HYDROLOGIC ASSOCIATES U.S.A., INC.
ENVIRONMENTAL CONSULTANTS

Big Pine Key Monitor Network Drilling

Contract C-11702

Results of Geologic Testing, Well Installation and Water Quality Analyses

Prepared for

South Florida Water Management District
3301 Gun Club Road
West Palm Beach, Florida 33406

Prepared by

HYDROLOGIC ASSOCIATES U.S.A., INC.
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Miami, Florida
December 2000

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INTRODUCTION

The freshwater lens on Big Pine Key is the largest freshwater lens in the Florida Keys and the sole source of water for the endangered Key Deer. The five-year work plan of Monroe County directed that:

1. The extent and quality of the lens system should be documented.

2. Recharge areas should be delineated and

3. Safe yield form the system should be determined.

A study group which included the South Florida Water Management District, the US Fish and Wildlife Service, Florida Department of Community Affairs, and Monroe County recommended that an ongoing monitoring program be initiated. This drilling program constitutes the initial implementation phase. Funding by the SFWMD was provided to install seven(7) permanent groundwater monitoring sites on Big Pine Key. This report presents the technical results from the drilling, installation and testing of these wells.

Purpose and Scope

The purpose of this project is to install seven (7) permanent groundwater-monitoring wells on Big Pine Key to monitor both salinity and water quality parameters that would indicate anthropogenic impacts to the freshwater lens.

The scope of this work included review of previous studies, site selection, continuous coring of each borehole using reverse – air rotary drilling technology, installing and developing each well, completing the initial salinity profiles and sampling the wells for water quality indicators. The final well depths and locations were determined in the field. All fieldwork was completed between August 30, and October 11, 2000.

Acknowledgements

Hydrologic Associates USA, Inc. is grateful for all the assistance and support provided by the personnel of the US Fish and Wildlife Service at the Key Deer Refuge especially to Dr. Philip A. Frank, Wildlife biologist, and to Ms. Emily Hopkins, Project Manager, SFWMD.

METHODOLOGY

After discussions with the US Fish and Wildlife Service and field reconnaissance, it was decided to move two of the wells outlined in the proposal and contract. Well BPK number 5(see figure) was moved to the north and well BPK 7 was moved to the west. This array allows for a four-well, north-south cross section and a four-well, east-west cross section.

Well BPK number 3 was drilled first because it was the centermost well and theoretically should penetrate the thickest part of the freshwater lens. Field observations were geared toward changes in the lithology and salinity.

A sharp interface between the freshwater lens zone of diffusion and the underlying saline water was not encountered in BPK number 3, Instead, the well was terminated at 35 feet BLS where the top of the Key Largo Limestone was identified. This interface represents an abrupt change in permeability below which the freshwater lens would be non-existent.

The contract called for the wells to be finished at 15 to 25 feet BLS. But because of our first test coring, it was decided to complete all wells at the Miami Oolite/KeyLargo Limestone facies. Therefore, all wells were completed at 34 to 36 feet BLS. (see well completion logs). At each well site the borehole was cored to the specified depth (interface) and all cores were saved in labeled core boxes for further identification. The cores were delivered to the University of Miami Sedimentary Lab for description by Dr. Harold Wanless. (see lithologic logs)

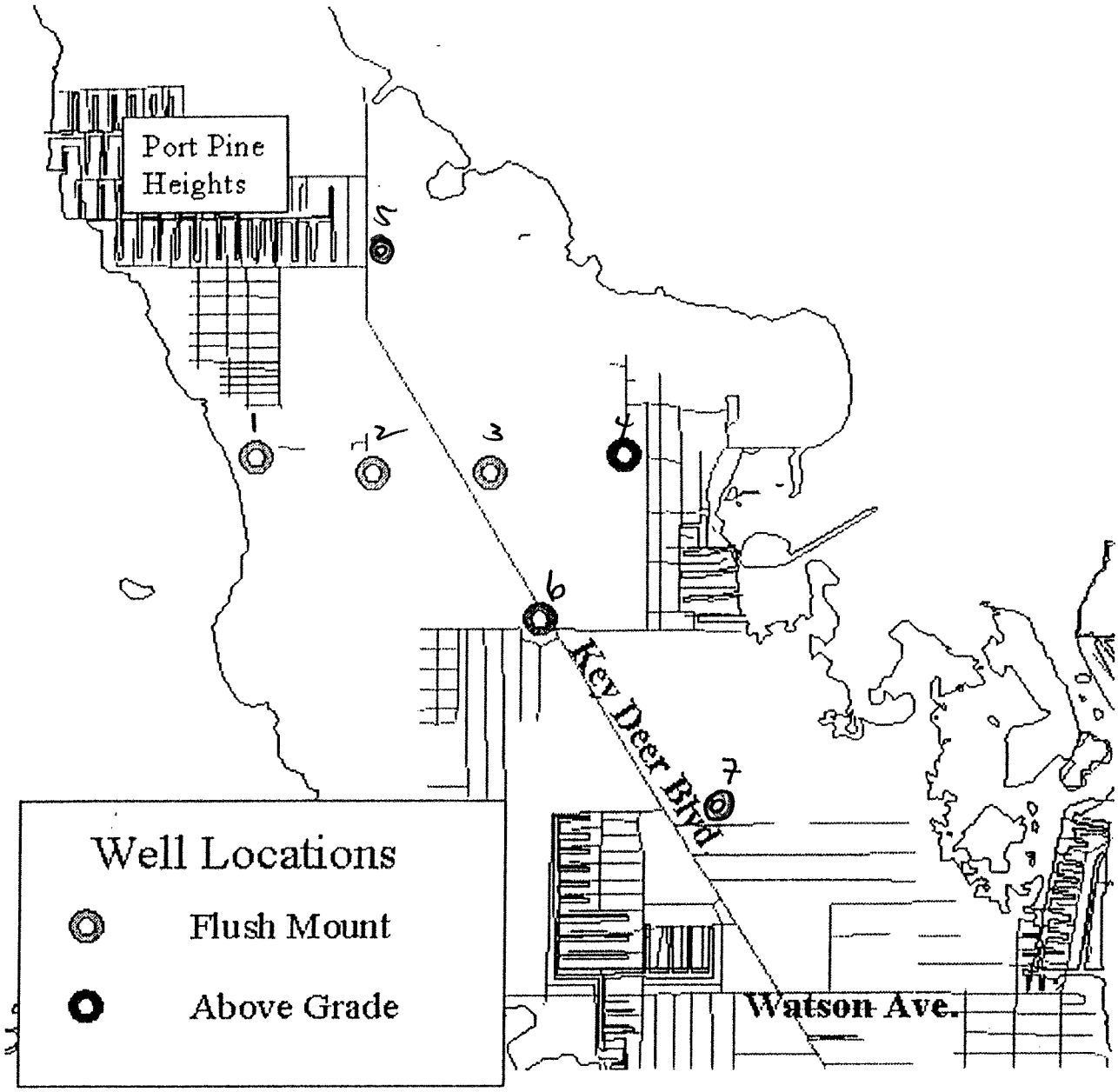
The wells were screened and cased with new, threaded 2-inch schedule 40 PVC. The screens extended from the bottom of the borehole to a few feet below land surface (see well completion diagrams). Screens were sand-packed with clean 6-20 silica sand tremied from the bottom to approximately 2 feet above the screen. The well was then cemented to the surface with Type II gray Portland neat cement. After the cement had set for a minimum of 24 hours, the wells were carefully developed. Each well was pumped at a low volume (<10 GPM) from the bottom to the top to minimize disturbance of the freshwater lens. Five wells were finished at land surface with a drivable meter box and concrete reinforced well pad emplaced in the cap rock (this was not fun). Two wells (BPK 6, Bluehole and BPK 4, East) were finished above grade (30 inches) with a 6-inch PVC outer surface casing cemented in place.

All wells were left undisturbed for a minimum of thirty days before water quality analyses were performed to allow for the freshwater lens and zone of diffusion to stabilize. Salinity profiles were collected at each well on October 10, 2000 using a YSI model 3000 T-L-C specific conductance, temperature and depth probe.

It should be noted that these profiles were done after a rainy period and should reflect "maximum" lens thickness. There was standing water over much of the project area. The freshwater lens is tidally influenced therefore an instantaneous water level reading is not valid. But generally, on October 10, 2000, the water table surface was from 1 to 3 feet below land surface. Groundwater samples were analyzed for total coliform and fecal coliform counts and Biological Oxygen Demand (BOD). Samples were collected from the upper 2 to 3 feet of the freshwater lens using a low volume pump with tygon tubing. After the turbidity cleared and the specific conductance and temperature stabilized, the samples were collected, iced, and delivered to Kappa Laboratory. Results of these analyses are summarized below and the lab sheets attached to this report.

Well Number	Total Coliform 1>	Fecal Coliform 1>	BOD 2>	Chloride 2>
BPK 1	<1	<1	<0.4	1920
BPK 2	<1	<1	<0.4	564
BPK 3	<1	<1	<0.4	791
BPK 4	<1	<1	<0.4	1240
BPK 5	<1	<1	<0.4	1930
BPK 6	<1	<1	<0.4	744
BPK 7	<1	<1	<0.4	1340

1> Counts (MPN) per 100 *ml*
2> Milligrams per liter



Locations of Salinity Monitoring Wells

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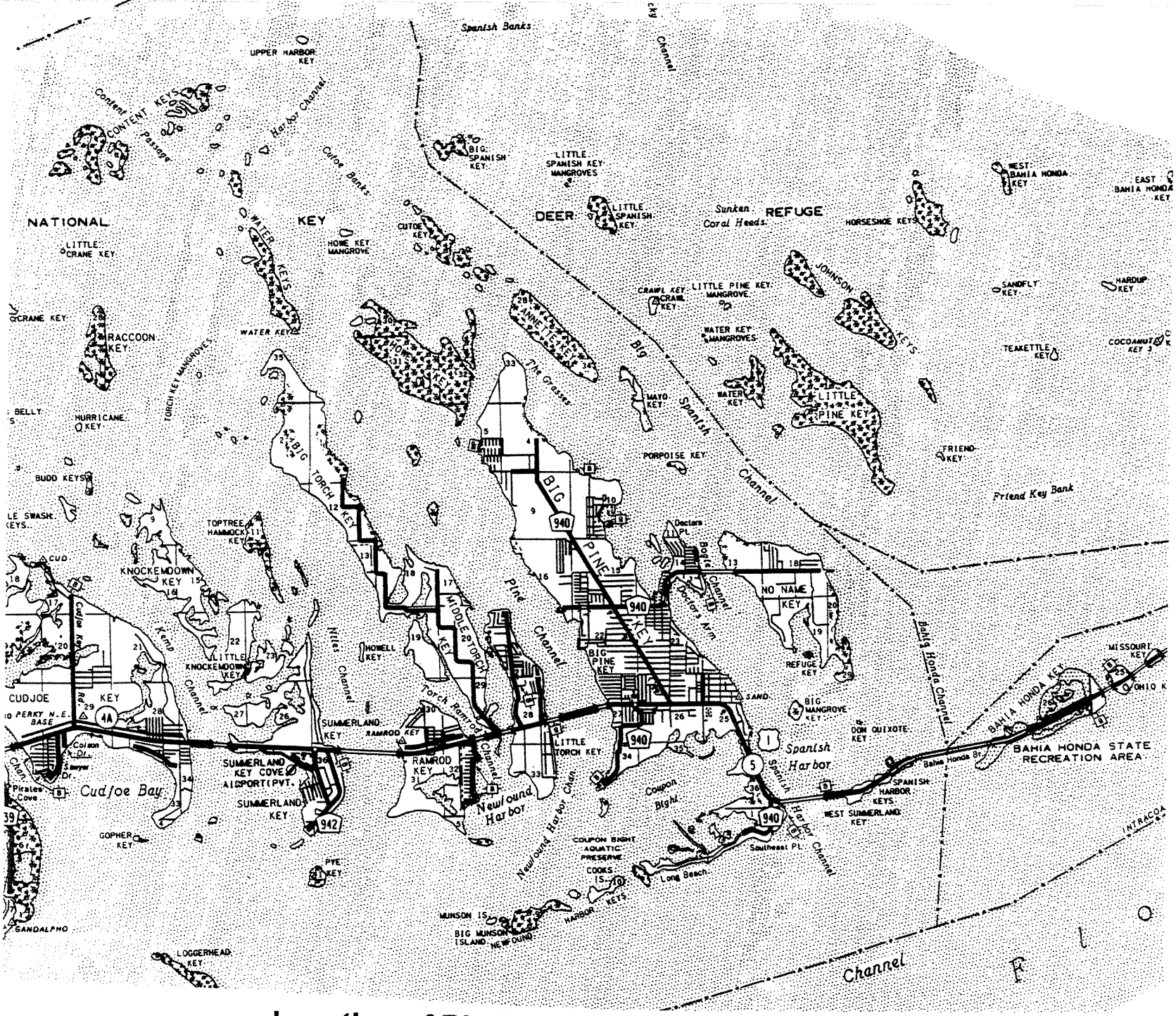

Location of Big Pine Key, Monroe County

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DAILY DRILLING LOGS

DAILY OPERATIONS REPORT FORM **HYDROLOGIC ASSOCIATES USA, INC.** Rig Number: 2

HA00-851 Superintendent: Weller Date: 9/1/00

Job Number: C-11702 Well Number: BPK 2/3/1 Lead Driller: Morris Herrigan Shift: —

Time From	Time To	Total Hours	Details of Operations in Sequence and Remarks	Production Recap
0800	1230	4.5	Drill and sample BPK 2 / set casing	Beginning:
			at -35ft w/ 25ft of screen / Sand -7	Ending:
			feet w/ bentonite	Reamed Size Footage
1300	1600	3.0	Drill and sample BPK 3 / set casing	/
			at -35ft / 25 ft of Screen / Sand	/
			pack to -7 ft bl LSD / seal	Casing Size Footage
			w/ bentonite	/
1645	1730	.75	Set up on BPK-1 / Rain and	/
			Lightning	Bit # Bit Type
				/

Time From	Time To	Total Hours	Employee Name	Empl Initials	Time From	Time To	Total Hours	Employee Name	Empl Initials
			Morris Herrigan						
			Ruben Smith						
			Brad Weller						

