TECHNICAL PUBLICATION SJ 85-6

TEST DRILLING REPORT FOR OBSERVATION WELLS AT SEBASTIAN INLET STATE PARK, BREVARD COUNTY, FLORIDA

by
David J. Toth
Hydrologist

Department of Water Resources

St. Johns River Water Management District
P. O. Box 1429
Palatka, Florida 32078-1429

July, 1985
Project Number 20 023 28

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

As part of the hydrological data collection program, the St. Johns River Water Management District contracted to have a 450 ft. and 650 ft. well drilled at Sebastian Inlet State Recreation area for the purpose of monitoring the upper two potable zones of the Sebastian freshwater lens. The geological and water quality data collected during construction, along with the ability to observe potentiometric levels and monitor the water quality of these zones on a continuing basis, will aid in evaluating the duration of the potable Sebastian freshwater lens, which will be reported on at a later date.

ACKNOWLEDGEMENTS

The District would like to thank the Division of Recreation and Parks, Florida Department of Natural Resources for their cooperation and agreement to provide a site to drill the monitor wells. The District would also like to express gratitude to Captain Perry Smith for his cooperation and assistance in selecting the well site. Thanks are also extended to George Crumb of Crumb's Well Drilling and his crew for providing drilling services and constructing the wells.

LOCATION

The well site is located in Sebastian Inlet State Recreation area in the southeast corner of Brevard County. The site, shown in Figure 1, is bordered by the Atlantic Ocean to the east, and the Indian River to the west. The wells are located west of State Road A1A approximately 0.6 mile north of Sebastian Inlet on the barrier island. Land surface is one foot above mean sea level at the well site.

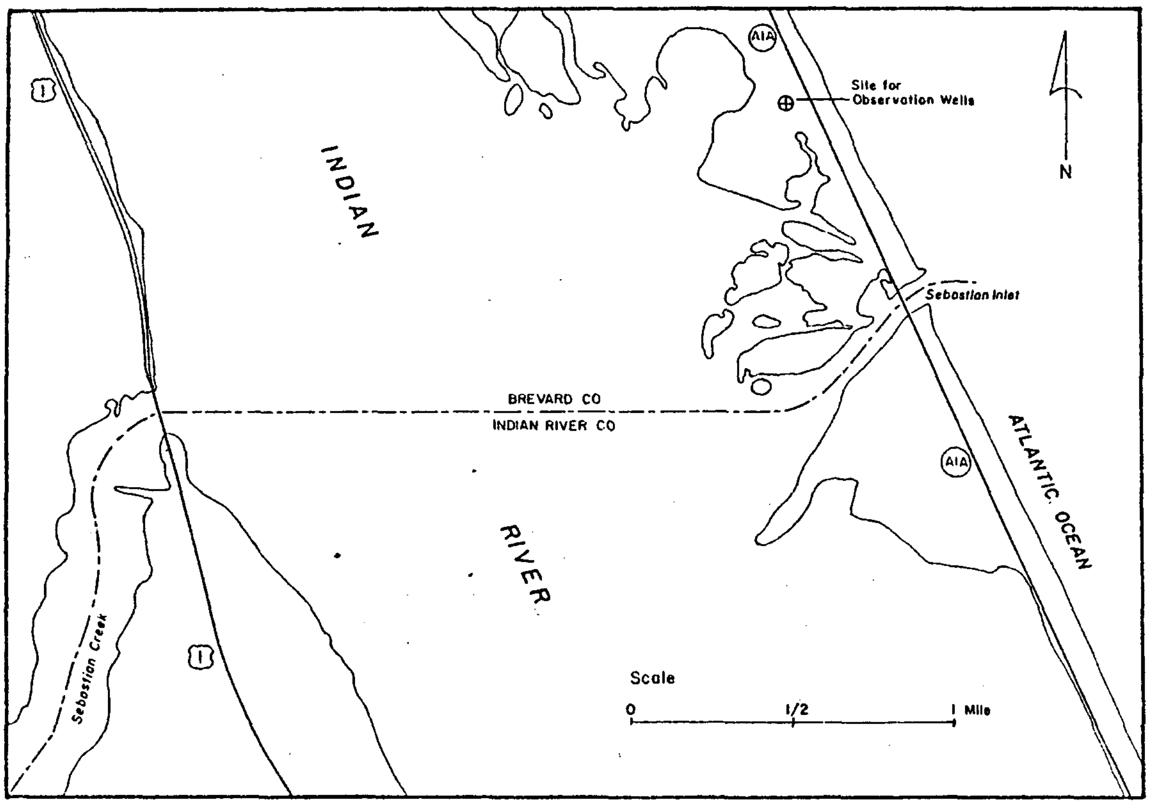

Figure 1. Site location for observation wells at Sebastian Inlet State Recreation area.

