HYDROGEOLOGIC INVESTIGATION OF THE FLORIDAN AQUIFER SYSTEM AT THE I-75 CANAL SITE COLLIER COUNTY, FLORIDA

Technical Publication WS-7

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December 2001

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EXECUTIVE SUMMARY

The Lower West Coast Planning Area includes Collier and Lee counties and portions of Hendry, Charlotte, and Glades counties. A combination of natural drainage basins and political boundaries defines the extent of this planning area. Water supply plans developed for the Lower West Coast Planning Area have identified the Floridan Aquifer System (FAS) as a possible water supply alternative. Based on these plans, the South Florida Water Management District (SFWMD) initiated a program of exploratory well construction, aquifer testing, and long-term monitoring to provide data needed to assess the FAS underlying this area. The long-term monitoring includes water quality and potentiometric heads monitoring.

This report documents the results of two Floridan aquifer wells constructed and tested under the direction of the SFWMD. These wells are located east of the city of Naples, near the SFWMD's D2-7 water control structure on the I-75 Canal in Collier County, Florida. This site was selected to augment existing data and provide broad, spatial coverage within the SFWMD's Lower West Coast Planning Area.

The scope of the investigation consisted of constructing and testing two FAS wells. The first well, I75-TW, was drilled to a total depth of 2,694 feet below land surface (bls), just northeast of the D2-7 water control structure. It was completed into three distinct hydrogeologic zones within the upper and lower Floridan aquifer. The second well, I75-PW, is located 283 feet southeast of the monitor well (I75-TW) and constructed to facilitate aquifer testing of two productive horizons within the upper Floridan aquifer. This well was drilled to a total depth of 1,050 bls.

The main findings of the exploratory drilling and testing program at this site were as follows:

- The top of the Floridan aquifer, as defined by the Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition (1986), was identified at a depth of approximately 690 feet bls.
- Lithologic and geophysical logs, specific capacity and packer test results, and petrophysical data indicate moderate to good production capacity of the upper Floridan aquifer.
- Water quality data from reverse air returns and straddle-packer tests indicate that chloride and total dissolved solids (TDS) in the upper Floridan aquifer waters exceed potable drinking water standards. Chloride and total dissolved solids concentrations range from 1,530 to 4,020 milligrams per liter (mg/L) and 3,410 to 7,150 mg/L, respectively.

- The first productive horizon in the upper Floridan aquifer, from 690 to 780 feet bls, yielded a transmissivity value of 116,640 gallons per day per foot (gpd/ft), a storage coefficient of 1.7×10^{-5}, a leakage factor (r/B) value of 0.04, with a calculated leakance value of 2.33×10^{-3} gpd/cubic foot (gpd/ft^3).
- The second productive interval in the upper Floridan aquifer, from 890 to 1,050 feet bls, yielded a transmissivity value of 52,500 gpd/ft, a storage coefficient of 2.3×10^{-5}, an (r/B) value of 0.05, with a calculated leakance value of 1.64×10^{-3} gpd/ft^3.
- The base of the underground source of drinking water, those waters having TDS concentrations less than 10,000 mg/L, occurs at an approximate depth of 1,090 feet bls.
- Fluid-type (flowmeter and temperature) geophysical logs show little natural flow below the base of the underground source of drinking water, at a depth of 1,090 feet bls.
- The average measured potentiometric heads for the Floridan aquifer monitoring intervals are as follows:
    - 34.6 feet above NGVD, 1929: ±0.41 feet for the 690 to 760 feet bls monitor interval
    - 34.5 feet above NGVD, 1929: ±0.39 feet for the 905 to 1,050 feet bls monitor interval
    - 9.1 feet above NGVD, 1929: ±0.44 feet for the 2,300 to 2,350 feet bls monitor interval
- Water levels in the Floridan aquifer respond to external stresses such as tidal loading and barometric pressure variations.

ACKNOWLEDGEMENTS

The author gratefully acknowledge the many people that aided in the successful completion of this project. I would like to thank those outside the SFWMD who reviewed the manuscript or lent technical expertise to the writing of the report. They include Ronald Reese of the United States Geological Survey and Daniel Acquaviva of Water Resource Solutions.

Appreciation is also extended to the technical and professional staff of the SFWMD who assisted in the compilation and analysis of data and the production of this report. They include Richard Bower, Linda Lindstrom, John Lukasiewicz, Richard Nevulis, Robert Verrastro, and E. Edward Rectenwald. I appreciate Janet Wise for her graphic capabilities. I thank Sorrel Hoover from Orion Consulting, Inc. and Kim Jacobs at SFWMD for their editorial assistance and expertise in bringing this document to publication. I would also like to thank David Demonstranti of Electronic Support and Data Acquistion at the SFWMD for the excellent field support during testing operations.

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INTRODUCTION

Background

The Lower West Coast Planning Area includes Collier and Lee counties and portions of Hendry, Charlotte, and Glades counties in South Florida. A combination of natural drainage basins and political boundaries defines the extent of this planning area. Water supply plans developed for the Lower West Coast Planning Area have identified the Floridan Aquifer System (FAS) as a possible water supply alternative. Based on these plans, the South Florida Water Management District (SFWMD) initiated a program of exploratory well construction, aquifer testing, and long-term monitoring (water quality and potentiometric heads) to provide data needed to assess the FAS underlying this area. These wells will supply information needed to characterize the water supply potential of the FAS and support the development of a groundwater flow model that will be used to support future planning and regulatory decisions. The first FAS test site completed under this program was located near the SFWMD's G-150 water control structure on the L-2 Canal in eastern Hendry County, Florida (Bennett, 2001). The second site, the focus of this report, is located in the Golden Gate Estates Area of western Collier County. These wells are located on Florida Department of Transportation property adjacent to the Big Cypress Basin's D2-7 water control structure on the I-75 Canal in the northwestern quarter of Section 29, Township 49 South, Range 26 East (**Figure 1**).

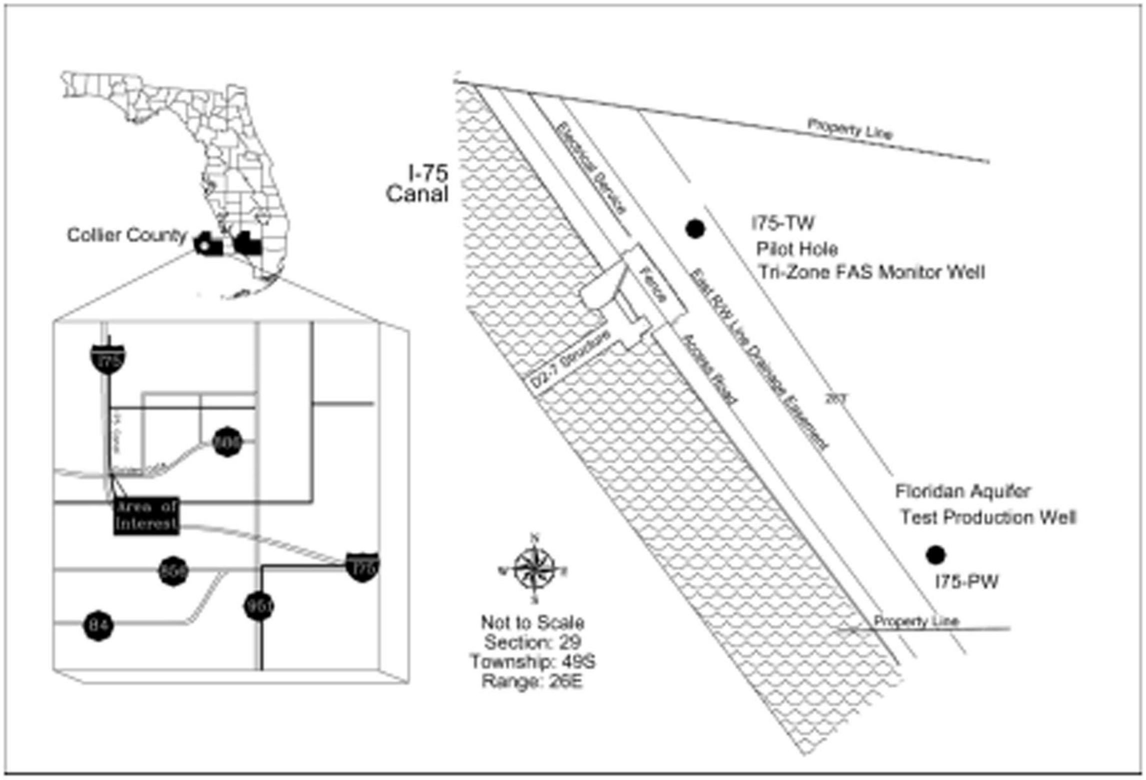


Figure 1. I-75 Canal Site Project Location Map and Site Plan

Purpose

The purpose of this report is to document the hydrogeologic data collected during the SFWMD-initiated Floridan aquifer well drilling, aquifer testing, and monitoring program at the I-75 Canal site. The information includes a summary of 1) well drilling and construction details, 2) hydrogeology, 3) water quality and productive capacity, 4) stable isotope and carbon 14 (^{14}C) data, 5) petrophysical and petrologic data, 6) aquifer performance test data and analyses, and 7) long-term potentiometric-head data.

Project Description

Two Floridan aquifer wells were constructed at the I-75 Canal site. The final depth of the test production well (I75-PW) is 1,050 feet below land surface (bls) with casing set at 890 feet in depth. A tri-zone FAS monitor well (I75-TW) is located 283 feet northwest of the test production well. It was completed in three distinct zones constructed to varying depths for aquifer testing and long-term monitoring of distinct hydrogeologic units. The original total depth of the monitor well was 2,694 feet bls.

The original drilling contractor, Youngquist Brothers, Inc. (YBI) for SFWMD Contract C-4172, withdrew from the project on April 1, 1994. After YBI withdrew, RST Company was assigned the drilling, well construction, and testing services under Amendment 1 to the contract. A Notice to Proceed was issued on April 6, 1994, to RST Company. Construction of the Floridan aquifer monitor well at the I-75 Canal site began on June 1, 1994.

EXPLORATORY DRILLING AND WELL CONSTRUCTION

I-75 Canal Tri-Zone Monitor Well

On June 1, 1994, drilling and support equipment was delivered to the I-75 Canal drill site to begin drilling and construction of the FAS monitor well (I75-TW). After clearing and rough grading the site, the ground surface beneath the drill rig and settling tanks was lined with a high-density polyethylene (HDPE) membrane. A 2-foot thick temporary drilling pad was then constructed using crushed limestone. An earthen berm, 2-feet high, was constructed around the perimeter of the rig and settling tanks to contain drilling fluids and/or formation waters produced during well drilling, testing, and construction activities.

Mud rotary and reverse air techniques were used during drilling operations. Mud rotary drilling was used during the initial pilot hole drilling from land surface to 737 feet bls. The pilot hole from 737 to 2,694 feet bls was drilled using the reverse air, open circulation method.

Data from formation samples (well cuttings), packer tests, and geophysical logs were used to determine the actual casing setting depths. The pilot hole was then reamed to specified diameters for the selected casing setting. Three concentric steel casings (24-, 18-, and 12-inch diameter) were used in the construction of the FAS tri-zone monitor well. Small diameter, fiberglass casings were used to construct the uppermost Floridan and lower Floridan aquifer monitor wells. A completion diagram of the I-75 Canal tri-zone FAS monitor well, I75-TW, is shown in **Figure 2**.

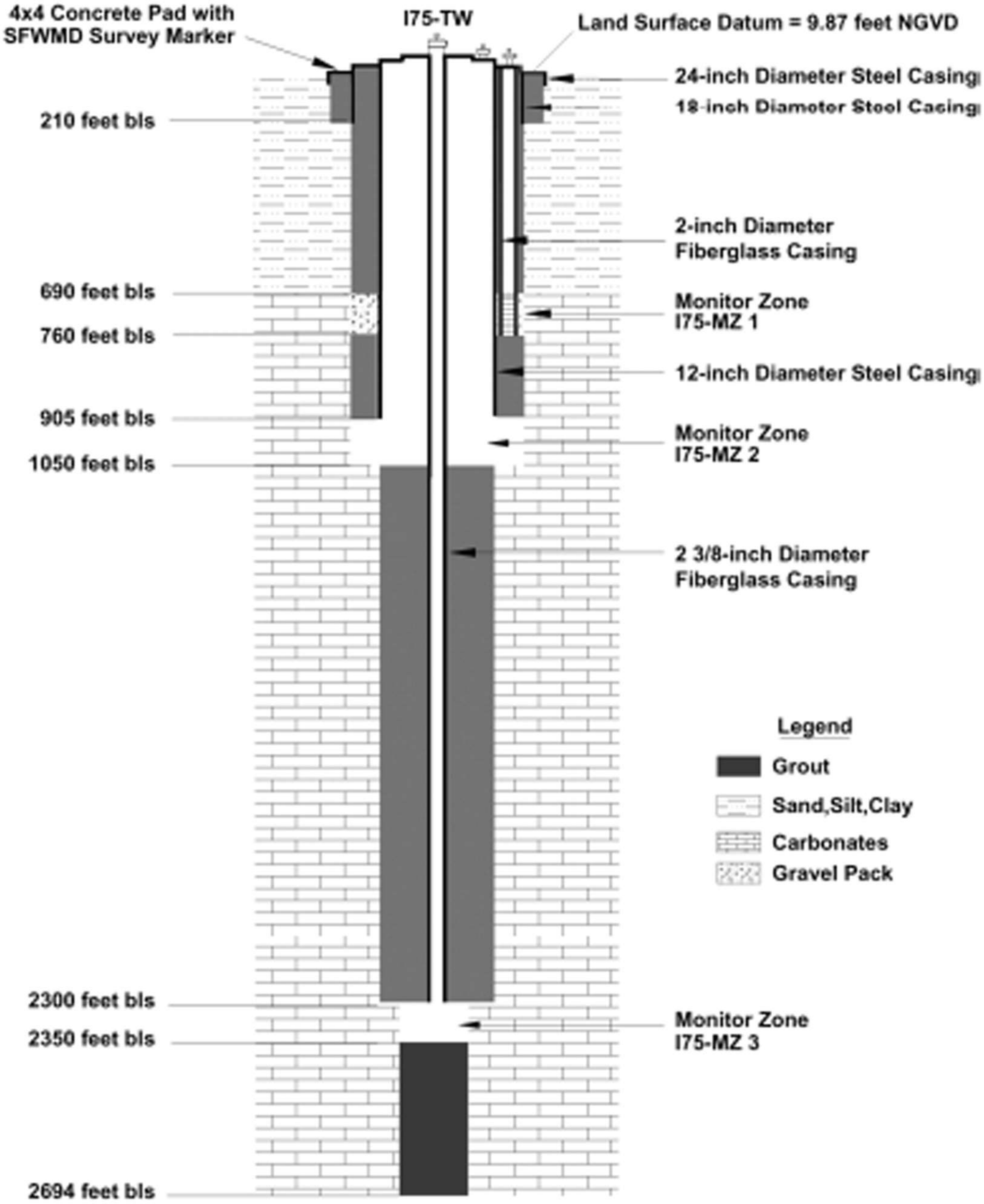


Figure 2. Well Completion Diagram for the Tri-Zone Monitor Well, I75-TW

On June 28, 1994, drilling began by advancing a 30-inch diameter borehole to a depth of 35 feet bls. Nominal 24-inch diameter, steel pit casing was installed in the nominal 30-inch diameter borehole. The steel pit casing was American Society of Testing Materials (ASTM) A53, Grade B, with 0.375-inch wall thickness. The annulus was grouted to land surface using 53 cubic feet (ft^3) of ASTM Type II, neat cement (15.6 pounds per gallon).

The pilot hole was drilled by the mud rotary method using a $7^7/_8$-inch diameter drill bit to a depth of 230 feet bls. Using well cuttings, the base of the Surficial Aquifer System (SAS) was identified at approximately 205 feet bls. The pilot hole was then reamed to 210 feet bls using a nominal 24-inch diameter staged bit reamer. An 18-inch diameter, steel surface pipe (ASTM A53, Grade B, 0.375-inch wall thickness) was installed in the nominal 24-inch diameter reamed hole at a depth of 210 feet bls. The annulus was grouted to land surface using 250 ft^3 of ASTM Type II, neat cement. The purpose of the surface casing was to 1) prevent unconsolidated surface sediments from collapsing into the drilled hole, 2) isolate the surficial aquifer from brackish water contamination, and 3) provide drill rig stability during continued drilling operations.

With the surface casing installed, the pilot hole was continued using the closed circulation mud rotary drilling method through the unconsolidated to semiconsolidated Pliocene-Miocene age sediments. Large volumes of drilling fluids were lost downhole while drilling through a high permeability dolostone unit encountered at a depth of 737 feet bls. On August 24, 1994, mud rotary drilling operations ceased (based on cost and time considerations). Drilling operations were continued using the reverse air open circulation drilling method to a depth of 925 feet bls.

The Big Cypress Basin Board provided additional funding (Amendment 2 to Contract C-4172) to perform geophysical logging, and conduct hydraulic and water quality tests on the lower portion of the Intermediate Aquifer System (IAS) at this site. This information was to be used in conjunction with other site-specific aquifer storage and recovery (ASR) assessments being conducted within the basin. Consequently, the nominal 8-inch diameter pilot hole was reamed from the base of the 18-inch diameter surface casing at 210 to 492 feet bls. Nominal 12-inch diameter steel pipe was temporarily installed at 490 feet bls to facilitate testing operations on the lower portion of the IAS. The temporary casing isolated the overlying unconsolidated to poorly consolidated silts and clays of the Peace River Formation of the Hawthorn Group from sloughing into the borehole during logging and testing operations.

A SFWMD-owned slim line geophysical unit was used to geophysically log the open hole section from 490 to 925 feet bls on August 27, 1994. Geophysical logs included a 3-arm caliper, natural gamma ray, spontaneous potential (SP), a 16/64-inch normal resistivity, and a 6-foot lateral resistivity. Production evaluation logs included a flowmeter run under dynamic conditions (artesian flow), temperature, and fluid resistivity. The individual log traces from I75-TW Geophysical Log Run 1 are provided in **Appendix A, Figure A-1**.

Based on the lithologic and geophysical log data, two formation evaluation tests were conducted using downhole inflatable packers to assess the water quality and production capacity of two potential ASR horizons within the IAS - primarily the Arcadia Formation of the Hawthorn Group. (Refer to the **Packer Tests** section of this report for further details and results of these two straddle-packer tests).

Upon completing the two straddle-packer tests, reverse air drilling operations resumed on September 23, 1994. Drilling operations continued to a depth of 1,361 feet bls, through the upper Floridan aquifer brackish-saline water interface, which was determined based on water quality results from reverse air returns. On September 28, 1994, a second suite of geophysical logs, also conducted by the SFWMD, was run in the open hole interval from 490 to 1,361 feet bls. The geophysical logging suite consisted of a 3-arm caliper, natural gamma ray, SP, a 16/64-inch normal resistivity, and a 6-foot lateral resistivity. Production-type logs included a flowmeter (dynamic run), temperature, and fluid resistivity. The individual log traces from I75-TW Geophysical Log Run 2 are presented in **Appendix A, Figure A-2**. A borehole video log was also conducted within this interval and is available for review at the SFWMD Headquarters in West Palm Beach, Florida.

The geophysical and lithologic data collected to this point were used to make design changes to the monitor well. To start, the temporary 12-inch diameter steel pipe (previously set at 490 feet bls) was removed. After reaming the borehole to a nominal 18-inch diameter, the pipe was permanently installed at a depth of 905 feet bls. Based on favorable water quality and productivity data, an interval from 690 to 760 feet bls was identified for further hydraulic testing and long-term monitoring. To isolate this zone, the 12-inch diameter casing (set at 905 feet bls) was cement grouted to 760 feet bls. Then, a combination of 2-inch diameter reinforced fiberglass pipe and stainless steel well screen (slot size 20) was installed between the 18-inch diameter surface casing and the 12-inch diameter intermediate casing. The gravel pack for the 2-inch stainless steel screen consisted of 3/8-inch diameter crushed limestone that was tremied into place from 690 to 760 feet bls. The remaining portion of the annulus was cement grouted from the top of gravel pack (at 690 feet bls) to land surface, completing the uppermost FAS monitor well (690 to 760 feet bls). This FAS monitor interval is referred to as I75-MZ 1.

After completing the second phase of monitor well construction, reverse air drilling operations resumed on November 19, 1994. Drilling continued through the poorly to well indurated limestone and dolostone units of the Ocala Limestone and Avon Park Formation to a depth of 2,694 feet bls. Once drilling operations were completed, the open hole section (905 to 2,694 feet bls) was reverse air developed, before conducting the third stage of geophysical logging operations.

On December 13, 1994, Florida Geophysical Logging Service ran the third suite of logs in the open hole section of the well bore from 905 to 2,374 feet bls. This geophysical logging suite consisted of the following logs: a 4-arm caliper, natural gamma ray, SP, dual induction with a laterolog (LL3), compensated density-neutron, and a borehole compensated (BHC) sonic log. Water production evaluation logs included a flowmeter conducted under static and dynamic conditions, a high-resolution temperature log, and a borehole video log. The individual log traces from I75-TW Geophysical Run 3 are presented in **Appendix A, Figure A-3**.

None of the geophysical probes were able to log the entire open hole section (905 to 2,694 feet bls) of the pilot hole because of an obstruction near its base. Several attempts were made to clear the obstruction by running drill pipe back to the bottom of the pilot hole. Second and third geophysical logging trips met with decreasing success with blockages occurring higher in the borehole. A borehole video camera was used to identify the obstruction and evaluate borehole stability. The borehole camera showed a highly fracture dolostone unit from 2,340 to 2,374 feet bls. At a depth of 2,374 feet bls, a series of large dolostone boulders from the borehole wall fell into and obstructed the borehole. Based on the images provided by the borehole camera, a fourth attempt to clear the borehole was not made, limiting geophysical logging operations to the interval above 2,374 feet bls.

Straddle-packer test intervals were selected using the information provided by analysis of the geophysical logs and well cuttings. The first of five tests within the FAS began on December 19, 1994. The purpose of these tests was to characterize the water quality and production capacities of specific intervals within the larger open hole interval (905 to 2,374 feet bls). From a water resource perspective, intervals having TDS concentrations greater than 10,000 milligrams per liter (mg/L) were not considered for further aquifer hydraulic characterization, since they are not considered potential sources of drinking water. An underground source of drinking water (USDW) is defined in Chapter 62-520 of the Florida Administrative Code as an aquifer containing water with a TDS concentration of less than 10,000 mg/L.

A set of five packer tests within the FAS was completed on January 26, 1995. The water quality data obtained from the straddle-packer tests were used in tandem with the geophysical logs to identify the base of the USDW at approximately 1,090 feet bls. The production and water quality results for the various packer tests are presented in the next section.

On February 3, 1995, the final stage of well construction began by setting a permanent cement plug within the pilot hole at the top of the obstruction at 2,374 feet bls. Backplugging operations then continued to a depth 2,350 feet bls using hydrated Type II Portland cement. Threaded 2-inch diameter, reinforced fiberglass plastic tubing (Smith Fiberglass, Series 1500) was used to construct the lower Floridan monitor well. This tubing, along with three steel cement baskets, were installed to a depth of 2,300 feet bls and cement grouted to 1,050 feet bls using multiple stages of neat cement (ASTM Type II). The open hole interval for the lower FAS monitor well is 2,300 to 2,350 feet bls (I75-MZ 3). Cement grouting of the 2–inch diameter reinforced fiberglass plastic tubing to 1,050 feet bls formed the base of the monitor interval for the second upper FAS monitor well. The open hole interval for the second FAS monitor zone is 905 to 1,050 feet bls (I75-MZ 2).

Three, 2-inch diameter, stainless steel piezometers, equipped with 2-inch inner diameter ball valves, were used to complete the wellhead for the tri-zone FAS monitor well. The piezometers monitor water levels in three intervals of the telescoped nested monitor well. The uppermost monitor well, I75-MZ 1, is constructed using 2-inch diameter fiberglass tubing and well screen installed between the 12- and 18-inch diameter, steel casings and monitors water levels between 690 to 760 feet bls. The intermediate well, I75-MZ 2, monitors water levels within a 145-foot section of the upper FAS between 905 to 1,050 feet bls. The lowermost well, I75-MZ 3, is constructed using 2-inch diameter threaded reinforced fiberglass tubing and monitors water levels in the lower FAS between 2,300 to 2,350 feet bls. **Table 1** lists the monitor intervals and completion methods for the tri-zone FAS monitor well.

Table 1. Tri-Zone FAS Monitor Well Intervals and Methods

Identifier	Monitor Interval (feet bls)	Completion Method
I75-MZ 1	690 to 760	Well Screen
I75-MZ 2	905 to 1,050	Annular Zone
I75-MZ 3	2,300 to 2,350	Open Hole

A 4-foot by 4-foot reinforced concrete pad was constructed at the surface of the monitor wellhead on April 20, 1995. This completed well construction operations in the Tri-Zone FAS monitor well.

I-75 Dual-Zone Test Production Well

Drilling and support equipment for the test production well was mobilized to the I -75 Canal site on August 12, 1996. After clearing and rough grading the site, the ground surface beneath the drill rig and settling tanks was lined with a HDPE membrane. A 2-foot thick temporary drilling pad was then constructed using crushed limestone. An earthen berm, two feet in height, was also constructed. The berm surrounded the perimeter of the rig and settling tanks and was used to contain drilling fluids and/or formation waters produced during well drilling, testing, and well construction.

Construction of the dual-zone test production well began during the third week of August 1996. This well was constructed to facilitate aquifer testing of two separate productive horizons in the upper Floridan aquifer between 690 to 1,050 feet bls. **Figure 3** is a completion diagram of the I-75 Canal Floridan aquifer dual-zone test production well identified as I75-PW.

Four concentric steel casings (24-, 18-, 12-, and 8-inch diameter) were used in the construction of the dual-zone Floridan aquifer test production well. Steel pit casing, 24 inches in diameter, was installed to 30 feet bls. Mud rotary drilling was used to advance the 24-inch diameter borehole to the top of the first FAS production interval at 690 feet bls. A caliper log was run to evaluate borehole stability and to calculate cement volumes for grouting operations. Eighteen-inch diameter steel pipe (ASTM A53, Grade B, and 0.375-inch wall thickness) was installed in the nominal 24-inch diameter borehole. Once installed, the 18-inch diameter casing was pressure grouted using 400 ft^3 of ASTM Type II neat cement. Additional stages of neat cement were placed using the tremie method with each stage being hard tagged after allowing sufficient time for the cement to harden. Successive cement stages were used to complete the cement grouting of the 18-inch diameter casing annulus back to land surface. Installation of the 18-inch diameter steel casing was completed on October 25, 1996.

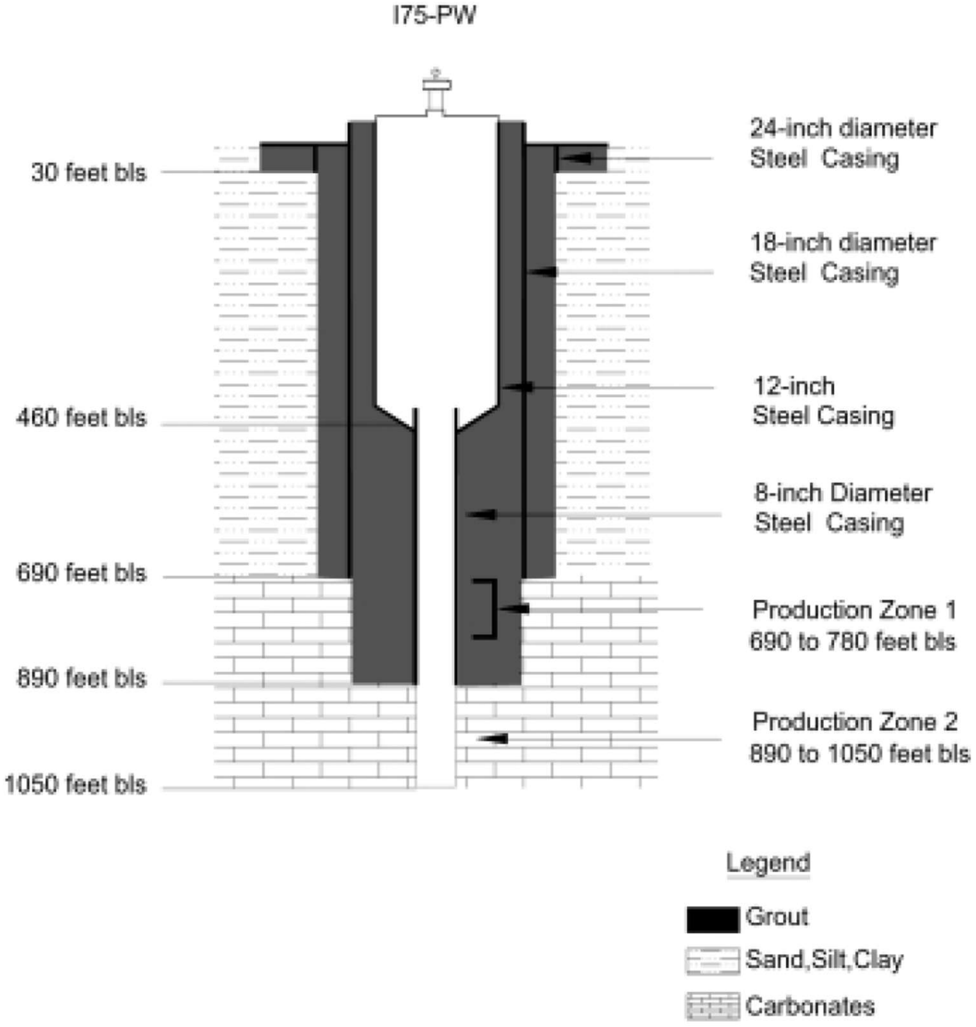


Figure 3. Well Completion Diagram for the Dual-Zone Test Production Well, I75-PW

Reverse air drilling was then used to drill the uppermost FAS production interval (Lower Hawthorn/Suwannee aquifer) from 690 to 780 feet bls. This interval was developed using reverse air, pressurized air, and artesian flow techniques until the formation water sediment concentrations were 15 mg/L or less (using an Imhoff tube). Once well development was completed, RST Company geophysically logged the open hole section of the production horizon. An aquifer performance test (APT) was then conducted on the upper FAS production interval during the latter part of November 1996 (refer to the **Aquifer Performance Testing** section of this report for details and results).