Approved: _____ Hydrologic Associates USA, _____ On-site Geologist

DAILY OPERATIONS REPORT FORM **HYDROLOGIC ASSOCIATES USA, INC.** Rig Number: 2

HA00-851 Superintendent: Welle Date: 9/1/00

Job Number: C-11702 Well Number: BPK-1 Lead Driller: Morris Harrison Shift: ____

Time From	Time To	Total Hours	Details of Operations in Sequence and Remarks	Production Recap
0800	1130	3.5	Drill and sample BPK-1 / Set casing	Beginning:
			to -35 ft w/ 25 ft of screen	Ending:
			Sand pack to -7 ft BLS	Reamed Size / Footage
			Seal with bentonite, cement to	/
			surface, complete surface finish	/
1200	1600	4.0	Cement BPK 2 and 3 to LSD	Casing Size / Footage
			Secure Equipment	/
			Break for long weekend	/
				Bit # / Bit Type
				/

Time From	Time To	Total Hours	Employee Name	Empl Initials	Time From	Time To	Total Hours	Employee Name	Empl Initials
			Morris Harrison						
			Ruben Smith						
			Brad Welle						

Approved: _____ Hydrologic Associates USA, BPW On-site Geologist

DAILY OPERATIONS REPORT FORM **HYDROLOGIC ASSOCIATES USA, INC.** Rig Number: 2

HA00-951 Superintendent: Waller Date: 9/5/00

Job Number: C-11702 Well Number: BPK 5/4 Lead Driller: Morris Hervijen Shift: ——

Time From	Time To	Total Hours	Details of Operations in Sequence and Remarks	Production Recap
0730	1230	5.0	Drill and Sample BPK-5 / Set casing	Beginning:
			@ -35 ft w/ 25' of Screen / Sand	Ending:
			pack to -7 ft / Seal with	Reamed Size Footage
			Bentonite Chips / Cement to LSD	/
1300	1730	4.5	Drill and Sample BPK 4 / Set casing	/
			to -35 ft w/ 25 ft of screen,	Casing Size Footage
			Sand pack to -7 BLS, Seal w/	/
			bentonite / Cement to LSD,	/
			Set 6" protective casing 3ft into	Bit # Bit Type
			Cement	/

Time From	Time To	Total Hours	Employee Name	Empl Initials	Time From	Time To	Total Hours	Employee Name	Empl Initials
			Morris Hervijen						
			Ruben Smith						
			Ted Miller						
			Brad Waller						

Approved: _____ Hydrologic Associates USA, _____ On-site Geologist

DAILY OPERATIONS REPORT FORM **HYDROLOGIC ASSOCIATES USA, INC.** Rig Number: 2

HA00 - 851 Superintendent: Weller Date: 9/6/00

Job Number: C-11702 Well Number: BPK 6/7 Lead Driller: Morris Harrison Shift: ——

Time From	Time To	Total Hours	Details of Operations in Sequence and Remarks	Production Recap
0730	1200	4.5	Drill and Sample BPK-6 at Blue	Beginning:
			Hole, set casing @ -40 ft due	Ending:
			to thickness of FW lens, 30 ft	Reamed Size Footage
			of screen, seal w/ bentonite, sand	/
			pack to -7 ft LSD, cement to	/
			LSD set 6" protective casing at -3 ft	Casing Size Footage
1230	1700	4.5	Drill and sample BPK 7, set casing at	/
			-35 ft w/ 25 ft of screen, Sand pack to	/
			-7 ft LSD, bentonite seal, cement to LSD	Bit # Bit Type
				/

Time From	Time To	Total Hours	Employee Name	Empl Initials	Time From	Time To	Total Hours	Employee Name	Empl Initials
			Morris Harrison						
			Ruben Smith						
			Brad Weller						
			Ted Meller						

Approved: _____ Hydrologic Associates USA, _____ On-site Geologist

DAILY OPERATIONS REPORT FORM **HYDROLOGIC ASSOCIATES USA, INC.** Rig Number: 2

HA 00-957 Superintendent: Weller Date: 9/7/00

Job Number: C-11702 Well Number: BPK-1-7 Lead Driller: Morris Harriga Shift: —

Time From	Time To	Total Hours	Details of Operations in Sequence and Remarks	Production Recap
0730	1800	10.5	Developed BPK wells number 1	Beginning:
			thru 7 using air lift and	Ending:
			pumping throughout screened	Reamed Size / Footage
			interval. Clear returns.	/
				/
				Casing Size / Footage
				/
				/
				Bit # / Bit Type
				/

Time From	Time To	Total Hours	Employee Name	Empl Initials	Time From	Time To	Total Hours	Employee Name	Empl Initials
			Morris Harriga						
			Ruben Smith						
			Ted Miller						

BW

DAILY OPERATIONS REPORT FORM **HYDROLOGIC ASSOCIATES USA, INC.** Rig Number: 2

HA00-951 Superintendent: Miller Date: 9/8/00

Job Number: C-11702 Well Number: BPK 1-7 Lead Driller: Morris Herrijan Shift:

Time From	Time To	Total Hours	Details of Operations in Sequence and Remarks	Production Recap
0800	1800	10	Complete well head finish of	Beginning:
			BPK wells 1 thru 7 - cap	Ending:
			and lock all wells.	Reamed Size / Footage
			Clean up all supplies	/
			Police all sides	/
			De Mobe to Miami	Casing Size / Footage
				/
				/
				Bit # / Bit Type
				/

Time From	Time To	Total Hours	Employee Name	Empl Initials	Time From	Time To	Total Hours	Employee Name	Empl Initials
			Morris Herrijan						
			Ruben Smith						
			Ted Miller						

Approved: _____ Hydrologic Associates USA, BJW On-site Geologist in absentia

KAPPA LABORATORIES, INC.
2577 N.W. 74th Avenue, Miami, Florida 33122
Phone (305) 599-0199 • Fax (305) 592-1224

LABORATORY REPORT
DOH #E86515

Hydrologic Associates USA
Attn: Brad Waller
8925 S.W. 148 Street
Miami, Florida 33176

October 19, 2000

Re: Results of Seven (7) Potable Water samples. The samples were delivered to Kappa Laboratories, Inc., 2577 N.W. 74th Ave., Miami, Florida on October 11, 2000. Seven samples from different locations were taken and tested for the following analyses.
Lab Ref. No: 623489/623491.

Methods Environmental Water: Total Coliform - 9222B, Membrane Filtration MPN - 9221B, Fecal Coliform Membrane Filtration - 9222D, Most Probable Numbers (MPN) - 9221C.

Methods Safe Drinking Water: Membrane Filtration - SM9222B, Most Probable Numbers (MPN) - SM9221B, Fecal Coliform - SM9221E.

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RESULTS

Sample #1 - Groundwater Well BPK-1

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1920 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #2 - Groundwater Well BPK -2

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 564 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #3 - Groundwater Well BPK -3

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 791 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #4 - Groundwater Well BPK-4

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1240 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #5 - Groundwater Well BPK-5

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1930 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #6 - Groundwater Well BPK-6

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 744 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #7 - Groundwater Well BPK-7

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1340 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

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Controls

Coliform Count - Negative

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Kappa Laboratories has been inspected and previously recognized by the U.S. Department of Agriculture (USDA Microbiology-#0093, Chemistry-#1282); certified by the Florida Dept. of Health, Drinking Water including Microbiology, Pesticides and PCB's; Environmental Certification as Basic Environmental Laboratory (DOH #E86515), Comp QAP#940109; Registered with the U.S. Food and Drug Administration (FDA-#1039389) and is an FDA Accepted Laboratory for Import Testing. Kappa Laboratories is currently a Contract Laboratory to the U.S. Centers for Disease Control (CDC), Atlanta, Georgia; Vessell Sanitation Program.

signed: Dr. Peter J. Kmieck
Dr. Peter J. Kmieck
Director, Kappa Laboratories, Inc.

LITHOLOGIC LOGS

Description of Core borings from Big Pine Key

Big Pine Key
Well #1

0-5 ft.	Light cream oolitic packstone (grains supported with carbonate mud in matrix); occasional shell fragments; medium grain size and moderate sorting; well cemented and with moderate porosity.
5-10 ft.	Light cream oolitic packstone; occasional shell fragments; medium grain size and moderate sorting; well cemented, with moderate-low porosity.
10-15 ft.	Light cream oolitic packstone; occasional shell fragments; medium grain size and moderate sorting; weakly cemented, with moderate-low porosity.
15-20 ft.	Light cream to cream oolitic packstone; medium grain size and moderate sorting; moderately well cemented with calcite spar and of moderate porosity.
20-25 ft.	Light cream to cream oolitic and skeletal packstone to grainstone (grain supported with no mud in matrix); occasional shell fragments; medium grain size and moderate sorting; moderately well cemented with calcite spar and with moderate-low porosity.
25-30 ft.	Cream skeletal (shell fragment) grainstone; medium to coarse grain size and moderate sorting; moderately well cemented with calcite spar and with low porosity, and contains areas of densely cemented yellow-tan calcrete crusts and clasts.
30-35 ft.	Cream to tan fragmental skeletal grainstone with coral; medium-coarse grain size and well sorted; visibly well cemented with calcite spar and some grain recrystallization, but with large interparticle macro porosity.
35- ft.	-

Grainstone = grain-supported sand-sized carbonate with no mud matrix
Packstone = grain-supported sand-sized carbonate with some mud matrix.

Description of Core borings from Big Pine Key

Big Pine Key
Well #2

0-5 ft.	Light cream, oolitic packstone, fine to medium grain size and moderately sorted; weakly cemented and with moderate porosity.
5-10 ft.	Light cream, oolitic packstone; fine to medium grain size and moderately sorted; weakly cemented and with moderate porosity.
10-15 ft.	Cream to tan, oolitic packstone with some shell fragments; fine to medium grain size and moderately sorted; weakly cemented with moderate porosity; contains patches of tan to orange calcrete cementation.
15-20 ft.	Cream, oolitic packstone with some shell fragments; medium grain size and moderately sorted; weakly cemented with moderate porosity; contains patches of tan to dark gray calcrete cementation.
20-25 ft.	Cream, oolitic and skeletal packstone; medium grain size and moderately sorted; weakly cemented with moderate porosity.
25-30 ft.	Cream, oolitic skeletal packstone; medium grain size and moderately sorted; weakly cemented with moderate porosity.
30-35 ft.	Tan, oolitic packstone with some shell fragments; medium grain size and moderately sorted; well cemented with moderate porosity; contains patches of yellow calcretes.
35-40 ft.	Tan, skeletal coralline packstone to grainstone; medium to very coarse grain size and well sorted; weakly cemented with calcite spar with high macro-porosity; contains patches of greenish-brown calcrete cementation.

Grainstone = grain-supported sand-sized carbonate with no mud matrix
Packstone = grain-supported sand-sized carbonate with some mud matrix.

Description of Core borings from Big Pine Key

Big Pine Key
Well #3

0-5 ft.	Light cream oolitic packstone mixed with dark gray soil matrix; fine to medium grain size and moderately sorted; weakly cemented with moderate porosity; scattered blackish calcrete cementation.
5-10 ft.	Light cream to cream, oolite packstone; medium grain size and moderately sorted; weakly cemented with moderate porosity.
10-15 ft.	Light cream to cream, oolitic packstone with some shell fragments; medium grain size and moderately sorted; weakly cemented with moderate porosity.
15-20 ft.	Light cream to cream, oolitic packstone with some shell fragments; medium grain size and moderately sorted; moderately cemented with moderate porosity.
20-25 ft.	Cream, skeletal coralline grainstone; medium to coarse grain size and moderately sorted; moderately cemented in part with calcite spar; low to moderate porosity; contains patches of orange-brown calcrete cementation.
25-30 ft.	Cream to tan, skeletal (shell and coral) grainstone; medium to coarse grain size and moderately sorted; moderate cementation in part with calcite spar and low porosity; contains patches of orange-brown calcrete cementation.
30-35 ft.	Cream, skeletal (shell and coral) grainstone; medium grain size and moderately sorted; moderately cemented with calcite spar and with moderate porosity; contains occasional patches of black calcrete cement.
35+ ft.	Cream to tan, skeletal (coral and shell) grainstone; medium to coarse grain size and well sorted; moderately cemented with calcite spar but with large macro porosity; contains occasional patches of yellowish calcrete cementation.

Grainstone = grain-supported sand-sized carbonate with no mud matrix
Packstone = grain-supported sand-sized carbonate with some mud matrix.

Description of Core borings from Big Pine Key

Big Pine Key
Well #4

0-5 ft.	Light cream, oolitic packstone; fine to medium grain size and moderately sorted; weakly cemented with moderate porosity; contains occasional blackish calcrete cementation.
5-10 ft.	Light cream, oolitic packstone; fine to medium grain size and moderately sorted; weakly cemented; moderate porosity; contains scattered blackish patches of calcrete cementation.
10-15 ft.	Light cream, oolitic packstone; fine to medium grain size and moderately sorted; weakly to moderately cemented with moderate porosity; widely scattered patches of blackish calcrete cementation.
15-20 ft.	Light cream, oolitic packstone with some shell fragments; fine to medium grain size and moderately sorted; weakly cemented with moderate porosity; contains scattered blackish calcrete cement patches.
20-25 ft.	Cream to tan, oolitic packstone and grainstone with some coarser shell and coral skeletal fragments; medium grain size and moderately sorted; weakly to moderately cemented with moderate porosity; contains patches of brown calcrete cementation.
25-30 ft.	Cream, oolitic grainstone with some shell and coralline skeletal fragments; medium to coarse grain size and moderately sorted; weakly to moderately cemented and with moderate porosity; contains scattered brownish calcrete cement patches.
30-35 ft.	Tan, oolitic grainstone with some shell and coralline skeletal fragments; medium to coarse grain size and moderately sorted; moderately cemented by calcite spar and with moderate porosity; contains widely scattered brown calcrete cement patches.
35+ ft.	-

Grainstone = grain-supported sand-sized carbonate with no mud matrix
Packstone = grain-supported sand-sized carbonate with some mud matrix.