TEST DRILLING

Drilling objectives were to; (1) collect in situ measurements of water quality with depth, (2) collect geophysical data pertaining to depth and thickness of the Hawthorn, Suwannee, Ocala, and Avon Park formations, and (3) establish two monitoring wells capable of observing Floridan aquifer potentiometric fluctuations and quality. The wells were drilled by the reverse-air rotary method and water samples were collected at least every 10 feet or as lithologic changes were observed. The wells were spaced approximately 15 feet apart and drilled to a total depth of 650 and 450 feet. The deeper well was drilled first and casing was set to the top of the Avon Park at a depth of 550 feet below land surface. Casing in the second well was set at the top of the Suwannee limestone at a depth of 300 feet below land surface. The upper 10 feet of casing in each well consisted of galvanized steel and projected two feet above land surface. The following drilling and sampling procedures were followed:

(1) Collect cutting samples every 10 feet or at each change in formation lithology during drilling through the unconsolidated material;

(2) Set and grout into place 8-inch (4-inch for 450 ft. well) PVC schedule 40 casing to the top of the first limestone unit encountered.

(3) Drill by the reverse-air rotary method to a depth necessary to encounter the Avon Park limestone. Water and cutting samples were collected every 10 feet or at each change in formation from the drill stem.

Periodically, water samples were also collected at the well head.

(4) pH, alkalinity, and chloride concentrations were measured at the well site. Water samples were stored on ice and returned to the laboratory for additional analyses.

(5) Set and grout into place 4-inch PVC schedule 40 casing to the top of the Avon Park limestone.

(6) Continue drilling by the reverse-air rotary method to a total depth of 640 feet, collecting water samples every 10 feet, as above, while drilling.

(7) Core three ten-foot intervals at depth of: 350-360 ft., 405-415 ft., and 640-650 ft. The cores provided representative samples of the Suwannee, Ocala, and Avon Park limestones, respectively. Send two inch portions from each core to Ardaman & Associates, Inc. for permeability, dry density, and porosity measurements.

(8) Geophysically log the well to determine the thickness and depth for each formation and the number and location of flow zones.

(9) Finish the well head in a manner allowing planned monitoring to occur.

RESULTS

Three wells were drilled at the well site. However, well construction problems were encountered in the first well at a depth of 405 feet. It was abandoned and plugged with grout from bottom to top. It is referred to as SI#1. The second well, SI#2, was drilled to 650 feet; the third well, SI#3, was drilled to a depth of 450 feet.

Data collected during well construction is shown in Figure 2. Descriptions of the drill cuttings from each well are combined and are presented in Appendix A. Descriptions of the cored intervals are presented in Appendix B.

In general, the first 108 feet comprise unconsolidated deposits consisting of clay, sand, coquina, and limestone of variable thicknesses. These deposits comprise the surficial aquifer system and are underlain by the Hawthorn formation which in this area is the intermediate confining unit. The Hawthorn formation consists of interbedded green clay, silt, sand, and carbonate beds all of which contain varying amounts of black to brown phosphatic material. The carbonate beds consist of sandy, hard, recrystallized phosphatic limestone with some brown dolostone, except at the base of the formation where hard, brown to dark blue, sandy, phosphatic dolostone predominates. Near the bottom of the formation, shell and chert beds also occur. Drillers refer to these basal beds as caprock. The Hawthorn formation acts as a confining unit which separates the overlying surficial aquifer system from the underlying Floridan aquifer system and is 178 feet thick at the site.

