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REPORT
DEEP EXPLORATORY/TEST INJECTION WELL
SOUTH BEACHES WASTE WATER TREATMENT PLANT FOR
BREVARD COUNTY, FLORIDA

JOB NO.: 13112-007-26
DATE: SEPTEMBER 17, 1985

Dames & Moore

BOCA RATON, FLORIDA

Dames & Moore

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September 16, 1985

Brevard County
Water Resources Department
2575 Courtenay Parkway
Merrit Island, Florida 32953

Attention: Mr. Charles Striffler

Re: Final Report
Deep Exploratory/Test Injection Well
South Beaches Waste Water Treatment Plant
For Brevard County, Florida

Dear Chuck,

The attached Final Report on the South Beaches Deep Exploratory/ Test Injection Well presents a great deal of new and positive information on the disposal of secondary treated effluent. We are pleased that the subsurface conditions are such that deep injection is an excellent disposal method. We have been pleased to be of service to Brevard County and particularly appreciate the countless hours which you and Mr. Bud Timmons have spent guiding and making the project a success. If you have any questions, please do not hesitate to contact us.

Very Truly Yours,

DAMES & MOORE

Porter C. Knowles

Porter C. Knowles, P.E., P.G.
Partner
Ground-Water Hydrologist

PORTER C. KNOWLES
CERTIFICATE
No. 20910
STATE OF FLORIDA
REGISTERED ENGINEER

PCK/tjl

DEEP EXPLORATORY/TEST INJECTION WELL
SOUTH BEACHES WASTE WATER TREATMENT PLANT
FOR
BREVARD COUNTY, FLORIDA

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1.0 INTRODUCTION

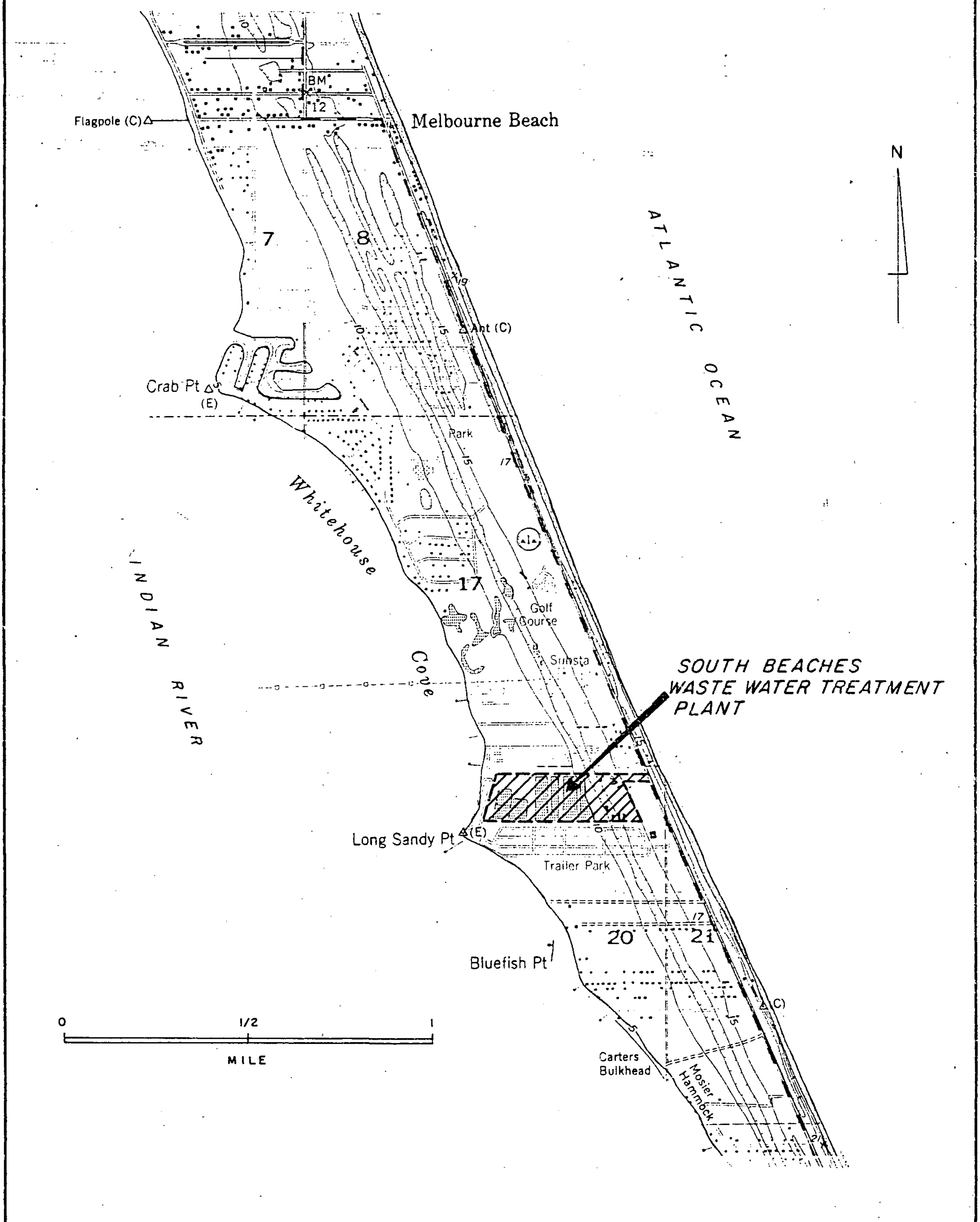
Brevard County started a program to evaluate the feasibility of disposing of municipal wastewater through deep well injection at several locations within the county. Dames & Moore was retained by Brevard County to provide consulting hydrogeologic services for the planning, drilling, testing and final design of an exploratory test well at the South Beaches Waste-Water Treatment Plant (WWTP) just south of Melbourne, Florida. Brevard County, in order to comply with chapter 403, Florida Statutes, and Florida Administrative Code Rules 17-3, 17-4 and 17-28, requested a permit from the Florida Department of Environmental Regulation (DER) to perform the work. The permit was issued by DER on November 30, 1982 under the number of UD05-64536.

The present report describes the activities undertaken by Dames & Moore, the data obtained and their analyses, as well as the necessary interpretations and final recommendations for the continuous operation of the exploratory test well.

Dames & Moore's involvement in this project started during the middle of 1982. With the exception of additional assistance to Brevard County in their activities related to obtaining an operating permit from DER, this report concludes Dames & Moore's work on the injection well at South Beaches WWTP.

Other companies were also involved in providing services in one or more phases of the project. Stottler Stagg & Associates of Cape Canaveral, Florida, was in charge of the design of all surface works such as mixing pond, pipe lines, pumping systems from the Indian River and into the injection well, etc. Zeni Drilling Company of Morgantown, West Virginia, provided the necessary drilling and well construction services and other associated technical expertise (subcontract geophysical logging services, provided equipment and personnel for the pumping and injection tests). Youngquist Brothers of Fort Myers, Florida provided the required drilling and well construction services to install the two Floridan aquifer monitoring wells. Warren-George of West Palm Beach installed three wells into the surficial aquifer for monitoring purposes. This study was conducted by Dames & Moore under the overall leadership of Mr. Porter-C. Knowles. Dr. Eduardo Aguilar was the Project Manager and provided also the required technical directives. Mr. James W. Furlow acted as Dames & Moore's field representative throughout the project and was responsible for providing surveillance, direction and continuity to all field activities.

Dames & Moore would like to express herewith our gratitude to the personnel of Brevard County for their helpful cooperation and excellent working relationship. In particular, we want to thank Mr. Charles Striffler, coordinator Environmental Services Division; Mr. Wilson R. Timmons, Jr., Hydrologist, Water Resources Department; and Mrs. Mary Anne White, Administrative Assistant.



REFERENCE :

U.S.G.S. MELBOURNE EAST, FLORIDA
7.5 MIN. QUAD. PHOTOREVISED 1980

GENERAL SITE LOCATION PLAN

PROJECT: SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION: BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 1.1

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2.0 GEOGRAPHIC SETTING IN BREVARD COUNTY

Melbourne Beach is located on the east coast of the Florida peninsula near latitude 28° 04' and longitude' 80° 32'. The barrier island chain, on which the city is located, is bordered by the Indian River to the west and the Atlantic Ocean to the east. The location of the injection well is shown in Figure 1.1.

Situated in central peninsular Florida, the area's climate is mild subtropical. The average annual temperature is approximately 72°F (34°C), with August as the hottest month, having an average of 82°F (38.7°C), and January as the coldest month, having an average of 61°F (28.7°C). The annual precipitation fluctuates from year to year but averages between 50 inches (127.0 cm) and 55 inches (139.1 cm).

Melbourne Beach is located on the Atlantic Barrier Chain (White, 1970). This chain of islands are composed of relict beach ridges and dunes that are continuous along the east coast of Brevard County and separated from the mainland by the Atlantic Coastal Lagoons (White, 1970). Elevations in the Melbourne Beach area do not exceed 15 feet above sea level. Highest elevations are near the beaches where sand dunes have developed.

3.0 HYDROGEOLOGY

3.1 GEOLOGY

3.1.1 Paleocene

The deepest and oldest hydrologic unit of the Tertiary limestones of south-central Florida is the Cedar Keys formation of Paleocene age. The name "Cedar Keys Formation" was originally proposed by Cole (1944) to describe the subsurface carbonate enveloped by the Borelis fauna at the top and the Cretaceous chalk at the bottom. Chen (1965) described the top of the formation as consisting of gray, micro-crystalline, slightly gypsiferous and rarely fossiliferous dolomite.

Chen contoured the top of this formation between -2500 and -3000 feet msl in the Melbourne Beach area. Miller (1982) contoured the top of this unit at near -3000 feet msl in this area. The nearest well to the injection site used to contour this unit by both Chen (1965) and Miller (1982) was approximately 20 miles away. This resulted in the top of the formation having to be largely inferred at the injection well site.

3.1.2 Eocene

Rock units of Eocene age penetrated at the Melbourne Beach site included the Oldsmar Limestone, Lake City Limestone, Avon Park Limestone and Ocala Group. The boundaries between all of these formations are considered conformable and gradational. The units are all composed of fossiliferous limestones with the major differences being in faunal content, grain size and degree of dolomitization. The Avon Park and Lake City could easily be combined into one rock formation. The Ocala and Oldsmar have distinctive lithologies and are easily differentiated from underlying and overlying formations.

Applin and Applin (1944) applied the name "Oldsmar Limestone" to a series of faunal zones overlying the Cedar Keys Formation marked at the top by the foraminifera Helicostegina gyralis and including Pseudophragmina cedarkeyensis, Coskinolina elongata and other diagnostic fossils. Chen (1965) described the unit in peninsular Florida as being predominantly dolomite and limestone with gypsum and anhydrite as minor components. In the Melbourne Beach area, Chen contoured the top of the formation between -1500 and -2000 feet msl and the thickness as approximately 900 feet. At a test site in Merritt Island (Geraghty and Miller 1984), the Oldsmar was principally composed of brownish dolomites with interbedded limestone. The thickness of the unit in that well was 910 feet with highly recrystallized dolomites occurring from near -1900 to the top of the Cedar Keys at -2670 below land surface.

The Lake City Limestone overlies the Oldsmar Limestone. Applin and Applin (1944) first used the term "Lake City Limestone" for rocks of early middle Eocene age and described this unit as a dark brown and chalky limestone in northern and peninsular Florida. The Lake City normally occurs as a dark brown fossiliferous limestone interbedded with carbonaceous dolomites and dolomitic limestones. In the type area it is described as "a gray-brown, dense microcrystalline dolomite with occasional thin beds of limestone, chert, and carbonaceous material" (Cervak, Knapp and Burnsen, 1982). It is commonly identified from it's characteristic fauna, the top being marked by the first appearance of the foraminifera Dictyoconus americanus. Chen (1965) showed the thickness of the Avon Park and Lake City to be between 1200 and 1400 feet in the south Brevard County area. He also described a rather thin but highly carbonaceous unit occurring near the top of the Lake City in peninsular Florida. In the Merrit Island area (Geraghty and Miller, 1984) the Lake City was logged at a depth of 978 feet below land surface as a brownish dolomite containing peat and chert. The unit was 700 feet thick in that area and was principally dolomite with interbedded limestone.

The "Avon Park Limestone" was proposed by Applin and Applin (1944) for sediments of late middle Eocene age in Florida. Chen (1965) described the formation as a fossiliferous limestone and dolomite with a very small amount of evaporites in peninsular Florida. In the type well located at the Avon Park Bombing range in central Florida the unit is, "a cream colored, chalky, limestone that contains a distinct fauna" (Vernon, 1951). The top of this formation was shown to be between -400 and -600 feet N.G.V.D by Chen (1965) In the Melbourne Beach area. It was logged in the Merrit Island area (Geraghty and Miller 1984) at 235 feet below land surface.

Dall and Harris (1892) first used the term "Ocala Limestone" for limestones being quarried near the town of Ocala in Marion County, Florida. Cooke (1915) established the "Ocala Limestone" as Eocene in age. Puri (1957) raised the formation to the Ocala Group and subdivided it into three formations; the Crystal River, Williston and Inglis. This usage is followed in this document. Chen (1965) showed the top of the Ocala in the Melbourne Beach area to be between -200 and -400 feet msl and the thickness near 100 to 150 feet. He described the top of the Group lithologically as a "chalky white to very light brown, poorly consolidated, fragmental, microcoquina-like and highly fossiliferous limestone...".

3.1.3 Miocene

Dall and Harris first used the term "Hawthorn Beds" for Miocene age phosphatic sediments being quarried near the town of Hawthorn in Alachua County, Florida. Matson and Clapp (1909) designated these beds the Hawthorn Formation and described them lithologically as clays, sands and phosphatic limestones. In recent work by Scott and Knapp (in review) the Hawthorn was described as "consisting of various mixtures of clay, quartz sand, carbonate (dolomite to limestone) and phosphates".

3.1.4 Pliocene/Miocene Series

Mansfield (1939) proposed the term "Tamiami Limestone" for a fossiliferous sandy limestone approximatley 25 feet thick, which was penetrated in shallow ditches along the Tamiami Trail (U.S.

Route 41) in southern Florida. The Tamiami Formation is considered as being either of upper Miocene or Pliocene age.

3.1.5 Pleistocene to Recent

In south-central Florida, Pleistocene deposits can vary greatly in thickness. In Brevard County, the Anastasia Formation of Pleistocene age is the predominant lithologic unit. Sellards (1912) used the name Anastasia Formation for exposures of coquina rock extending southward along the Atlantic coast of Florida from St. Augustine. Lithologically the formation consists of a sandy coquina of mollusk shells held loosely together by a calcareous cement (Puri and Vernon, 1964).

3.2 LOCAL GEOLOGY

Figure 3.1a shows the major stratigraphic units encountered in the exploratory well to a total depth of 2915 feet below land surface. The oldest formation penetrated was of Paleocene age and identified as the Cedar Keys Formation. Eocene age rock units included the Oldsmar Limestone, Lake City Limestone, Avon Park Limestone and Ocala Group. The Hawthorn Formation of Miocene age overlies the Ocala Group in the exploratory well. Sediments of Pliocene to Recent age were also present and were represented by the Tamiami Formation, Anastasia Formation and Undifferentiated Deposits. Figure 3.2a is a cross section constructed using data from an exploratory well drilled in

Merritt Island and from the Melbourne Beach well. Although the Merritt Island test well is located nearly 30 miles to the north, an excellent correlation was made between it and the Melbourne Beach site.

3.2.1 Cedar Keys Limestone

At the test injection site the Cedar Keys Formation was logged from 2760 feet below land surface to the total depth of the well. The upper beds occurred as medium gray (N5), fine grained and highly altered, rather dense dolomite. These beds were immediately overlain by a thick sequence of dark yellowish brown (10 Y R 1/2), fine grained, highly altered, dense and peaty dolomite assigned to the basal portion of the Oldsmar Limestone. The Cedar Keys is composed predominantly of pale yellowish brown (10 Y R 6/2) to very pale orange (10 Y R4/2), very fine to fine grained, well indurated gypsiferous dolomite. Seams or beds of anhydrite were indicated by large fragments of this material in some of the well cuttings. No Borelis type fauna was encountered, probably due to the high degree of dolomitization. The formation, however differed distinctly from the overlying Oldsmar Limestone. The Oldsmar contained only trace amounts, if any, of evaporites, and the dolomites were coarser grained and peaty towards the bottom. Although, no guide fossils were recognized in the Cedar Keys, the high percentage of evaporites and finer grained dolomites differentiate this unit in this well.

3.2.2 Oldsmar Limestone

At the injection well site in Melbourne Beach the top of the Oldsmar was logged at 1665 feet below land surface and the base at 2700 feet. The Oldsmar was immediately overlain by a relatively thick sequence of dolomites assigned to the Lake City Limestone. The upper portion (1655 to 2083 feet below land surface) of the Oldsmar was predominantly very pale orange (10 Y R 8/2), micritic and biogenic limestones with intervals of chert, dolomite, and glauconitic limestone. Chert nodules occurred near the top of the formation and a glauconitic sequence of limestones was penetrated from 1733 to 1780. Although highly recrystallized, the limestone sequence yielded many specimens of the foraminifera Helicostegina gyralis and Pseudophragmina cedarkeyrensis. Cavernous and possibly fractured dolomites occurred from 2083 to the base of the formation at 2700 feet below land surface. The dolomites were pale yellowish brown (10 Y R 4/2) to grayish brown (5 Y R 3/2) in color and texturally varied from microcrystalline to medium in grain size. Honeycomb structures as well as solution cavities were apparent in some cores. The larger dolomite crystals were euhedral and sometimes sucrosic.

3.2.3 Lake City Limestone

At the Melbourne Beach site the Lake City Limestone was identified at 920 feet below land surface. The upper 40 feet of the unit occurred as a tan, dolomitic limestone with peat flecks.

It is immediately underlain by a very thick sequence (590 feet) of calcarenitic limestones containing abundant specimens of the foraminifera <u>Dictyoconus</u> <u>americanus</u>. The lower interval (1510 to 1663) was principally dolomite with sporadic interbedded limestone. Lithologically the Lake City showed little variation from the overlying Avon Park Limestone. The occurrence of carbonaceous limestone and <u>Dictyoconus</u> <u>americanus</u> were the main criteria for formation delineation.

1960
580
1550

3.2.4 Avon Park Limestone

At the exploratory site in Melbourne Beach the top of the Avon Park Limestone occurred at 400 feet below land surface and the formation was 520 feet thick. It is immediately overlain by calcarenitic limestones of the basal Ocala Group. The upper 140 feet of the formation occur as a very pale orange (10 Y R 8/2), fine grained, well indurated limestone with sparry calcite and micrite cements. The foraminifera <u>Dictyoconus</u> <u>cookei</u> was abundantly present in this interval. The lower sequence (540 to 920 feet below land surface) was predominantly dolomite and interbedded dolomitic limestone. The top of the Lake City Limestone was picked at the base of these dolomites.

3.2.5 Ocala Group

251
149
100

The top of the Ocala Group at the injection site occurred at 251 feet below land surface. It occurs as a white (N 9) micritic and coquinoid limestone with a large and diverse number of larger foraminifera (especially Lepidocyclina ocalana). It is unconformably overlain by olive gray dolomitic silts and sands of the Hawthorn Formation. The Ocala Group is 149 feet thick at the site. The lower 40 feet is a calcarenitic limestone containing the foraminifera Amphistegina pinnarensis cosdeni. This sequence is correlatable with the Williston Formation.

3.2.6 Hawthorn Formation

The top of the Hawthorn Formation was logged at 120 feet below land surface at the Melbourne Beach injection site. The unit is 131 feet thick and is overlain by the Tamiami Formation. The top is marked by a yellowish gray (5 Y 8/1) silty quartz sand with a five percent phosphate content. Immediately underlying this unit, and to the total depth of the formation, the lithology varied from clayey phosphatic sands and sandy clays to very fine dolosilts. The unit is phosphatic and sandy throughout and exhibits low permeability.

3.2.7 Tamiami Formation

This formation was logged at 80 feet below land surface at the injection site and is 40 feet thick. The upper 20 feet occur as a very light gray (N 8), moderately indurated, sandy limestone with micrite and sparry calcite cements. The lower 20 feet are characterized by a moderately indurated sandstone with sparry calcite cement.

3.2.8 Anastasia Formation and Undifferentiated Deposits

The Anastasia is present at the injection site from a depth of 20 feet to 80 feet below land surface. It occurs as a grayish orange (10 Y R 7/4) heterogeneous mixture of calcareous sandstone, silt, and shell.

The upper 20 feet of the exploratory well consists of a grayish orange (10 Y R 7/4) medium to coarse grained unconsolidated sand with mollusk shells. This sequence is here undifferentiated and probably is correlatable to Pamlico terrace sands.

3.3 HYDROGEOLOGIC FRAMEWORK

There are four major hydrogeologic units that occur in peninsular Florida. These are, the surficial aquifer system, intermediate confining beds, Floridan aquifer system, and sub-Floridan confining beds (Vechiolli, et. al., in preparation). The surficial aquifer system contains the water table and other semi-confined water bearing zones. The intermediate confining beds normally are restricted to the Hawthorn Formation, but other low permeability beds may be included. The top of the Floridan Aquifer system occurs within the lower most carbonates of the Hawthorn Formation and its base is considered to be within the bedded anhydrites (sub-Floridan confining beds) associated with the Cedar Keys Formation (Miller 1982c). The relationship of the hydrogeologic units and relative permeabilities in the exploratory well are depicted in Figure 3.1a.

3.3.1 Surficial Aquifer System

At the Melbourne Beach site the surficial aquifer system is 120 feet thick and extends from land surface to the top of the Hawthorn Formation (Figure 3.1a). The system in this area can be divided into the water table aquifer and the lower or Tamiami aquifer. The water table aquifer in the exploration well was present from land surface to a depth of 40 feet and occurred within the Undifferentiated Terrace Deposits and the upper part of the Anastasia Formation. A low permeability silty sand occurring at the base of this aquifer acts to retard the vertical flow of water between it and the underlying Tamiami aquifer. The lower aquifer within this system occurs within the basal shell beds of the Anastasia Formation and the sandy limestones of the Tamiami Formation. The shell beds are possibly of high permeability and the sandy limestones are of moderate permeability with visible porosity not exceeding 15 percent.

3.3.2 Intermediate Confining Beds

In the exploratory well (Figure 3.1a) the intermediate confining beds were 133.1 feet thick. These beds are contained wholly within the Hawthorn Formation and exhibited low permeability throughout. They are regionally extensive and effectively confine the Floridan aquifer system in central and southern

Florida. The top of the confining beds were penetrated at 120 feet below land surface and extended to 251 feet below land surface. The low permeability of this zone is a result of the clayey and silty nature of the Hawthorn Formation.

3.3.3 Floridan Aquifer System

The term "Floridan Aquifer" was established by Parker (1955) for water bearing rocks associated with the Lake City Limestone, Avon Park Limestone, Ocala Limestone, Suwannee Limestone, Tampa Limestone, and the lower permeable parts of the Hawthorn Formation in hydrologic contact with underlying units. Miller (1982 a, b, c) referred to these beds as the Tertiary limestone aquifer system. He showed the top of the system to be present between -200 and -300 msl in the Melbourne Beach area and the base to be at approximately -3000 msl. Recently, the Southeastern Geological Society Committee on Hydrostratigraphic Nomenclature has adopted the term Floridan aquifer system for this unit in Florida. This terminology is used in this document.

The Floridan aquifer system is present from 251 feet below land surface to the top of the Cedar Keys limestone at 3000 feet below land surface. A corrected Flowmeter Log (Spinner) run when the well was at a depth of 2218 feet, indicated that the majority of the water entering the borehole in the exploratory well was from the interval between 290 and 680 feet below land surface. Figure 3.1 shows four zones within this interval that were of possible high permeability as evidenced by visual examination of well cuttings. The uppermost zone was penetrated at 292 feet below land surface in a coquinoid limestone that is part of the Ocala Group. The second zone occurs at 360 feet below land surface in a calcarenitic limestone of the lower Ocala Group. The other two zones occur within the Avon Park limestone at 500 and 580 feet, respectively. An estimated 50 percent of the total water produced from the well was entering the borehole from this upper interval. Although other zones of possible high permeability were identified within the Lake City limestone, the Flowmeter survey did not reflect a corresponding increase of water entering the borehole in those horizons.

The thickest and most highly permeable zones within the well were encountered in the Oldsmar limestone from a depth of 2081 feet to near 2500 feet below land surface. These horizons consisted of highly altered and solutioned dolomites that are referred to as "boulder zones". The Caliper Log shows this interval to be cavernous and cores taken form the upper section indicate possible fracturing. Some core samples exhibited a honeycomb structure of sucrosic dolomite with a very high porosity.

Beds of low permeability are present throughout the sequence of carbonates penetrated in the exploration well (Figure 3.1a). Within the Avon Park and Lake City limestones these beds occur as very micritic almost pasty limestones. A significant sequence of low permeability limestone occurs in the upper portion of the Oldsmar. These beds were logged at 1665 feet below land surface and extended to the top of the cavernous dolomites at 2081.

Lithologically, they are moderately indurated micritic sometimes glauconitic and cherty limestones with a very low intergranular porosity. The long and short normal electric logs show that this zone occurs from 1668 feet to 2081 feet with well indurated beds (chert) at 1725 feet to 1730 feet and 1862 feet to 1900 feet.

3.3.4 Sub-Floridan Confining Beds

Miller (1982, c) shows the base of the Floridan Aquifer System to be between -3000 feet and -3100 feet msl in the Melbourne Beach area. The rocks associated with the sub-Floridan confining beds are part of the Cedar Keys Formation and consist of bedded anhydrites and other evaporites inbedded in carbonates.

The sub-Floridan confining beds were penetrated at a depth of 2760 feet below land surface. This unit extentes to the total depth of the well at 2915 feet. These continuing beds are composed primarily of low permeability gypsiferous dolomites. These rocks posses very little porosity and were assigned to the Cedar Keys Formation.

3.4 GROUND-WATER QUALITY

Water samples were collected from both deep and shallow monitoring wells and from the injection well. A Schoeller diagram (Figure 3.1) graphically shows the distribution of major ionic species in the deep and shallow monitoring wells. Two-dimensional linear plots (Figures 3.2 through 3.13) and bar graphs (Figures 3.14 through 3.23) show the relative changes in chemical composition encountered in the injection well as a function of depth.

Figure 3.1 shows the concentrations of chemical constituents at the deep and shallow monitoring wells. A general pattern can be discerned from the diagram. Generally, the deep monitoring wells consistently exhibited higher concentrations than the shallow monitoring wells. Chemical analyses are included in Appendix B. Figures 3.24 to 3.27 show general fluctuations in salinity, chloride, specific conductivity, and turbidity as a function of time in the four surficial aquifer monitoring wells.

Upon completion of the injection well borehole, water samples were collected from a depth of 700 feet to 2050 feet by means of a messenger bottle sampler. The resulting analyses are included in Appendix B. Accompanying these analyses are linear plots showing the changes in some major parameters as a function of depth (Figures 3.2 through 3.13).

Water samples were also collected for chemical analysis during the drill-stem (Packer) testing. The first test isolated an interval from 1970 feet to 2070 feet. Subsequent tests were conducted at progressively shallower depths, the final test covered an interval from 1000 feet to 1100 feet. The results of these analyses are shown in figures 3.14 to 3.23 in the form of bar graphs and in Figures 3.28 to 3.37 in the form of Pipes Diagrams. The chemical data from the Packer Tests can also be found in Appendix B.

3.4.1 General Chemical Characteristics

Figures 3.2 through 3.13 show the concentration of major species as a funtion of depth. An evident change in water quality occurs at a depth of 1100 feet to 1200 feet. Based on lithologic information, an increase in magnesium with depth is expected corresponding to the greater degree of dolomitization. Similarly, sulfate concentrations show a rise with depth which correlates with the increasing amounts of gypsiferous (evaporitic) sediments.

At a depth of 1800 feet, marked increases in the potassium and iron concentrations could be attributable to the glauconitic zone which prevails at this depth. Although the bicarbonate alkalinity graph exhibits a sharp decline beyond a depth of 1200 feet, the corresponding change in concentrations is not that significant (158 mg/l to 132 mg/l). This drop can be related to a decline in pH from 7.8 at a depth of 700 feet to a pH of 7.4 at a depth of 2050 feet. Finally, sodium, flouride and phosphorus also showed increases in concentrations with depth. However, only the phosphorus curve showed the least discernable overall trend due to repeated irregularities.

Figures 3.14 through 3.23 correlate moderately well with Figures 3.2 through 3.13. This is a comparison between the analytical results obtained from the 13 messenger bottle water samples and the analytical results obtained from the packer tests. The results from the packer tests are more interval-specific than the messenger bottle samples and hence less susceptible to dilution effects. Table 3.1 summarizes the chemical results from the packer tests.

3.4.2 Chlorides, Total Dissolved Solids and Specific Conductivity

Figures 3.2 to 3.4 show the effect of depth on total dissolved solids (TDS), conductivity, and chlorides. The general linear relationship between dissolved solids and conductivity (K x A = S; Hem, 1970) is applicable for the range of concentrations encountered. In the formula, 'A' is a conversion factor which generally ranged from 0.63 to 0.82. The higher value was representative of deeper waters with elevated sulfate concentrations.

At a depth of a little over 1200 feet, the TDS value exceeded the 10,000 mg/l concentration. This value constitutes the interface between potable and non-potable ground waters. The injection zone which starts at 2080 feet far surpasses the 10,000 mg/l level. Therefore, in accordance with Chapter 17-28 of the Florida Administration Code, this zone could be used for the disposal of treated effluent.

The Piper Diagrams are designed to show the evolution of Chemical constituents in terms of major ionic species. They have been constructed in order to define the predominant types of waters encountered along different depth intervals. These figures (3.28 to 3.37) represent the relative percentages of dominant cations and anions for the different chemical analysis resulting from the Packer tests. With the exception of the analysis from Packer test number 9, which is representative of a zone where waters are chiefly of magnesium-sulfate/ magnesium-chloride, the remaining analysis depict a predom- inantly sodium-chloride/potassium-chloride type waters.

3.4.3 Indian River Water Quality

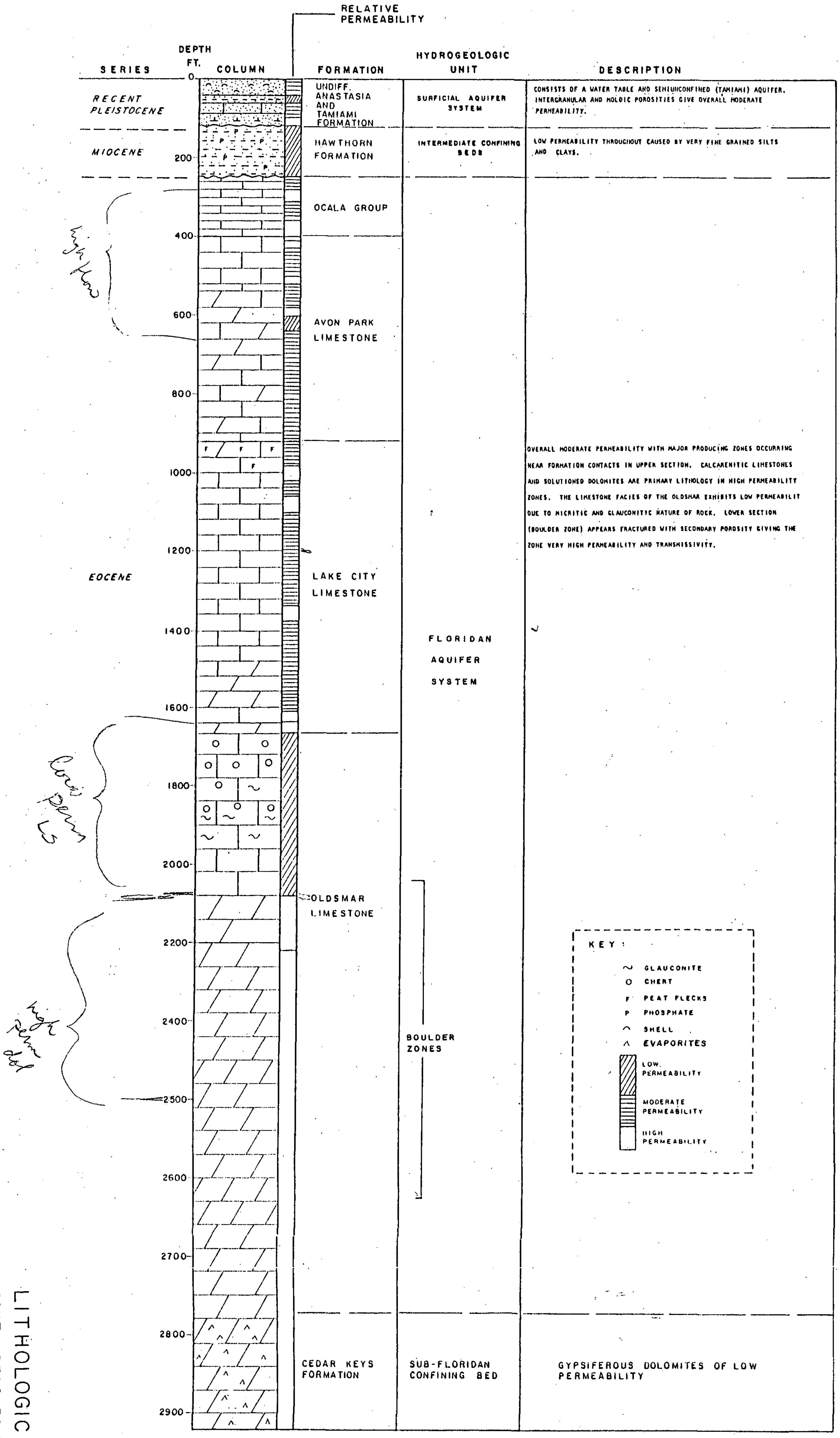
As required by DER, the water for injection testing was obtained from the Indian River. The water used for the test was analyzed for the following parameters: Total Suspended Solids, Chloride, Salinity, Conductivity, Turbidity, pH, and Fecal Coliforms. A total of eleven (11) samples were collected during the injection test (see Appendix B). The following are the results:

Parameter	Range
TSS	45-204 mg/l
Chloride	11370-15245 mg/l
Salinity	15.5-18.2 ppt
Conductivity	22750-29000 umhos/cm
Fecal Coliform	1-158 /100 mls
Turbidity	6-15 NTU
pH	8.2

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______ REVISION ______ DATE ______

13112 00726 (9/85)

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLA.



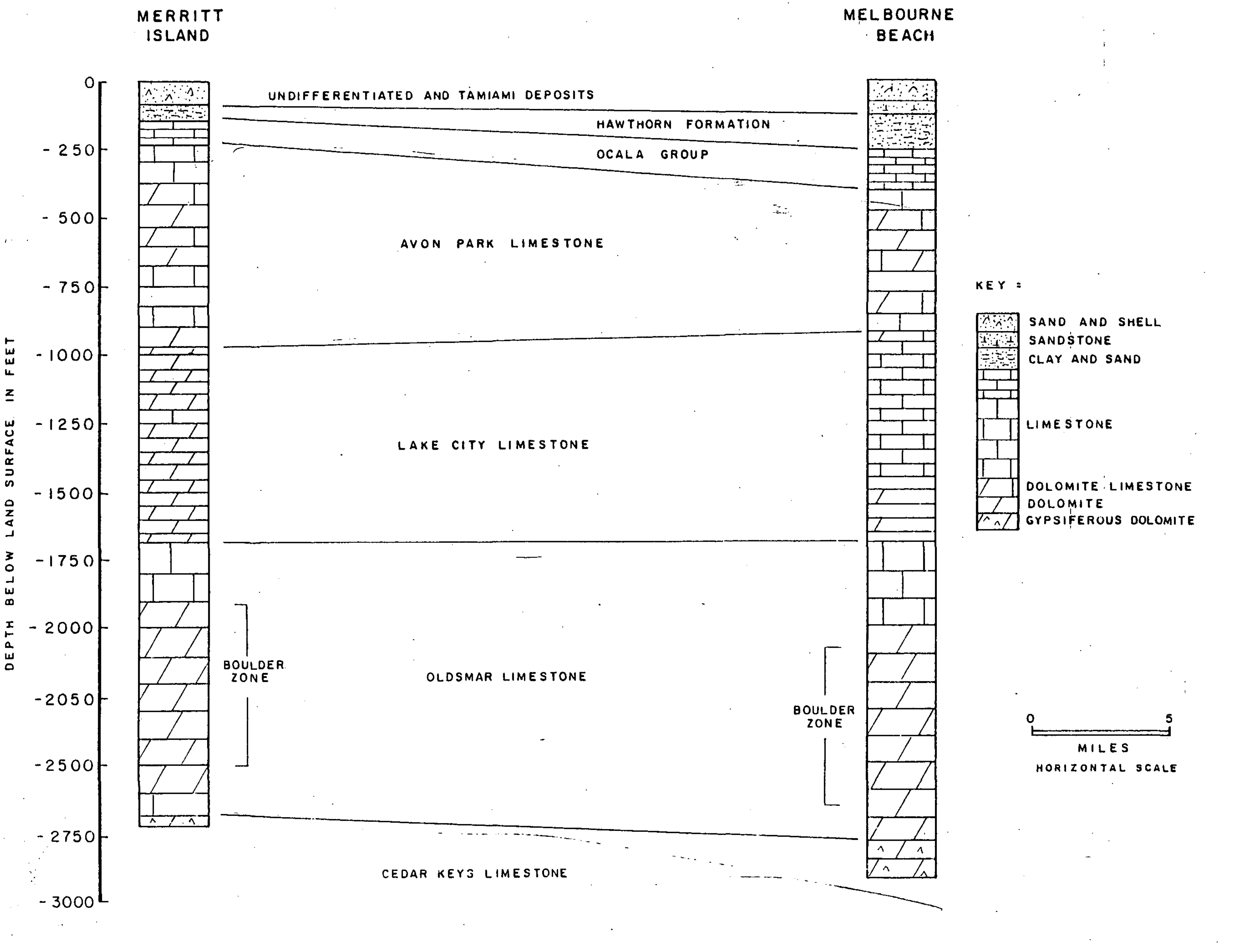
LITHOLOGIC COLUMN
SOUTH BEACHES INJECTION WELL

DAMES & MOORE
FIGURE 3.1a

BY [signature] DATE 9/85 CHECKED ______ DATE ______ APPROVED ______ DATE ______

JOB No. 1311200926 (9/85)

PROJECT : SOUTH BEACH EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA



CROSS-SECTION
MERRITT IS.-MELBOURNE BEACH

DAMES & MOORE
FIGURE 3.2a

TABLE 3.1

REPORT OF ANALYSIS

PACKER TESTING

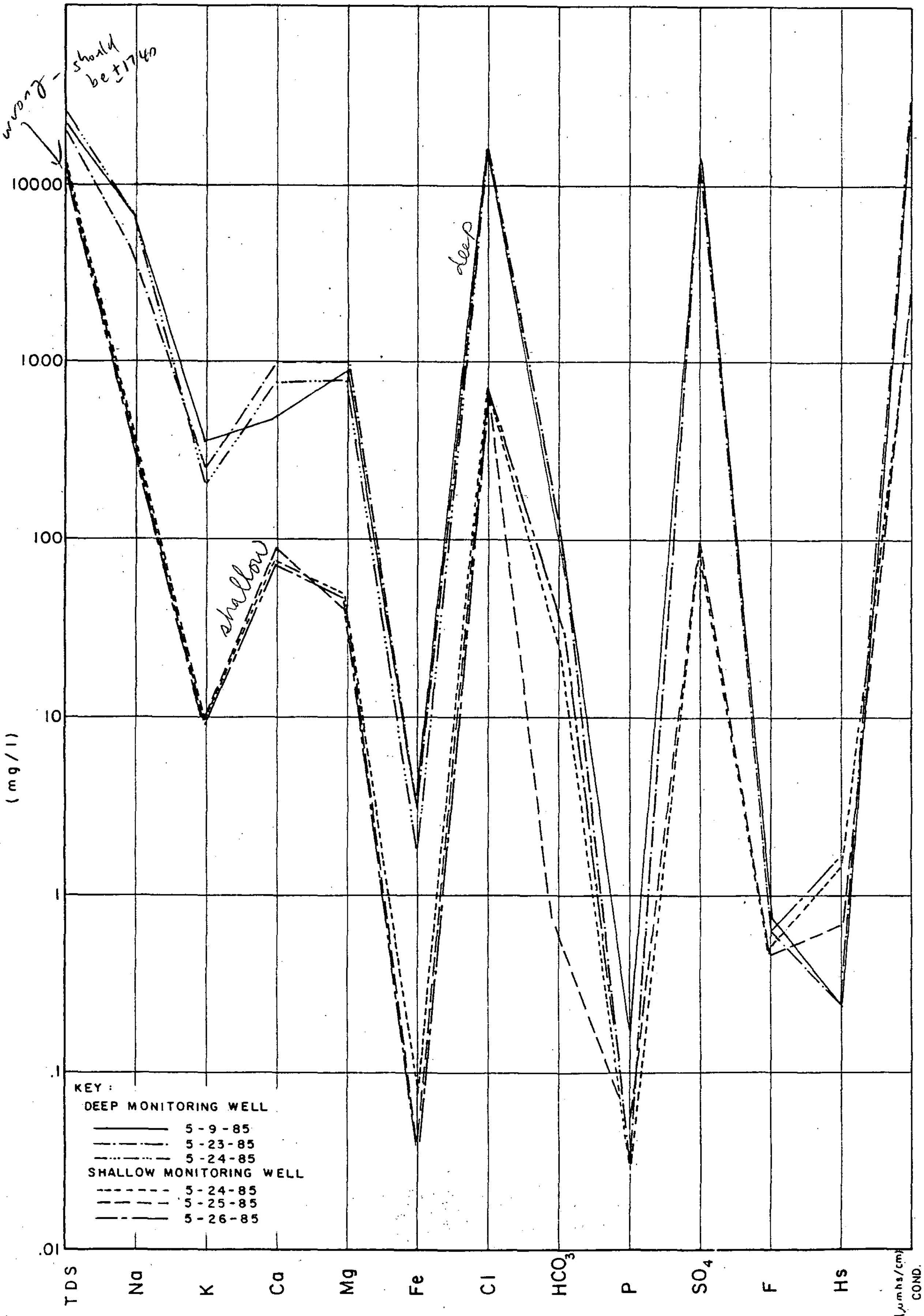
PERFORMED ON 8/8/84 AND 8/17/85

Chemical Parameter	Packer Test 1 Test Interval 1970-2070 Feet	Packer Test 2 Test Interval 1880-1980 Feet	Packer Test 3 Test Interval 1785-1885 Feet	Packer Test 4 Test Interval 1690-1790 Feet	Packer Test 5 Test Interval 1605-1705 Feet	Packer Test 6 Test Interval 1500-1600 Feet	Packer Test 7 Test Interval 1405-1505 Feet	Packer Test 8 Test Interval 1253-1353 Feet	Packer Test 9 Test Interval 1155-1255 Feet	Packer Test 10 Test Interval 1000-1100 Feet
T.D.S.	33144	33749	31740	36404	33174	29493	36882	36166	5186	2966
Cl	20000	20000	19000	19000	21000	17000	21000	21000	1030	1400
Cond.	47100	46000	44000	48000	43000	44000	47000	45000	8000	4500
Mg	1100	1010	850	870	770	1000	1200	1000	1100	100
Na	7000	7600	7000	9000	7800	7600	9800	9700	1700	740
SO4	3000	2850	2570	3050	2600	2590	2990	2725	1050	275
K	360	260	310	340	270	305	320	280	43	28
Ca	590	560	540	390	420	500	460	480	90	66
HCO3	134	134	165	125	136	132	176	196	150	156
Fe	10	10	4.1	6.6	7.4	3.4	9.6	1.4	0.94	0.44
P	0.06	0.06	0.06	0	0.53	0.45	0.09	0.02	0	0
F	0.7	0.68	2.2	0.84	0.94	0.66	0.68	0.8	0.86	0.8
HS	0.01	0.16	0.28	0.28	0.2	0.44	0.16	0.2	1.5	1.6

Laboratory analysis performed by Enviropact of Jacksonville, Inc..

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods, or other approved methods.