Description of Core borings from Big Pine Key

Big Pine Key
Well #5

0-5 ft.	Light cream and brown-black, oolitic packstone; fine to medium grain size and moderately sorted; uncemented to weakly cemented with moderate to good interparticle porosity; contains abundant brown-blackish calcrete cement areas.
5-10 ft.	Light cream, oolitic packstone; fine to medium grain size and moderately sorted; weakly to moderately cemented with moderate porosity.
10-15 ft.	Light cream, oolitic packstone; medium grain size and moderately sorted; weakly to moderately with moderate porosity.
15-20 ft.	Light cream, oolitic packstone; medium grain size and moderately sorted; very weakly to moderately cemented with moderate porosity.
20-25 ft.	Light cream, oolitic packstone; medium grain size and moderately sorted; moderately cemented with moderate porosity.
25-30 ft.	Light cream, oolitic packstone with some shell fragments; medium grain size and moderately sorted; moderately cemented with moderate porosity; contains scattered patches of tan-orange calcrete cement patches.
30-35 ft.	Cream, fragmental skeletal (coral and shell) grainstone; medium to coarse grain size and well sorted; moderately cemented with moderate to high interparticle porosity; contains scattered brownish calcrete cement patches.
35+ ft.	-

Grainstone = grain-supported sand-sized carbonate with no mud matrix
Packstone = grain-supported sand-sized carbonate with some mud matrix.

Description of Core borings from Big Pine Key

Big Pine Key
Well #6

0-5 ft.	Light cream oolitic packstone and brown/black soil matrix; fine to medium grain size and moderately sorted; very weakly to moderately cemented with moderate porosity; contains patches of brown and blackish calcrete cementation.
5-10 ft.	Light cream, oolitic packstone and minor darker soil patches; fine to medium grain size and moderately sorted; very weakly to moderately cemented with moderate porosity; contains some brown and black calcrete cement patches.
10-15 ft.	Light cream to cream, oolitic packstone; medium grain size and moderately sorted; moderately cemented by calcite spar and with moderate porosity; contains widely scattered brownish calcrete cement patches.
15-20 ft.	Light cream to cream, oolite packstone with some shell fragments; medium grain size and moderately sorted; moderately cemented by calcite spar and with moderate porosity; contains widely scattered patches of blackish calcrete cement.
20-25 ft.	Light cream to cream, oolitic packstone with some shell fragments; medium grain size and moderately sorted; moderately cemented by calcite spar and with moderate porosity.
25-30 ft.	Cream, oolitic packstone; medium grain size and moderately sorted; moderately cemented by calcite spar and with moderate to high porosity; contains brown calcrete cement patches.
30-35 ft.	Cream to tan, oolitic skeletal (shell) packstone to grainstone; medium to coarse grain size and moderate to well sorted; moderately cemented by cal cite spar and with moderate to high interparticle porosity; contains brownish and tan-orange patches of calcrete cement.
35+ ft.	Cream to tan fragmental skeletal (shell and coral) packstone to grainstone; medium to coarse grain size and moderately to well sorted; moderately cemented by calcite spar and with moderate to high porosity; contains patches and stringers of brownish calcrete cement.

Grainstone = grain-supported sand-sized carbonate with no mud matrix
Packstone = grain-supported sand-sized carbonate with some mud matrix.

Description of Core borings from Big Pine Key

Big Pine Key
Well #7

0-5 ft.	Cream oolitic packstone and brown soil matrix; fine to medium grain size and moderately sorted; weakly cemented with moderate porosity.
5-10 ft.	Light cream to cream, oolitic packstone and some shell fragments; fine to medium grain size and moderately sorted; very weakly cemented with moderate porosity.
10-15 ft.	Light cream to cream, oolitic packstone with some shell fragments; medium grain size and moderately sorted; moderately cemented by calcite spar and has moderate to high interparticle porosity
15-20 ft.	Light cream to cream, oolite packstone with some shell fragments; medium grain size and moderately sorted; moderately cemented with calcite spar and with moderate to high interparticle porosity.
20-25 ft.	Light cream to cream, oolite packstone with some shell fragments; medium grain size and moderately sorted; weakly to moderately cemented with calcite spar and with moderate to high interparticle porosity; contains scattered blackish and brownish calcrete cement zones.
25-30 ft.	Light cream to cream, oolitic skeletal (shell fragment) packstone to grainstone; medium to coarse grain size and moderately sorted; moderately to well cemented with calcite spar and with moderate to high interparticle porosity; contains densely cemented layers of brownish calcrete.
30-35 ft.	Cream, skeletal (shell fragment and coral) grainstone; medium to coarse grain size and moderately sorted; moderately to well cemented with calcite spar and with moderate to high interparticle porosity; contains scattered brownish-orange calcrete cements
35+ ft.	Tan, skeletal (shell fragment and coral) grainstone; medium to coarse grain size and moderately sorted moderately well cemented by calcite spar and with high porosity.

Grainstone = grain-supported sand-sized carbonate with no mud matrix
Packstone = grain-supported sand-sized carbonate with some mud matrix.

WELL COMPLETION DIAGRAMS

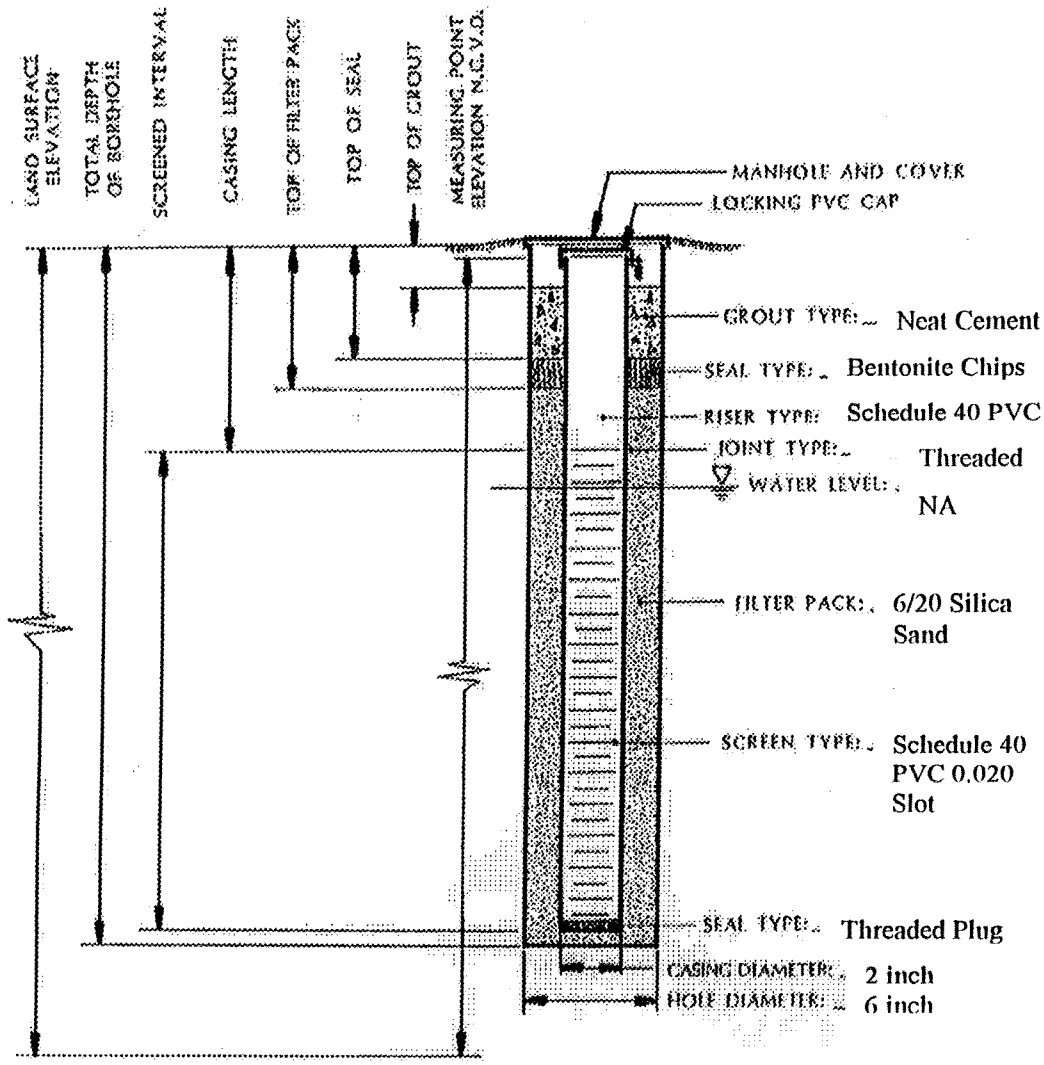
WELL CONSTRUCTION SUMMARY
BELOW GROUND

Big Pine Key - SFWMD

Feet BLS

NA	35	25	10	7	7	0	NA

PROJECT:
WELL NUMBER: BPK-1
DATE INSTALLED: 9/1/00



NOTE:
ALS-ABOVE LAND SURFACE
BLS-BELOW LAND SURFACE
N.G.V.D.-NATIONAL GEODETIC VERTICAL DATUM

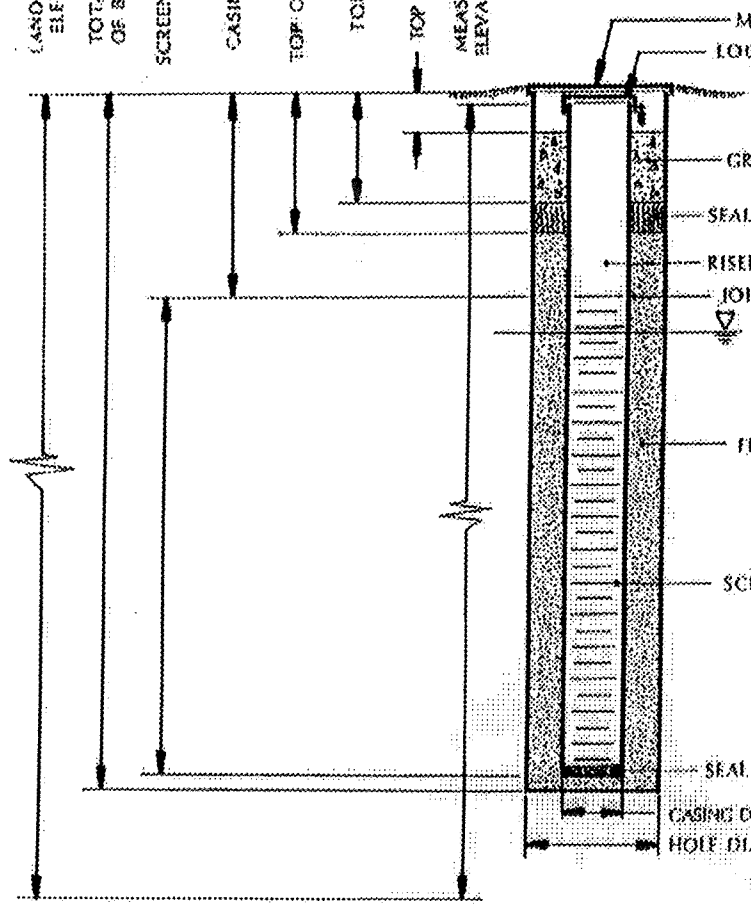
WELL CONSTRUCTION SUMMARY
BELOW GROUND

Feet BLS

LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED INTERVAL	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION N.G.V.D.
NA	35	25	10	7	7	0	NA

Big Pine Key - SFWMD

PROJECT: _
WELL NUMBER: BPK-2
DATE INSTALLED: 8/31/00



NOTE:
ALS-ABOVE LAND SURFACE
BLS-BELOW LAND SURFACE
N.G.V.D.-NATIONAL GEODETIC VERTICAL DATUM

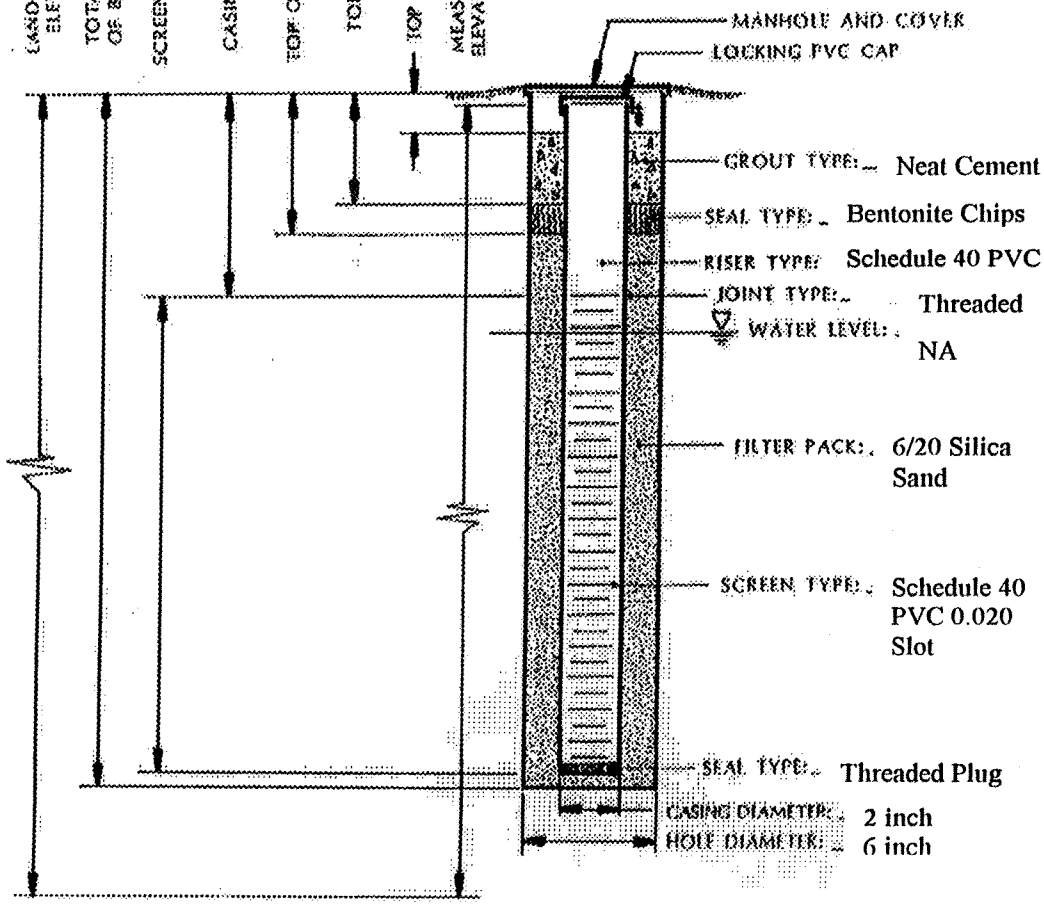
WELL CONSTRUCTION SUMMARY
BELOW GROUND

Big Pine Key - SFWMD

Feet BLS

LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED INTERVAL	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION N.G.V.D.
NA	35	25	10	7	7	0	NA