After successfully completing the first APT, the borehole was advanced by the reverse air drilling method, using a nominal 18-inch diameter, staged bit reamer to the top of the second FAS production horizon at 890 feet bls. Again, a caliper log was run to evaluate borehole stability and calculate cement volumes for subsequent grouting operations. The second stage of well construction consisted of installing 890 feet of production casing using both 8- and 12-inch diameter steel pipes (ASTM A53, Grade B, and 0.375-inch wall thickness). The upper 460 feet consisted of 12-inch diameter steel pipe, with the lower section consisting of 430 feet of 8-inch diameter steel pipe. The production casing was installed and grouted to land surface with 857 ft^3 of ASTM Type II neat cement, using both pressure and tremie grouting methods. The second test interval was then drilled with a nominal 8-inch bit, using the reverse air method to a total depth of 1,050 feet bls. Three, 10-foot long, full diameter rock cores (4-inch diameter) were obtained from the second production interval (890 to 1,050 feet bls – Suwannee Limestone). These cores were sent to Core Laboratories in Midland, Texas, for petrophysical and petrologic analyses (refer to the **Petrophysical and Petrologic Data** section of this report for further information). On December 30, 1996, drilling of the second FAS test interval was completed to a depth of 1,050 feet bls.

Well development on the open hole section was completed using reverse air, pressurized air, and artesian flow techniques until the formation water sediment concentrations were 15 mg/L or less (using an Imhoff tube). Once sufficiently developed, RST Company geophysically logged the open hole section (890 to 1,050 feet bls). The second APT was then conducted and completed on January 15, 1997 (refer to the **Aquifer Performance Testing** section of this report for test details and results).

A standard 12-inch diameter wellhead was installed consisting of an iron body, bronze-mounted valves with flanged ends, solid wedge gate, and outside screw and yoke gate valves with an 8-inch diameter side discharge port. A 4-foot by 4-foot reinforced concrete pad was then constructed at the surface to complete the construction of the test production well. Well construction activities were completed on February 12, 1997.

This well was backplugged and abandoned on October 30, 2000, due to changes in land ownership. The well and surface facilities caused a physical obstruction to a new building planned for the property. Before well abandonment operations began, MV Geophysical ran both a natural gamma and caliper log prior to back-plugging operations.

HYDROGEOLOGIC TESTING

Specific information was collected during the drilling program to determine the lithologic, hydraulic, and water quality characteristics of the FAS at this site. These data were to be used to design both the Floridan aquifer monitor and test production wells for site specific aquifer tests and a long-term water level and water quality monitoring program.

Formation Sampling

Geologic formation samples (well cuttings) were collected, washed, and described (using the Dunham, 1962, classification scheme) on site during the drilling of the pilot hole for the tri-zone monitor well (I75-TW). Formation samples were collected continuously and separated based on their dominant lithologic or textural characteristics, and to a lesser extent, color. If a massively bedded unit was encountered, composite samples were taken at 5-foot intervals. The representative formation samples were split into two sets and distributed to the SFWMD and the Florida Geological Survey (FGS).

The lithostratigraphic column, shown in **Figure 4**, was constructed using both the SFWMD's on-site drilling log and lithologic descriptions provided by the FGS. The FGS's detailed lithologic description for the pilot hole/monitor well (FGS Reference W-17405) is provided in **Appendix B**. Copies of the original on-site drillers log (lithologic description) are archived and available for review at the SFWMD's headquarters in West Palm Beach, Florida.

Formation Fluid Sampling

During reverse air drilling of the tri-zone monitor well (I75-TW), samples were taken from circulated return fluids (composite formation water) at 30-foot intervals (average length of drill rod) from 1,209 feet bls to the total depth of the pilot hole at 2,694 feet bls. Field parameters, including temperature, specific conductance, and pH were determined on each sample using a Hydrolab multiparameter probe. Chloride concentrations were also determined using a field titration method (Hach Kit). **Figure 5** shows the field chloride concentrations and the specific conductance values with respect to depth. As shown in this figure, between 1,209 to 1,267 feet bls, specific conductance values and chloride concentrations average 12,000 micromhos per centimeter (µmhos/cm) and 4,500 mg/L, respectively. Between 1,267 and 1,392 feet bls, specific conductance, and chloride concentrations increase to about 17,000 µmhos/cm and 7,000 mg/L, respectively. At 1,392 feet bls, conductance and chloride values show marked increases; brackish to saline waters (chloride concentrations in excess of 10,000 mg/L) occur from this depth to the total depth of the well at 2,694 feet bls.

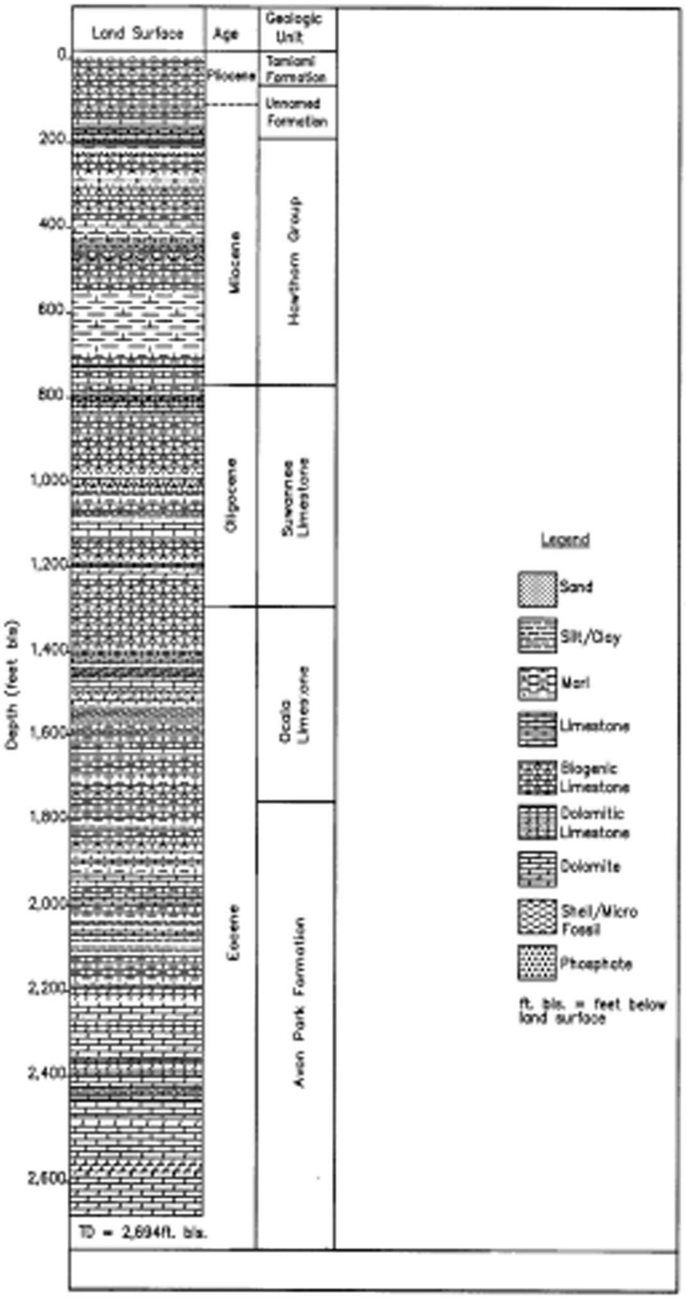


Figure 4. Lithostratigraphic Column

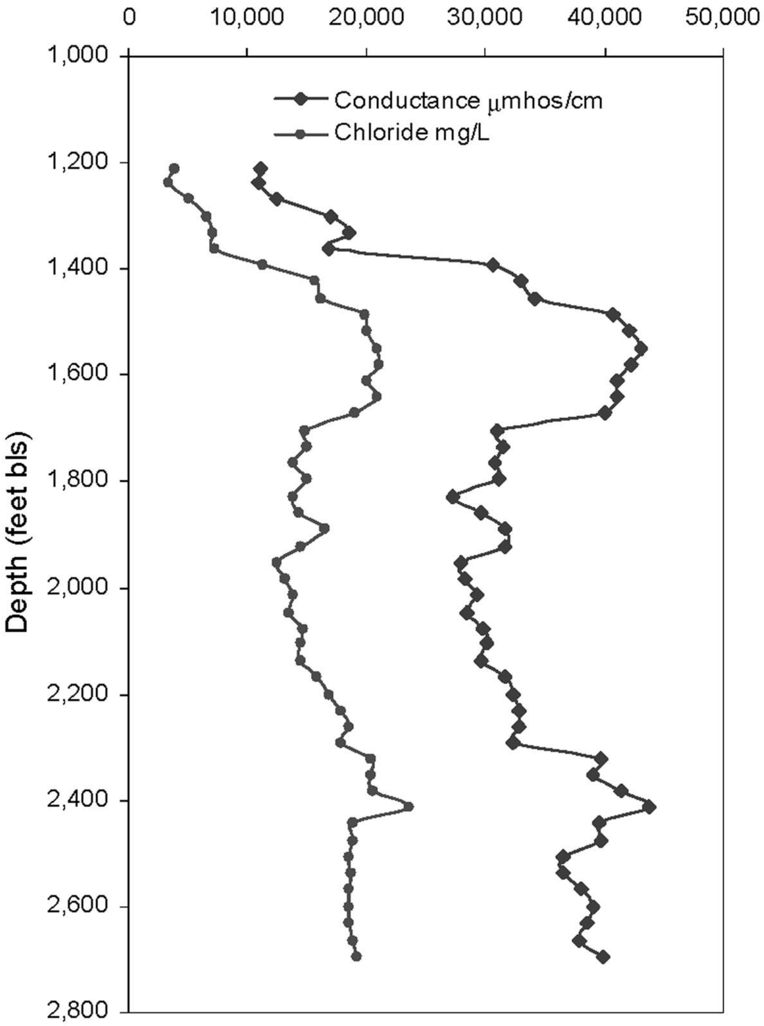


Figure 5. Water Quality Data from Reverse Air Returns for I75-TW

Geophysical Logging

Geophysical logging was conducted in the pilot hole after each stage of drilling and before reaming of the borehole for casing installations. The resulting logs provide a continuous record of the physical properties of the subsurface formations and their contained fluids (Hallenburg, 1998). These logs were later used to assist in the interpretation of lithology; provide estimates of permeability, porosity, bulk density, and resistivity of the aquifer; and determine the salinity profile of the groundwater (using Archie's equation, Archie, 1942). In addition, the extent of confinement of discrete intervals can be discerned from the individual logs. All geophysical log data were downloaded directly from the on-site logging processor in log American Standard Code for Information Interchange (ASCII) Version 1.2 or 2.0 format. The SFWMD and local slim line logging firms provided supplemental geophysical logging services. The geophysical log traces from Log Runs 1, 2, and 3 for Well I75-TW are presented in **Appendix A**, **Figures A-1**, **A-2**, and **A-3**, respectively. The original geophysical logs and video surveys are archived and available for review at the SFWMD's headquarters in West Palm Beach, Florida.

A summary of the geophysical logging program conducted at this site is listed in **Table 2**. The neutron and density porosities for Geophysical Log Run 3 for Well I75-TW were derived using a limestone matrix with a density of 2.71 grams per cubic centimeter (g/cm^3).

Table 2. Summary of Geophysical Logging Operations for the I-75 Canal Site

Date	Run No.	Logging Company	Elevation (feet NGVD)	Logged Interval (feet bls)	Caliper	Natural Gamma	Spontaneous Potential	Resistivity 16"/64" 6' Lateral	Induction	Density	Neutron	Sonic	Flowmeter	Temperature	Fluid Resistivity	Video
				I75-TW												
08/27/94	1	SFWMD	9.87	490-925	x	x	x	x			x		x	x	x	
9/28/94	2	SFWMD	9.87	490-1361	x	x	x	x					x	x	x	x
12/13/94	3	Florida Geophysical	9.87	905-2374	x	x	x		x	x	x	x	x	x		x
				I75-PW												
11/22/96		RST Enterprises	10.5	5-780	x	x		x					x	x	x	
10/26/00		MV Geophysical	10.5	0-1050	x	x										

Packer Tests

The first set of straddle-packer tests was limited to the open hole section transecting the lower portion of the IAS. The second set of straddle-packer tests was conducted within the FAS (1,158 to 2,251 feet bls). The purpose of these tests was to 1) gain water quality and production capacity data on discrete intervals (25 to 75 feet in length) and 2) establish the depth of the 10,000 mg/L TDS interface.

The procedures listed below were used to conduct individual packer tests in Well I75-TW at the I-75 Canal site:

1. The packer assembly was lowered to the interval selected for testing based on geophysical and lithologic logs.
2. The packers were set and inflated, and the ports opened between the packers to the test interval.
3. A 4-inch diameter submersible pump was installed to depth of 60 to 120 feet below the drill floor with a pumping capacity of 120 gallons per minute (gpm).

4. Two 100-pounds per square inch (psi) pressure transducers were installed inside the drill pipe and one 30-psi transducer was installed in the annulus.
5. A minimum of three drill-stem volumes were purged.
6. Pressure transducer readings and field water quality parameters (e.g., temperature, specific conductance, and pH) from the purged formation water were monitored until stable. These parameters were used to determine the quality of isolation of the packed off interval.
7. Once the interval was effectively isolated, a constant rate drawdown and recovery test was performed.
8. Representative formation water samples were collected for laboratory water quality analyses following the SFWMD's quality assurance/ quality control sampling protocol.
9. Recovery data was recorded until water levels returned to static conditions.

Before groundwater sampling commenced, the packer intervals were purged until three drill-stem volumes were evacuated or until field parameters of samples collected from the discharge pipe had stabilized. A limit of ±5 percent variation in consecutive field parameter readings was used to determine chemical stability. In each sample, field parameters, including temperature, specific conductance, and pH were measured using a Hydrolab multiparameter probe. Chloride concentrations were also determined using a field titration method (Hach Kit). The flow of water from the discharge point was adjusted to minimize the aeration and disturbance of the samples. Unfiltered and filtered samples were collected directly from the discharge point into a Teflon bailer. The bailer was then placed on a bailer stand where the sample bottles were filled slowly to minimize aeration. Duplicate samples were collected from consecutive bailers. Sample splits were collected from the same bailer.

Once samples were collected, the bottles were preserved and immediately placed on ice in a closed container and transported to the SFWMD's water quality laboratory. The samples were then analyzed for major cation and anions using United States Environmental Protection Agency and/or standard method procedures from SFWMD's CompQAP (SFWMD, 1994).

The Hazen-Williams equation was used to calculate the friction (head) losses for all drawdown data because of induced flow up the drill pipe. These head losses were then used to correct the drawdown data for specific capacity determinations. Curve matching techniques were not used to determine transmissivity values because the drawdown and recovery data from the individual packer tests were lost during the downloading of the Hermit 1000 data recorder as result of an internal memory error.

Intermediate Aquifer System

Packer Test 1 (495 to 550 feet bls)

The purpose of Packer Test 1 was to obtain water samples for inorganic analyses and determine the interval's production capacity. The main intent of this packer test was to gather pertinent information to complement future ASR feasibility studies focusing on the IAS. This test was conducted on September 19, 1994, and consisted of pumping an interval between 495 and 550 feet bls (part of the Arcadia Formation). This interval was pumped for two hours at an average discharge rate of 20 gpm. The maximum measured drawdown while pumping was 59.40 feet (minimal friction loss), and the specific capacity was calculated as 0.34 gpm per foot of drawdown (gpm/ft/dd). The static water level after recovery was measured as 31.64 feet above the National Geodetic Vertical Datum of 1929 (feet NGVD) and was density corrected to 32.77 feet NGVD. The land surface at the site was surveyed at 10.25 feet NGVD. Water quality results indicated that the produced formation water had 3,640 mg/L of TDS, exceeding the potable drinking water standard of 500 mg/L TDS. The results of the complete anion/cation analyses are listed in **Table 3**.

Packer Test 2 (654 to 710 feet bls)

The purpose of Packer Test 2 was to gather hydraulic and water quality data from the lowermost section of the IAS. The main intent of this packer test was also to gather pertinent information to complement future regional ASR feasibility studies in the IAS. This test, conducted on September 20, 1994, consisted of pumping an interval between 654 and 710 feet bls (lower portion of the Arcadia Formation). This interval was pumped for one hour at an average discharge rate of 94 gpm. The maximum measured drawdown while pumping was 62.60 feet with a friction loss of 3.64 feet. Using a corrected drawdown of 58.96 feet, the specific capacity was calculated as 1.59 gpm/ft/dd. The static water level was measured at 32.41 feet NGVD (density corrected to 34.01 feet NGVD). Water quality results indicated that the produced formation water also exceeded the potable drinking water standard of 500 mg/L TDS with a measured concentration of 3,890 mg/L. The results of the complete anion/cation analyses are also listed in **Table 3**.

Table 3. Summary of Packer Test Results for the IAS for I75-TW

Packer Test	Sample Date	Depth Interval (feet bls)	Specific Capacity (gpm/ft/dd)	Measured Static Head (feet NGVD)	Cations (mg/L)[a]				Anions (mg/L)[b]			TDS	Field Parameters[c]		
					Na$^+$	K$^+$	Ca^{2+}	Mg^{2+}	Cl$^-$	Alkalinity as CaCO$_3$	SO$_4^{2-}$		Spec Cond (µmhos/cm)	Temp (°C)	pH (s.u.)
1	09/19/94	495-550	0.34	31.64	1,035	40	140	170	1,630	195	532	3,640	6,230	28.62	7.01
2	09/20/94	654-710	1.59	32.41	1,092	41	190	171	1,754	160	558	3,890	7,150	28.29	7.18

a. Na = sodium; K = potassium; Ca = calcium, Mg = magnesium
b. Cl = chloride; CaCo$_3$ = calcium carbonate; SO$_4$ = sulfate
c. Spec Cond = specific conductance; Temp (°C) = temperature (degrees Celsius); s.u. = standard units

Floridan Aquifer System

Packer Test 1 (2,195 to 2,251 feet bls)

The purpose of Packer Test 1 was to measure the potentiometric head and obtain a water quality sample for inorganic and stable isotope analysis from the lower Floridan aquifer. An interval between 2,195 and 2,251 feet bls was selected, and a drawdown/ recovery test was conducted on December 19, 1994. This interval was pumped for 1.7 hours at an average rate of 100 gpm. Maximum drawdown measured while pumping was 24.52 feet. The specific capacity was calculated as 9.38 gpm/ft/dd using a drawdown corrected for friction loss of 10.66 feet. The static water level was measured at 9.81 feet NGVD, which was density corrected to a freshwater equivalent head of 68.83 feet NGVD. Chloride and TDS concentrations from samples collected from the zone were 19,262 and 34,600 mg/L, respectively. The complete results of the anion/cation analyses are reported in **Table 4**.

Packer Test 2 (1,851 to 1,901 feet bls)

Packer Test 2 was conducted to determine the hydraulic properties and water quality characteristics of a productive interval within the middle Floridan aquifer. The dual packers isolated an interval between 1,851 and 1,901 feet bls. A drawdown test was conducted on December 20, 1994, by pumping this interval for 100 minutes at an average rate of 102 gpm. The maximum drawdown was 19.21 feet and the specific capacity was calculated as 13.49 gpm/ft/dd, correcting for friction loss of 11.65 feet. The static water level was measured at 10.46 feet NGVD, which was density corrected to a freshwater equivalent head of 60.28 feet NGVD. Chloride and TDS concentrations from the zone were comparable to seawater with values of 19,281 and 34,900 mg/L, respectively. The complete results of the anion/cation analyses are reported in **Table 4**.

Packer Test 3 (1,469 to 1,524 feet bls)

The purpose of Packer Test 3 was to evaluate the hydraulic and water quality characteristics of a flow zone (based on lithologic and geophysical log data) in the middle FAS confining unit. The dual packer configuration isolated an interval between 1,469 and 1,524 feet bls. A drawdown test was conducted on December 21, 1994, by pumping this interval for 62 minutes at an average rate of 102 gpm. The maximum measured drawdown was 16 feet, with a corrected drawdown for friction loss of 6.74 feet. The specific capacity was calculated as 15.13 gpm/ft/dd. The static water level was measured at 10.51 feet NGVD, which was density corrected to 49.54 feet NGVD. Chloride and TDS concentrations from samples collected from the zone were 19,037 and 35,100 mg/L, respectively. The complete results of the anion/cation analyses are reported in **Table 4**.

Packer Test 4 (1,158 to 1,185 feet bls)

Packer Test 4 was conducted to help approximate the base of the USDW at this site. The dual packer configuration isolated an interval within the brackish water zone of the upper Floridan between 1,158 and 1,185 feet bls. A drawdown test was conducted on December 30, 1994, by pumping this interval for 76 minutes. The average pumping rate during the test was 67 gpm, with a maximum recorded drawdown of 62.26 feet. The drawdown was corrected for friction loss and the specific capacity was calculated as 1.45 gpm/ft/dd. The static water level was measured at 16.26 feet NGVD, which was density corrected to 32.67 feet NGVD. Water quality results from this zone yielded chloride and TDS concentrations of 10,151 and 17,600 mg/L, respectively. The results of the complete anion/cation analyses are reported in **Table 4**.

Packer Test 5 (1,287 to 1,318 feet bls)

The purpose of Packer Test 5 was to evaluate the hydraulic and water quality characteristics of a proposed long-term monitor interval in the middle FAS confining unit at this site. However, a permanent, long-term monitor zone was never established due to well construction problems. The dual packer setup isolated an interval between 1,287 and 1,318 feet bls. A drawdown test was conducted on January 25, 1995, by pumping this interval for 63 minutes. The average pumping rate during the test was 48 gpm with a maximum recorded drawdown of 41.74 feet. The drawdown was corrected for friction loss, and the specific capacity was calculated as 1.21 gpm/ft. The static water level was measured at 14.55 feet NGVD (density corrected to 40.29 feet NGVD). Water quality results from this zone yielded chloride and TDS concentrations of 14,330 and 27,300 mg/L, respectively. The results of the complete anion/cation analyses are reported in **Table 4**.

Table 4. Summary of Packer Test Results for the FAS for I75-TW

Packer Test	Depth Interval (feet bls)	Specific Capacity (gpm/ft/dd)	Measured Static Head (feet NGVD)	Sample Date	Cations (mg/L)				Anions (mg/L)			TDS	Field Parameters		
					Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	Alkalinity as $CaCO_3$	SO_4^{2-}		Spec Cond (µmhos /cm)	Temp (°C)	pH (s.u.)
1	2,195-2,251	9.38	9.81	12/19/94	11,520	428	620	1,354	19,262	108	2,511	34,600	46,610	29.56	6.91
2	1,851-1,901	13.49	10.46	12/20/94	11,260	418	600	1,334	19,281	108	2,136	34,900	45,080	30.16	6.81
3	1,469-1,524	15.13	10.51	12/21/94	11,460	432	620	1,368	19,037	110	2,259	35,100	45,050	30.00	6.84
4	1,158-1,185	1.45	16.26	12/30/94	6,050	200	400	638	10,151	165	1,336	17,600	25,390	29.67	6.89
5	1,287-1,318	1.21	14.55	01/25/95	9,780	321	491	994	14,330	154	1,745	27,300	35,650	29.42	6.91

Stable Isotope and Carbon 14 Data

The acquisition of isotopic data can complement inorganic geochemistry and physical hydrogeology investigations. Therefore, water samples were also collected during packer tests and monitor well development and sent to the University of Waterloo for stable isotope determination. The analytical services included the determination of the stable isotope compositions for the following parameters: oxygen 18 (^{18}O), hydrogen (^{2}H) or deuterium (D), carbon 13 (^{13}C), and sulfur 34 (^{34}S). The ^{18}O values were determined by carbon dioxide (CO_2) equilibration using standard procedures outlined by Epstein and Mayeda (1953) and Drimmie (1993). The D compositions were determined using the methods of Coleman et al. (1982) and Drimmie et al. (1991). The ^{13}C values were performed on CO_2 produced from dissolved inorganic carbon treated with phosphoric acid using methods described by Drimmie et al. (1990). An accelerator mass spectrometer at the Rafter Radiocarbon Laboratory, located at the Institute of Geological and Nuclear Sciences in New Zealand, was used to determine radiocarbon age, delta ^{14}C, and percent of modern carbon (pmC) using procedures outlined in Stuiver and Polach (1977).

The data collected at this site will be used in a regional investigation currently being conducted by the author to better understand the groundwater circulation patterns (Kohout, 1965, 1967) and identify recharge and discharge areas within the FAS. If an interval has a particular isotopic signature, it may help to identify and assist in the mapping of ASR and reverse osmosis horizons within the upper Floridan aquifer. Carbon-14 dating of groundwater can be used to determine regional flow velocity estimates within the Floridan aquifer (Hanshaw et al., 1964).

The stable isotopic results from the I-75 Canal site (**Table 5**) show that the upper Floridan waters are depleted in both ^{18}O and D, as compared to standard mean ocean water (SMOW), $\delta^{18}O = 0$ per mil ($^{0}/_{00}$) and $\delta D = 0$ $^{0}/_{00}$. **Figure 6** shows that the isotopic composition of the upper Floridan aquifer waters deviate slightly from the global meteoric water line (GMWL) (Craig, 1961) and mean isotopic composition of recent Everglades

Table 5. Summary of Stable Isotope and Carbon 14 Analyses for the FAS

Identifier[a]	Depth (feet bls)	Sample Date	$\delta^{18}O$ $^{0}/_{00}$ SMOW	$\delta^{2}H$ $^{0}/_{00}$ SMOW	$\delta^{37}Cl$ $^{0}/_{00}$ SMOC[b]	$\delta^{13}C$ $^{0}/_{00}$ PDB[c]	$\delta^{34}S$ $^{0}/_{00}$ CDT[d]	$\delta^{14}C$ $^{0}/_{00}$	^{14}C (pmc)	^{14}C Age (year BP)
I75-MZ 1	690-760	04/13/95	-1.05	-6.51	0.11	-3.97	23.08	-993.3	0.67	40,130
I75-MZ 2	905-1050	04/13/95	-1.05	-6.45	0.24	-2.64	21.99			
I75-PT 4	1158-1185	12/30/94	0.57	2.61	0.19	-1.87	20.44			
I75-PT 3	1469-1524	12/21/94	0.67	2.97	0.15	-1.42	20.81			
I75-PT 2	1851-1901	12/20/94	0.54	4.28	-0.01	-1.59	20.86			
I75-PT 1	2195-2251	12/19/94	0.60	2.46	0.19	-1.35	20.86			
I-75-MZ 3	2300-2350	04/13/95	0.65	1.16	0.01	-1.78	21.11	-809.3	19.70	13,429

a. PT = Packer Test; MZ = Monitor Zone
b. SMOC = Standard Mean Ocean Chloride Standard
c. PDB = Pee Dee Belemnitella Standard
d. CDT = Canon Diablo Meteorite Standard

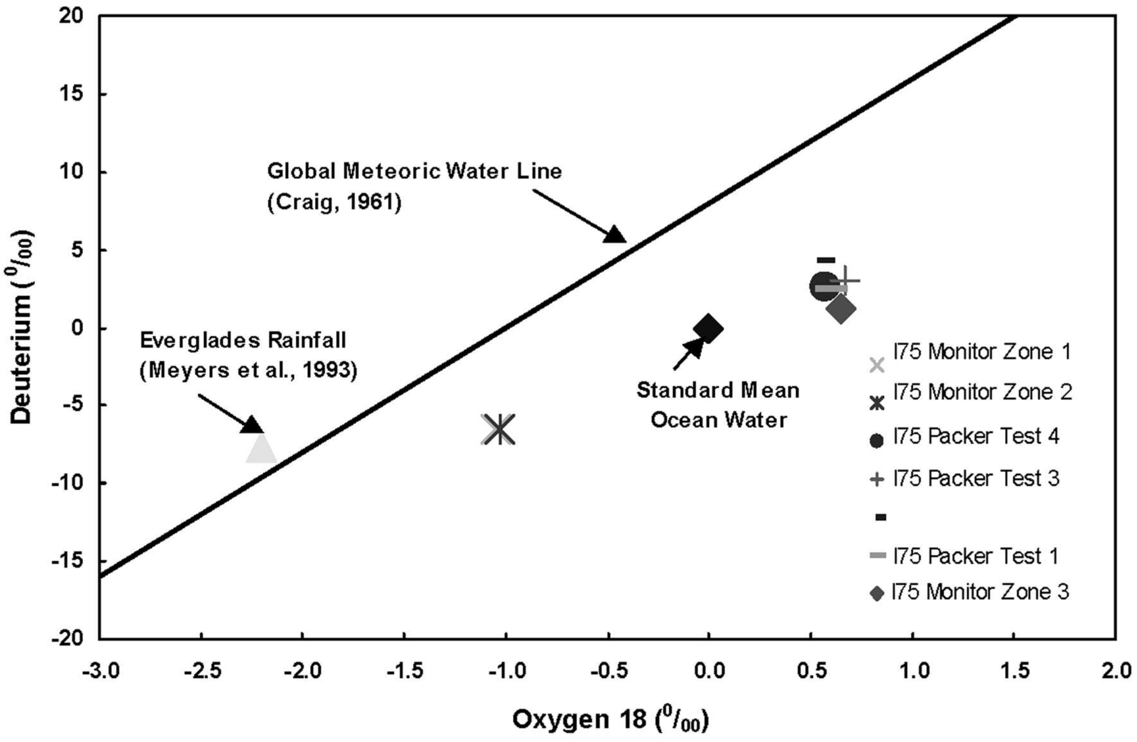


Figure 6. Relationship between Stable Isotopes Deuterium and Oxygen 18

rainfall, which is $\delta^{18}O=-2.2^{0}/_{00}$ and $\delta D=-7.6\ ^{0}/_{00}$ (Meyers et al., 1993). This may indicate that climatic conditions and recharge of meteoric water into the upper Floridan aquifer were slightly different than present. In addition, evaporation may have been minimal before meteoric recharge, which caused the upper Floridan aquifer waters to plot near the GMWL. The stable isotopic results from the I-75 Canal site show that the middle and lower Floridan aquifer waters are slightly enriched in both $\delta^{18}O$ and δD, as compared to SMOW. The inorganic water quality results from intervals below 1,158 feet bls are brackish to saline in composition and the $\delta^{18}O$ and δD values are similar, plotting above SMOW (**Figure 6**). These results suggest that the middle and lower portions of the Floridan aquifer have been intruded by seawater.