Background Sampling



BY ____ DATE ____ CHECKED ____ DATE ____ APPROVED ____ DATE ____

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

DAMES & MOORE

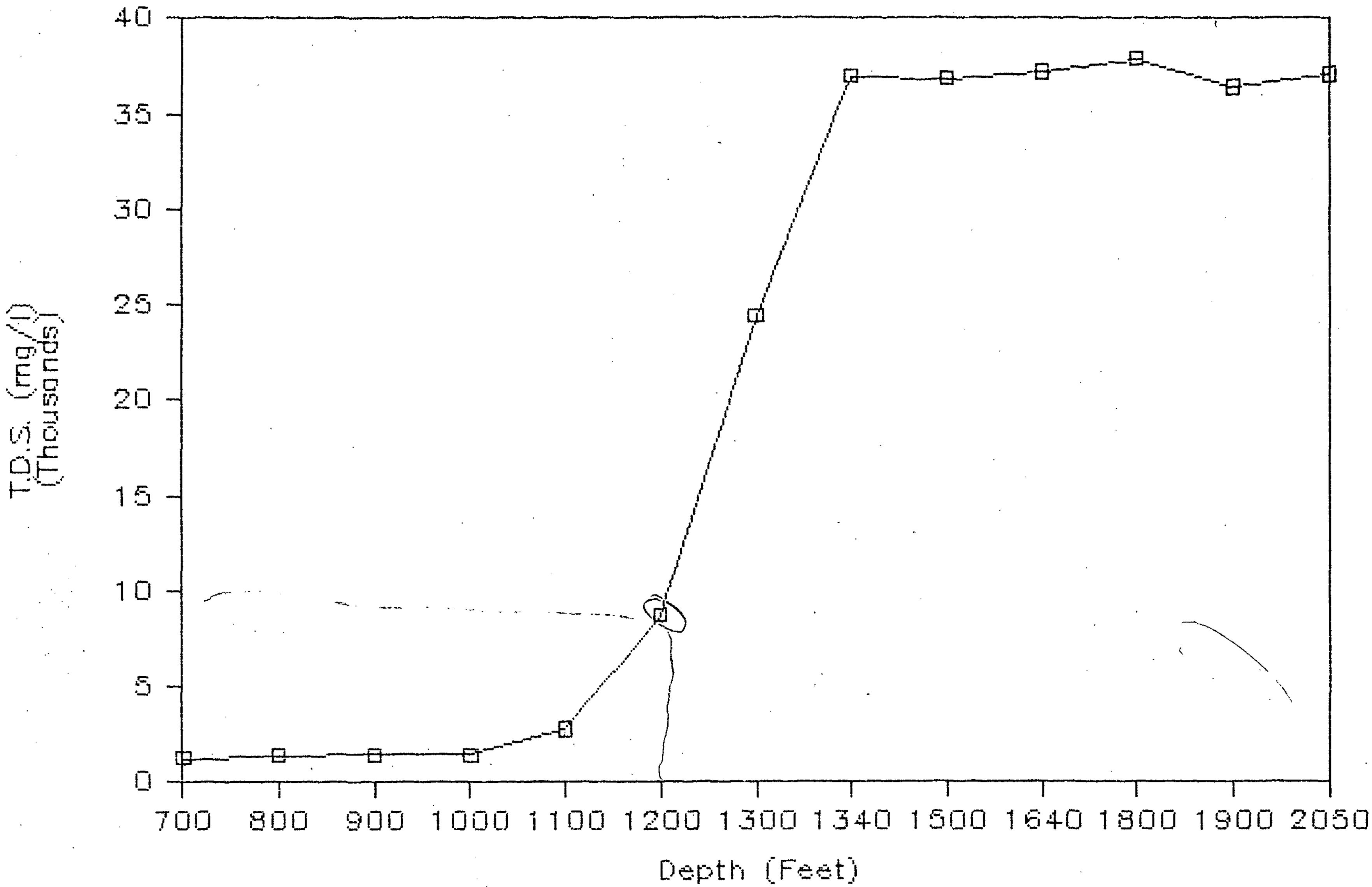
FIGURE 3.1

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

T.D.S. CONCENTRATION VERSUS DEPTH INJECTION WELL



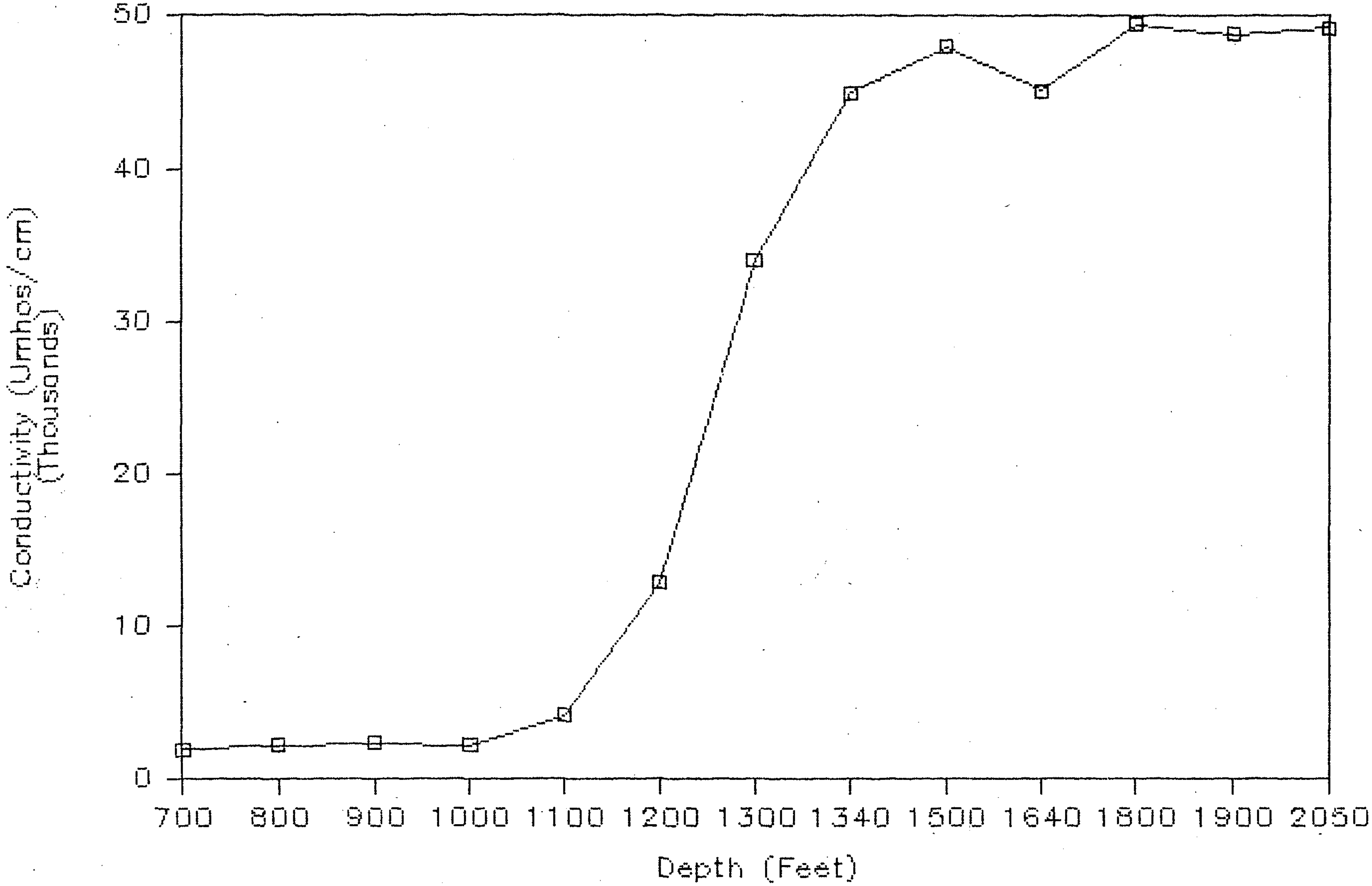
DAMES & MOORE
FIGURE 3.2

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

CONDUCTIVITY CONCENTRATION VERSUS DEPTH INJECTION WELL

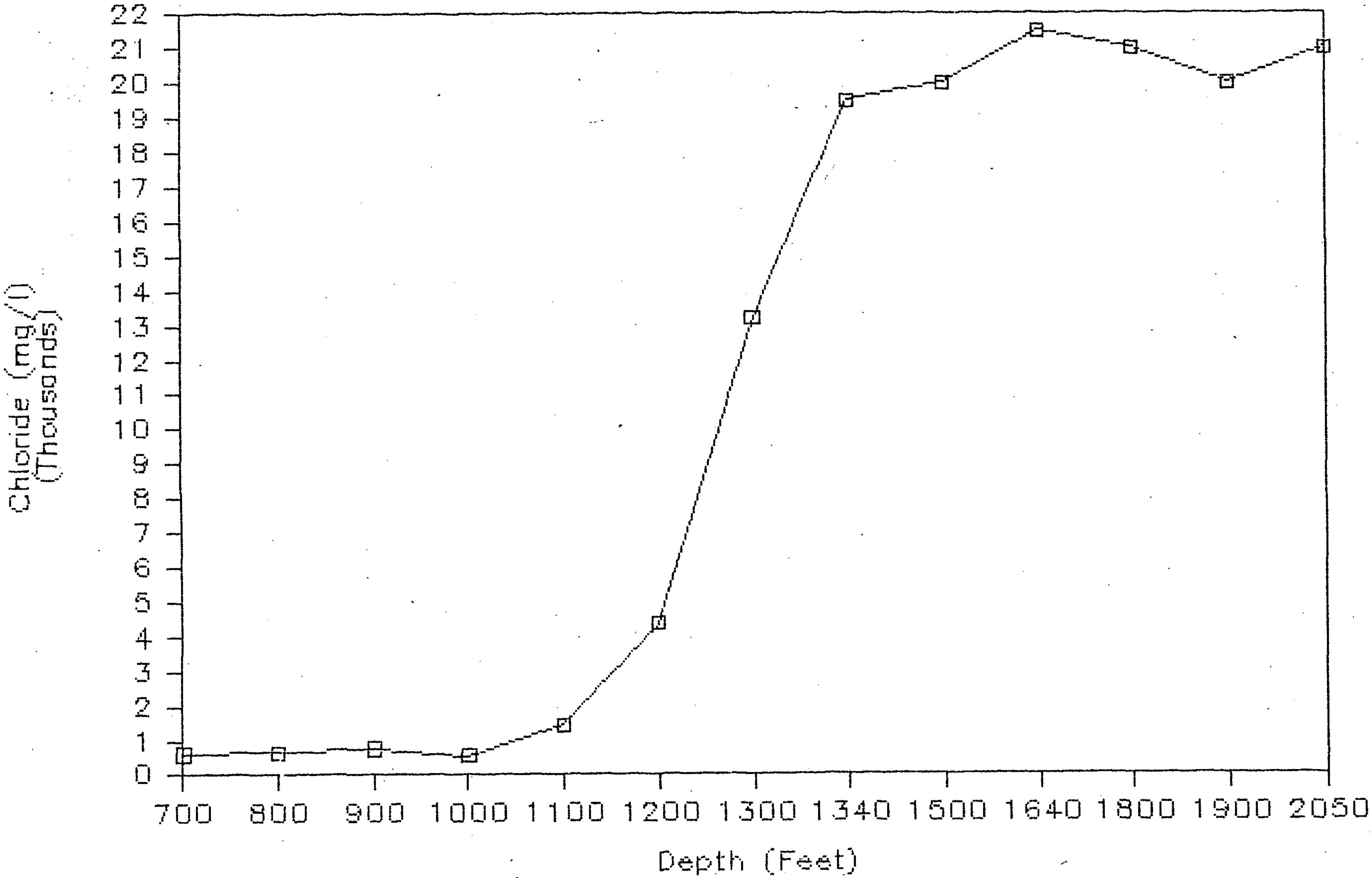


DAMES & MOORE
FIGURE 3.3

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:



CHLORIDE CONCENTRATION VERSUS DEPTH INJECTION WELL

DAMES & MOORE

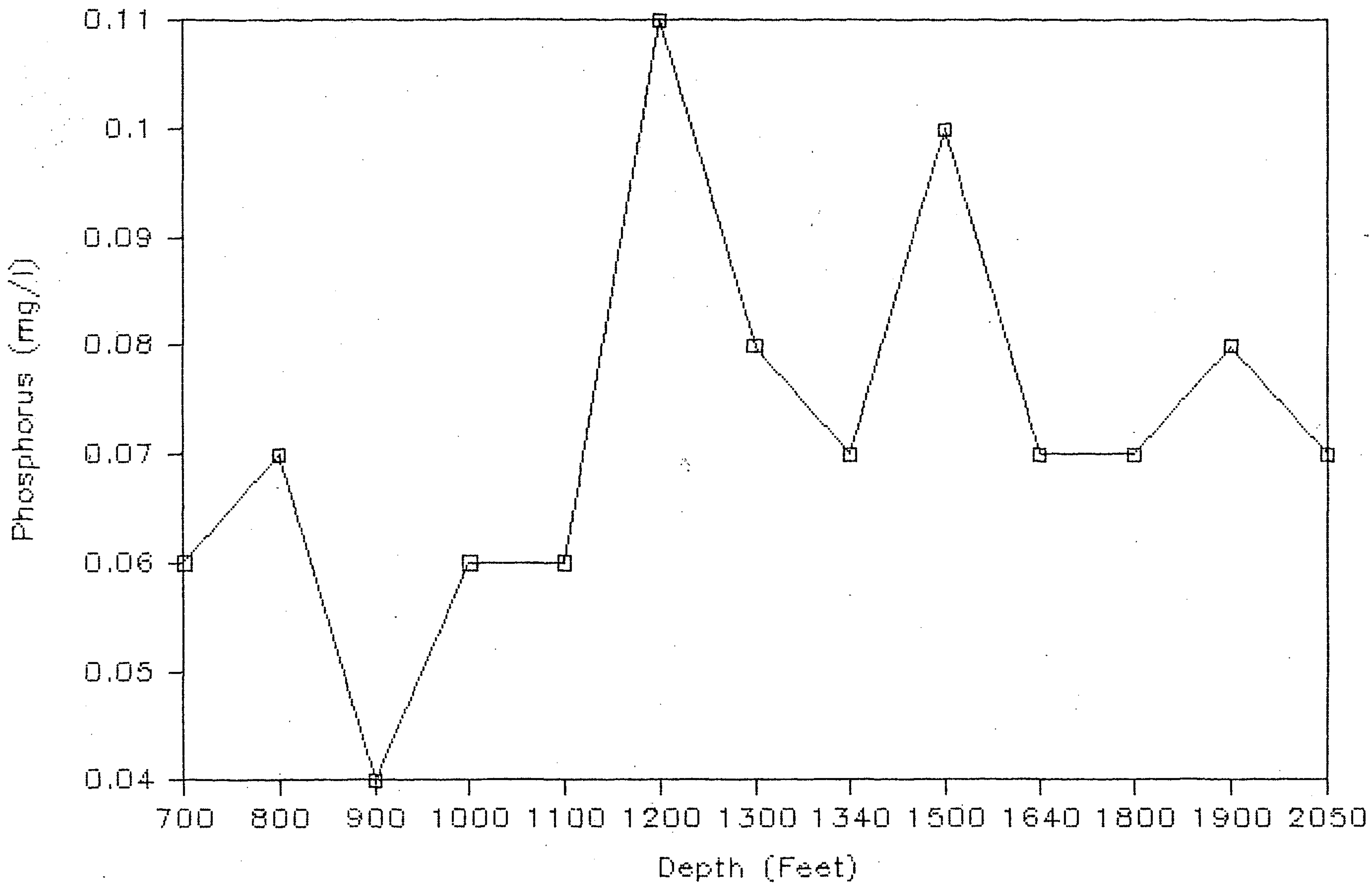
FIGURE 3.4

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

PHOSPHORUS CONCENTRATION VERSUS DEPTH INJECTION WELL

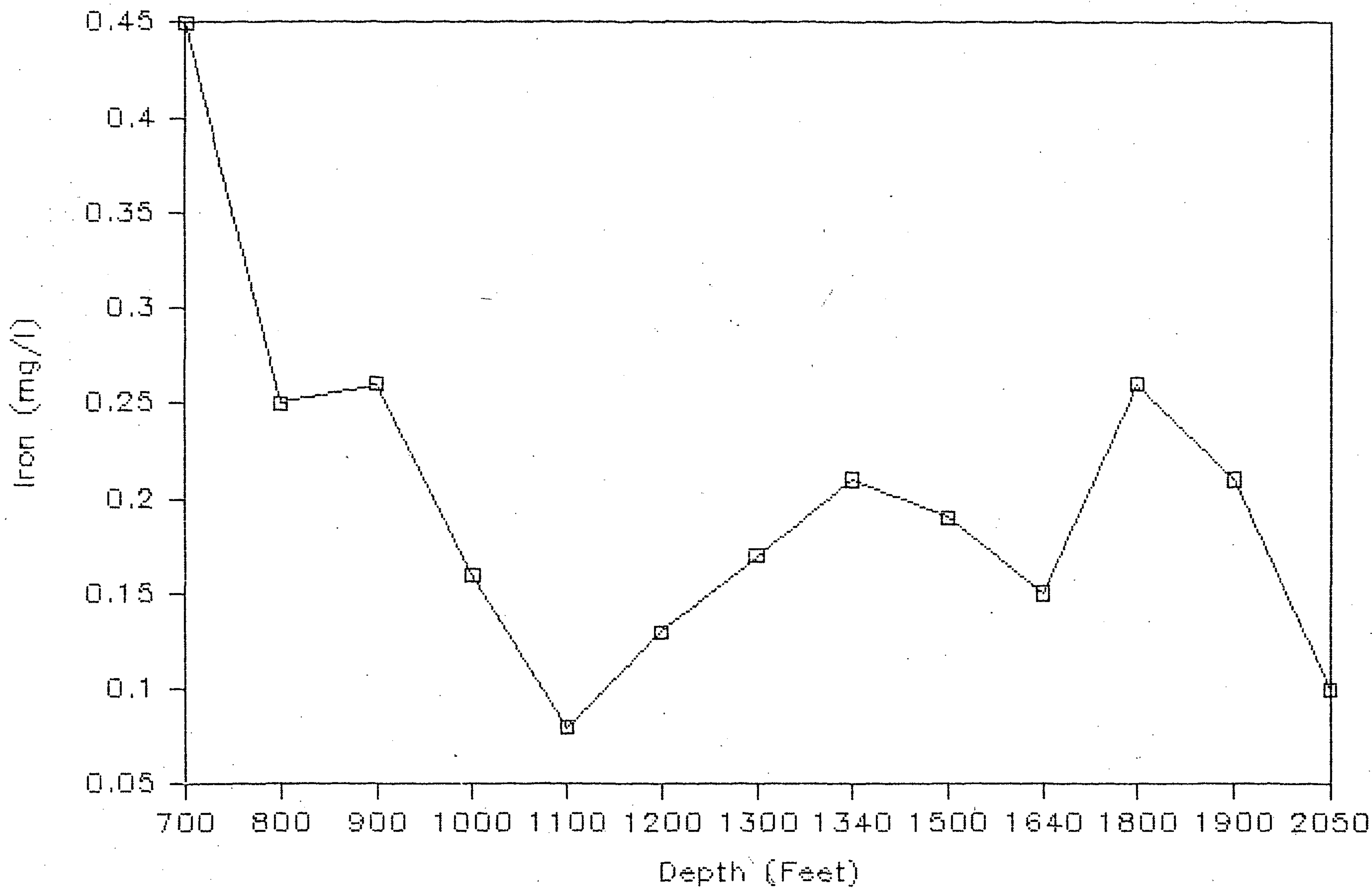


DAMES & MOORE
FIGURE 3.5

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:



IRON CONCENTRATION VERSUS DEPTH INJECTION WELL

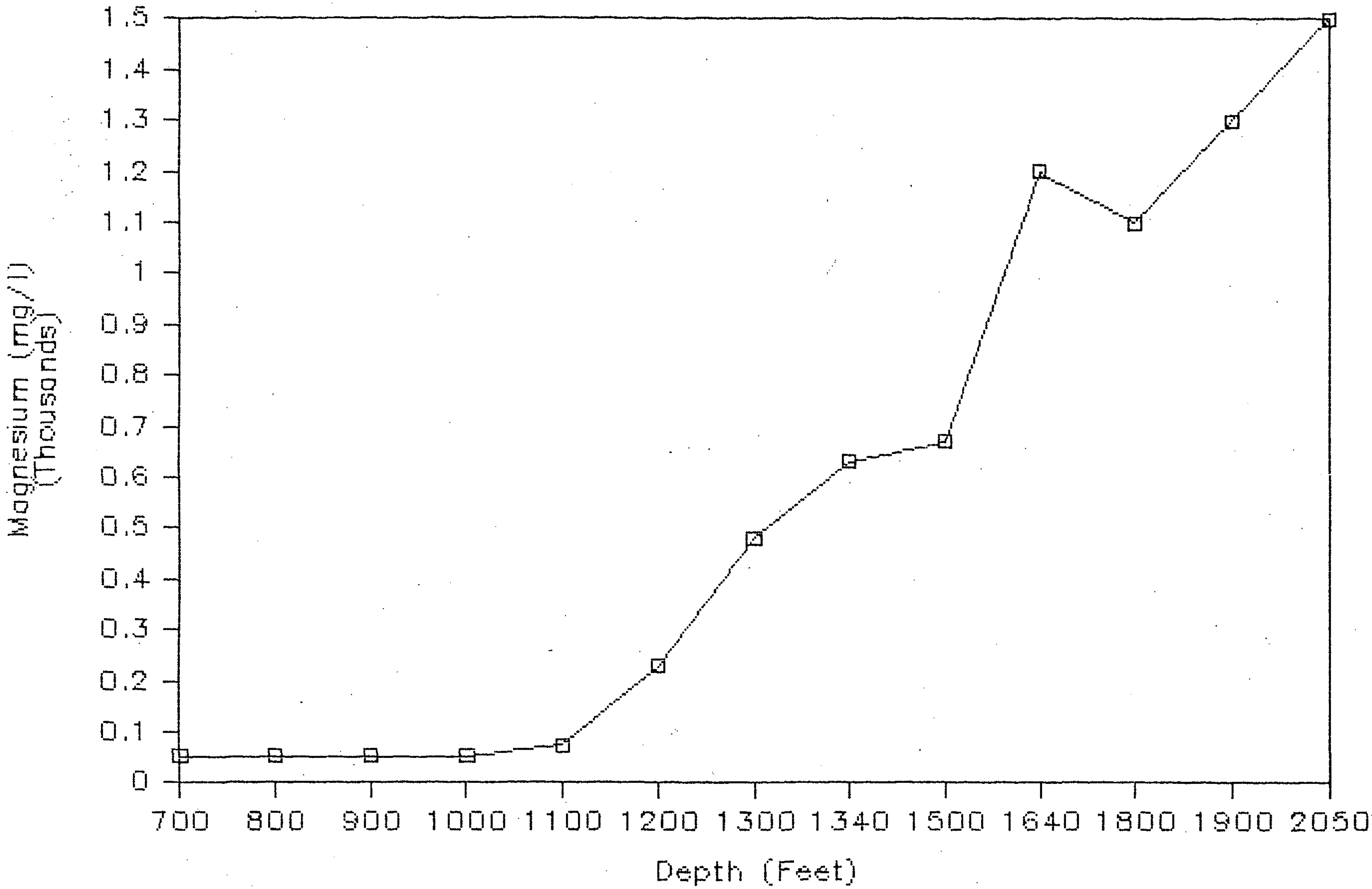
DAMES & MOORE
FIGURE 3.6

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT :
LOCATION :

MAGNESIUM CONCENTRATION VERSUS DEPTH INJECTION WELL

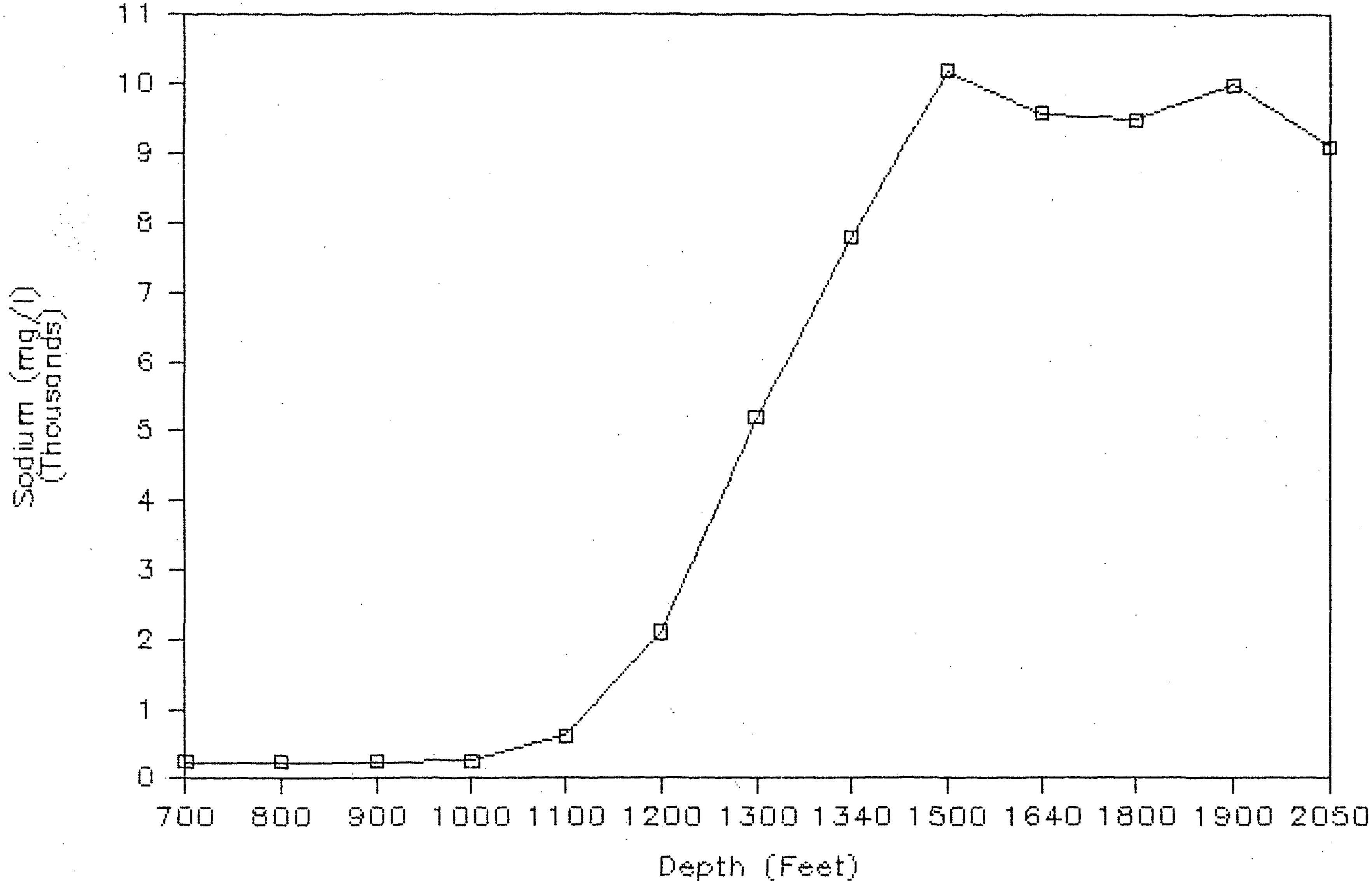


DAMES & MOORE
FIGURE 3.7

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:



SODIUM CONCENTRATION VERSUS DEPTH INJECTION WELL

DAMES & MOORE

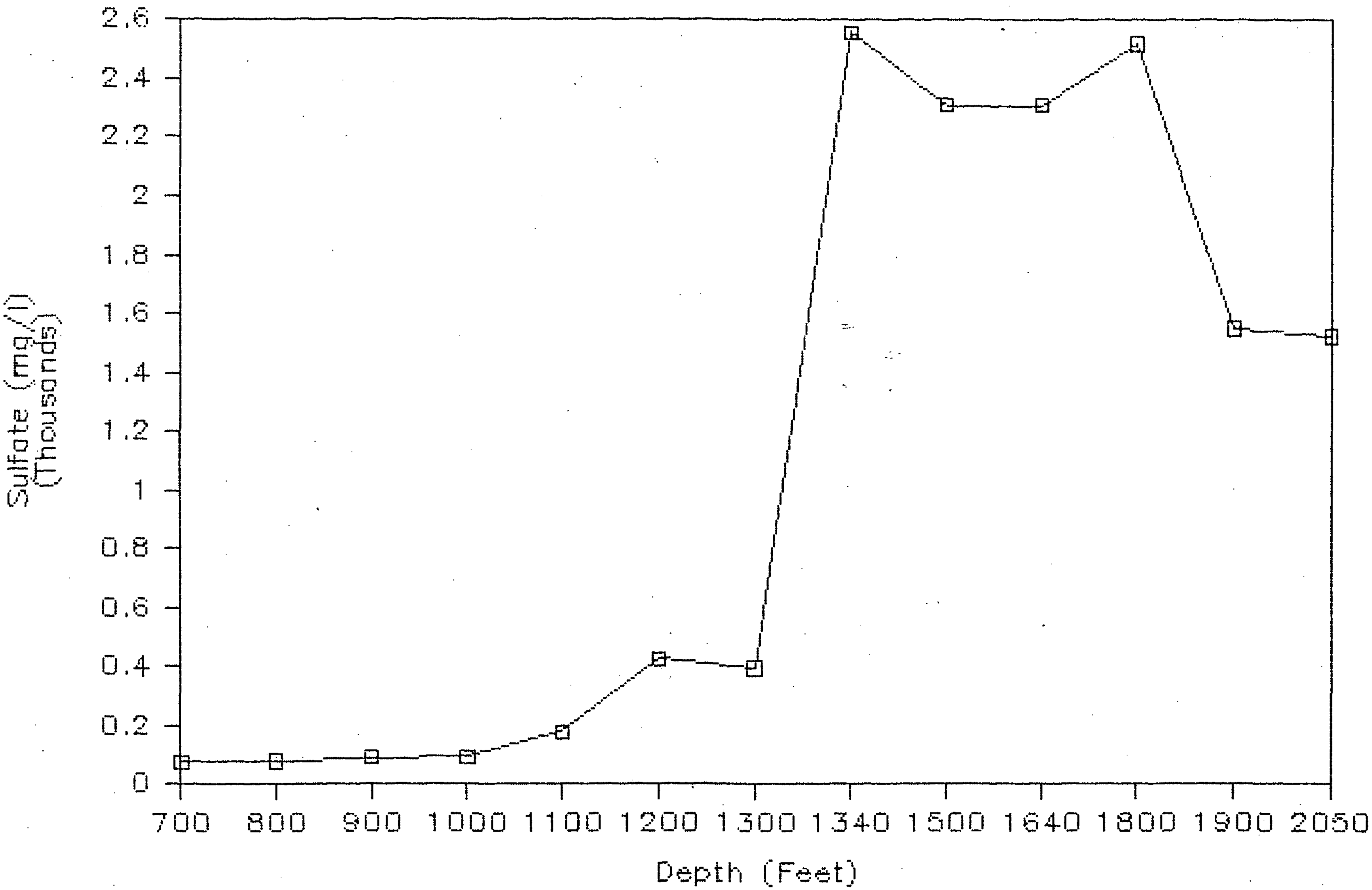
FIGURE 3.8

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

SULFATE CONCENTRATION VERSUS DEPTH INJECTION WELL



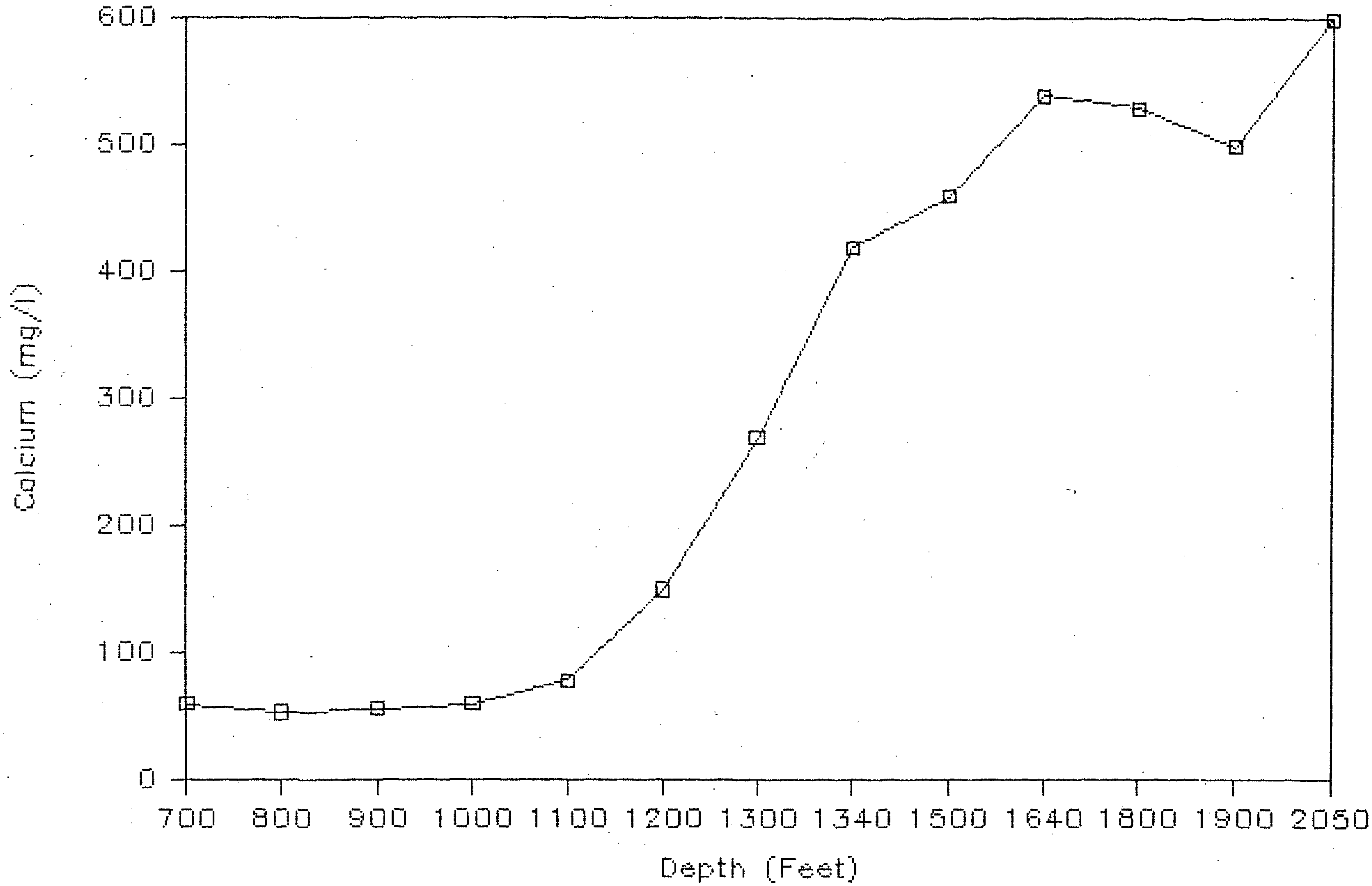
DAMES & MOORE
FIGURE 3.9

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

CALCIUM CONCENTRATION VERSUS DEPTH INJECTION WELL



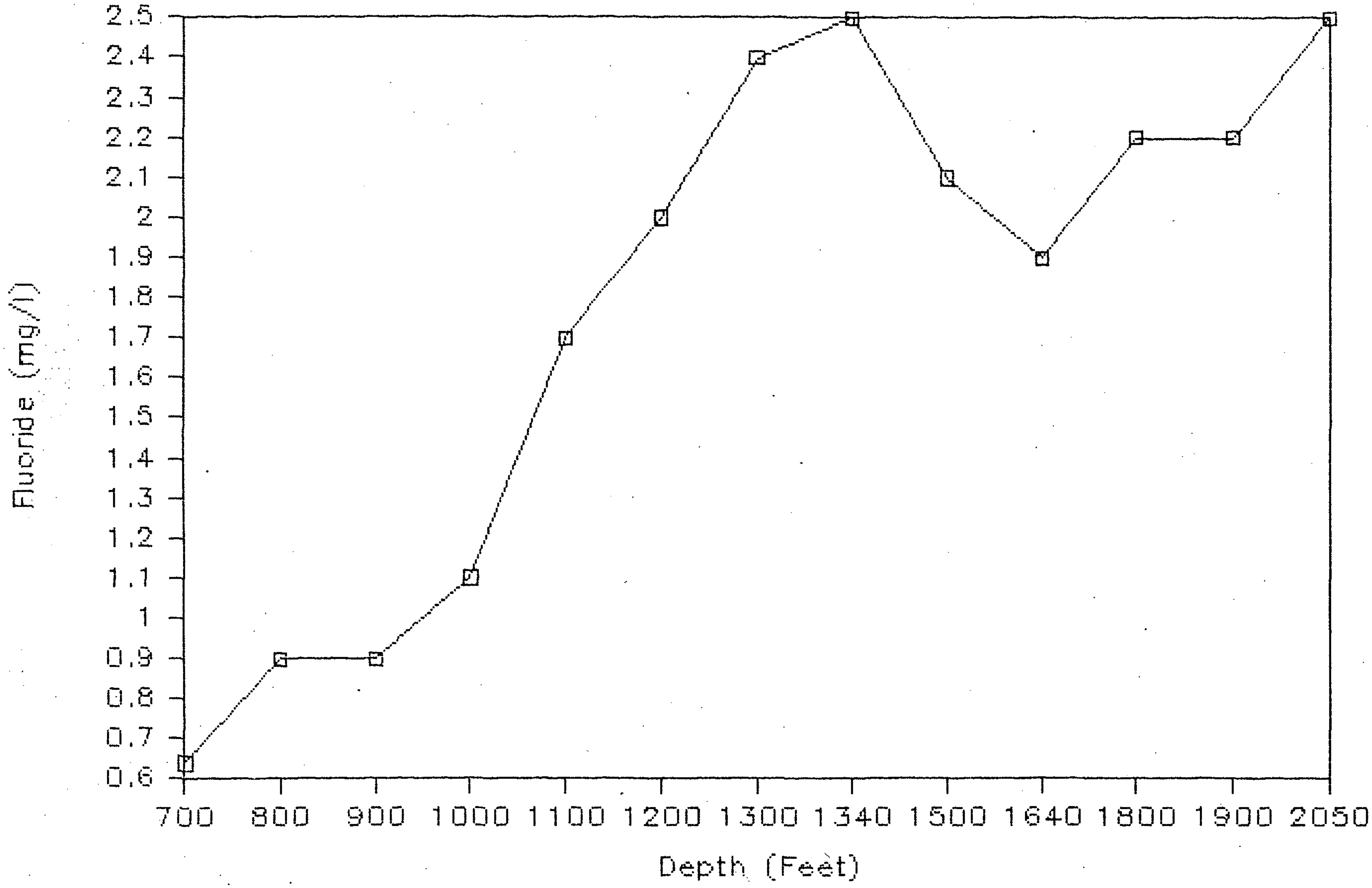
DAMES & MOORE
FIGURE 3.10

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

FLUORIDE CONCENTRATION VERSUS DEPTH INJECTION WELL



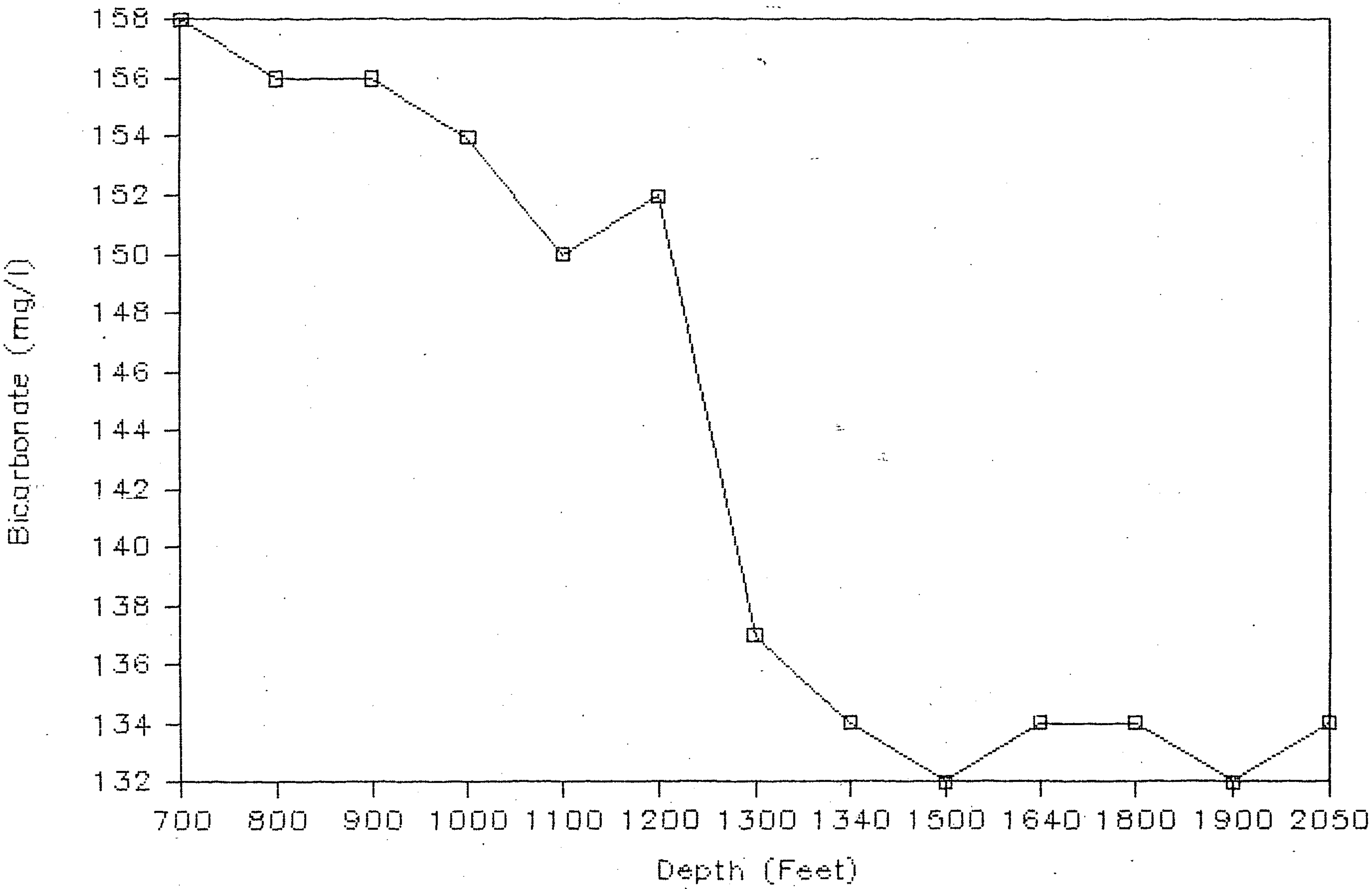
DAMES & MOORE

FIGURE 3.11

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311-200926 (9/85)

PROJECT:
LOCATION:



BICARBONATE CONCENTRATION VERSUS DEPTH INJECTION WELL

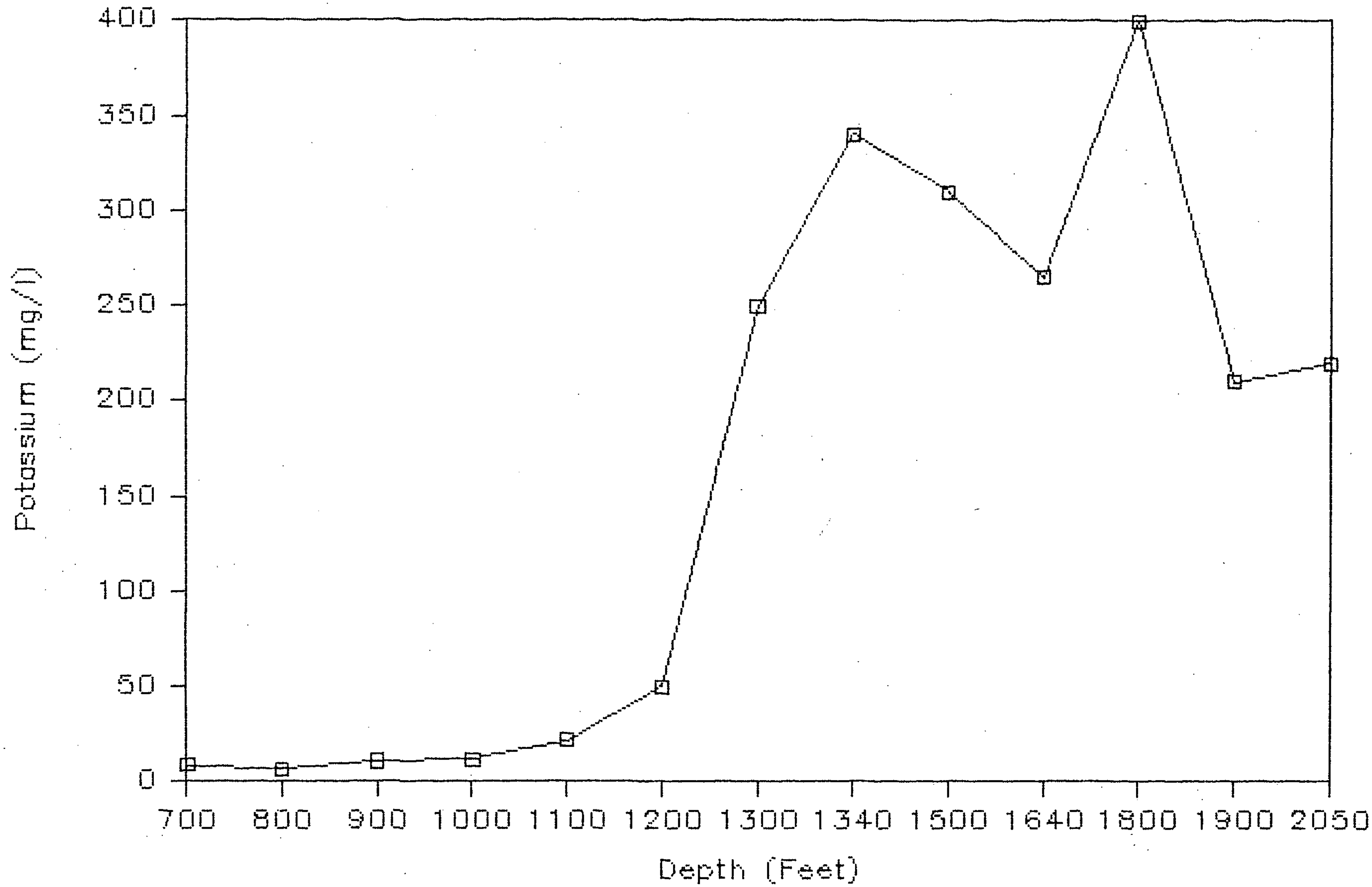
DAMES & MOORE
FIGURE 3.12

BY ________ DATE ________ CHECKED ________ DATE ________ APPROVED ________ DATE ________

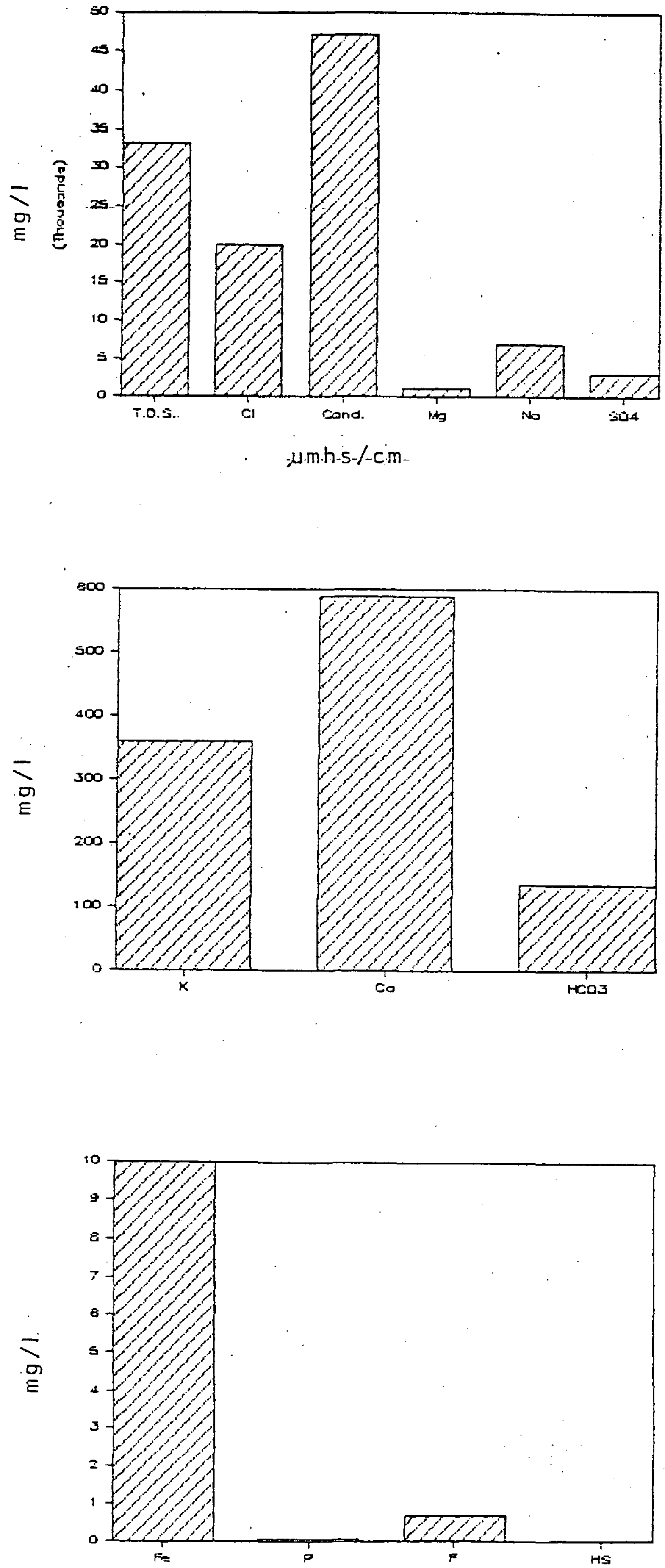
JOB No. 1311200926 (9/85)