PROJECT: _
WELL NUMBER: BPK-3
DATE INSTALLED: 8/31/00



NOTE:
ALS-ABOVE LAND SURFACE
BLS-BELOW LAND SURFACE
N.G.V.D.-NATIONAL GEODETIC VERTICAL DATUM

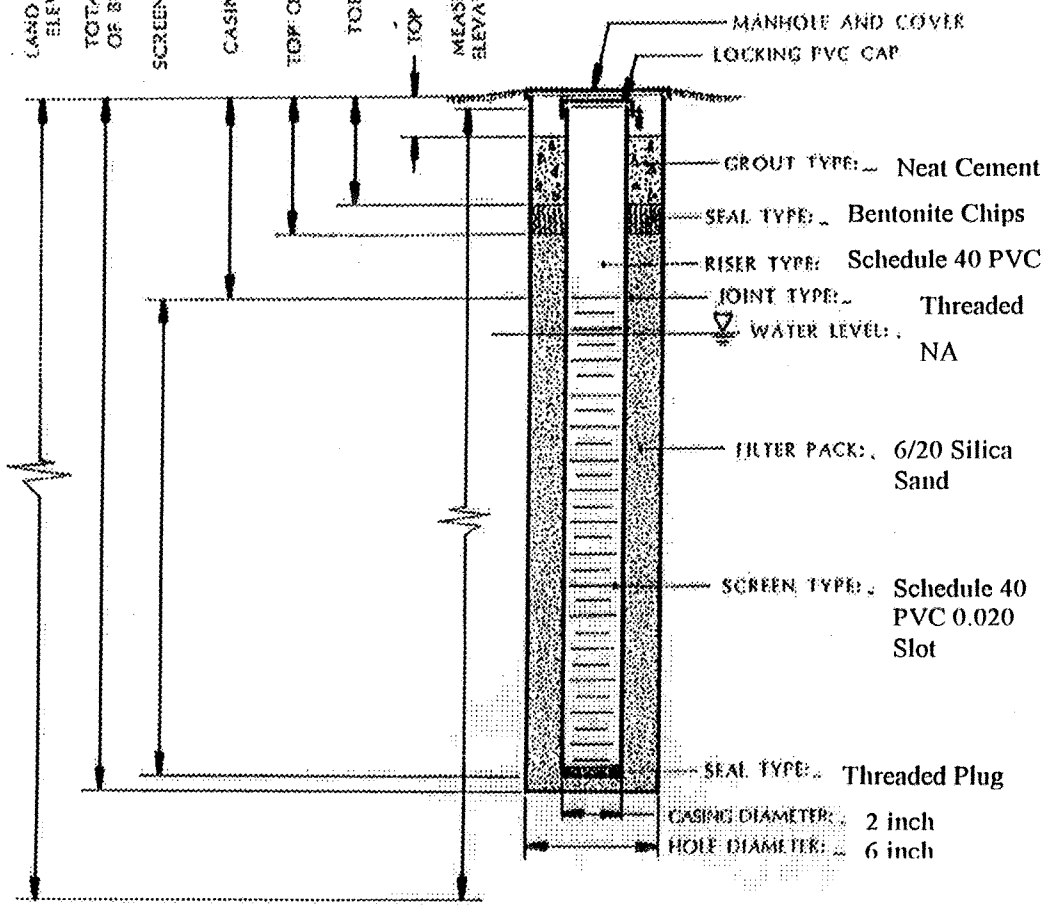
WELL CONSTRUCTION SUMMARY
BELOW GROUND

Big Pine Key - SFWMD

Feet BLS

LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED INTERVAL	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION N.G.V.D.
NA	35	25	10	7	7	0	NA

PROJECT: _
WELL NUMBER: BPK-4
DATE INSTALLED: 9/6/00



NOTE:
ALS-ABOVE LAND SURFACE
BLS-BELOW LAND SURFACE
N.G.V.D.-NATIONAL GEODETIC VERTICAL DATUM

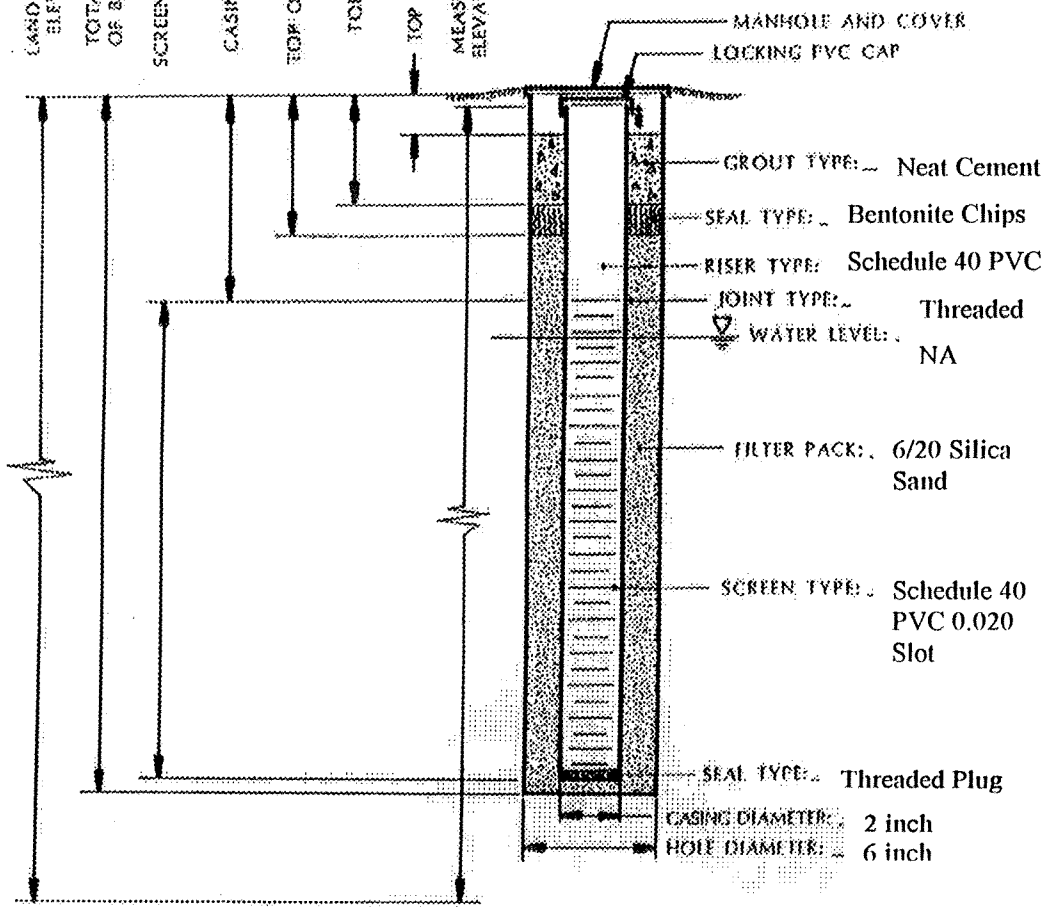
WELL CONSTRUCTION SUMMARY
BELOW GROUND

Big Pine Key - SFWMD

Feet BLS

LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED INTERVAL	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION N.G.V.D.
NA	35	25	10	7	7	0	NA

PROJECT: _
WELL NUMBER: BPK-5
DATE INSTALLED: 9/5/00

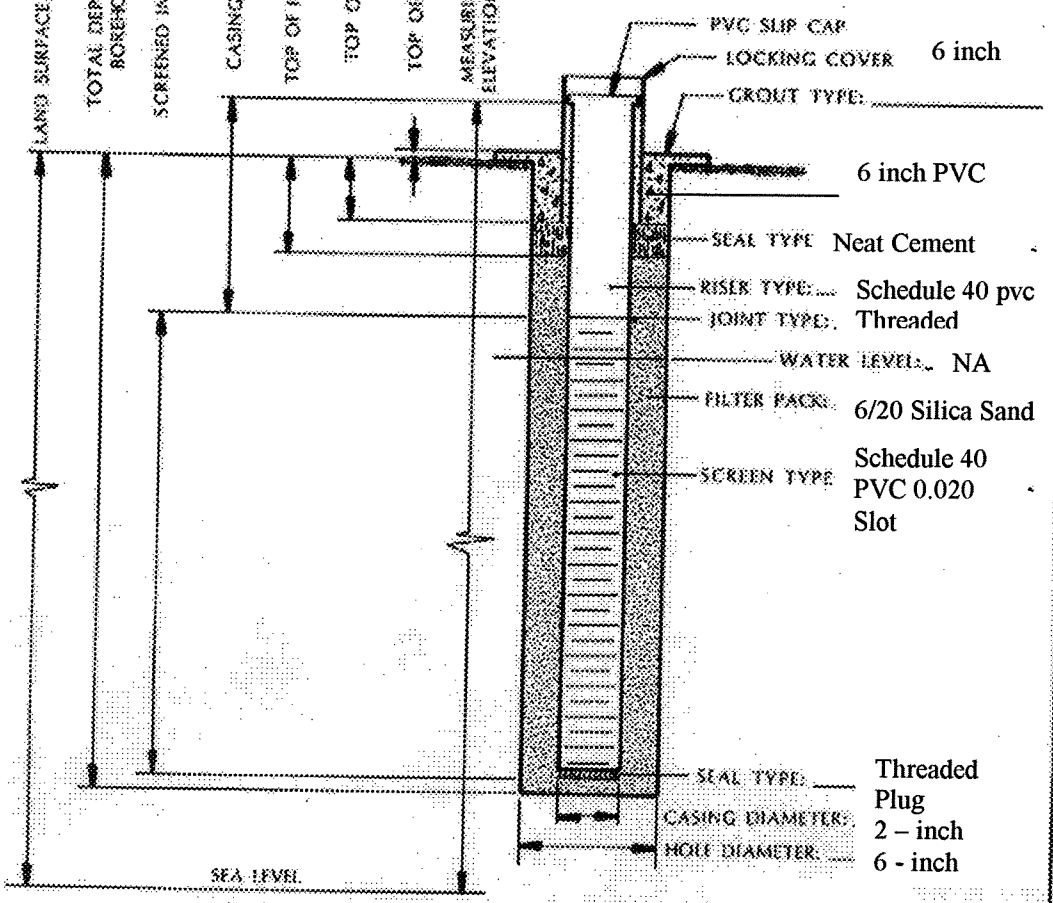


NOTE:
ALS-ABOVE LAND SURFACE
BLS-BELOW LAND SURFACE
N.G.V.D.-NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION SUMMARY
ABOVE GROUND

NA	40	30	12.5	7	7	42.5	NA
LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED INTERVAL	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION N.G.V.D.

PROJECT: Big Pine Key - SFWMD
WELL NUMBER: BPK-6
DATE INSTALLED: 9/6/00



NOTE:
ALS-ABOVE LAND SURFACE
BLS-BELOW LAND SURFACE
N.G.V.D.-NATIONAL GEODETIC VERTICAL DATUM

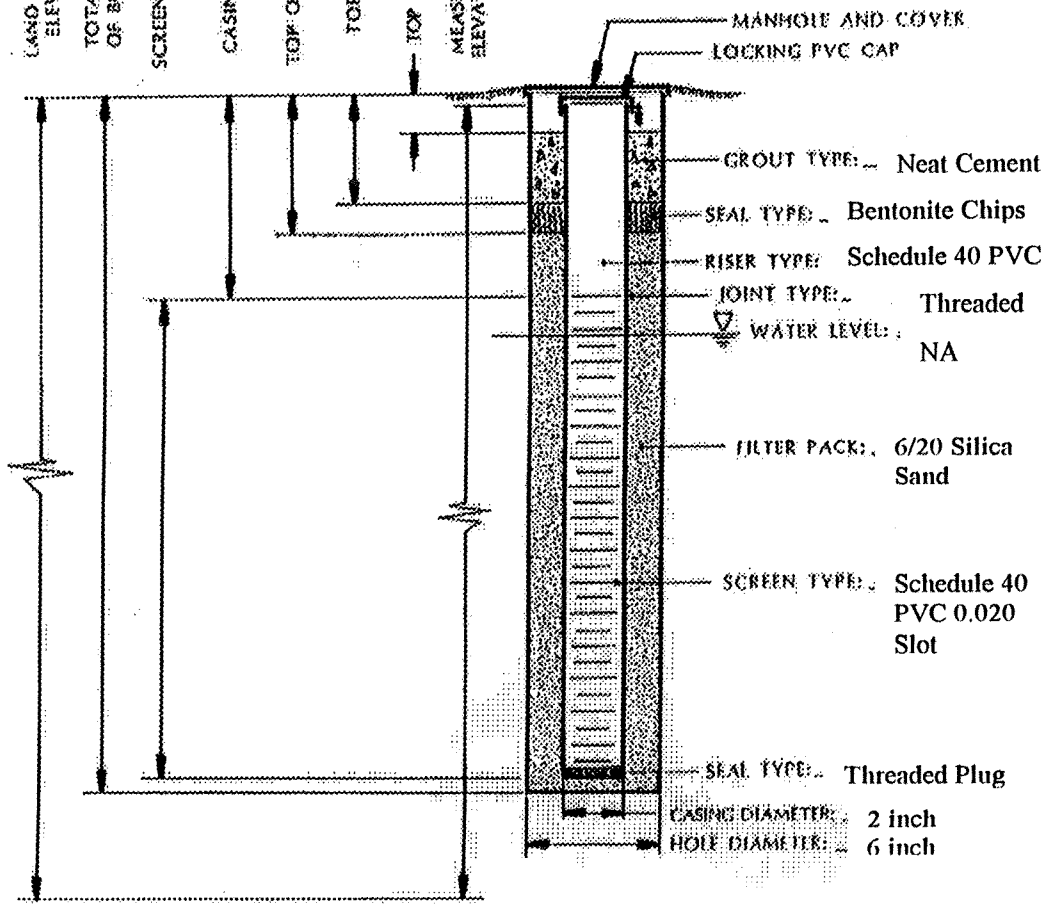
WELL CONSTRUCTION SUMMARY
BELOW GROUND

Big Pine Key - SFWMD

PROJECT:
WELL NUMBER: BPK-7
DATE INSTALLED: 9/6/00

Feet BLS

LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED INTERVAL	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION N.G.V.D.
NA	35	25	10	7	7	0	NA