The ^{14}C activities or pmC values listed in this report are absolute percent of modern relative to the National Bureau of Standards oxalic acid (HOxI) standard corrected for decay since 1950. The ^{14}C activity of a groundwater sample from the upper Floridan (690 to 760 feet bls) produced a value of 0.67 pmC. The apparent radiocarbon age for this interval is approximately 40,130 years before present (BP). The apparent radiocarbon age was not corrected for chemical or isotopic dilution methods and other factors (Tamers, 1967; Mook, 1976). If the apparent radiocarbon age is considered an absolute age, assuming a closed system and little or no chemical or isotopic dilution, meteoric recharge to the Floridan occurred during the late Pleistocene. However, this age may not be accurate as the $\delta^{13}C$ data suggest rock-water interactions. The ^{14}C activities of groundwater samples from the lower Floridan aquifer (2,300 to 2,350 feet bls) interval generated an average value of 19.7 pmC. The apparent radiocarbon age for this interval was approximately 13,400 years BP. The significant differences in the $\delta^{18}O$ and δD values, ^{14}C activities, and reported radiocarbon ages between the upper and lower

Floridan aquifers suggest two different water masses may be present. Similar variations with depth have been reported from a FAS well constructed in western Broward County, Florida (Meyer, 1989). The upper Floridan waters may be a combination of meteoric and intruded seawater. The lower Floridan waters appear to be younger intruded seawater that may have entered somewhere along the Florida Straits. That water may have moved inland through the "Boulder Zone" or other highly permeability rock units of the lower Floridan to its present position some 13,000 or less years BP. Unfortunately, ^{14}C activities of groundwater samples were not determined between 780 and 2,300 feet bls and, therefore, the validity of Kohout's (1965, 1967) cyclic flow theory could not be determined and the presence of an upward flow component from the lower Floridan was not discerned.

Petrophysical and Petrologic Data

During drilling of the test production well (I75-PW), conventional coring methods were employed using a 4-inch diameter, 10-foot long, diamond-tipped core barrel. Three rock cores of various lengths were recovered from the Suwannee Limestone between 910 to 1,030 feet bls, with core recoveries of 20 to 50 percent. The three vertically oriented cores were then sent to Core Laboratories, Midland, Texas, to determine the following parameters: horizontal and vertical permeability, porosity, grain density, and lithologic character.

Upon arrival at Core Laboratories, a core spectral gamma log was recorded on the cores for downhole correlation. Full diameter and plug samples (when core conditions necessitated) were then selected for further core analyses, and fluid removal was achieved by convection oven drying.

Full diameter porosity was determined by direct pore volume measurement using Boyle's law of helium expansion. Once the samples were cleaned and dried, bulk volume was measured by Archimedes Principle. Grain density was calculated from the dry weight, bulk volume, and pore volume measurements using **Equation 1** (American Petroleum Institute, 1998). Porosity was calculated using bulk volume and grain volume measurements using **Equation 2**.

$$\text{Grain Density} = \text{Dry Weight}/(\text{Bulk Volume} - \text{Pore Volume}) \qquad (1)$$

$$\text{Porosity} = (\text{Bulk Volume} - \text{Grain Volume})/\text{Bulk Volume} \times 100 \qquad (2)$$

The 1-inch diameter plugs had direct grain volume measurements using Boyle's helium expansion law. After cleaning, bulk volume was measured by Archimedes Principle on the individual plug samples. The bulk volume and grain volume measurements were used in **Equation 2** to calculate porosity. Two plug samples from a core obtained from 910 to 911 feet bls were selected for stress pore volume measurements, at 400-psi net confining pressure, to determine net overburden effects on porosity. The stress pore volume data indicate minimal-to-no pore volume reductions (**Table 6**).

Table 6. Summary of Net Overburden Pressure Effects on Porosity

Sample	Depth (feet bls)	Data Source	Horizontal Permeability (millidarcies)	Porosity Helium (percent)	Grain Density (g/cm^3)	Description
1	910.8	Original ambient porosity		33.5	2.69	Limestone, vuggy fossils
1	910.8	Second ambient porosity		33.7	2.69	
1	910.8	400-psi net overburden porosity	3.24	33.8	2.69	
2	911.3	Original ambient porosity		39.7	2.70	Limestone, vuggy fossils
2	911.3	Second ambient porosity		39.7	2.70	
2	911.3	400-psi net overburden porosity	380	39.7	2.70	

Steady state air permeability was measured on full diameter samples in two horizontal directions and vertically while the core was confined in a Hassler rubber sleeve at 400-psi net confining stress. Permeability for plug samples was measured in the horizontal direction and confined at 400-psi net stress.

The cores were double slabbed and boxed after analysis, and photographed under natural and ultraviolet light. Negatives of the slabbed cores were scanned and stored on a compact disc and reproduced in **Appendix C**. The results of the petrophysical analyses are listed in **Table** 7.

Horizontal to vertical permeability and horizontal permeability (K_{90}/K_{max}) anisotropy ratios were not calculated due to the limited number of values. A semi-log cross-plot of laboratory determined horizontal permeability versus (helium) porosity for 910.8 and 1,020.5 feet bls is shown in **Figure** 7. The widely scattered data points suggest no linear relationship between horizontal permeability and porosity.

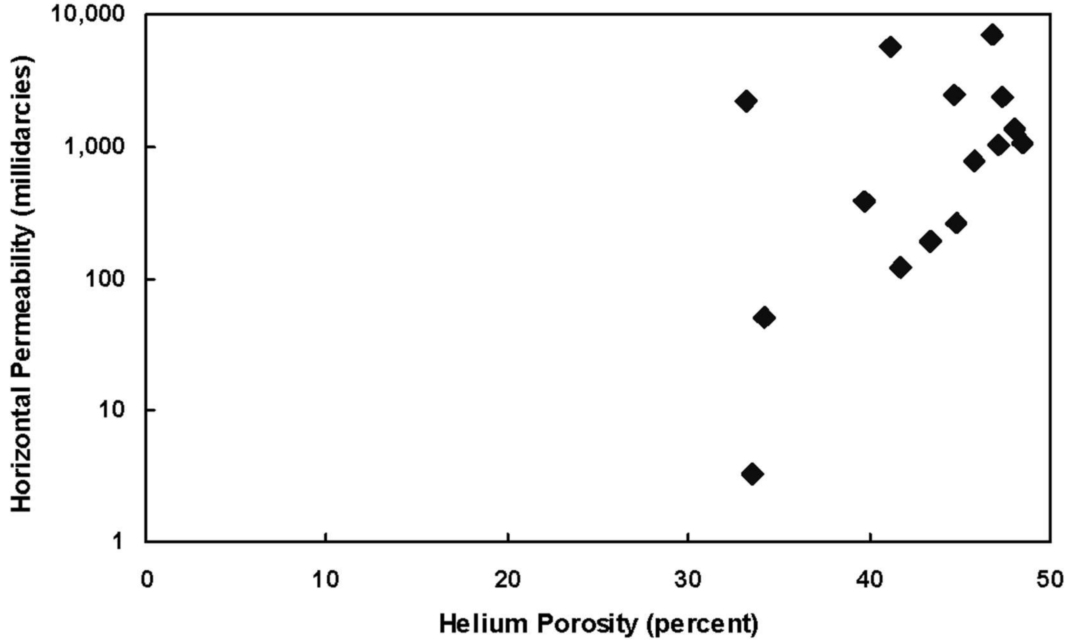


Figure 7. Cross-Plot of Permeability versus Porosity for I75-PW at 910.8 and 1,020.5 feet bls

Table 7. Summary of Petrophysical Analyses

Sample	Depth (feet bls)	Horizontal Permeability (millidarcies)	Vertical Permeability (millidarcies)	Porosity Helium (percent)	Grain Density (g/cm^3)	Description
Core 1						
1*	910.8	3.24		33.5	2.69	Limestone, vuggy, fossils
2*	911.3	380.00		39.7	2.70	Limestone, vuggy, fossils
3	912.5	2,206.00		33.2	2.71	Limestone, vuggy, fossils
Mean		863.1		35.5	2.7	
Standard Deviation		1,178.16		3.67	0.01	
Core 2						
4	945.2	260.00		44.8	2.71	Limestone, pinpoint porosity
5	946.5	193.00		43.4	2.70	Limestone, pinpoint porosity
6	947.5	2,444.00		44.7	2.71	Limestone, slightly vuggy
7*	948.7	7,027.00		46.8	2.71	Limestone, slightly vuggy
8	949.6	17,294.00		42.9	2.71	Limestone, slightly vuggy
9	950.5	5,613.00	5,759.0	41.2	2.72	Limestone, slightly vuggy
10	951.2	770.00		45.8	2.71	Limestone, slightly vuggy
11*	952.1	1,026.00		47.1	2.71	Limestone, vuggy, fossils
12*	953.1	1,057.00		48.4	2.71	Limestone, vuggy, fossils
13*	954.3	1,375.00		48.0	2.70	Limestone, vuggy, fossils
14	954.8	2,339.00		47.3	2.70	Limestone, vuggy, fossils
Mean		3581.6		45.5	2.7	
Standard Deviation		5,050.35		2.30	0.01	
Core 3						
15	1,020.8	49.70	1.8	34.2	2.72	Limestone, vuggy, fossils
16*	1,021.5	121.00		41.7	2.71	Limestone, vuggy, fossils
Mean		85.4		38.0	2.7	
Standard Deviation		50.42		5.30	0.01	

*core plug analysis

Once the cores were slabbed, a petrologic study was conducted on the cores. This study provides preliminary data on the gross reservoir heterogeneity and depositional environment (facies) controls or porosity and permeability development within the Floridan aquifer.

The slabbed cores were examined and described by Dr. Hughbert Collier of Collier Consulting, Inc., Stephensville, Texas. Intervals were then selected from which to prepare thin sections. The thin sections were stained with Alizarin Red S to determine dolomite content, and examined using a Nikon SMZ-2T binocular and a Nikon petrographic microscope. Thin section analyses included the identification of porosity types, visual estimation of porosity, rock type, cement type, mineralogy, dominate allochems, fossil types, grain size, sorting, and sand content. Once compiled, this information was used to determine the lithofacies, and depositional environment of the various core intervals. A petrologic summary for each core section, generated by Collier Consulting, is listed in **Table 8** and a complete core description is provided in **Appendix C** as **Table C-1**.

Table 8. Summary of Petrologic Analyses

Sample	Depth (feet bls)	Lithofacies	Depositional Environment	Horizontal Permeability (millidarcies)	Vertical Permeability (millidarcies)	Porosity Helium (percent)	Grain Density (g/cm^3)
Core 1							
1H	910.8	Foram-peloidal packstone	Open Lagoon Shoal	3		33.5	2.69
2H	911.3	Foram-peloidal packstone	Open Lagoon Shoal	380		39.7	2.70
3H	912.5	Pelecypod coquina	Shoal	2,206		33.2	2.71
Mean				863		35.5	2.70
Median				380		33.5	2.70
Core 2							
4H	945.2	Ostracod-foram-peloidal packstone	Open Lagoon Shoal	260		44.8	2.71
5H	946.5	Ostracod-foram-peloidal packstone	Open Lagoon Shoal	193		43.4	2.70
6H	947.5	Intraalgal-foram-peloid packstone	Restrict. Lagoon Shoal	2,444		44.7	2.71
7H	948.7	Intraalgal-foram-peloid packstone	Open Lagoon Shoal	7,027		46.8	2.71
8H	949.6	Intraalgal-foram-peloid packstone	Open Lagoon Shoal	17,294		42.9	2.71
9H	950.5	Intraalgal-foram-peloid packstone	Open Lagoon Shoal	5,613	5,759.0	41.2	2.72
10H	951.2	Foram-pellet packstone	Open Lagoon Shoal	770		45.8	2.71
Mean				4,800		44.2	2.71
Median				2,444		44.7	2.71
Core 3							
11H	952.1	Bryzoan-pelecypod wackestone packstone	Bryzoan Mound	1,026		47.1	2.71
12H	953.1	Bryzoan-pelecypod wackestone packstone	Bryzoan Mound	1,057		48.4	2.71
13H	954.3	Bryzoan-pelecypod wackestone packstone	Bryzoan Mound	1,375		48.0	2.70
14H	954.8	Bryzoan-pelecypod wackestone packstone	Bryzoan Mound	2,339		47.3	2.70
Mean				1,449		47.7	2.71
Median				1,216		47.7	2.71
Core 4							
15H	1020.8	Peloidal skeletal packstone	Mound Flank	50	1.8	34.2	2.72
16H	1021.5	Peloidal skeletal packstone	Mound Flank	121		41.7	2.71
Mean				85		38.0	2.72
Median				85		38.0	2.72

Individual photomicrographs of selected cores are provided in **Appendix D.** The petrologic analysis, combined with the petrophysical data, indicate variations in horizontal permeability and porosity, based on lithofacies and corresponding depositional environment. The highest mean horizontal permeability (4,800 millidarcies) corresponds to a cored section at approximately 950 feet bls consisting of intraalgal, foraminiferal, peloidal packstone likely deposited in an open lagoonal shoal environment. Petrologic analyses of a Floridan well in eastern Hendry County (L2-TW) had similar results with the highest mean horizontal permeability occurring in a foraminiferal-peloidal packstone thought to be deposited in an open lagoonal shoal environment (Bennett, 2001).

AQUIFER PERFORMANCE TESTING

Aquifer Performance Test 1 (690 to 780 feet bls)

The first of two aquifer performance tests (APTs) was conducted to determine the hydraulic performance of a section (690 to 780 feet bls) of the upper Floridan aquifer (Lower Hawthorn/Suwannee) at the I-75 Canal site. The principle factors of aquifer performance, such as transmissivity and storage coefficients, can be calculated from the drawdown and/or recovery data obtained from the proximal monitor well completed in the same interval. If the aquifer tested is semiconfined, the hydraulic parameter of leakance of the semipervious layer(s) can also be determined.

A 55.25-hour constant rate discharge (1,472 gpm) test was conducted on an interval from 690 to 780 feet bls. **Figure 8** shows the well configuration of the tri-zone monitor well (I75-TW) and test production well (I75-PW) used in the APT. The 55.25-hour drawdown phase was followed by a 41.5-hour recovery period, where water levels were allowed to return to background condition.

A 10-inch diameter submersible pump was installed in the test production well on November 23, 1996, with the pumping bowl set at 120 feet bls. This depth was chosen based on preliminary data, indicating moderate drawdowns would occur. The wellhead was reinstalled with appurtenances consisting of a shutoff valve, discharge pressure gauge, and wellhead pressure gauge. A 12-inch diameter PVC discharge line was connected to the wellhead. A 12-inch diameter circular orifice weir with an 8-inch diameter orifice plate was used to measure discharge rates during pumping, verified by an in-line flowmeter. A pressure transducer was installed on the orifice weir to record discharge rates during the pump test at 5-minute intervals. Additional pressure transducers were installed on/in both the test production and monitor wells and connected to a Hermit 2000 (Insitu, Inc.), data logger with electronic cables. The transducers and data logger were used to measure and record water level changes at predetermined intervals during testing operations.

On November 24, 1996, a specific-capacity test was conducted to determine the most efficient pump rate for the planned 60-hour drawdown test. A specific capacity of 16.72 gpm/ft/dd at 1,472 gpm was calculated for the test production well. Once completed, water levels were allowed to recover to static condition. The next morning,

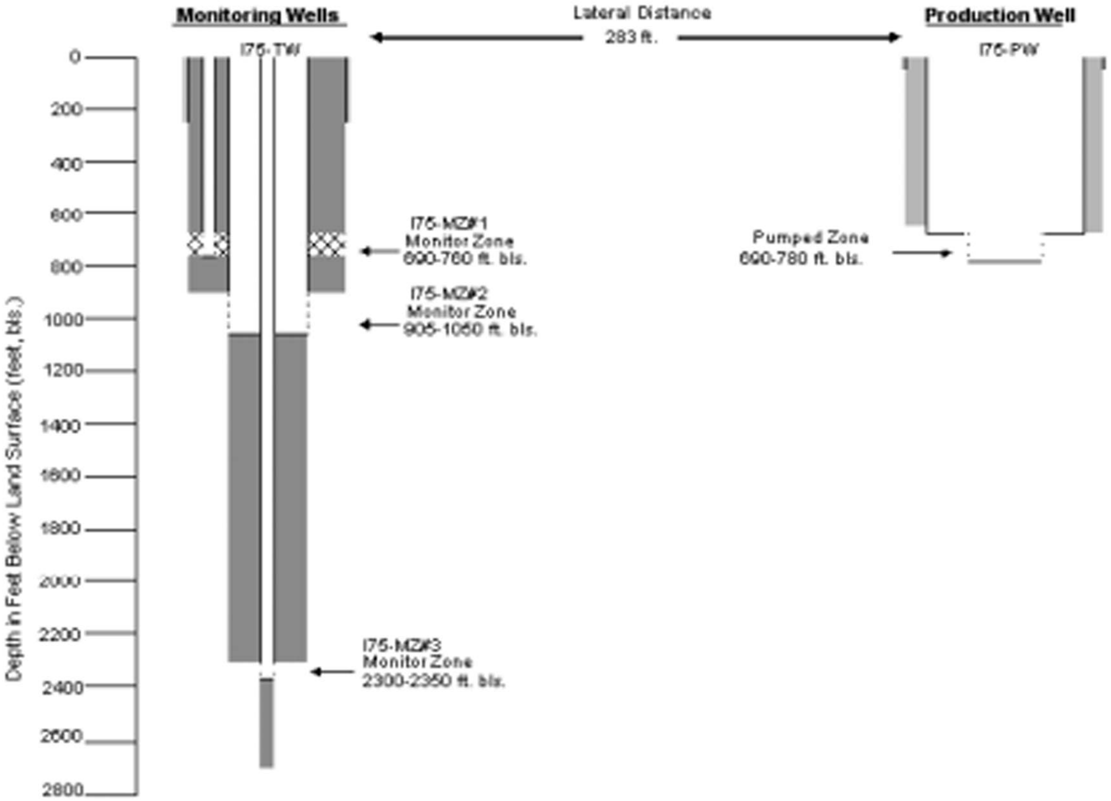


Figure 8. Well Configuration during Aquifer Performance Test 1

November 25, 1996, the drawdown phase of the APT started by initiating pumping of the test production well (I75-PW), located 283 feet south of the monitor well (I75-TW), at 1,472 gpm. During the drawdown phase, water levels and pump rates were continuously measured and recorded by the installed electronic instruments. Pumping continued uninterrupted for the next 55.25 hours, completing the drawdown phase on November 27, 1996. A semi-log plot of the drawdown data for pumped monitor well (I75-MZ 1) is shown in **Figure 9**. Time series plots of water level fluctuations during the drawdown phase of the APT for the lower monitor zones, I75-MZ 2 and I75-MZ 3 are included in **Figure 10**.

Discharge data from the 12-inch diameter, circular orifice weir acquired during the pumping phase of the APT are shown in **Figure 11**. Minor fluctuations in pump rates occurred during the course of the APT, but were not substantial enough (less than ±1 percent) to effect the overall test results.

In addition, water samples were taken from the test production well I75-PW, during the drawdown phase. The field parameters measured include temperature, pH, specific conductance, and chlorides. These parameters fluctuated less than 3 percent with no discernible trend during the course of the test. Specific conductance values and chloride concentrations ranged from 6,339 to 6,490 µmhos/cm and 1,818 to 1,884 mg/L, respectively.

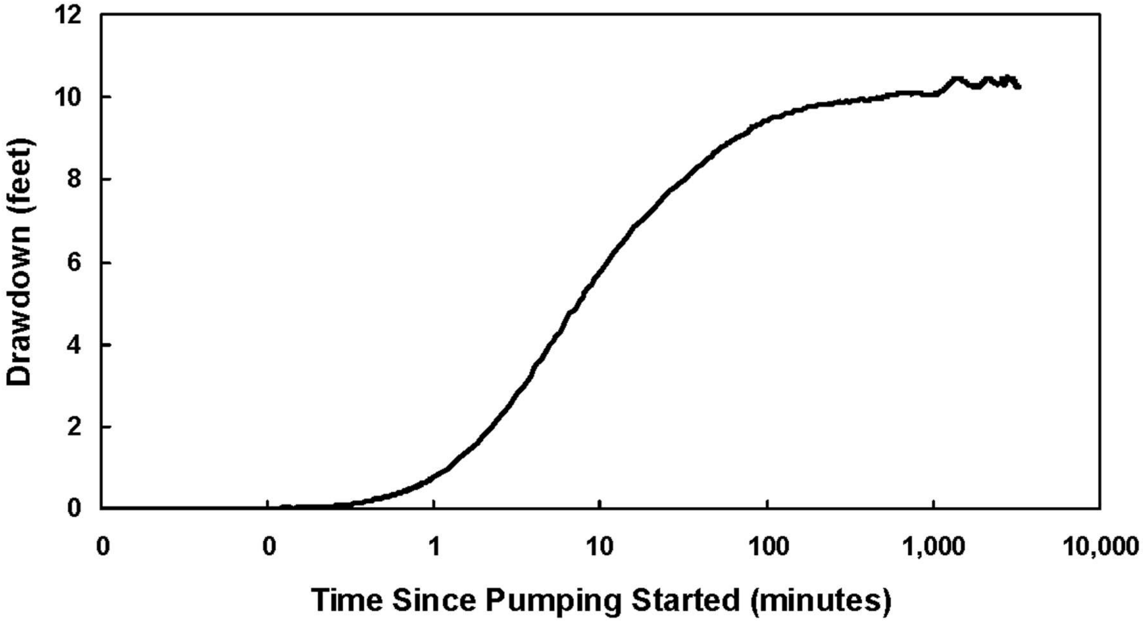


Figure 9. Semi-Log Plot of Drawdown Data from I75-MZ 1 during Aquifer Performance Test 1

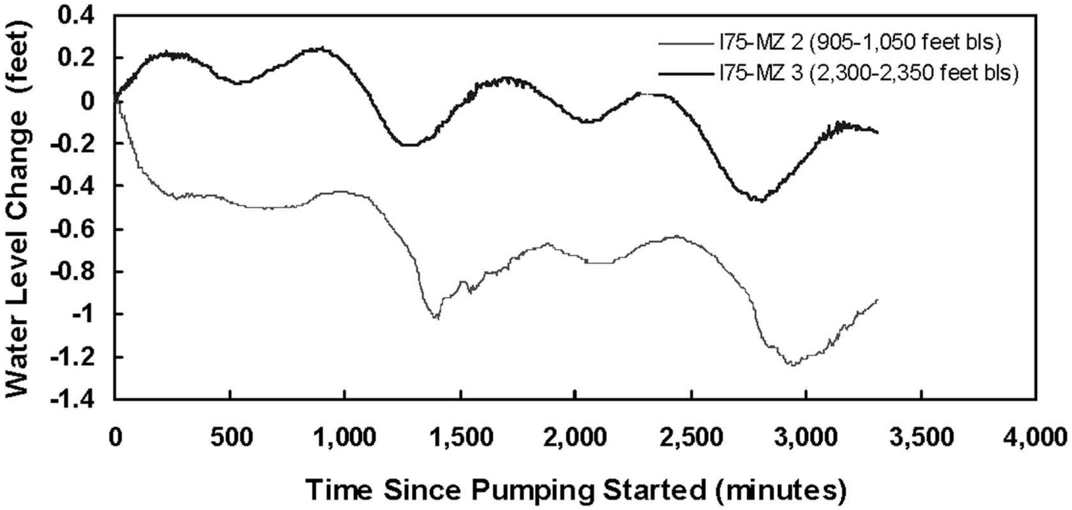


Figure 10. Time Series Plot of Water Levels from I75-MZ 2 and I75-MZ 3 during the Pumping Phase of Aquifer Performance Test 1

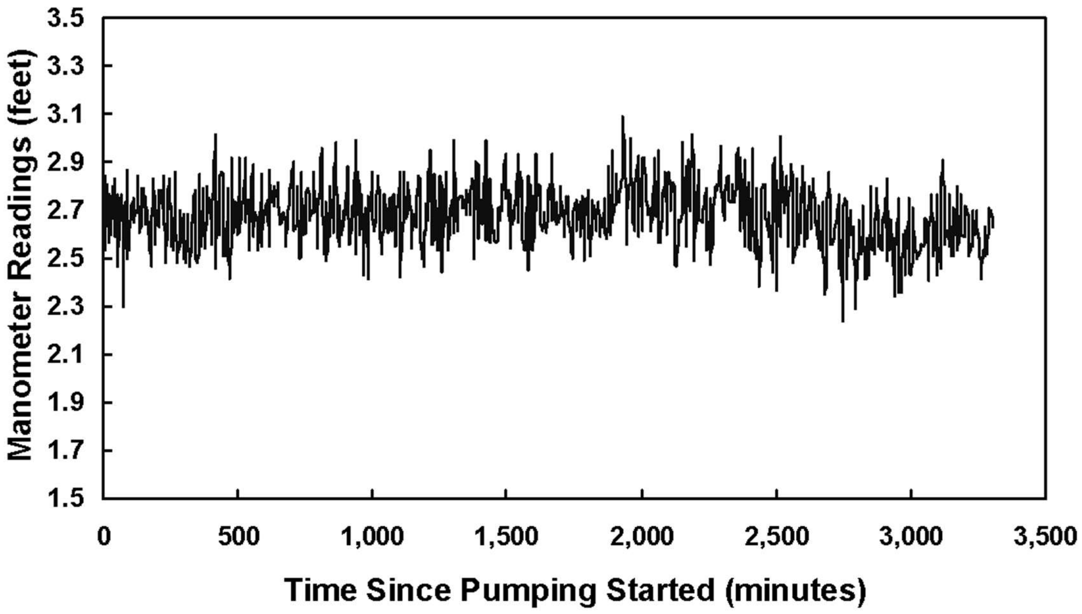


Figure 11. Pumping Phase Manometer Readings for Discharge Orfice Weir during Aquifer Performance Test 1 (average pump rate was 1,472 gpm)

Before pumping stopped, the data loggers were reconfigured to record the recovery data. The pump was then manually stopped and water levels were allowed to recover to static condition. The recovery phase of the APT continued for 41.5 hours, ending on November 29, 1996. A semi-log plot of the recovery data for the pumped monitor zone (I75-MZ 1) is shown in **Figure 12**. A time series plot of the lower monitor intervals (I75-MZ 2 and I75-MZ 3) is shown in **Figure 13**. Electronic copies of the original drawdown, recovery, and manometer data for APT 1 are archived and available for review at the SFWMD's headquarters in West Palm Beach, Florida.

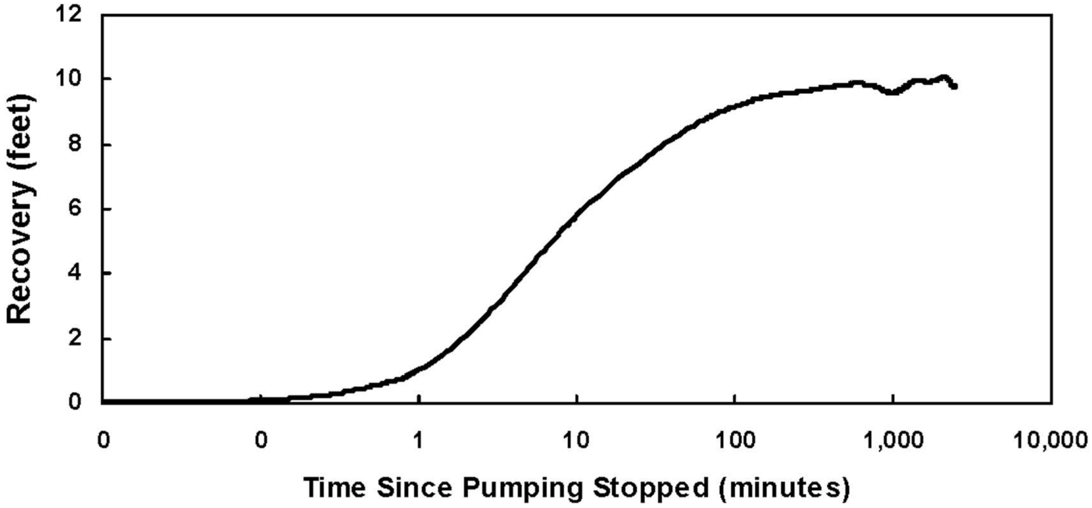


Figure 12. Semi-Log Plot of Recovery Data from I75-MZ 1 during Aquifer Performance Test 1

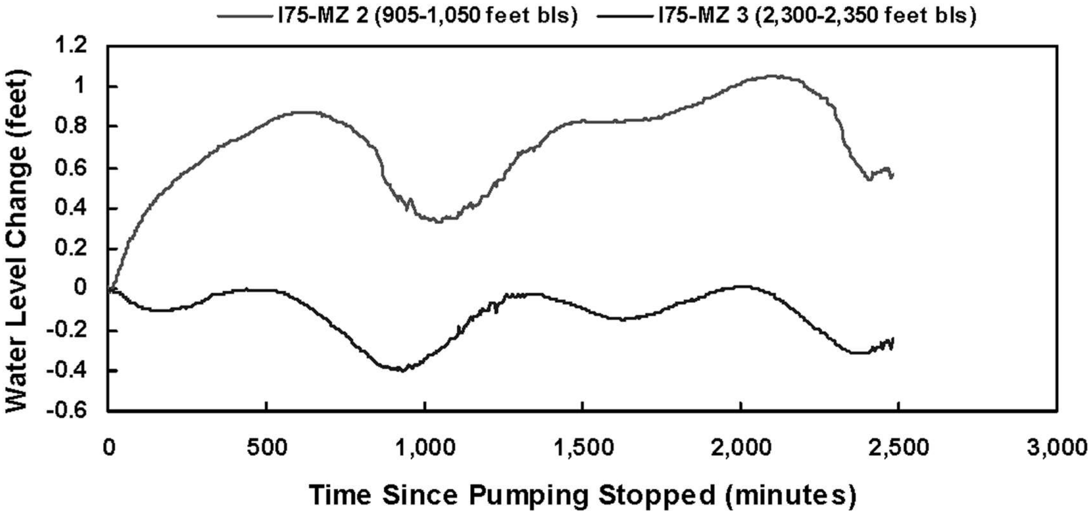


Figure 13. Time Series Plot of Water Levels Responses for I75-MZ 2 and I75-MZ 3 during the Recovery Phase of Aquifer Performance Test 1

A log-log plot of drawdown versus time is shown in **Figure 14**. The shape of the drawdown curve is indicative of a leaky-type aquifer, defined as an aquifer that loses or gains water (depending on the pressure gradients) through an adjacent semiconfining unit (aquitard). The relatively flat portion of the drawdown curve indicates steady state conditions, whereby a linear gradient is established across the aquitard, and the pumped water is derived from the unpumped aquifer. The overlying and underlying semiconfining units are composed of porous (25 to 45 percent porosity) mudstones to wackestones that have the potential to transmit water through them and supply additional water released from storage to the pumping well. A proximal FAS monitor well completed above the test interval of 690 to 780 feet bls was not available for monitoring during the APT to quantify the relative contribution of the overlying semiconfining unit. However, the FAS monitor well identified as I75-MZ 2 was completed below the test interval from 905 to 1,050 feet bls. During the pump phase of the APT, water levels in I75-MZ 2 declined a maximum of 1.2 feet (**Figure 10**).