PROJECT:
LOCATION:

POTASSIUM CONCENTRATION VERSUS DEPTH INJECTION WELL



DAMES & MOORE
FIGURE 3.13



PACKER TEST No. 1

INTERVAL 1970-2070

PROJECT :

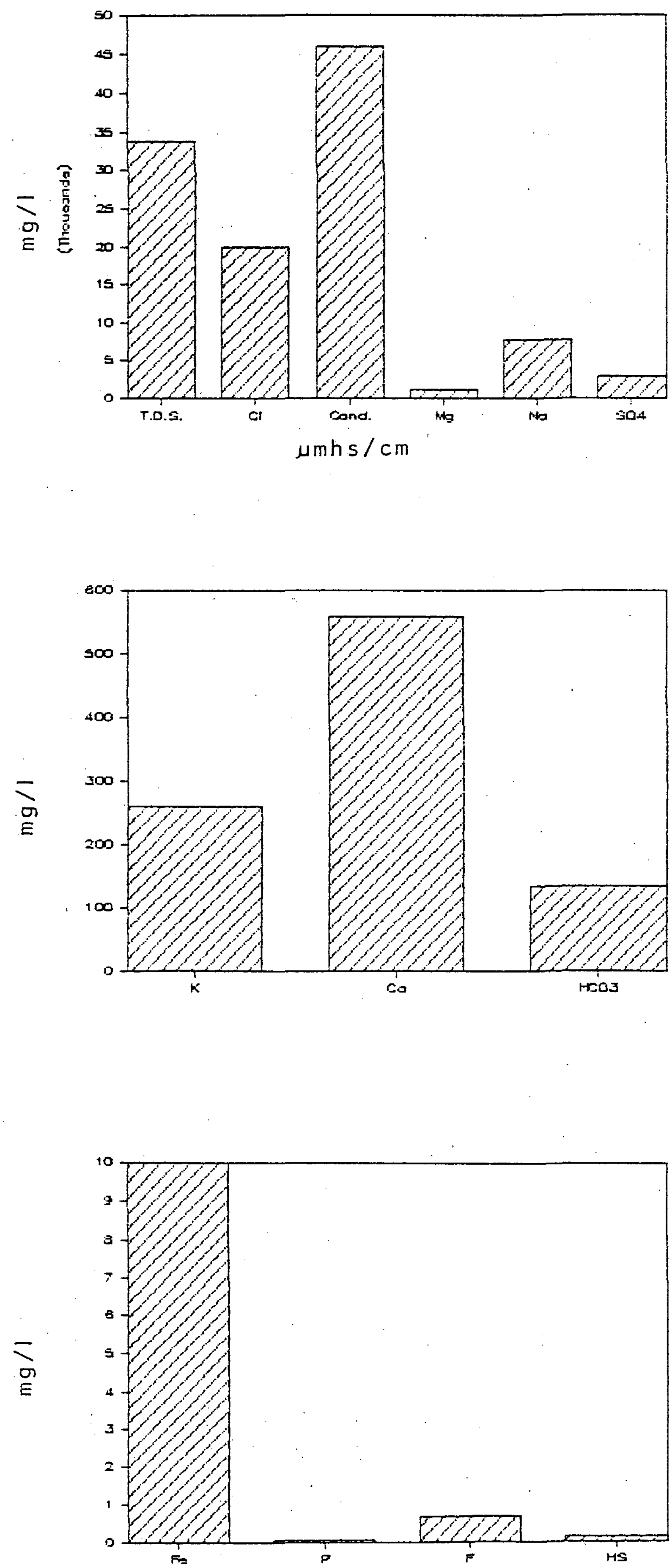
LOCATION :

DAMES & MOORE

FIGURE 3.14

JOB No. 1311200926 (9/85)

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______



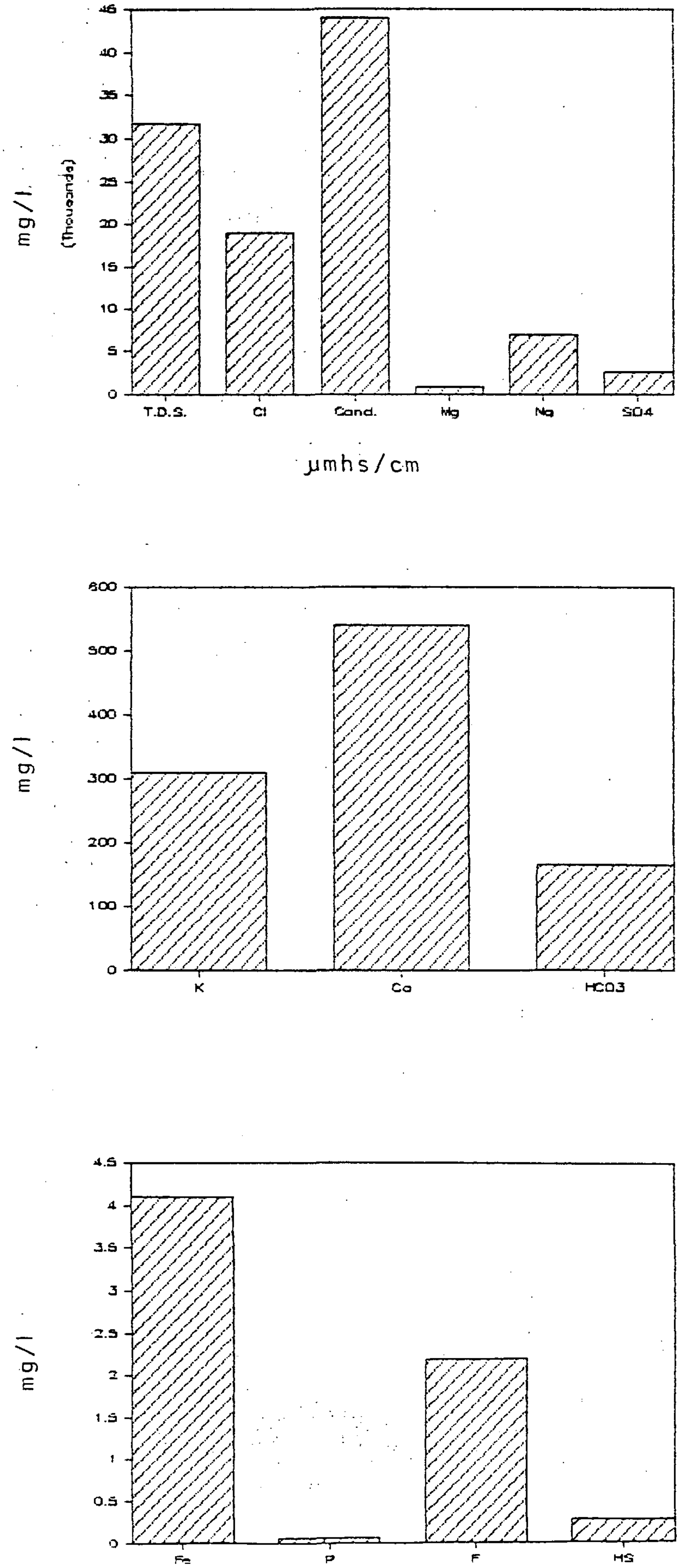
PACKER TEST No. 2
INTERVAL 1880-1980

PROJECT:
LOCATION:

DAMES & MOORE
FIGURE 3.15

JOB No. 1311200926 (9/85)

BY ____ DATE ____ CHECKED ____ DATE ____ APPROVED ____ DATE ____



PACKER TEST No. 3

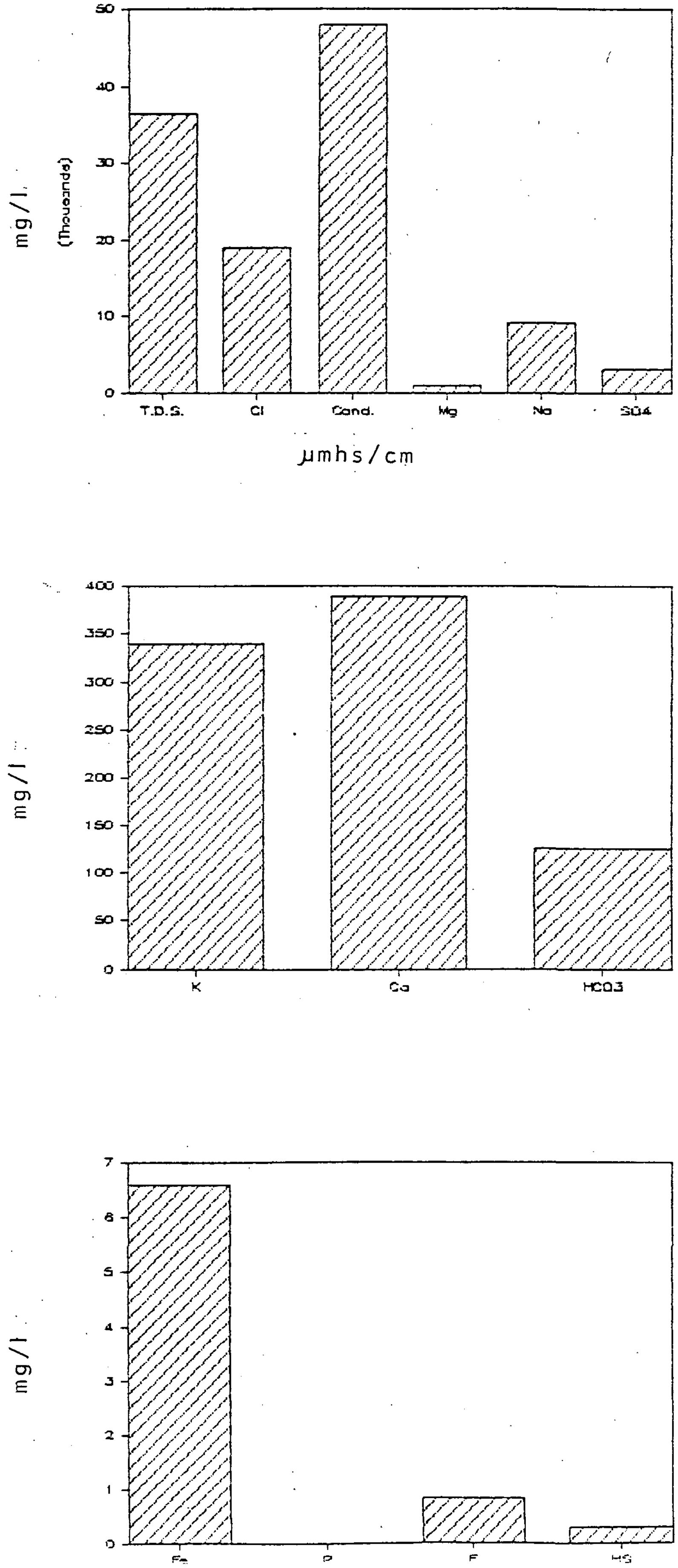
INTERVAL 1785-1885

PROJECT :
LOCATION :

DAMES & MOORE
FIGURE 3.16

JOB No. 1311200926 (9/85)

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______



PACKER TEST No. 4

INTERVAL 1690-1790

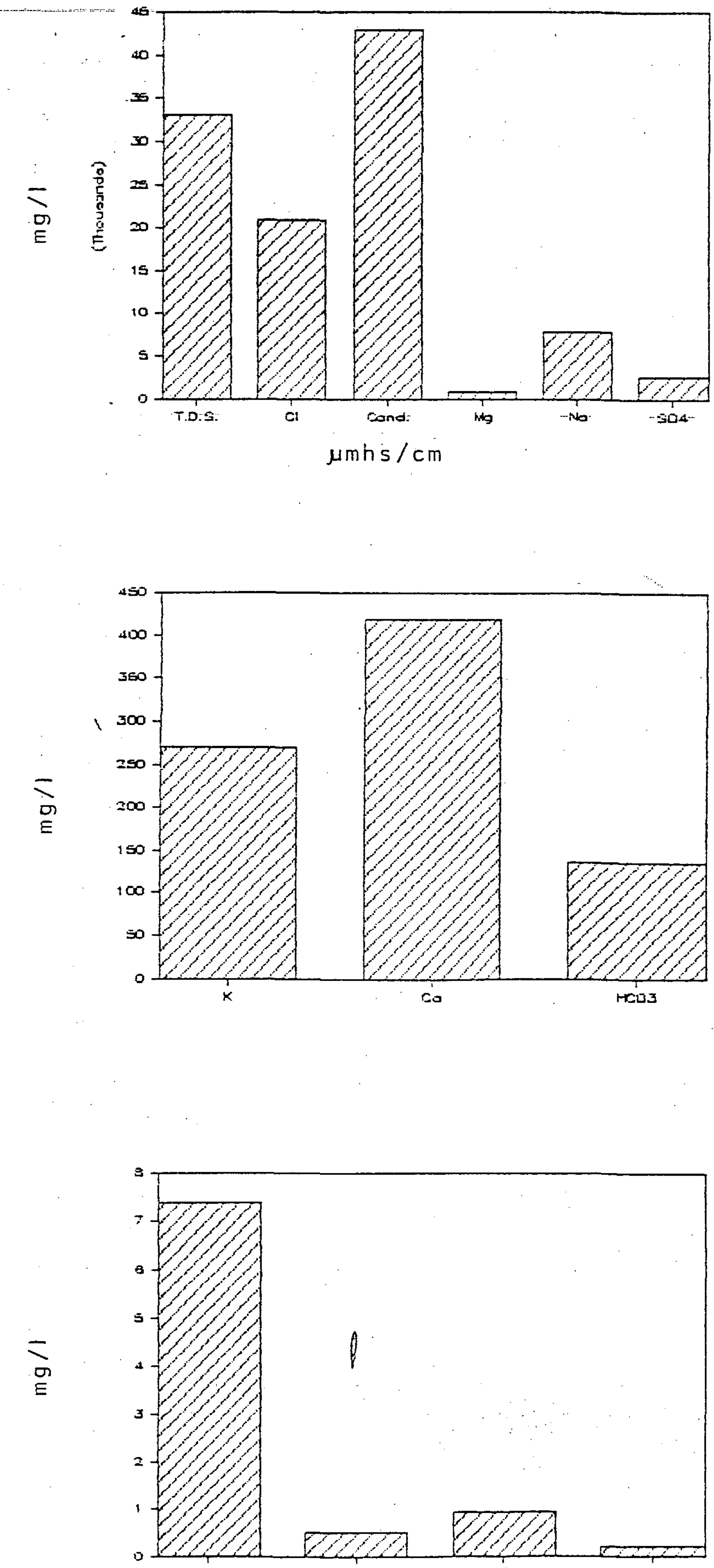
PROJECT :
LOCATION :

DAMES & MOORE

FIGURE 3.17

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______

JOB No.1311200926 (9/85)



PACKER TEST No. 5
INTERVAL 1605-1705

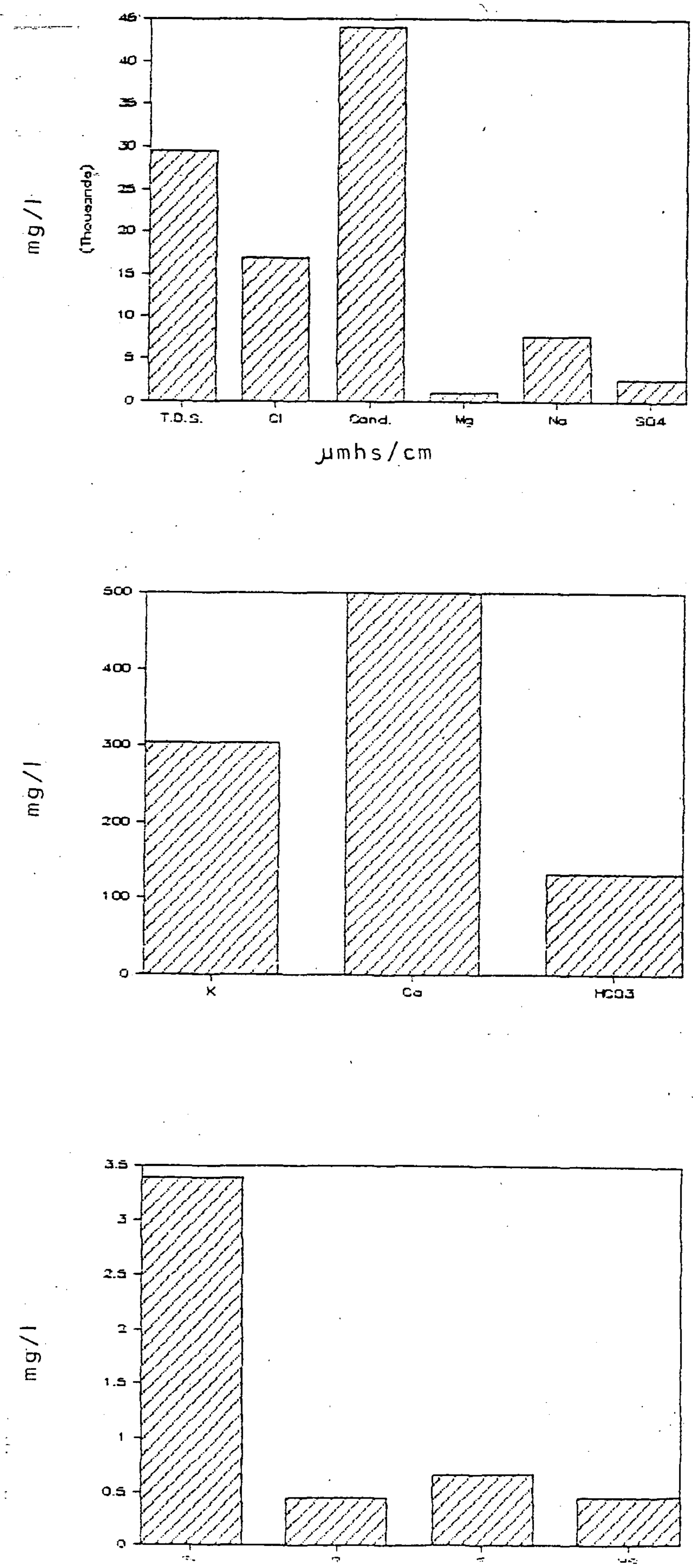
BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______

JOB No. 1311200926 (9/85)

PROJECT :
LOCATION :

DAMES & MOORE

FIGURE 3.18



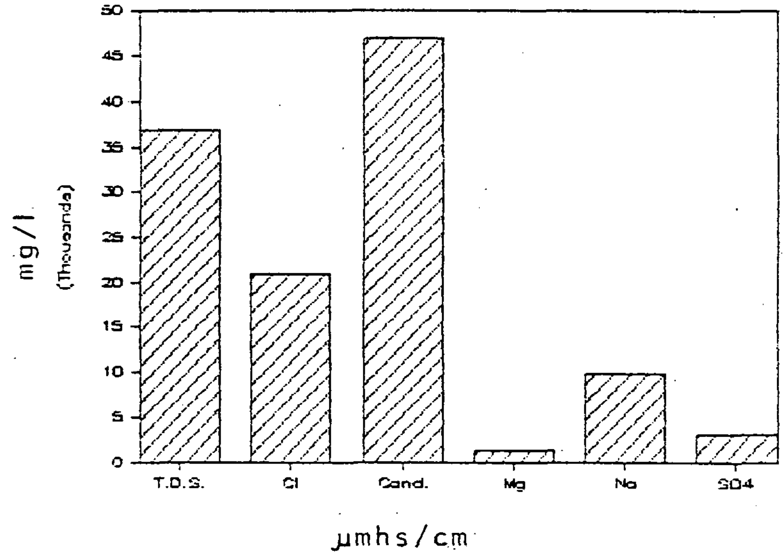
PACKER TEST No. 6
INTERVAL 1500-1600

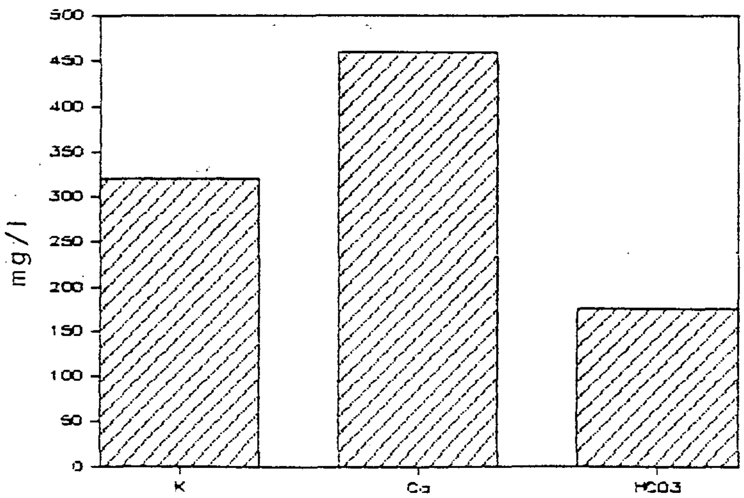
PROJECT :
LOCATION :

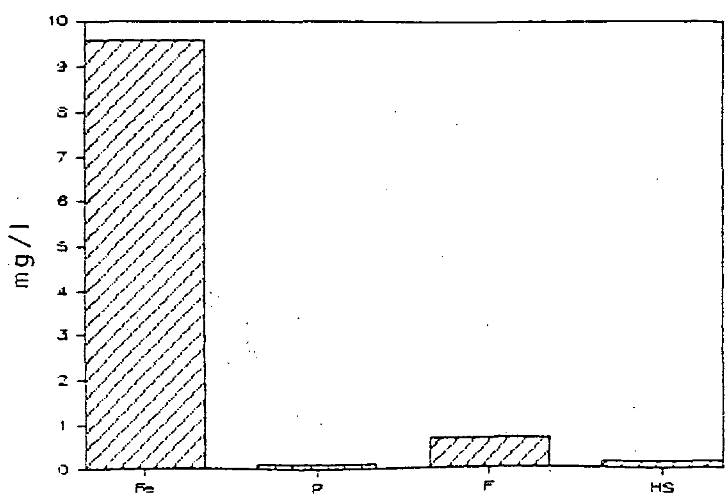
DAMES & MOORE
FIGURE 3.19

JOB No. 1311200926 (9/85)

BY ____ DATE ____ CHECKED ____ DATE ____ APPROVED ____ DATE ____







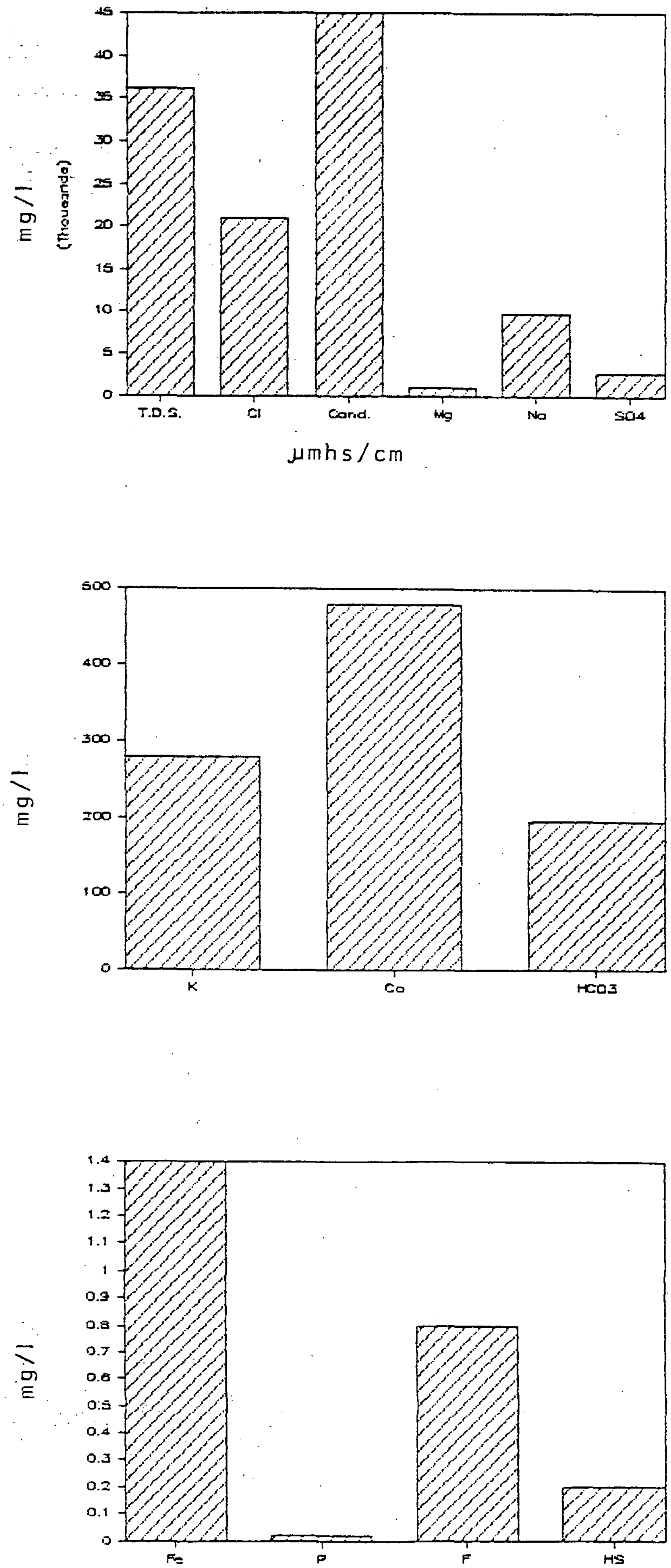
PACKER TEST No. 7
INTERVAL 1405-1505

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______

JOB No. 1311200926 (9/85)

PROJECT :
LOCATION :

DAMES & MOORE
FIGURE 3.20



PACKER TEST No. 8

INTERVAL 1253-1353

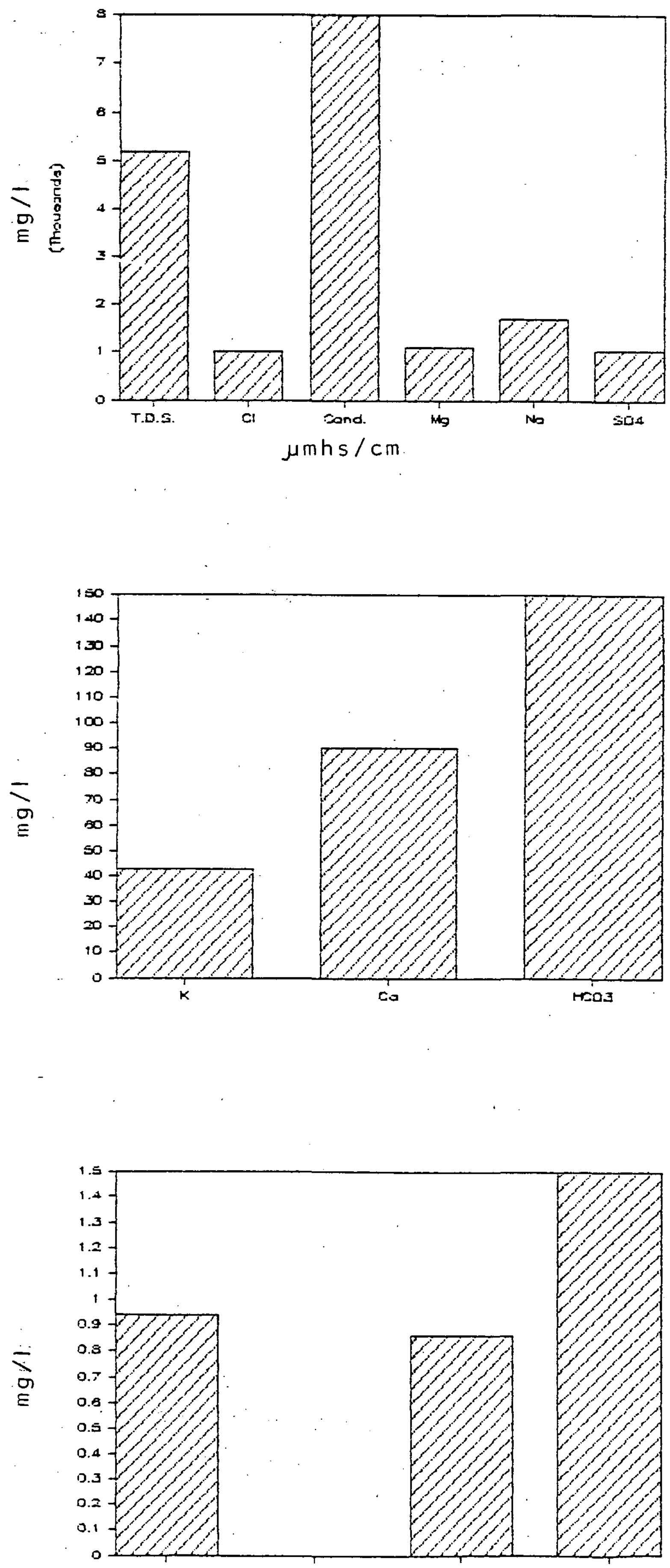
BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______

JOB No. 1311200926 (9/85)

PROJECT :
LOCATION :

DAMES & MOORE

FIGURE 3.21



PACKER TEST No. 9

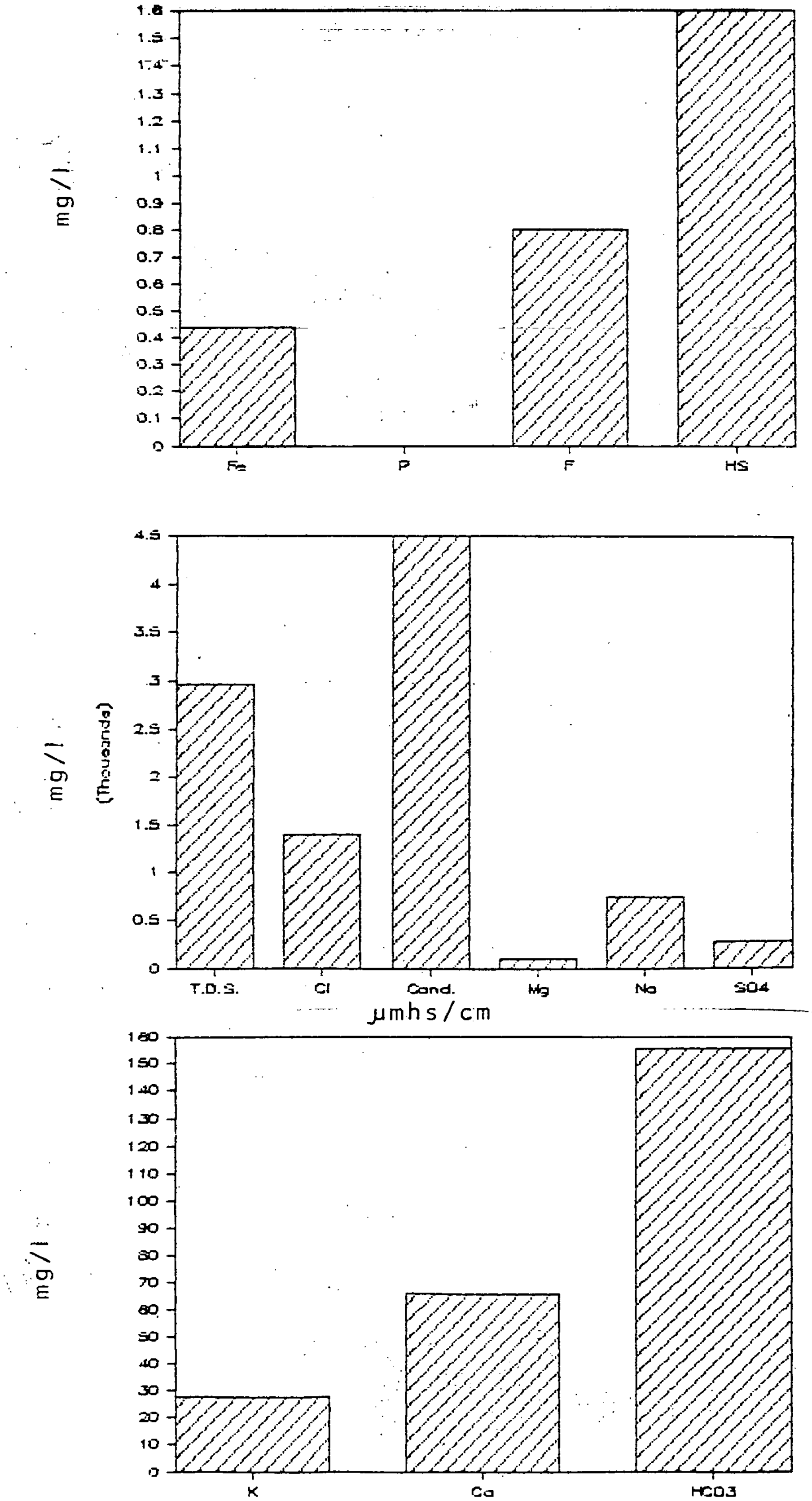
INTERVAL 1155-1255

PROJECT :
LOCATION :

DAMES & MOORE
FIGURE 3.22

JOB No. 1311200926 (9/85)

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______



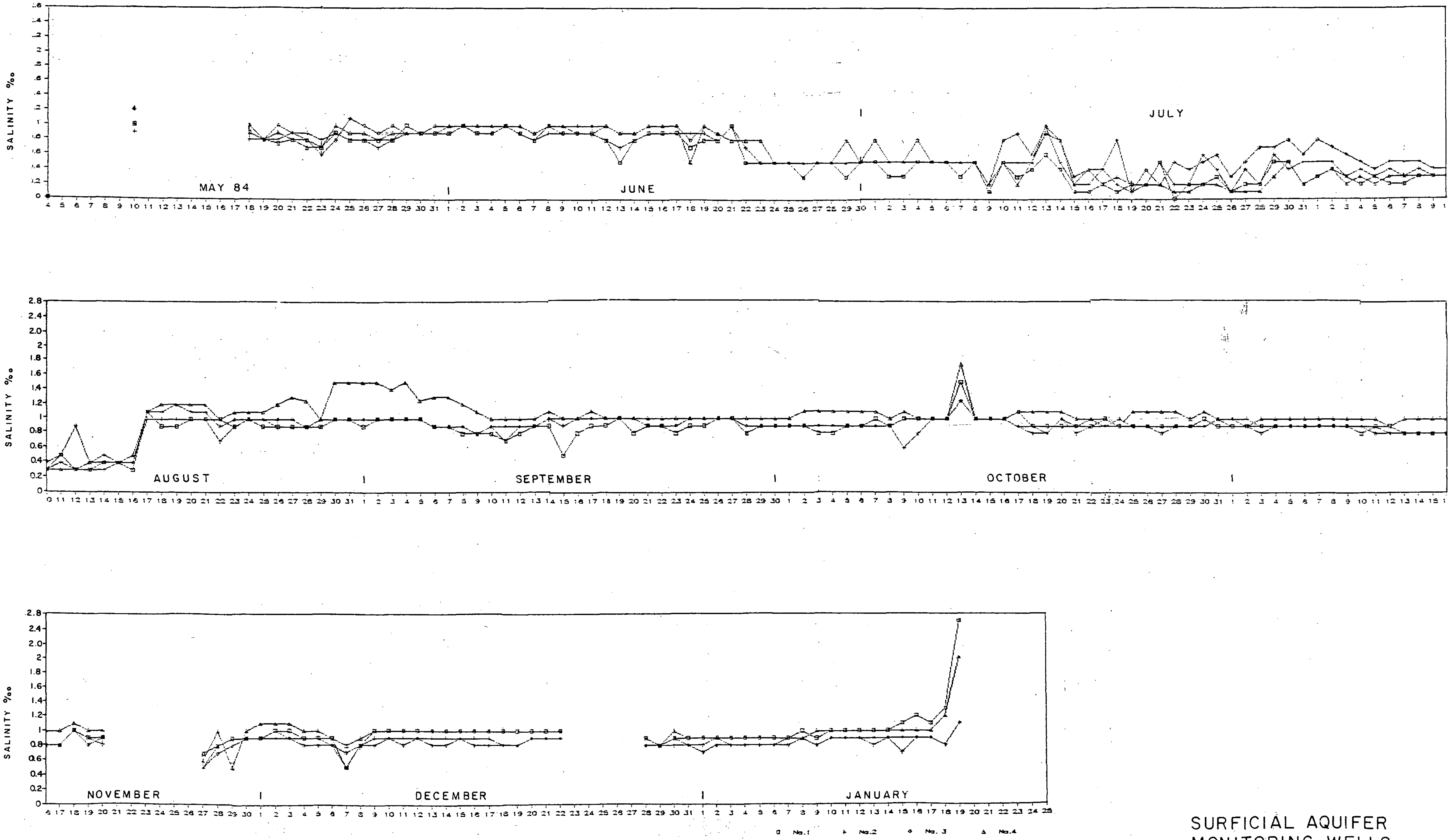
PACKER TEST No. 10
INTERVAL 1000-1100

PROJECT :
LOCATION :

DAMES & MOORE
FIGURE 3.23

JOB No. 1311200926 (9/85)

BY ______ DATE ______ CHECKED ______ DATE ______ APPROVED ______ DATE ______



SURFICIAL AQUIFER MONITORING WELLS

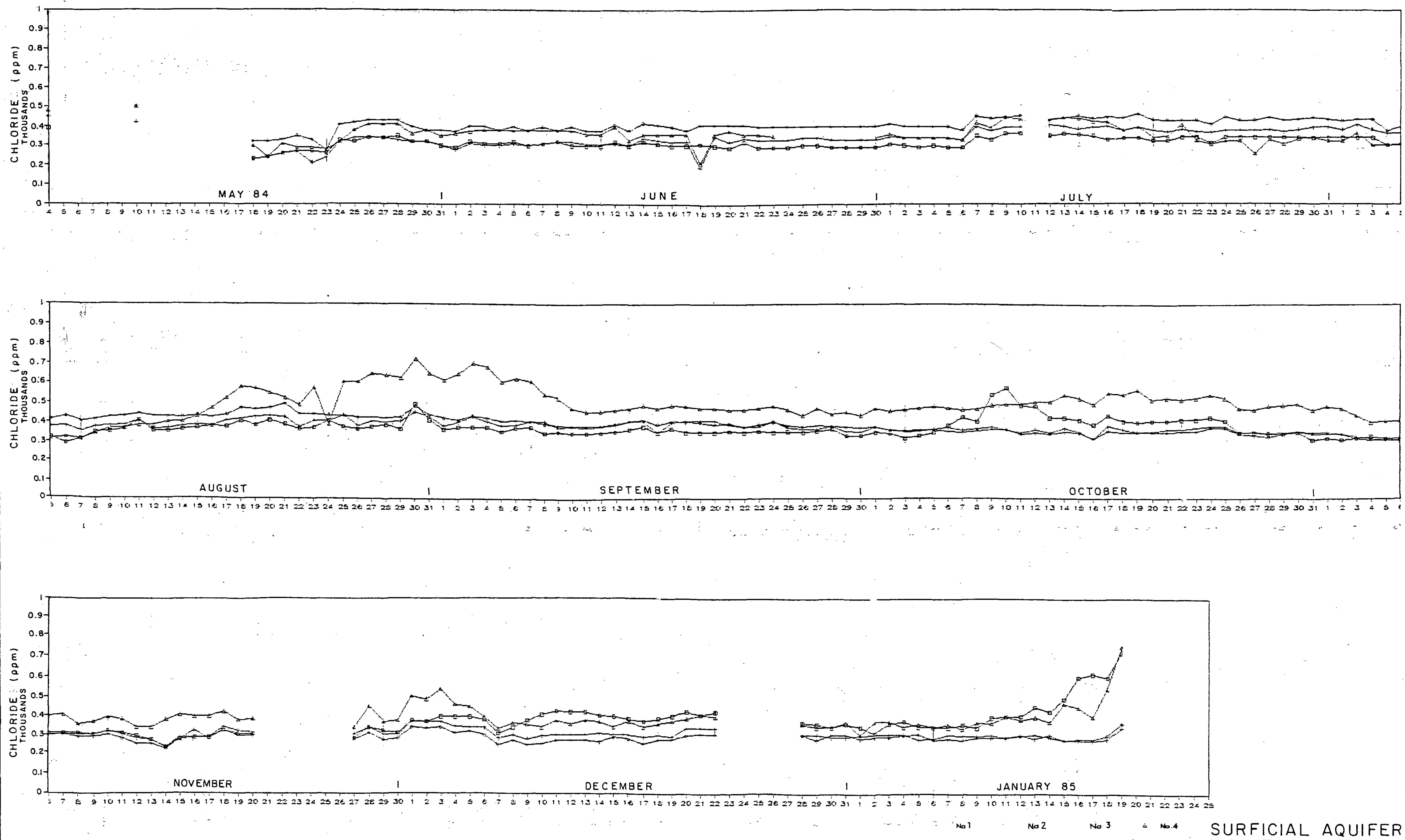
SALINITY VS. TIME

PROJECT : SOUTH BEACH EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE

FIGURE 3.24

13112009 (9/85)