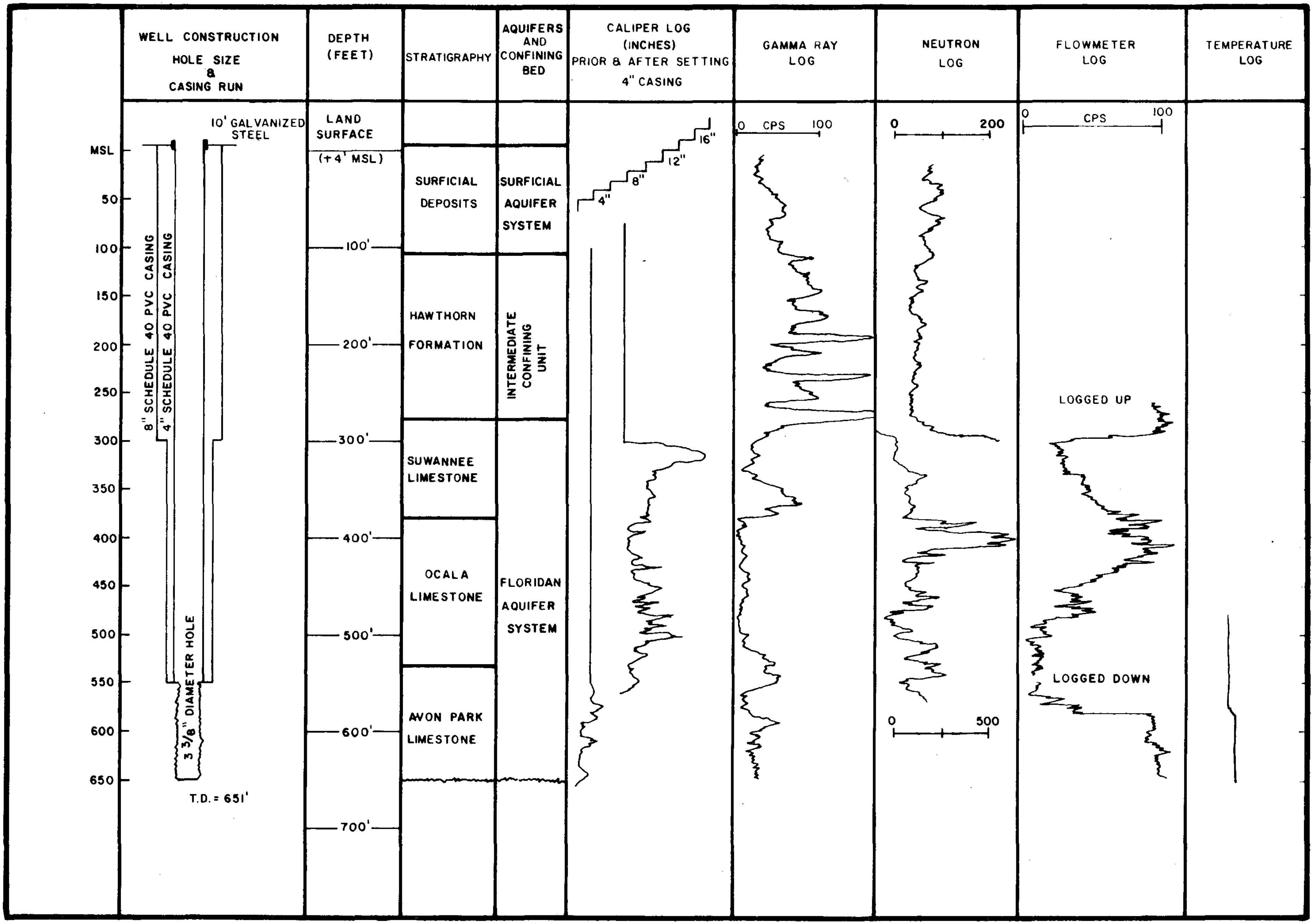

Figure 2. Hydrogeological data for the deep well (SI #2) at Sebastian Inlet.

The Suwannee limestone occurs at a depth of 278 feet below land surface and is considered the top of the Floridan aquifer. The Suwannee consists of 102 feet of white to light tan, slightly argillaceous to arenaceous to pure, bioclastic to chalky limestone.

Underlying the Suwannee, the Ocala limestone consists of 153 feet of white to light tan, soft and very weakly cemented to hard and recrystallized coquinoid (foraminiferal), relatively pure limestone. The coquina is composed of whole and fragmented foraminiferal tests and other biological debris. Generally, two zones can be distinguished: a lower, more recrystallized micritic zone and an upper, less well-cemented zone of calcarenite. In SI#2, the lower zone contains light tan, hard, thick beds of dolomitic limestone.

The Avon Park limestone lies beneath the Ocala limestone at a depth of 533 feet. It is characterized by interbedded limestone and dolostone. The limestone is generally white to tan to light brown, hard and completely recrystallized to soft, and composed of weakly cemented, partially altered foraminiferal tests. The dolostone is dark brown to brown, hard and recrystallized (micrite-like) to a moderately well cemented calcarenite.

The Avon Park is composed of an upper and lower zone. The lower zone was not penetrated in SI#2. It is composed of very hard, low porosity, brown to dark brown, cavernous dolostone. Based on geophysical logs of wells in Brevard and Indian River counties, the contact of the lower zone is estimated to occur at approximately 800 feet.

Table 1 gives porosity, permeability, and dry density values for core samples from the Suwannee, Ocala, and Avon Park limestones. Coincident with the uncemented nature of the Suwannee is its high porosity (0.50). It also has a large vertical permeability (1×10^{-4} cm/sec). In contrast, the upper Ocala is well-cemented and hard. A core sample from this zone has a porosity of 0.14 and a vertical permeability of 1×10^{-6} cm/sec. Such porosity and permeability would provide for greatly reduced vertical transport between the lower Ocala and Suwannee limestones. The sampled interval in the Avon Park has a porosity of 0.32 and a vertical permeability of 3×10^{-4} cm/sec. This interval would permit vertical flow and transport of water from either above or below.

Table 1. Porosity, permeability, and dry density values for core samples from the Suwannee, Ocala, and Avon Park Limestones.

Formation	Depth (ft)	Permeability (cm/sec)	Dry Density (g/cc)	Porosity
Suwannee	358	1×10^{-4}	1.40	0.50
Ocala	410	1×10^{-6}	2.40	0.14
Avon Park	645-646	3×10^{-4}	1.90	0.32

Measurements were performed by Ardaman & Associates, Inc. in Orlando, Florida.

Dry density in Table 1 represents a weighted average of the densities of each of the constituent minerals in the sample as well as porosity. Since the predominant minerals in these samples -- quartz (2.65), calcite (2.71), dolomite (2.87), and calcium phosphate (2.8-3.2), as illustrated in the appendix -- have similar densities, density also reflects porosity. For the cores analyzed, densities ranged between 1.4 and 2.4 g/cc. For comparison, the density of well-cemented limestone ranges between 2.68-2.76 g/cc, and well-indurated dolomite has a density of 2.84 g/cc. The smaller measured densities for the core material, compared to those above, supports the porous nature of the samples.

Three flow zones were detected from the flowmeter log at 457, 493, and 540 feet. The first two occur within the lower Ocala limestone whereas the third occurs at the contact of the Ocala and Avon Park limestones.