Based on the site-specific hydrogeology and well construction, three different semiconfined analytical models were applied to the drawdown data collected during the APT to determine the hydraulic properties of the aquifer and aquitard(s). The analytical models included those developed by Hantush-Jacob (1955), Hantush (1960), and Moench (1985). The results were obtained from each method and are based on various assumptions. These assumptions are listed in **Table 9**. In general, drawdown data from a single observation well only provides an estimate of aquifer and aquitard properties. Many of the curves are similar in shape to one another and do not necessarily provide a unique match to a given data set.

Moench (1985) derived an analytical solution for predicting water level displacements in response to pumping a large diameter well (well bore storage in a leaky confined aquifer assuming storage in the aquitard(s) and well bore skin. Moench (1985) also builds on several previously establish analytical solutions, such as Hantush (1960), Papadopulos and Copper (1967), Agarwal et al. (1970), and Sandal et al. (1978). Based on these considerations and the site specific hydrogeologic data collected during drilling and aquifer testing, the Moench analytical model appears to best represent the conditions present at this site. The results of this solution yielded a transmissivity value of 116,400 gpd/ft, a storage coefficient of 1.664 x 10^{-5}, and an r/B value of 0.04. The dimensionless parameter r/B characterizes the leakage across the aquitard(s) to the pumped aquifer. From this value, a leakance value of 2.33 x 10^{-3} gpd/ft^3 was calculated (Walton, 1960).

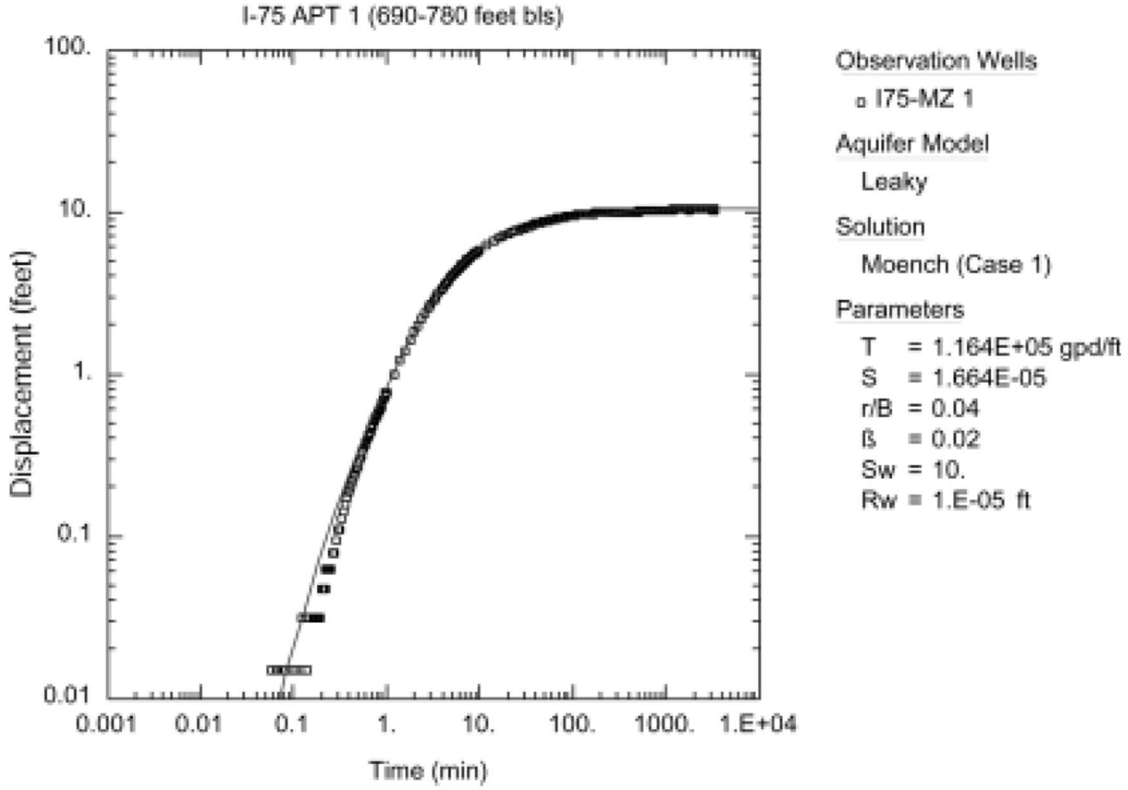


Figure 14. Log-Log Plot of Drawdown versus Time for Monitor Well I75-MZ 1 during Aquifer Performance Test 1

Table 9. Summary of Leaky Analytical Model Results for Aquifer Performance Test 1.

Analytical Method	Transmissivity (gpd/ft)	Storativity	r/B[a]	β[b]
Hantush-Jacob, 1955 (Leaky)	72,200	1.9E-05	0.14	NA
Hantush, 1960 (Leaky)	118,800	1.4E-05	NA[c]	0.03
Moench, 1985 (Leaky)	116,400	1.7E-05	0.04	0.02

a. r/B = Leakance Factor
b. β = Aquitard Storage Factor
c. N/A = Not Applicable

Aquifer Performance Test 2 (890 to 1,050 feet bls)

The second APT was conducted to determine in situ hydraulic characteristics of a section from 890 to 1,050 feet bls in the upper Floridan aquifer (Suwannee Limestone). A 72.9-hour constant rate discharge (743-gpm) test was conducted on an interval from 890 to 1,050 feet bls. **Figure 15** shows the well configuration of the tri-zone monitor well (I75-TW) and test production well (I75-PW) used in the APT. The 72.9-hour drawdown phase was followed by a 73.5-hour recovery period, where water levels were allowed to return to background condition.

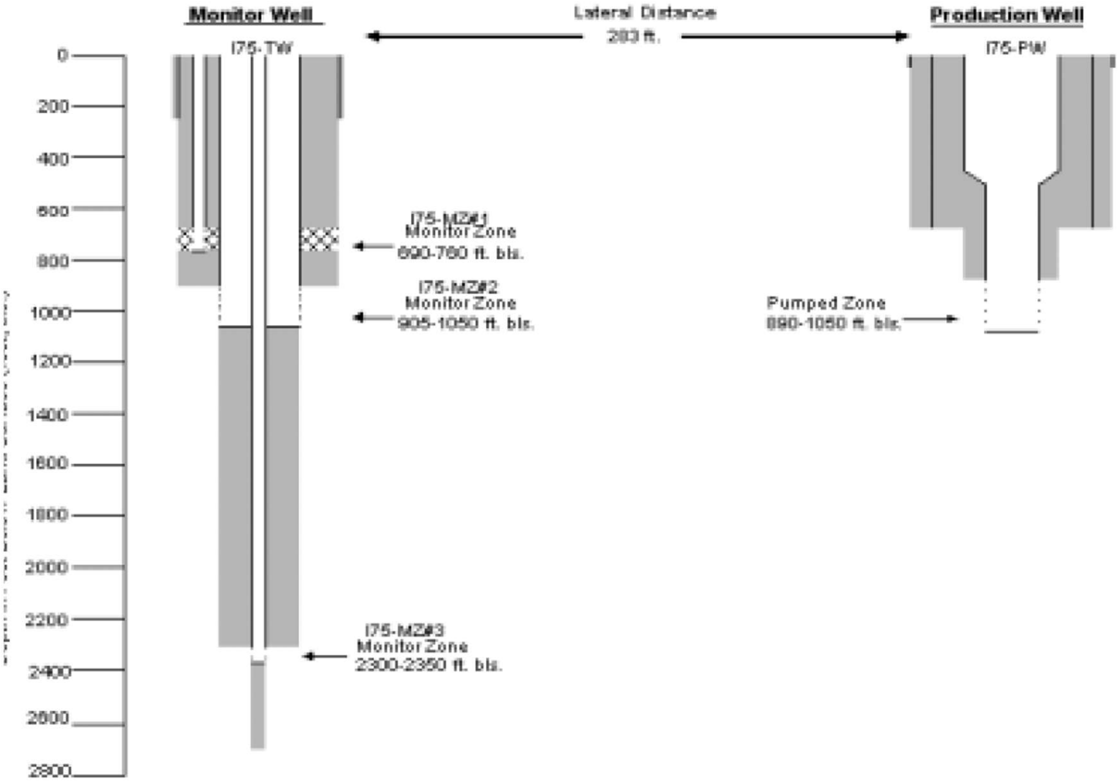


Figure 15. Well Configuration for Aquifer Performance Test 2

A 10-inch diameter submersible pump was installed in the test production well on January 20, 1997, with the pumping bowl set at 100 feet bls. This depth was chosen, based on preliminary data, indicating moderate drawdowns would occur. The wellhead was reinstalled with appurtenances consisting of a shutoff valve, discharge pressure gauge, and wellhead pressure gauge. A 12-inch diameter PVC discharge line was connected to the wellhead. A 12-inch diameter, circular orifice weir with a 6-inch diameter orifice plate was used to measure discharge rates during pumping, verified by an in-line flowmeter. A pressure transducer was installed on the orifice weir to record discharge rates during the pump test at 2-minute intervals. Additional pressure transducers were again installed on/in both the test production and monitor wells and connected to a Hermit 2000 (Insitu, Inc.) data logger with electronic cables. The transducers and data logger were used to measure and record water level changes at predetermined intervals during testing operations.

On January 20, 1997, a specific capacity test was conducted to determine the most efficient pump rate for the planned 72-hour drawdown test. Once completed, water levels were allowed to recover to static condition. The next morning (January 21, 1997), the drawdown phase of the APT started by initiating pumping of the test production well (I75-PW) at 743 gpm. During the drawdown phase, water levels and pump rates were continuously measured and recorded by the installed electronic instruments. Pumping continued uninterrupted for the next 72.9 hours, completing the drawdown phase on January 24, 1997. A semi-log plot of the drawdown data for the pumped monitor zone I75-MZ 2 is shown in **Figure 16**. Time series plots of water level fluctuations during the drawdown phase of the APT for the other two monitor zones I75-MZ 1 and I75-MZ 3 are included in **Figure 17**.

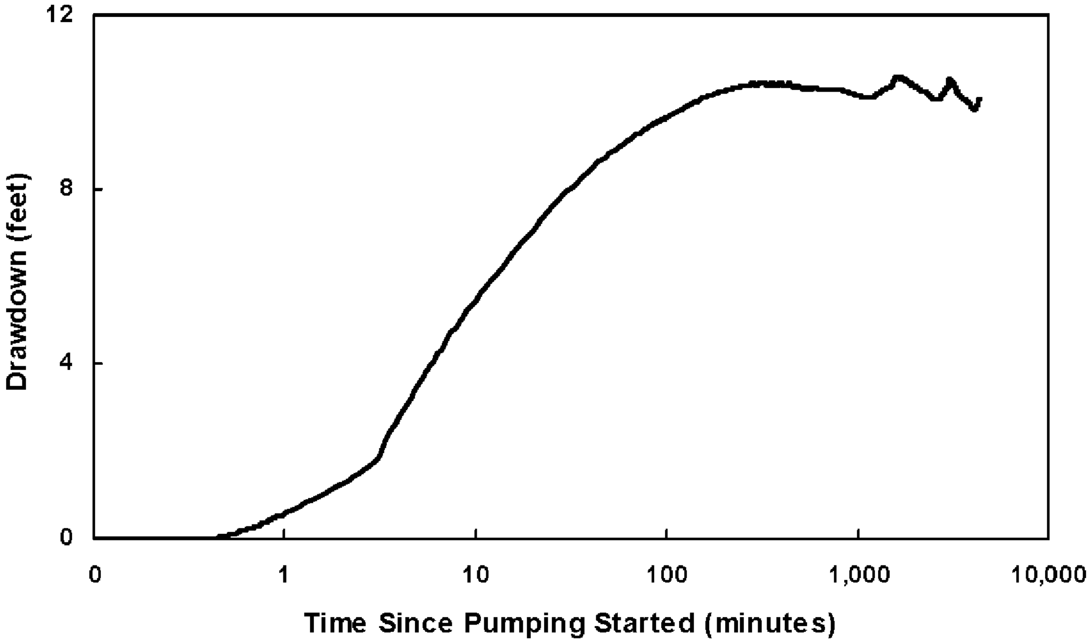


Figure 16. Semi-Log Plot of Drawdown Data from Aquifer Performance Test 2 for I75-MZ 2

The discharge data from the 12-inch diameter, circular orifice weir acquired during the pumping phase of the APT are shown in **Figure 18**. Minor fluctuations in pump rates occurred during the course of the APT, but were not substantial enough (less than ±1 percent) to effect the overall test results.

Similar to the first APT, water samples were taken from the test production well, I75-PW, and field parameters including temperature, pH, specific conductance, and chlorides were measured. These parameters fluctuated less than 5 percent with no discernible trend during the withdrawal period. Specific conductance values and chloride concentrations ranged from 11,710 to 12,210 µmhos/cm and 3,910 to 4,190 mg/L, respectively.

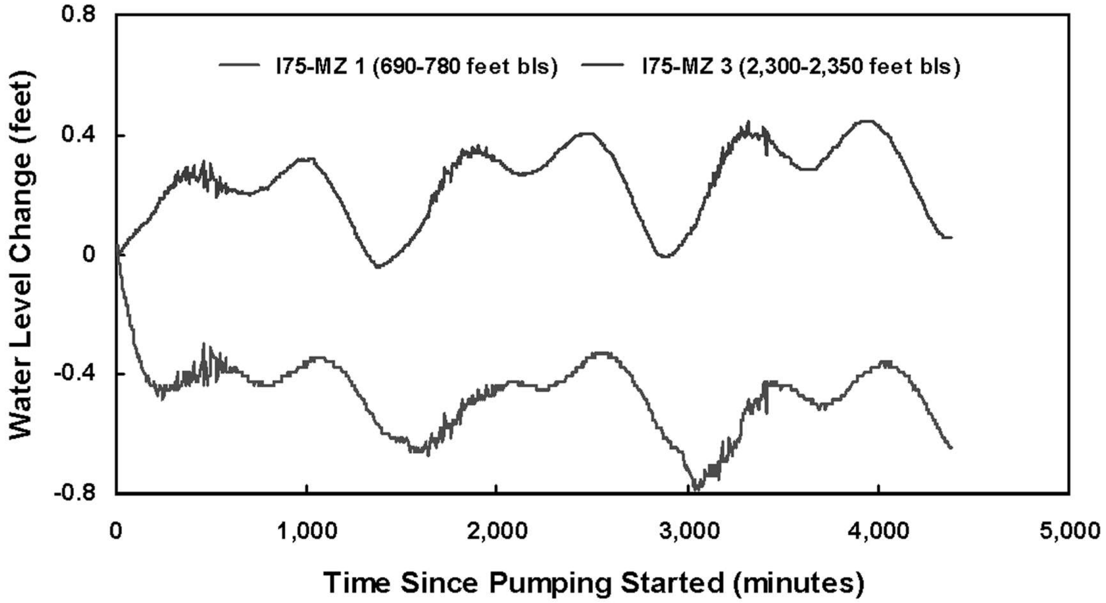


Figure 17. Pumping Phase Responses for I75-MZ 1 and I75-MZ 3 during Aquifer Performance Test 2

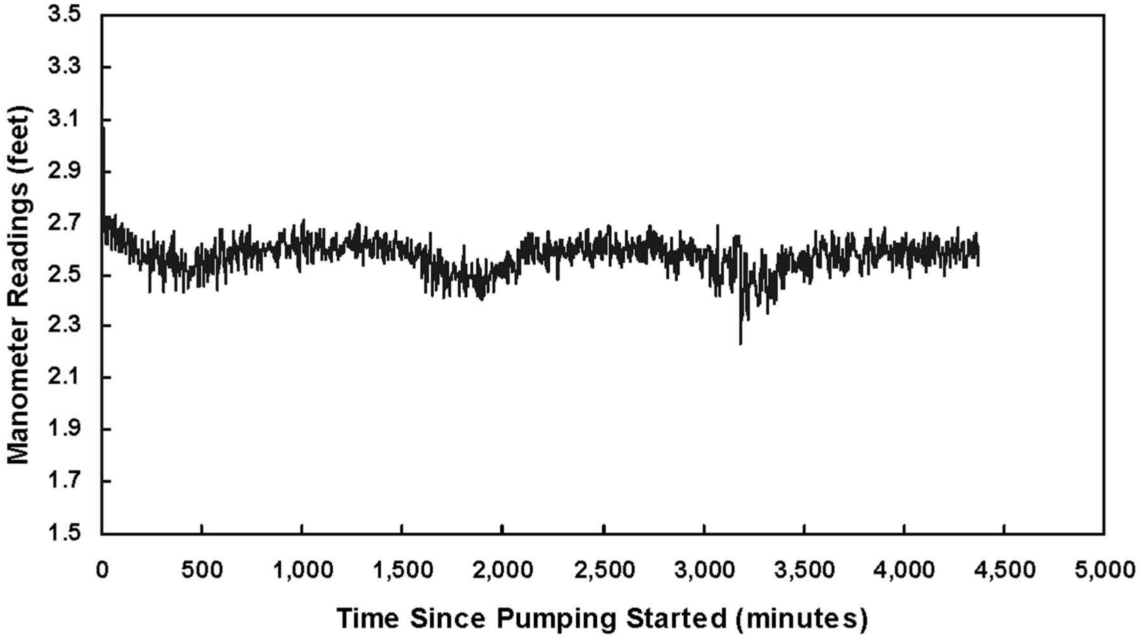


Figure 18. Pumping Phase Manometer Readings for Discharge Orfice Weir during Aquifer Performance Test 2 (average pump rate 743 gpm)

Before pumping stopped, the data loggers were reconfigured to record the recovery data. The pump was then manually stopped and water levels were allowed to recover to static condition. The recovery phase of the APT continued for 73.5 hours, ending on January 27, 1997. A time series, semi-log plot of the recovery data for the pumped monitor zone (I75-MZ 2) is shown in **Figure 19**. A time series plot of water levels acquired during the recovery phase of the APT for the upper and lower monitor zones (I75-MZ 1 and I75-MZ 3) are shown in **Figure 20**. Electronic copies of the original drawdown, recovery, and manometer data for APT 2 are also archived and available for review at the SFWMD's headquarters in West Palm Beach, Florida.

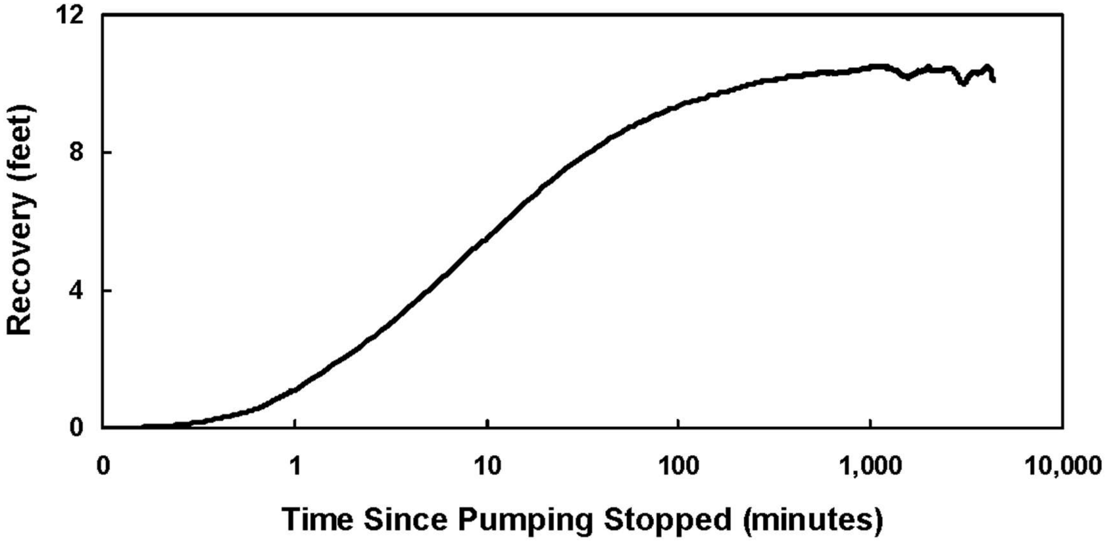


Figure 19. Semi-Log Plot of Recovery Data from I75-MZ 2 during Aquifer Perfomance Test 2 at depths of 905 to 1,050 feet bls

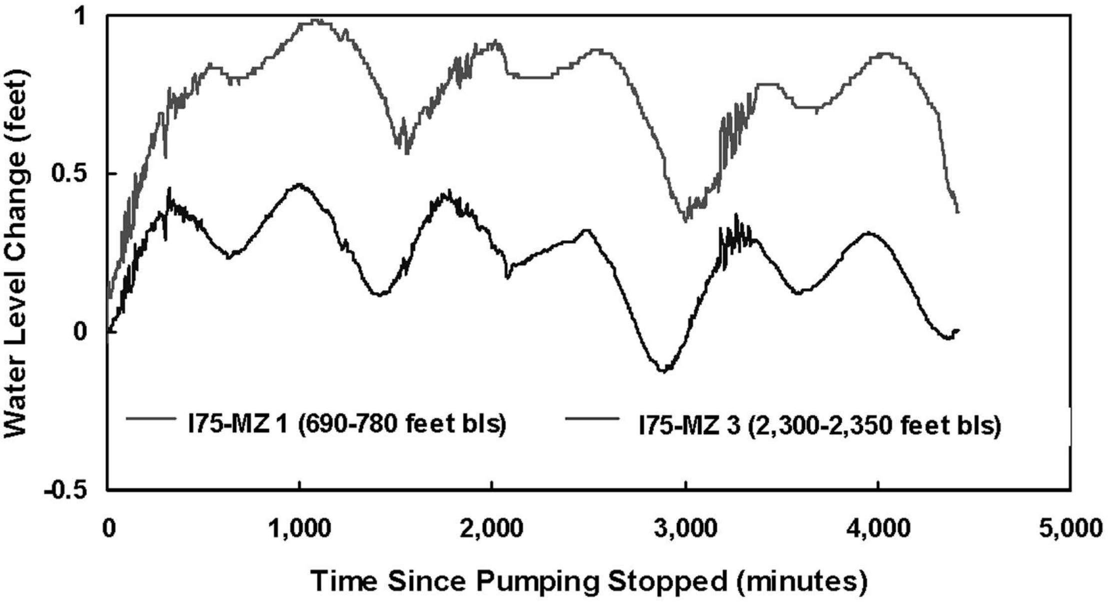


Figure 20. Time Series Plot of Water Levels Responses for I75-MZ 1 and I75-MZ 3 during the Recovery Phase of Aquifer Performance Test 2

Again, three different "leaky" type analytical solutions were applied to the drawdown data collected during the second APT to determine the aquifer and aquitard(s) hydraulic properties. The solutions used were Hantush-Jacob (1955), Hantush (1960), and Moench (1985). The results from each analytical method are listed in **Table 10**.

Table 10. Summary of Leaky Analytical Model Results for Aquifer Performance Test 2

Analytical Method	Transmissivity (gpd/ft)	Storativity	r/B	β^{α}
Hantush-Jacob, 1955 (Leaky)	54,280	2.800E-05	0.05	NA[b]
Hantush, 1960 (Leaky)	58,480	1.000E-05	NA	0.02
Moench, 1985 (Leaky)	52,500	2.300E-05	0.05	0.02

a. β = aquitard storage factor
b. NA = not applicable

A log-log plot of drawdown versus time is shown in **Figure 21**. The shape of the drawdown curve is indicative of a leaky-type aquifer where the late-time drawdown remains relatively flat similar to drawdowns from the first APT at this site. The telescoping-type FAS monitor well (I75-TW) had monitor intervals completed above and below the test interval (905 to 1,050 feet bls). Water levels were monitored during the APT to determine if there was any contribution from or through the overlying and underlying semiconfining units. During the APT, water levels in I75-MZ 1 (690 to 760 feet bls)

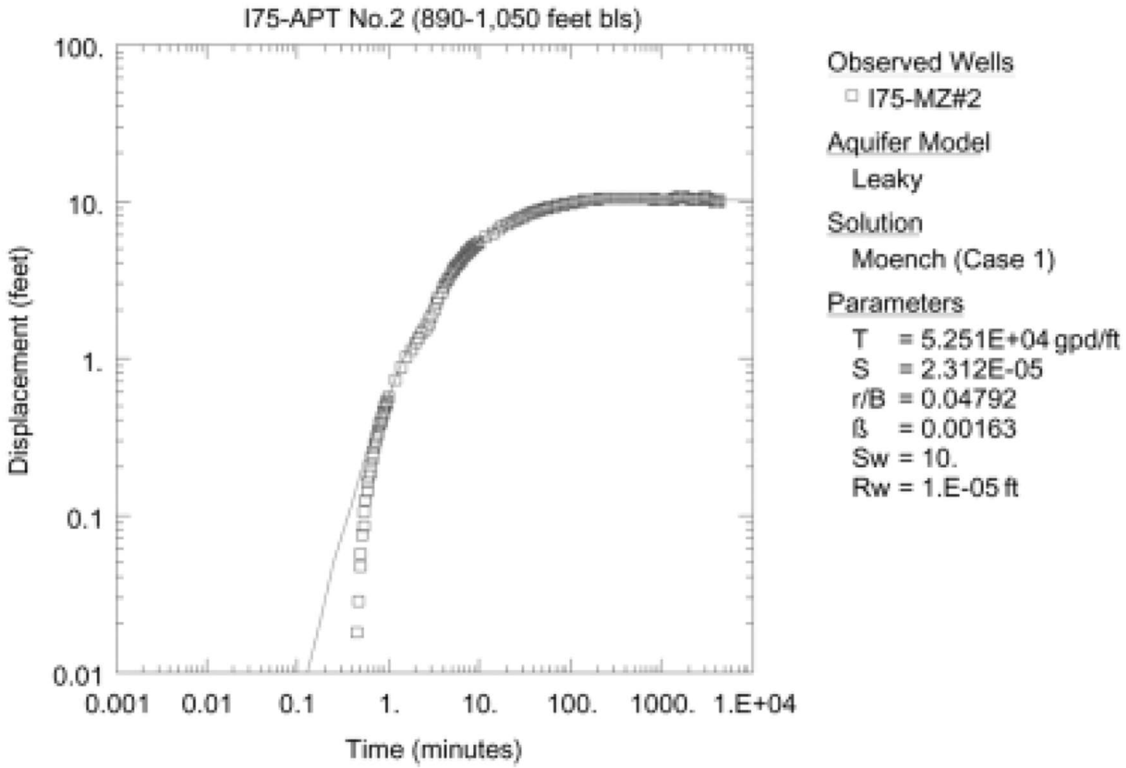


Figure 21. Log-Log Plot of Drawdown versus Time for Monitor Well I75-MZ 2 during Aquifer Performance Test 2

declined 0.785 feet. This indicates that low permeability sediments above the pumped interval are “leaky” semiconfining in nature and additional water can be derived from it (storage albeit small, B=0.02) and through it during pumping. Water levels fluctuations in I75-MZ 3 (2,300 to 2,350 feet bls) are attributed to diurnal tidal and barometric pressure changes that occurred during the APT.

As mentioned previously, Moench (1985) derived an analytical solution for predicting water level displacements in response to transient flow to a large diameter well in an aquifer with storative aquitard(s) and well bore skin and combines the efforts of several previously established analytical methods. The Moench (1985) analytical model appears to best represent the conditions present at this site based on the lithologic character of the productive interval and the overlying/underlying units, water level declines in I75-MZ 1 (**Figure 17**), the large diameter of Well I75-PW, and the resulting drawdown curve derived from the test interval. The results generalized from this analytical solution, yielded a transmissivity value of 52,500 gpd/ft, a storage coefficient of 2.3 x 10^{-5}, and an r/B value of 0.05 with a calculated leakance value of 1.64 x 10^{-3} gpd/ft^3 (Walton, 1960).

During each of the two APTs, water samples were taken from the production well in accordance with SFWMD’s quality assurance/quality control sampling protocol (SFWMD, 1994). These samples were then submitted to the SFWMD’s Water Quality Laboratory for major cation/anion analyses. The results of these analyses are summarized in **Table 11.**

Table 11. Water Quality Data from Aquifer Performance Tests

Identifier	Depth Interval (feet bls)	Specific Capacity (gpm/ft/ dd)	Sample Date	Cations (mg/L)				Anions (mg/L)			TDS (mg/L)	Field Parameters		
				Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	Alkalinity as $CaCO_3$	SO_4^{2-}		Specific Conduct. (µmhos/ cm)	Temp (°C)	pH (s.u.)
I75-PW 1	690-780	16.72	11/26/96	1,060	43	169	157	1,848	152	562	3,910	6,690	28.39	7.01
I75-PW 2	890-1050	15.75	01/23/97	2,080	80	274	304	4,021	161	665	6,900	12,410	29.67	7.02

Long-Term Groundwater Level/Quality Monitoring Program

Shortly after the construction of the tri-zone Floridan aquifer monitor well (I75-TW), water quality samples were collected from each monitor interval and submitted to the SFWMD Laboratory for cation-anion analyses to establish baseline data. The results of these analyses are summarized in **Table 12**.