SURFICIAL AQUIFER MONITORING WELLS

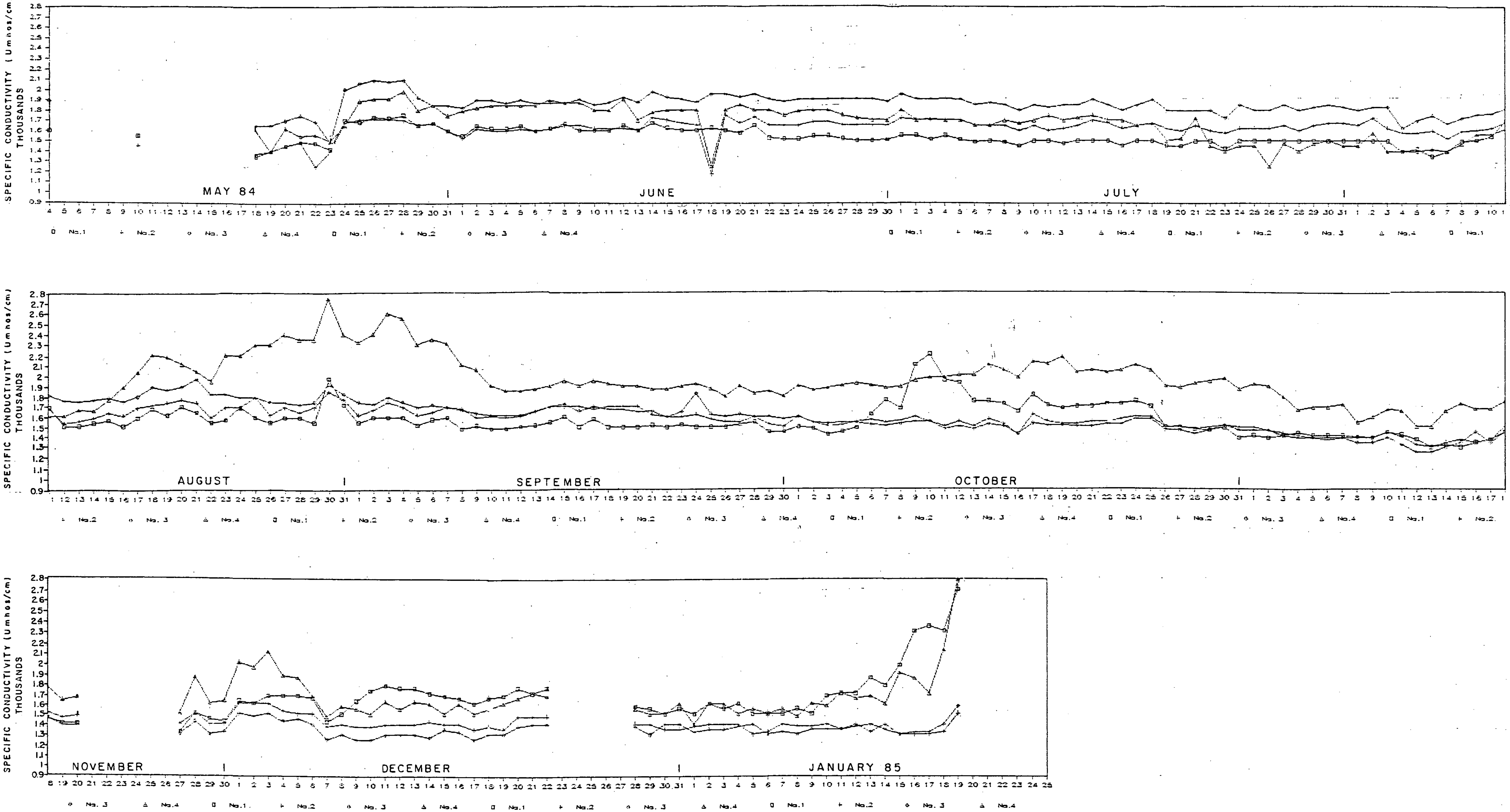
CHLORIDE CONCENTRATION VS. TIME

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE

FIGURE 3.25

13112 00826(9/85)



SURFICIAL AQUIFER
MONITORING WELLS

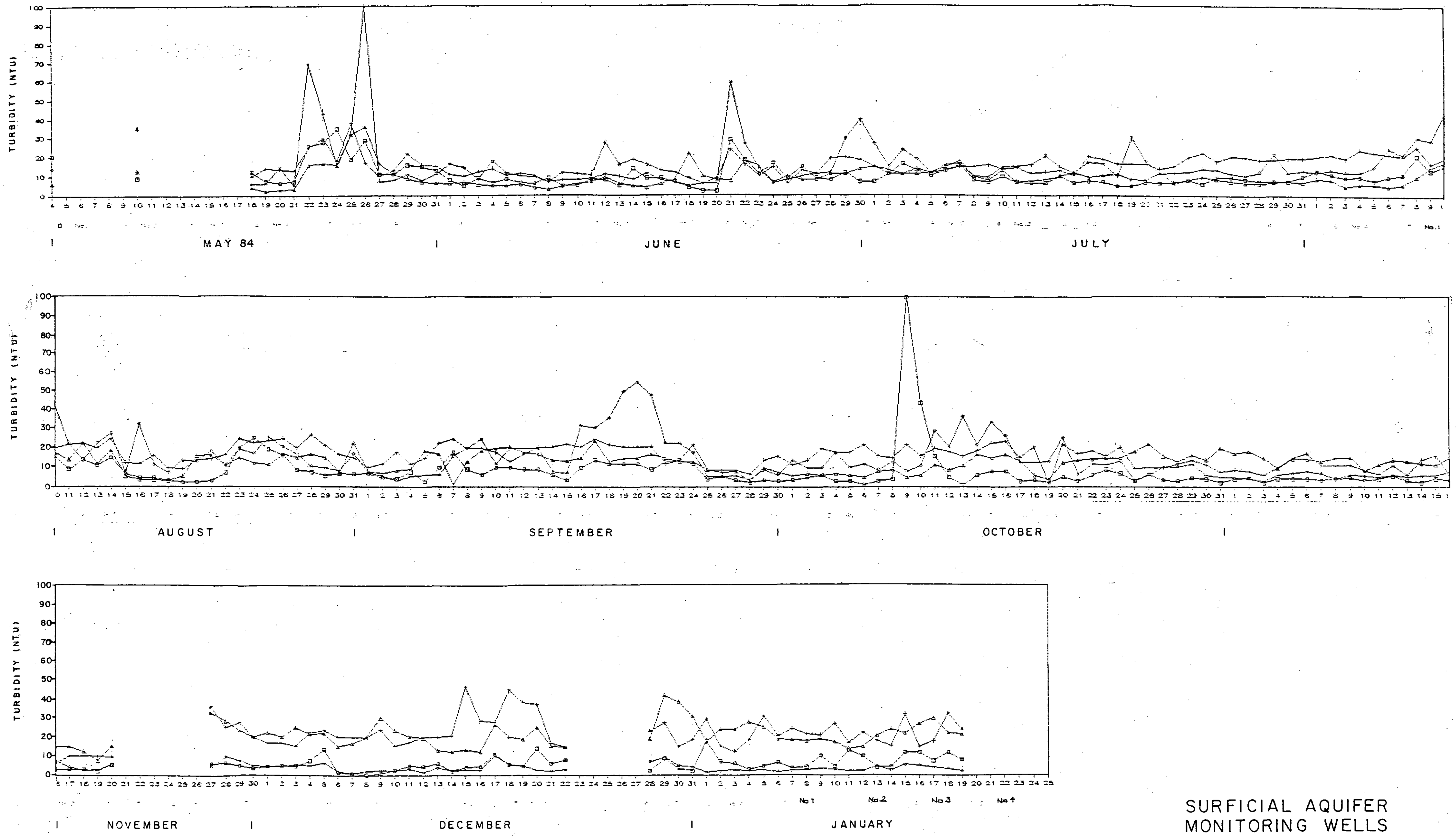
SPECIFIC CONDUCTIVITY VS. TIME

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.26

REVISION — DATE
APPROVED — DATE
CHECKED — DATE
BY — DATE

1311200985 (9/85)



SURFICIAL AQUIFER
MONITORING WELLS

TURBIDITY VS. TIME

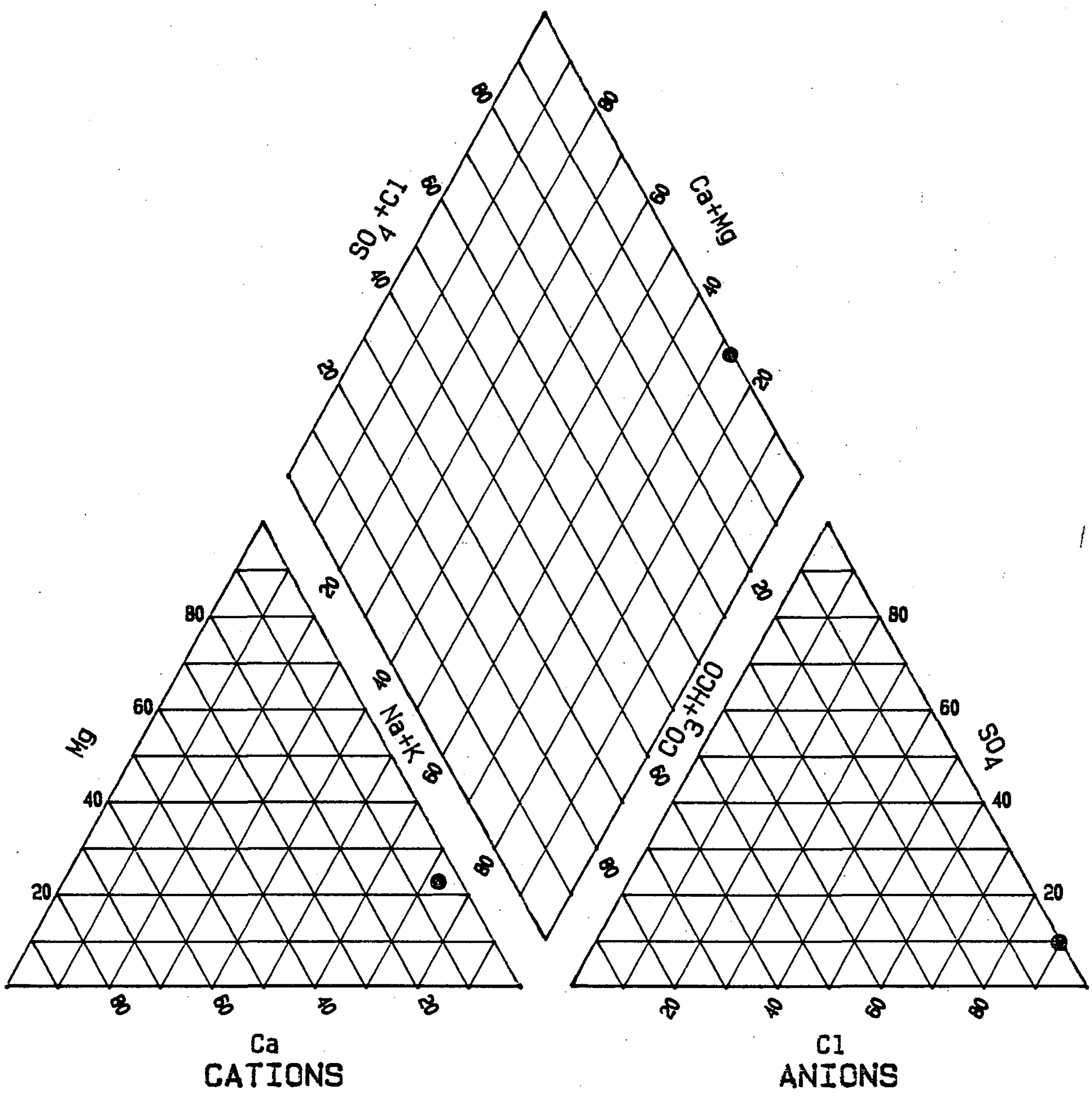
PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.27

1311200926 (9/85)

BY ___ DATE ___ CHECKED ___ DATE ___ APPROVED ___ DATE ___ REVISION ___ DATE ___

CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION

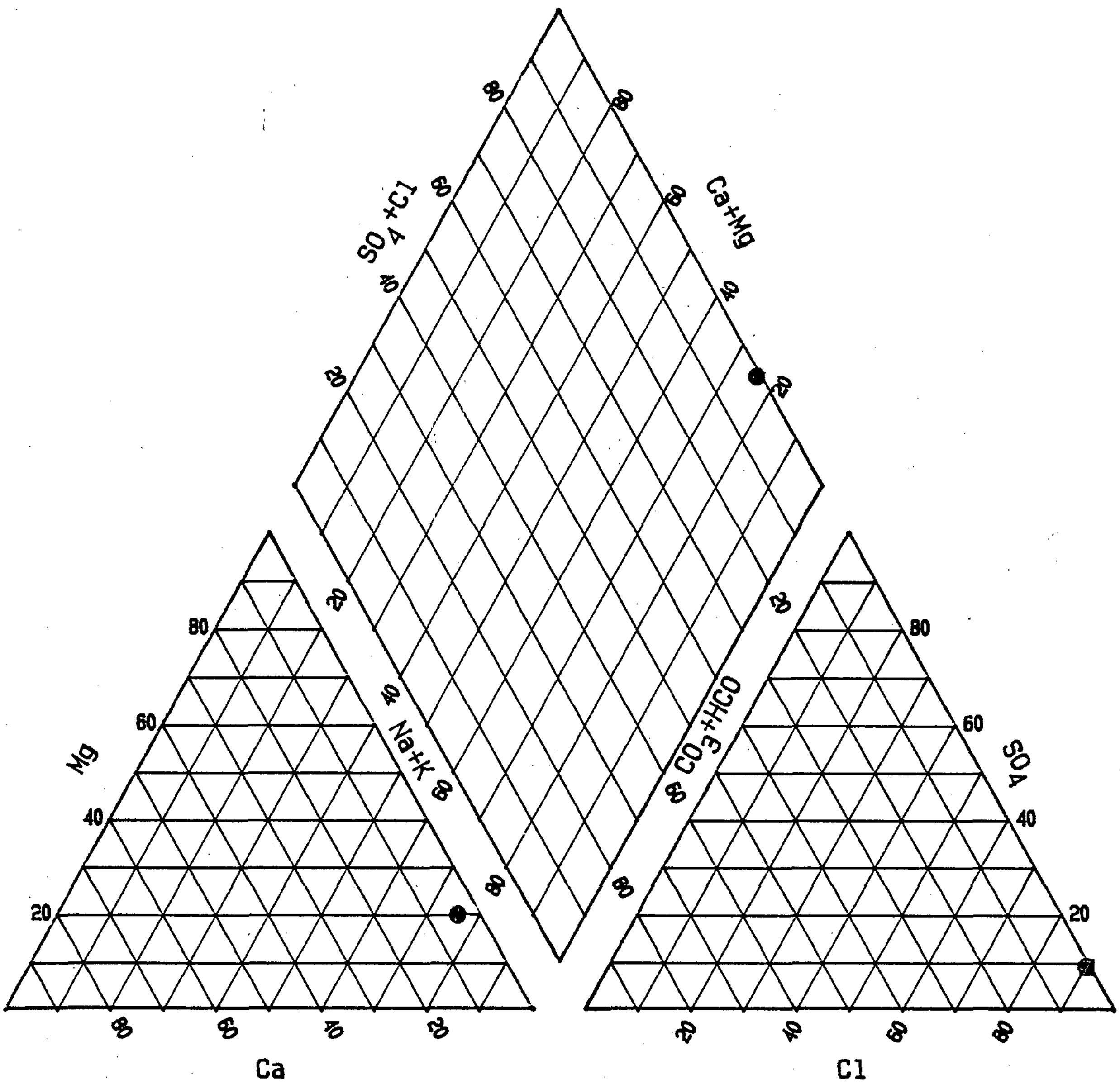


SYMBOL	STATION	SAMPLING DATE
●	PACKER #1	08/13/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL
LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.28

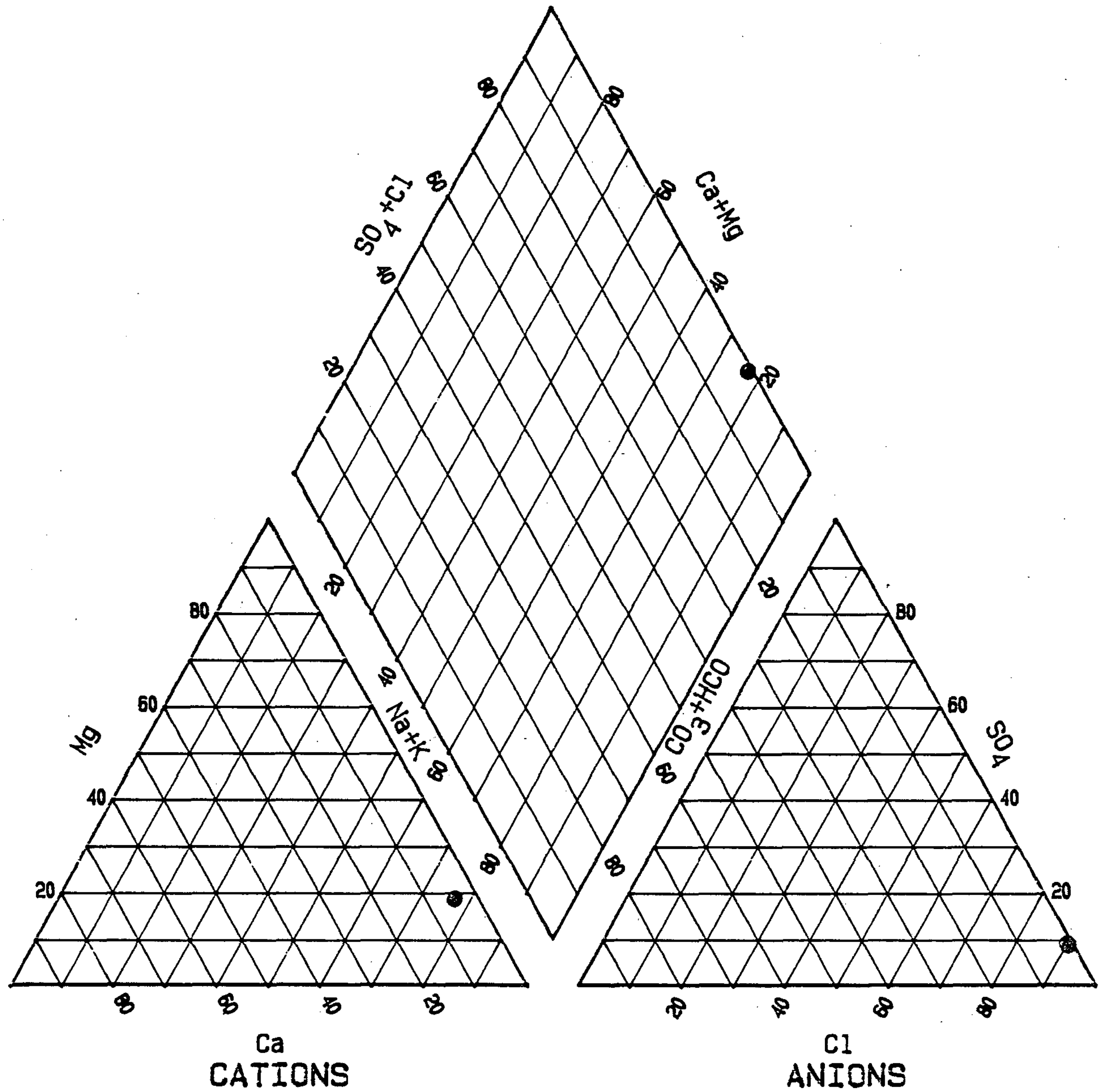
CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION



SYMBOL	STATION	SAMPLING DATE
●	PACKER #2	08/13/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA	DAMES & MOORE FIGURE 3.29

CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION

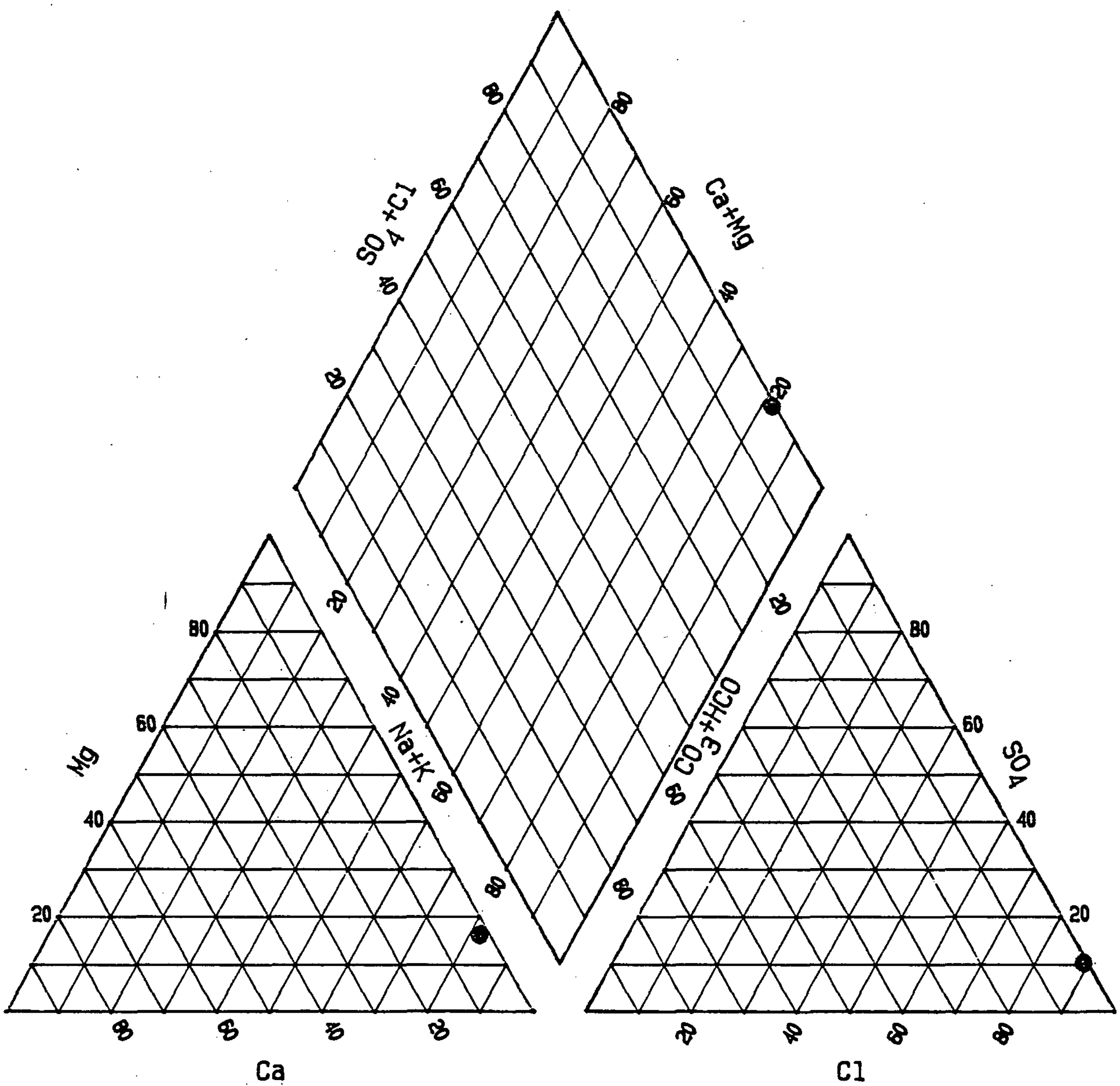


SYMBOL	STATION	SAMPLING DATE
●	PACKER #3	08/13/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL
LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.30

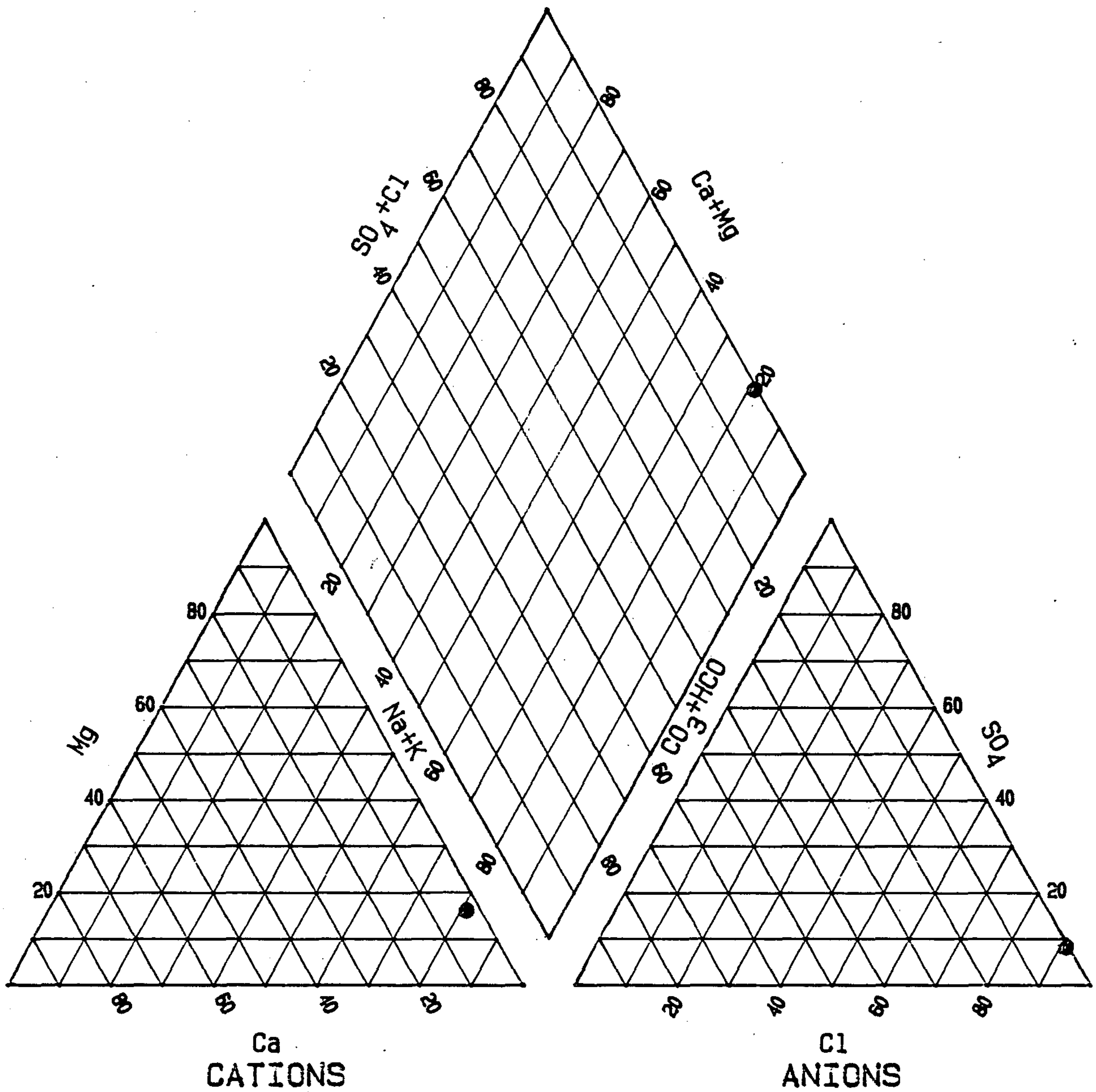
CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION



SYMBOL	STATION	SAMPLING DATE
●	PACKER #4	08/20/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA	DAMES & MOORE FIGURE 3.31

CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION

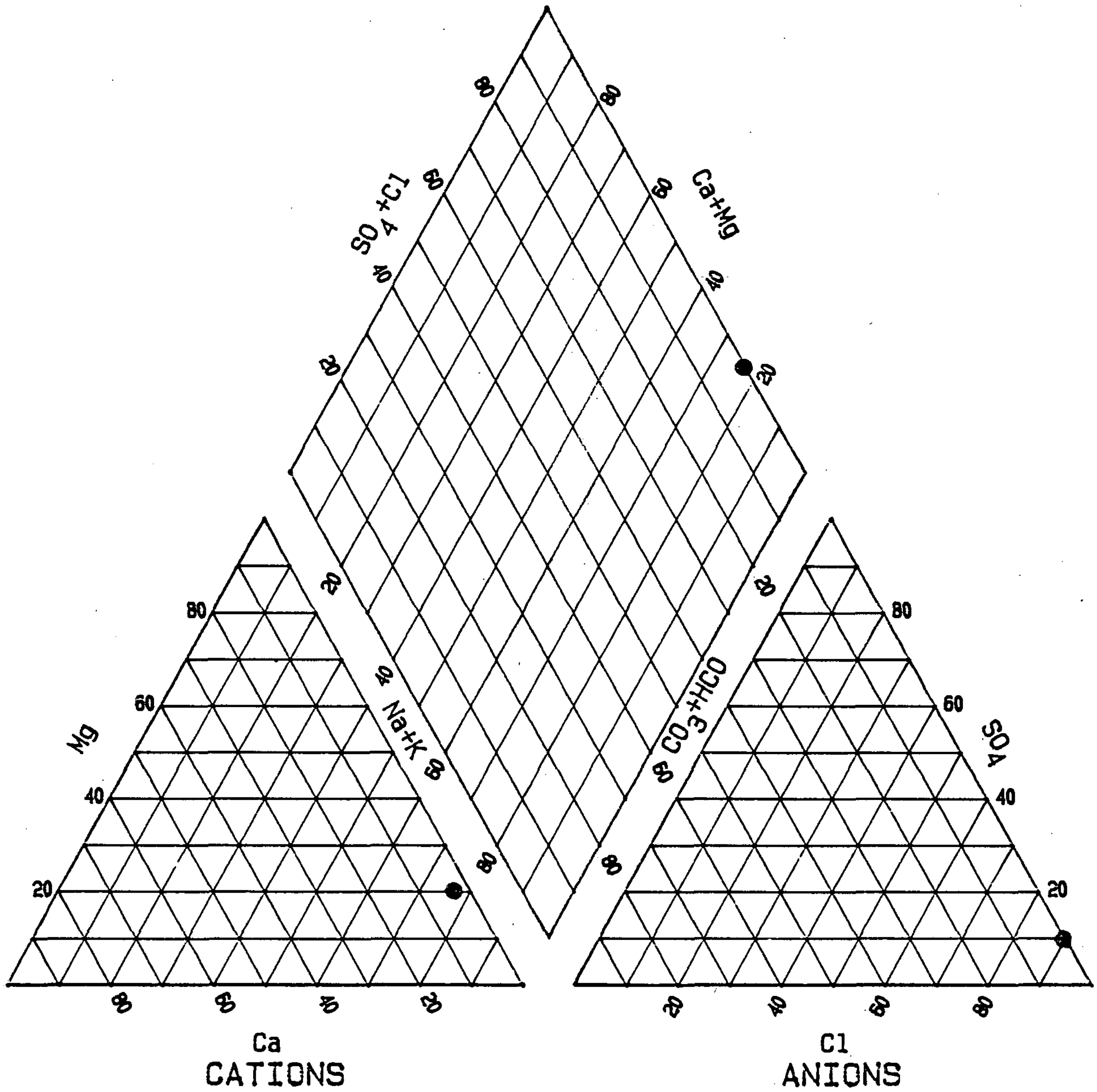


SYMBOL	STATION	SAMPLING DATE
●	PACKER #5	08/20/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL
LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.32

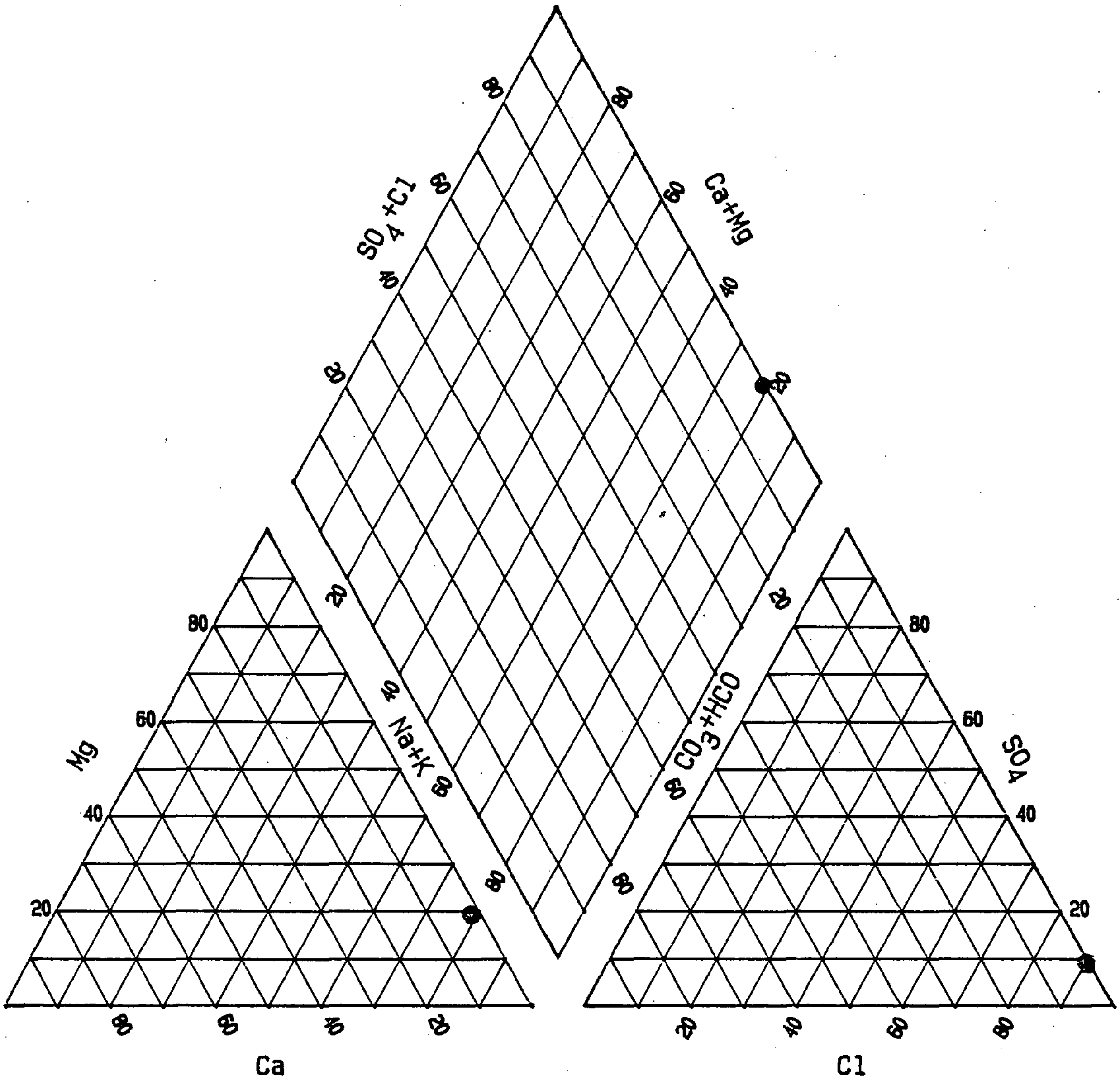
CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION



SYMBOL	STATION	SAMPLING DATE
●	PACKER #6	08/20/84

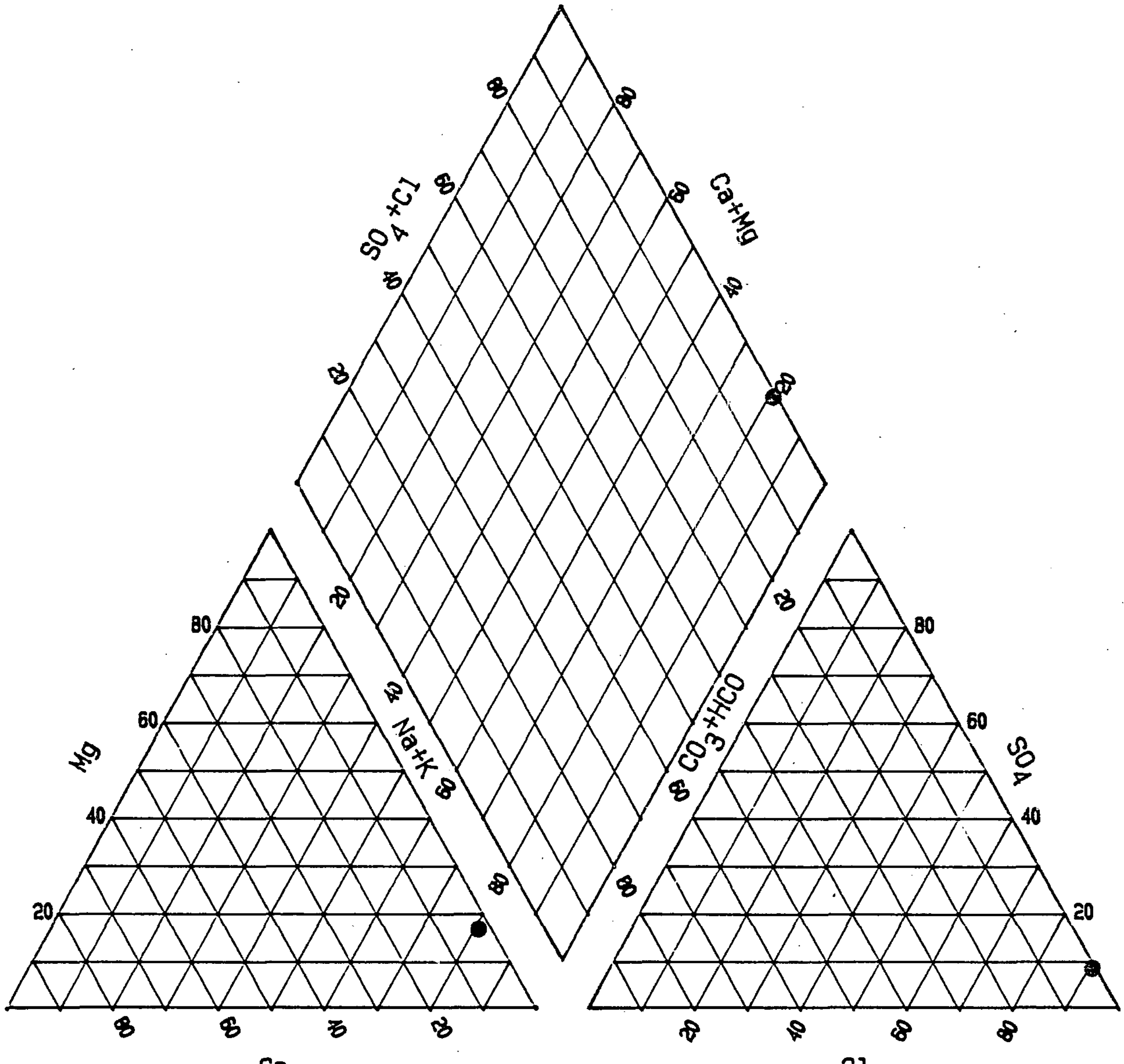
PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA	DAMES & MOORE FIGURE 3.33

CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION



SYMBOL	STATION	SAMPLING DATE
●	PACKER #7	08/20/84

CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION

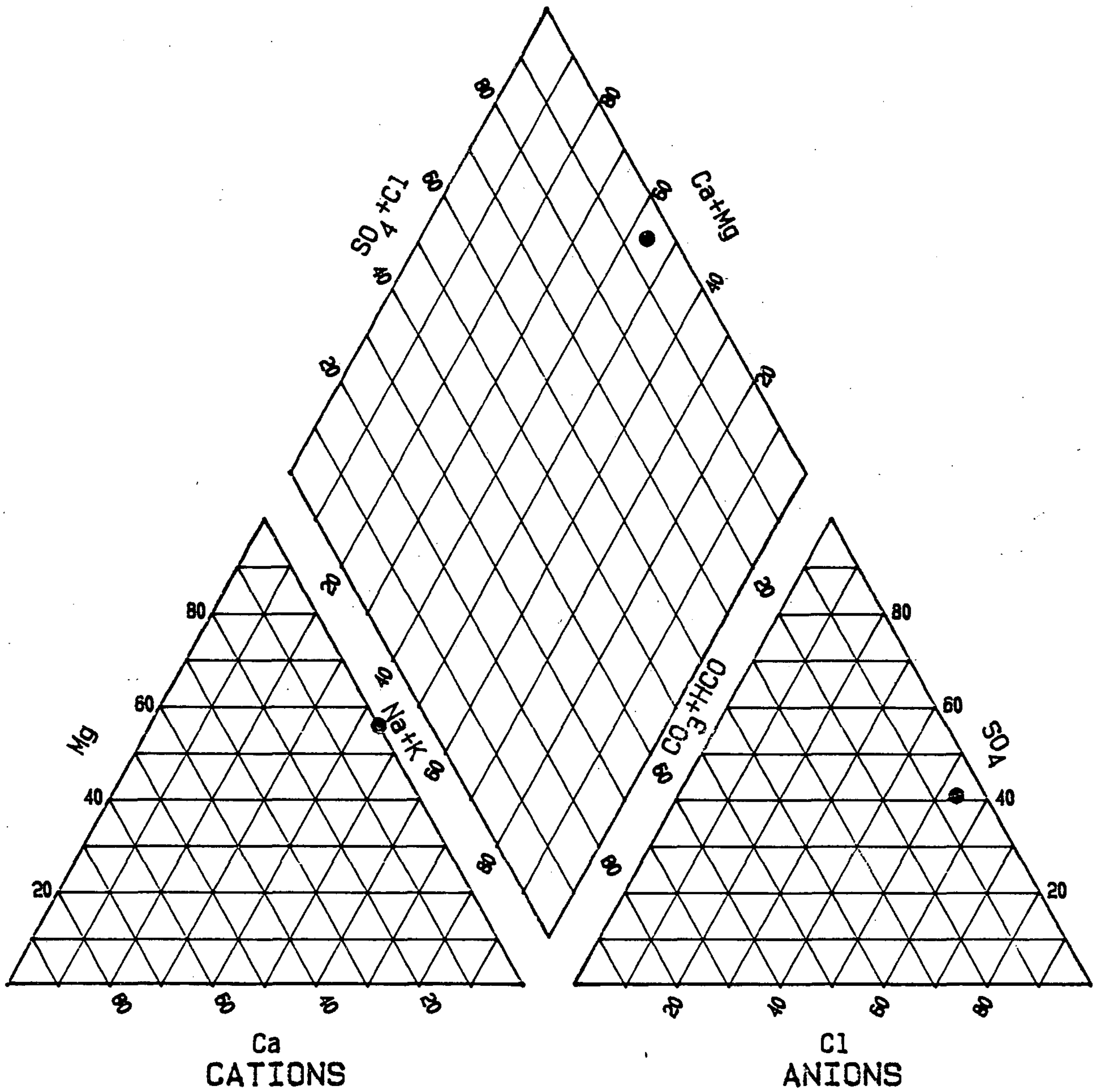


SYMBOL	STATION	SAMPLING DATE
●	PACKER #8	08/20/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL
LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.35

CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION

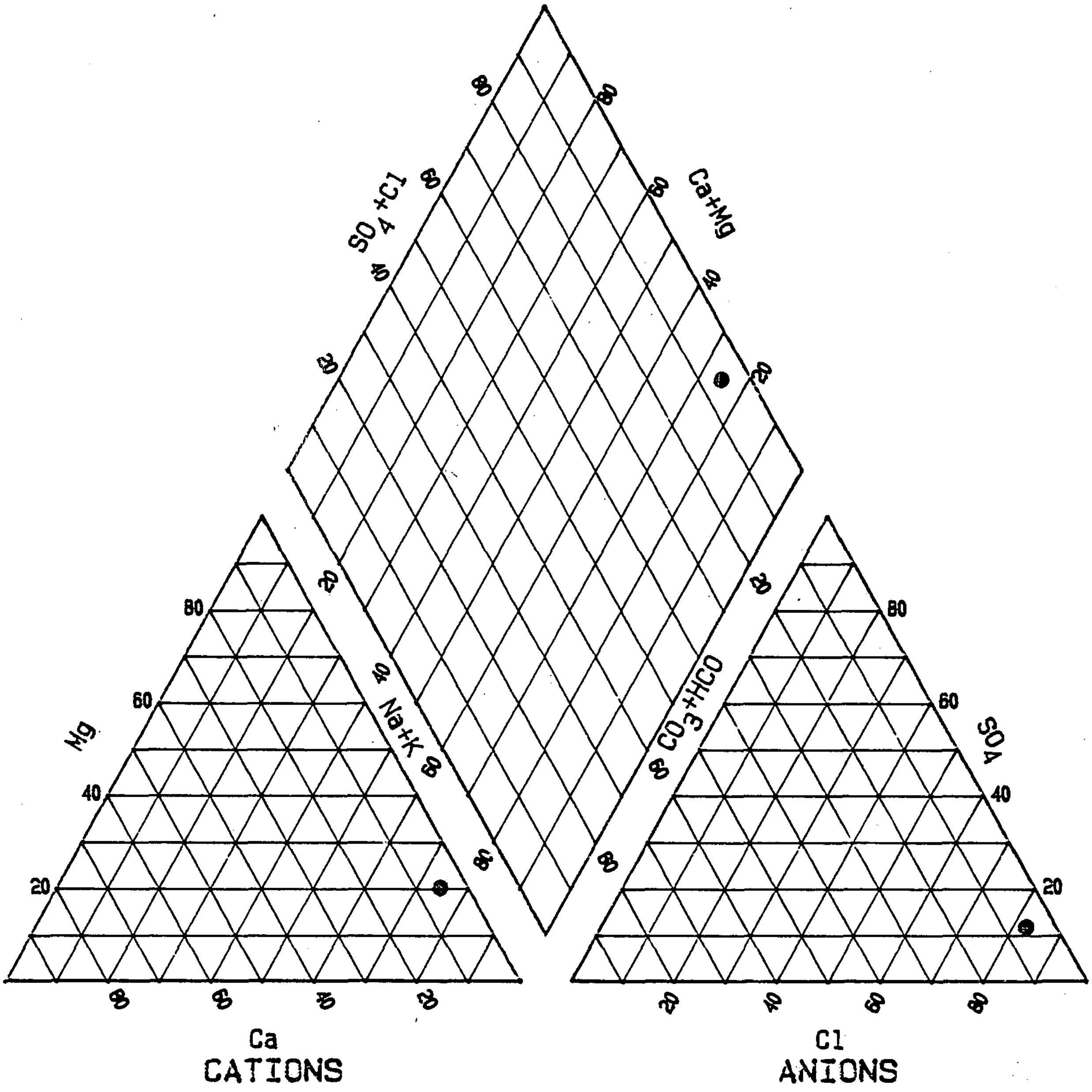


SYMBOL	STATION	SAMPLING DATE
●	PACKER #9	08/20/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL
LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.36

CHEMICAL ANALYSIS OF WATER
AS PERCENT OF TOTAL EQUIVALENTS PER MILLION



SYMBOL	STATION	SAMPLING DATE
●	PACKER #10	08/20/84

PROJECT: DEEP EXPLORATORY/TEST INJECTION WELL
LOCATION: SOUTH BEACHES, BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 3.37

4.0 WELL DESIGN AND CONSTRUCTION

Design characteristics for all wells constructed at the site were developed by Dames & Moore. Three sets of wells were constructed to comply with DER requirements.

