie Highsmith/DER/WPB
Oliver P. Board/DER/WPB
Cathy Conrardy/DER/TLH
David Butler/SFWMD
Michael Merritt/USGS/Miami
Lawton McCall/PBCWUD
Anthony LasCasas/PBCHD
James H. Carey/EPA/ATL
Alex Padva/DER/WPB
J.I. GARCIA-Bengochea/CH2M HILL/GNV
Thomas M. McCormick/CH2M HILL/DFB
Bart Ziegler/CH2M HILL/DFB

COPIES: Bevin Beaudet/PBCWUD
Robert Weisman/PBCWUD

PROJECT: SEF247708.JO

PREPARED BY: Bart Ziegler

Mr. Don White, TAC Chairman, opened the meeting. Members of the TAC reviewed the agenda prepared and distributed by CH2M HILL.

1. Mr. White stated that DER was now in receipt of a letter of certification for the pressure test conducted on the final casing string of the injection well and a letter of certification of completion for the injection well which were requested at the June 14, 1988 TAC meeting. The letters were prepared by CH2M HILL, the engineer of record for the Palm Beach County Water Utilities Department System #9(N) Injection Well. Mr. White stated that both letters were in order and accepted by DER.

   Mr. White inquired as to the status of the warranty deed preparations and financial responsibility preparations. Mr. Lawton McCall advised that both were in progress and would be completed as soon as possible.

2. Mr. White moved the discussion to the fourth item on the agenda, reevaluation of the need for a radio active tracer survey (RTS).

Dr. J.I. Garcia-Bengochea outlined the process leading to the identification of the monitor well water quality discrepancies. Dr. Garcia stated that the discrepancies were due to existing wellhead plumbing and sampling procedures as described in Mr. Bevin Beaudet's letter to Mr. White on June 20, 1988. The sampling procedures were corrected and sampling continues on a weekly basis.

Mr. Bart Ziegler presented weekly conductivity and chlorine data for the monitor well which had been collected from November 12, 1987 through July 27, 1988. The new sampling procedures for the monitor well were outlined. Slides of the monitor well wellhead were used to illustrate the procedure. Mr. Ziegler also stated that total dissolved solids (TDS) analyses on the upper and lower monitor zones began on July 27, 1988.

Mr. White stated that there was some variability in the data after CH2M HILL's site visit and sampling procedure alterations. (These data were distributed to TAC members on August 3, 1988 by CH2M HILL)

Dr. Alex Padva pointed out that standard deviation in testing methodology could cause the variability in results that appear in the reported data. This variability could be addressed by repeatedly testing a large single sample over an extended period of time. This data should be collected to illustrate the possible variations.

It was agreed upon by TAC members that weekly sampling will continue for two months. At the end of this period TAC members will review collected data to determine if an additional meeting is required.

Ms. Peggy Highsmith stated that, in her opinion, the monitor well water quality was not the primary issue regarding the necessity for the RTS. The validity of the temperature log performed March 9, 1988 is not adequate to confirm Part II mechanical integrity on the injection well.

Mr. Thomas McCormick stated that he believed the pressure test conducted on the final casing string and the variable density log met the requirements for Part I and II of mechanical integrity testing at the time of construction. Mr. McCormick also stated that the RTS

was not required as part of construction permit for the injection well.

DER maintains that the RTS was part of the Florida Administrative Code (FAC) 17.28 at the time of construction and is therefor required for issuance of the operating permit.

Dr. Padva stated that the issue regarding the RTS be turned over to DER's legal counsel to determine if the test will be required for issuance of the operating permit.

3. Mr. White adjourned the meeting at approximately 2:45 p.m.