Also after construction, a monthly potentiometric head monitoring program was established. Pressures were recorded from the various monitor zones using a 30-psig transducer and a Hermit 3000 (Insitu, Inc.) data logger once a month. Automated pressure recorders (Insitu Troll 4000) were installed on the FAS tri-zone monitor well (I75-TW) on

Table 12. Background Water Quality Data from the Tri-Zone Monitor Well (I75-TW)

				Cations (mg/L)				Anions (mg/L)				Field Parameters		
Identifier	Depth Interval (feet bls)	Measured Static Head (feet NGVD)	Sample Date	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	Alkalinity as $CaCO_3$	SO_4^{2-}	TDS (mg/L)	Specific Conduct. (µmhos/cm)	Temp (°C)	pH (s.u.)
I75-MZ 1	695-760	34.49	04/13/95	902	37	157	152	1,529	174	486	3,410	5,790	28.90	7.90
I75-MZ 2	905-1050	34.07	04/13/95	1,820	65	246	263	3,558	159	630	6,750	11,560	29.23	7.11
I75-MZ 3	2300-2350	8.64	04/13/95	11,200	407	533	1,235	19,398	106	2,531	35,700	46,360	30.66	7.21

November 24, 1997. The sample frequencies were set to hourly readings to identify short- and long-term stresses to the Floridan aquifer system.

All pressures readings were converted to equivalent heads in feet using a conversion factor of 2.31 feet of head per psi. Once the pressures were converted, they were added to the surveyed measuring point elevation to obtain a potentiometric head referenced to the NGVD of 1929.

The long-term hourly potentiometric head data for the three FAS monitor intervals and barometric pressure are illustrated in the hydrograph shown in **Figures 22** and **23**. **Table 13** lists the monitor intervals within the FAS, average recorded potentiometric head, and degree of variation. The hydrographs generated using hourly readings show diurnal variations due to tidal loading and long-term changes due to seasonal barometric pressure variations.

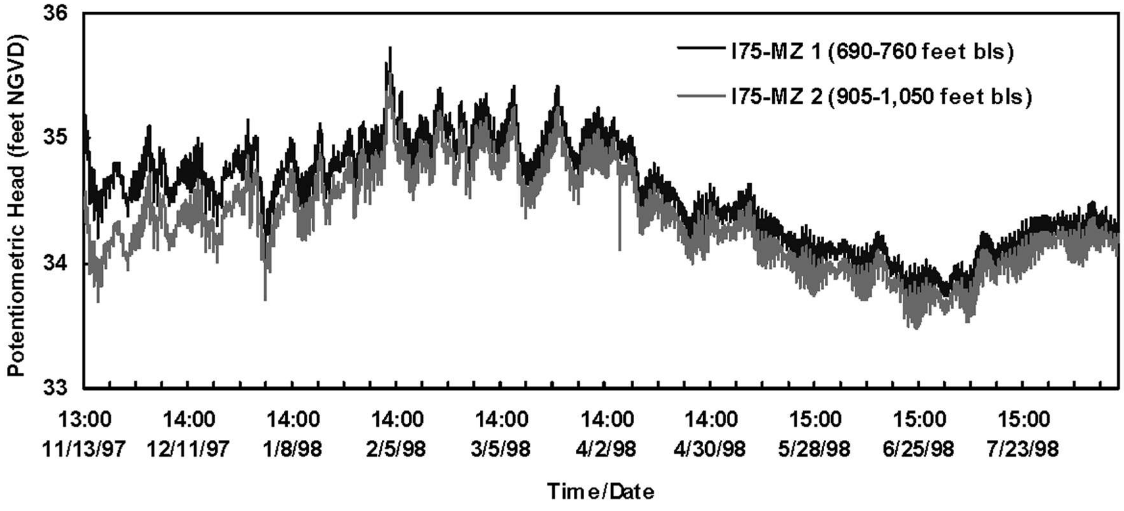


Figure 22. Long-Term Hydrograph of I75-MZ 1 and I75-MZ 2

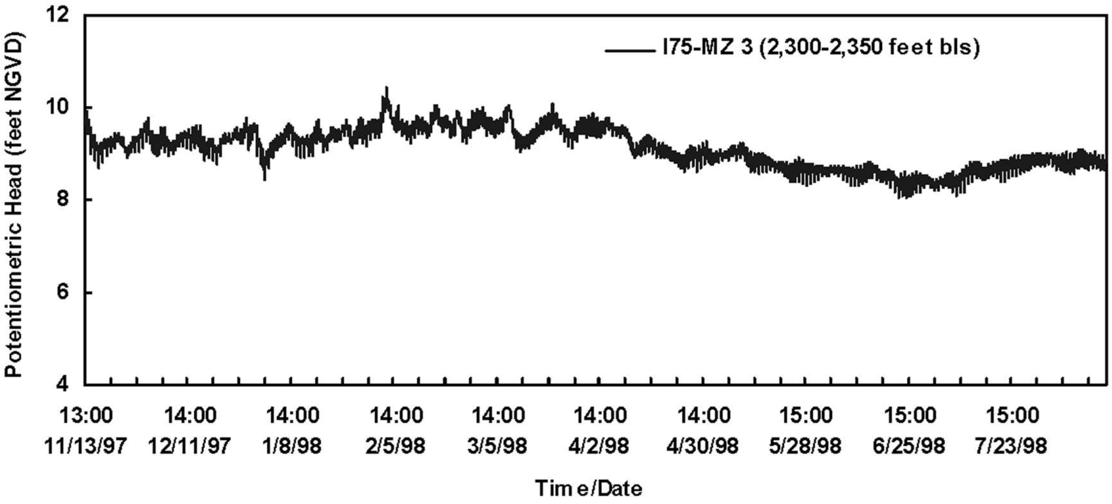


Figure 23. Long-Term Hydrograph of I75-MZ 3

Table 13. Average FAS Potentiometric Head Data from I75-TW for the Period of Record, November 1997 to August 1998

Identifier	Monitor Interval (feet bls)	Average Measured Potentiometric Head (feet NGVD)	Standard Deviation (feet)
I75-MZ 1	690 to 760	34.6	0.41
I75-MZ 2	905 to 1,050	34.5	0.39
I75-MZ 3	2,300 to 2,350	9.1	0.44

HYDROGEOLOGIC FRAMEWORK

Three major aquifer systems underlie this site: the Surficial Aquifer System (SAS), the IAS, and the FAS, with the FAS being the focus of this test well program. These aquifer systems are composed of multiple, discrete aquifers separated by low permeability “confining” units that occur throughout this Tertiary/Quaternary age sequence. **Figure 24** shows a hydrogeologic section underlying the I-75 Canal site.

Surficial Aquifer System

The SAS extends from land surface to a depth of 205 feet bls. It consists of Holocene and Miocene to Pleistocene age (agcor aged?) sediments. The undifferentiated Holocene sediments occur from land surface to a depth of 10 feet bls, and consist of unconsolidated orange to light gray, very fine to coarse grained quartz sands, and shell fragments within a calcilutite matrix. The sediments from 10 to 90 feet bls consist primarily of light gray to medium gray, moderate to well indurated biogenic limestone, with minor fine-grained sands (moderate to good permeability). This interval is identified as the Pliocene age Tamiami Formation (Ochopee Limestone member), which forms the bulk of the productive capacity of this system. Low permeability arenaceous calcilutite

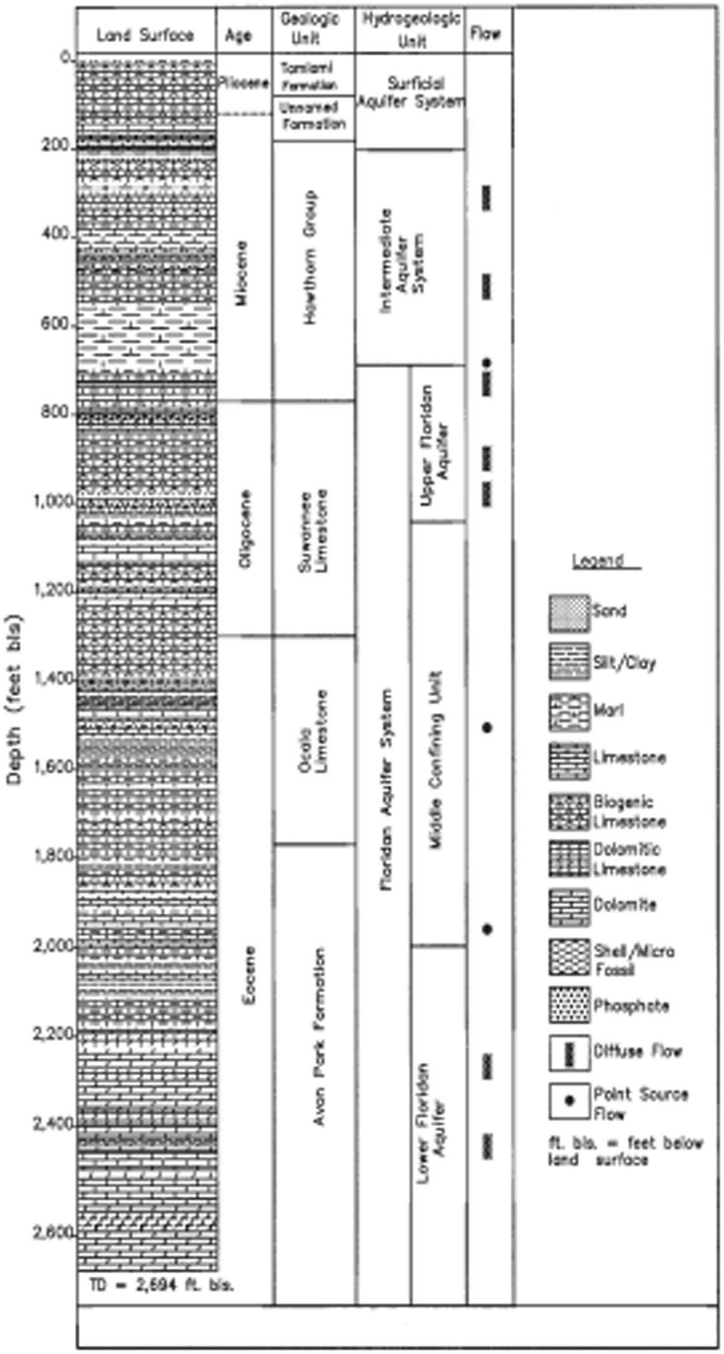


Figure 24. Hydrostratigraphic Column

(marl) underlies the productive biogenic limestones at 90 feet bls and extends to 118 feet bls. This low permeability unit forms an interaquifer confining unit. Moderate to well indurated limestone units occur from 118 to 176 feet bls with quartz sand content increasing 10 to 35 percent with depth. The limestone and quartz sand units from 90 to 195 feet bls are part of the "Unnamed Formation" (Edward et al., 1998). An interval of fine to coarse grained quartz sand (Miocene Coarse Clastics? [Knapp et al., 1986]) within a carbonate matrix occurs from 176 to 205 feet. A low permeability poorly indurated olive green, silty clay unit of the Peace River Formation at 206 feet bls forms the base of the SAS at this site.

Intermediate Aquifer System

Below the SAS lies the IAS, which extends from 206 to 690 feet bls. The Peace River and Arcadia Formations of Miocene-Pliocene age Hawthorn Group (Scott, 1988) act as semiconfining units separating the Floridan aquifer from the SAS. The IAS contains multiple productive horizons, separated by low permeability interaquifer confining units. The low permeability siliciclastic sediments of the Peace River Formation from 206 to 220 feet bls form the top of this system. A moderately productive unit occurs from 220 to 280 feet bls and consists of moderately indurated biogenic limestone with up to 5 percent phosphatic sands, identified as the carbonate facies of the Sandstone aquifer (Smith and Adams, 1988). Below this productive interval is a low permeability, gray to olive green colored, clayey-silt and mudstone unit that extents to a depth of 322 feet bls (base of the Peace River Formation). A second productive horizon occurs from 322 to 370 feet bls (identified based primarily on well cuttings), composed of a moderately indurated wackestone containing 30 to 40 percent allochems consisting of mollusks and bryozoans. This unit was correlated to the mid-Hawthorn aquifer, that underlies this area (Knapp et al., 1986). A relatively thick, low permeability carbonate unit extends from 370 to 490 feet bls, consisting of poorly indurated mudstones. A moderately indurated wackestone with evidence of minor secondary porosity development is present below 490 feet bls.

Formation evaluation tests were conducted on productive intervals below a depth of 490 bls as part of the ASR evaluation of the lower portion of the IAS, requested by the Big Cypress Basin. Therefore, the 12-inch diameter casing was temporarily installed at 490 bls to facilitate geophysical logging and packer testing from 490 to 925 feet bls. The geophysical logs and lithologic data were used to identify a moderately permeability unit from 490 to 550 feet bls. Lithologically, this interval is composed of moderately indurated wackestones with minor stringers of well indurated packstones. The flowmeter and borehole video logs indicate an increase in water flow near the base of this unit at 545 feet bls with diffuse flow over its extent (see geophysical logs from I75-TW Run 2, in **Appendix A**). A low permeability unit consisting of micrite and poorly indurated mudstones are present in the subsurface from 550 to 690 feet bls. A portion of this interval (550 to 620 feet bls) correlates to the Marker Unit, as identified by Reese (2000). The natural gamma log signature that was used to identify the Marker Unit produces thin, intermittent, high-gamma radiation peaks, associated primarily with intervals of high phosphatic sand/silt content below a depth of 550 feet bls. The Marker Unit and other low permeability sediments form the lower boundary of the IAS at 690 feet bls.

Floridan Aquifer System

The FAS consists of a series Tertiary age limestone and dolostone units. The system includes the lower Arcadia Formation, Suwannee and Ocala Limestones, Avon Park Formation, and the Oldsmar Formation. The Paleocene age Cedar Keys Formation with evaporitic gypsum and anhydrite forms the lower boundary of the FAS (Miller, 1986).

Upper Floridan Aquifer

The top of the FAS, as defined by the Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition (1986), coincides with the top of a vertically continuous permeable carbonate sequence at Miocene to Oligocene Age. The upper Floridan aquifer consists of thin, high permeability water bearing horizons interspersed within thick, low permeability units of early Miocene to middle-Eocene age sediments, including the basal Arcadia Formation, Suwannee and Ocala Limestones, and the Avon Park Formation. At this site, the top of the FAS occurs at a depth of 690 feet bls, which coincides with the lower portion of the Arcadia Formation (Basal Hawthorn Unit, Reese, 2000).

Generally, two predominant permeability zones exist within the upper Floridan aquifer. The uppermost permeable zone typically lies between 700 and 1,300 feet bls. The most transmissive part of this upper zone usually occurs near the top, coincident with an unconformity at the top of the Oligocene or Eocene age formations (Miller, 1986). The first transmissive horizon at the I-75 site includes the lower portion of the Basal Hawthorn Unit (Reese and Memberg, 2000), and occurs from 690 to 780 feet bls. The top of this unit is composed of light to pale orange, moderate to well indurated mudstones to wackestones. Light gray to medium brown, well indurated dolostones (surcosic in nature) extend from 705 to 742 feet bls. Through this interval, the caliper log indicates a relatively gauged borehole (similar to bit diameter), the 16/64-inch resistivity readings increase to 20 to 30 ohm-m, and the neutron porosity readings (single detector tool) increase-low porosity (see geophysical logs from I75-TW Run 2 in **Appendix A**), all of which are indicative of a well indurated (fractured) low porosity horizon. However, the flowmeter log indicates increased upward water flow at 745 feet bls, the fluid resistivity trace shows a sharp deflection at 735 feet bls, and combined with the lost circulation encountered from 725 to 737 feet bls during mud rotary drilling, suggests a highly transmissive horizon. Lithologically, moderate to well indurated wackestones to packstones with good secondary (moldic) porosity development continues from 742 to 777 feet bls.

At a depth of 768 feet bls, the upper boundary of the Suwannee Limestone was identified by a gradual change from an olive gray to medium brown, slightly phosphatic limestone and dolostone to a tan to light gray, phosphate free packstone. This formation boundary is also characterized by an attenuation of both the natural gamma activity and measured resistivity (see geophysical log traces from I75-TW Run 2 in **Appendix A**). Therefore, the base of this productive horizon terminates within the upper portion of the Suwannee Limestone at a depth of 780 bls. The base is identified by a positive deflection in both the flowmeter and temperature gradient logs and negative deflection in the fluid resistivity log trace. This productive horizon, located at 690 to 780 feet bls, correlates with the lower Hawthorn-Suwannee aquifer (Knapp et al., 1986) present within this area and is identified as the uppermost portion of the Floridan aquifer at this site.

Below the lower Hawthorn/Suwannee aquifer is a relatively thick, low permeability interaquifer, semiconfining carbonate unit that extends from 780 to 905 feet bls, consisting of poorly to moderately indurated mudstones and wackestones. A second productive interval within the upper Floridan aquifer was identified from 905 to 1,050 feet bls. This interval consists of moderately indurated packstone and grainstone units with minor to moderate secondary porosity development (e.g., pinhole and moldic porosity). The flowmeter log was of limited use in identifying this productive horizon due to the enlarged borehole muting evidence of water production. However, the signature of the temperature log trace from Geophysical Log Run 2, and the results of the borehole video survey (evidence of vuggy porosity) were invaluable in identifying this productive interval. This productive interval terminates in a low permeability, moderately indurated wackestones of the Suwannee Limestone at depth of 1,050 feet bls. The inorganic water quality, stable isotopes (e.g., ^{2}H and ^{18}O), and potentiometric heads, summarized in the previous section, suggest that the two productive horizons identified in the upper Floridan aquifer, 690 to 780 and 890 to 1,050 feet bls, are hydraulically connected.

Middle Confining Unit

Low permeable, poorly to moderately-indurated mudstones to packstones of the Suwannee Limestone occur from 1,050 to 1,100 bls. The resistivity log trace show a positive deflection, suggesting lower porosities and/or lower formation water TDS concentrations from 1,050 to 1,090 feet bls. The deep induction log values below 1,090 feet bls decrease to 2 to 2.5 ohm-meters (ohm-m) with very little change in lithology or porosity. The low resistivity log readings, less than 5 ohm-m (Reese, 2000), coupled with the water quality results from straddle-packer tests, were used to identify the base of the USDW (10,000 mg/L TDS) at approximately 1,090 feet bls. Archie's equation (1942) was also used to estimate the resistivity of formation waters over the portion of the well bore from 900 to 2,374 feet bls. The calculated conductivity was then used to estimate TDS concentrations using the linear regression equations developed by Reese (1994). The results of these calculations also indicated the base of the USDW occurs at approximately 1,090 feet bls. **Figure 25** shows derived TDS concentrations using Archie's equation (Archie, 1942) and linear regression equations developed by Reese (1994) compared to measured TDS values from water samples taken from packer tests.

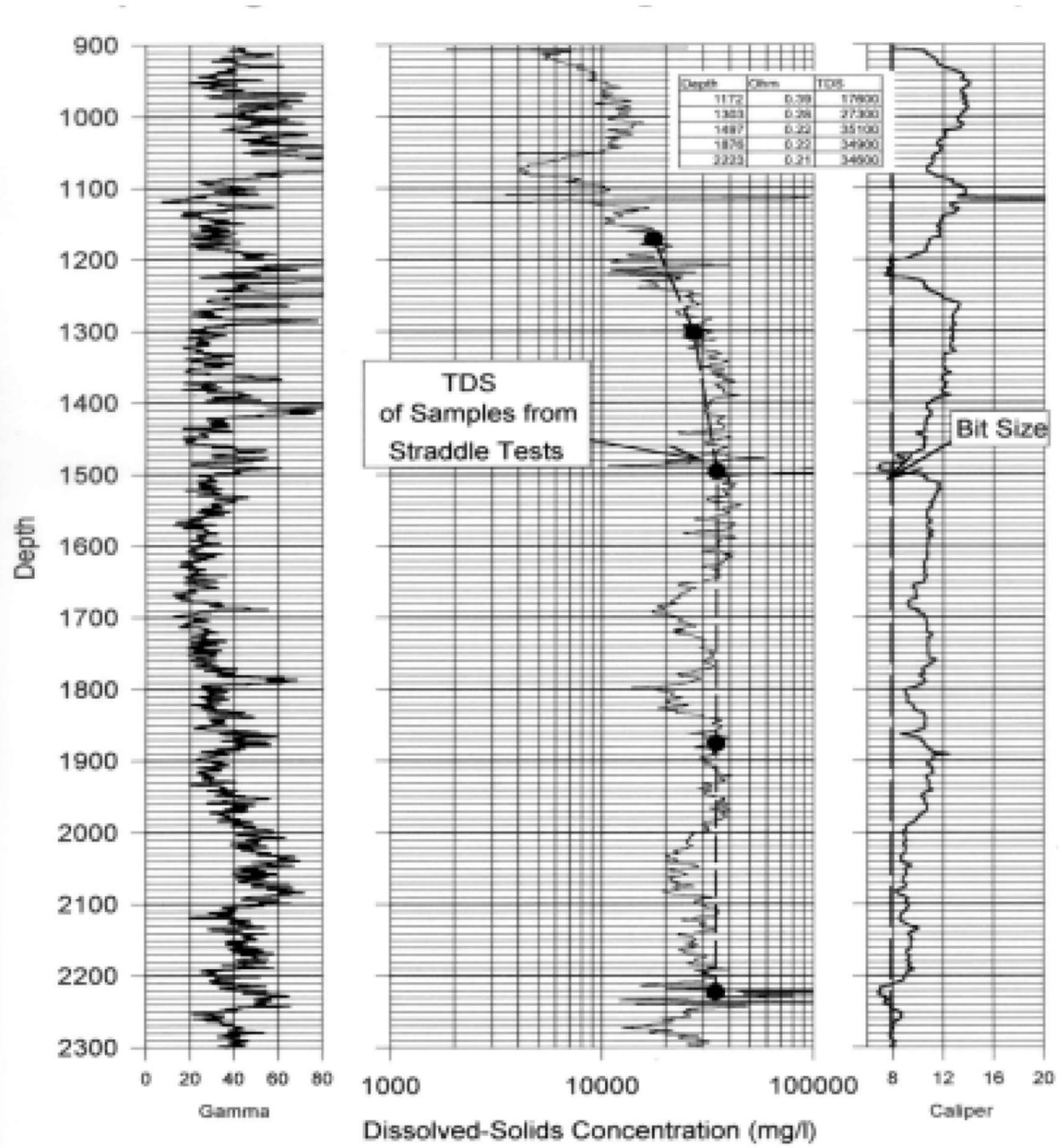
From 1,110 to 1,121 feet bls, a medium gray colored, fine grained, unconsolidated quartz sand with minor organic material (subaerial exposure) was found. The borehole was enlarged through this interval (as shown on the caliper log from Geophysical Log Run 1 and 2, **Appendix A**), due to the unconsolidated nature of the sediments being evacuated during reverse air drilling operations. Below this sand interval, poorly to moderately indurated mudstones and packstones continue to approximately 1,204 feet bls, where a well indurated dolostone unit was found. This olive to light gray, well indurated crystalline (anhedral to euhedral) dolostone unit continues to a depth of 1,231 feet bls. This dolostone unit was easily identified on the geophysical logs by a gauged caliper and deflections in both the resistivity and sonic log traces. Minor water production primarily above and below this dolostone unit was indicated by deflections in the temperature differential log trace (**Figures A-2** and **A-3** in **Appendix A**).

The upper boundary of the Ocala Limestone is difficult to distinguish at this site because of similar lithologic character to the overlying Suwannee Limestone. Reese (2000) identified the top to the Ocala Limestone at 1,231 feet bls. In this report, it was identified at a depth 1,299 feet bls, marked by a slight change in lithology from a yellowish gray, peliodal packstone with 1 to 2 percent phosphate to light gray to tan colored, moderately indurated, mudstone-wackestone with no visible phosphate as indicated in the on-site lithologic log. A slight attenuation of the natural gamma response (see geophysical log traces from I75-TW Run 2 in **Appendix A**) also helped to identify the top of this lithostratigraphic unit.

The lithologic character of the upper portion of the Avon Park Formation is also very similar to the light orange to beige chalky limestones of the lower Ocala Limestone, as shown in the well cuttings and geophysical log responses. The top of the Avon Park Formation was identified by the Florida Geological Society (FGS) at a depth of 1,785 feet bls, based on the absence of a diagnostic Ocala Limestone microfossil *Lepidocyclina* sp., (Applin and Applin, 1944). The matrix becomes finer and abundantly higher altered echnoid fragments are present (Rick Green, Florida Geological Survey, personal communication). Reese (2000) identified the top of the Avon Park Formation at a depth of 1,485 feet bls, based on a regional correlation of formations underlying the lower west coast region of Florida. In this report, this change in lithology at 1,785 feet bls was designated as the top of the Avon Park Formation. This slight change in lithology at 1,785 feet bls is noted on the geophysical logs by a slight increase in natural gamma activity and sonic travel times and decrease in derived density/neutron porosities (**Figure A-3** in **Appendix A**). The minor lithologic differences between the two stratigraphic units may reflect continuous and/or similar depositional environments across the middle to late Eocene time stratigraphic boundary.

The Ocala Limestone from 1,299 to 1,690 feet bls forms in large part an interaquifer confining unit within the FAS at this site. This interval consists of low permeability mudstones and wackestones. Formation samples from this interval do not show evidence of large-scale secondary porosity development. In addition, the production type geophysical logs traces (e.g., temperature and flowmeter logs) indicate limited production horizons, supporting the overall confining nature of this interval.

Intervals with high permeability have been documented within the middle confining unit ranging in depth from 1,400 to 1,600 feet bls (Miller, 1986). Within this interaquifer confining unit, a minor flow zone is present within a medium brown to olive gray crystalline dolomite unit at a depth of 1,481 to 1,500 feet bls. Through this interval, the induction, sonic and density/neutron log traces indicate a well indurated, low porosity unit. Near the center of this dolostone unit, the caliper log identifies an enlarged borehole with a diameter exceeding 20 inches, and deflections in the temperature and flowmeter logs indicate minor water production (see Geophysical Log Run 3 in **Appendix A**). A packer test was conducted within this interval yielded a specific capacity of 15.13 gpm/ft



Depth	Ohm	TDS
1172	0.39	17600
1303	0.28	27300
1497	0.22	35100
1876	0.22	34900
2223	0.21	34900

$F = a/\phi^m$ $m = 1.95$, $a=0.883$

F = Formation Factor

a = Tortuosity Factor

ϕ = Porosity in decimal form derived from semilog

m = Cementation exponent

$R_o = F \times R_w$

R_o = Resistivity in ohm-meters of the formation 100% water saturated

F = Formation factor, a proportionality constant

R_w = Resistivity in ohm-meters of the water saturating the formation

RILD = Rt

RILD = Deep induction log value

Rt = Formation resistivity

Figure 25. Calculated Formation Water Total Dissolved Solid Concentrations for I75-TW at Depths of 900 to 2,350 feet bls

of drawdown, but produced water similar to seawater in composition with chloride concentrations greater than 17,000 mg/L.

The Avon Park Formation from 1,785 to 1,986 feet bls is characterized by moderate to well indurated packstones to grainstones, interbedded with minor dolostone units. These limestone units show evidence of varying degrees of pinhole and moldic porosity development with the dolostones being slightly surcrosic in nature. However, a well defined flow zone is not evident, as indicated by smooth log traces in both the temperature and flowmeter logs (See I75-TW Geophysical Log Run 3 in **Appendix A**). The lithology and moderate degree of secondary porosity development as seen in the well cuttings suggests low to moderate production capacity over this interval. However, a productive horizon at 1,850 to 1,901 feet bls identified from well cuttings and borehole video log, yielded a specific capacity of 13.49 gpm/ft at a pumping rate of 102 gpm. This interval produced saline waters and is located well below the USDW. Therefore, this interval was not identified for composite aquifer testing and long-term water level and water quality monitoring.

Miller (1986) observed that portions of the lower Avon Park Formation are fine grained and have low permeability, thereby acting as interaquifer confining units within the FAS. Based on well cuttings, well indurated, low porosity mudstone to packstone units with intermittent brown to gray dolostones occur in the subsurface from 1,986 to 2,213 feet in depth. The geophysical logs also identify this lithologic change with the caliper log measuring a relatively gauged borehole, an increase in both resistivity and bulk density values, and shorter sonic travel times (see I75-TW Geophysical Log Run 3 in **Appendix A**).

Lower Floridan Aquifer

Below the middle confining unit is the lower Floridan aquifer from 1,986 and 2,213 feet bls that is characterized by thin, moderate to high permeability, fractured, and cavernous dolostones that occur interspersed within low permeability dolostone and limestone units. A significant lithologic change occurs at a depth of 2,213 feet bls, and continues to the total depth of the borehole at 2,694 feet. Well indurated, crystalline (euhedral to subhedral) dolostones dominate this interval with only minor stringers of wackestone and packstone limestone units. This change in lithology is indicated by an increase in resistivity and decrease in sonic travel times (see I75-TW Geophysical Log Run 3 in **Appendix A**). A highly fractured dolostone unit from 2,340 to 2,374 feet bls was initially identified by sharp deflections in both the resistivity and sonic traces and later verified by a borehole video log. This highly fractured interval produced boulders that obstructed the borehole, precluding geophysical logging of the borehole below a depth of 2,374 feet bls. Based on Meyers (1989) and Reese (2000), the interval from 2,213 to 2,694 feet bls was identified as the upper dolostone units of the lower Floridan aquifer. The pilot hole extends through the upper dolostone units of the lower Floridan to a total depth of 2,694 feet bls. From a stratigraphic perspective, the Oldsmar Formation was not found at this site, based on lithologic criteria defined by Miller (1986), the lack of a glauconite marker bed used by Duncan et al. (1994), and the absence of early Eocene index fossils such as *Helicostegina gyralis (*Chen, 1965).

Table 14 summarizes the stratigraphic formations identified at the I-75 Canal site and the depth below land surface at which they were reported.

Table 14. Summary of Stratigraphic Units Identified in the Subsurface

Formation	FGS[a] (feet bls)	USGS[b] (feet bls)	This Report (feet bls)
Hawthorn Group	195	NR[c]	195
Suwannee Limestone	768	750	768
Ocala Limestone	1,299	1,240	1,299
Avon Park Formation	1,785	1,485	1,785
Oldsmar Formation	NI[d]	NI	NI

a. FGS = Florida Geological Society
b. Reese, 2000
c. NR = not reported
d. NI = not identified

SUMMARY

- The top of the FAS, as defined by the Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition (1986), was identified at a depth of approximately 690 feet bls.
- Lithologic and geophysical logs, specific capacity and packer test results, and petrophysical data indicate moderate to good production capacity of the upper Floridan aquifer.
- Water quality data from reverse air returns and straddle-packer tests indicate that chloride and TDS in the upper Floridan aquifer waters exceed potable drinking water standards. Chloride and TDS concentrations above 1,050 feet bls range from 1,530 to 4,020 mg/L and 3,410 to 7,150 mg/L, respectively.
- The first productive horizon in the upper Floridan aquifer, from 690 to 780 feet bls, yielded a transmissivity value of 116,400 gpd/ft, a storage coefficient of 1.664×10^{-5}, and an r/B value of 0.04, and a leakance value of 2.33×10^{-3} gpd/ft^3.
- The second productive interval in the upper Floridan aquifer, from 890 to 1,050 feet bls, yielded a transmissivity value of 52,500 gpd/ft, a storage coefficient of 2.3×10^{-5}, and an r/B value of 0.05 and a leakance value of 1.64×10^{-3} gpd/ft^3.
- The base of the USDW, those waters having TDS concentrations less than 10,000 mg/L, occurs at an approximate depth of 1,090 feet bls.