The first group consisted of four shallow wells that were built to monitor any potential changes in the quality of the shallow water table aquifer as a result of the drilling operations near the injection well and near the mixing pond. These wells were all constructed to a depth of 20 feet. A deep (1700 feet) and a shallow (350 feet) well were constructed to monitor the possible influence of the pressure increases in the Floridan aquifer resulting from the injected fluid into the Oldsmar Limestone.Finally, the deep injection well was drilled to a total depth of 2916 feet.

Construction details of those wells are presented in Figures 4.2, 4.3, 4.4, and 4.5. Their locations are shown in Figure 4.1.

4.1 WELL INSTALLATION METHODS

The methods used for installation of the South Beaches injection well encompassed a wide variety of drilling techniques. For purposes of brevity, some nonpertinent details of the well installation process have been omitted from this section. However, should additional information regarding the drilling and installation programs be required, it would be made available from the individual daily progress reports kept on file in the offices of Dames & Moore, Brevard County Water Resources Department and DER, Orlando.

Setup of the South Beaches project began in the spring of 1984, with construction of a concrete pad large enough to contain the drill rig and related mud/drilling fluid tanks. Prior to pouring the concrete slab of the pad, a length of 48-inch diameter surface casing was installed by vibrating it down into the surficial unconsolidated sand. This casing was set to a depth of about 35 feet below present pad level. The casing was then cemented in place.

After the pad had been poured and allowed to set for a period of one week, the drill rig was brought on site and assembled. The drill rig used was manufactured by the drilling contractor, Zeni Drilling Company; it is electrically powered in all respects with the exception of the rotary turntable. The turntable is operated by a hydraulic system which is in turn powered by a large electric motor. From the standpoint of both equipment reliability and noise control, this drill rig proved to be highly acceptable. Maximum rated hook load on the drill rig is 500,000 pounds.

Drilling of the South Beaches injection well began on May 15, 1984, with a 14 3/4-inch diameter pilot hole. Mud was used in this stage of drilling as drilling fluid. Mud control was provided by Advanced Fluid Systems of Denver, Colorado.

Drilling of the pilot hole in this stage went quickly. Surficial unconsolidated sand and shells extended to a depth of 123 feet below pad level, at which point green sand and clay of the Hawthorn Formation were encountered. At a depth of 251 feet below pad level, the drill bit exited the Hawthorn clay and penetrated into the clean white limestone of the Ocala Group. The 14 3/4-inch pilot hole was drilled to a depth of 292 feet in order to ensure that clay beds were not present within the limestone.

Upon completion of this stage of drilling, the drill string was pulled from the hole and geophysical logging was conducted. Logs run on this portion of the hole included spontaneous potential, resistivity, gamma ray, and caliper.

After logging, reaming of the pilot hole to a diameter of 46 inches began, which was extended to a depth of 286 feet below pad level, or some 35 feet into the limestones of the Ocala Group. The drill string was then pulled from the hole, and the drilling contractor began installation of 40-inch diameter casing.

The 40-inch casing was installed to a depth of 274.5 feet below pad level, or 23.5 feet into the Ocala Group. Each casing joint was welded with a triple bead and inspected by Dames & Moore personnel before being lowered into the hole. When the casing was in place, a bulkhead was attached to the top of the casing string and a cement line was run through it to the approximate bottom depth of the casing. Cement was then pressure injected so as to rise up the annulus between the casing and the reamed hole. During this stage of grouting, 1358 sacks of API Class B cement were injected by Dowell Cementing Services. There was no return of cement at the surface from this grout stage.

After a 12-hour waiting period to allow the cement to cure, a tremmie line was run down the annulus and another 80 sacks of cement were injected, this time with return circulation to the surface. All cement was then allowed to set for a period of 24 hours. During this time, a flange was welded onto the 40-inch casing and a tee attached. A shutoff valve was bolted onto the tee for control of artesian flow later in the drilling process.

At this point, drilling with mud was discontinued, and all further drilling was done by the reverse air method, using formation water as the drilling fluid. Artesian flow from the well, which eventually reached several thousand gallons per minute, was discharged through a pipeline to the Indian River, with daily monitoring required for a number of water quality parameters. The concentrations of these parameters versus time are presented in Figures 4.6 through 4.9 and Table 4.1 and 4.2 in Appendix C. In addition, artesian flow was monitored every 30 feet drilled for temperature, pH, conductivity, salinity, turbidity and chlorides; water samples were taken for laboratory analysis every 90 feet drilled. The results of these analyses are presented in Appendix B.

Drilling resumed on June 21, 1984, when the cement plug in the bottom of the 40-inch casing was reamed out. Drilling of the 14 3/4-inch pilot hole then resumed. Artesian flow on the order of a few hundred gallons per minute began as soon as all cement and mud were removed from the hole, and steadily increased with depth.

Drilling of the pilot hole went very rapidly down through the Ocala Group and into the Avon Park Limestone. The Avon Park Limestone was encountered at a depth of about 402 feet below pad level. The top of the Lake City Limestone was encountered at a depth of 920 feet.

Coring operations began in early July in the lower part of the Lake City Limestone. Coring in run lengths of 20 feet began at a depth of 1510 feet. In general, 20-foot coring runs were followed by 40 feet of drilling, then another 20 feet of coring. Core recovery was generally very good in this portion of the hole. A total of eleven coring runs were made, until the rock became so highly fractured at a depth of about 2100 feet that recovery was poor and no longer worth the effort required.

Drilling and coring of the pilot hole continued into the Oldsmar Limestone (top at about 1665 feet). At a depth of 2081 feet the drill bit went into a highly fractured and solution-leached dolomite. This marked the top of the injection zone for the South Beaches well. In order to confirm that an injection zone had been reached, the pilot hole was drilled to a depth of 2218 feet. However, as a result of the extensive fracturing present in the dolomite, drilling progress in this zone was difficult since caving of the fractured rock occurred frequently.

When it was decided that a potentially good injection zone had been reached, the drill string was removed from the hole and geophysical logging of the hole commenced. The following logs were performed at this time:

1. color tv survey
2. gamma ray
3. caliper
4. long and short normal
5. fluid resistivity
6. spinner
7. temperature

In addition, water samples were taken by messenger bottle sampler from 13 zones in the well under static water conditions.

Once logging of the hole had been completed, packer testing of specific intervals within the hole began. Packer testing was accomplished . When the packers were set in place and inflated, and the water between them removed by bailing, an approximation of formation permeability could be obtained from the resulting rate of water repressurization. While the test zone was being bailed out, water samples were taken for laboratory analysis.

A total of 10 packer tests were completed, ranging in depth from 2070 feet to 1000 feet below pad level. The 10 tests were spaced so as to cover the entire thickness of sediments that might be considered potential confining beds above the injection zone.

When packer testing had been completed, all equipment was removed from the hole, and preparations began for reaming the pilot hole out to 32 inches in diameter. Reaming of the hole to 32 inches began on August 22, 1984.

Almost immediately after reaming operations began, the artesian flow from the well became very heavily loaded with fine suspended sediment, primarily finely-ground limestone. This sediment load was in excess of turbidity standards set by DER for water discharge into the Indian River, and therefore had to be reduced to acceptable levels.

Compliance with turbidity standards for discharge to the Indian River was finally achieved through a combination of methods. This included filter tanks, a mechanical seal on the well head to significantly reduce the volume of artesian flow, and the addition of coagulant and flocculating chemicalss to the flow discharge pipeline.

Once turbidity reduction efforts brought water discharge into compliance with state requirements, reaming of the hole to a diameter of 38 inches proceeded without great difficulty.

Reaming of the hole to a diameter of 38 inches was completed to the desired depth of 1710 feet on September 23, 1984. The drill string was then pulled from the hole, and a caliper log and black and white tv camera survey were run. When the logging was completed, all artesian flow from the well was stopped by injection of a brine solution into the upper portion of the hole.

As soon as the flow was stopped, the drilling contractor began placing a 32-inch diameter casing into the hole. Again, each welded joint was inspected by Dames & Moore personnel before lowering into the hole. Casing installation was delayed for a period of about one day by high winds and heavy rains of tropical storm Isadore, but resumed as soon as the storm moved out of the area.

The 32-inch diameter casing was installed to a depth of 1697 feet below pad level without further difficulty. A bulkhead was then welded on top of the casing string so that the casing could be pressurized on the inside during grouting. A grout pipeline was run down through the bulkhead to the approximate bottom of the casing string, and the first stage of cement grout was injected so as to go out the bottom of the casing and up the annulus between the casing and the wall of the 38-inch reamed hole. The grout pipeline was then removed from the hole.

After the first grout stage had set up for 20 hours, a temperature log was run inside the casing, and the second stage of grout was injected through a tremmie line placed in the annulus between the casing and the hole wall. Following a 12-hour set-up time, a temperature log was run and the third grout stage was injected by tremmie line into the annulus. After another 12-hour set-up time, a temperature log was run which was interpreted to show an anomaly or possible zone of no grout from a depth of 1310 feet up to 1250 feet. At that point, grouting operations were suspended.

After a thorough review of the details of the third grouting stage, it was concluded that the temperature anomally was due to the reaction characteristics of two different batches of cement rather than to lack of grout. Accordingly, with the concurrence of the Technical Advisory Committee, grouting of the 32-inch casing was resumed. A total of seven stages of grout were required to complete cementing for the casing string. Again, each stage was followed by a period of set-up time and a temperature log. Grouting was completed on October 13, 1984, with a total of 5587 sacks of cement. The casing was pressure tested to 100 psi after a final set-up period of 24 hours.

Drilling was then resumed using a 14 3/4-inch diameter drill bit. The pilot hole, however, had previously been drilled to a depth of 2218 feet, so it was believed that the interval from the bottom of the casing (1697 feet) to the top of the injection zone (2080 feet) could be cleaned of rubble from earlier reaming operations fairly quickly. This did not prove to be the case. Progress down to the top of the injection zone was slow, mainly as a result of lost circulation problems caused by plugging of the inside of the drill string. At the top of the injection zone (2080 feet), the drill string was pulled from the hole and logging necessary for a Volan computer analysis was conducted by Schlumberger Geophysical Services.

A 30-inch diameter reaming bit was then put on the drill string, and reaming of the hole for a 20-inch casing began. Reaming of the hole to 30 inches was completed to a depth of 2083 feet on

November 6, 1984. Installation of a 20-inch diameter casing began immediately. As before, all joints were welded with a triple bead and inspected by Dames & Moore personnel before lowering into the hole. Casing installation to a depth of 2080 feet was completed on November 14, 1984.

Immediately upon reaching the desired casing installation depth, preparations began for grouting the casing in place. Grouting was done in a manner similar to that of the 32-inch casing, with the initial grout stage injected out the bottom of the casing and subsequent stages injected into the annulus by tremmie line, with set-up periods and temperature logging between each grout stage.

A total of five grout stages and 6174 sacks of cement were required, followed by a 24-hour set-up time and a casing pressurization test. At this point, it was planned to have a cement bond log run on the 20-inch casing, but the logging contractor (Schlumberger) was not available until after Thanksgiving. Therefore, drilling operations were suspended over Thanksgiving until the Schlumberger truck arrived on site and conducted the required logging operation.

Upon completion of logging, the casing bulkhead was replaced on the 20-inch casing sealed, and the casing interior was pressurized to over 100 psi for one hour, without a loss in pressure. The bulkhead was then removed and preparations were made to resume drilling down through the injection zone. Again, it was thought that the previously-drilled pilot hole (2080-2218 feet) could be cleared of fill from earlier reaming operations without too much time loss, but this did not prove to be the case. Immediately upon drilling through the cement plug and entering the injection zone, the drilling contractor encountered severe lost circulation problems caused by large pieces of gravel becoming lodged inside the drill pipe and shutting off the upward flow of water and cuttings. Although on most occasions the blockage could be removed by surging the air line, there were some blockages that could only be removed by pulling the drill string out of the hole and physically cleaning the pipe out, piece by piece. To reduce this problem, the drilling contractor brought on site and installed a larger diameter drill string. This helped somewhat, but blockages with even larger pieces of gravel continued to occur. It was then realized that in addition to rubble filling the pilot hole from reaming operations, rubble was also falling in from the sides of the pilot hole in the zones where the rock is highly fractured. Periodically, the walls of the hole would cave, covering the drill bit and cutting off circulation. When this happened, any cuttings or gravel inside the drill stem would fall back down and bridge over, blocking circulation off even after the drill bit was lifted out of the caved rubble.

Once the drilling conditions were better understood, Zeni Drilling Company personnel built a slotted sleeve to go over the outside of the drill string. This sleeve allowed water to circulate up through the bit, but held the rubble off the bit when caving occurred. Once this device was installed, drilling went smoothly. At a depth of 2218 feet (original depth of pilot hole), the drill string was removed from the hole and an 18-inch diameter bit installed. This bit would be used to drill the open hole portion of the well to the required diameter down to the final depth.

Again, circulation problems caused by caving of fractured rock occurred, but the drillers were usually able to regain circulation by surging. In most cases, it was necessary to continuously dredge rubble from the hole until a particular zone stopped caving. It was then possible to make some forward progress until the next fractured zone began caving. Although progress was slow, it was being attained. Drilling operations were suspended for a five-day period over the Christmas holiday, and resumed on the morning of December 27, 1984.

At a depth of 2231 feet, the drill bit went into rock that was less fractured and no longer caved in. From this point on, drilling progressed smoothly without problems due to rock characteristics. Some delays occurred as a result of the air line breaking off and falling to the bottom of the drill string three times in one week. There was a 24-hour delay each time the drill string had to be pulled out of the hole and put back in.

Drilling progressed on down through hard, dense dolomite of the Oldsmar Limestone at an average rate of about two feet per hour. At a depth of 2810 feet, the bit began encountering dense anhydrite, or gypsum, indicating the top of the Cedar Keys Limestone. Drilling was extended on down to a depth of 2916 feet to be certain that the Cedar Keys Limestone had been penetrated, and the hole was ended at that depth.

Immediately upon completion of drilling, the well was developed by surging and pumping until the water being produced was clear. The drill string was then pulled out of the hole, and the contractor began set-up for the water withdrawal test.

The withdrawal, or pump-out test was conducted for a period of six hours. Pumping was by the air lift method, at a rate of 3000 gallons per minute. When the test was completed, the well was logged for temperature, flowmeter, and caliper while being pumped a second time. The well was then logged under static conditions for color tv survey.

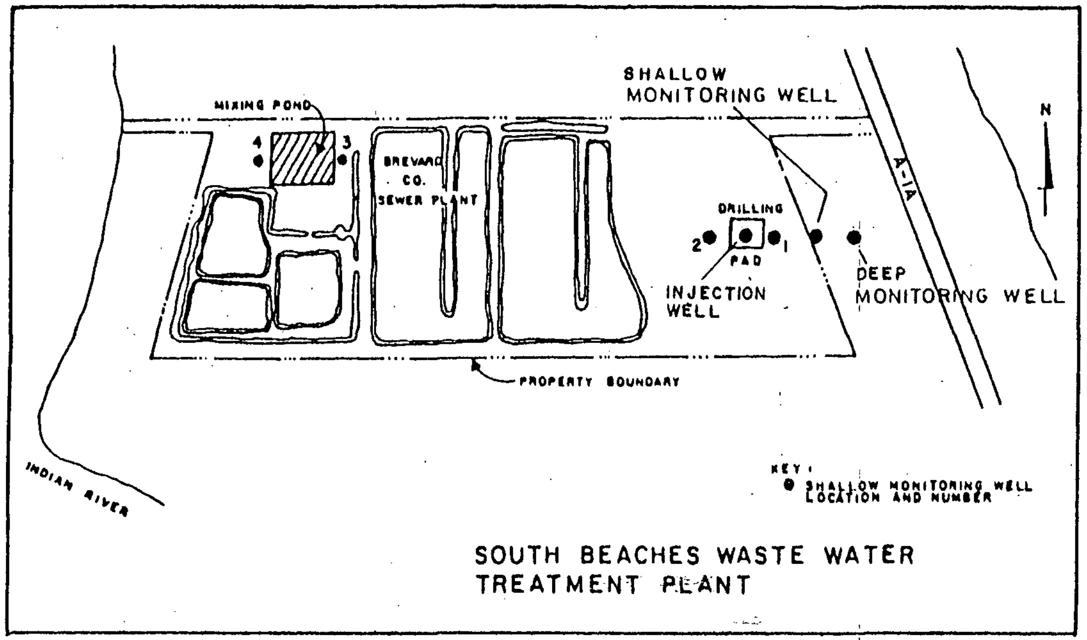
When logging was completed, all test equipment was removed from the well and a flange was welded onto the 20-inch casing. A tee and shutoff valve were then bolted on according to contract specifications. Demobilization of the drill rig by the subcontractor then began, and Dames & Moore personnel were demobilized from the site on January 20, 1985.

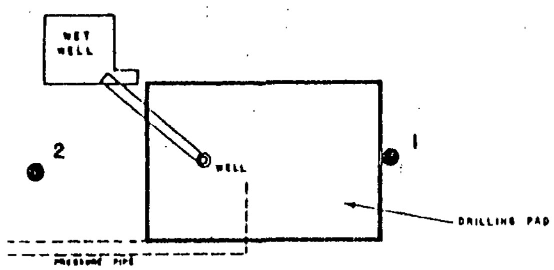
BY [signature] DATE 9/85 CHECKED ______ DATE ______ APPROVED ______ DATE ______

JOB No. 1311200226 (9/85)

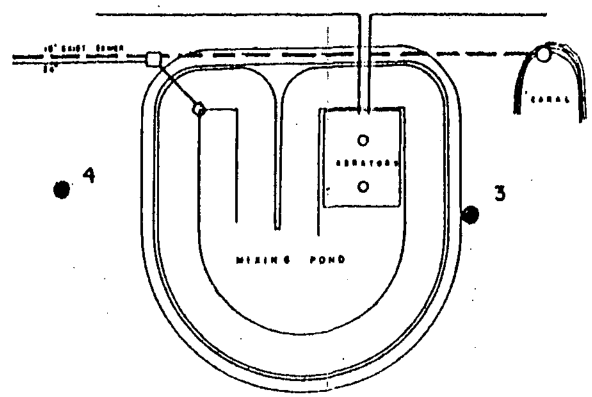
PROJECT: SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION: BREVARD COUNTY, FLORIDA

LOCATION OF INJECTION AND MONITORING WELLS



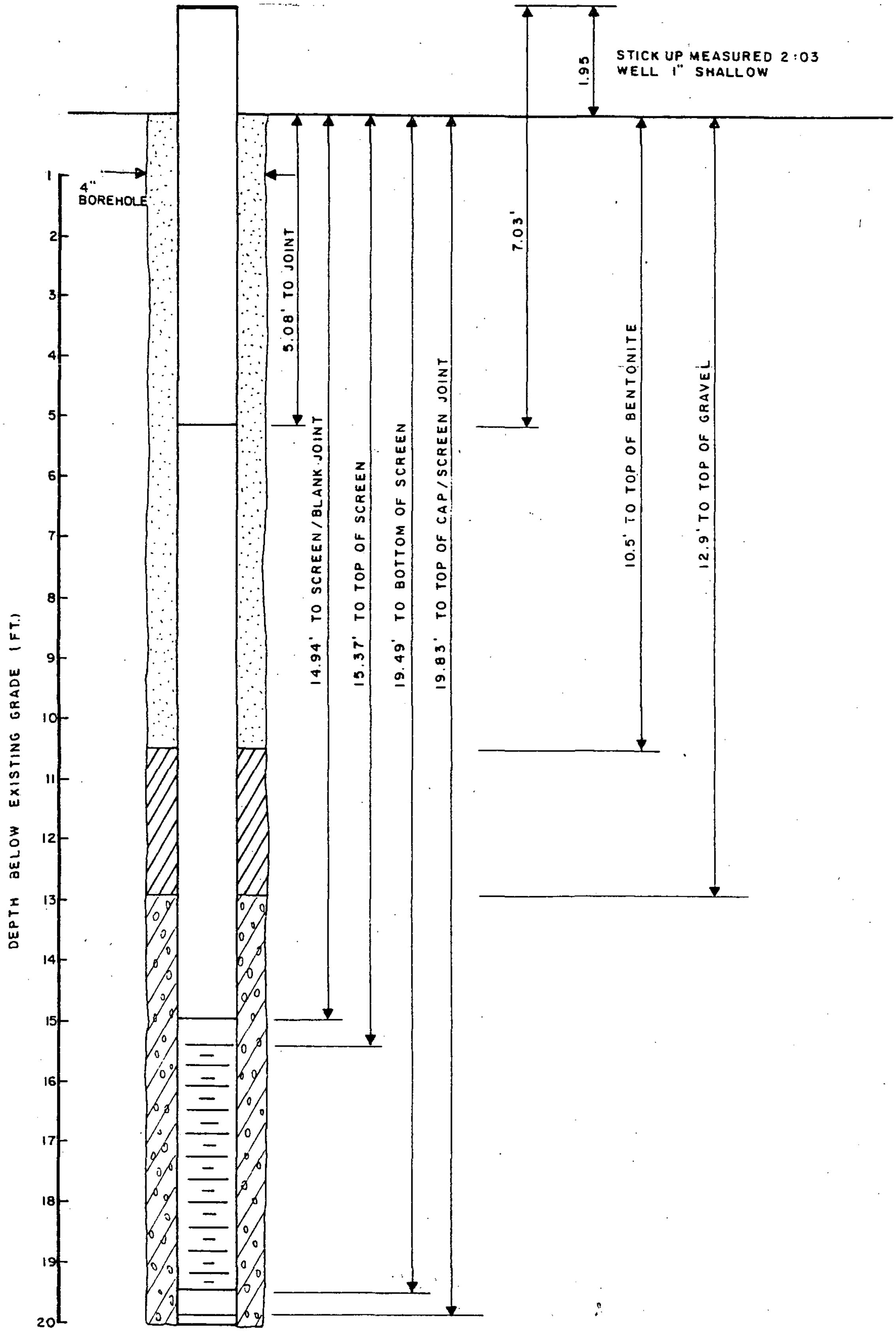


DRILLING PAD



MIXING POND

DAMES & MOORE
FIGURE 4.1



CONSTRUCTION DETAILS AS BUILT SURFICIAL AQUIFER MONITORING WELLS

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE

PLATE 4.2

JOB No. 1311200826 (9/85)

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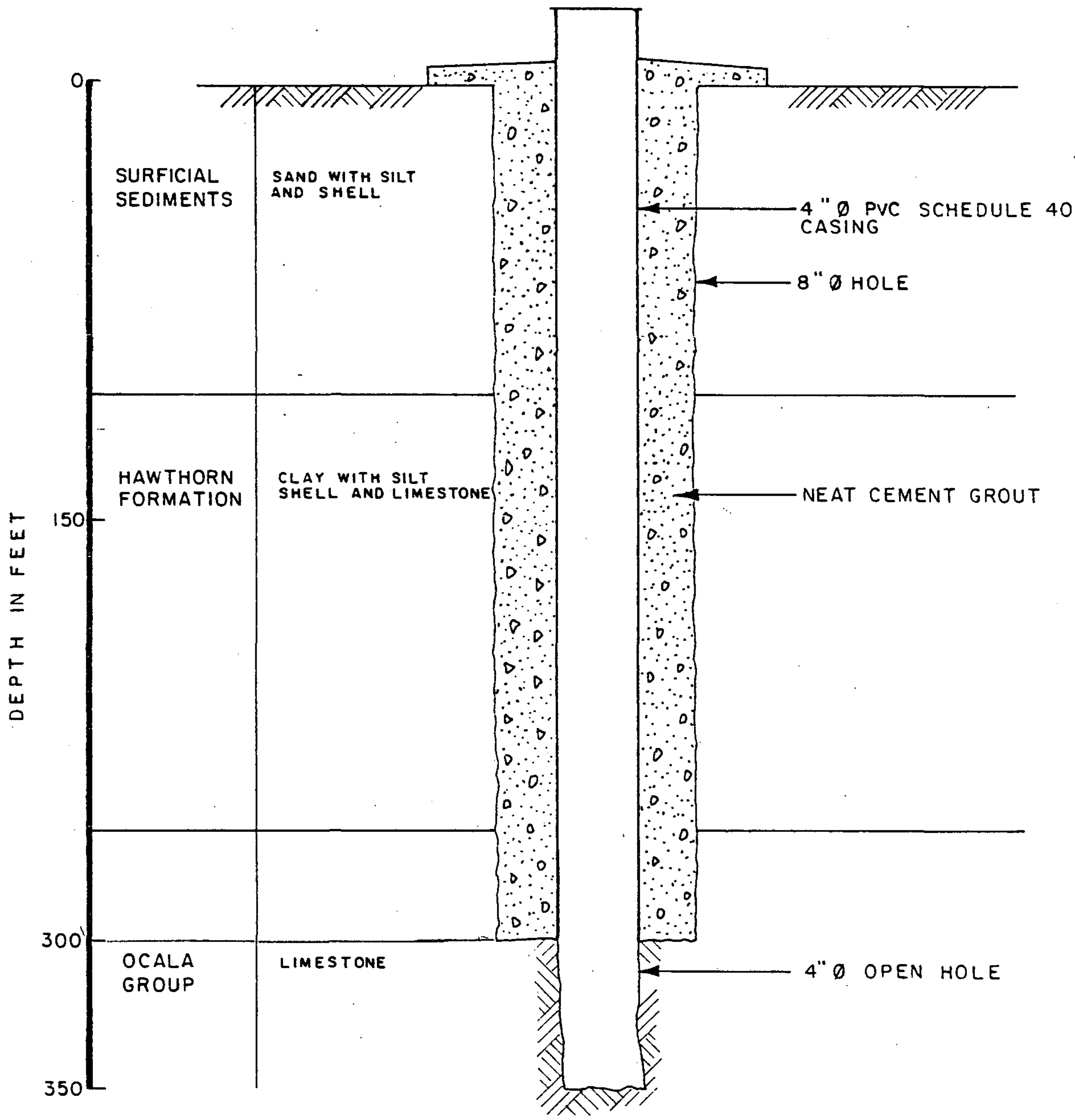

SHALLOW (350') MONITORING WELL

PROJECT: SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION: BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 4.4

JOB No. 13112009 26 (5/85)

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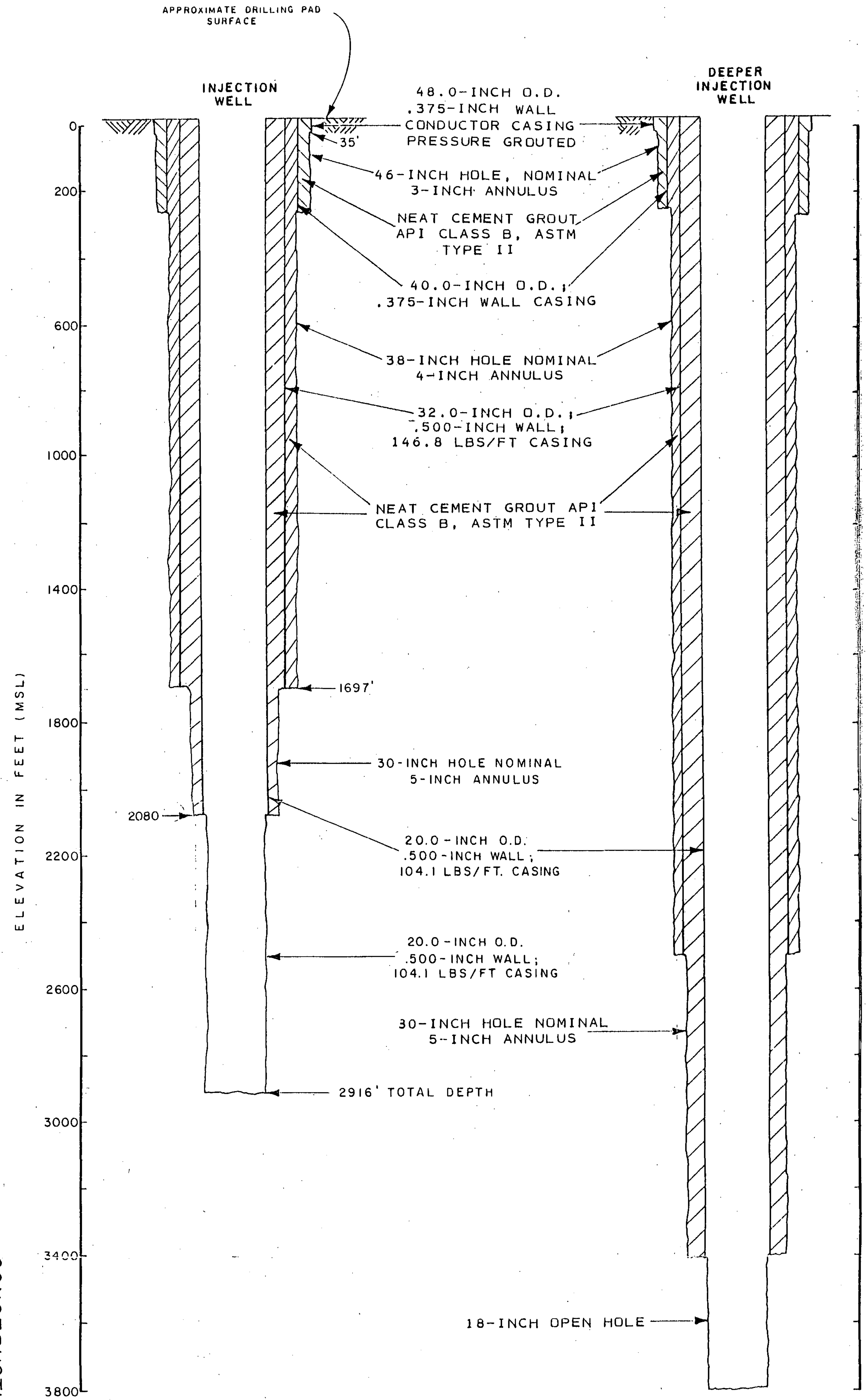
1311200226(9/85)

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION: BREVARD COUNTY, FLORIDA



CONSTRUCTION DETAILS AS BUILT INJECTION WELL

DAMES & MOORE
FIGURE 4.5

5.0 TESTING METHODS

5.1 BORE-HOLE GEOPHYSICS

5.1.1 Type of Logs

Geophysical logs were run on the exploratory well at selected intervals and at total depth. The logs acquired included; Natural Gamma Ray, Flowmeter, Caliper, Self Potential, Temperature, Fluid Resistivity, 16 inch and 64 inch normal resistivity, Dual Induction, Sonic, Compensated Neutron, Cement Bond, and a Volan. The Gamma Ray, 16 inch - 64 inch electric and Dual Induction logs proved the most useful for lithology. The Flowmeter, Caliper, Temperature, and Compensated Neutron logs were useful in determing water bearing characteristics.

5.1.2 Interpretation of Geophysical Logs

The Natural Gamma Ray log detects gamma radiation in formations adjacent to the borehole. The main application is for identification of lithology and stratigraphic correlation if the formation signatures are known. Within the exploratory well the gamma log correlated relatively well with formation lithologies. The Hawthorn Formation, which usually shows high gamma activity due to its phosphate and clay content, did not give strong responses on the log. It did, however, show more activity than the underlying Ocala, which generated characteristically low responses on a Gamma Ray log. The dolomite and dolomitic limestone within the Avon Park, from 450 feet to near 1000 feet below land surface exhibited relatively strong activity on these logs. Relatively high activity was also detected in the lower dolomite sequence of the Lake City and the glauconitic and cherty limestones of the Oldsmar. The dense and highly recrystallized dolomites in the lower part of the Oldsmar also gave high responses on the natural gamma ray log.

The 16-inch and 64-inch normal resistivity logs mesure the electrical resistivity of a volume of the earth's materials under direct application of an electric current. The responses on the logs are sensitive to changes in borehole diameter and borehole fluid resistivity. The 16-inch short normal measures the resistivity of the zone invaded by the drilling mud. The 64-inch long normal survey measures the average resistivity beyond the invaded zone. The long and short normal surveys acquired from the exploratory well correlated well with formation lithologies and water quality changes. The limestone sequence in the lower part of the Ocala group was well indurated and correspondingly showed a good response on both the 16-inch and 64-inch normal logs. This was also a major flow zone and the lateral velocity of the water may have caused the probe to become off centered with resultant high readings. The dolomitic sequence forming the lower portion of the Avon Park Limestone from 600 to 1000 feet below land surface also caused increased activity of the short and long normal logs.

An apparent water quality change from relatively low to high chloride concentrations took place at approximately 1040 feet below land surface. The logs showed correspondingly lower activity and the read out had to be adjusted at a depth of 1200 feet below land surface. From 1300 feet below land surface to the top of the boulder zone the logs showed little activity with the exception of intervals 1715 to 1720 and 1860 to 1900 feet below land surface. The presence of chert in these intervals is probably responsible for these increases in activity. The highly recrystallized dolomites encountered in the boulder zone show a marked resistivity increase.

The Dual Induction log provides all of the information that normal electric logs are capable of supplying while reducing the influence of the borehole and the surrounding formations. This log verified the 16 and 64 inch normal resistivity log and show the dense and cavernous dolomites in the lower Oldsmar from 2050 to 2700 feet below land surface.

The Caliper Log shows borehole diameter and is useful for locating cavernous zones and correcting flowmeter logs. The log indicated the presence of cavernous zones from 2083 feet to 2280 feet below land surface. Borehole diameters exceeds 32" in this zone. The televideo surveys also verified this zone as cavernous. Borehole diameter was uniform for the sequence of Oldsmar sediments above this zone to 1750 below land surface. Other cavernous zones in the well occurred from 635 to 640 feet below land surface, 400 to 500 feet below land surface, and 300 to 325 feet below land surface. These upper zones are not as significant as the Boulder zones, but did contribute a major portion of the flow to the well.

The flowmeter log measures the relative rate of vertical flow within the borehole. To accurately assess the flow contributions from individual zones within a well this log needs to be corrected for borehole diameter. The flowmeter log shows a large portion of water entering the borehole from 292 to 680 feet below land surface. A lower zone from 2083 to 2520 feet below land surface also showed significant contributions on the flowmeter when corrected for borehole diameter. No other significant flow zones were identified by the flowmeter log.

Temperature logs give a record of borehole fluid temperature with depth. They can be used in combination with other logs to identify flow zones. Abrupt temperature changes took place in the exploration well at depths of 600 to 700 feet, 1200 to 1300 feet and 2520 to 2560 feet below land surface. The temperature varied from 81^{o}F at the top of casing to 90^{o}3"F at a depth of 2915 feet below land surface.

The Neutron Porosity survey measures the effect of the borehole environment on introduced neutrons. The neutron probe directly measures hydrogen saturation within the formation pore spaces. A cavity will attenuate a neutron response. The survey run on the exploration hole showed dense dolomite and cavities from 2000 feet to 2600 feet below land surface.

Of all the geophysical tests conducted the Volan, which was required by the Technical Advisory Committee, was the least informative and the most expensive. This test yielded very unreliable and inconsistent results and from all indications it appears to have been of little value in this deep well injection study.

5.2 PERMEABILITY TESTING

Eleven drill-stem tests (DST) were performed in conjunction with laboratory permeability testing of six core samples to assess the variation of permeability at various depth intervals.

Lynes Inc. from Oklahoma City, Oklahoma, provided all equipment and personnel to conduct the DST. Professional Service Laboratories, Inc., Florida Testing Division from Clearwater, Florida, provided the necessary services for laboratory testing of the core samples.

DST was conducted during the period August 8 to August 17, 1984; whereas laboratory permeability testing took place during late September, 1984.

5.2.1 Testing Tools and Techniques

A brief description of the tools and techniques utilized during the permeability testing program is herein provided to assist the reader in understanding the results of the program.

5.2.1.1 Drill-stem testing

The geometry of the testing tool and the way it is operated once inside the bore-hole are shown in Figures 5.1a and 5.1b. The test tool is assembled in the field using spacing rods to properly place the packers above and below the zone or formation to be tested. Once the string has been run to the setting depth, the downhole DST pump is operated to inflate both packers simultaneously. The pump automatically by-passes when the packers are fully inflated. Picking up on the drill pipe will show an increase on the weight indicator, ensuring that the packers are inflated and set.

When setting of the packers has been achieved, setting weight on the tool opens the hydraulic shut-in valve which allows the formation fluid to flow into the drill pipe and the flow test begins. To measure the pressure buildup due to the flowing fluid, the hydraulic shut-in periods are possible in this manner. Since the packers are anchored directly to the well bore, they are not dependent on drill pipe load. The drill pipe weight can be shifted to open and close the tool without affecting the packers seal.

When the test is complete, the differential pressure across the packers is allowed to equilize. The packers are then deflated by picking up on the drill pipe after equalization is achieved. Once the packers are free, the string can be retrieved or repositioned for further testing.

The data obtained from the DSTs were analyzed according to the following equation:

✓ k = [2.30 Qu/(4 HP)] log [(tp+ t)/(t)]

Where: k = Permeability, ft/min.
Q = Discharge, cubic ft/min.
u = Kinematic viscosity of water, lb.xsec/ft.sq.

H = Water column, ft.
P = Pressure difference, ft.
tp = Flowing time with stable psi prior to openning tool, min.
p = Duration of tool oipenning, min.

5.2.1.2 Laboratory Testing

Testing of the core samples was conducted to estimate the vertical permeability of selected intervals of the formations encountered. Vertical permeability testing of samples at back pressures of up to 700 psi was performed following procedures outlined in ASTM D2434 for permeabilities at atmospheric pressures.

Figure 5.2 illustrates the testing apparatus. Distilled,de-aired water was used for the fluid, and bottled compressed nitrogen was used to pressurize the system. It was assumed that the reservoirs above and below the sample were large enough to maintain a constant head, h, at which the sample is tested.

Calculations of permeability were based on the following equation:

$$K = QL/(Ath)$$

Where: k = Permeability, cm/sec.
Q = Total flow, ml.
L = Thickness of sample, cm.
A = Cross-sectional area, cm. sq.
t = Time, seconds
h = Head, cm.

5.2.1.3 Pumping Tests

Two pumping test were conducted to assess the hydraulic characteristics of the injection zone by setting the 32-inch diameter casing from the ground surface to a depth of 2050 feet. The first test consisted of pumping an average of 3200 gpm, with a standard deviation of 40 gpm, for a period of 6 hours; whereas, during the second test average pumpage was 3100 gpm, with a standard deviation of 46 gpm, for a period of 45 minutes. Recovery tests were conducted in both cases, after pumping had stopped.

5.2.2 Results of Testing

The following is a description of the results of permeability testing from each of the above methods.

5.2.2.1 Results of Drill-Stem Testing

The zones tested and the results obtained are tabulated below:

Depth Interval (feet)	K (ft/min)	K (cm/sec)
1920-2070	3.65E-04	1.85E-04
1880-1980	6.26E-04	3.18E-04
1785-1885	3.66E-05	1.86E-05
1690-1790	1.85E-05	9.50E-06
1605-1705	1.62E-03	8.21E-04
1500-1600	2.06E-04	1.04E-04
1405-1505	2.92E-04	1.48E-04
1253-1353	3.22E-03	1.64E-03
1155-1255	2.71E-03	1.37E-03
1000-1100	8.80E-03	4.50E-03

5.2.2.2 Results of laboratory Testing

The results from laboratory testing of vertical permeability from the six core samples are as follows:

SAMPLE No.	DEPTH (ft)	BACK PRESSURE (psi)	VERTICAL PERMEABILITY (k) (ft/min)	(cm/sec)
1	1547	350	4.93E-05	2.50E-05
2	1627	370	4.14E-06	2.10E-06
3	1736	400	1.58E-06	8.00E-05
4	1890	428	3.94E-06	2.00E-06
5	1953	450	4.14E-06	2.10E-06
6	2069	475	5.52E-06	2.80E-06

5.2.2.3 Results of Pumping Tests

Drawdowns obtained during the tests were as follows:

Pumping Rate (gpm)	Length of Pumping (min)	Total Drawdown (ft)
3200	360	3.0
3100	45	1.1

The above values yield specific capacities of 2,818 gpm/ft and 1,067 gpm/ft after periods of 45 minutes and 6 hours, respectively. These data also yield a value of approximately 550,000 gpd/ft for the Transmissivity of the injection zone. The Storage Coefficient, however could not be calculated since no observation wells were available during the test. Nevertheless, using Cooper & Jacob's approximation (1946) an estimate for the storage coefficient of 0.00066 is obtained for a time of 6 hours.

5.2.3 Significance of Permeability Data

Drill-stem testing provided horizontal permeabilities for several depth intervals between 1000 and 2070 feet below ground surface. These results indicate a marked permeability decrease from 10^{-3} to 10^{-4} cm/sec at a depth of about 1400 feet. This decrease occurs at a depth of about 150 feet below the zone where 10,000 mg/l TDS concentration occur. Another zone of high permeability occurs between 1600 and 1700 feet only to decrease again to levels of 10^{-5} - 10^{-6} at the top of the confining beds. Finally, permeability increases again near the bottom of these beds.

Generally, the horizontal permeability of sediments such as those making up the confining zone at the injection well site is usually higher than the vertical permeability by a factor that could be as high as one or two orders of magnitude when no fractures or solution cavities are present. Based on results of drill-stem testing the vertical permeability of the confining zone is sufficiently low to effectively preclude a upward migration of injected waste waters into the lower sections of the Floridan Aquifer System.

Laboratory testing corroborated the decrease in permeability with depth and confirmed the existence of a zone of confinement extending between 1600 and 2069 feet of depth. This depth interval corresponds to the confining zone already identified in this study.

The data from the pumping tests is indicative that the zone selected for injection possesses the necessary highly transmissive nature to accept the projected maximum amounts of waste waters. Although the longest pumping test was only conducted for a duration of 6 hours, it showed clearly that a value of the transmissivity of at least 550,000 gpd/ft is obtained.

The injection zone extends from 2080 feet to 2916 feet below ground. This results in an injection thickness of 836 feet. However, the effective reservoir thickness of the zone is considered between 400 and 500 feet since several intercalated layers of low permeability are present. Therefore, taking the value of transmissivity of 550,000 gpd/ft and an effective reservoir thickness of 500 feet, a value of permeability of about 145 ft/day results. Considering the cavernous nature of the Boulder Zone of the Oldsmar Limestone, such a high value was not unexpected.

5.3 INJECTION TESTING

Injection testing was performed to evaluate whether the injection zone could to accept the projected effluent rates. Maximum projected disposal rates are 9 MGD. The test was also designed to predict the injection pressures needed for permanent operating conditions.

5.3.1 Testing Methodology

Injection testing started on June 18, 1985. Pre-test water levels in the monitoring wells and ambient wellhead and bottom-hole pressures in the injection well were recorded since

June 8, 1985. These records are presented in Figures 5.3, 5.4, 5.5, and 5.6.

The injection test started at 8:36 a.m. on June 18, continued through June 28, and was stopped approximately 9:12 a.m., the same day. Additional readings were obtained at the end of the test to observe the behavior of the injection zone after the test was completed.

Water for the test was withdrawn from the Indian River and was injected according to the following schedule:

- 5000 gpm for about 10 minutes;
- 4000 gpm for a period of 4 hours; and
- 6250 gpm for the remainder of the test.

Water from the Indian River was conveyed through a 24-inch diameter pipe to a previously constructed "wet well". Within this wet well a divider was constructed to allow for the water to settle some of its sediment load. The overflow that passed above the dividing wall into the other half of the wet well was pumped into the injection well by a pump capable of discharging 6250 gpm at a total maximum hydraulic head of 200 feet.

Flow meters having an accuracy of about five percent were installed between the wet well and the injection well and between the Indian River and the wet well. A throttling valve was installed on the injection well discharge line. Continuously recording pressure gauges were installed at the wellhead and a depth of 2080 feet in the injection well.

Water levels in the monitoring wells were continuously recorded by pressure transducers located at least 20 feet below the top of the initial water level in the wells.

5.3.2 Pre-Test Conditions

These records show ambient values for the wellhead and bottom-hole pressures that range between 13.6 and 14.5 psia and between 943.6 and 944.2 psia respectively. Therefore, for simplicity, values of 14 psia for ambient wellhead pressure and of 944 psia for ambient bottom-hole pressure are used in this report.

5.3.3 Analysis of Injection Test Data

Analysis of the pressure data versus time results in a transmissivity value of about 1,000,000 mgd/ft. This value is almost twice as high as the value obtained during the pumping test. However, the larger duration injection test generated results that are considered more representative of the actual hydraulic characteristics.

The following equation was utilized to evaluate the amount of distance that the waste-water front may travel with time:

$$r = \sqrt{v/(\pi \, b \, \phi)} \qquad \text{(Warner and Lehr, 1977)}$$

where:

r = radial distance of wastewater front from well.

v = as mulative volume of injected wastewater through time.

b = effective reservoir thickness

ϕ = average effective porosity.

If dispersion is considered, the actual distance traveled becomes:

$$r^1 = r + 2.3 \sqrt{Dxr}$$

r^1 = actual distance traveled by the wastewater from the well.