A depth profile of chloride concentrations is plotted in Figure 3. The chloride concentrations appear to be formation dependent and averaged 154 milligrams per liter (mg/l) within the Suwannee, 177 mg/l within the Ocala, and 172 mg/l within the Avon Park limestone. Chloride concentrations are highest at the top of the Avon Park limestone, but decrease with depth to the bottom of the well from 204 to 152 mg/l.

The decrease in chlorides is related to the entrapment of low chloride water by low permeability layers within the Avon Park limestone. Similar findings were found at Aquarina, approximately 5 miles north of the Sebastian Inlet well site. Here chlorides as high as 570 mg/l occurred at the top of the Avon

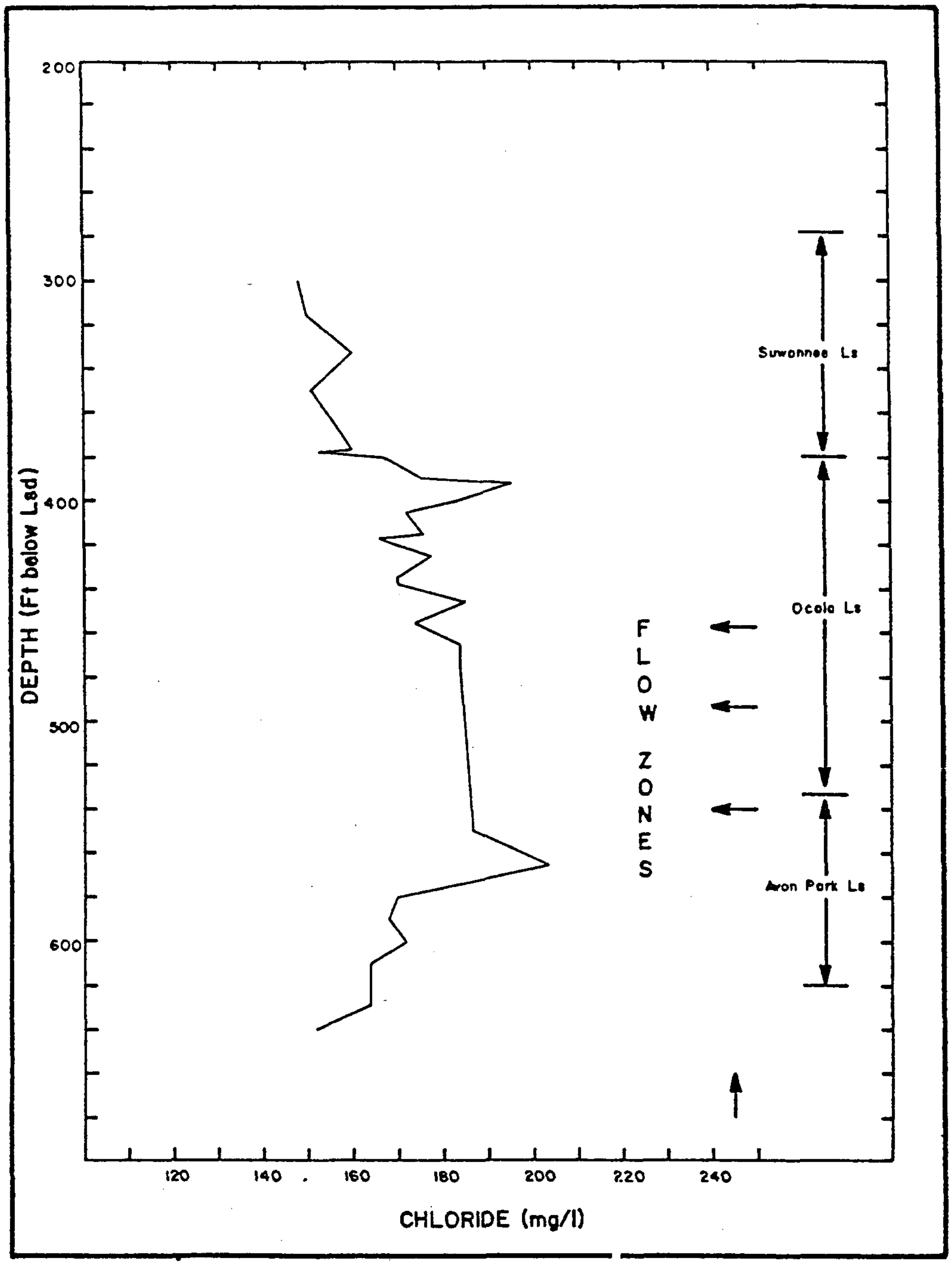

Figure 3. Chloride-depth profile of water samples collected from the drill stem while drilling the wells listed in Table 2. Chloride values were measured in the laboratory. Also indicated are depths to different limestones and the location of flow zones.

Park limestone at a depth of 450 feet, but decreased to 220 mg/l at a depth of 550 feet (Pitt, 1981). The low chloride water in the Avon Park limestone defines a second potable zone in the area of the Sebastian Freshwater Lens.

Table 2 lists water quality at depth for each well. Inspection of the table indicates that chloride concentrations measured at the well site (field) for SI #2 do not change by more than 20 mg/l between the three flow zones mentioned above. However, chloride concentration increased from 150 to 204 mg/l as depth increased from 315 feet to 565 feet in this well.