NOTE:
ALS-ABOVE LAND SURFACE
BLS-BELOW LAND SURFACE
N.G.V.D.-NATIONAL GEODETIC VERTICAL DATUM

SALINITY PROFILES

Big Pine Key Freshwater Lens

Salinity Profile

Well: BPK 1
Date: October 10, 2000
Time: 1450

Distance Below Water Surface (in feet)	Specific Conductance (in µmhos)	Temperature (°C)
Surface	821	29.1
2	**819**	28.6
4	**817**	28.2
6	**793**	27.3
8	**794**	27.2
10	**1960**	26.5
11	**2090**	26.4
12	**2100**	26.4
13	**2040**	26.3
14	**1942**	26.3
15	**1853**	26.2
17	**1882**	26.2
19	**1875**	26.1
21	**1850**	26.1
23	**1836**	26.1
25	**1823**	26.0
27	**3710**	25.8
28	**4860**	25.8
29	**7550**	25.7
30	**11020**	25.7
31	**11800**	25.7
32	**12750**	25.7
33	**14250**	25.7
34	**16350**	25.7
35	**15830**	25.7

Big Pine Key Freshwater Lens

Salinity Profile

Well: BPK 2
Date: October 10, 2000
Time: 15:50

Distance Below Water Surface (in feet)	Specific Conductance (in µmhos)	Temperature (°C)
Surface	652	27.5
2	636	28.0
4	633	28.0
6	634	27.9
8	633	27.7
10	1086	27.3
12	1281	27.1
14	1294	27.1
16	1287	26.8
18	1273	26.7
20	1274	26.5
22	1298	26.4
24	1915	26.2
25	2140	26.1
26	2440	26.0
27	2950	25.9
28	3380	25.8
29	4320	25.8
30	4950	25.7
31	5380	25.7
32	5670	25.7
33	6350	25.7
34	6450	25.7

Big Pine Key Freshwater Lens

Salinity Profile

Well: BPK 3
Date: October 10, 2000
Time: 1620

Distance Below Water Surface (in feet)	Specific Conductance (in µmhos)	Temperature (°C)
Surface	538	27.9
2	**534**	28.1
4	**533**	28.1
6	**532**	27.8
8	**1035**	27.4
10	**1095**	27.2
12	**1054**	27.2
14	**1066**	27.1
16	**1079**	27.0
18	**1088**	26.9
20	**1094**	26.9
22	**1103**	26.8
24	**1192**	26.7
26	**3970**	26.1
27	**4720**	26.0
28	**5340**	25.9
29	**6010**	25.9
30	**6120**	25.9
31	**6230**	25.8
32	**7350**	25.8

Big Pine Key Freshwater Lens

Salinity Profile

Well: BPK 4
Date: October 10, 2000
Time: 1640

Distance Below Water Surface (in feet)	Specific Conductance (in µmhos)	Temperature (°C)
Surface	1534	27.5
2	**1527**	28.0
4	**1522**	28.0
6	**1518**	28.0
8	**1509**	27.9
10	**1875**	27.8
11	**1948**	27.7
12	**1970**	27.6
13	**1980**	27.6
14	**2060**	27.5
15	**2040**	27.4
16	**2050**	27.3
17	**2050**	27.3
18	**2050**	27.2
19	**2040**	27.2
20	**2010**	27.2
21	**2010**	26.5
22	**2690**	26.2
23	**3430**	26.1
24	**3710**	25.9
25	**4010**	25.8
26	**4250**	25.8
27	**4500**	25.7
28	**4660**	25.7
29	**4950**	25.7
30	**5290**	25.6
31	**5900**	25.6
32	**7200**	25.6
33	**10900**	25.6

Big Pine Key Freshwater Lens

Salinity Profile

Well: BPK 5
Date: October 10, 2000
Time: 1530

Distance Below Water Surface (in feet)	Specific Conductance (in µmhos)	Temperature (°C)
Surface	747	32.1
2	**1553**	29.3
4	**1550**	28.9
6	**1553**	28.7
8	**1880**	28.3
10	**2720**	28.0
11	**2740**	27.8
12	**2810**	27.7
14	**2970**	27.6
16	**3020**	27.6
18	**3010**	27.5
20	**3070**	27.5
22	**3050**	27.5
24	**3080**	27.5
26	**10090**	26.8
27	**11950**	26.7
28	**14200**	26.6
29	**16600**	26.5
30	**18100**	26.4
31	**19400**	26.4
32	**>20000**	26.4

Big Pine Key Freshwater Lens

Salinity Profile

Well: BPK 6- Blue Hole
Date: October 10, 2000
Time: 1655

Distance Below Water Surface (in feet)	Specific Conductance (in µmhos)	Temperature (°C)
Surface	680	27.8
2	**676**	28.0
4	**515**	28.0
6	**513**	27.7
8	**571**	27.6
10	**585**	27.3
12	**609**	27.3
14	**633**	27.1
16	**639**	27.0
18	**647**	27.0
20	**950**	26.9
22	**1830**	26.6
23	**2060**	26.6
24	**2310**	26.5
25	**2640**	26.4
26	**3450**	26.4
27	**4550**	26.3
28	**6300**	26.3
29	**7500**	26.3
30	**9100**	26.2
31	**10060**	26.2
32	**10500**	26.2
33	**11500**	26.2
34	**13600**	26.1
35	**17300**	26.1
36	**>20000**	26.1