D = dispersion (= 65 feet for limestone, Warner and Lehr, 1977).

Figure 5.7 illustrates the results of the application of the above formulations. Notice that in the figure the volumes represent cummulative values and assumes that 9 mgd will be injected daily (9 mgd = 440 mg/year).

The testing results have confirmed that the injection zone can easily accept the projected amounts of wastewater and that no connection exists between the injection zone (Boulder Zones) and the lower Floridan Aquifer System.

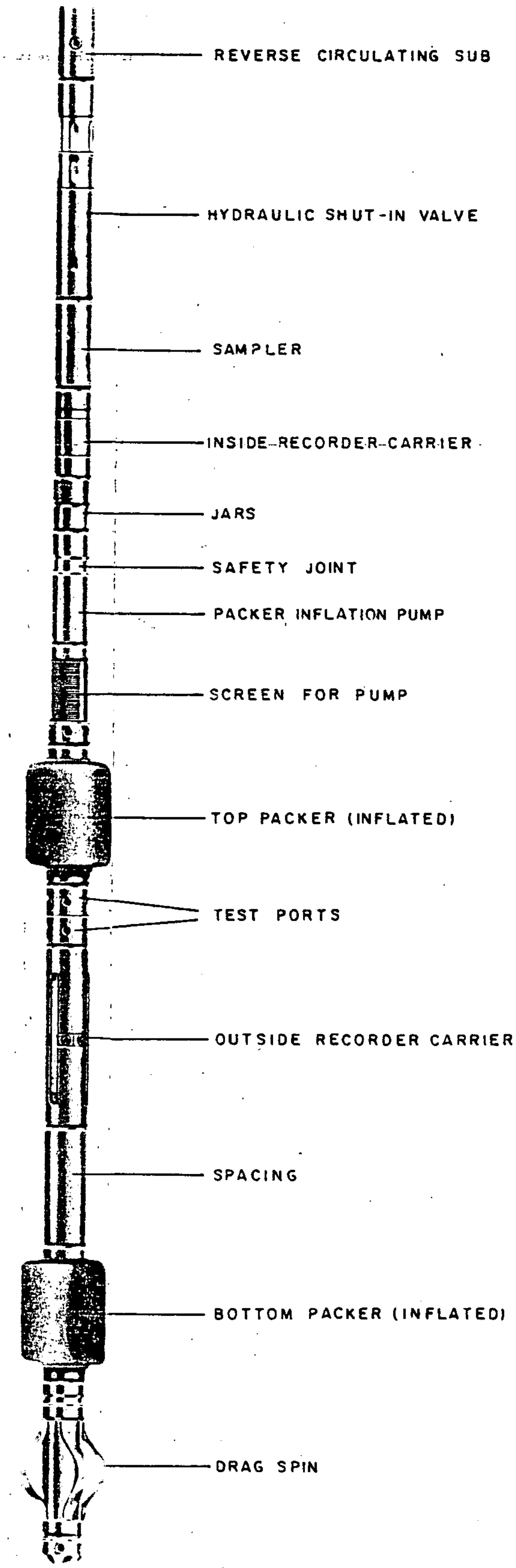
5.3.3.1 Bore-Hole Pressures

As shown in Figures 5.5 and 5.6, pressure increases during injection, ranged between 13 psia at the wellhead and up to 3 psia at a pressure gauges setting of 2080 feet. The small pressure increases recorded during the injection zone confirms the very high injection potential exhibited by within the "Boulder Zone" of the Oldsmar Formation. The 13 psia pressure increase recorded at the wellhead, also evidences the small operating pressures that are required to inject 9 mgd (6250 gpm) of effluent at this location.

5.3.3.2 Water Levels Monitoring

Water levels recorded in both the shallow (350 feet) and the deep (1700 feet) wells are presented in Figures 5.3 and 5.4. The level in the shallow well varied from about 10 feet to 15 above ~~below~~ ground surface throughout the recording period. Daily fluctuations were on the order of 1.5 feet and the record shows that the water levels were directly affected by daily tidal variations and barometric changes and by lunar cycles. The same phenomena were observed at the deep monitoring well. The fluctuations throughout the monitoring record were from 2 to 4.4 feet and of 0.5 to 1 foot on a daily basis.

Neither well showed any variation that could be correlated with the injection of Indian River water into the Oldsmar Formation. Consequently, the injection test has proven that good confinement exists between the lower Floridan Aquifer and the injection zone within the Oldsmar Formation.



DRILL-STEM TESTING
APPARATUS

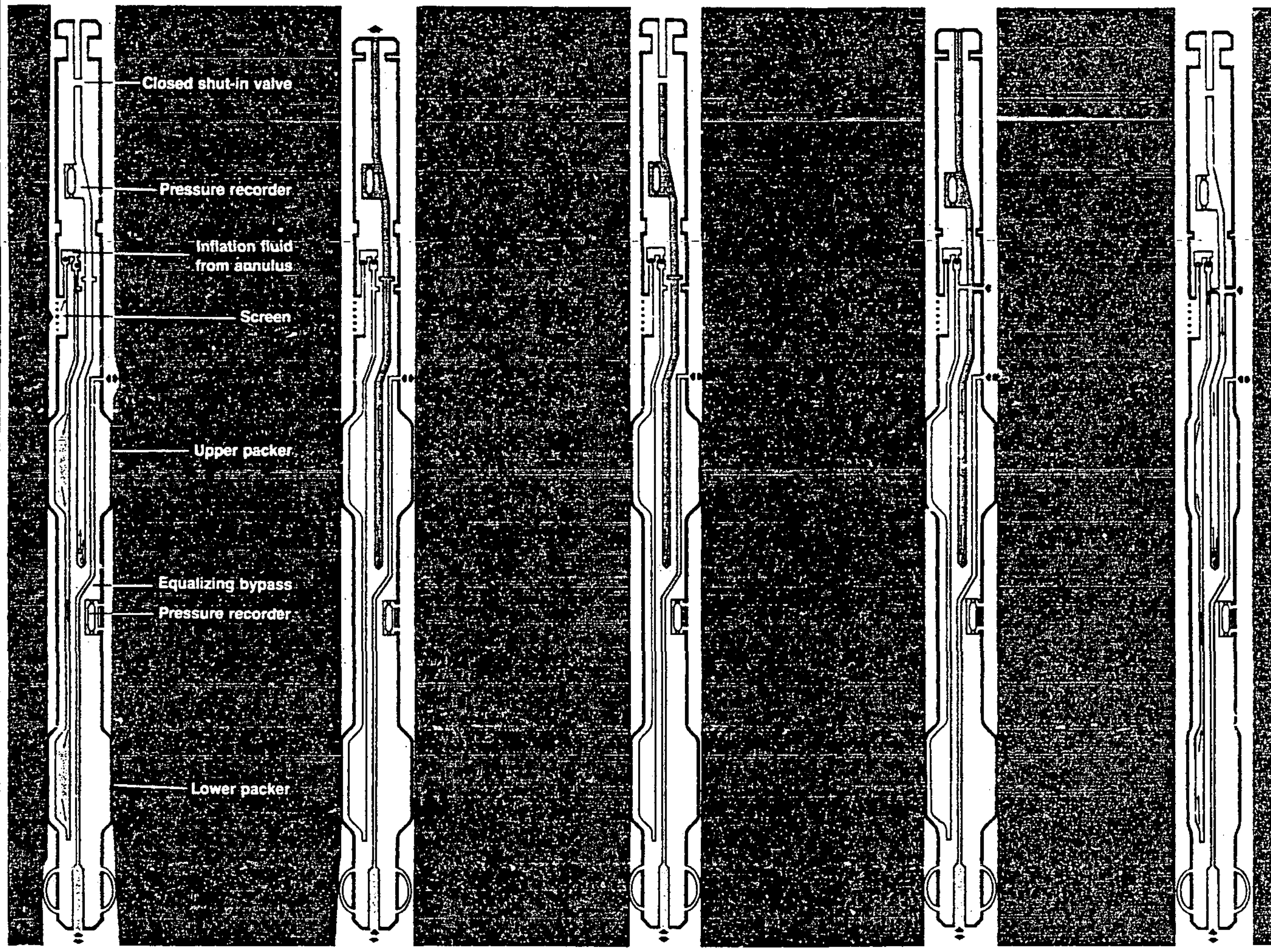
JOB No. 13112002 26 (9/85)

BY ______ DATE 9/85 CHECKED ______ DATE ______ APPROVED ______ DATE ______

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE
FIGURE 5.1a

Running the Inflatable Drill-Stem Test Tool



DRILL-STEM TESTING APPARATUS

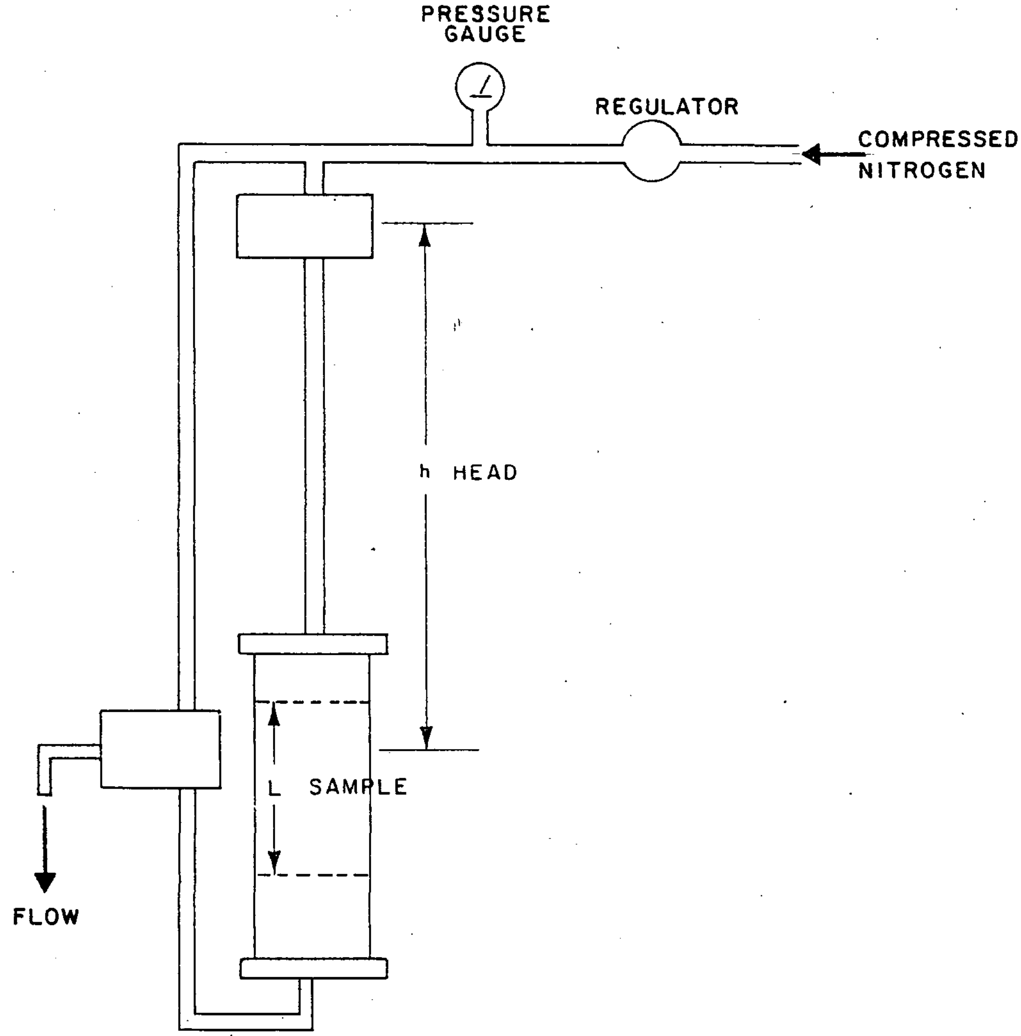
PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE

FIGURE 5.1b

JOB No. 13112002 26 (9/85)

BY [signature] DATE 9/85 CHECKED ___ DATE ___ APPROVED ___ DATE ___

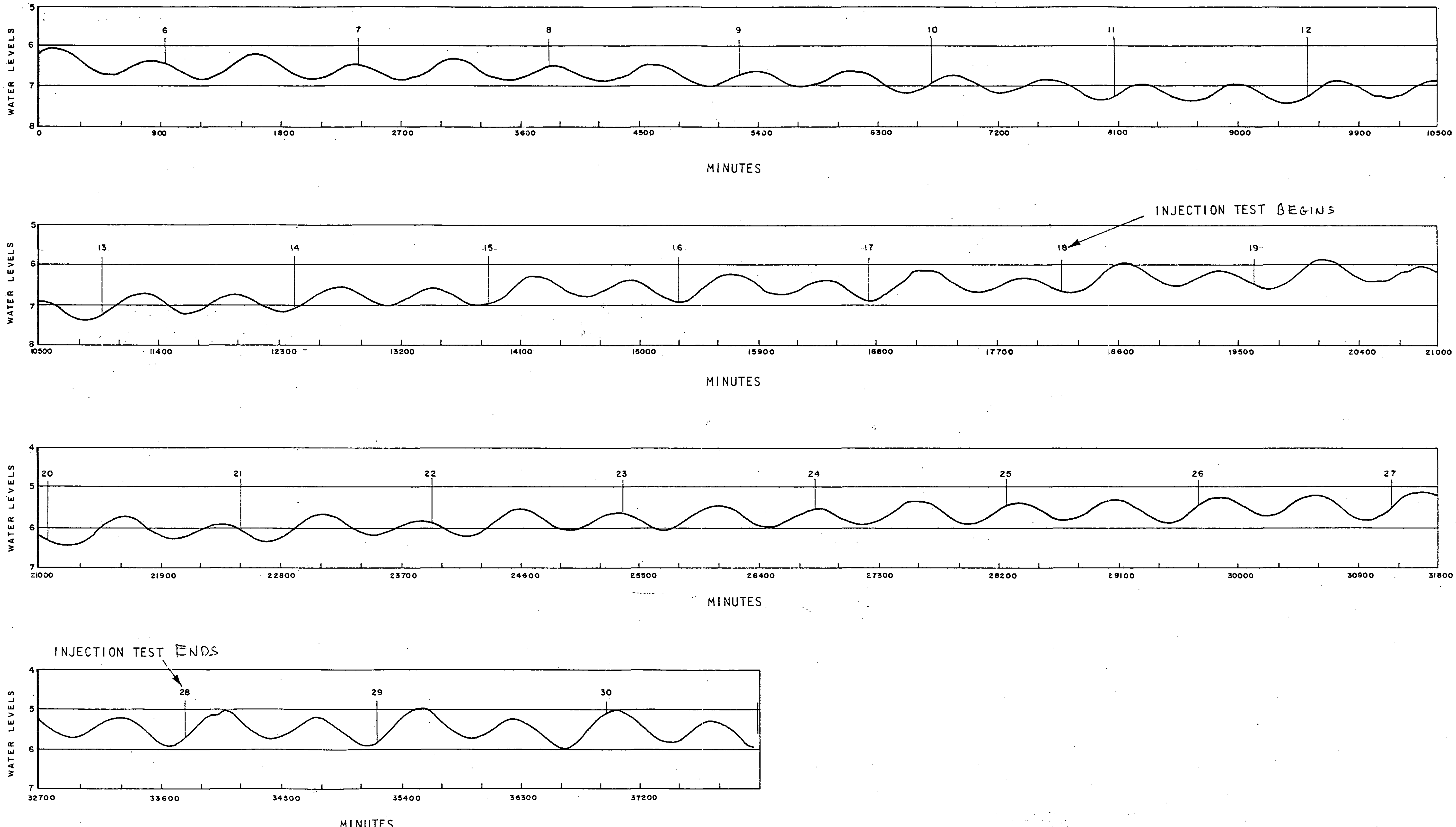


PERMEAMETER FOR TESTING
UNDER BACK PRESSURE

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL LOCATION : BREVARD COUNTY, FLORIDA	DAMES & MOORE PLATE 5.2

JOB No. 13112008 26 (9/85)

BY [signature] DATE 9/85 CHECKED DATE APPROVED DATE



TOP OF CASING AT 3 FEET ABOVE GRADE

DEEP OBSERVATION WELL

WATER LEVEL MEASUREMENTS

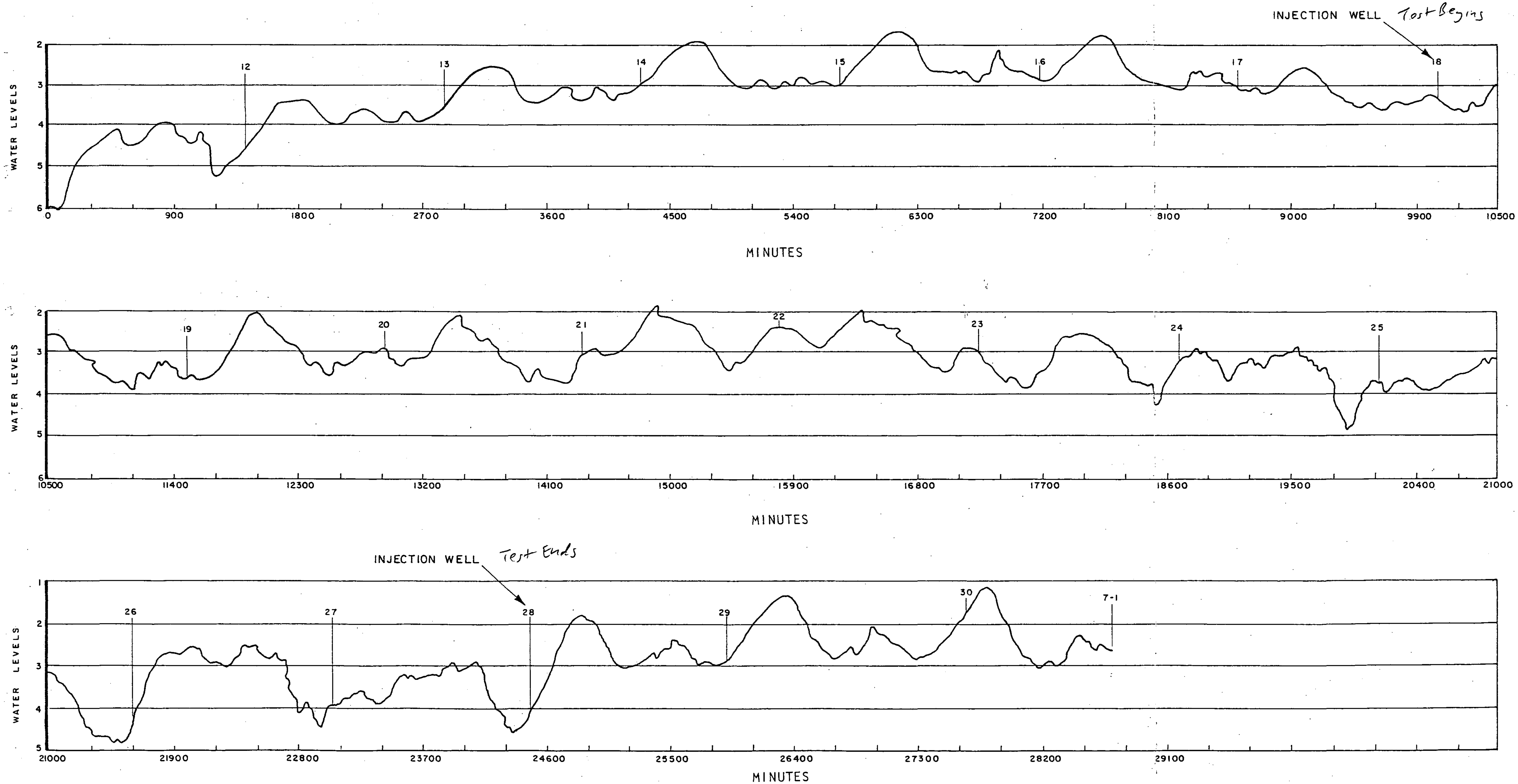
PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE

FIGURE 5.3

131200926(9/85)

BY — DATE — CHECKED — DATE — APPROVED — DATE — REVISION — DATE



TOP OF CASING AT 16.25 FEET ABOVE GRADE

SHALLOW OBSERVATION WELL

WATER LEVEL MEASUREMENTS

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

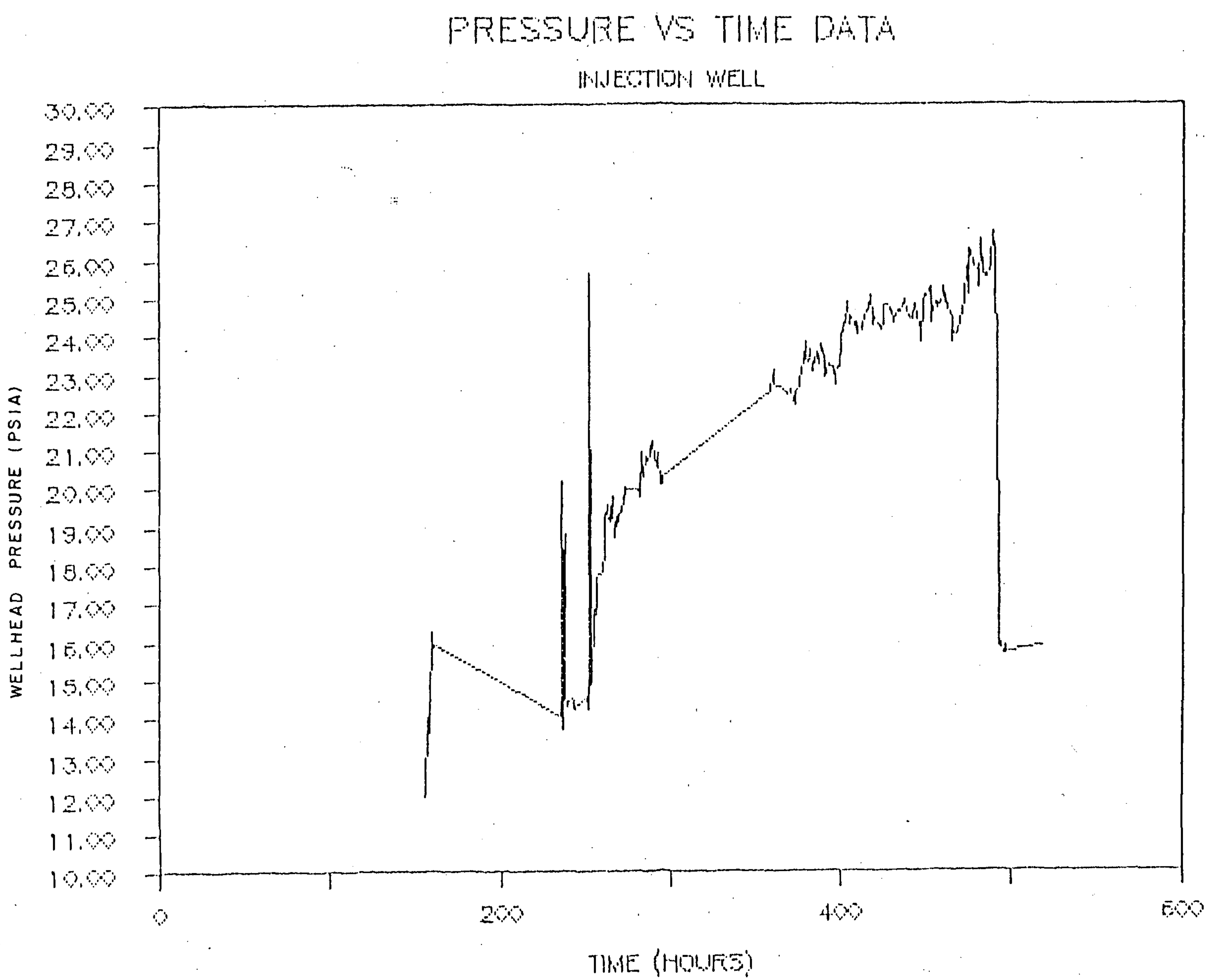
DAMES & MOORE
FIGURE 5.4

13112009 26(9/85)

BY DATE CHECKED DATE APPROVED DATE REVISION DATE

BY [signature] DATE 9/25 CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)



PROJECT: SOUTH BEACH EXPLORATORY TEST WELL
LOCATION: BREVARD COUNTY, FLORIDA

PRESSURE VS. TIME DATA

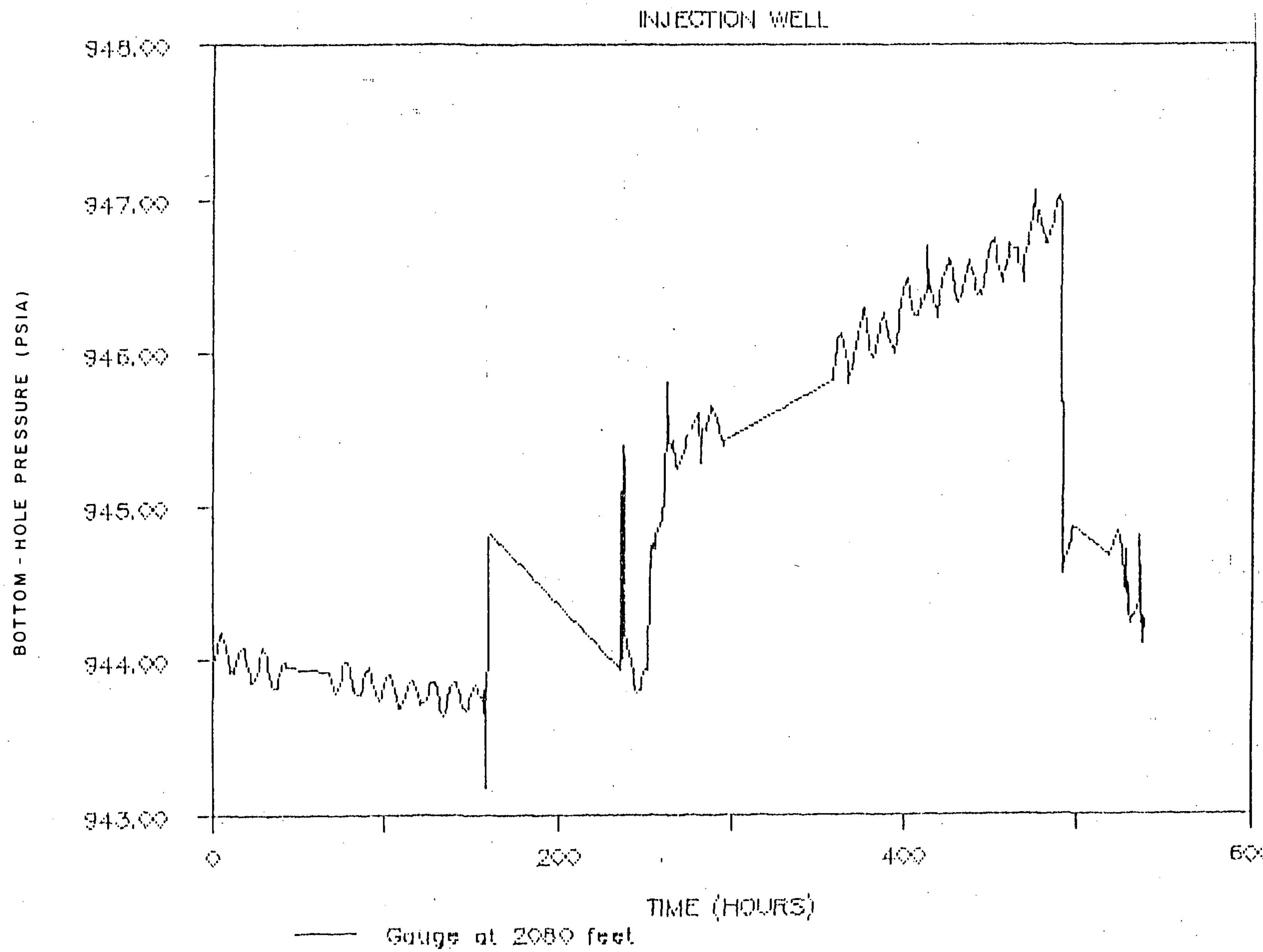
DAMES & MOORE
FIGURE 5.5

BY [signature] DATE 9/85 CHECKED ________ DATE ________ APPROVED ________ DATE ________

JOB No. 1311200926 (9/85)

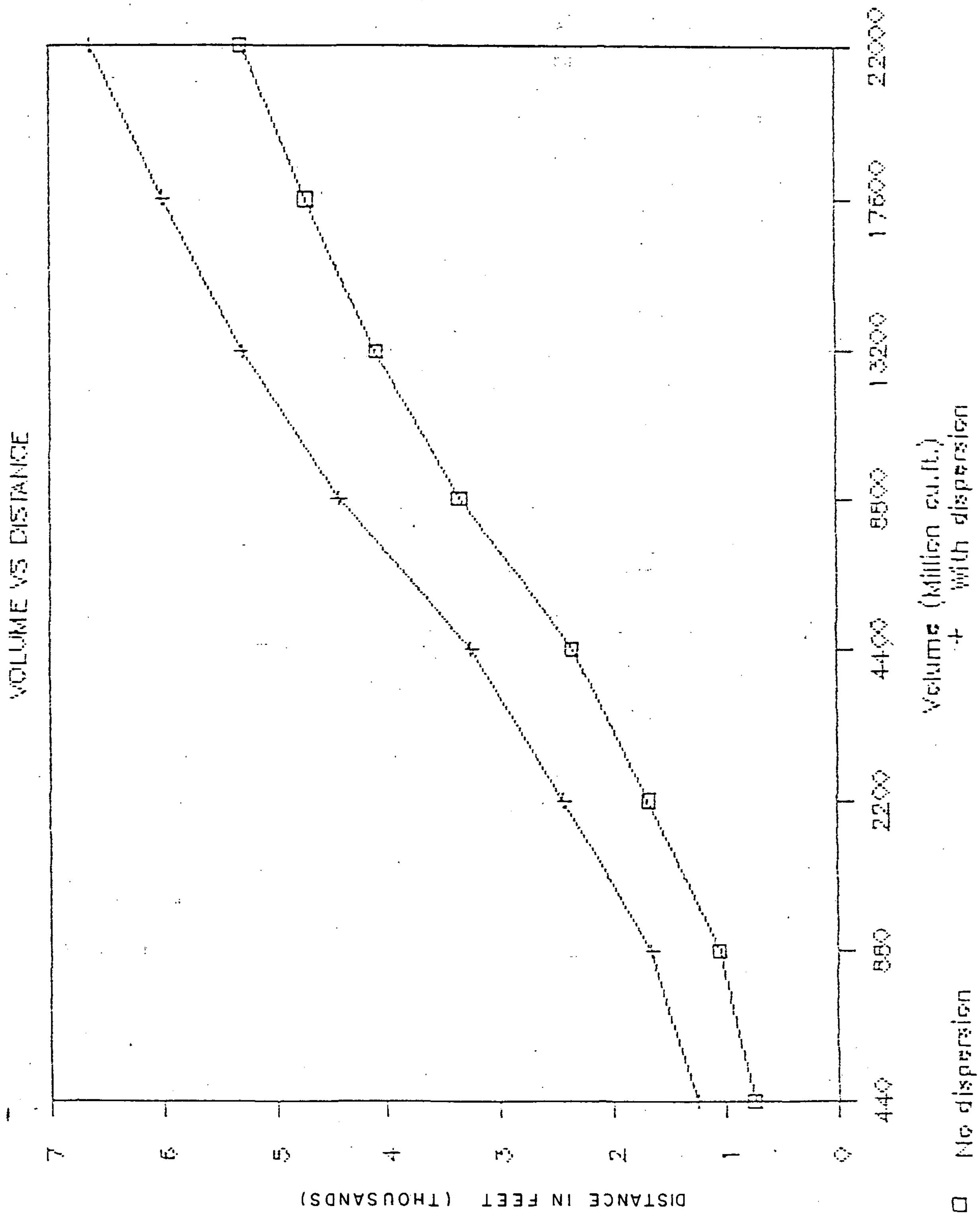
PROJECT: SOUTH BEACH EXPLORATORY TEST WELL
LOCATION: BREVARD COUNTY, FLORIDA

PRESSURE VS. TIME DATA



DAMES & MOORE

FIGURE 5.6



RATE OF WASTE-WATER MOVEMENT

PROJECT : SOUTH BEACH EXPLORATORY TEST WELL LOCATION : BREVARD COUNTY, FLORIDA	DAMES & MOORE FIGURE 5.7

JOB No. 13112 00926 (9/85)   BY ______ DATE 9/25   CHECKED ______ DATE ______   APPROVED ______ DATE ______

6.0 AREA OF REVIEW

To conform with FAC 17-28.13(4), Brevard County identified and presented a the TAC meeting of December 8, 1982, a 2000 foot radius Area of Review. By the end of that same month, the water Resource Department of Brevard County completed a well inventory which identified approximately 51 wells within 2000 feet of the injection well site. The deepest well depth reported was 325 feet. It was established that no injection wells, dry holes, springs, mines or quarries exist in the vicinity of the area of review.

for op pmt increase to 1 mile radius

7.0 CONCLUSIONS AND RECOMMENDATIONS

Drilling and testing of the injection and confining zones proved the existance of an isolated area of high permeability capable of accepting the projected injection volumes.

- The sequence of sediments in the upper part of the Oldsmar Limestone from 1665 feet 2081 feet below land surface were observed to have a low porosity and permeability. These sediments provide excellent confinement above the injection zone and therefore can preclude any upward migration of injected wastewater.

- Highly recrystallized dolomites were penetrated from 2081 feet to 2760 feet below land surface. These rocks constitute the proposed injection zone and contain cavernous zones from 2081 feet to 2500 feet below land surface. Solution and channel porosity were observed in core samples. Pumping and injection tests provide large values of Transmissivity, indicating high injection potential.

- Ground-water quality in the injection zone indicates conditions similar to sea water. The 10,000 mg/l TDS concentration level in the ground-waters is reached at a depth of about 1250 feet below land surface, which is about 400 feet above the top of the confining zone.

7.2 RECOMMENDED OPERATING CONDITIONS

7.2.1 Injection Volumes

The maximum injection volumes discharged into the well were 6250 gpm. However, the results of all analysis indicate that the injection zone can take into storage much higher amounts.

7.2.2 Operating Injection Pressures

The bottom-hole and wellhead pressures obtained during the injection test showed very low pressure increases due to the injected volumes. Wellhead pressures increase were in the order of 13 psia only. Therefore, it is herewith recommended that the pumping injection system be designed to accomodate for a maximum peak injection rate of 15 MGD; consequently 15 to 20 psia of injection pressure should be available from the system.

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APPENDIX A

LITHOLOGIC DESCRIPTIONS

APPENDIX A

LITHOLOGIC DESCRIPTION

Depth	
0 - 20	Sand, grayish orange (10 Y R 7/4), intergranular porosity, medium to coarse grained subrounded quartz, unconsolidated, mollusks (15 percent), calcareous sandstone (12 percent), heavy minerals (2 percent).
20 - 40	Sandstone, grayish orange (10 Y R 7/4), to pale yellowish brown (10 Y R 6/2), intergranular, intercrystalline and moldic porosity, medium to coarse grained, moderately indurated with micrite and sparry calcize cements, mollusks, some cavings.
40 - 60	Silt and shell, greenish gray (5 G Y 6/1), intergranular porosity, low permeability, very fine grained subangular quartz, poor induration with a silt and clay matrix, trace phosphate, mollusks (60 percent).
60 - 80	Shell Bed, grayish orange (10 Y R 7/4) to yellowish gray (5 Y 8/1), intergranular porosity, possibly high permeability, primarily gastropods

and pelecypods, quartz sand (25 percent), echinoid plates and corals also present.

80 - 100	Sandy limestone, very light gray (N 8), inter-granular and moldic porosity, grain type, micrite, intraclast, skeletal, spar, 10 percent allochems, microcrystalline to medium grained, moderately indurated with spar and micrite cement, quartz sand (15 percent), mollusks and fossil molds. Looks like Tamiami.
100 - 111	Sandstone, very pale orange (10 Y R 8/2), inter-granular, intercrystalline and moldic porosity, medium to coarse grained subrounded quartz, moderately indurated with sparry calcite cement, mollusks (40 percent).
111 - 123	Sandstone, very pale orange (10 Y R 8/2), inter-granular, moldic and intracrystalline porosity, medium grained subrounded quartz, poorly to moderately indurated with micrite and sparry calcite cement, mollusks (40 percent).

Hawthorn Formation

123 - 125	Silty quartz sand, yellowish gray (5 Y 8/1), inter- granular porosity, low permeability, very fine grained to coarse quartz sand, poorly indurated with micrite, dolosilt, and clay

cements, phosphate (5 percent), mollusks (25 percent), looks like Hawthorn.

125 - 140	Clayey sand, light olive gray (5 Y 8/1), intergranular porosity, low permeability, fine to coarse grained subrounded quartz, poorly indurated with clay (5 percent) and dolosilt (10 percent) cements, phosphate (10 percent), mollusks (15 percent).
140 - 160	Clayey sand, grayish olive (10 Y 4/2), intergranular porosity, low permeability, medium to coarse grained subrounded quartz, poorly indurated with clay (5 percent) cement, phosphate (15 percent), shark teeth.
160 - 180	Dolosilt, light olive gray (5 Y 5/2), intergranular porosity, low permeability, very fine grained subhedral dolomite, poorly indurated with dolosilt, clay (5 percent), and micrite (25 percent) cements, quartz sand (15 percent) phosphate (5 percent). Good Hawthorn.
180 - 200	Clayey sand, light olive gray (10 Y 5/2), intergranular porosity, low permeability, very fine to fine grained subangular quartz, poorly indurated with dolosilt (5 percent) and clay (2 percent) cements, phosphate (15 percent).

200 - 220 Sandy clay, yellowish gray (5 Y 7/2) to light olive gray (5 Y 5/2), intergranular porosity, low permeability, poorly indurated with clay, dolosilt (15 percent) and micrite (5 percent) cements, quartz sand (25 percent), phosphate (10 percent).

220 - 251 Dolosilt, yellowish gray (5 Y 7/2), intergranular porosity, low permeability, very fine grained subhedral crystals, poorly indurated with dolosilt and clay (25 percent) cements, quartz sand (20 percent), phosphate (5 percent).

Ocala Group

Crystal River Formation

251 - 260 Limestone, white (N 9), intergranular and moldic porosity, grain type, skeletal, biogenic, micrite, 75 percent allochems, microcrystalline to coarse grained, moderate induration calcilutite matrix, bryozoans, mollusks, benthonic foraminifera (Lepidocyclina ocalana), good Ocala, six-inch cavity reported at 255.

260 - 280 Limestone, white (N 9), intergranular and moldic porosity, grain type; biogenic, micrite, skeletal, 40 percent allochems, microcrystalline to coarse grained, moderate induration with a calcilutite matrix, mollusks, echinoids, bryozoans, benthonic

foraminifera.

280 - 292 Limestone, white (N 9), intergranular porosity, grain types; biogenic, micrite, crystal, 20 percent allochems, microcrystalline to medium grained, moderate induration with micrite and sparry calcite cements, mollusks benthonic foraminifera (Operculinoides sp., Heterestegina sp.).

292 - 300 Limestone, white (N 9) to very light gray (N 8), intergranular and moldic porosity, possibly high permeability, grain types, biogenic, micrite, skeletal, 75 percent allochems, fine to coarse grained, moderately indurated with micrite and sparry calcite cements, may be reworked, mollusks, echinoids, crustacea, bryozoans, benthonic forminifera (Lepidocyclina ocalana, Gypsina globula, Operculinoides sp.).

300 - 320 Limestone, white (N 9), intergranular and moldic porosity, grain types, biogenic, micrite, skeletal, 75 percent allochems, medium grained, moderately indurated with a calcilutite matrix, bryozoans, echinoids, mollusks, benthonic foraminifera (Operculinoides moodysbranchensis).

320 - 340 Limestone, very pale orange (10 Y R 9/2), inter-

granular, intercrystalline and moldic porosity, grain types, crystal, micrite, skeletal, 30 percent allochems, microcrystalline to medium grained, good induration with sparry calcite and micrite cements, high alteration, fossil molds, benthonic foraminifera.

320 - 340 Limestone, very pale orange (10 Y R 9/2), intergranular, moldic and intercrystalline porosity, grain types; crystal, micrite, biogenic, 60 percent allochems, microcrystalline to coarse grained, good induration with sparry calcite and micrite cements, high alteration, echinoids, bryozoans, mollusks, benthonic foraminifera.

Williston Formation

360 - 380 Calcarenite, very pale orange (10 Y R 8/2), intergranular and moldic porosity, possibly high permeability, grain types, biogenic, skeletal, crystal, 80 percent allochems, medium grained, moderate induration with sparry calcite and micrite cements, mollusks, echonoids, bryozoans, pellets, benthonic foraminifera (Lepidocyclina sp.).

380 - 400 Calcarenite, very pale orange (10 Y R 8/2), intergranular and moldic porosity, possibly high

permeability, grain types, biogenic, skeletal, crystal, 75 percent allochems, medium grained, good induration with sparry calcite and micrite cement, mollusk, bryozoans, echinoids, pellets, benthonic foraminifera (<u>Amphistegina</u> <u>pinnarensis</u> <u>cosdeni</u>).

<u>**Avon Park Limestone**</u>

400 - 420 Limestone, very pale orange (10 Y R 8/2) to white (N 9), intercrystalline and vugular porosity, grain types, crystal, skeletal, intraclast, 20 percent allochems, microcrystalline to medium grained, good induration with sparry calcite and micrite cements, pellets, benthonic foraminifera (<u>Dictyoconus</u> <u>sp</u>.), echinoids.

420 - 440 Limestone, white (N 9), intergranular and moldic porosity, grain types, biogenic, micrite, 10 percent allochems, microcrystalline to fine grained, moderately indurated with a calcilutite matrix, fossil molds, benthonic foraminifera.

440 - 460 As above with large (<u>Dictyoconus</u> sp.).

460 - 480 Limestone, very pale orange (10 Y R 8/2) to white (N 9), intergranular and moldic porosity, grain types; biogenic, crystal, skeletal, 25 percent allochems, microcrystalline to coarse grained,

good induration with sparry calcite and micrite cements, echinoids, mollusks, pellets, benthonic foraminifera (Dictyoconus cookei).

480 - 500 Limestone, white (N 9) to light gray (N 7), vugular, intracrystalline and moldic porosity,grain types; crystal, micrite, skeletal, 5 percent allochems, microcrystalline grained, good induration with sparry calcite and micrite cement, high alteration, fossil molds.

500 - 520 Calcarenite, very pale orange (10 Y R 8/2), intergranular and moldic porosity, possibly high permeability, grain types, skeletal, intraclast, crystal, 75 percent allochems, medium grained, good induration with sparry calcite and micrite cement, echinoids (Peronella dalli), pellets, benthonic foraminifera (Dictyoconus cookei).

520 - 540 Limestone, very pale orange (10 Y R 8/2) to grayish orange (10 Y R 7/4), intracrystalline, intergranular and moldic porosity, grain types, crystal, skeletal, micrite, 40 percent allochems, microcrystalline to medium grained, good induration with sparry calcite cement, high alteration, benthonic foraminifera, fossil molds.

540 - 560 Dolomite, grayish orange (10 Y R 7/4), intra-

crystalline and moldic porosity, very fine grained euhedral crystals, high alteration, good induration with dolomite and micrite cements, benthonic foraminifera, fossil molds.

560 - 580	Dolomitic limestone, very pale orange (10 Y R 8/2) to grayish orange (10 Y R 7/4), intergranular porosity, grain types; micrite, crystal, skeletal, 20 percent allochems, microcrystalline to medium grained, good induration with micrite, spar, and dolomite cements, benthonic foraminifera, fossil molds.
580 - 600	Dolomite, dark yellowish brown (10 Y R 6/2), inter- granular and moldic porosity, possibly high permeability, fine to medium grained euhedral crystals, high alteration, good induration with dolomite and micrite (5 percent) cement, sucrosic, fossil molds.
600 - 620	Dolomite, very pale orange (10 Y R 8/2) to grayish orange (10 Y R 7/2), pin-point vugs, moldic and intracrystalline porosity, possibly low permeability, very fine grained euhedral crystals, high alteration, good induration with dolomite and micrite (10 percent) cements, fossil molds.
620 - 640	Dolomite, light gray (N 7), intracrystalline and

vugular porosity, low permeability, very fine grained euhedral crystals, high alteration, good induration with dolomite and micrite (10 percent) cements, dense.

640 - 660 Limestone, white (N 9) to very light gray (N 8), intergranular and moldic porosity, grain types; micrite, crystal, biogenic, 5 percent allochems, microcrystalline to very fine grained, moderate induration with micrite and sparry calcite cements, fossil molds.

660 - 680 Dolomite, pale yellowish brown (10Y R 8/2), vugular, intracrystalline and moldic porosity, very fine grained subhedral crystals, high alteration, good induration with dolomite and micrite cements, dense.

Sample also contains Dolomitic Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain types, crystal, micrite, skeletal, 30 percent allochems, microcrystalline to fine grained, good induration with sparry calcite, micrite and dolomite cements, benthonic foraminifera.

680 - 700 Dolomite, very pale orange (10 Y R 8/2) to very light gray (N 8), intercrystalline, vugular and moldic porosity, very fine to fine grained

euhedral crystals, high alteration, good induration with dolomite and micrite cements, fossil molds.

700 - 720 Dolomitic Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain types; skeletal, crystal, micrite, 60 percent allochems, microcrystalline to coarse grained, good induration with sparry calcite, micrite and dolomite cements, mollusks, benthonic foraminifera (Dictyoconus cookei).

720 - 740 Dolomite, pale yellowish brown (10 Y R 6/2), vugular, moldic and intercrystalline porosity, very fine grained euhedral crystals, high alteration, good induration with dolomite and spar cements,dense, fossil molds.