Despite the 54 mg/l difference observed in chloride concentration as shown in Table 2, the water type in each limestone is similar. Water samples throughout the vertical profile plot in the central area of the diamond-shaped region of the Piper tri-linear diagram (Figure 4). This area of the diagram represents a transition or mixing of fresh and highly mineralized waters as points move from left to right, respectively. Although there was no significant change in type as the three flow zones were sampled, water quality is expected to change with depth below the Sebastian Lens. This change is expected to occur below the low porosity zone in the Avon Park limestone, estimated to occur at approximately 800 feet.

Table 2. Water quality with depth for wells drilled at Sebastian Inlet Recreation area. Water samples were collected from the drill stem and at the well head (W.H.). Concentration units are mg/l.

Well	Depth	Date	Time	pH	Temp	HCO_3	CL	CL (field)	Ca	Mg	SR	K	Na	SO_4	Silica
SI#1	350	3/27/84	1300	8.19		193	152	161	58	39.6	5.6	6.7	75	93	18
			1400	8.05		187		162				6.5		88	18
			1730					158				5.8		82	18
		3/28/84	1000	7.65		187	152	160	47	37.9	5.3	6.5	74	82	20
			1400					152						84	20
		3/29/84	1300					154						80	20
			1544				150	162						124	12
	378	3/30/84	0945	8.3		143	150	157	45	33.7	4.5	5.8	76	111	20
	W.H.			7.56											
			1030	8.0		197	156	165	63	37.1	5.8	4.5	81	88	18
	380		1100				167							89	19
	381 W.H.		1200				154	163						87	18
	390		1300	8.0		202	176	164	61	36.4	6.2	4.3	79	84	17
	W.H.			7.54											
	400		1630	8.0		192		172						84	23
		3/31/84	0750				190							88	18
	320-405 W.H.	4/17/84	1030	7.80	25	199	174	172	54	35.9	7.58	4.5	70	91	18
	W.H.	4/30/84	1130	7.75	25	192	172	176	57	33.8	6.38	4.7	97	83	19
	W.H.	5/01/84	0845	7.78	25	193	172	181	47	41.2	6.85	4.6	113	93	19
	W.H.	5/03/84	1515				170		47	37.8	4.98	4.5	78	77	19
	W.H.		1516				160							85	19
	W.H.	5/07/84	1445	9.68	24	99	140	163	29	29	2.71	7.0	76	78	19
	W.H.		1446	9.73	24	97	150	165	29	29.6	2.50	6.8	75	82	18
	W.H.	5/08/84	0730	8.82	24	160	150	163	40	35.5	3.82	6.6	75	79	29
	W.H.		1300				150							85	32
		5/09/84	Pumped grout down hole.												
		5/11/84	Completed plugging well.												
SI#2	315	4/16/84	1430	8.36		192	150	161	48	37.1	6.20	8.3	73	78	23
	332		1630	8.20		177	160	161	50	37.6	7.04	5.4	78	77	20
	392 W.H.	4/17/84	0700	7.51	25	199	160	173	57	38.8	7.67	4.5	83	76	19

Table 2. Water quality with depth for wells drilled at Sebastian Inlet Recreation area. Water samples were collected from the drill stem and at the well head (W.H.). Concentration units are mg/l. (Continued.)

Well	Depth	Date	Time	pH	Temp	HCO_3	CL	CL (field)	Ca	Mg	SR	K	Na	SO_4	Silica
	392		1200	8.04	26	193	196	179	54	37.6	7.04	4.5	83	85	18
	400	4/18/84	1000				174	179						106	19
	405		1045				172	176						76	19
	415		1700	7.94	24	192	176	180	57	38.3	6.83	4.7	84	81	19
	425		1810				178	181						72	19
	435		1845	8.0	24	204	170	179	59	38.3	7.08	4.6	75	78	19
	W.H.	4/19/84	0645	7.27	25	193	176	177	57	37.4	7.27	4.6	71	78	19
	415-435		0730	7.40	25	202	180	178	59	38.1	6.89	4.6	70	76	19
	445		0850				180	180						69	19
	455		1400				174	184						76	19
	465		1640	8.0	25		184	185						80	19
	475		1750	7.98	24.8	198	184	181	53	37.2	7.04	4.7	72	72	19
	490	4/23/84		7.97	25.5			190							
	500			8.02	25.5			199							
	510			8.03	25.5			195							
	520			7.98	25.5			195							
	530			7.99	25.5			185							
	540			7.92	25.5			190							
	550			8.03	25.5			200							
		4/24/84		7.30	25.0			210							
	W.H.			7.44	25.5			210							
	560			7.93	25.5			210							
	570				25.5			210							
	500-550	4/23/84	1154	8.02	25.5		172		60	38.6	6.57	4.6	85	83	19
	550(BHS)	4/24/84	1200	7.19		180	174		60	36.2	6.26	4.7	76	92	19
	565(BHS)	4/26/84					204							102	
	W.H.	4/27/84	0713				176		51	39.5	4.96	4.8	86	85	19
	550		0858				200		53	41.6	6.09	5.2	98	86	19
	580	4/30/84	1330	10.98	25.2	183	170	179						69	17
	590		1355	8.16	25.2	204	168	168	53	35.5	5.42	5.2	77	81	18
	600		1435				172	170						88	18
	610		1535	8.08	25.2	207	164	175	49	34.2	5.44	4.0	85	75	18

Table 2. Water quality with depth for wells drilled at Sebastian Inlet Recreation area. Water samples were collected from the drill stem and at the well head (W.H.). Concentration units are mg/l. (Continued.)