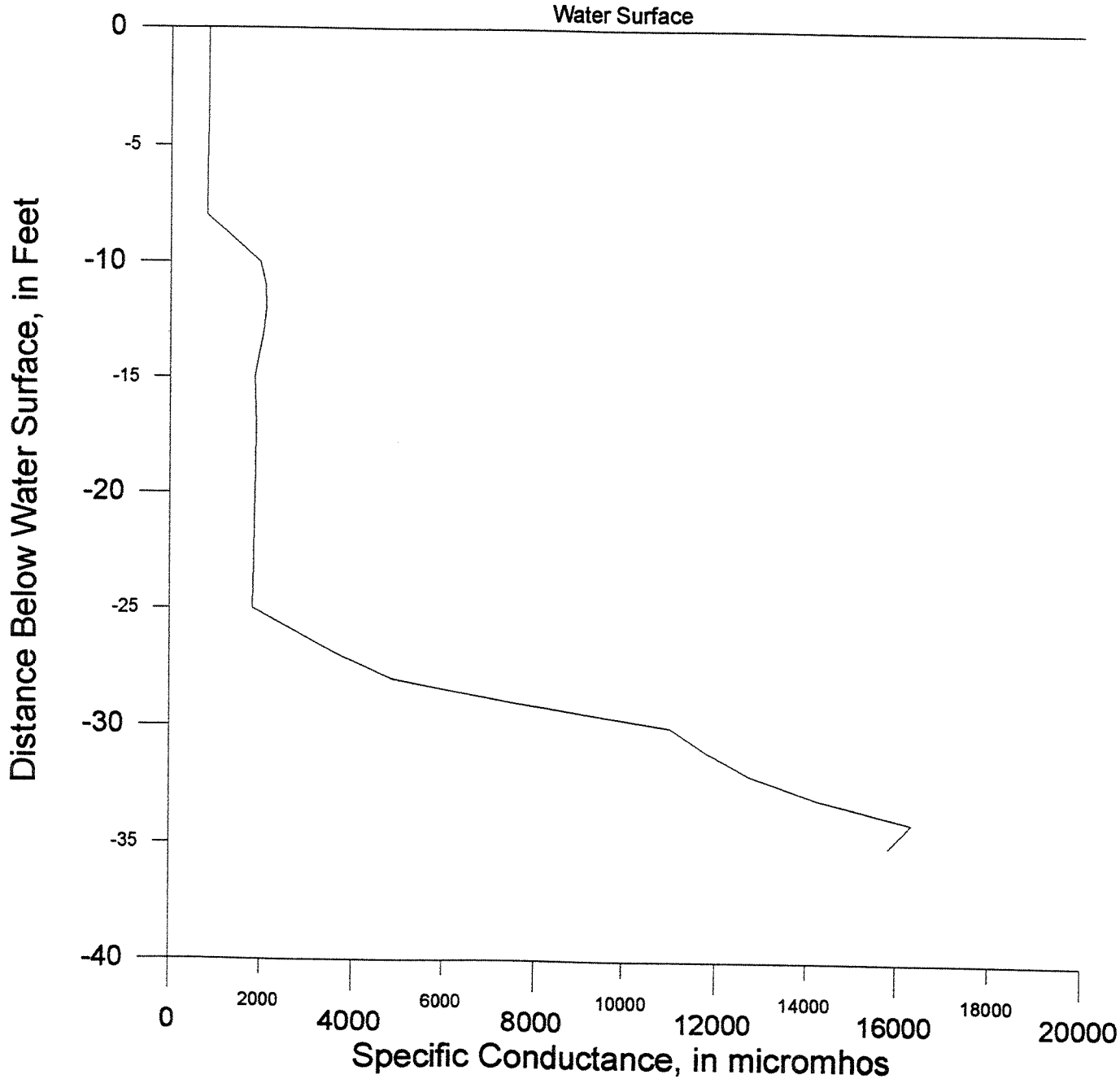
Big Pine Key Freshwater Lens

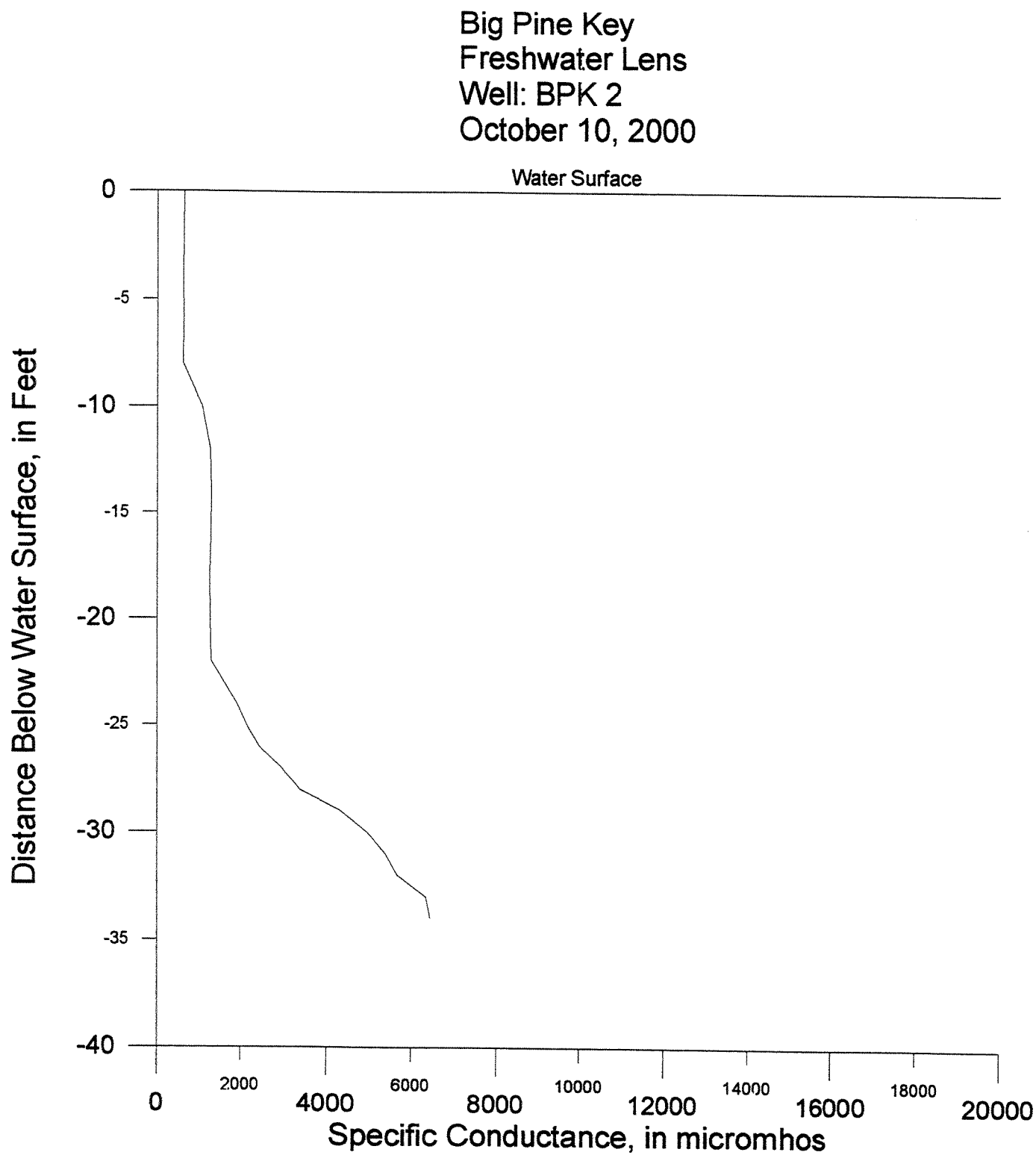
Salinity Profile

Well: BPK 7
Date: October 10, 2000
Time: 17:20

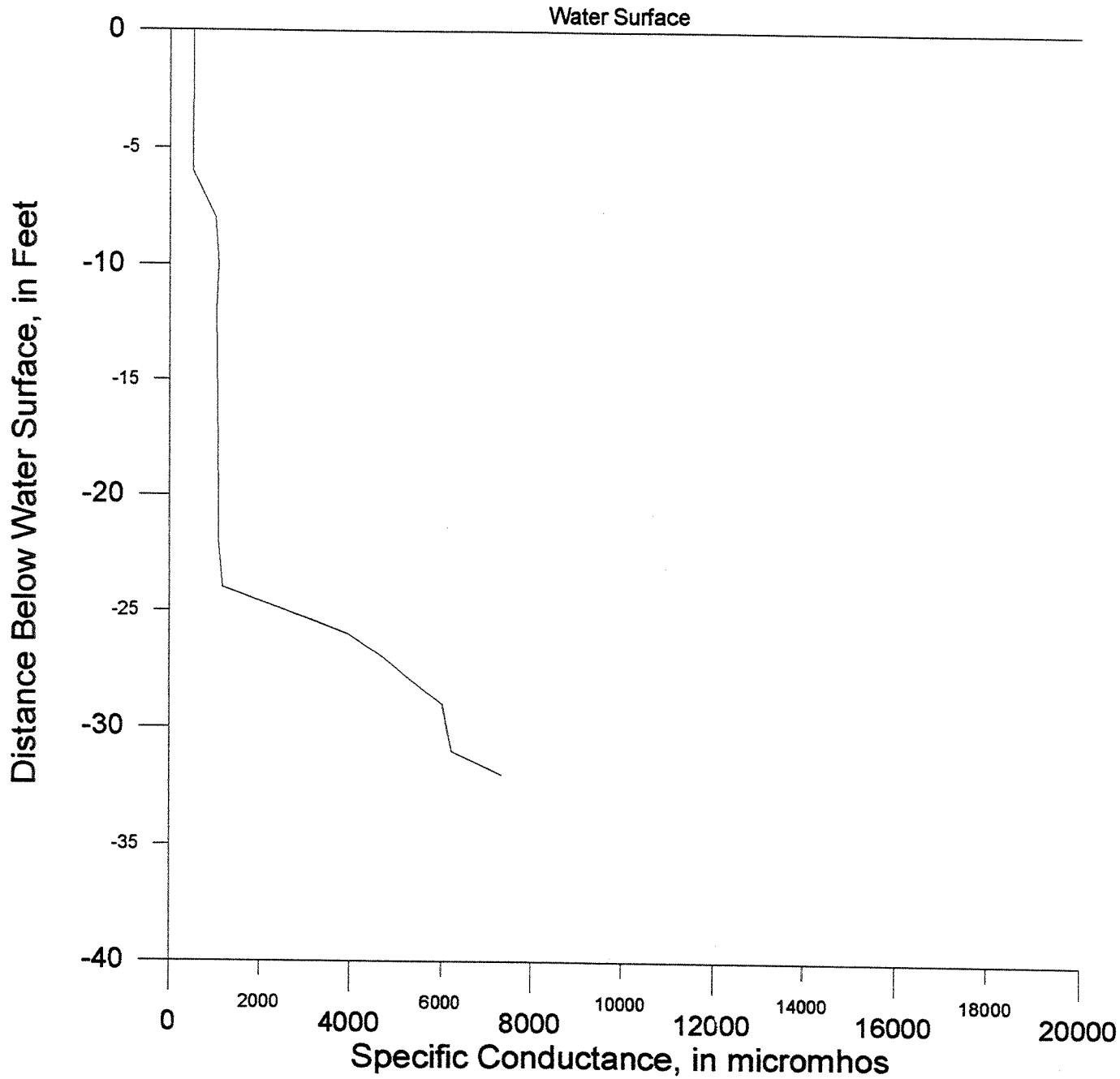
Distance Below Water Surface (in feet)	Specific Conductance (in µmhos)	Temperature (°C)
Surface	534	27.0
2	**553**	27.4
4	**569**	27.4
6	**655**	27.1
8	**1085**	27.0
10	**1110**	26.7
12	**1097**	26.6
14	**1065**	26.4
16	**1051**	26.3
18	**1030**	26.2
20	**1036**	26.2
22	**1049**	26.2
24	**1060**	26.2
26	**1195**	26.1
27	**7000**	25.8
28	**9700**	25.9
29	**13500**	25.8
30	**16700**	25.7
31	**> 20000**	25.7

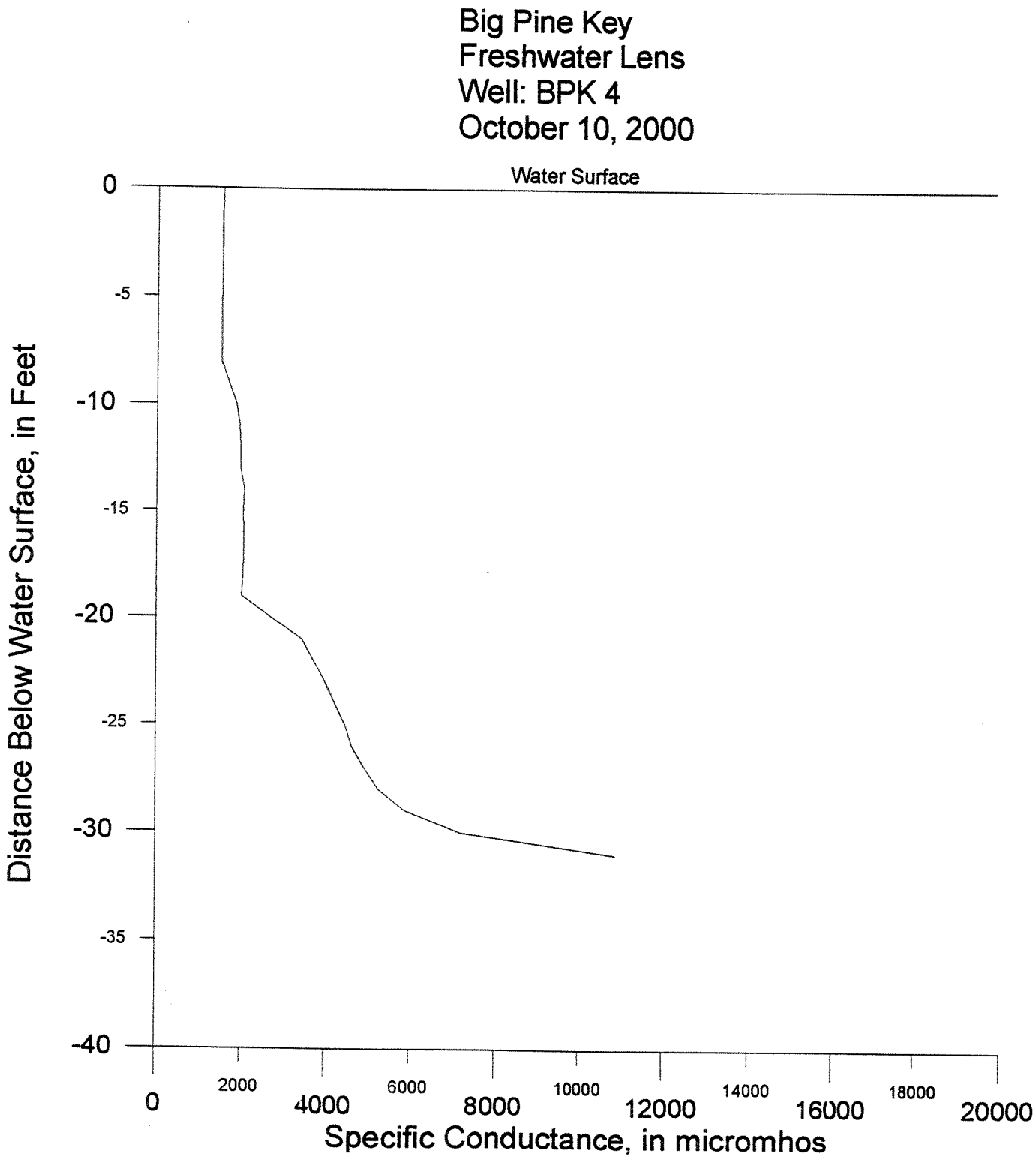
Big Pine Key
Freshwater Lens
Well: BPK 1
October 10, 2000

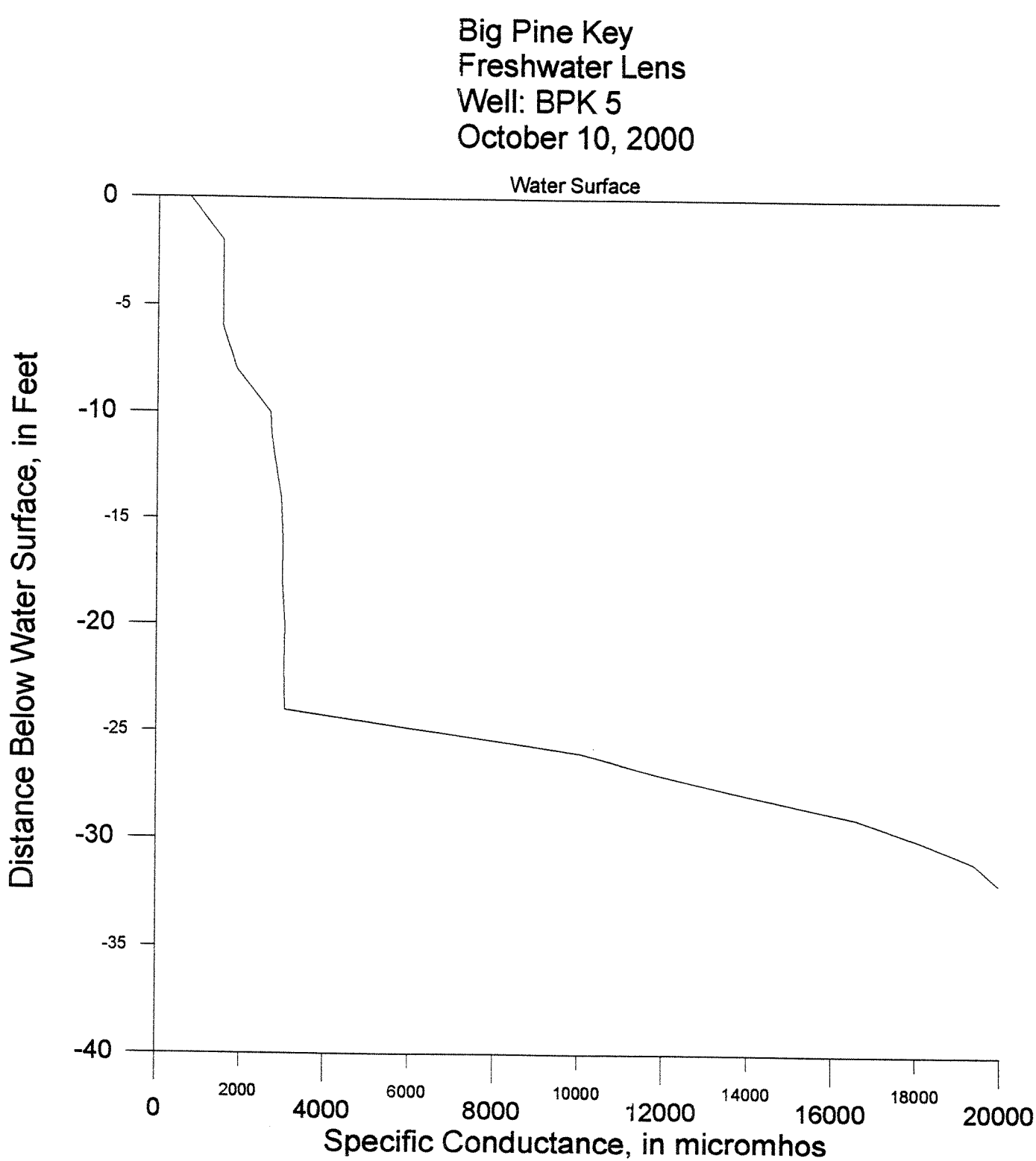


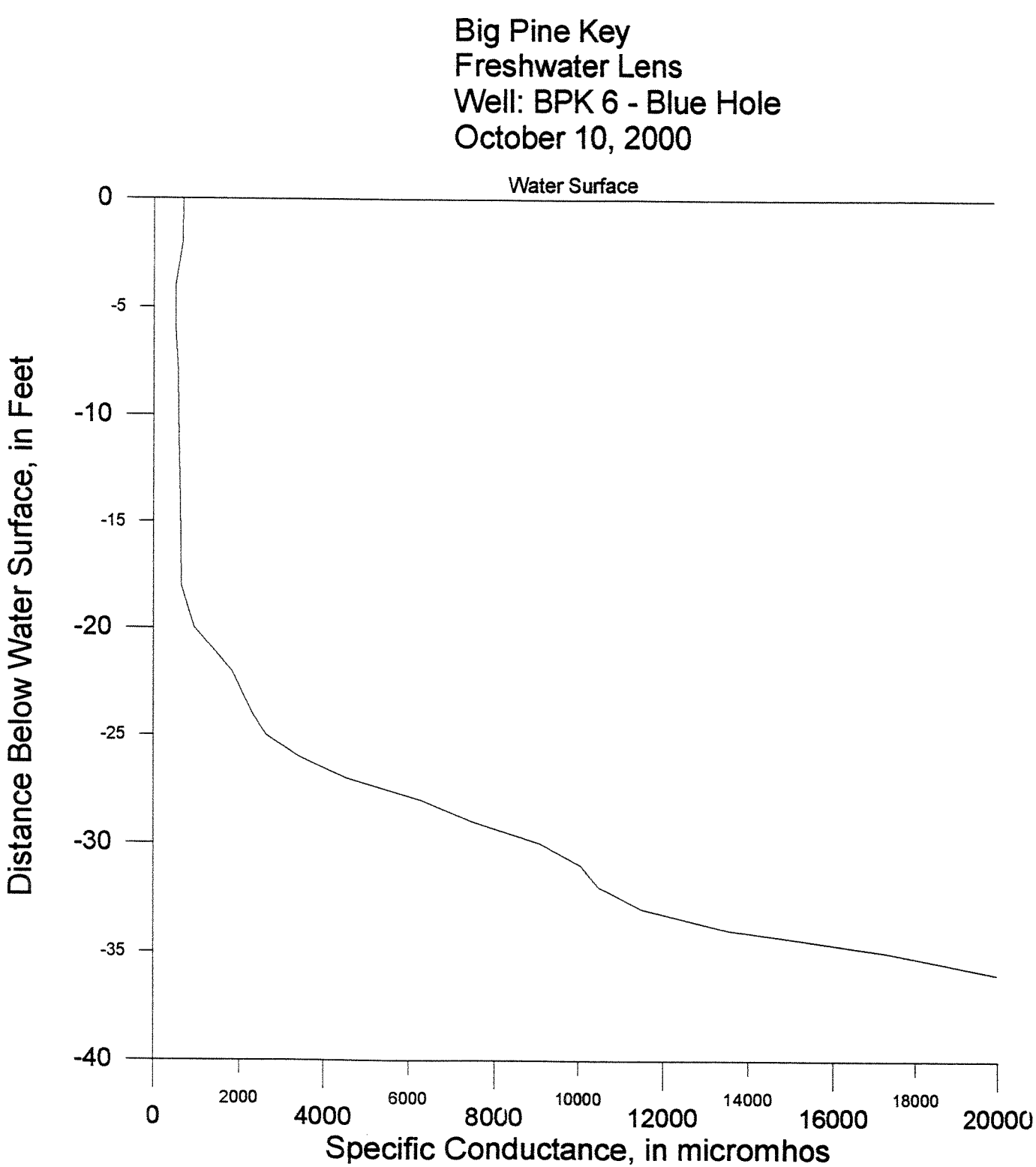

Big Pine Key
Freshwater Lens
Well: BPK 2
October 10, 2000
Water Surface
0
-5
-10
-15
-20
-25
-30
-35
-40
Distance Below Water Surface, in Feet
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
Specific Conductance, in micromhos