740 - 760 Dolomite, grayish orange (10 Y R 7/4), intercrystalline and moldic porosity, very fine to fine euhedral crystals, high alteration, good induration with dolomite cement, sucrosic.

760 - 780 Limestone, light gray (N 7), pin-point vugs, moldic and intracrystalline porosity, grain types; crystal, micrite, biogenic, 5 percent allochems, microcrystalline to very fine grained, good induration with sparry calcite, micrite and

dolomite (5 percent) cements, highly recrystallized, fossil molds.

780 - 800	Dolomitic Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain types; biogenic, crystal, skeletal, 40 percent allochems, microcrystalline to coarse grained, good induration with sparry calcite, micrite and dolomite cements, benthonic foraminifera (Dictyoconus cookei).
800 - 820	Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain types; crystal, micrite, biogenic, 10 percent allochems, microcrystalline to fine grained, moderate induration with sparry calcite and micrite cement, fossil molds (Dictyoconus cookei).
820 - 840	As above, many cones
840 - 860	Dolomitic Limestone, very light orange (10 Y R 8/2) to grayish orange (10 Y R 7/4), intergranular and moldic porosity, grain types, biogenic, crystal, skeletal, 60 percent allochems, fine to coarse grained, good induration with sparry calcite, micrite, and dolomite cements, Dictyoconus cookei, driller reports six inche void at 858 feet.

860 - 880 Dolomitic Limestone, very pale orange (10Y R 8/2), intergranular, moldic and intracrystalline porosity, grain types; biogenic, micrite, crystal, 10 percent allochems, microcrystalline to fine grained, good induration with sparry calcite, micrite and dolomite cements, benthonic foraminifera (Dictyoconus cookei. Dolomite also in sample (cavings).

880 - 900 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain types; biogenic, micrite, skeletal, 60 percent allochems, fine to coarse grained, moderate induration with micrite and spar cements, pellets, benthonic foraminifera.

900 - 920 Calcarenite, very pale orange (10 Y R 8/2), intergranular porosity, grain type; biogenic, micrite, skeletal, 80 percent allochems, medium grained, good induration with micrite and sparry calcite cements, benthonic foraminifera (Dictyoconus cookei, Rotalia sp.).

Lake City Limestone

920 - 940 Dolomitic Limestone, very pale orange (10 Y R 8/2) to pale yellowish brown (10 Y R 6/2), intracrystalline and moldic porosity, grain type;

crystal, micrite, skeletal, 40 percent allochems, microcrystalline to medium grained, good induration with spar, micrite and dolomite cements, peat flecks, benthonic foraminifera (Dictyoconus, sp.).

940 - 960	As above some crystalline dolomite.
960 - 980	Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain type, biogenic, micrite, crystal, 30 percent allochems, micro- crystalline to fine grained, moderate induration with micrite and spar cements, peat flecks, bgenthonic foraminifera, echinoids.
980 - 1000	Calcarenite, very pale orange (10 Y R 8/2), intergranular porosity, possibly high permeability, grain type; skeletal, crystal, micrite, 75 percent allochems, medium grained, moderate induration with sparry calcite and micrite cements, benthonic foraminifera (Dictyoconus americanus), pellets.
1000 - 1020	As above.
1020 - 1040	Limestone, white (N 9) to very pale orange (10 Y R 8/2), intergranular and intracrystalline porosity, grain type; crystal, skeletal, micrite, 40 percent allochems, microcrystalline to medium grained, good induration with sparry calcite cement,

pellets, benthonic foraminifera.

1040 - 1060	Limestone, white (N 9), intergranular and moldic porosity, grain type; micrite, biogenic, skeletal, 60 percent allochems, microcrystalline to medium grained, moderate induration with a calcilutite matrix, benthonic foraminifera, mollusks, worm tubes.
1060 - 1080	Calcarenite, very pale orange (10 Y R 8/2) to white (N 9), intergranular porosity, possibly high per- meability, grain type; biogenic, skeletal, micrite, 75 percent allochems, medium grained, moderate induration with micrite cement, virtually a coquina of forams (<u>Dictyoconus americanus</u>, <u>Coskinolina sp</u>., <u>Fabularia sp</u>.), pellets.
1080 - 1100	As above.
1100 - 1120	Limestone, very pale orange (10 Y R 8/2), inter- granular, moldic and intracrystalline porosity, grain type; crystal, biogenic, micrite, 30 percent allochems, microcrystalline to medium grained, moderate induration with sparry calcite and micrite cements, benthonic foramminifera, fossil molds.
1120 - 1140	Limestone, very pale orange (10 Y R 8/2), inter- granular porosity, grain type; skeletal, crystal,

micrite, 60 percent allochems, microcrystalline to coarse grained, moderate induration with sparry calciate and micrite cement, benthonic foraminifera, mollusks, echinoids.

1140 - 1160	As above.
1160 - 1180	Limestone, very pale orange (10 Y R 8/2), inter-granular, intracrystalline and moldic porosity, grain type; crystal, skeletal, micrite, 35 percent allochems, microcrystalline to medium grained, moderate induration with sparry calcite and micrite cements, benthonic foraminifera.
1180 - 1200	Limestone, very pale orange (10 Y R 8/2), moldic and intracrystalline porosity, grain type; crystal, skeletal, 20 percent allochems, microcrystalline to medium grained, moderate induration with sparry calcite cement, fossil molds.
1200 - 1220	As above.
1220 - 1240	Limestone, very pale orange (10 Y R 8/2) inter-granular and moldic porosity, grain type; micrite, crystal, biogenic, 10 percent allochems, microcrystalline to fine grained, moderate induration with sparry calcite and micrite cement, fossil molds.

1240 - 1260 Limestone, very pale orange (10 Y R 8/2) to white (N 9), intergranular porosity, grain type; micrite, crystal, skeletal, 20 percent allochems, micro- crystalline to fine grained, moderate induration with a calcilutite matrix, benthonic foraminifera.

1260 - 1280 As above.

1280 - 1300 Limestone, very pale orange (10 Y R 8/2), vugular, moldic and intercrystalline porosity, grain type; crystal, micrite, skeletal, 10 percent allochems, microcrystalline to very fine grained, moderate induration with sparry calcite cement, fossil molds.

1300 - 1320 Limestone, very pale orange (10 Y R 8/20, inter-granular, intracrystalline and moldic porosity, grain type; biogenic, crystal, skeletal, 75 percent allochems, microcrystalline to coarse grained, moderate induration with sparry calcite cement, <u>Dictyoconus americanus</u>.

1320 - 1340 As above.

1340 - 1360 Limestone, very pale orange (10 Y R 8/2), inter-granular and moldic porosity, grain type; biogenic, micrite, crystal, 60 percent allochems, microcrystalline to medium grained, moderate induration with micrite and spar cement, benthonic foraminifera (Dictyoconus americanus, Lituenella sp., Coskinolina sp.), mollusks, bryozoans, echinoids.

1360 - 1380 Calcarenite, very pale orange (10 Y R 8/2), intergranular porosity, grain type; skeletal, micrite, crystal, 75 percent allochems, medium grained, moderate induration with a calcilutite matrix, benthonic foraminifera.

1380 - 1400 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain type; micrite, skeletal, biogenic, 40 percent allochems, microcrystalline to coarse grained, moderate induration with micrite and spar cements, benthonic foraminifera (Dictyoconus sp., Lituenella sp, Coskinolina sp.), echinoids.

1400 - 1420 As above.

1420 - 1440 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain type; micrite, biogenic, skeletal, 60 percent alochems, microcrystalline to medium grained, moderate induration with a calcilutite matrix, benthonic foraminifera.

1440 - 1460 As above.

1440 - 1460 Limestone, very pale orange (10 Y R 8/2), intergranular and vugular porosity, grain type; micrite, crystal, skeletal, 10 percent allochems, micro- crystalline to fine grained, moderate induration with micrite and spar cements, benthonic foraminifera.

1460 - 1480 As above with, dolomite, grayish brown (10 Y R 7/4), moldic and intercrystalline porosity, fine grained euhedral crystals, high alteration, good induration with dolomite and micrite cements.

1480 - 1500 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, grain type, micrite, skeletal, biogenic, 40 percent allochems, microcrystalline to medium grained, moderate induration with micrite cement, benthonic foraminifera (<u>Operculinoides</u> <u>sp</u>., <u>Lepidocyclina</u> <u>sp</u>, <u>Dictyoconus americanus</u>).

1500 - 1510 As above with some grayish brown fragmental dolomite.

1510 - 1530 Core run Number 1, 20 feet cored - 10.2 feet recovered, for 51 percent recovery.

1510 - 1511 Dolomite, yellowish gray, (5 Y 7/2), intercrystalline and moldic porosity, microcrystalline to very fine grained euhedral crystals, good induration with dolomite cement, fossil molds, peat flecks.

1511 - 1526 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, low permeability, grain type, micrite, skeletal crystal, 20 percent allochems, microcrystalline to medium grained, moderate induration with a calcilutite matrix, benthonic foraminifera (Coskinolina sp.), mollusks, echinoids, peat flecks, interbedded with poorly indurated micrite mud (low permeability), near bottom.

1526 - 1530 Dolomite, moderate yellowhish brown (10 Y R 5/4), intercrystalline and moldic porosity, very fine grained euhedral crystals, good induration with dolomite and micrite cement, micrite (10 percent), fossil molds.

1530 - 1550 Dolomite, grayish orange (10 Y R 7/8), to pale yellowish brown (10 Y R 6/2), moldic, vugular, and intercrystalline porosity, very fine grained euhedral crystals, high alteration, good induration with dolomite cement, fossil molds.

1550 - 1560 As above.

1560 - 1580 Dolomite as above, and limestone, white (N 9), intergranular porosity, grain type; micrite, skeletal, biogenic, 60 percent allochems, microcry- stalline to coarse grained, good induration with micrite cement, benthonic foraminifera.

1580 - 1602 Dolomite, grayish orange (10 Y R 7/4) to pale yellowish brown (10 Y R 6/2), moldic, vugular and intercrystalline porosity, very fine grained euhedral crystals, high alteration, good indur- ation with dolomite and micrite (5 percent) cements, fossil molds.

1602- 1622 Core run Number 2, 20 Feet cored - 19.2 feet recovered, for 96 percent recovery.

1602 -1604 Dolomite, grayish orange (10 Y R 7/4) to moderate yellowish brown (10 Y R 5/4), intercrystalline and intracrystalline porosity, very fine grained to microcrystalline euhedral crystals, good induration with dolomite and micrite cement, micrite (10 percent), benthonic foraminifera (Florilus sp.).

1604 - 1608 Dolomitic Limestone, very pale orange (10 Y R 8/2) to white (N 9), intergranular porosity, possibly low permeability, grain type, biogenic, micrite, crystal, 15 percent allochems, microcrystalline to fine grained, moderate induration with micrite, spar, and dolomite cement, benthonic foraminifera, (Operculinoides sp., Florilus sp.), mollusks.

1608 - 1612	Dolomite, pale yellowish brown, (10 Y R 6/2), intercrystalline and moldic porosity, possibly fracture, possibly high permeability, fine to microcrystalline grained euhedral cyrstals, good induration with dolomite cement, fossil molds, benthonic foraminifera.
1612 - 1618	Dolomitic Limestone, very pale orange (10 Y R 6/2) to pale yellowish brown (10 Y R 6/2),intergranular porosity, grain type, biogenic, crystal, micrite, 30 percent allochems, microcrystalline to coarse grained, good induration with micrite, spar and dolomite cements, benthonic foraminifera (Lepidocyclina sp).
1618 - 1622	Grades into a limestone.
1622 - 1640	Limestone, very pale orange (10 Y R 8/2), inter-granular porosity, grain type, micrite crystal, skeletal, 40 percent allochems, microcrystalline to coarse grained, good induration with micrite and sparry calcite cements, benthonic foraminifera (Operculinoides sp), some very fine grained pale brown dolomite in sample.
1640 - 1655	As above.

1655 - 1663 Dolomite, moderate yellowish brown (10 Y R 5/4), intracrystalline and vugular porosity, microcrystalline to very fine grained euhedral crystals, good induration with dolomite cement.

Oldsmar Limestone

1665 - 1685 Core run Number 3 20 feet cored - 20.2 feet recovered for 101 percent recovery.

1665 - 1670 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type; biogenic, micrite, crystal, 30 percent allochems, microcrystalline to coarse grained, moderate induratioan with spar and micrite cements, benthonic foraminifera (Helicostegina sp., Pseudophragmina cedarkeyensis), Oldsmar.

1670 - 1675 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type; biogenic, micrite, crystal, 10 percent allochems, microcrystalline to medium grained, moderate induration with a calcilutite matrix, benthonic foraminifera (Lepidocyclina sp.).

1675 - 1680 As above, becoming slightly dolomitic.

1680 - 1684 Limestone, very pale orange (10 Y R 8/2), intergranular and intercrystalline porosity, low permeability, grain type, biogenic, crystal, micrite, 10 percent allochems, microcrystalline to medium grained, good induration with sparry calcite and micrite cements, benthonic foraminifera, chert (2 percent).

1684 - 1685	Limestone, white (N 9), intergranular porosity, very low permeability, grain type; micrite, microcry- stalline to very fine grained, <u>poor</u> induration with calcilutite matrix.
1680 - 1700	Dolomitic Limestone, very pale orange (10 Y R 8/2), intergranular porosity, grain type, micrite, crystal, skeletal, 30 percent allochems, microcrystalline to coarse grained, good induration with micrite, spar and dolomite cements, benthonic foraminifera, <u>chert</u>.
1700 - 1726	As above.
1726.7-1746.7	Core run Number 4, 20 feet cored - recovered 20.2 feet for 100 percent recovery.
1726 - 1726.5	Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type, micrite, crystal, biogenic, 10 percent allochems, microcrystalline to fine grained, good induration with micrite and spar cements, benthonic foraminifera.

1726.5- 1733 Dolomite, grayish orange (10 Y R 7/4) to moderate yellowish brown (10 Y R 5/4), intercrystalline moldic and channel porosity, very fine grained to microcrystalline euhedral crystals, high alteration, good induration with dolomite cement. Solution channels at 1728 and 1729 feet.

1733 - 1740 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type, biogenic micrite, skeletal, 25 percent allochems, microcrystalline to medium grained, moderate induration with micrite and spar cements, benthonic foraminifera (Lepidocyclina sp. Pseudophragmina sp.), glauconite (1 percent).

1740 - 1743 Limestone, very pale orange (10 Y R 8/2) to white (N 9), intergranular porosity, low permeability, grain type, micrite, skeletal, crystal, 10 percent allochems, microcrystalline to fine grained, moderate induration with a calcilutite matrix, spar (25 percent), benthonic foraminifera.

1743 - 1746 Becomes more granular (40 percent allochems), Helicostegina gyralis.

1746 - 1760 Dolomitic Limestone, very pale orange (10 Y R 8/2), intergranular porosity, grain type, biogenic, micrite, skeletal, 65 percent allochems, micro- crystalline to coarse grained, good induration with micrite, spar and dolomite cements, glauconite (2 percent), chert (2 percent), crystalline dolomite (10 percent), benthonic foraminifera.

1760 - 1780 As above, more chert (5 percent).

1780 - 1788 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, possibly low permeability, grain type: micrite, biogenic, 10 percent allochems, microcrystalline to fine grained, moderate induration with a calcilutite matrix, benthonic foraminifera, chert (15 percent).

1788 - 1808 Core run Number 5, 20 feet cored-recovered 19.2 feet for 96 percent recovery.

1788 - 1790 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type; micrite, crystal, biogenic, 5 percent allochems, microcrystalline to very fine grained, good induration with micrite and spar cements, benthonic foraminifera (rare).

1790 Chert nodule four inch thick.

1793 Chert nodule eight inch thick.

1790 - 1796 As above, limestone, low permeability, rare forams.

1796 - 1800	Limestone, grayish orange (10 Y R 7/4), intergranular porosity, low permeability, grain type; crystal, micrite, biogenic, 15 percent allochems, microcrystalline to fine grained, good induration with spar and micrite cements, Chert nodule at 1798 four inches thick, benthonic foraminifera.
1800 - 1808	Limestone, grayish orange (10 Y R 7/4), intergranular porosity, low permeability, grain type, micrite, crystal, 15 percent allochems, microcrystalline of fine grained, good induration with spar and micrite cements, chert nodule at 1800 (four inch thick) and 1803 (four inch thick), rhombohedral quartz crystals in matrix of limestone, forams (rare).
1808 - 1820	Limestone, very pale orange (10 Y R 8/2), intergranular porosity, grain type; micrite, biogenic, 25 percent allochems, microcrystalline to medium grained, good induration with a calcilutite matrix, benthonic foraminifera, chert (5 percent).
1820 - 1840	As above.
1840 - 1849	Sample is primarily chert with minor amount of glauconite flecked crystalline limestone with poorly preserved specimens of Helicostegina sp.

(Oldsmar).

1849 - 1857 Core run Number 6, 7.5 feet cored - 2.1 feet recovered for 26 percent recovery.

1849 - 1854 Limestone, very pale orange (10 Y R 8/2) to very light gray (N 8), intergranular and moldic porosity, grain type, micrite, crystal, skeletal, 15 percent allochems, microcrystalline to medium grained, moderately indurated with micrite and spar cements, benthonic foraminifera (Helicostegina gyralis).

1854 - 1856 Chert, medium gray, vitreous conchoidal fracture, crystalline, very well indurated.

1860 - 1870 Limestone, white (N 9) to very pale orange (10 Y R 8/2), moldic and intercrystalline porosity, grain type; crystal, micrite, biogenic, 30 percent allochems, microcrystalline to medium grained, good induration with sparry calcite and micrite cement, brilliant green (5 G 6/6) glauconite flecks (4 percent), benthonic foraminifera (Helicostegina sp.).

1870 - 1881 As above with Helicostegina gyralis.

1881 - 1897 Core run Number 7, 16 feet cored - 20.3 feet recovered for 103 percent recovery.

1897 - 1885	Limestone, very pale orange (10 Y R 8/2) to pale yellowish orange (10 Y R 8/6), intergranular and moldic porosity, grain type; micrite, crystal, skeletal, 25 percent allochems, microcrystalline to medium grained, good induration with micrite and spar cement, glauconite flecks (3 percent), benthonic foraminifera, chert (2 percent) at 1883.
1885 - 1890	Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type; micrite, crystal, skeletal, 10 percent allochems, microcrystalline to fine grained,good induration with micrite and spar cements, glauconite (5 percent), benthonic foraminifera (Pseudophragmina sp.)
1890 - 1897	As above.
1897 - 1900	Limestone, white (N 9) to very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type, micrite, skeletal, crystal, 35 percent allochems, microcrystalline to medium grained, moderate induration with a calcilutite matrix, benthonic foraminifera (Helicostegina gyralis).
1897 - 1900	Limestone, white (N 9) to very pale orange (10 Y R 8/2), intergranular porosity, grain type; micrite, skeletal, crystal, 50 percent allochems,

microcrystalline to coarse grained, good induration with a calcilutite matrix and some spar, glauconite flecks (5 percent), benthonic foraminifera (Helicostegina gyralis), mollusks, bryozoans.

1900 - 1920 As above.

1900 - 1920 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, grain type, biogenic, micrite, crystal, 60 percent allochems, microcrystalline to coarse grained, good induration with micrite and sparry calcite cement, glauconite flecks (trace), Helicostegina gyralis.

1920 - 1940 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain type; crystal micrite, skeletal, microcrystalline to coarse grained, good induration with sparry calcite and micrite cements, benthonic foraminifera, chert (2 percent).

1940 - 1944 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain type, crystal, biogenic, micrite, 25 percent allochems, microcrystalline to medium grained, good induration with sparry calcite and micrite cement, benthonic foraminifera (Helicostegina sp.).

1944 - 1964	Core run Number 8, 20 feet cored - 15.2 foot recovered for 76 percent recovery.
1944 - 1951	Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, low permeability, grain type; micrite, crystal, skeletal, 30 percent allochems, microcrystalline to coarse grained, good induration with sparry calcite and micrite cement, benthonic foraminifera (Quinqueloculina sp.).
1951 - 1954	As above, dolomite rhombs in micrite matrix.
1954 - 1964	Limestone, grayish orange (10 Y R 7/4), intergranular intracrystalline porosity, grain type, crystal, skeletal biogenic, 15 percent allochems, microcrystalline to medium grained, good induration with sparry calcite cement, mollusks, fossil molds, benthonic foraminifera.
1964 - 1980	As above, trace of chert.
1980 - 2005	Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, grain type; biogenic, crystal, micrite, 50 percent allochems, microcrystalline to coarse grained, good induration with sparry calcite and micrite cement, benthonic foraminifera (Helicostegina gyralis), mollusks, chert nodule at 2001.

2005 - 2025 Core run Number 9, 20 feet cored - 12 feet recovered for 60 percent recovery.

2005 -2010 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type, micrite, skeletal, biogenic, 25 percent allochems, microcrystalline to medium grained,moderate induration with micrite and spar cements, benthonic foraminifera (<u>Helicostegina</u> <u>sp</u>).

2010 - 2015 Limestone, grayish orange (10 Y R 7/4), intergranular, intercrystalline and moldic porosity, grain type, crystal, biogenic, skeletal, 10 percent allochems, microcrystalline to coarse grained, good induration with sparry calcite cement, fossil molds,echinoids, benthonic foraminifera.

2015 - 2025 Limestone, white (N 9) to very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type, micrite, skeletal, 5 percent allochems,microcrystalline to medium grained, poor induration with a calcilutite matrix, benthonic foraminifera.

2020 - 2040 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, low permeability, grain type; skeletal, micrite, crystal, microcrystalline to medium grained, poor to moderate induration with spar and micrite cements, mollusks, fossil molds,benthonic foraminifera (Helicostegina gyralis), chert at 2028 to 2029.

2040 - 2065 Limestone, very pale orange (10 Y R 8/2), intergranular and moldic porosity, low permeability, grain type; micrite, crystal, skeletal, microcrystalline to medium grained, moderate induration with sparry calcite and micrite cements, benthonic foraminifera.

2065 - 2070 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type, micrite, skeletal, crystal, 10 percent allochems, microcrystalline to fine grained, moderate induration with spar and mcirite cement, benthonic foraminifera, peat flecks.

2070 - 2075 As above, low permeability.

2075 - 2081 Limestone, very pale orange (10 Y R 8/2), intergranular porosity, low permeability, grain type, biogenic, micrite, crystal, 30 percent allochems, microcrystalline to coarse grained, good induration with micrite and spar cements, benthonic foraminifera.

2081 - 2083 Dolomite, moderate yellowish brown (10 Y R 5/4), intercrystalline, vugular, and moldic porosity, possibly high permeability, very fine to medium grained euhedral crystals, high alteration, good induration with dolomite cement, fossil molds.

2083 - 2100	Dolomite,pale yellowish brown (10 Y R 4/2) to medium gray (N 5), intercrystalline, vugular and moldic porosity, some fragments may be very high permeability (honeycomb structure), very fine to medium grained euhedral crystals, good induration with dolomite cement, fossil molds.
2100 - 2128	As above, dense.
2128 - 2135	Dolomite, grayish orange (10 Y R 7/4) to pale yellowish brown (10 Y R 5/4), intracrystalline, vugular and possibly high permeability, very fine grain crystals, good induration with dolomite cement.
2135 - 2138	Dolomite, pale yellowish brown (10 Y R 5/4), intra- crystalline, moldic, and fracture porosity, possibly high permeability, microcrystalline to medium grained crystals, good induration with dolomite cement.
2138 - 2160	Dolomite, very pale brown (10 Y R 4/2) to medium gray (N 5), intercrystalline, moldic, and vugular porosity, possibly fractured with secondary

porosity created by subsequent solutioning, high permeability, very fine to medium grained euhedral crystals, high alteration, good induration with dolomite cement, some fragments sucrosic and honeycombed, fossil molds.

2160 - 2180	Dolomite, grayish brown (5 Y R 3/2), intercrystalline, intracrystalline, vugular and moldic porosity, possibly fractured (creates rubble in hole during drilling) with subsequent dissolution, high permeability in solutioned zones, microcrystalline to medium grained euhedral crystals, high alteration, good induration with dolomite cement, peat flecks (1 percent), fossil molds, fossil ghosts.
2180 - 2200	As above, sparry calcite lining fracture traces, dense.
2200 - 2218	Dolomite, very pale brown (10 Y R 4/2) to grayish brown (5 Y R 7/2), intercrystalline, vugular and moldic porosity, possible fracture porosity, high permeability in solutioned zones, microcrystalline to medium grained euhedral crystals, high alteration in good induration with dolomite cement fossil molds.
2218 - 2220	Dolomite, grayish brown (5 Y R 3/2), intercry-

stalline, moldic, and possible fracture porosity, very fine to fine grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous.

2220 - 2240 Dolomite, dark gray (N 3) to moderate brown (5 Y R 3/4), intercrystalline and vugular porosity, very fine grained euhedral to subhedral crystals, medium to high alteration, good induration with dolomite and micrite (15 percent) cements, fossil molds (rare), dense.

2240 - 2260 Dolomite, pale yellowish brown (10 Y R 6/2) to dark yellowish brown (10 Y R 4/2), intercrystalline and intercrystalline porosity, possible low permeability, fine grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous.

2260 - 2280 Dolomite, pale yellowish brown (10 Y R 6/2), inter- crystalline porosity, low permeability, very fine to microcrystalline euhedral and subhedral crystals, medium to high alteration, good induration with dolomite and micrite (20 percent) cements, unfossiliferous.

2280 -2300 Dolomite, pale yellowish brown (10 Y R 6/2), inter- crystalline and vugular porosity, fine to medium euhedral crystals, high alterations, good induration with dolomite cement, trace micrite, trace selenite lining vugs, unfossiliferous.

2300 - 2320	Dolomite, dusky yellowish brown (10 Y R 2/2), intercrystalline porosity, fine to medium grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous.
2320 - 2340	As above, with fragments of pale yellowish brown (10 Y R 6/2), very fine grained, highly altered dolomite.
2340 - 2360	Dolomite, moderate dark gray (N 4) to dark yellowish brown (10 Y R 4/2), intercrystalline porosity, fine to coarse grained, euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous, dense.
2360 - 2380	Dolomite, medium gray (N 5), intercrystallien and moldic porosity, fine to medium grained euhedral and subhedral crystals, medium to high alteration, good induration with dolomite and micrite cement, fossil molds.
2380 - 2400	Dolomite, moderate yellowish brown (10 Y R 5/4), intercrystalline, moldic and vugular porosity, fine to coarse grained euhedral crystals, high alteration, good induration with dolomite and

micrite cements, fossil molds.

2400 - 2420 Dolomite, medium gray (N 5) to dark yellowish brown (10 Y R 4/2), intercrystalline porosity, very fine to coarse grained euhedral crystals, high alteration with dolomite cements unfossiliferous.

2420 - 2440 Dolomite, moderate yellowish brown (10 Y R 5/4), pin point vugs, intercrystalline porosity, very fine to fine grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous, dense.

2440 - 2460 Dolomite, medium gray (N 5), intercrystalline and vugular porosity, fine to medium grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous.

2460 - 2480 Dolomite as above, and dolomitic limestone, very pale orange (10 Y R 8/2) to light gray (N 8), intergranular and intercrystalline porosity, grain type, micrite, moderately indurated with micrite and dolomite cements, trace phosphate, unfossiliferous.

2480 - 2500 Dolomite, moderate yellowish brown (10 Y R 5/4), intercrystalline porosity, very fine to medium grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous, dense, some cavings.

2500 - 2520	Dolomite, medium gray (N 5) to moderate yellowish brown (10 Y R 5/4), intercrystalline and vugular porosity, very fine to fine grained euhedral crystals, high alteration, good indruation with dolomite cement, unfossiliferous.
2520 - 2540	Dolomite, moderate dark gray (N 4), intercrystalline porosity, medium to coarse grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous, dense.
2540 - 2560	Dolomite, medium gray (N 5) to moderate yellowish brown (10 Y R5/4), intercrystalline and vugular porosity, fine to medium grained euhedral to subhedral crystals, high alteration, good induration with dolomite cement, fossil ghosts, molds.
2460 - 2480	Dolomite, moderate yellowish brown (10 Y R 5/4), intercrystalline porosity, very fine to fine grained euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous, crystalline.
2480 - 2500	Dolomite, pale yellowish brown (10 Y R 6/2), intracrystalline and vugular porosity, fine grained

euhedral crystals, high alteration, good induration with dolomite cement, unfossiliferous.

2500 - 2520	As above, with Dolomite, dark gray (N 3), intra-crystalline porosity, low permeability, micro-crystalline to very fine grained euhedral crystals, high alteration, good induration with dolomite cement, crystalline.
2520 - 2540	Dolomite, pale yellowish brown (10 Y R 6/2) to medium gray (N 6), intracrystalline and moldic porosity, very fine to medium grained euhedral crystals, high alteration, good induration with dolomite cement, fossil molds.
2540 - 2560	As above.
2560 - 2580	Dolomite, moderate yellowish brown (10 Y R 5/4), interacrystalline and intergranular porosity, possibly high permeability, medium grained euhedral crystals, high alteration, moderate induration with dolomite cement, suerosic.
2580 - 2600	Dolomite, grayish orange (10 Y R 7/4), inter-granular, intracrystalline, and moldic porosity, possibly high permeability, fine to medium grained euhedral crystals, high alteration, good induration with micrite (10%) and dolomite cements, fossil molds and fragments.

2600 - 2620	Dolomite, as above with high recrystallized benthonic foraminifera and peat flecks.
2620 - 2640	Dolomite, grayish orange (10 Y R 7/4), intergranular, moldic, and intracrystalline porosity, very fine to medium euhedral crystals, medium alteration, good induration with dolomite and micrite (20%) cements, fossil molds, peat flecks, bendnonic foraminifera.
2640 - 2660	As above.
2660 - 2680	Dolomite, grayish orange (10 Y R 7/4) to medium light gray (N 6), intracrystalline and moldic porosity, microcrystalline to very fine grained euhedral crystals, high alteration, good induration with dolomite and micrite (5%) cements, fossil molds.
2680 - 2700	Dolomite, pale yellowish brown (10 Y R 6/2) intracrystalline, ntergranular and moldic porosity, very fine grained euhedral crystals, high alteration, good induration with micrite and dolomite cements, fossil molds, peat flecks.
2700 - 2720	Dolomite, dark yellowish brown (10 Y R 4/2), intracrystalline porosity, low permeability, microcrystalline to very fine grained euhedral crystals, high alteration, good induration with

dolomite cement, dense.

2720 - 2740 Dolomite dark yellowish brown (10 Y R 4/2) to dark yellowish orange (10 Y R 6/6), intergranular, intercrystalline and moldic porosity, fine grained euhedral crystals, medium alteration, good induration, benthonic foraminifera, peat flecks, fossil molds, fragments of high, recrystallized dark brown peaty dolomite.

2740 - 2760 As above.

2760 - 2780 Dolomite, medium gray (N 5), intercrystalline and moldic porosity, fine grained euhedal crystals, high alteration, good induration with dolomite cement, fossil molds, dense.

<u>**Cedar Keys Formation**</u>

2780 - 2800 Dolomite as above, and gypsum, light gray (N 7), low permeability, approximately 10% of sample.

2800 - 2820 Dolomite, medium gray (N 5), intercrystalline porosity, low permeability, very fine grained euhedral crystals, densely packed, high alteration, good induration with dolomite and gypsum cements. Also gypsum, grayish orange (10 Y R 7/4) to medium light gray (N 6), low permeability, very fine grained, moderately indurated with dolomite and

	micribe cements.
2820 - 2840	Gypsiferous Dolomite, pale yellowish brown (10 Y R 6/2) to grayish orange (10 Y R7/4), intercrystalline and vugular porosity, low permeability, very fine grained subhedral to euhedral crystals, high alteration, good induration with dolomite and gypsum cements, 30% gysum, unfossiliferous.
2840 - 2860	As above, gypsiferous dolomite.
2860 - 2880	Gypsiferous dolomite, very pale orange (10 Y R 4/2), intercrystalline and vugular porosity, low permeability, very fine grained euhedral crystals, high alteration, good induration with dolomite and gypsum cements, unfossiliferous.
2880 - 2900	As above, some fragments of pure gypsum or anhydrite, possibly seams or beds.
2900 - 2915	Dolomite, moderate yellowish brown (10 Y R 5/4), intercrystalline and vugular porosity, low permeability, very fine to fine grained euhedral crystals, high alteration, good induration with dolomite cement, gypsum fragments.

APPENDIX B

RESULTS OF CHEMICAL ANALYSES

Deep and Shallow
Monitoring Wells

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

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Client: Mr. Eduardo Aguilar
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350 W. Camino Gardens Blvd.
Boca Raton, Florida 33432

June 6, 1985

Report # J 4978
Lab I.D. # 82223

Sample Received: 5/29/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Deep Monitor Well #1 (1555'-1702')

REPORT OF ANALYSIS

Total Dissolved Solids	23,105	mg/l
Sodium	7,000	mg/l
Potassium	360	mg/l
Calcium	496	mg/l
Magnesium	880	mg/l
Iron	3.00	mg/l
Chloride	12,750	mg/l
Bicarbonate Alkalinity	133	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	1,448	mg/l
Phosphorus, Total as P	✓ 0.17	mg/l
Fluoride	✓ 0.73	mg/l
Hydrogen Sulfide	✓ 0.24	mg/l
Fluid Density	1.0127	g/ml
pH	7.74	S.U.
Conductivity	28,800	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

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June 6, 1985

Report # J 5034
Lab I.D. # 82223

Sample Received: 5/23/85   Collected by: Your Rep.
Sample Designation: Melbourne Beach Deep Monitor Well #2

REPORT OF ANALYSIS

Total Dissolved Solids	22,230	mg/l
Sodium	4,000	mg/l
Potassium	260	mg/l
Calcium	1,000	mg/l
Magnesium	1,000	mg/l
Iron	3.20	mg/l
Chloride	14,200	mg/l
Bicarbonate Alkalinity	136	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	1,655	mg/l
Phosphorus, Total as P	0.03	mg/l
Fluoride	0.66	mg/l
Hydrogen Sulfide	0.26	mg/l
Fluid Density	1.0158	g/ml
pH	7.9	S.U.
Conductivity	30,900	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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June 6, 1985

Report # J 5043
Lab I.D. # 82223

Sample Received: 5/24/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Deep Monitor Well #3

REPORT OF ANALYSIS

Total Dissolved Solids	26,590	mg/l
Sodium	6,600	mg/l
Potassium	220	mg/l
Calcium	750	mg/l
Magnesium	800	mg/l
Iron	1.80	mg/l
Chloride	16,300	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	1,770	mg/l
Phosphorus, Total as P	0.03	mg/l
Fluoride	0.67	mg/l
Hydrogen Sulfide	0.28	mg/l
Fluid Density	1.0164	g/ml
pH	7.9	S.U.
Conductivity	33,200	umhos/cm
Nitrate, as N	0.04	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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June 5, 1985

Report # J 5046
Lab I.D. # 82223

Sample Received: 5/29/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Shallow Well Samples, as noted.

REPORT OF ANALYSIS

	# 1 (5/24)	# 2 (5/25)	# 3 (5/26)	
Total Dissolved Solids	1,752	1,742	1,730	mg/l
Sodium	460	430	390	mg/l
Potassium	10.0	9.80	9.20	mg/l
Calcium	77	89.5	73.0	mg/l
Magnesium	48.0	41.0	47.0	mg/l
Iron	0.08	0.04	0.04	mg/l
Chloride	770	770	710	mg/l
Sulfate	106	101	105	mg/l
Phosphorus, Total as P	0.03	0.05	0.05	mg/l
Fluoride	0.55	0.46	0.55	mg/l
Hydrogen Sulfide	1.48	0.68	1.72	mg/l
Conductivity	2,500	2,500	2,470	umhos/cm
Nitrate, as N	0.37	0.46	0.66	mg/l
Fluid Density	0.9969	0.9976	0.9973	g/ml
pH	8.20	9.82	8.56	S.U.
Bicarbonate Alkalinity	24.0	< 1.0	37.0	mg/l
Carbonate Alkalinity	10.0	4.0	10.0	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

CHEMICAL DATA

Injection Well Via Messenger
Bottle Samplers

Enviropact of Jacksonville, Inc.
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Plaza 6-Suite 201
Boca Raton, FL 33432

August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ ~~X~~ 700'. (#1)
700' - #1

REPORT OF ANALYSIS

Total Dissolved Solids	1,260	mg/l
Sodium	250	mg/l
Potassium	9.0	mg/l
Calcium	60	mg/l
Magnesium	52	mg/l
Iron	0.45	mg/l
Chloride	610	mg/l
Bicarbonate Alkalinity	158	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	79	mg/l
Phosphorus, Total as P	0.06	mg/l
Fluoride	0.64	mg/l
Fluid Density	0.9982	g/ml
pH	7.8	S.U.
Conductivity	1,990	umhos/cm
Nitrate, as N	0.04	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84
Collected by: Your Rep.
Sample Designation: Well Sample @ 800' (#2)

REPORT OF ANALYSIS

Total Dissolved Solids	1,385	mg/l
Sodium	240	mg/l
Potassium	7.0	mg/l
Calcium	54	mg/l
Magnesium	52	mg/l
Iron	0.25	mg/l
Chloride	660	mg/l
Bicarbonate Alkalinity	156	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	80	mg/l
Phosphorus, Total as P	0.07	mg/l
Fluoride	0.90	mg/l
Fluid Density	0.9983	g/ml
pH	7.8	S.U.
Conductivity	2,210	umhos/cm
Nitrate, as N	0.03	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 900'. (#3)

REPORT OF ANALYSIS

Total Dissolved Solids	1,461	mg/l
Sodium	240	mg/l
Potassium	11.0	mg/l
Calcium	56	mg/l
Magnesium	52	mg/l
Iron	0.26	mg/l
Chloride	750	mg/l
Bicarbonate Alkalinity	156	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	91	mg/l
Phosphorus, Total as P	0.04	mg/l
Fluoride	0.90	mg/l
Fluid Density	0.9984	g/ml
pH	7.8	S.U.
Conductivity	2,390	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen

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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,000'. (#4)

REPORT OF ANALYSIS

Total Dissolved Solids	1,460	mg/l
Sodium	260	mg/l
Potassium	12.0	mg/l
Calcium	60	mg/l
Magnesium	53	mg/l
Iron	0.16	mg/l
Chloride	550	mg/l
Bicarbonate Alkalinity	154	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	97	mg/l
Phosphorus, Total as P	0.06	mg/l
Fluoride	1.10	mg/l
Fluid Density	0.9984	g/ml
pH	7.7	S.U.
Conductivity	2,220	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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Scott Van Vonderen
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August 23, 1984

Report # J 3777
Lab. I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,100'. (#5)

REPORT OF ANALYSIS

Total Dissolved Solids	2,814	mg/l
Sodium	620	mg/l
Potassium	22.0	mg/l
Calcium	79	mg/l
Magnesium	75	mg/l
Iron	0.08	mg/l
Chloride	1,440	mg/l
Bicarbonate Alkalinity	150	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	181	mg/l
Phosphorus, Total as P	0.06	mg/l
Fluoride	1.70	mg/l
Fluid Density	0.9996	g/ml
pH	7.6	S.U.
Conductivity	4,200	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84
Collected by: Your Rep.
Sample Designation: Well Sample @ 1,200'. (#6)

REPORT OF ANALYSIS

Total Dissolved Solids	8,713	mg/l
Sodium	2,100	mg/l
Potassium	50.0	mg/l
Calcium	150	mg/l
Magnesium	230	mg/l
Iron	0.13	mg/l
Chloride	4,375	mg/l
Bicarbonate Alkalinity	152	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	425	mg/l
Phosphorus, Total as P	0.11	mg/l
Fluoride	2.00	mg/l
Fluid Density	1.0047	g/ml
pH	7.5	S.U.
Conductivity	12,900	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,300'. (#7)

REPORT OF ANALYSIS

Total Dissolved Solids	24,396	mg/l
Sodium	5,200	mg/l
Potassium	250	mg/l
Calcium	270	mg/l
Magnesium	480	mg/l
Iron	0.17	mg/l
Chloride	13,250	mg/l
Bicarbonate Alkalinity	137	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	395	mg/l
Phosphorus, Total as P	0.08	mg/l
Fluoride	2.40	mg/l
Fluid Density	1.0185	g/ml
pH	7.4	S.U.
Conductivity	34,000	umhos/cm
Nitrate, as N	0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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Scott Van Vonderen
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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,340'. (#8)

REPORT OF ANALYSIS

Total Dissolved Solids	36,990	mg/l
Sodium	7,800	mg/l
Potassium	340	mg/l
Calcium	420	mg/l
Magnesium	630	mg/l
Iron	0.21	mg/l
Chloride	19,500	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,560	mg/l
Phosphorus, Total as P	0.07	mg/l
Fluoride	2.50	mg/l
Fluid Density	1.0296	g/ml
pH	7.4	S.U.
Conductivity	45,000	umhos/cm
Nitrate, as N	0.16	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,500'. (#9)

REPORT OF ANALYSIS

Total Dissolved Solids	36,817	mg/l
Sodium	10,200	mg/l
Potassium	310	mg/l
Calcium	460	mg/l
Magnesium	670	mg/l
Iron	0.19	mg/l
Chloride	20,000	mg/l
Bicarbonate Alkalinity	132	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,310	mg/l
Phosphorus, Total as P	0.10	mg/l
Fluoride	2.10	mg/l
Fluid Density	1.0294	g/ml
pH	7.4	S.U.
Conductivity	48,000	umhos/cm
Nitrate, as N	0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,640'. (#10)

REPORT OF ANALYSIS

Total Dissolved Solids	37,181	mg/l
Sodium	9,600	mg/l
Potassium	265	mg/l
Calcium	540	mg/l
Magnesium	1,200	mg/l
Iron	0.15	mg/l
Chloride	21,500	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,310	mg/l
Phosphorus, Total as P	0.07	mg/l
Fluoride	1.90	mg/l
Fluid Density	1.0297	g/ml
pH	7.3	S.U.
Conductivity	45,100	umhos/cm
Nitrate, as N	0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

Enviropact
of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
Jacksonville, Florida 32206
Telephone: (904) 354-6755
Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,800'. (#11)

REPORT OF ANALYSIS

Total Dissolved Solids	37,884	mg/l
Sodium	9,500	mg/l
Potassium	400	mg/l
Calcium	530	mg/l
Magnesium	1,100	mg/l
Iron	0.26	mg/l
Chloride	21,000	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,520	mg/l
Phosphorus, Total as P	0.07	mg/l
Fluoride	2.20	mg/l
Fluid Density	1.0304	g/ml
pH	7.3	S.U.
Conductivity	49,500	umhos/cm
Nitrate, as N	0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

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Client: Mr. Eduardo Aguilar
DAMES & MOORE
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Plaza 6-Suite 201
Boca Raton, FL 33432

August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 1,900'. (#12)

REPORT OF ANALYSIS

Total Dissolved Solids	36,404	mg/l
Sodium	10,000	mg/l
Potassium	210	mg/l
Calcium	500	mg/l
Magnesium	1,300	mg/l
Iron	0.21	mg/l
Chloride	20,000	mg/l
Bicarbonate Alkalinity	132	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	1,550	mg/l
Phosphorus, Total as P	0.08	mg/l
Fluoride	2.20	mg/l
Fluid Density	1.0290	g/ml
pH	7.4	S.U.
Conductivity	48,800	umhos/cm
Nitrate, as N	0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

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Environmental Consulting and Analysis

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Plaza 6-Suite 201
Boca Raton, FL 33432

August 23, 1984

Report # J 3777
Lab I.D. # 82223

Sample Received: 8/9/84 Collected by: Your Rep.
Sample Designation: Well Sample @ 2,050'. (#13)

REPORT OF ANALYSIS

Total Dissolved Solids	37,064	mg/l
Sodium	9,100	mg/l
Potassium	220	mg/l
Calcium	600	mg/l
Magnesium	1,500	mg/l
Iron	0.10	mg/l
Chloride	21,000	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	1,525	mg/l
Phosphorus, Total as P	0.07	mg/l
Fluoride	2.50	mg/l
Fluid Density	1.0296	g/ml
pH	7.4	S.U.
Conductivity	49,200	umhos/cm
Nitrate, as N	0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

CHEMICAL DATA

Packer Tests

Rec 1

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
Jacksonville, Florida 32206
Telephone: (904) 354-6755
Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

August 28, 1984

Report # J 3796A
Lab I.D. # 82223

Sample Received: 8/13/84 Collected by: Your Rep.
Sample Designation: Packer Test #1 (1,970'-2,070')

8/9/84

REPORT OF ANALYSIS

Total Dissolved Solids	33,144	mg/l
Sodium	7,000	mg/l
Potassium	360	mg/l
Calcium	590	mg/l
Magnesium	1,100	mg/l
Iron	10.0	mg/l
Chloride	20,000	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	3,000	mg/l
Phosphorus, Total as P	0.06	mg/l
Fluoride	0.70	mg/l
Hydrogen Sulfide	< 0.10	mg/l
Fluid Density	1.0262	g/ml
pH	7.1	S.U.
Conductivity	47,100	umhos/cm
Nitrate, as N	0.28	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

Rec 2

Enviropact
of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
Jacksonville, Florida 32206
Telephone: (904) 354-6755
Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

August 28, 1984

Report # J 3796A
Lab I.D. # 82223

Sample Received: 8/13/84
Collected by: Your Rep.
Sample Designation: Packer Test #2 (1,800'-1,980')
8/11/84

REPORT OF ANALYSIS

Total Dissolved Solids	33,749	mg/l
Sodium	7,600	mg/l
Potassium	260	mg/l
Calcium	560	mg/l
Magnesium	1,010	mg/l
Iron	10.0	mg/l
Chloride	20,000	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,850	mg/l
Phosphorus, Total as P	0.06	mg/l
Fluoride	0.68	mg/l
Hydrogen Sulfide	0.16	mg/l
Fluid Density	1.0267	g/ml
pH	7.1	S.U.
Conductivity	46,000	umhos/cm
Nitrate, as N	0.07	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

BREVARD County
BOARD OF COUNTY COMMISSIONERS

SEAL OF BREVARD COUNTY FLORIDA

UTILITY SERVICES DEPARTMENT, 255 Sykes Creek Parkway, Suite 103, Merritt Island, FL 32953

October 13, 1988

CENTRAL FLORIDA DISTRICT
OCT 1988
RECEIVED

John Armstrong
Department of Environmental
Regulation
3319 Maguire Blvd.
Suite 232
Orlando, FL 32803

RE: REVISED O & M MANUAL INJ. WELL #1, SOUTH BEACHES WWTP

I am hereby submitting for your review two (2) copies of the Revised Operation and Maintenance Manual for Injection Well # 1 at the South Beaches WWTP. I am confident that this submittal will fulfill your requirements. It is my understanding that this submittal completes the application for the operating permit.