- Fluid-type (flowmeter and temperature) geophysical logs show little natural flow below the base of the USDW, at a depth of 1,090 feet bls.
- The highest mean horizontal permeability, 4,800 millidarcies, from cores corresponds to a cored section at approximately 950 feet bls consisting of an intraalgal foraminiferal peloidal packstone likely deposited in an open lagoonal shoal environment.
- The average measured potentiometric heads for the Floridan monitoring intervals are as follows:
  - 34.6 feet NGVD: ±0.41 feet for the 690 to 760 feet bls monitor interval
  - 34.5 feet NGVD: ±0.39 feet for the 905 to 1,050 feet bls monitor interval
  - 9.1 feet NGVD: ±0.44 feet for the 2,300 to 2,350 feet bls monitor interval
- Water levels in the FAS respond to external stresses such as tidal loading and barometric pressure variations.

REFERENCES

Agarwal, R.G., R. Al-Hussainy, and H.J. Ramey, Jr. 1970. An investigation of wellbore storage and skin effect in unsteady liquid flow – analytical treatment. *Trans. Soc. Pet. Eng. AIME* 249: 279-290.

American Petroleum Institute. 1998. *Recommended Practices for Core Analysis*.

Applin, P.L., and E.R. Applin. 1944. Regional subsurface stratigraphy and structure of Florida and southern Georgia. *AAPG Bulletin* 28 (12): 1,673-1,753.

Archie, G.E. 1942. The electrical resistivity log as an aid in determining some reservoir characteristics. *AIME Transaction* 146: 54-61.

Bennett, M.W. 2001. *Hydrogeologic Investigation of the Floridan Aquifer System at the L-2 Canal Site Hendry County, Florida*. Technical Publication WS-3, South Florida Water Management District, West Palm Beach, FL.

Chen, C.S. 1965. *The Regional Lithostratigraphic Analysis of Paleocene and Eocene Rocks of Florida*. Bulletin 45, Florida Geological Survey.

Coleman, M.L., T.J. Shepherd, J.J. Durham, J.E. Rouse, and G.R. Moore. 1982. Reduction of water with zinc for hydrogen isotope analysis. *Analytical Chemistry* 54: 993-995.

Craig, H. 1961. Isotopic variations in meteoric waters. *Science*, 133: 1,702-1,703.

Drimmie, R.J., A.R. Heemskerk, and R. Aravena. 1990. *Dissolved Inorganic Carbon (DIC)*. Technical Procedure 5.0, Rev. 01, Environmental Isotope Laboratory, Department of Earth Sciences, University of Waterloo.

Drimmie, R.J., A.R. Heemskerk, W.A. Mark, and R.M. Weber. 1991. *Deuterium by zinc Reduction*. Technical Procedure 4.0, Revision 02, Environmental Isotope Laboratory, Department of Earth Sciences, University of Waterloo.

Drimmie, R.J., and A.R. Heemskerk. 1993. *Water ^{18}O by CO_2 Equilibration*. Technical Procedure 13.0, Revision 02, Environmental Isotope Laboratory, Department of Earth Sciences, University of Waterloo.

Duncan, J.C., W.L. Evan III, and K.L. Taylor. 1994. *The Geologic Framework of the Lower Floridan Aquifer System in Brevard County, Florida*. Bulletin No. 64, Florida Geological Survey.

Dunham, R.J. 1962. Classification of Carbonate Rocks according to depositional texture. In: Ham, W.E. (ed), Classification of Carbonate Rocks Mem, *AAPG* 1: 108-121.

Edwards, L.E., S.D. Weedman, K.R. Simmons, T.M. Scott, G.L. Brewster-Wingard, S.E. Ishman, and N.M. Carlin. 1998. *Lithostratigraphy, Petrography, Biostratigraphy, and Strontium-Isotope Stratigraphy of the Surficial Aquifer System of Western Collier County, Florida.*

Epstein, S., and T.K Mayeda. 1953. Variations of the $^{18}O/^{16}O$ ratio in natural waters. *Geochimica et Cosmochimica Acta* 4: 213.

Hantush, M.S. 1960. Modification of the theory of leaky aquifers. *Jour. of Geophys. Res.* 65(11): 3,713-3,725

Hantush, M.S., and C.E. Jacob. 1955. Nonsteady radial flow in an infinite leak aquifer. *Eos Trans. AGU* 36(1): 95-100.

Hanshaw, B.N., W. Back, and M. Rubin. 1964. Radiocarbon determinations for estimating flow velocities in Florida. *Science* 143: 494-495.

Knapp, M.S., W.S. Burns, and T.S. Sharp. 1986. *Preliminary Assessment of the Ground Water Resources of Western Collier County, Florida*. Technical Publication 86-1, South Florida Water Management District.

Kohout, F.A. 1965. A hypothesis concerning cyclic flow of salt water related to geothermal heating in the Floridan Aquifer. *New York Academy of Sciences Transaction, Ser.2* 28(1): 11-15.

Kohout, F.A. 1967. Ground water flow and the geothermal regime of the Florida Plateau. *Trans. Gulf Coast Assoc. Geol. Soc.* 17: 339-354.

Hallenburg, J.K. 1998. *Standard Methods of Geophysical Formation Evaluation*. CRC Press, Lewis Publishing, Boca Raton, FL.

Meyer, F.W., 1989. *Hydrogeology, Ground Water Movement, and Subsurface Storage in the Floridan Aquifer System in Southern Florida*. Professional Paper 1403-G, United States Geological Survey.

Meyers, J.B., P.K. Swart, J.L. Myers. 1993. Geochemical evidence for groundwater behavior in an unconfined aquifer, south Florida. *Journal of Hydrology* 149: 249-27

Miller, J.A. 1986. *Hydrogeologic Framework of the Floridan Aquifer System in Florida and in Parts of Georgia, Alabama, and South Carolina*. Professional Paper 1403-B, United States Geological Survey.

Moench, A.F., 1985. Transient flow to a large-diameter well in an aquifer with storative semi-confining layers. *Water Resources Research* 21(8): 1,121-1,131.

Mook, W.G., 1976. The dissolution-exchange model for dating groundwater with ^{14}C. In: EDITOR (ed), *Interpretation of Environmental Isotope and Hydrochemical Data in Groundwater Hydrology*, Vienna, IAEA, pp. 213-225.

Papadopulos, I.S., and H.H. Cooper, Jr. 1967. Drawdown in a well of large diameter. *Water Resource Research* 3(1): 241-244.

Reese, R.S. 1994. *Hydrogeology and the Distribution and Origin of Salinity in the Floridan Aquifer System, Southeastern Florida*. Water Resources Investigation Report 94-4010, United States Geological Survey.

Reese, R.S. 2000. *Hydrogeology and the Distribution of Salinity in the Floridan Aquifer System, Southwestern Florida*. Water Resources Investigation Report 98-4253, United States Geological Survey.

Reese, R.S., and S.J. Memberg. 2000. *Hydrogeology and the Distribution of Salinity in the Floridan Aquifer System, Palm Beach County, Florida*. Water Resources Investigation Report 99-4061, United States Geological Survey.

Sandal, H.M., R.N. Horne, H.J. Ramey, Jr., and J.W. Williamson. 1978. *Interference Testing with Wellbore Storage and Skin Effect at the Produced Well*. Paper presented at the 53rd Annual Fall Technical Conference and Exhibition, Society of Petroleum Engineers of AIME, Houston, Texas Oct 1-3, 1978.

Scott, T.M. 1988. *The Lithostratigraphy of the Hawthorn Group (Miocene) of Florida*. Bulletin No. 59, Florida Geological Survey.

SFWMD. 1994. Comprehensive Quality Assurance Plan. South Florida Water Management District, West Palm Beach, FL.

Smith, K.R., and K.M. Adams. 1988. *Preliminary assessment of the Ground Water Resources of Hendry County, Florida*. Technical Publication 88-12, South Florida Water Management District, West Palm Beach, FL.

Southeastern Geological Society Ad Hoc Committee on Florida Hydrostratigraphic Unit Definition. 1986. *Hydrogeologic Unit of Florida*. Special Publication No. 28, Florida Department of Natural Resources, Bureau of Geology.

Stuiver, M, and H.A. Polach. 1977. Discussion, reporting of ^{14}C data. *Radiocarbon* 19(3): 355-363.

Tamers, M.A. 1967. Surface-water infiltration and groundwater movement in arid areas of Venezuela. *Isotopes in Hydrology, IAEA, Vienna*, pp. 339-351.

Walton, W.W. 1960. *Leaky artesian aquifer condition in Illinois*. Report of Investigations No.39, Illinois State Water Survey.

APPENDIX A
GEOPHYSICAL LOGS

Legend for Geophysical Log Traces

CALI	caliper
CORPOR	core porosity
c.p.s.	counts per second
dec	decimal fraction
DegF	degrees Fahrenheit
DT	delta time
DTEM	delta temperature
FLOW	flowmeter
FLOWNS	flowmeter - static
FR	fluid resistivity
FT	feet
gAPI	gamma American Petroleum Institute units
gm/cc	grams per cubic centimeter
GR	gamma ray
ILD	deep induction log
ILM	medium induction log
in	inches
LAT	lateral - 6-foot restivity
NPHI	neutron porosity
ohm.m	ohm-meters
RES	resistivity
RHOB	bulk density
SFR	shallow focused resistivity
SPHI	sonic porosity
TEMP	temperature
us/ft	microseconds per foot

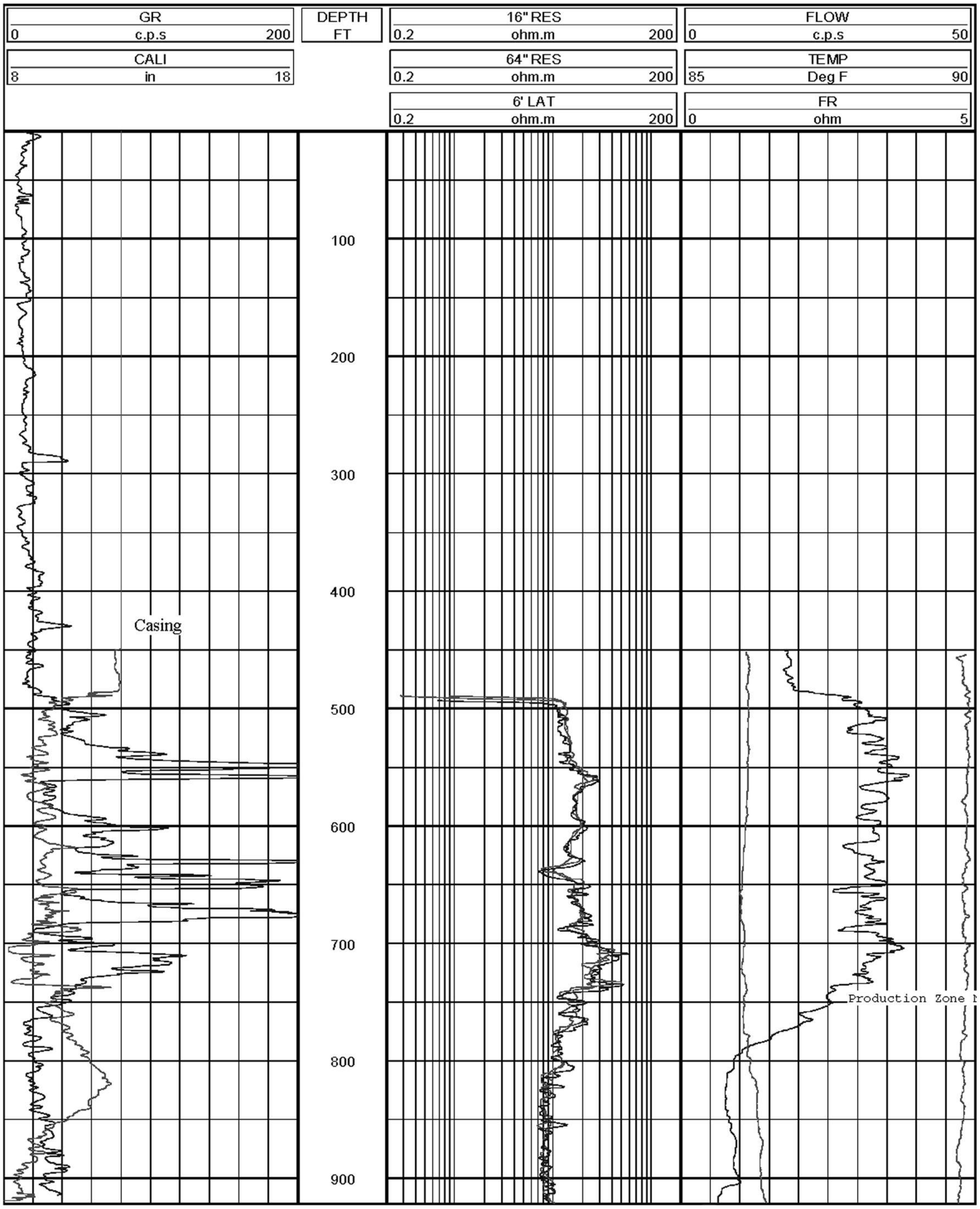


Figure A-1. Log Traces from I75-TW Geophysical Log Run 1

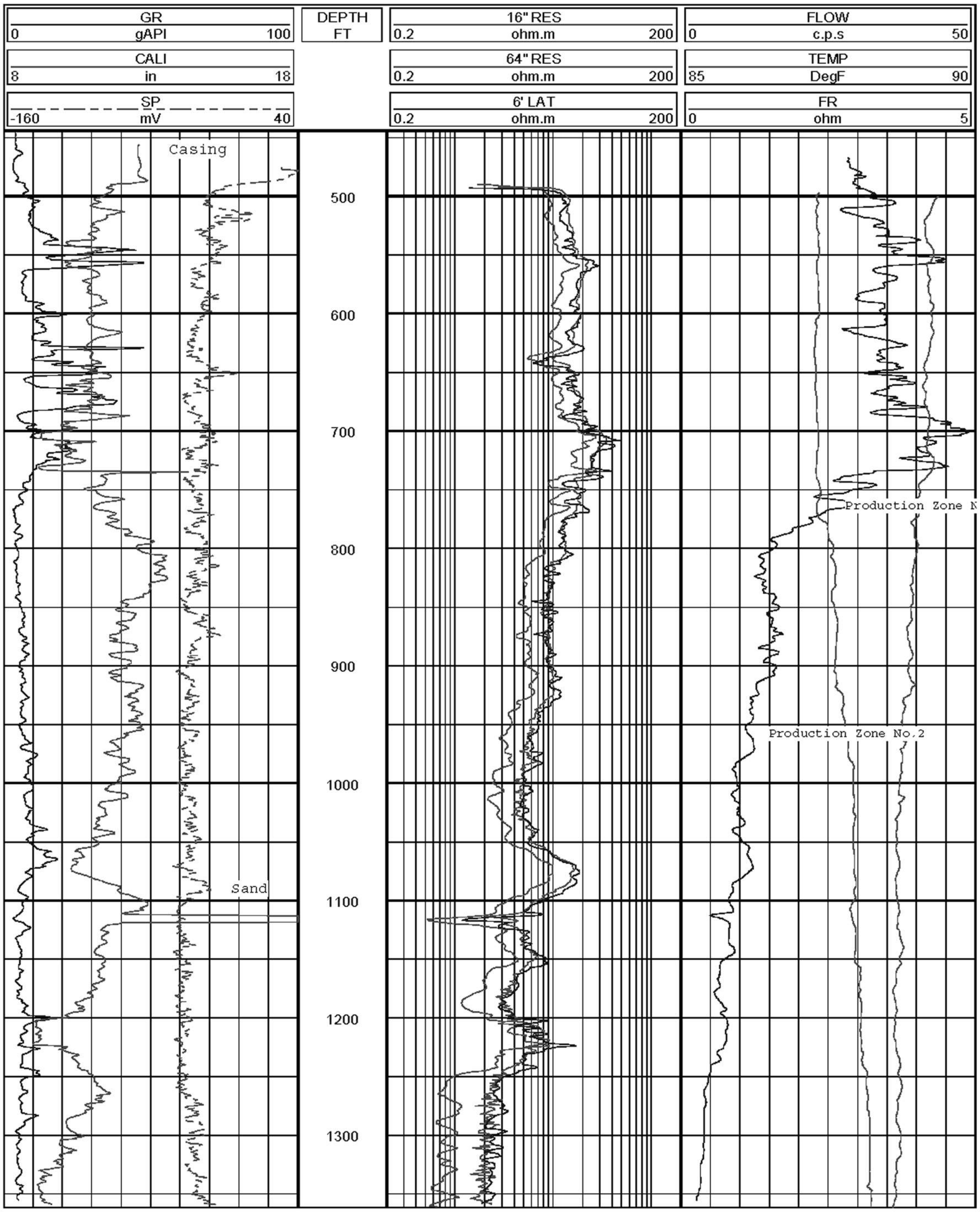


Figure A-2. Log Traces from I75-TW Geophysical Log Run 2

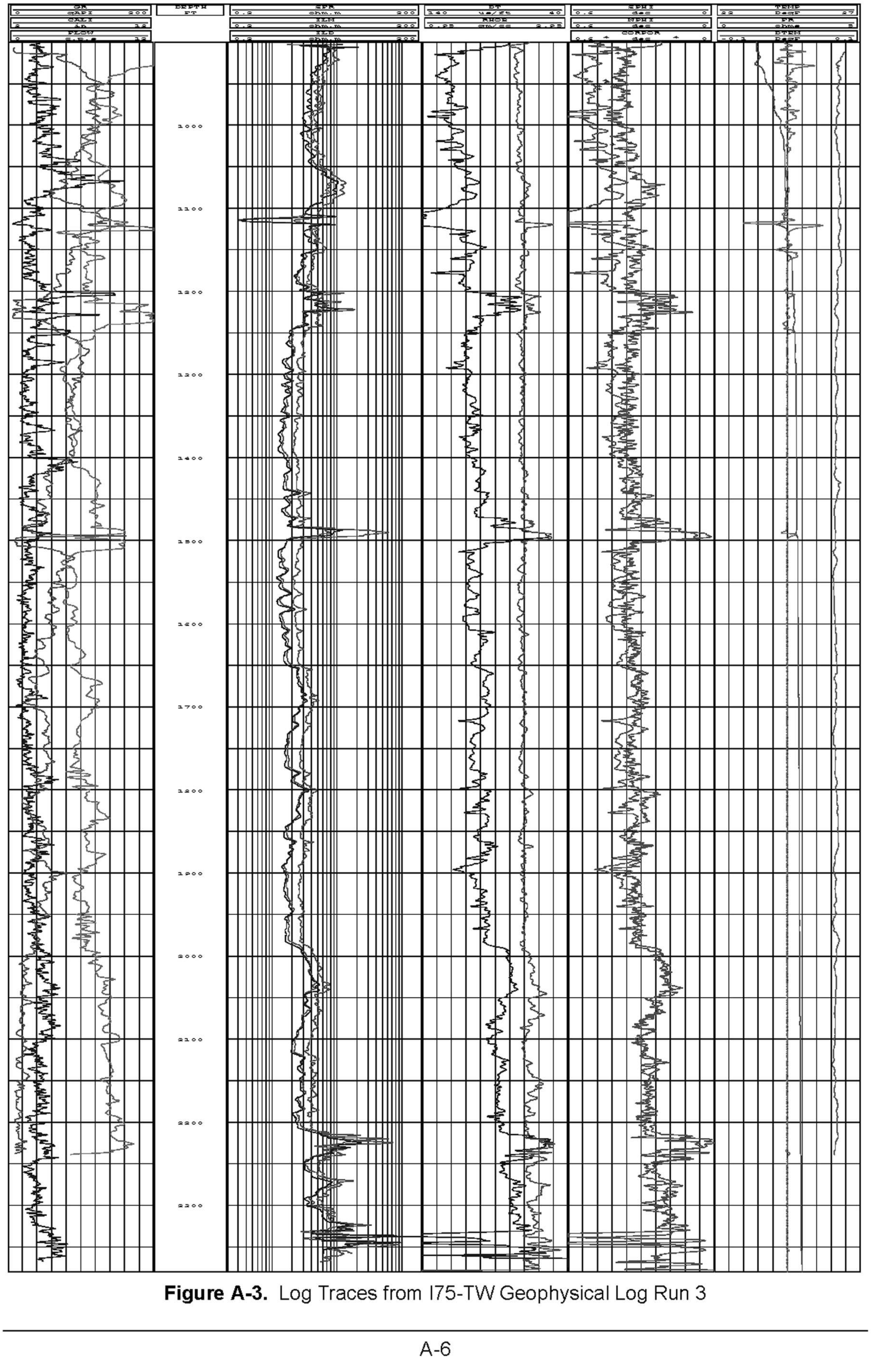


Figure A-3. Log Traces from I75-TW Geophysical Log Run 3

APPENDIX B
LITHOLOGIC DESCRIPTION

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LITHOLOGIC WELL LOG PRINTOUT        SOURCE - FGS

WELL NUMBER: W-17405                COUNTY -   COLLIER
TOTAL DEPTH: 2694 FEET              LOCATION:   T.49S R.26E S.29
331 SAMPLES FROM 10 TO 2694 FEET                LATITUDE = 26D 10M 12S
                                                LONGITUDE = 81D 43M 51S
COMPLETION DATE: 03/26/96           ELEVATION: 10 FT

OTHER TYPES OF LOGS AVAILABLE - ELECTRIC

OWNER/DRILLER: SFWMD/RST Enterprise Inc.

WORKED BY: MARTIN BALINSKY (FGS) (9/19/96)
SFWMD GEOPHYSICAL # 021-000066
SFWMD ID# FOR CUTTINGS IS I75-TW (021-26)
WELL IS LOCATED IN SECTION 29, TOWNSHIP 49S, RANGE 26E
BELLE MEADE SW QUADRANGLE, COLLIER COUNTY

      0 -     10    000NOSM   NO SAMPLES
     10 -    195    121PCPC   PLIOCENE-PLEISTOCENE
    195 -    768    122HTRN   HAWTHORN GROUP
    768 -   1299    123SWNN   SUWANNEE LIMESTONE
   1299 -   1785    124OCAL   OCALA GROUP
   1785 -   2694    124AVPK   AVON PARK FORMATION
      0 -     10    000NOSM   NO SAMPLES
    280 -    287    000NOSM   NO SAMPLES
    482 -    490    000NOSM   NO SAMPLES
   1795 -   1796    000NOSM   NO SAMPLES


 10  - 30       SHELL BED; YELLOWISH GRAY TO WHITE
                25% POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
                UNCONSOLIDATED
                ACCESSORY MINERALS: CALCILUTITE-05%
                FOSSILS: MOLLUSKS

30   -   90     SHELL BED; VERY LIGHT ORANGE TO GRAYISH OLIVE
                25% POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
                UNCONSOLIDATED
                ACCESSORY MINERALS: CALCILUTITE-15%, PHOSPHATIC SAND-01%
                FOSSILS: MOLLUSKS

90   -  195     SAND; YELLOWISH GRAY TO MODERATE LIGHT GRAY
                30% POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
                GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
                HIGH SPHERICITY; UNCONSOLIDATED

195   -  210    WACKESTONE; LIGHT OLIVE GRAY TO WHITE
                15% POROSITY: LOW PERMEABILITY, INTERGRANULAR
                GRAIN TYPE: CALCILUTITE, SKELETAL
                40% ALLOCHEMICAL CONSTITUENTS
                GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
                MODERATE INDURATION
                CEMENT TYPE(S): CALCILUTITE MATRIX
                ACCESSORY MINERALS: QUARTZ SAND-25%
                FOSSILS: MOLLUSKS
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                 THE SAND FOUND HERE IS DOMINANTLY FINE-GRAINED. POSSIBLE
                 TOP OF MIOCENE HAWTHORN FORMATION

210  -  220      SAND; MODERATE OLIVE BROWN TO WHITE
                 20% POROSITY: INTERGRANULAR
                 GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
                 HIGH SPHERICITY; POOR INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 ACCESSORY MINERALS: SILT-30%, CALCILUTITE-20%
                 FOSSILS: MOLLUSKS

220  -  280      SHELL BED; MODERATE LIGHT GRAY TO WHITE
                 25% POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY
                 POOR INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 ACCESSORY MINERALS: PHOSPHATIC GRAVEL-02%
                 PHOSPHATIC SAND-01%
                 FOSSILS: MOLLUSKS
                 SOME RECRYSTALLIZATION (5%)

280  -  287      NO SAMPLES

287  -  305      SAND; LIGHT OLIVE GRAY TO WHITE
                 25% POROSITY: INTERGRANULAR,
                 GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
                 MEDIUM SPHERICITY; POOR INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 ACCESSORY MINERALS: CALCILUTITE-10%, SHELL-85%
                 FOSSILS: MOLLUSKS
                 SHELLY SAND

305  -  335      WACKESTONE; WHITE TO LIGHT GRAY
                 20% POROSITY: INTERGRANULAR
                 GRAIN TYPE: SKELETAL, CALCILUTITE
                 15% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
                 POOR INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 ACCESSORY MINERALS: PHOSPHATIC SAND-01%
                 FOSSILS: MOLLUSKS

335  -  370      WACKESTONE; WHITE TO MODERATE LIGHT GRAY
                 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR
                 GRAIN TYPE: SKELETAL, CALCILUTITE
                 40% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO VERY COARSE
                 MODERATE INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 ACCESSORY MINERALS: PHOSPHATIC SAND-01%
                 BRYOZOANS

370  -  430      MUDSTONE; WHITE
                 POROSITY: LOW PERMEABILITY, INTERGRANULAR
                 GRAIN TYPE: CALCILUTITE, SKELETAL
                 05% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
                 MODERATE INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
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	ACCESSORY MINERALS: PHOSPHATIC SAND-01% FOSSILS: MOLLUSKS
430 - 482	MUDSTONE; YELLOWISH GRAY POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 03% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: PHOSPHATIC SAND-01% FOSSILS: MOLLUSKS
482 - 490	NO SAMPLES
490 - 635	MUDSTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: PHOSPHATIC SAND-01% FOSSILS: MOLLUSKS PARTIALLY RECRYSTALLIZED
635 - 660	MUDSTONE; VERY LIGHT GRAY TO LIGHT OLIVE GRAY POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
660 - 735	MUDSTONE; YELLOWISH GRAY POROSITY: LOW PERMEABILITY, INTERGRANULAR, VUGULAR GRAIN TYPE: CALCILUTITE, SKELETAL 03% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: PHOSPHATIC SAND-01% FOSSILS: MOLLUSKS
735 - 764	WACKESTONE; WHITE TO DARK GRAYISH YELLOW 12% POROSITY: LOW PERMEABILITY, INTERGRANULAR, VUGULAR GRAIN TYPE: CALCILUTITE, SKELETAL 12% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: DOLOMITE-15%, PHOSPHATIC SAND-01% VUGGY EUHEDRAL DOLOSTONE EXISTS AS SEPARATE FRAGMENTS FROM CALCILUTITE

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764   -  777     PACKSTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
                 12% POROSITY: LOW PERMEABILITY, INTERGRANULAR
                 GRAIN TYPE: CALCILUTITE, SKELETAL
                 70% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE
                 GOOD INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 FOSSILS: MOLLUSKS
                 GASTROPODS. SOME PARTIAL RECRYSTALLIZATION OBSERVABLE

777   -  806     MUDSTONE; WHITE TO PINKISH GRAY
                 POROSITY: LOW PERMEABILITY, INTERGRANULAR
                 GRAIN TYPE: CALCILUTITE, CRYSTALS
                 05% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
                 MODERATE INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 FOSSILS: MOLLUSKS

806   -  860     WACKESTONE; VERY LIGHT ORANGE TO WHITE
                 12% POROSITY: LOW PERMEABILITY, INTERGRANULAR
                 GRAIN TYPE: CALCILUTITE, SKELETAL
                 30% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
                 MODERATE INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 FOSSILS: MOLLUSKS
                 GASTROPODS. ABOUT 80% RECRYSTALLIZED

860   -  912     PACKSTONE; VERY LIGHT ORANGE TO WHITE
                 12% POROSITY: LOW PERMEABILITY, INTERGRANULAR
                 GRAIN TYPE: CALCILUTITE, SKELETAL, CRYSTALS
                 80% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
                 MODERATE INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 FOSSILS: MOLLUSKS
                 DOMINANTLY PELOIDS. ABOUT 90% RECRYSTALLIZED

912   -  996     PACKSTONE; GRAYISH ORANGE TO VERY LIGHT ORANGE
                 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR
                 GRAIN TYPE: CALCILUTITE, SKELETAL
                 70% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
                 MODERATE INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 FOSSILS: MOLLUSKS
                 ABOUT 30% RECRYSTALLIZED

996   - 1030     WACKESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
                 11% POROSITY: LOW PERMEABILITY, INTERGRANULAR, VUGULAR
                 GRAIN TYPE: CALCILUTITE, SKELETAL
                 40% ALLOCHEMICAL CONSTITUENTS
                 GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
                 GOOD INDURATION
                 CEMENT TYPE(S): CALCILUTITE MATRIX
                 FOSSILS: BENTHIC FORAMINIFERA, MOLLUSKS
                 ABOUT 90% RECRYSTALLIZED
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1030 - 1033	GRAINSTONE; DARK GRAYISH YELLOW TO WHITE 17% POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY GRAIN TYPE: CALCILUTITE, SKELETAL, CRYSTALS 95% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: BENTHIC FORAMINIFERA, MOLLUSKS GASTROPODS. ABOUT 95% RECRYSTALLIZED. PELOIDS AND FORAMINIFERA. IDENTIFICATION OF TYPES OF FORAMINIFERA INDETERMINATE
1033 - 1040	PACKSTONE; WHITE TO VERY LIGHT ORANGE 14% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 65% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX THIS SAMPLE CONSISTS OF ABOVE UNIT (1030-1033 FEET) AND A MATRIX-SUPPORTED UNIT (PARTIALLY RECRYSTALLIZED) CONTAINING FORAMINIFERA AND PELOIDS
1040 - 1045	WACKESTONE; WHITE TO VERY LIGHT ORANGE 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 35% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS, CORAL GASTROPODS
1045 - 1060	WACKESTONE; VERY LIGHT ORANGE TO WHITE 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 15% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
1060 - 1070	MUDSTONE; YELLOWISH GRAY TO WHITE POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
1070 - 1073	MUDSTONE; WHITE TO VERY LIGHT ORANGE POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS

1073 - 1092	MUDSTONE; VERY LIGHT ORANGE TO WHITE POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 03% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
1092 - 1122	PACKSTONE; YELLOWISH GRAY TO WHITE 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL, BIOGENIC 85% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS, BENTHIC FORAMINIFERA EXTENSIVE RECRYSTALLIZATION (95%). SKELETAL FRAGMENTS OF MOLLUSKS, FORAMINIFERA AND PELOIDS.
1122 - 1126	SAND; VERY LIGHT ORANGE 30% POROSITY: INTERGRANULAR, POSSIBLY HIGH PERMEABILITY GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM HIGH SPHERICITY; UNCONSOLIDATED THIS SAMPLE IS DOMINANTLY MEDIUM-GRAINED SAND.
1126 - 1173	PACKSTONE; YELLOWISH GRAY TO WHITE 12% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 60% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO VERY COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX DICTYOCONUS (FIRST OCCURRENCE). POSSIBLE OLIGOCENE SUWANNEE LIMESTONE. GASTROPODS
1173 - 1195	MUDSTONE; VERY LIGHT ORANGE 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX
1195 - 1204	WACKESTONE; VERY LIGHT ORANGE TO WHITE 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ABOUT 80% RECRYSTALLIZED
1204 - 1207	DOLOSTONE; OLIVE GRAY TO LIGHT OLIVE GRAY 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR 90-100% ALTERED; ANHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE GOOD INDURATION

CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: CALCILUTITE-05%
FOSSILS: ALGAE
CALCILUTITE AND DOLOSTONE EXIST AS SEPARATE FRAGMENTS

1207 - 1227 DOLOSTONE; YELLOWISH GRAY
10% POROSITY: LOW PERMEABILITY, INTERGRANULAR, VUGULAR
90-100% ALTERED; EUHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: CALCILUTITE-02%
MINOR REMNANT CALCILUTITE. MINOR VUGS, LINED WITH
EUHEDRAL DOLOMITE RHOMBS

1227 - 1231 DOLOSTONE; MODERATE LIGHT GRAY
10% POROSITY: LOW PERMEABILITY, INTERGRANULAR
90-100% ALTERED; EUHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: CALCILUTITE-05%
SEPARATE CALCILUTITE AND DOLOSTONE FRAGMENTS

1231 - 1267 WACKESTONE; MODERATE LIGHT GRAY TO YELLOWISH GRAY
12% POROSITY: LOW PERMEABILITY, INTERGRANULAR
GRAIN TYPE: CALCILUTITE, SKELETAL
25% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: DOLOMITE-40%
OTHER FEATURES: DOLOMITIC
FOSSILS: MOLLUSKS, ECHINOID
SEPARATE FRAGMENTS OF CALCILUTITE AND DOLOSTONE.
DICTYOCONUS ABOUT 70% RECRYSTALLIZED. SOME FRAGMENTS ARE
HIGH IN SKELETAL MATERIAL

1267 - 1287 PACKSTONE; YELLOWISH GRAY TO WHITE
15% POROSITY: LOW PERMEABILITY, INTERGRANULAR
GRAIN TYPE: CALCILUTITE, SKELETAL
70% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
FOSSILS: MOLLUSKS, ECHINOID

1287 - 1299 PACKSTONE; YELLOWISH GRAY
15% POROSITY: LOW PERMEABILITY, INTERGRANULAR
GRAIN TYPE: CALCILUTITE, SKELETAL, BIOGENIC
85% ALLOCHEMICAL CONSTITUENTS
GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
MODERATE INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
DOMINANTLY PELOIDS

1299 - 1413 WACKESTONE; YELLOWISH GRAY TO MODERATE LIGHT GRAY
10% POROSITY: LOW PERMEABILITY, INTERGRANULAR
GRAIN TYPE: CALCILUTITE, SKELETAL

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               40% ALLOCHEMICAL CONSTITUENTS
               GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE
               MODERATE INDURATION
               CEMENT TYPE(S): CALCILUTITE MATRIX
               FOSSILS: CRUSTACEA, MOLLUSKS
               SIMILAR TO PRECEDING LITHOLOGY, BUT BETTER INDURATED, AND
               LOWER AMOUNT OF PELOIDS. GASTROPODS

1413  - 1481   WACKESTONE; YELLOWISH GRAY TO WHITE
               15% POROSITY: LOW PERMEABILITY, INTERGRANULAR
               GRAIN TYPE: CALCILUTITE, SKELETAL
               15% ALLOCHEMICAL CONSTITUENTS
               GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
               MODERATE INDURATION
               CEMENT TYPE(S): CALCILUTITE MATRIX
               FOSSILS: MOLLUSKS

1481  - 1483   DOLOSTONE; DARK GRAYISH YELLOW
               12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE
               90-100% ALTERED; EUHEDRAL
               GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM
               GOOD INDURATION
               CEMENT TYPE(S): DOLOMITE CEMENT
               ACCESSORY MINERALS: CALCILUTITE-01%

1483  - 1485   MUDSTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY
               POROSITY: LOW PERMEABILITY, INTERGRANULAR
               GRAIN TYPE: CALCILUTITE, SKELETAL
               01% ALLOCHEMICAL CONSTITUENTS
               GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
               MODERATE INDURATION
               CEMENT TYPE(S): CALCILUTITE MATRIX
               ACCESSORY MINERALS: DOLOMITE-20%
               FOSSILS: MOLLUSKS
               PARTIALLY DOLOMITIZED FRAGMENTS INTERBEDDED WITH
               CALCILUTITE

1485  - 1500   DOLOSTONE; GRAYISH BROWN TO MODERATE YELLOWISH BROWN
               13% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR
               90-100% ALTERED; EUHEDRAL
               GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE
               GOOD INDURATION
               CEMENT TYPE(S): DOLOMITE CEMENT
               ACCESSORY MINERALS: CALCILUTITE-10%
               OTHER FEATURES: CALCAREOUS
               MINOR VUGS

1500  - 1527   WACKESTONE; WHITE TO GRAYISH BROWN
               10% POROSITY: LOW PERMEABILITY, INTERGRANULAR
               GRAIN TYPE: CALCILUTITE, SKELETAL
               30% ALLOCHEMICAL CONSTITUENTS
               GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE
               GOOD INDURATION
               CEMENT TYPE(S): CALCILUTITE MATRIX
               ACCESSORY MINERALS: DOLOMITE-15%
               OTHER FEATURES: DOLOMITIC
               FOSSILS: MOLLUSKS
               SEPARATE FRAGMENTS OF DOLOSTONE AND WACKESTONE.
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	LEPIDOCYCLINA PRESENT. POSSIBLE TOP OF LATE EOCENE OCALA LIMESTONE
1527 - 1532	MUDSTONE; YELLOWISH GRAY 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 01% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
1532 - 1545	MUDSTONE; WHITE POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 01% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
1545 - 1610	MUDSTONE; VERY LIGHT ORANGE POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS LEPIDOCYCLINA
1610 - 1620	WACKESTONE; VERY LIGHT ORANGE TO YELLOWISH GRAY 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 12% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: DOLOMITE-05% FOSSILS: MOLLUSKS CALCILUTITE-BEARING DOLOSTONE EXISTS AS SEPARATE FRAGMENTS FROM CALCILUTE. NUMMULITES COMPRISE ABOUT 10% OF SAMPLE.DICTYOCONUS
1620 - 1690	WACKESTONE; VERY LIGHT ORANGE 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 40% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX LEPIDOCYCLINA
1690 - 1747	PACKSTONE; YELLOWISH GRAY 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 85% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE MODERATE INDURATION

	CEMENT TYPE(S): CALCILUTITE MATRIX NUMMULITES DOMINATE. LEPIDOCYCLINA
1747 - 1777	WACKESTONE; YELLOWISH GRAY 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 20% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS NUMMULITES MINOR (1%)
1777 - 1795	PACKSTONE; YELLOWISH GRAY TO WHITE 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 60% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: CORAL, MOLLUSKS NUMMULITES
1795 - 1796	NO SAMPLES
1796 - 1800	WACKESTONE; DARK GRAYISH YELLOW 15% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE GRAIN TYPE: CALCILUTITE, SKELETAL 15% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS, ECHINOID SAMPLE CONSISTS OF DOMINANTLY RECRYSTALLIZED CALCITE FRAGMENTS, WITH SOME CALCILUTITE. EXTENSIVE SKELETAL FRAGMENTS FLOAT IN THIS MATRIX.
1800 - 1864	PACKSTONE; YELLOWISH GRAY 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 65% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS, BENTHIC FORAMINIFERA, SPICULES SOME RECRYSTALLIZATION (APPROXIMATELY 15%). MANY SKELETAL FRAGMENTS. IDENTITY UNCLEAR. DICTYOCONUS AMERICANUS. POSSIBLE TOP OF MIDDLE EOCENE AVON PARK FORMATION
1864 - 1876	WACKESTONE; GRAYISH ORANGE TO WHITE 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL, CRYSTALS 35% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS, BENTHIC FORAMINIFERA EXTENSIVE RECRYSTALLIZATION. MATRIX-SUPPORTED FRAGMENTS WITH RECRYSTALLIZED CALCITE AND REMNANT CALCILUTITE (15%)

	AND FLOATING SKELETAL FRAGMENTS. FORAMINIFERA TYPES INDETERMINATE
1876 - 1900	GRAINSTONE; VERY LIGHT ORANGE 18% POROSITY: LOW PERMEABILITY, INTERGRANULAR POSSIBLY HIGH PERMEABILITY GRAIN TYPE: SKELETAL, CALCILUTITE 95% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: BENTHIC FORAMINIFERA, MOLLUSKS DOMINANTLY PELOIDS AND BENTHIC FORAMINIFERA WHOSE IDENTITY IS INDETERMINATE
1900 - 1905	WACKESTONE; VERY LIGHT ORANGE TO LIGHT OLIVE BROWN 20% POROSITY: INTERGRANULAR GRAIN TYPE: SKELETAL, CALCILUTITE 40% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE POOR INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX TWO DISTINCT COLORS OF FRAGMENTS ARE PRESENT--DARKER(ABOUT 70%) AND LIGHTER (ABOUT 30%). THE DARKER FRAGMENTS ARE POORLY INDURATED. NUMMULITES PRESENT--CAVINGS? (NOT IN MATRIX)
1905 - 1952	PACKSTONE; VERY LIGHT ORANGE TO GRAYISH BROWN 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: SKELETAL, CALCILUTITE 60% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX SAMPLE IS ABOUT 20% RECRYSTALLIZED. DOMINANTLY VERY LIGHT FRAGMENTS, BUT MINOR PALE YELLOWISH-BROWN FRAGMENTS. PELOIDS
1952 - 1986	WACKESTONE; VERY LIGHT ORANGE TO WHITE 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: SKELETAL, CALCILUTITE, BIOGENIC 40% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
1986 - 1997	WACKESTONE; VERY LIGHT ORANGE TO LIGHT OLIVE BROWN 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: SKELETAL, CALCILUTITE 20% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS TWO DISTINCT COLORS OF FRAGMENTS AGAIN, SIMILAR TO 1900-1905. MILDLY VUGGY. SKELETAL FRAGMENTS FLOAT IN MATRIX

1997 - 2084	WACKESTONE; YELLOWISH GRAY TO WHITE 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: SKELETAL, CALCILUTITE 30% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS
2084 - 2127	WACKESTONE; VERY LIGHT ORANGE 13% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: SKELETAL, CALCILUTITE, BIOGENIC 40% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX FOSSILS: MOLLUSKS PELOIDS, MOST OF WHICH HAVE BEEN RECRYSTALLIZED
2127 - 2155	WACKESTONE; GRAYISH YELLOW 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, BIOGENIC 30% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX
2155 - 2185	WACKESTONE; YELLOWISH GRAY TO LIGHT OLIVE GRAY 13% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL, BIOGENIC 35% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX DICTYOCONUS
2185 - 2189	DOLOSTONE; OLIVE GRAY TO WHITE 17% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 50-90% ALTERED; ANHEDRAL GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT ACCESSORY MINERALS: CALCILUTITE-15% OTHER FEATURES: CALCAREOUS FOSSILS: BENTHIC FORAMINIFERA DOLOSTONE WITH REMNANT SKELETAL CALCITE FRAGMENTS AND SOME CALCILUTITE FRAGMENTS. DOLOSTONE IS EXTENSIVELY VUGGY. DOMINANTLY ANHEDRAL AND SUBHEDRAL, BUT EUHEDRAL CRYSTALS ARE FOUND AS VUG LINERS AND DOMINATING A FEW PARTICULAR AREAS
2189 - 2210	DOLOSTONE; OLIVE GRAY TO WHITE 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 50-90% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX

	ACCESSORY MINERALS: CALCILUTITE-35% OTHER FEATURES: CALCAREOUS PELOIDS AND REMNANT FORAMINIFERA. DIFFICULT TO DETERMINE THE IDENTITY OF THE FORAMINIFERA. CALCILUTITE IS INTERBEDDED WITH DOLOSTONE
2210 - 2213	DOLOSTONE; OLIVE GRAY TO WHITE 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 50-90% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX ACCESSORY MINERALS: CALCILUTITE-35% OTHER FEATURES: CALCAREOUS WHICH RESEMBLES THAT SEEN FROM 2185 TO 2189 FEET. ABOUT 90% OF DOLOSTONE IS SUBHEDRAL AND 10% IS EUHEDRAL
2213 - 2215	DOLOSTONE; MODERATE YELLOWISH BROWN TO LIGHT OLIVE GRAY 10% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX ACCESSORY MINERALS: CALCILUTITE-01% APPROXIMATELY 35% EUHEDRAL CRYSTALS, AND 65% SUBHEDRAL. EUHEDRAL CRYSTALS DOMINATE CERTAIN AREAS ON THE SAMPLE, AND LINE VUGS
2215 - 2222	DOLOSTONE; LIGHT OLIVE GRAY TO MODERATE YELLOWISH BROWN 10% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 90-100% ALTERED; EUHEDRAL GRAIN SIZE: MEDIUM; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT ACCESSORY MINERALS: SHELL-% DOMINANTLY LARGE FRAGMENTS WITH SMOOTH FACES. POSSIBLE "FRACTURE ZONE" EUHEDRAL CRYSTALS ON FRACTURE SURFACES
2222 - 2235	DOLOSTONE; LIGHT BROWNISH GRAY 10% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT ACCESSORY MINERALS: SHELL-% MOSTLY LARGE FRAGMENTS WITH ALMOST ALL SMOOTH FACES--POSSIBLE "FRACTURE ZONE" ROCK. MOST FRACTURE SURFACES DISPLAY FINE-GRAINED SUBHEDRAL AND ANHEDRAL CRYSTLAS, BUT MEDIUM-GRAINED EUHEDRAL RHOMBS DOMINATE A FEW FACES OF THE ROCK
2235 - 2242	DOLOSTONE; LIGHT OLIVE GRAY TO MODERATE YELLOWISH BROWN 10% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT EXTENSIVE VUGS WHICH ARE LINED WITH EUHEDRAL CRYSTALS. EUHEDRAL CRYSTALS ARE ALSO FOUND ALONG SMOOTH SURFACES

	WHICH ARE LESS DOMINANT THAN IN ABOVE SAMPLE
2242 - 2244	DOLOSTONE; MODERATE LIGHT GRAY TO DARK GRAYISH YELLOW 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT STILL DOMINANTLY LARGE FRACTURES WITH SMOOTH FACES. SOME FACES HAVE EUHEDRAL DOLOMITE CRYSTALS (FRACTURE FILL)
2244 - 2249	DOLOSTONE; MODERATE LIGHT GRAY TO GRAYISH OLIVE 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT ACCESSORY MINERALS: CALCILUTITE-08% CALCILUTITE AND DOLOSTONE EXIST AS SEPARATE FRAGMENTS. ABOUT 15% EUHEDRAL CRYSTALS
2249 - 2265	WACKESTONE; VERY LIGHT ORANGE TO DARK YELLOWISH BROWN 15% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, SKELETAL 30% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: COARSE; RANGE: VERY FINE TO COARSE MODERATE INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: DOLOMITE-10% OTHER FEATURES: DOLOMITIC FRAGMENTS OF VERY PALE ORANGE MATRIX WITH UNIDENTIFIABLE COARSE-GRAINED WHITE ALLOCHEMS FLOATING IN THEM. DOLOSTONE AND CALCILUTITE EXIST AS SEPARATE FRAGMENTS. SOME OF THE DOLOSTONE FRAGMENTS HAVE THESE PALER FRAGMENTS FLOATING IN THEM. 20% OF
2265 - 2271	DOLOSTONE; LIGHT GRAY TO WHITE 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR 50-90% ALTERED; EUHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: CALCILUTITE-35%, GYPSUM-05% CALCILUTITE IS PRESENT AS REMNANT SPOTS IN DOLOSTONE, AND AS SEPARATE FRAGMENTS
2271 - 2277	DOLOSTONE; OLIVE GRAY TO WHITE 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 50-90% ALTERED; EUHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: CALCILUTITE-15%, GYPSUM-03% SIMILAR TO ABOVE DESCRIPTION. ABOUT 40% OF DOLOSTONE IS SUBHEDRAL
2277 - 2298	LIMESTONE; YELLOWISH GRAY 12% POROSITY: LOW PERMEABILITY, INTERGRANULAR, VUGULAR

GRAIN TYPE: CRYSTALS, CALCILUTITE
GRAIN SIZE: VERY FINE; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: DOLOMITE-15%
ABOUT 35% OF SAMPLES ARE DOLOSTONE WITH LARGE PATCHES OF CALCILUTITE. ABOUT 65% OF FRAGMENTS ARE FAIRLY PURE CALCILUTITE. RECRYSTALLIZATION MAKES IT DIFFICULT TO ESTIMATE ALLOCHEMICAL PERCENTAGE. BOTH LITHOLOGIES ARE VUGGY.

2298 - 2302 LIMESTONE; VERY LIGHT ORANGE
11% POROSITY: LOW PERMEABILITY, INTERGRANULAR, VUGULAR
GRAIN TYPE: CRYSTALS, CALCILUTITE
GRAIN SIZE: VERY FINE; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: DOLOMITE-01%
EXTENSIVE RECRYSTALLIZATION (70%) LIMESTONE. AGAIN DIFFICULT TO ESTIMATE PERCENTAGE OF ALLOCHEMICAL CONSTITUENTS

2302 - 2323 LIMESTONE; VERY LIGHT ORANGE
11% POROSITY: LOW PERMEABILITY, INTERGRANULAR, VUGULAR
GRAIN TYPE: CRYSTALS, CALCILUTITE
GRAIN SIZE: VERY FINE; GOOD INDURATION
CEMENT TYPE(S): CALCILUTITE MATRIX
ACCESSORY MINERALS: DOLOMITE-07%
OTHER FEATURES: DOLOMITIC
SEPARATE FRAGMENTS OF CALCILUTITE AND DOLOSTONE WITH CALCILUTITE

2323 - 2329 DOLOSTONE; MODERATE DARK GRAY TO MODERATE YELLOWISH BROWN
12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE
90-100% ALTERED; SUBHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT
ACCESSORY MINERALS: CALCILUTITE-03%
CALCILUTITE EXISTS AS REMNANT AMONG DOLOSTONE. DOMINANTLY SUBHEDRAL CRYSTALS, BUT EUHEDRAL CRYSTALS ARE FOUND LINING VUGS AND CERTAIN SURFACES ON FRAGMENTS

2329 - 2331 DOLOSTONE; MODERATE LIGHT GRAY TO YELLOWISH GRAY
13% POROSITY: LOW PERMEABILITY, INTERGRANULAR INTERCRYSTALLINE; 50-90% ALTERED; SUBHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX
ACCESSORY MINERALS: CALCILUTITE-30%
DOLOSTONE EXISTS AS SEPARATE FRAGMENTS FROM PARTIALLY DOLOMITIC LIMESTONE, AND NONDOLOMITIC LIMESTONE

2331 - 2337 DOLOSTONE; MODERATE YELLOWISH BROWN TO MODERATE GRAY
13% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR
90-100% ALTERED; SUBHEDRAL
GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM
GOOD INDURATION
CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX
ACCESSORY MINERALS: CALCILUTITE-01%
DOMINANTLY SUBHEDRAL CRYSTALS, BUT ABOUT 35% EUHEDRAL

	RHOMBS FOUND AS VUG LINERS, AND CONCENTRATED IN CERTAIN AREAS
2337 - 2352	DOLOSTONE; GRAYISH BROWN 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 90-100% ALTERED; ANHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT MINOR CALCILUTITE EXIST AS SEPARATE FRAGMENTS FROM DOLOSTONE. DOMINANTLY ANHEDRAL. MINOR AREAS (15%) OF EUHEDRAL AND SUBHEDRAL CRYSTALS. EUHEDRAL RHOMBS DOMINATE SOME SURFACES
2352 - 2392	DOLOSTONE; DARK YELLOWISH BROWN TO MODERATE YELLOWISH BROWN LX% POROSITY: VUGULAR; 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT DOLOMITE RHOMBS (ABOUT 30%) EXIST AS VUG LINERS AND ALONG SURFACES.
2392 - 2412	WACKESTONE; YELLOWISH GRAY TO MODERATE LIGHT GRAY 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, BIOGENIC 30% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO FINE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: DOLOMITE-35% OTHER FEATURES: DOLOMITIC CALCILUTITE AND DOLOSTONE EXIST AS SEPARATE FRAGMENTS. DOLOSTONE IS VUGGY--SIMILAR IN APPEARANCE TO THAT FOUND BETWEEN 2350 AND 2392 FEET
2412 - 2422	DOLOSTONE; MODERATE GRAY TO MODERATE YELLOWISH BROWN 11% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX ACCESSORY MINERALS: CALCILUTITE-02% ABOUT 70% SUBHEDRAL FINE-GRAINED DOLOMITE CRYSTALS, AND ABOUT 28% MEDIUM-SIZED EUHEDRAL RHOMBS
2422 - 2432	CALCILUTITE; VERY LIGHT ORANGE TO MODERATE DARK GRAY 14% POROSITY: LOW PERMEABILITY, INTERGRANULAR INTERCRYSTALLINE GRAIN TYPE: CALCILUTITE, BIOGENIC 01% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO FINE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX, DOLOMITE CEMENT ACCESSORY MINERALS: DOLOMITE-35% A MIX OF PARTIALLY DOLOMITIZED FRAGMENTS (30%), ALMOST ENTIRELY DOLOMITIZED FRAGMENTS (10%), AND CALCILUTITE FRAGMENTS (70%). THE CALCILUTITE IS MODERATELY INDURATED

	WHILE THE DOLOSTONE IS WELL-INDURATED
2432 - 2434	DOLOSTONE; MODERATE DARK GRAY TO WHITE 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 50-90% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX SOME PARTIALLY DOLOMITITE CALCILUTITE FRAGMENTS (DOLOMITIZED AREAS ARE DISTINCT REGIONS OF FRAGMENTS) INTERBEDDED WITH FULLY DOLOMITIZED FRAGMENTS. DOLOSTONE HAS SAME CHARACTERISTICS AS THAT BETWEEN 2422 AND 2432 FRAGMENTS
2434 - 2436	DOLOSTONE; GRAYISH OLIVE TO MODERATE BROWN 11% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 50-90% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX ACCESSORY MINERALS: CALCILUTITE-05% OTHER FEATURES: CALCAREOUS
2436 - 2438	DOLOSTONE; MODERATE DARK GRAY TO VERY LIGHT ORANGE 12% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE, VUGULAR 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT ACCESSORY MINERALS: CALCILUTITE-01% VERY SIMILAR TO PRECEDING LITHOLOGIES OF DOLOSTONE--PARTIALLY EUHEDRAL, AND DOMINANTLY SUBHEDRAL
2438 - 2451	GRAINSTONE; YELLOWISH GRAY TO LIGHT OLIVE GRAY 12% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, BIOGENIC 90% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: DOLOMITE-20% DOMINANTLY PELOIDS. DOLOSTONE AND GRAINSTONE EXIST AS SEPARATE FRAGMENTS
2451 - 2458	DOLOSTONE; MODERATE DARK GRAY TO MODERATE YELLOWISH BROWN 11% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX, DOLOMITE CEMENT ACCESSORY MINERALS: CALCILUTITE-45% OTHER FEATURES: CALCAREOUS SIMILAR TO SAMPLES FOUND FROM 2436-2438 FEET
2458 - 2537	GRAINSTONE; YELLOWISH GRAY TO PINKISH GRAY 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, BIOGENIC 95% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: FINE; RANGE: VERY FINE TO FINE

	GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX ACCESSORY MINERALS: DOLOMITE-45% OTHER FEATURES: DOLOMITIC DOMINANTLY PELOIDS. DOLOSTONE IS INTERBEDDED WITH GRAINSTONE
2537 - 2541	DOLOSTONE; MODERATE LIGHT GRAY TO YELLOWISH GRAY 11% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE INTERGRANULAR; 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX, DOLOMITE CEMENT ACCESSORY MINERALS: CALCILUTITE-45% OTHER FEATURES: CALCAREOUS GRAINSTONE AND DOLOSTONE EXIST AS SEPARATE FRAGMENTS
2541 - 2575	MUDSTONE; WHITE TO LIGHT GRAY 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR GRAIN TYPE: CALCILUTITE, BIOGENIC 05% ALLOCHEMICAL CONSTITUENTS GRAIN SIZE: VERY FINE; RANGE: VERY FINE TO FINE GOOD INDURATION CEMENT TYPE(S): CALCILUTITE MATRIX, DOLOMITE CEMENT ACCESSORY MINERALS: DOLOMITE-15% OTHER FEATURES: DOLOMITIC
2575 - 2581	DOLOSTONE; OLIVE GRAY TO LIGHT OLIVE GRAY 11% POROSITY: LOW PERMEABILITY, INTERCRYSTALLINE 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT ACCESSORY MINERALS: CALCILUTITE-02%
2581 - 2585	DOLOSTONE; YELLOWISH GRAY TO LIGHT OLIVE GRAY 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR 90-100% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT ACCESSORY MINERALS: CALCILUTITE-15% OTHER FEATURES: CALCAREOUS LARGE SMOOTH-SIDED FRAGMENTS. TWO TYPES OF FRAGMENTS--YELLOWISH GRAY, WHICH ARE SLIGHTLY CALCAREOUS AND LIGHT OLIVE GRAY FAIRLY PURE DOLOSTONE). MINOR CALCILUTITE EXISTS AS SEPARATE FRAGMENTS FROM DOLOSTONE
2585 - 2694	DOLOSTONE; DARK YELLOWISH BROWN TO GRAYISH BROWN 10% POROSITY: LOW PERMEABILITY, INTERGRANULAR INTERCRYSTALLINE; 50-90% ALTERED; SUBHEDRAL GRAIN SIZE: FINE; RANGE: VERY FINE TO MEDIUM GOOD INDURATION CEMENT TYPE(S): DOLOMITE CEMENT, CALCILUTITE MATRIX ACCESSORY MINERALS: CALCILUTITE-25% OTHER FEATURES: CALCAREOUS CALCILUTITE AND DOLOSTONE EXIST AS SEPARATE FRAGMENTS. DOLOSTONE FRAGMENTS SLIGHTLY CALCAREOUS
2694	TOTAL DEPTH

APPENDIX C
CORE DESCRIPTIONS FOR I75-PW

(Provided by Collier Consulting, Inc.)

SUWANNEE LIMESTONE

Core Interval: 910 to 911.8 feet below land surface

Description: Cream to white colored, very fine to fine grained, slightly phosphatic, foram-peloid packstone-wackestone; good interparticle porosity with scattered moldic and vugs, common forams, increasing porosity at 911.8 feet below land surface (bls) (**Figure C-1**)

Depositional Environment: Open lagoon shoal

Core Interval: 911.8 to 913 feet below land surface

Description: Yellowish-gray, fine to pebble grained, poor sorted, very porous, molluscan-coquina rudstone; good interparticle and moldic porosity (**Figure C-1**)

Depositional Environment: Shoal

Core Interval: 945 to 946.8 feet below land surface

Description: Yellowish-gray, fine to medium grained, well sorted, slightly laminated, ostracod-foram-peloidal packstone-grainstone; fair to good intraparticle porosity, a trace of large vugs (**Figure C-2**)

Depositional Environment: Open lagoon shoal

Core Interval: 946.8 to 947 feet below land surface

Description: Yellowish-gray, medium grained, well sorted, foram-peloidal packstone, with good interparticle moldic porosity; fair to good intraparticle porosity increasing to vuggy porosity with increasing grain size (**Figure C-2**)

Depositional Environment: Open lagoon shoal

Core Interval: 947 to 947.25 feet below land surface

Description: Yellowish gray, slightly laminated, fine to medium grained, moderate to well sorted, foram-peloidal packstone; this interval is very porous with abundant good interparticle and vuggy moldic porosity with traces of coarse to very coarse vugs (**Figure C-2**)

Depositional Environment: Restrictive lagoon shoal

Core Interval: 947.25 to 950.75 feet below land surface

Description: Yellowish gray to pale orange, coarse to granular grained, moderately sorted, intraclast-algal-foram-peloidal packstone; this interval is very porous and has good interparticle to vuggy moldic porosity with abundant

2 to 3-millimeter (mm) algae at 950 feet with scattered 1 to 5-mm vugs (**Figure C-2**)

Depositional Environment: Open lagoon shoal

Core Interval: 950.75 to 951.6 feet below land surface

Description: Very pale orange, slightly laminated, fine to very fine grained, foram-peloidal packstone with very fine to fine sized vugs and molds, and scattered intraparticle porosity (**Figure C-2**)

Depositional Environment: Open lagoon shoal

Core Interval: 951.6 to 956 feet below land surface

Description: Very light brown to pale orange, fine to very coarse grained, very poorly sorted, bryozoan-gastropod wackestone-rudstone; this interval has good vuggy moldic porosity with scattered 40-mm bryozoan molds and abundant bryozoan molds at 952-953 feet bls; pelecypod shells dominate below 953 feet more akin to a pelecypod packstone-wackestone (**Figures C-2** and **C-3**)

Depositional Environment: Bryozoan mound

Core Interval: 1,020 to 1,020.3 feet below land surface

Description: Yellowish gray, coarse to granular, gastropod-molluscan coquina with very good moldic and interparticle porosity development containing scattered vugs measuring 5-10 mm in size (**Figure C-3**)

Depositional Environment: Restrictive lagoon

Core Interval: 1,020.3 to 1,023.5 feet below land surface

Description: White, very fine to medium grained, skeletal packstone; this interval has good vuggy moldic porosity with scattered intraparticle porosity; a discontinuous, slightly laminated surface occurs at 1,020.5-1,020.6 feet (**Figure C-3**)

Depositional Environment: Mound flank

The core descriptions are summarized in **Table C-1**. Preceding the table is a legend defining the abbreviations used in the table.