Well	Depth	Date	Time	pH	Temp	HCO_3	CL	CL^- (field)	Ca	Mg	SR	K	Na	SO_4	Silica
	W.H.		1536	7.90	25.2	200	164	172	50	34.4	4.81	4.6	88	79	18
	620		1600	8.02	25.2	195	164	172	48	34.4	5.12	4.0	67	89	18
	630		1630	8.0	25.2	195	164	174	47	33.6	5.12	4.0	82	84	18
	640		1715	8.04	25.2	197	156	176	47	34.2	5.69	4.2	88	68	18
	W.H.		1716	7.90	25.0	196	168	171	51	34.2	5.65	4.5	89	84	18
		5/01/84	0730	7.80	24.5	203	150	163	44	34.0	5.88	3.9	76	64	18
	W.H.		0731	7.71	24.5	203	164	178	49	35.1	5.86	4.2	86	83	18
	650 W.H.		1130			196	164		48	32.1	5.65	4.2	98	81	18
	500-650 W.H.	5/02/84	0755			197	154		48	35.5	4.83	4.2	72	73	18
	500-650 W.H.		0756				152							78	18
	650 W.H.	5/07/84	1400	7.59	25.0	197	164	170	56	36.1	5.23	4.1	75	78	18
	W.H.		1401	7.57	25.0	193	144	170	55	35.5	5.12	4.1	77	82	18
	W.H.	5/08/84	0730	7.44	25.0	194	156	162	56	35.1	5.17	4.0	74	83	18
	W.H.		0731	7.48	25.0	193	150		56	35.1	4.87	4.0	73	74	18
	570-650	5/25/84					154							89	
	640						150							80	
SI#3	377	5/11/84	1200	7.79	25.0	184	160		56	37.4	4.79	4.7	83	79	18
	417		1335	7.79	25.0	199	166		57	38.2	4.43	4.5	78	51	19
	437		1425	7.78	25.0	195	170		57	37.6	4.98	4.5	80	77	19
	300	5/30/84					148							98	
	445						190							90	

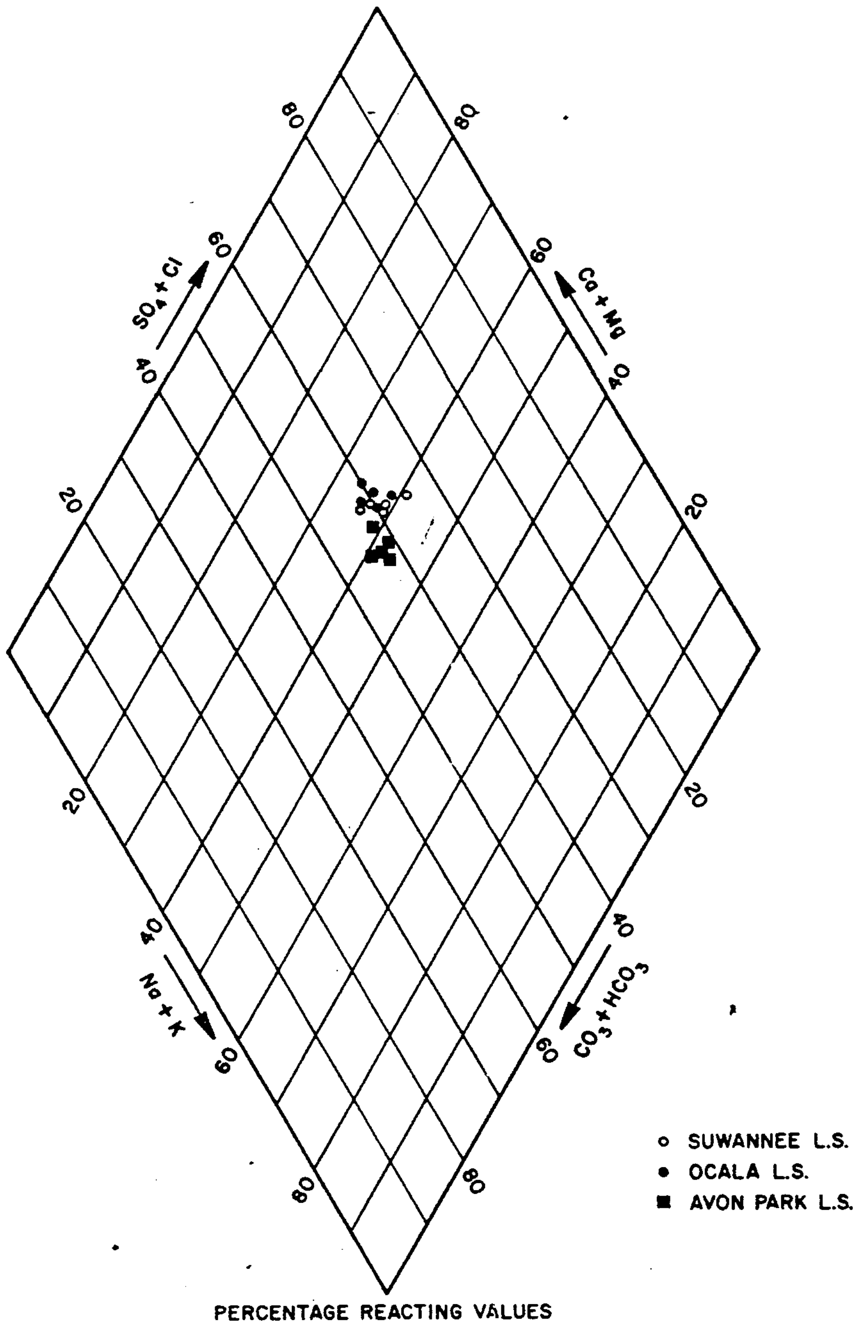

Figure 4. Water quality data plotted on the central field of the Piper diagram.