Please let us know if any further problems arise that will effect the issuance of this permit.

Sincerely,

Chuck Striffler

Chuck Striffler
Utility Services Director

CAS/RHM:snb

Enclosures

cc: R. H. Martens
Tom King
Robert Hutcheson - G & M

RECEIVED
OCT 26 1988
UIC
Technical Support Section

Rec 3

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
Jacksonville, Florida 32206
Telephone: (904) 354-6755
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Client: Mr. Eduardo Aguilar
DAMES & MOORE
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Plaza 6-Suite 201
Boca Raton, FL 33432

August 28, 1984

Report # J 3796A
Lab I.D. # 82223

Sample Received: 8/13/84 Collected by: Your Rep.
Sample Designation: Packer Test #3 (1,785'-1,885')
8/11/84

REPORT OF ANALYSIS

Total Dissolved Solids	31,740	mg/l
Sodium	7,000	mg/l
Potassium	310	mg/l
Calcium	540	mg/l
Magnesium	850	mg/l
Iron	4.1	mg/l
Chloride	19,000	mg/l
Bicarbonate Alkalinity	165	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,570	mg/l
Phosphorus, Total as P	0.06	mg/l
Fluoride	2.20	mg/l
Hydrogen Sulfide	0.28	mg/l
Fluid Density	1.0249	g/ml
pH	7.2	S.U.
Conductivity	44,000	umhos/cm
Nitrate, as N	0.11	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

16c-

RECEIVED SEP 7 1984

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
Jacksonville, Florida 32206
Telephone: (904) 354-6755
Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84 Collected by: Your Rep.
Sample Designation: Packer Test # 4. 8/15/84 (1690-1790)

REPORT OF ANALYSIS

Total Dissolved Solids	36,404	mg/l
Sodium	9,000	mg/l
Potassium	340	mg/l
Calcium	390	mg/l
Magnesium	870	mg/l
Iron	6.60	mg/l
Chloride	19,000	mg/l
Bicarbonate Alkalinity	125	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	3,050	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.84	mg/l
Hydrogen Sulfide	0.28	mg/l
Fluid Density	1.0290	g/ml
pH	7.1	S.U.
Conductivity	48,000	umhos/cm
Nitrate, as N	0.03	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

Rec 5

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

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Plaza 5-Suite 201
Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84
Sample Designation: Packer Test # 5. (1605-1705)
Collected by: Your Rep.

REPORT OF ANALYSIS

Total Dissolved Solids	33,174	mg/l
Sodium	7,800	mg/l
Potassium	270	mg/l
Calcium	420	mg/l
Magnesium	770	mg/l
Iron	7.40	mg/l
Chloride	21,000	mg/l
Bicarbonate Alkalinity	136	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,600	mg/l
Phosphorus, Total as P	0.53	mg/l
Fluoride	0.94	mg/l
Hydrogen Sulfide	0.20	mg/l
Fluid Density	1.0262	g/ml
pH	7.3	S.U.
Conductivity	43,000	umhos/cm
Nitrate, as N	0.38	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

Rcc 6

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

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Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84
Collected by: Your Rep.
Sample Designation: Packer Test # 6. (1500-1600)

REPORT OF ANALYSIS

Total Dissolved Solids	29,493	mg/l
Sodium	7,600	mg/l
Potassium	305	mg/l
Calcium	500	mg/l
Magnesium	1,000	mg/l
Iron	3.40	mg/l
Chloride	17,000	mg/l
Bicarbonate Alkalinity	132	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,590	mg/l
Phosphorus, Total as P	0.45	mg/l
Fluoride	0.66	mg/l
Hydrogen Sulfide	0.44	mg/l
Fluid Density	1.0229	g/ml
pH	7.4	S.U.
Conductivity	44,000	umhos/cm
Nitrate, as N	0.07	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

Rec 7

Enviropact
of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
Jacksonville, Florida 32206
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Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84
Collected by: Your Rep.
Sample Designation: Packer Test # 7. 8/16/84 (1405-1505)

REPORT OF ANALYSIS

Total Dissolved Solids	36,882	mg/l
Sodium	9,800	mg/l
Potassium	320	mg/l
Calcium	460	mg/l
Magnesium	1,200	mg/l
Iron	9.60	mg/l
Chloride	21,000	mg/l
Bicarbonate Alkalinity	176	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,990	mg/l
Phosphorus, Total as P	0.09	mg/l
Fluoride	0.68	mg/l
Hydrogen Sulfide	0.16	mg/l
Fluid Density	1.0294	g/ml
pH	7.2	S.U.
Conductivity	47,000	umhos/cm
Nitrate, as N	0.20	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

Rec 9

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

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Plaza 6-Suite 201
Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84 Collected by: Your Rep.
Sample Designation: Packer Test # 8. 8/16/84 (1353 - 1353)

REPORT OF ANALYSIS

Total Dissolved Solids	36,166	mg/l
Sodium	9,700	mg/l
Potassium	280	mg/l
Calcium	480	mg/l
Magnesium	1,000	mg/l
Iron	1.40	mg/l
Chloride	21,000	mg/l
Bicarbonate Alkalinity	196	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,725	mg/l
Phosphorus, Total as P	0.02	mg/l
Fluoride	0.80	mg/l
Hydrogen Sulfide	0.20	mg/l
Fluid Density	1.0288	g/ml
pH	7.4	S.U.
Conductivity	45,000	umhos/cm
Nitrate, as N	0.04	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

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Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84 Collected by: Your Rep.
Sample Designation: Packer Test # 8. (REPEAT)
8/17/84

REPORT OF ANALYSIS

Total Dissolved Solids	33,026	mg/l
Sodium	7,500	mg/l
Potassium	320	mg/l
Calcium	390	mg/l
Magnesium	1,200	mg/l
Iron	1.40	mg/l
Chloride	19,000	mg/l
Bicarbonate Alkalinity	150	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	2,800	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.86	mg/l
Hydrogen Sulfide	0.24	mg/l
Fluid Density	1.0261	g/ml
pH	7.3	S.U.
Conductivity	43,000	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

Rec 9

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

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Fla. Watts: (800) 432-9706

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DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84 Collected by: Your Rep.
Sample Designation: Packer Test # 9. 8/16/84 (1155-1255)

REPORT OF ANALYSIS

Total Dissolved Solids	5,186	mg/l
Sodium	1,700	mg/l
Potassium	43	mg/l
Calcium	90	mg/l
Magnesium	1,100	mg/l
Iron	0.94	mg/l
Chloride	1,030	mg/l
Bicarbonate Alkalinity	150	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	1,050	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.86	mg/l
Hydrogen Sulfide	1.50	mg/l
Fluid Density	1.0016	g/ml
pH	7.5	S.U.
Conductivity	8,000	umhos/cm
Nitrate, as N	0.13	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

Rec 10

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
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Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

September 5, 1984

Report # J 3837
Lab I.D. # 82223

Sample Received: 8/20/84
Collected by: Your Rep.
Sample Designation: Packer Test # 10. 8/17/84 (1000-1100)

REPORT OF ANALYSIS

Total Dissolved Solids	2,966	mg/l
Sodium	740	mg/l
Potassium	28	mg/l
Calcium	66	mg/l
Magnesium	100	mg/l
Iron	0.44	mg/l
Chloride	1,400	mg/l
Bicarbonate Alkalinity	156	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	273	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.80	mg/l
Hydrogen Sulfide	1.60	mg/l
Fluid Density	0.9997	g/ml
pH	7.5	S.U.
Conductivity	4,500	umhos/cm
Nitrate, as N	0.10	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

CHEMICAL DATA

Indian River Water used for
Injection Testing

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
Jacksonville, Florida 32206
Telephone: (904) 354-6755
Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 West Camino Gardens Boulevard
Boca Raton, Florida 33432

July 1, 1985

Report # J 5158
Lab I.D. # 82223

Sample Received: 6/21/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #1

Total Suspended Solids	45	mg/l
Chloride	11,370	mg/l
Salinity	17.1	ppt
Conductivity	29,000	umhos/cm
Fecal Coliform	< 1	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy
Radford S. Murphy
Laboratory Director

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

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Jacksonville, Florida 32206
Telephone: (904) 354-6755
Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 West Camino Gardens Boulevard
Boca Raton, Florida 33432

July 1, 1985

Report # J 5158
Lab I.D. # 82223

Sample Received: 6/21/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #2

Total Suspended Solids	95	mg/l
Chloride	14,625	mg/l
Salinity	19.1	ppt
Conductivity	27,800	umhos/cm
Fecal Coliform	< 1	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

1627 East 8 Street
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Telephone: (904) 354-6755
Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 West Camino Gardens Boulevard
Boca Raton, Florida 33432

July 1, 1985

Report # J 5158
Lab I.D. # 82223

Sample Received: 6/21/85
Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #3

Total Suspended Solids	67	mg/l
Chloride	12,000	mg/l
Salinity	18.1	ppt
Conductivity	27,100	umhos/cm
Fecal Coliform	< 1	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy
Radford S. Murphy
Laboratory Director

Enviropact of Jacksonville, Inc.
Environmental Consulting and Analysis

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Telephone: (904) 354-6755
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Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 West Camino Gardens Boulevard
Boca Raton, Florida 33432

July 1, 1985
Report # J 5165
Lab I.D. # 82223

Sample Received: 6/24/85
Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #4

Total Suspended Solids	47	mg/l
Chloride	12,095	mg/l
Salinity	15.5	ppt
Conductivity	26,900	umhos/cm
Fecal Coliform	< 1	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

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Fla. Watts: (800) 432-9706

Client: Mr. Eduardo Aguilar
DAMES & MOORE
350 West Camino Gardens Boulevard
Boca Raton, Florida 33432

July 1, 1985

Report # J 5165
Lab I.D. # 82223

Sample Received: 6/24/85
Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #5

Total Suspended Solids	79	mg/l
Chloride	14,250	mg/l
Salinity	17.8	ppt
Conductivity	26,100	umhos/cm
Fecal Coliform	3	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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Radford S. Murphy
Laboratory Director

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July 1, 1985

Report # J 5165
Lab I.D. # 82223

Sample Received: 6/24/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #6

Total Suspended Solids	65	mg/l
Chloride	13,750	mg/l
Salinity	17.9	ppt
Conductivity	27,000	umhos/cm
Fecal Coliform	2	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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Radford S. Murphy
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Client: Mr. Eduardo Aguilar
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Boca Raton, Florida 33432

July 16, 1985

Report # J 5176
Lab I.D. # 82223

Sample Received: 6/27/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #7

Total Suspended Solids	49	mg/l
Chloride	15,245	mg/l
Salinity	16.9	ppt
Conductivity	22,750	umhos/cm
Fecal Coliform	120	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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July 16, 1985

Report # J 5176
Lab I.D. # 82223

Sample Received: 6/27/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #8

Total Suspended Solids	54	mg/l
Chloride	11,750	mg/l
Salinity	15.9	ppt
Conductivity	26,900	umhos/cm
Fecal Coliform	158	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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July 16, 1985

Report # J 5176
Lab I.D. # 82223

Sample Received: 6/27/85 Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #9

Total Suspended Solids	62	mg/l
Chloride	11,371	mg/l
Salinity	17.3	ppt
Conductivity	28,000	umhos/cm
Fecal Coliform	2	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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July 16, 1985

Report # J 5196
Lab I.D. # 82223

Sample Received: 7/1/85
Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #10

Total Suspended Solids	82	mg/l
Chloride	14,371	mg/l
Salinity	17.1	ppt
Conductivity	27,500	umhos/cm
Fecal Coliform	< 1	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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Radford S. Murphy
Laboratory Director

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July 16, 1985

Report # J 5196
Lab I.D. # 82223

Sample Received: 7/1/85
Collected by: Your Rep.
Sample Designation: Melbourne Beach Injection Well Sample, as noted.

REPORT OF ANALYSIS

INJECTION TEST #11

Total Suspended Solids	204	mg/l
Chloride	13,500	mg/l
Salinity	18.2	ppt
Conductivity	28,200	umhos/cm
Fecal Coliform	< 1	/100mls

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

CHEMICAL DATA

Artesian Flow
(300 - 2160 Feet)

Enviropact of Jacksonville, Inc.
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July 9, 1984

Report # J 3562
Lab I.D. # 82223

Sample Received: 6/26/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 300'. (#1)

REPORT OF ANALYSIS

Total Dissolved Solids	1,030	mg/l
Sodium	230	mg/l
Potassium	8.4	mg/l
Calcium	130	mg/l
Magnesium	34	mg/l
Iron	0.33	mg/l
Chloride	420	mg/l
Bicarbonate Alkalinity	80	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	78	mg/l
Phosphorus, Total as P	0.14	mg/l
Fluoride	0.54	mg/l
Hydrogen Sulfide	0.44	mg/l
Fluid Density	0.9980	g/ml
pH	7.7	S.U.
Conductivity	1,700	μmhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy
Radford S. Murphy
Laboratory Director

CC: Mr. Jim Furlow

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July 9, 1984

Report # J 3569
Lab I.D. # 82223

Sample Received: 6/27/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 383' (#2)

REPORT OF ANALYSIS

Total Dissolved Solids	1,160	mg/l
Sodium	280	mg/l
Potassium	7.4	mg/l
Calcium	150	mg/l
Magnesium	68	mg/l
Iron	0.09	mg/l
Chloride	510	mg/l
Bicarbonate Alkalinity	140	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	94	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.48	mg/l
Hydrogen Sulfide	2.80	mg/l
Fluid Density	0.9981	g/ml
pH	7.6	S.U.
Conductivity	2,200	µmhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy
Radford S. Murphy
Laboratory Director

CC: Mr. Jim Furlow

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July 9, 1984

Report # J 3569
Lab I.D. # 82223

Sample Received: 6/27/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 479' (#3)

REPORT OF ANALYSIS

Total Dissolved Solids	1,391	mg/l
Sodium	220	mg/l
Potassium	6.6	mg/l
Calcium	140	mg/l
Magnesium	62	mg/l
Iron	0.04	mg/l
Chloride	470	mg/l
Bicarbonate Alkalinity	140	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	90	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.44	mg/l
Hydrogen Sulfide	2.90	mg/l
Fluid Density	0.9983	g/ml
pH	7.6	S.U.
Conductivity	2,090	µmhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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CC: Mr. Jim Furlow

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July 13, 1984

Report # J 3580
(ADDENDUM)
Lab I.D. # 82223

Sample Received: 6/28/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 575' (#4))

REPORT OF ANALYSIS

Total Dissolved Solids	1,253	mg/l
Sodium	230	mg/l
Potassium	6.6	mg/l
Calcium	98	mg/l
Magnesium	54	mg/l
Iron	0.06	mg/l
Chloride	450	mg/l
Bicarbonate Alkalinity	136	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	81	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.50	mg/l
Hydrogen Sulfide	3.0	mg/l
Fluid Density	0.9982	g/ml
pH	7.3	S.U.
Conductivity	1,800	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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Radford S. Murphy
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July 13, 1984

Report # J 3590
(ADDENDUM)
Lab I.D. # 82223

Sample Received: 6/29/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 667' (#5)

REPORT OF ANALYSIS

Total Dissolved Solids	1,080	mg/l
Sodium	210	mg/l
Potassium	6.2	mg/l
Calcium	130	mg/l
Magnesium	58	mg/l
Iron	0.08	mg/l
Chloride	460	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	86	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.46	mg/l
Hydrogen Sulfide	3.1	mg/l
Fluid Density	0.9980	g/ml
pH	7.2	S.U.
Conductivity	1,850	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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July 13, 1984

Report # J 3596
Lab I.D. # 82223

Sample Received: 6/30/84
Collected by: Your Rep.
Sample Designation: Artesian Flow @ 759'. (#6)

REPORT OF ANALYSIS

Total Dissolved Solids	1,092	mg/l
Sodium	230	mg/l
Potassium	5.1	mg/l
Calcium	130	mg/l
Magnesium	58	mg/l
Iron	0.06	mg/l
Chloride	450	mg/l
Bicarbonate Alkalinity	146	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	80	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.48	mg/l
Hydrogen Sulfide	3.2	mg/l
Fluid Density	0.9981	g/ml
pH	7.2	S.U.
Conductivity	1,720	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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July 13, 1984

Report # J 3596
Lab I.D. # 82223

Sample Received: 6/30/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 854'. (#7)

REPORT OF ANALYSIS

Total Dissolved Solids	1,190	mg/l
Sodium	280	mg/l
Potassium	5.1	mg/l
Calcium	125	mg/l
Magnesium	59	mg/l
Iron	0.09	mg/l
Chloride	440	mg/l
Bicarbonate Alkalinity	146	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	95	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.47	mg/l
Hydrogen Sulfide	3.2	mg/l
Fluid Density	0.9981	g/ml
pH	7.4	S.U.
Conductivity	1,700	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

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July 13, 1984

Report # J 3596
Lab I.D. # 82223

Sample Received: 6/30/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 944'. (#8)

REPORT OF ANALYSIS

Total Dissolved Solids	1,015	mg/l
Sodium	230	mg/l
Potassium	5.0	mg/l
Calcium	130	mg/l
Magnesium	57	mg/l
Iron	0.04	mg/l
Chloride	430	mg/l
Bicarbonate Alkalinity	146	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	92.5	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.45	mg/l
Hydrogen Sulfide	3.2	mg/l
Fluid Density	0.9980	g/ml
pH	7.4	S.U.
Conductivity	1,450	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

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Radford S. Murphy
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July 13, 1984

Report # J 3596
Lab I.D. # 82223

Sample Received: 6/30/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,041' (#9)

REPORT OF ANALYSIS

Total Dissolved Solids	1,060	mg/l
Sodium	240	mg/l
Potassium	4.8	mg/l
Calcium	140	mg/l
Magnesium	61	mg/l
Iron	0.07	mg/l
Chloride	400	mg/l
Bicarbonate Alkalinity	148	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	86	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.40	mg/l
Hydrogen Sulfide	3.2	mg/l
Fluid Density	0.9981	g/ml
pH	7.5	S.U.
Conductivity	1,380	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
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July 13, 1984

Report # J 3599
Lab I.D. # 82223

Sample Received: 7/2/84
Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,135′ (#10)

REPORT OF ANALYSIS

Total Dissolved Solids	1,158	mg/l
Sodium	200	mg/l
Potassium	4.9	mg/l
Calcium	120	mg/l
Magnesium	55	mg/l
Iron	0.04	mg/l
Chloride	400	mg/l
Bicarbonate Alkalinity	142	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	86	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.40	mg/l
Hydrogen Sulfide	3.3	mg/l
Fluid Density	0.9981	g/ml
pH	7.5	S.U.
Conductivity	1,800	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

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Laboratory Director

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July 13, 1984

Report # J 3619
Lab I.D. # 82223

Sample Received: 7/5/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,229' (#11)

REPORT OF ANALYSIS

Total Dissolved Solids	1,153	mg/l
Sodium	188	mg/l
Potassium	5.4	mg/l
Calcium	105	mg/l
Magnesium	61	mg/l
Iron	0.03	mg/l
Chloride	410	mg/l
Bicarbonate Alkalinity	140	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	114	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.40	mg/l
Hydrogen Sulfide	3.6	mg/l
Fluid Density	0.9981	g/ml
pH	7.5	S.U.
Conductivity	1,710	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

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July 13, 1984

Report # J 3619
Lab I.D. # 82223

Sample Received: 7/5/84
Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,323' (#12)

REPORT OF ANALYSIS

Total Dissolved Solids	1,159	mg/l
Sodium	176	mg/l
Potassium	5.0	mg/l
Calcium	106	mg/l
Magnesium	62	mg/l
Iron	0.05	mg/l
Chloride	410	mg/l
Bicarbonate Alkalinity	142	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	111	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.48	mg/l
Hydrogen Sulfide	3.5	mg/l
Fluid Density	0.9981	g/ml
pH	7.7	S.U.
Conductivity	1,700	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
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RSM/sam
CC: Mr. Jim Furlow

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July 13, 1984

Report # J 3619
Lab I.D. # 82223

Sample Received: 7/5/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,416' (#13)

REPORT OF ANALYSIS

Total Dissolved Solids	1,155	mg/l
Sodium	154	mg/l
Potassium	5.7	mg/l
Calcium	68	mg/l
Magnesium	58	mg/l
Iron	0.09	mg/l
Chloride	450	mg/l
Bicarbonate Alkalinity	140	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	108	mg/l
Phosphorus, Total as P	0.16	mg/l
Fluoride	0.49	mg/l
Hydrogen Sulfide	3.6	mg/l
Fluid Density	0.9981	g/ml
pH	7.6	S.U.
Conductivity	1,780	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
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July 13, 1984

Report # J 3626
Lab I.D. # 82223

Sample Received: 7/6/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,507' (#14)

REPORT OF ANALYSIS

Total Dissolved Solids	1,175	mg/l
Sodium	228	mg/l
Potassium	5.8	mg/l
Calcium	102	mg/l
Magnesium	56	mg/l
Iron	0.01	mg/l
Chloride	480	mg/l
Bicarbonate Alkalinity	140	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	100	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.48	mg/l
Hydrogen Sulfide	3.4	mg/l
Fluid Density	0.9981	g/ml
pH	7.7	S.U.
Conductivity	1,780	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
CC: Mr. Jim Furlow

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DAMES & MOORE
350 W. Camino Gardens Blvd.
Plaza 6-Suite 201
Boca Raton, FL 33432

July 18, 1984

Report # J 3635A
Lab I.D. # 82223

Sample Received: 7/9/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,602' (#15)

REPORT OF ANALYSIS

Total Dissolved Solids	1,172	mg/l
Sodium	210	mg/l
Potassium	2.9	mg/l
Calcium	69	mg/l
Magnesium	62	mg/l
Iron	0.03	mg/l
Chloride	460	mg/l
Bicarbonate Alkalinity	144	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	100	mg/l
Phosphorus, Total as P	0.14	mg/l
Fluoride	0.47	mg/l
Hydrogen Sulfide	3.4	mg/l
Fluid Density	0.9981	g/ml
pH	7.8	S.U.
Conductivity	1,700	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Radford S. Murphy

Radford S. Murphy
Laboratory Director

RSM/sam
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July 25, 1984

Report # J 3659A
Lab I.D. # 82223

Sample Received: 7/16/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,695' (#16)

REPORT OF ANALYSIS

Total Dissolved Solids	1,134	mg/l
Sodium	200	mg/l
Potassium	3.9	mg/l
Calcium	73	mg/l
Magnesium	76	mg/l
Iron	0.03	mg/l
Chloride	520	mg/l
Bicarbonate Alkalinity	136	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	82	mg/l
Phosphorus, Total as P	0.05	mg/l
Fluoride	0.55	mg/l
Hydrogen Sulfide	3.6	mg/l
Fluid Density	0.9983	g/ml
pH	7.4	S.U.
Conductivity	1,800	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

RSM/sam
CC: Mr. Jim Furlow

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Client: Mr. Eduardo Aguilar
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~~Plaza 6~~ Suite 201
Boca Raton, FL 33432

July 25, 1984

Report # J 3664A
Lab I.D. # 82223

Sample Received: 7/17/84
Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,788' (#17)

REPORT OF ANALYSIS

Total Dissolved Solids	1,020	mg/l
Sodium	200	mg/l
Potassium	5.6	mg/l
Calcium	70	mg/l
Magnesium	56	mg/l
Iron	0.05	mg/l
Chloride	498	mg/l
Bicarbonate Alkalinity	140	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	84	mg/l
Phosphorus, Total as P	0.05	mg/l
Fluoride	0.57	mg/l
Hydrogen Sulfide	3.4	mg/l
Fluid Density	0.9980	g/ml
pH	7.5	S.U.
Conductivity	1,950	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

RSM/sam
CC: Mr. Jim Furlow

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July 30, 1984

Report # J 3692
Lab I.D. # 82223

Sample Received: 7/23/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,881' (#18)

REPORT OF ANALYSIS

Total Dissolved Solids	1,399	mg/l
Sodium	260	mg/l
Potassium	6.6	mg/l
Calcium	83	mg/l
Magnesium	76	mg/l
Iron	0.10	mg/l
Chloride	510	mg/l
Bicarbonate Alkalinity	132	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	115	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.58	mg/l
Hydrogen Sulfide	3.7	mg/l
Fluid Density	0.9983	g/ml
pH	7.4	S.U.
Conductivity	2,000	umhos/cm

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

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Client: Mr. Eduardo Aguilar
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Boca Raton, FL 33432

August 7, 1984

Report # J 3709A
Lab I.D. # 82223

Sample Received: 7/25/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 1,974' (#19)

REPORT OF ANALYSIS

Total Dissolved Solids	1,584	mg/l
Sodium	380	mg/l
Potassium	10	mg/l
Calcium	80	mg/l
Magnesium	100	mg/l
Iron	0.11	mg/l
Chloride	780	mg/l
Bicarbonate Alkalinity	134	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	140	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.91	mg/l
Hydrogen Sulfide	3.0	mg/l
Fluid Density	0.9985	g/ml
pH	7.4	S.U.
Conductivity	2,800	umhos/cm
Nitrate, as N	0.50	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

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Client: Mr. Eduardo Aguilar
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Boca Raton, FL 33432

August 8, 1984

Report # J 3732
Lab I.D. # 82223

Sample Received: 7/30/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 2,065' (#20)

REPORT OF ANALYSIS

Total Dissolved Solids	1,424	mg/l
Sodium	300	mg/l
Potassium	7.0	mg/l
Calcium	99	mg/l
Magnesium	94	mg/l
Iron	0.024	mg/l
Chloride	615	mg/l
Bicarbonate Alkalinity	142	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	110	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.86	mg/l
Hydrogen Sulfide	2.8	mg/l
Fluid Density	0.9983	g/ml
pH	7.4	S.U.
Conductivity	2,250	umhos/cm
Nitrate, as N	0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

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August 8, 1984

Report # J 3732
Lab I.D. # 82223

Sample Received: 7/30/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 2,096' (#21)

REPORT OF ANALYSIS

Total Dissolved Solids	2,528	mg/l
Sodium	740	mg/l
Potassium	11.0	mg/l
Calcium	120	mg/l
Magnesium	160	mg/l
Iron	0.073	mg/l
Chloride	1,140	mg/l
Bicarbonate Alkalinity	144	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	196	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.72	mg/l
Hydrogen Sulfide	2.9	mg/l
Fluid Density	1.0000	g/ml
pH	7.5	S.U.
Conductivity	3,400	umhos/cm
Nitrate, as N	< 0.02	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

>11

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Environmental Consulting and Analysis

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August 9, 1984

Report # J 3744
Lab I.D. # 82223

Sample Received: 8/2/84 Collected by: Your Rep.
Sample Designation: Artesian Flow @ 2,160' (#22)

REPORT OF ANALYSIS

Total Dissolved Solids	3,150	mg/l
Sodium	1,000	mg/l
Potassium	22.0	mg/l
Calcium	120	mg/l
Magnesium	170	mg/l
Iron	0.05	mg/l
Chloride	1,450	mg/l
Bicarbonate Alkalinity	153	mg/l
Carbonate Alkalinity	< 1	mg/l
Sulfate	253	mg/l
Phosphorus, Total as P	< 0.02	mg/l
Fluoride	0.72	mg/l
Hydrogen Sulfide	3.1	mg/l
Fluid Density	0.9998	g/ml
pH	7.7	S.U.
Conductivity	4,500	umhos/cm
Nitrate, as N	0.05	mg/l

Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.

Respectfully submitted,

Scott Van Vonderen
Scott Van Vonderen
Laboratory Supervisor

SVV/sam
CC: Mr. Jim Furlow

APPENDIX C

GROUND-WATER DISCHARGE
TO INDIAN RIVER FROM DRILLING OPERATIONS

TABLE 4.1

Seepp028

DAILY MONITORING OF MIXING POND DISCHARGE INTO INDIAN RIVER

FIELD DATA

Month/1984	Day	Dissolved Oxygen (mg/l)	Temperature (Degrees C)	pH	Specific Conductivity (Umhos/cm)	Salinity (0/00)	Turbidity (NTU)	Chloride (ppm)	Depth
June	26	5.5	26	7.8	8000	5	27.5	2500	Does not agree with Appendix B
	27	7.2	27	7.6	26000	15.7	13	8000	
	28	6.5	26	7.3	18000	11	15	6000	
	29	7	26.5	7.3	11000	6.5	25	3000	
	30	6.7	26	6.8	2450	1	32	560	
July	1	6.7	26	6.7	1820	0.5	22	360	
	2	6.2	25.5	6.5	1680	0.3	31	310	
	3	6.6	26	6.4	1700	0.5	22	320	
	4	6.6	26	7.3	1920	0.8	19	390	
	5	6.4	26	7.6	1900	0.8	25	390	
	6	6.3	26	7.8	1900	0.8	24	505	
	7	6.4	26	7.7	1800	0.5	23	500	
	8	6.4	26	7.6	1850	0.8	26	470	
	9	6.2	26	7.6	1825	0.4	28	540	
	10	6.8	26	7.4	925	0.2	13	500	
	11	6.1	26	7.4	1800	0.2	18.5	500	
	12	6.9	26	7.5	2075	0.8	20	530	
	13	7.4	28	7.7	2000	1	25	503	
	14	7.6	27	7.8	2175	1	24.5	505	
	15	7	26.5	7	1900	1	23.5	530	
	16	6.9	25.5	7.8	1925	0.5	20	535	1695
	17	7.1	25.5	7.8	2000	0.6	18	500	1788
	18	6.9	26.5	7.7	2000	0.7	21.5	500	
	19	6.4	25.5	7.7	2000	0.7	25	500	
	20	6.4	25.5	7.8	1900	0.7	25	476	
	21	6.7	26	7.8	1975	0.6	25	500	
	22	6.4	25	7.7	1900	0.5	26.5	476	
	23	6.5	24.5	7.5	1900	0.6	12.5	476	1881
	24	6.1	25.5	7.6	2075	0.9	25	540	
	25	6.5	24.5	7.6	1800	0.6	26	439	1974
	26	6.1	24.5	7.6	2100	0.9	25	549	
	27	6.2	26	7.6	1950	0.8	26.5	494	
	28	6.2	23.5	7.6	2275	0.9	32	577	
	29	6.2	25	7.7	5100	3	26.5	1610	
	30	6.4	25	7.7	4800	2.5	26	1503	2076
	31	6.4	25	7.6	4950	2.6	29	1556	
August	1	6.4	25	7.7	6100	3.6	26.5	1957	
	2	6.7	24.5	7.7	7000	4	26	2270	2160
	3	6.4	25	7.6	4500	2	25	1397	
	4	6.8	26	7.6	6000	3.5	22	1850	
	5	6.5	25.2	7.6	5500	3.1	22	1750	
	6	6.6	26	7.6	4925	2.5	24	1567	
	7	7.6	24	7.9	5250	3.1	9	1670	
	8	6.5	26	7.7	4500	2.6	20	1397	
	9	6	26	7.4	3000	1.8	24	854	
	10	---	---	---	---	---	---	---	
	11	---	---	---	---	---	---	---	

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TABLE 4.1 CONT.

FIELD DATA

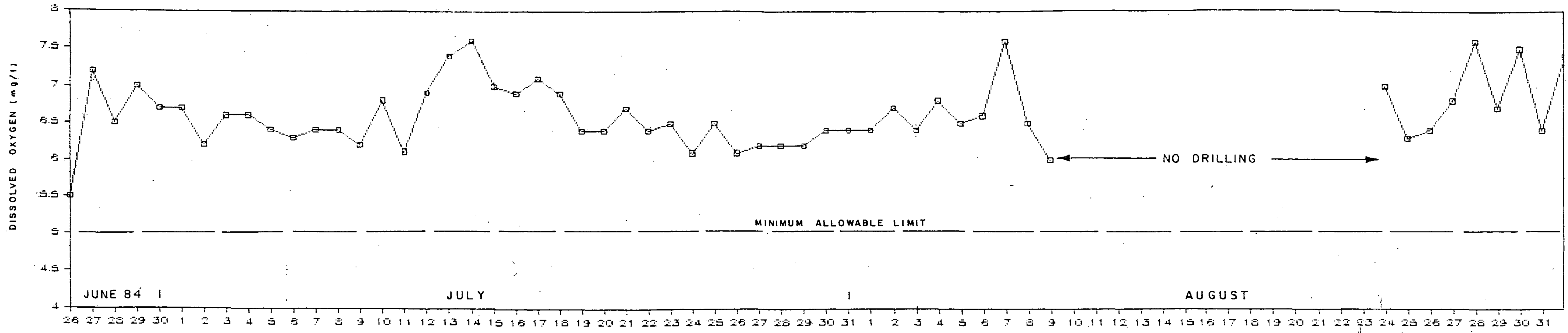
Month/1984	Day	Dissolved Oxygen (mg/l)	Temperature (Degrees C)	pH	Specific Conductivity (Umhos/cm)	Salinity (0/00)	Turbidity (NTU)	Chloride (ppm)
	12	---	---	---	---	---	---	---
	13	---	---	---	---	---	---	---
	14	---	---	---	---	---	---	---
	15	---	---	---	---	---	---	---
	16	---	---	---	---	---	---	---
	17	---	---	---	---	---	---	---
	18	---	---	---	---	---	---	---
	19	---	---	---	---	---	---	---
	20	---	---	---	---	---	---	---
	21	---	---	---	---	---	---	---
	22	---	---	---	---	---	---	---
	23	---	---	---	---	---	---	---
	24	7	25	7.7	12100	7.25	51	3809
	25	6.3	25.5	7.6	3300	2	47.5	960
	26	6.4	25.5	7.6	3825	2.2	31	1142
	27	6.8	25	7.2	4700	2.9	28.5	1468
	28	7.6	25	7.8	22000	13.5	45	6808
	29	6.7	25	7.9	27750	17	57	8165
	30	7.5	26	8	23000	14.25	57.5	6973
	31	6.4	25.5	8	4200	2.5	31.5	1250
September	1	7.4	25	7.9	2100	1.2	31	536
	2	6.7	25	7.9	1675	1	49.5	393
	3	6.1	26	7.6	2300	1.2	20	614
	4	6.4	26	7.8	2150	1.2	32	553
	5	7.8	25	8	1900	1.1	29.5	464
	6	6.4	26	7.9	13600	7.9	34	4213
	7	6.4	24	7.7	1910	1.1	22	481
	8	5.9	25	7.7	1890	1.1	23	474
	9	6	25	7.6	1820	1	33	444
	10	5.8	25	7.6	1800	1	31	439
	11	6.3	25	7.4	1790	1	29	437
	12	6	25	7.6	1600	0.9	26	378
	13	6	26	7.5	1600	0.9	29	378
	14	6.7	25.5	7.4	1650	0.9	29	380
	15	6.6	26	7.3	1700	1	32	409
	16	6.6	26	7.6	1625	0.9	32	384
	17	6.7	25.5	7.6	1625	1	32	384
	18	6.8	25	7.6	1600	0.9	26	378
	19	7.5	25	7.6	1700	1	29	409
	20	7.5	25	7.6	1700	1	27	409
	21	7.4	25	7.6	1650	1	28	380
	22	7.1	24.5	7.6	1700	1	31.5	409
	23	7.2	24.5	7.6	1900	1	49	476
	24	7.2	24.5	7.6	1800	1	31	439

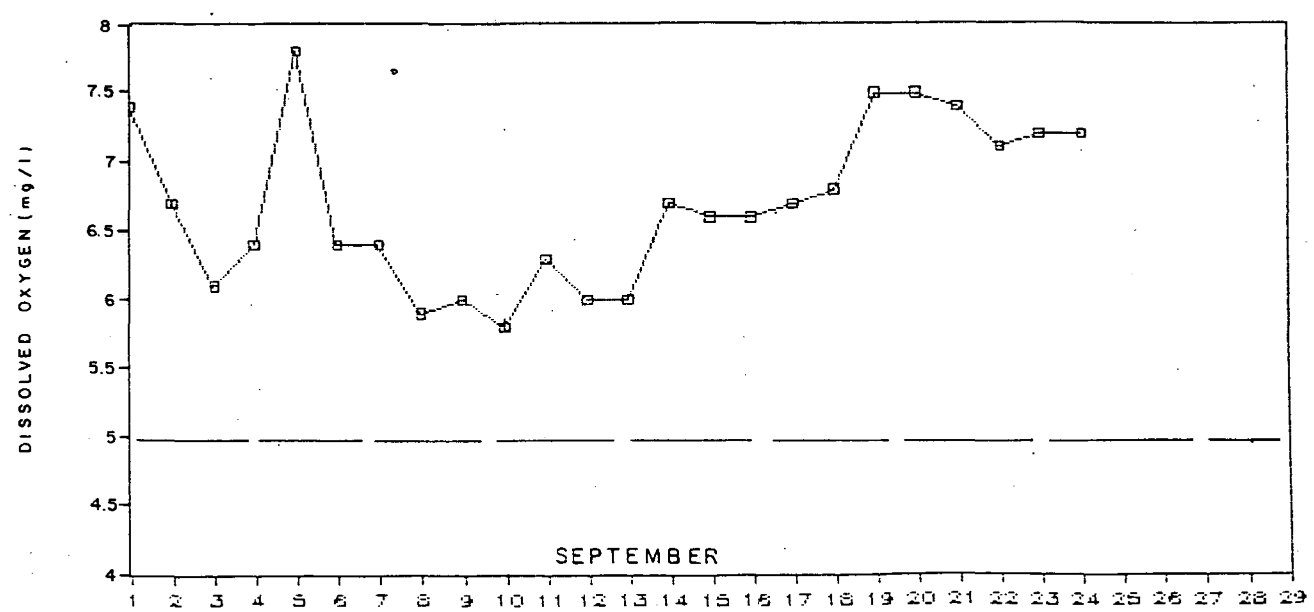
TABLE 4.2

DAILY MONITORING OF MIXING POND DISCHARGE INTO INDIAN RIVER

Month/1984	Day	Total Dissolved Solids (mg/l)	Total Suspended Solids (mg/l)
June	26	6630	10
	27	17959	17
	28	13316	16
	29	7313	19
	30	2503	5
	31	---	---
July	1	1073	1
	2	1139	<1
	3	1085	<1
	4	1267	<1
	5	1147	<1
	6	1177	3
	7	1198	2
	8	1127	1
	9	---	---
	10	1148	<1
	11	1175	1
	12	1372	1
	13	1212	1
	14	1090	4
	15	976	<1
	16	1056	<1
	17	1355	1
	18	1263	1
	19	1352	<1
	20	1220	<1
	21	1244	<1
	22	1256	<1
	23	1175	1
	24	1248	<1
	25	1266	<1
	26	1336	<1
	27	1352	<1
	28	1392	<1
	29	3787	1
	30	3103	<1
	31	3543	1
August	1	4393	1
	2	3288	4
	3	3158	2
	4	4207	5
	5	3982	6
	6	3272	<1
	7	4122	6
	8	3230	2
	9	2303	1
	10	1416	<1
	11	1947	1
	12	2307	1
	13	3706	6
	14	3611	5
	15	3304	2
	16	2269	11
	17	2326	15
	18	3995	13
	19	3956	12
	20	3977	7
	21	3535	5
	22	9809	41
	23	15509	131
	24	7350	36
	25	2159	161
	26	2607	21
	27	3135	17
	28	16100	88
	29	22561	67
	30	17925	59
	31	2417	39
September	1	1310	42
	2	891	93
	3	1405	11
	4	1246	2
	5	1383	31
	6	9754	78
	7	1208	40
	8	1137	27
	9	1040	8
	10	1265	3
	11	1152	20
	12	1088	4
	13	1195	9
	14	1200	4
	15	1128	<1
	16	1108	4
	17	1071	3
	18	1015	1
	19	1226	18
	20	828	32
	21	1315	45
	22	1070	18
	23	1270	178
	24	1289	3

Laboratory analysis performed by Enviropact of Jacksonville,Inc.. Analysis made in accordance with E.P.A., A.S.T.M., Standard Methods or other approved methods.





GROUND-WATER DISCHARGE TO INDIAN RIVER FROM DRILLING OPERATION

DISSOLVED OXYGEN

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE

FIGURE 4.6

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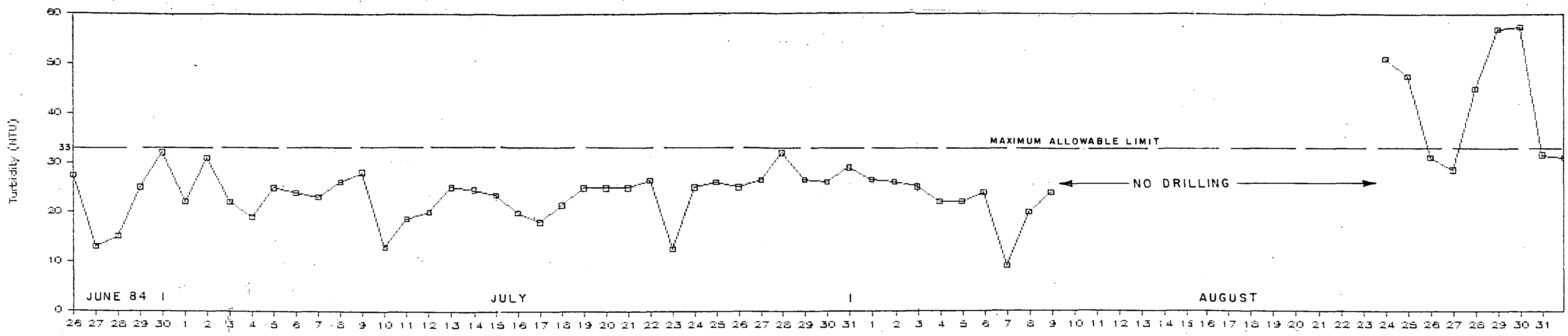
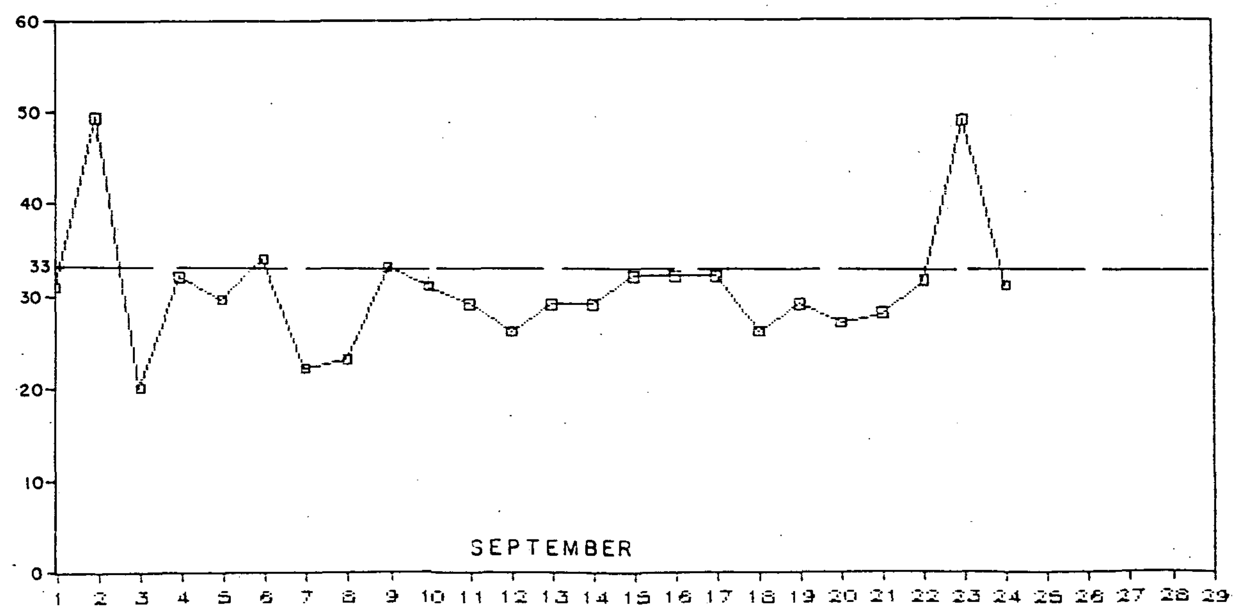
BEST AVAILABLE COPY





GROUND-WATER DISCHARGE TO INDIAN RIVER FROM DRILLING OPERATION

TURBIDITY

PROJECT : SOUTH BEACHES EXPLORATORY TEST WELL
LOCATION : BREVARD COUNTY, FLORIDA

DAMES & MOORE

FIGURE 4.7

1311200926 (9/85)