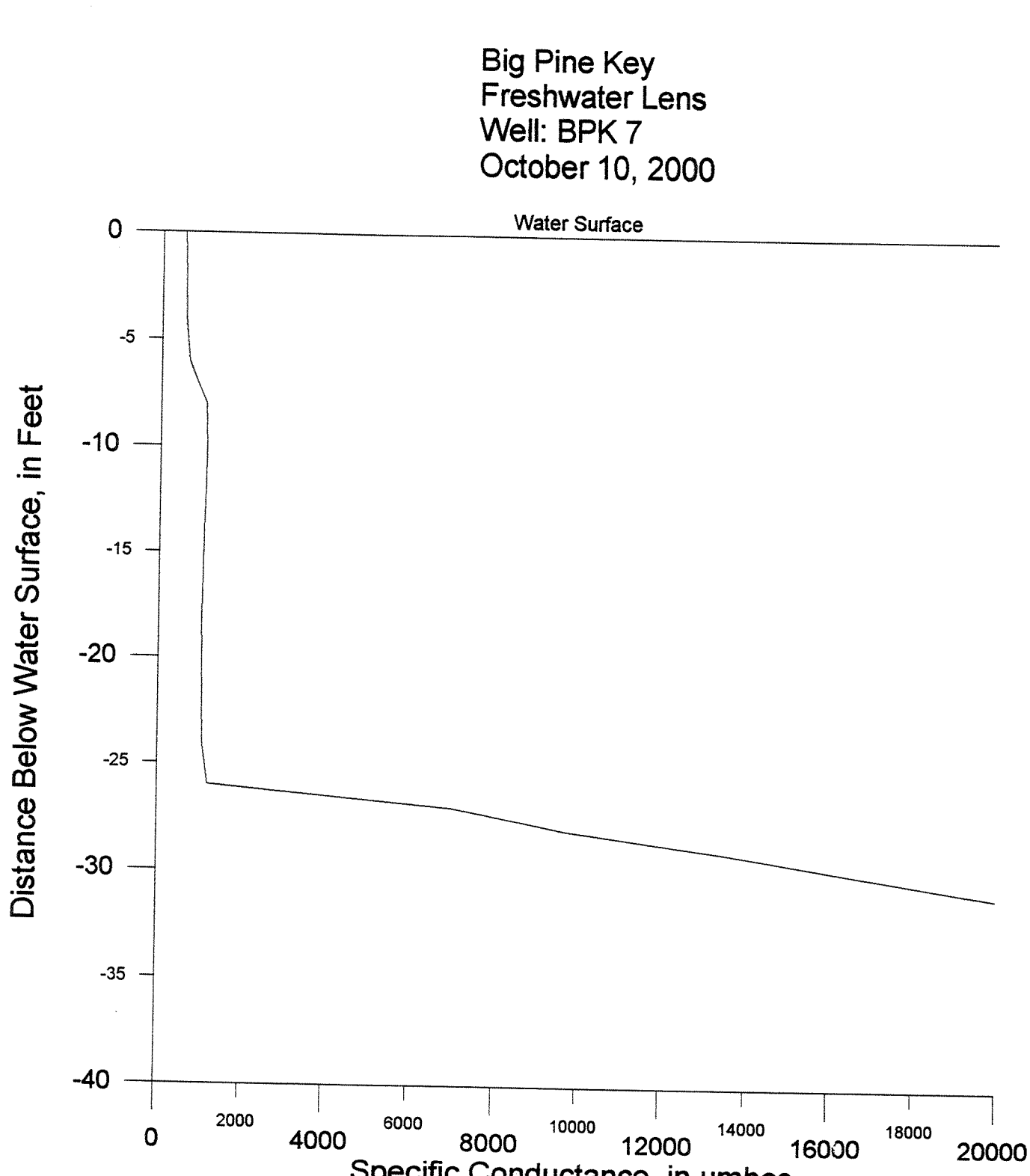
Big Pine Key
Freshwater Lens
Well: BPK 3
October 10, 2000



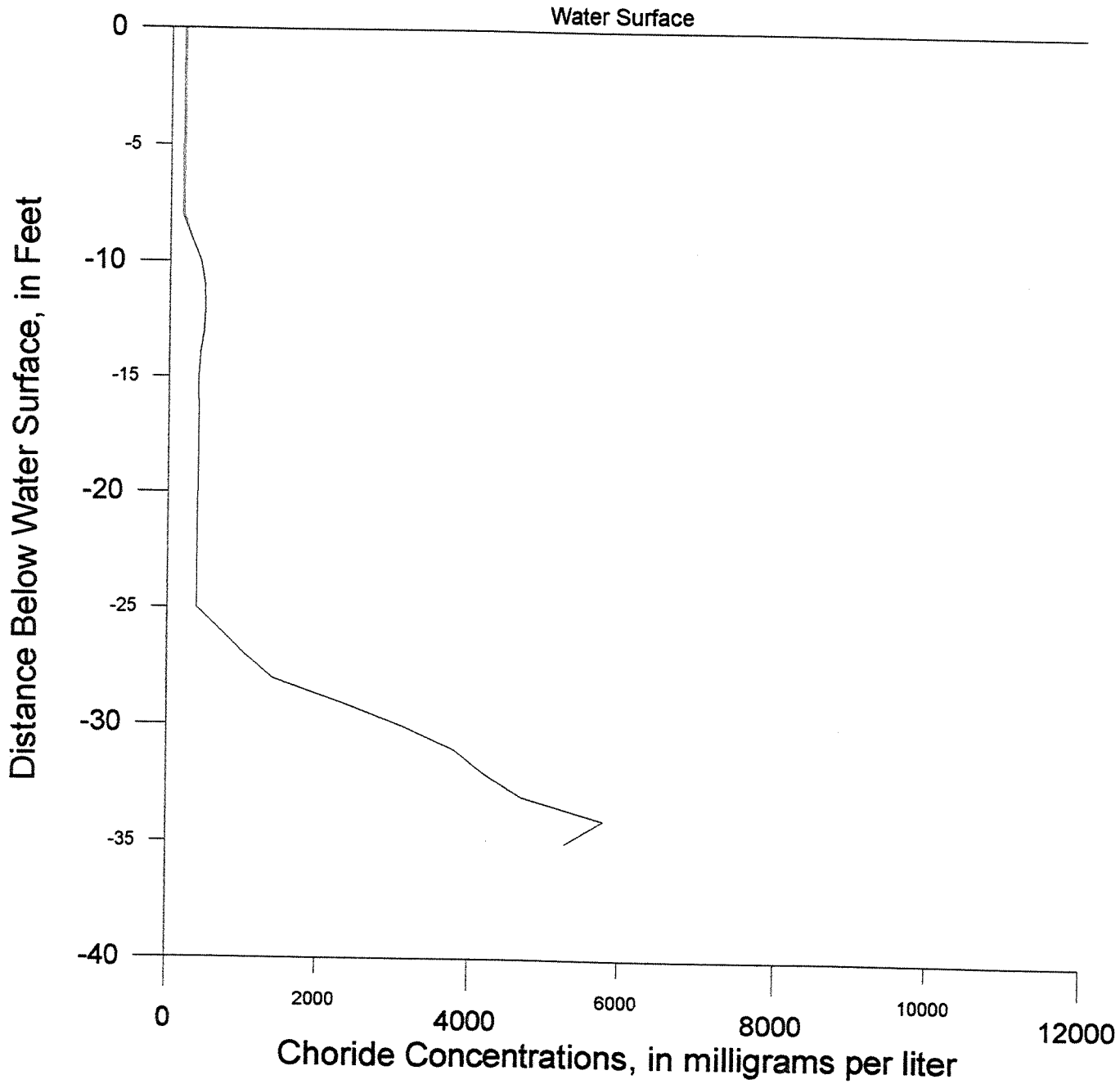

Big Pine Key
Freshwater Lens
Well: BPK 4
October 10, 2000
Water Surface
0
-5
-10
-15
-20
-25
-30
-35
-40
Distance Below Water Surface, in Feet
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
Specific Conductance, in micromhos


Big Pine Key
Freshwater Lens
Well: BPK 5
October 10, 2000
Water Surface
0
-5
-10
-15
-20
-25
-30
-35
-40
Distance Below Water Surface, in Feet
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
Specific Conductance, in micromhos

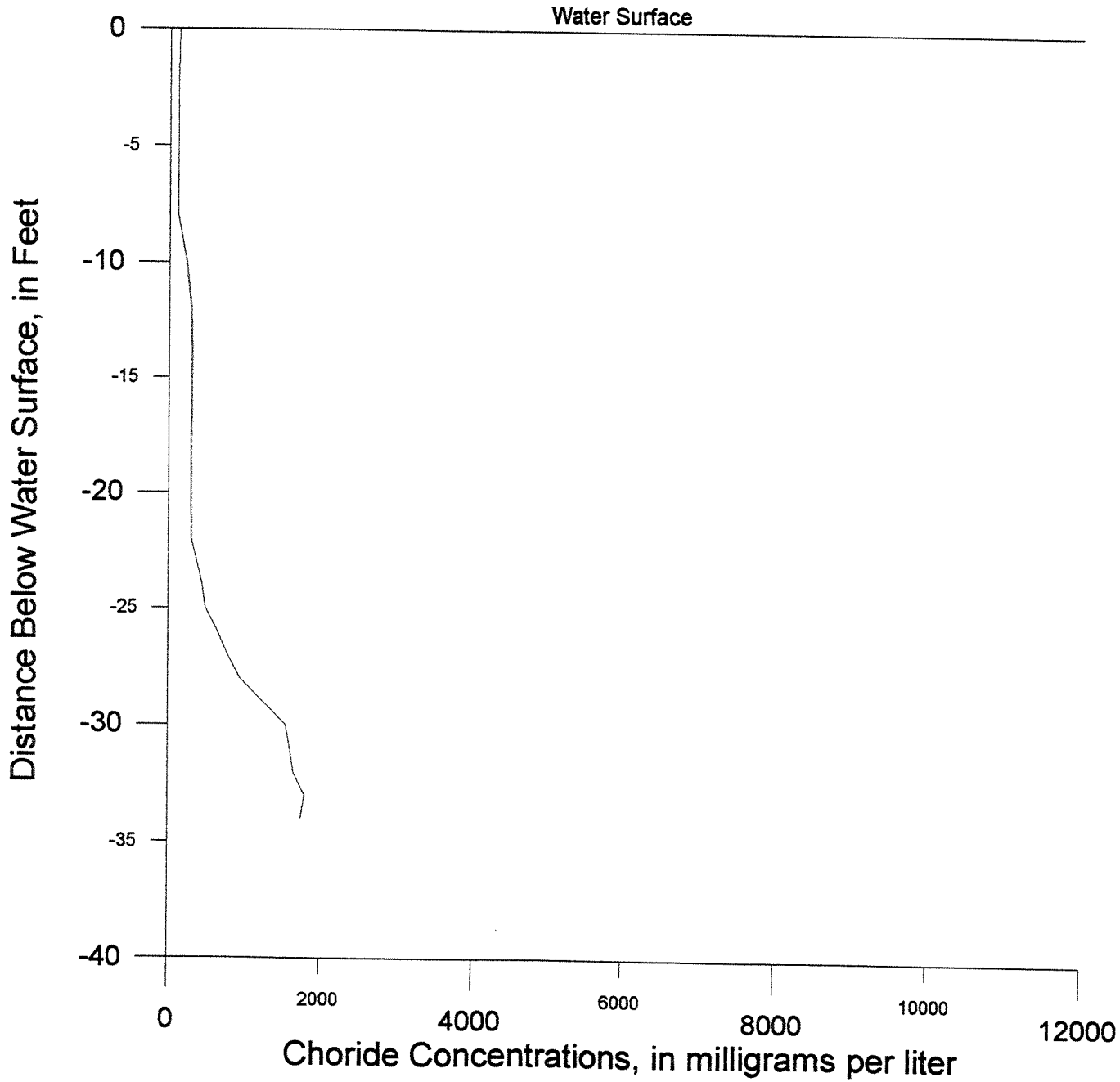

Big Pine Key
Freshwater Lens
Well: BPK 6 - Blue Hole
October 10, 2000
Water Surface
0
-5
-10
-15
-20
-25
-30
-35
-40
Distance Below Water Surface, in Feet
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
Specific Conductance, in micromhos


Big Pine Key
Freshwater Lens
Well: BPK 7
October 10, 2000
Water Surface
0
-5
-10
-15
-20
-25
-30
-35
-40
Distance Below Water Surface, in Feet
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000