REFERENCES

Pitt, W., 1981, November 30, Memorandum to Ed Fleis documenting phone conversation with Jim Frazee, Project No. 775-020.62.

APPENDIX A

CUTTINGS DESCRIPTION/SEBASTIAN INLET

8' Sand and shell, sand is light gray, silica, fine, clear, subangular to angular, predominates; shell is mollusc fragments (coarse sand size) white to tan, scattered.

9' Sand and shell, sand is light gray, silica, medium, clear to cloudy, subrounded; shell is mollusc fragments (coarse sand size to small pebble size), multi-colored; sand and shell in approximately equal proportions.

13' Limestone, white to yellow-brown, recrystallized, composed of much euhedral calcite, scattered silica sand (clear, fine, subrounded) and scattered black phosphate grains (fine sand size).

22' Limestone, do., but contains original material mollusc frags; probably is very recrystallized coquina.

28' Limestone, do., also scattered to some silt size black phosphate grains.

33'-34' Limestone, do., many original material mollusc fragments, less euhedral calcite.

41'-42' Limestone, do., less original material mollusc fragments and more euhedral calcite.

47' Limestone and silt, limestone is do., more massive, finer grained, more sand size and silt size silica; silt is carbonate, gray.

57' Silt, sand, shell and limestone, gray, silt is carbonate, loose; sand is silica, subrounded to subangular, clear to cloudy to dark blue; shell is mollusc fragments, multi-colored; limestone is gray, massive, silty, sandy, phosphatic, probably recrystallized mollusc fragments.

67' Silt and shell, silt is gray, carbonate, soft; shell is mollusc fragments, dark gray and light gray.

73' Limestone, gray, calcisiltite, composed of silt size mollusc fragments partially recrystallized, poorly cemented, sandy (fine to medium, clear, subangular silica) and slightly phosphatic (silt size).

75' Limestone, do., more carbonate silt, soft.

81' Limestone, light gray, calcisiltite/recrystallized, composed of completely recrystallized mollusc fragments recrystallized and hard silt size grains, sandy (very fine, silica) and slightly phosphatic (silt size, black).

87' Limestone, white, calcisiltite, composed of silt size forams and pellets, mod. well cemented by chalky white calcite.

94' Limestone, white, calcisiltite, composed of very fine silt, size calcite particles (some are as do.), very soft, sandy and silty (silica).

101' Limestone, do., also many white original material, mollusc fragments.

108' Limestone, do.

116' Limestone, do.

120'-158' Silt, green, carbonate, sandy and silty (silica), moderately phosphatic, some original material (white) mollusc fragments.

161' Silt, very dark olive green, carbonate.

178'-197' Silt and sand, green silt is do. 121-158; sand is medium, silica, subrounded.

201'-207' Limestone, white, calcisiltite, soft, chalky, phosphatic (silt size).

224' Silt, shell and chert, silt is do. 121-158; shell is mollusc fragments, white and dark gray; chert is dark green; phosphatic.

230' Silt, shell, chert and dolostone, silt, shell and chert are do.; dolostone is light brown, very hard, euhedral rhombs; phosphatic.

238'-239' Silt, shell, chert and dolostone do.

244' Silt and phosphate, silt is green carbonate; phosphate is black (sand size).

255' Silt, green, carbonate.

265' Silt and shell, silt is do.; shell is white, original material; silt predominates.

270'-280' Silt and phosphate, silt do.; phosphate is silt size, black.

290'-300' Silt, dolomitic limestone and phosphate, silt is do.; dolomitic limestone is white to brown, silty (silica), phosphatic (silt size, black); phosphate is black coarse sand to small pebble size.

300'-350' Limestone, light tan, calcisiltite, composed of very fine grained biohash well-to-poorly cemented by translucent micrite to chalky calcite, relatively soft to hard, not much cement visible.

350'-360' See Core #1 listing.

363'-373' Limestone, do., 300-350 very soft and uncemented, yellow-tan.

383'-384' Limestone, do., 300-350 hard and well cemented, moldic porosity.

393'-404' Limestone, white, recrystallized, micrite, very hard, composed of recrystallized foram and fossil debris (including Lepidocyclina sp.) with some glauconite, low porosity.

405'-416' See Core #2 listing.

425'-435' Limestone, do., 405-415 (core) but probably less well cemented.

442' Limestone, tan, calcisiltite (recrystallized), composed of honeycomb-like mass of euhedral very fine calcite crystals, relatively high intergranular porosity, homogeneous, hard.

445'-460' Limestone, do., 425-435, relatively uncemented and loose.