Figure C-1. Core Slabs from depths of 910 to 930 bls for I75-PW

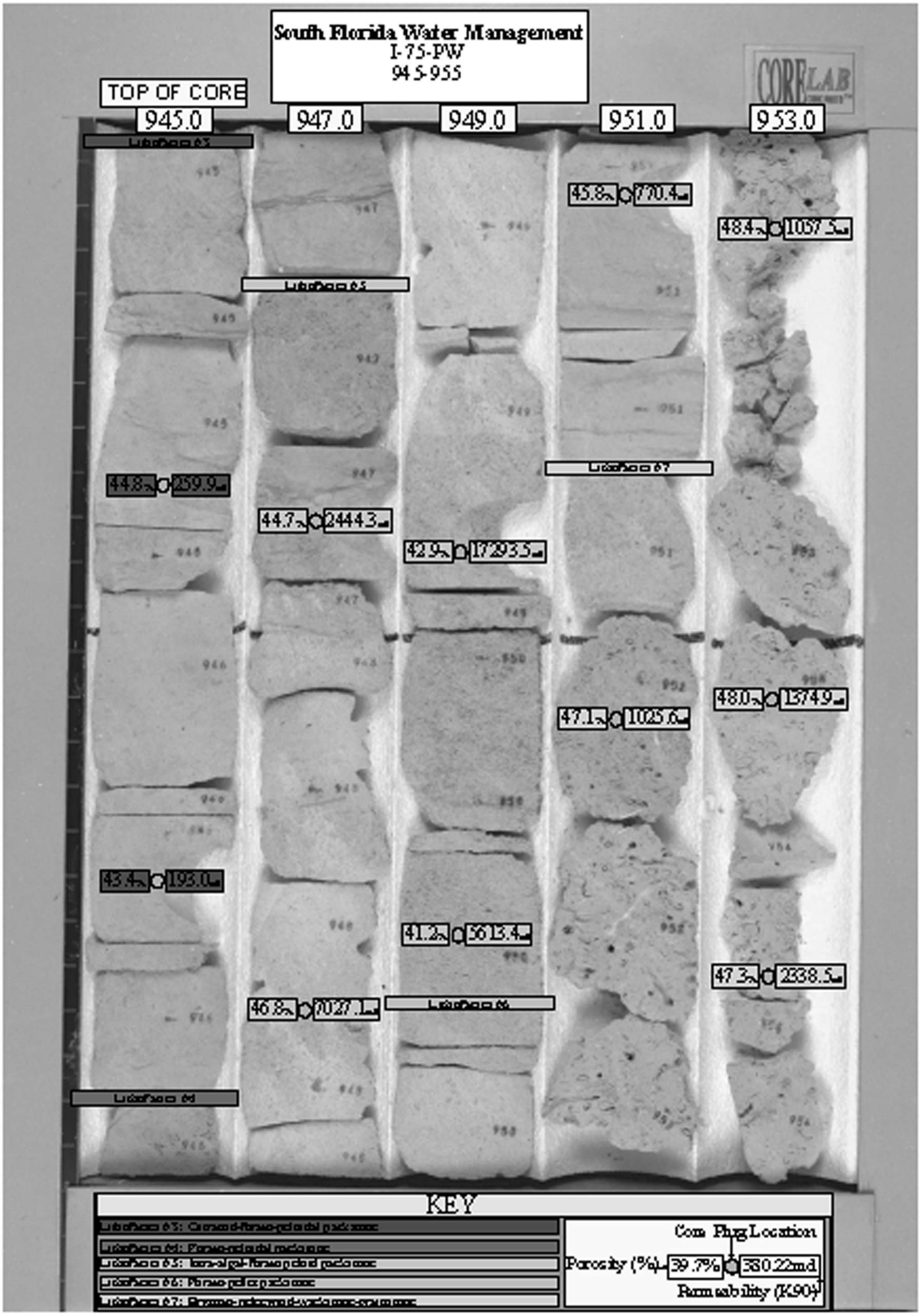


Figure C-2. Core Slabs from depths of 945 to 930 bls for I75-PW

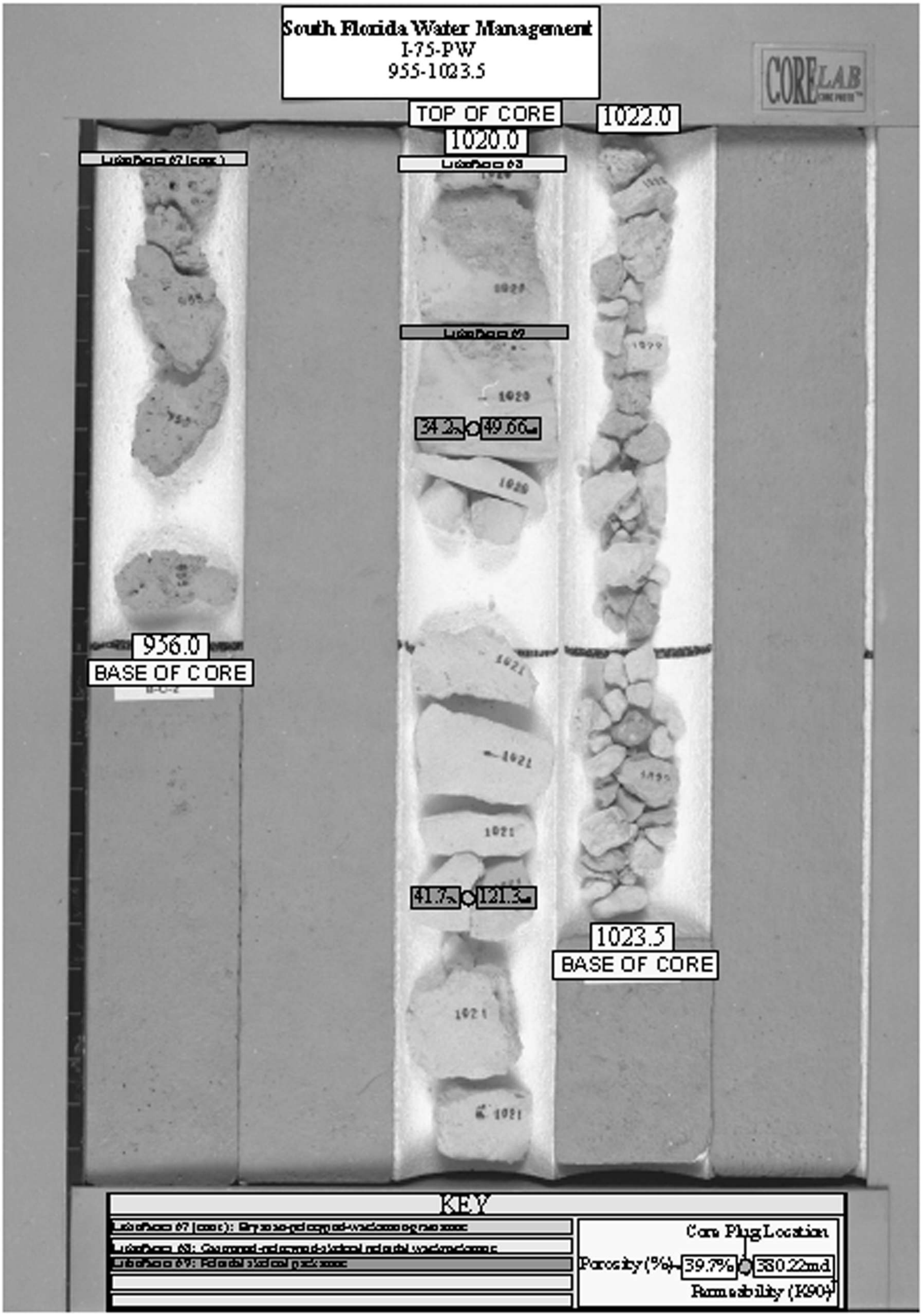


Figure C-3. Core Slabs from depths of 955 to 1,023.5 bls for I75-PW

KEY TO CORE DESCRIPTIONS IN TABLE C-1

Rock Type

COQ	Coquina
G	Grainstone
P	Packstone
R	Rudstone
W	Wackestone

Grain Size

C	Coarse
F	Fine
G	Granule
M	Medium
P	Pebble
VF	Very Fine

Porosity Visual Dominant, Porosity Visual Other

F	Fair
G	Good
P	Poor
VG	Very Good

Porosity Dominant, Porosity Other

BP	Between Particles
LV	Large Vug
MICOR	Microscopic
MO	Moldic
SH	Shelter
V	Vug
WP	Within Particles

Pore Size Dominant, Pore Size Other

C	Coarse
F	Fine
G	Granule
LMO	Large Moldic
LV	Large Vug
M	Medium
MICRO	Microscopic
MO	Moldic
P	Pebble
TR	Trace
VC	Very Coarse
VF	Very Fine

Cement

REXL	Recrystallization
SL	Slight
TR	Trace
W	Well

Laminations

INCL	Inclined
SL	Slight
T	Thin
VT	Very Thin

Sorting

M	Medium
MW	Moderately Well
P	Poor
VP	Very Poor
W	Well

Glauconite

SL	Slight

Sand

S	Some
SL	Slight
V	Very
VSL	Very Slight

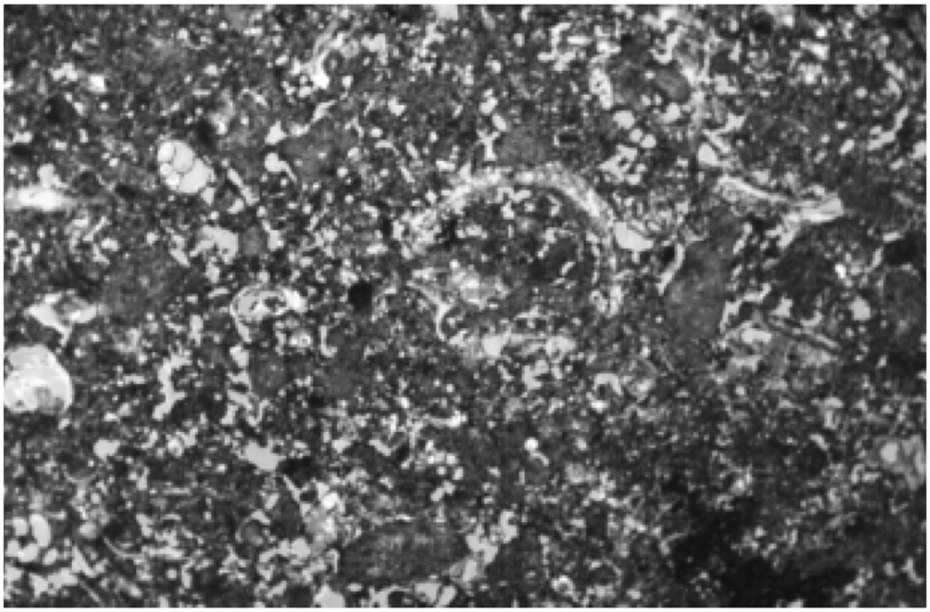
Dolomite

SL	Slight
TR	Trace

Table C-1. Core Descriptions

Core Depth	Rock Type	Grain Size	Porosity Visual Dominant	Porosity Dominant	Porosity Visual Other	Porosity Other	Pore Sizes Dominant	Pore Sizes Other	Laminations	Sorting	Glauconite	Dolomite	Lithofacies	Depositional Environment
910 - 911.8	wackestone	very fine to fine	good	BP	F	MO-V	very fine to fine	moldic		moderately well	slightly		foram peloidal packstone	open lagoon shoal
911.8 - 913	coquina-rudstone	fine to pebble	very good	BP-MO			very fine to fine	C		poor		TR	pelecypod coquina	shoal
945 - 946.8	packstone-grainstone	fine to medium	fair	WP-P			very fine to medium	large vugs moldic C	slightly	well			ostracod-foram-peloidal packstone	open lagoon shoal
946.8 - 947	packstone	medium	good	BP-MO	F	WP-V	very fine to fine	large vugs moldic		well			foram-peloidal packstone	open lagoon shoal
947 - 947.25	packstone	fine to medium	good	BP-V-M0	TR	V	very fine to fine	large vugs moldic C	slightly	poor			foram-peloidal packstone	restrictive lagoon shoal
947.25 - 950.75	packstone	very fine to coarse to granular	very good	BP-V-MO	F	MICRO V	very fine to medium	large vugs C VC		moderately well			intra-algal-foram peloid packstone	open lagoon shoal
950.75 - 951.6	packstone	very fine to fine	fair	V-WP	TR	BP	very fine to fine	large vugs moldic		well			foram-pellet packstone	open lagoon shoal
951.6 - 956	packstone-wackestone-grainstone-rudstone	fine to coarse to pebble	good	V-MO			very fine to medium	LMO C VC		very poor		TR	bryzoan-pelecypod wackstone-grainstone	bryozan mound
1,020 - 1,020.3	wackestone-packstone	very fine to coarse to granular	fair to good	MO-WP-BP	F	LV	very fine to fine	large vugs C VC		poor			gastropod-pelecypod-skeletal peloidal wackestone-packstone	restrictive lagoon
1,020.3 - 1,023.5	packstone	medium to course	good	V-MO-WP	P	BP-M0-V	very fine to fine	moldic C		very poor	slightly		peloidal skeletal packstone	mound flank

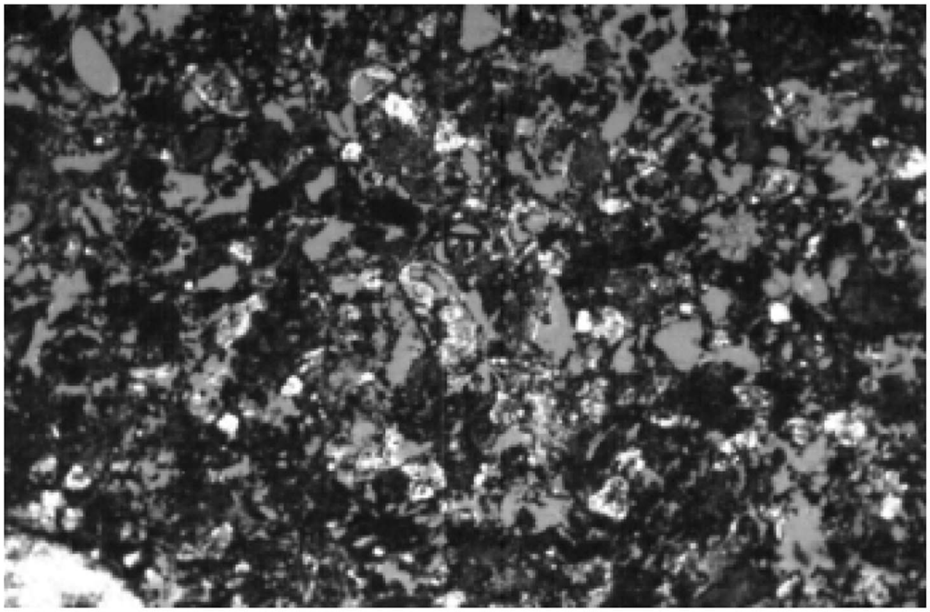
APPENDIX D
PHOTOMICROGRAPHS



WELL: I-75-PW
DEPTH: 910.5
MAGNIFICATION: X40

LITHOFACIES: FORAM-PELOIDAL PACKSTONE WITH GOOD VERY FINE-FINE INTERPARTICLE AND FAIR VUGGY MOLDIC INTRAPARTICLE POROSITY

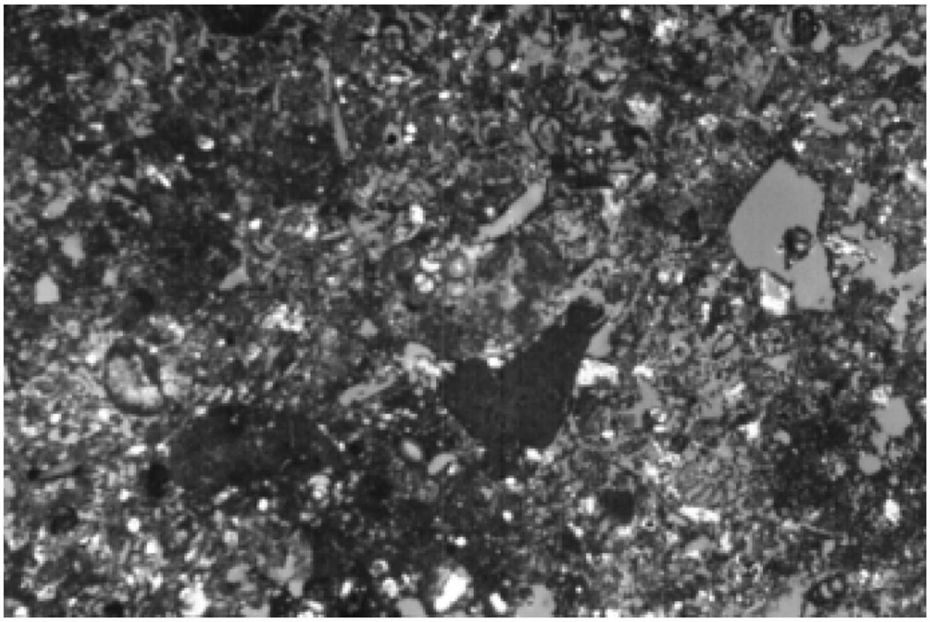
Figure D-1. Photomicrograph for Well I75-PW at a Depth of 910.5 feet bls.



WELL: I-75-PW
DEPTH: 947.2
MAGNIFICATION: X40

LITHOFACIES: SLIGHTLY GLAUCONITIC FORAM-PELOIDAL PACKSTONE WITH GOOD INTERPARTICLE VUGGY POROSITY

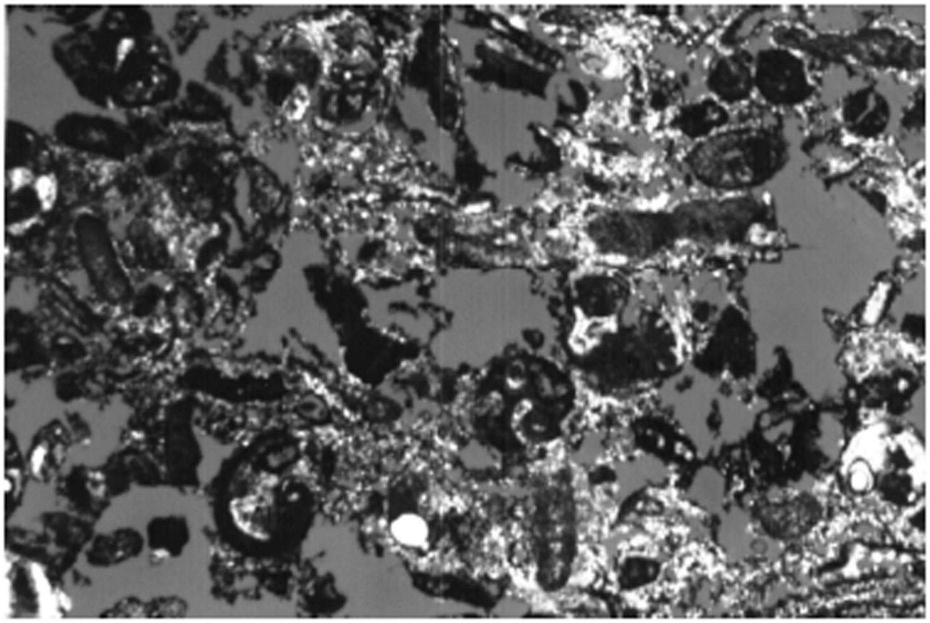
Figure D-2. Photomicrograph for Well I75-PW at a Depth of 947.2 feet bls.



WELL: I-75-PW
DEPTH: 947.3
MAGNIFICATION: X20

LITHOFACIES: ALGAL-INTERCLASTIC-FORAM-PELOIDAL PACKSTONE WITH GOOD INTERPARTICLE, VUG, AND MOLDIC POROSITY

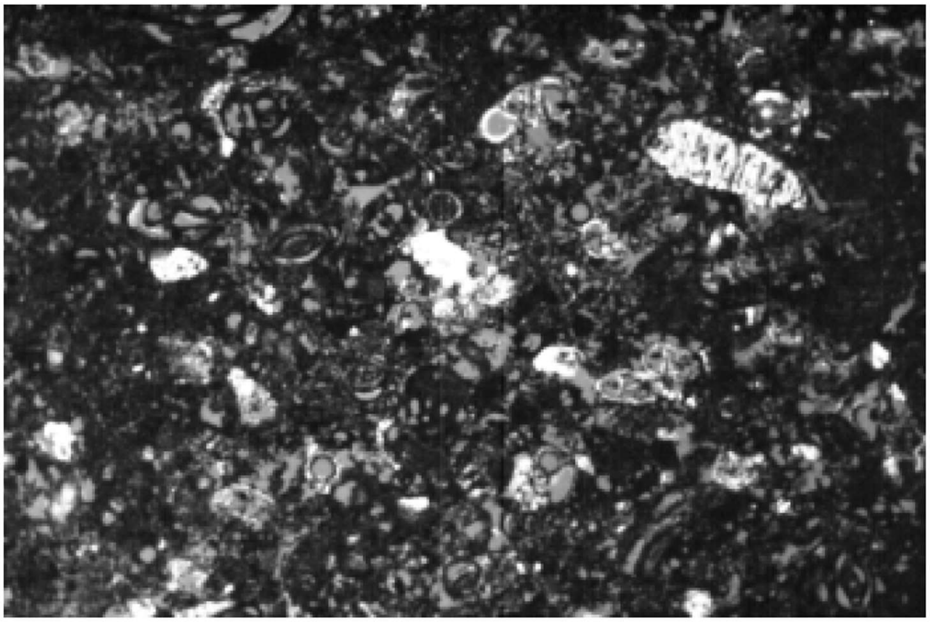
Figure D-3. Photomicrograph for Well I75-PW at a Depth of 947.3 feet bls.



WELL: I-75-PW
DEPTH: 950
MAGNIFICATION: X20

LITHOFACIES: FORAM-PELOIDAL PACKSTONE-GRAINSTONE WITH VERY GOOD VUGGY INTERPARTICLE, LARGE SECONDARY VUGS, AND "FLOATING GRAINS"

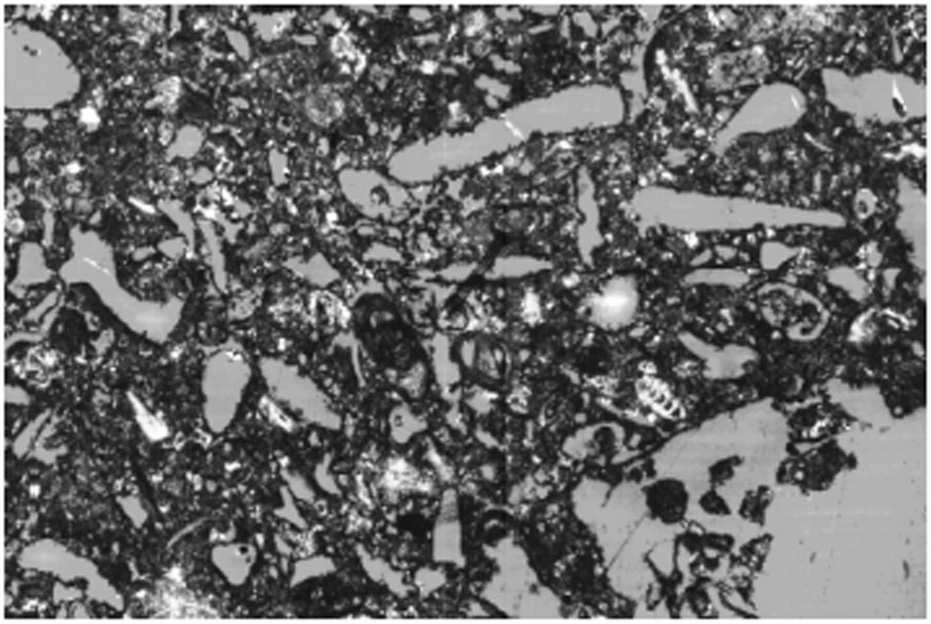
Figure D-4. Photmicrograph for Well I75-PW at a Depth of 950 feet bls.



WELL: I-75-PW
DEPTH: 951.4
MAGNIFICATION: X20

LITHOFACIES: PELOIDAL-FORAM PACKSTONE WITH FAIR VUGGY INTRAPARTICLE AND MOLDIC POROSITY

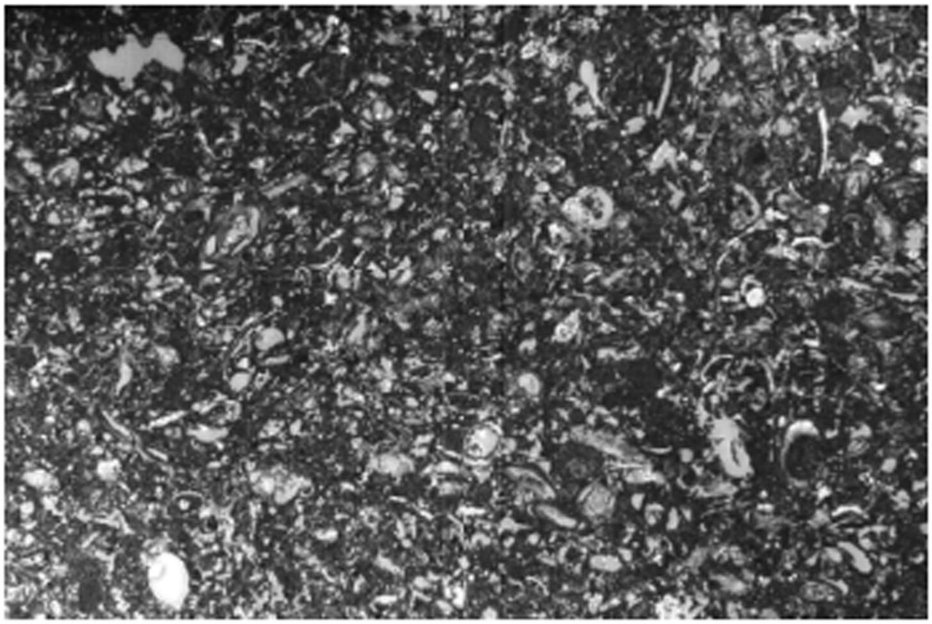
Figure D-5. Photomicrograph for Well I75-PW at a Depth of 951.4 feet bls.



WELL: I-75-PW
DEPTH: 952.2
MAGNIFICATION: X20

LITHOFACIES: BRYOZOAN PELECYPOD COATED GRAIN PELOIDAL WACKESTONE-GRAINSTONE WITH GOOD VUGGY-MOLDIC POROSITY. NOTE: "FLOATING" COATINGS ARE INDICATIVE OF SECONDARY LEACHING.

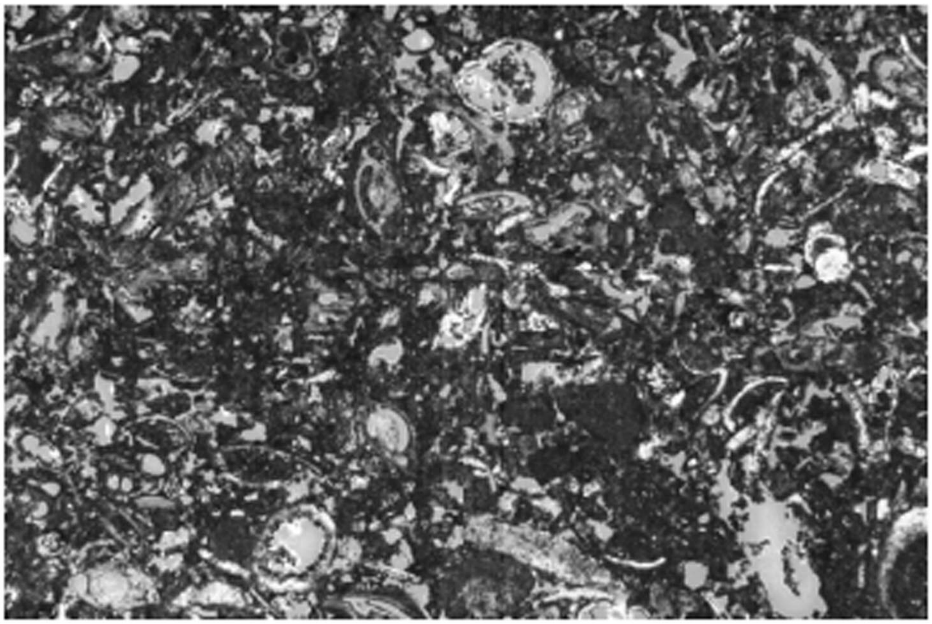
Figure D-6. Photomicrograph for Well I75-PW at a Depth of 952.2 feet bls.



WELL: I-75-PW
DEPTH: 1020.3
MAGNIFICATION: X20

LITHOFACIES: SKELETAL PELOIDAL PACKSTONE

Figure D-7. Photomicrograph for Well I75-PW at a Depth of 1,020.3 feet bls.



WELL: I-75-PW
DEPTH: 1021
MAGNIFICATION: X40

LITHOFACIES: PELOIDAL SKELETAL PACKSTONE, GLAUCONITIC WITH GOOD VUGGY, MOLDIC, AND INTRAPARTICLE POROSITY

Figure D-8. Photmicrograph for Well I75-PW at a Depth of 1,021 feet bls.