464'-472' Limestone, gray and tan mottled, recrystallized, composed of fossil hash recrystallized and well cemented, hard, individual grains not generally visible.

475' Dolomitic limestone, brown and white (speckled), recrystallized (calcarenite), composed of original material (white) forams well cemented by much brown dolomite rhombs, very hard.

490' Limestone, do. 475; do. 464-472; do. 405-415.

498.5' Dolomitic limestone, tan, recrystallized, micrite, composed of very hard homogeneous dolomitic calcite, some grain boundaries visible.

500' Dolomitic limestone, do. but some gray mottling and less micrite, more grain boundaries visible.

510' Dolomitic limestone, do. 475.

520' Limestone do. 405-415 with scattered carbonized (?) microfossils.

530'-540' Limestone, light tan to tan and dark gray mottled, recrystallized, composed of hard homogeneous calcite with some grain boundaries visible, some dolomite (brown).

550' Limestone, white to light tan, recrystallized, composed of massive to very finely crystalline calcite with scattered micromoldic porosity and very small diameter worm tubes, some dark gray mottling, scattered carbonized "spots".

560' Limestone and dolomitic limestone, limestone is two types: 1. tan, calcarenite (recrystallized), composed of completely recrystallized microfossils (grain outlines distinct to indistinct), relatively hard, some to moderate porosity; 2. gray with white specks, calcarenite (recrystallized), composed of original material to completely recrystallized forams cemented by much very hard gray micrite (to finely crystalline); dolomitic limestone is dark gray and brown, recystallized, composed of dark gray dolomitic calcite cementing recrystallized (grain boundaries distinct) forams, very hard, zero porosity.

570' Limestone and dolomitic limestone, do. 560 and 550.

580' Dolomitic limestone, light tan, recrystallized, composed of massive, completely recrystallized dolomitic calcite (very finely crystalline) with scattered minute original material forams, very hard, low worm tube porosity.

590' Dolostone, light brown to brown, recrystallized, composed of completely recrystallized biological material (grain boundaries distinct), well cemented and hard, some euhedral dolomite (some calcite?), only very scattered original material forams, some moldic porosity.

600' Dolostone, light brown, recrystallized, composed of completely recrystallized biological material (grain boundaries indistinct to occasionally distinct), massive, very low porosity.

610'-620' Limestone and dolostone, limestone is white to light tan, recrystallized, composed of completely recrystallized biological material (grain boundaries indistinct) well cemented and hard, low porosity; dolostone is grayish brown, recrystallized, composed of completely recrystallized micrite, very hard, homogeneous, low to zero porosity.

630' Limestone, light tan, recrystallized, composed of completely recrystallized calcite (some dolomite), massive, well cemented and hard, zero to low porosity.

640' Limestone, brown and white, calcarenite, composed of poorly cemented and crumbly forams and other biological debris, not much cement visible, high intergranular porosity.

640'-650' See Core #3 listing.

APPENDIX B

CORE DESCRIPTION

Core #1

350'-360' Limestone, (upper 1/2): light tan to greenish tan, calcisiltite to calcarenite, composed of moderately well cemented, slightly crumbly silt size to coarse sand size biological debris (some forams) and scattered to common silt size black phosphate grains, moderate to high roughly outlined moldic porosity, some to scattered silt size silica (clear, subangular) (lower 1/2): light tan to yellow-tan, calcisiltite, composed of poorly to moderately well cemented crumbly silt size biological debris (some forams) and common black silt size phosphate grains, very low roughly-outlined moldic porosity but some intergranular porosity also, some silt size silica (clear, subangular).

Core #2

405'-416' Limestone, light tan, calcarenite, composed of well cemented to moderately well cemented forams (including *Lepidocyclina* sp.), echinoids, coral, echinoid spines, pelecypods, bryozoa, worm tubes, sponge spicules and other biological debris, loosely cemented crumbly zones alternate with fully recrystallized micrite (no grain boundaries visible), zero to low moldic porosity very hard zones, sure euhedral drusy calcite crystals.

Core #3

640'-650' (Upper 3 ft.): limestone, light brown, calcarenite to calcisiltite, composed of moderately well cemented forams and other biological debris, not much cement visible, somewhat crumbly, high intergranular porosity, some roughly outlined moldic porosity, some zones of brown calcite (dolomitic) cement.

(Middle 2 ft.): limestone, light brown, calcisiltite, composed of relatively fine grained moderately to well cemented forams and other biological debris (by chalky calcite cement) and some seams of dark brown peat.

(Middle 1 ft.): dolomitic limestone, very light brown, calcarenite (recrystallized), composed of completely recrystallized (grain boundaries visible) forams and other biological debris well cemented by very fine euhedral calcite or dolomite, hard, much cement visible (low intergranular porosity), moderate moldic porosity, relatively massive and hard.

(Middle 1 ft.): dolomitic limestone, light brown, do. but less cement, not as massive or as hard, high roughly outlined moldic porosity, crumbly.

(lower 3 ft.): dolomitic limestone, very light brown, recrystallized, composed of completely recrystallized (grain boundaries not visible) biological material, massive, hard, much roughly outlined moldic porosity, some worm tubes, scattered to common zones of calcisiltite: well cemented and recrystallized (grain boundaries visible).