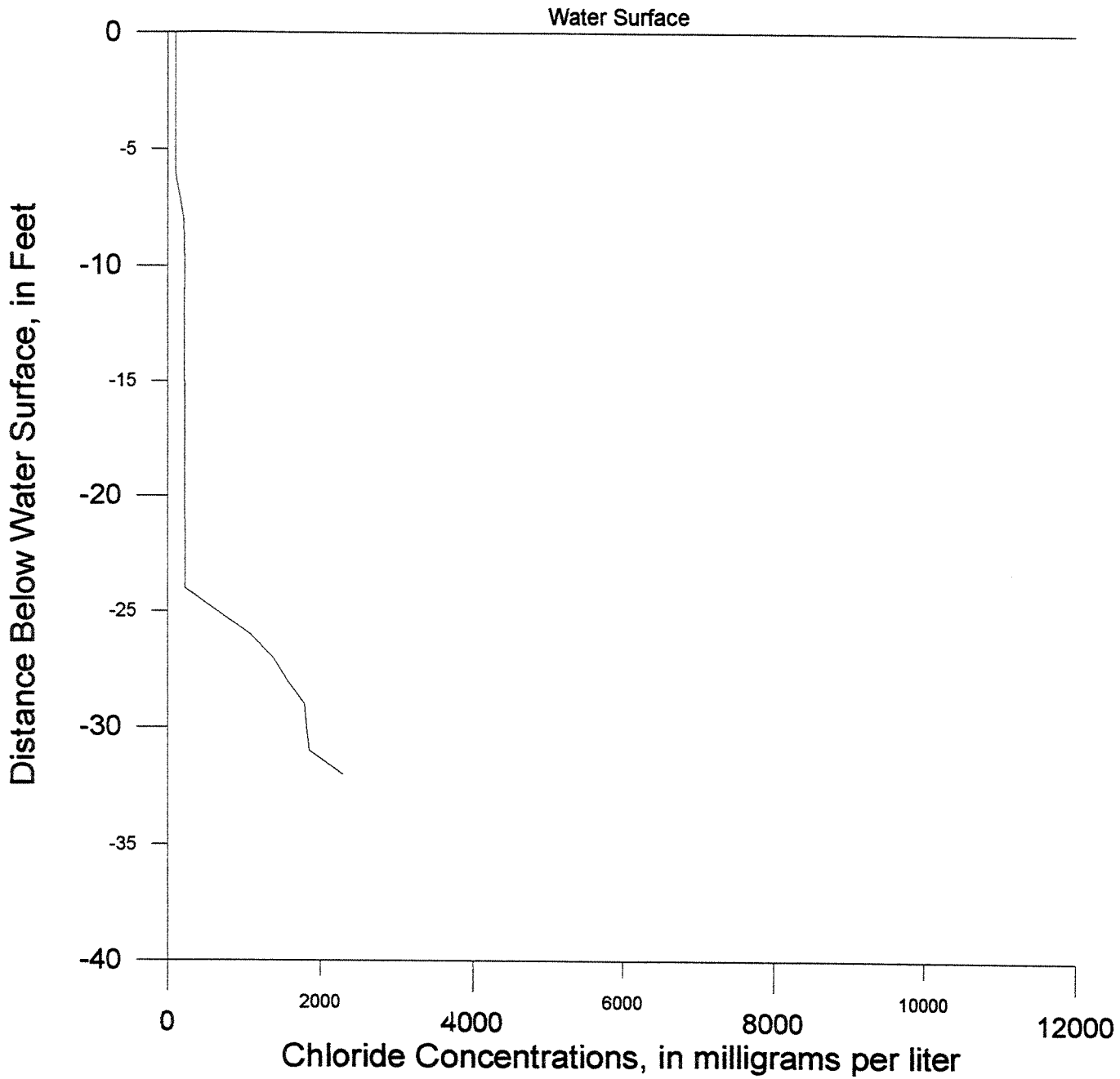
Big Pine Key
Freshwater Lens
Well: BPK 1
October 10, 2000



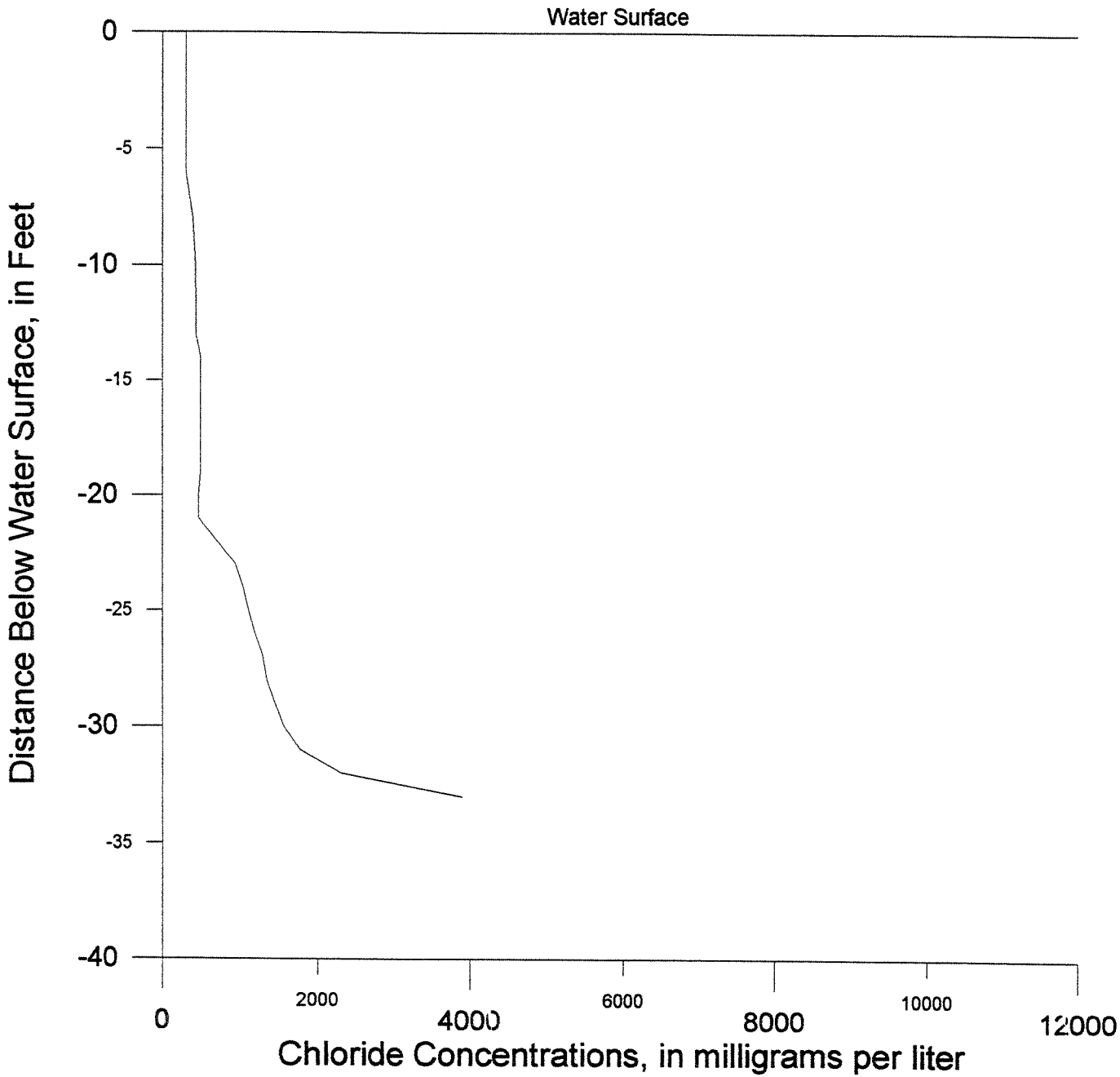
Big Pine Key
Freshwater Lens
Well: BPK 2
October 10, 2000



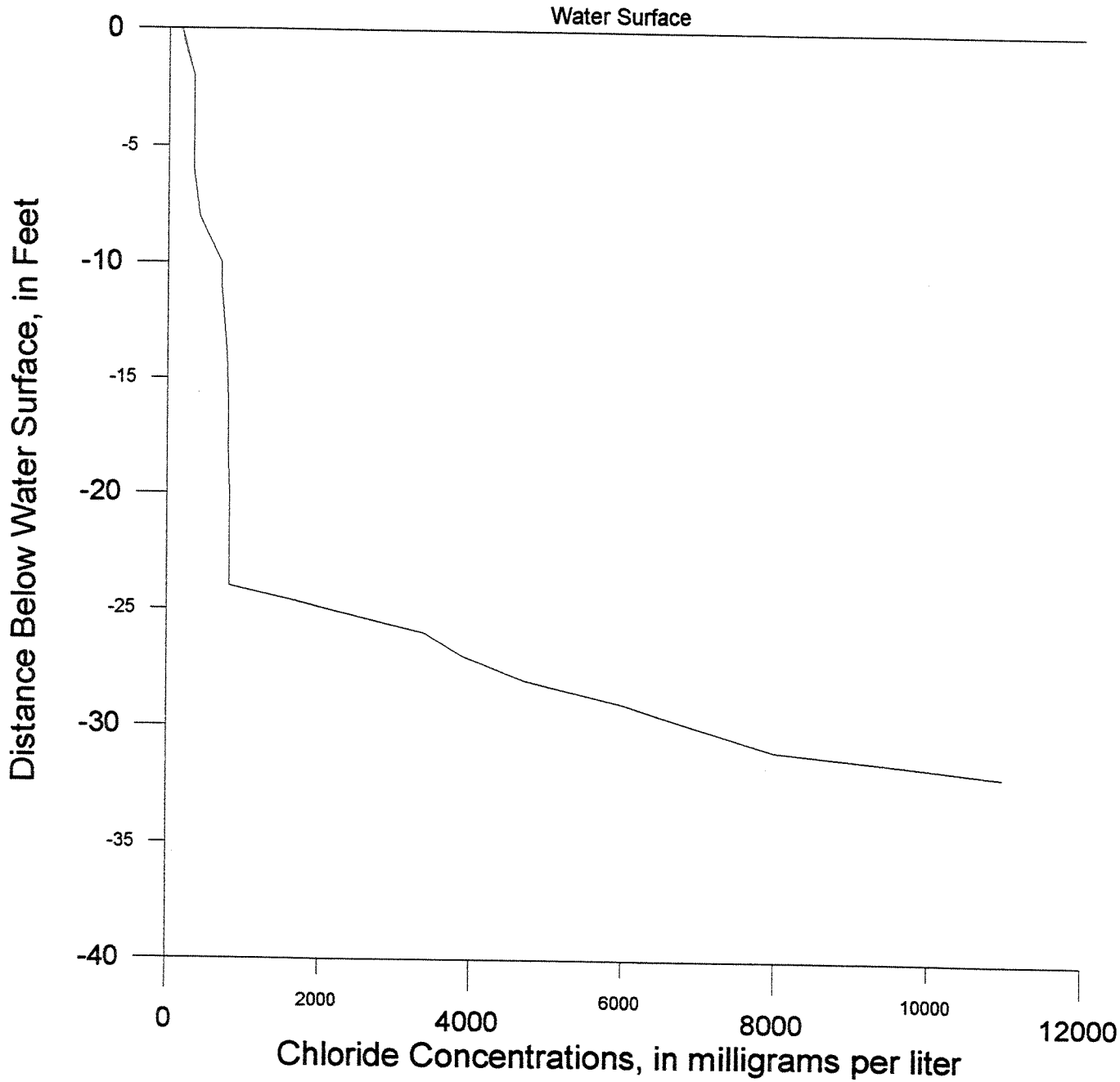
Big Pine Key
Freshwater Lens
Well: BPK 3
October 10, 2000



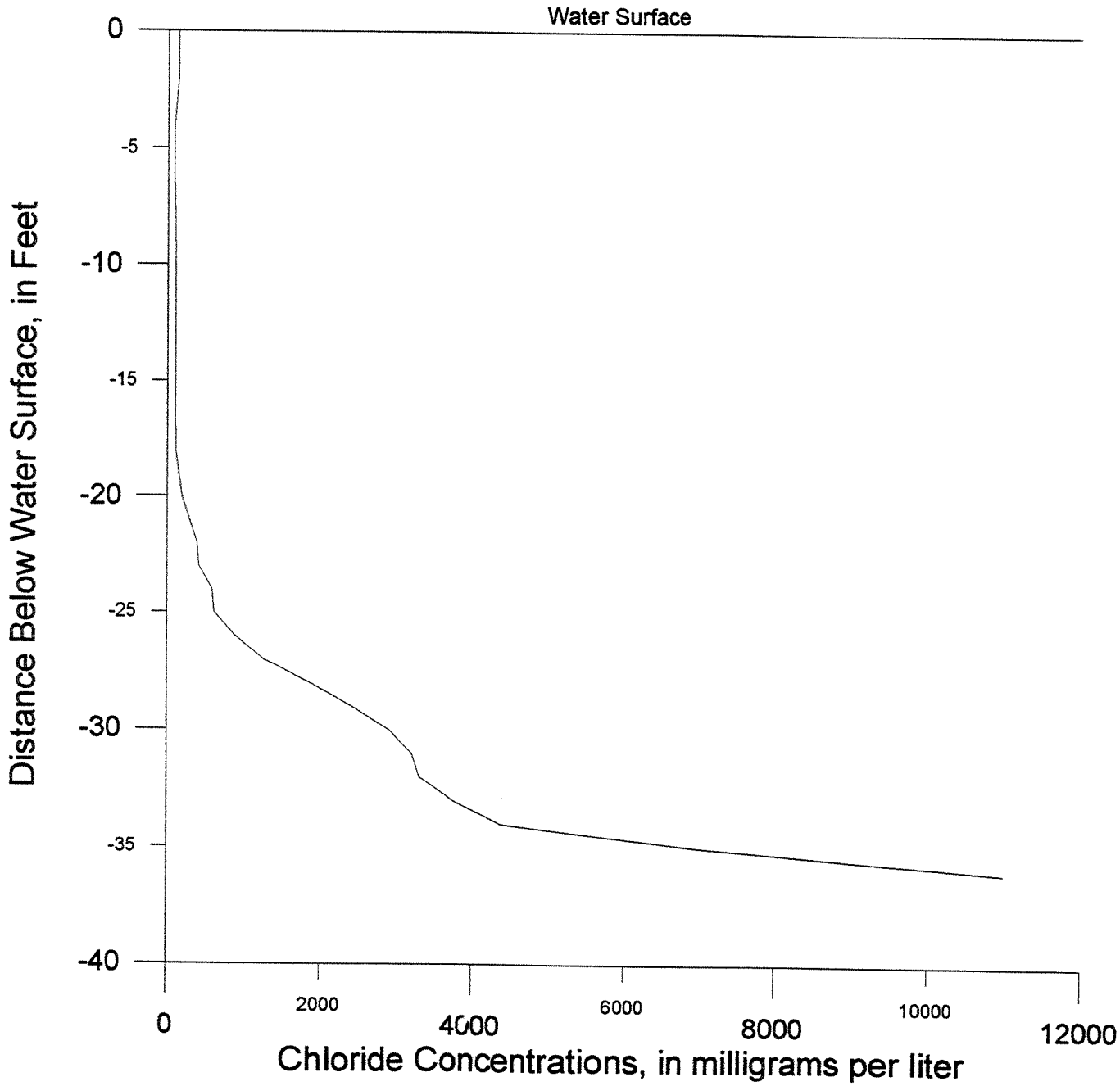
Big Pine Key
Freshwater Lens
Well: BPK 4
October 10, 2000



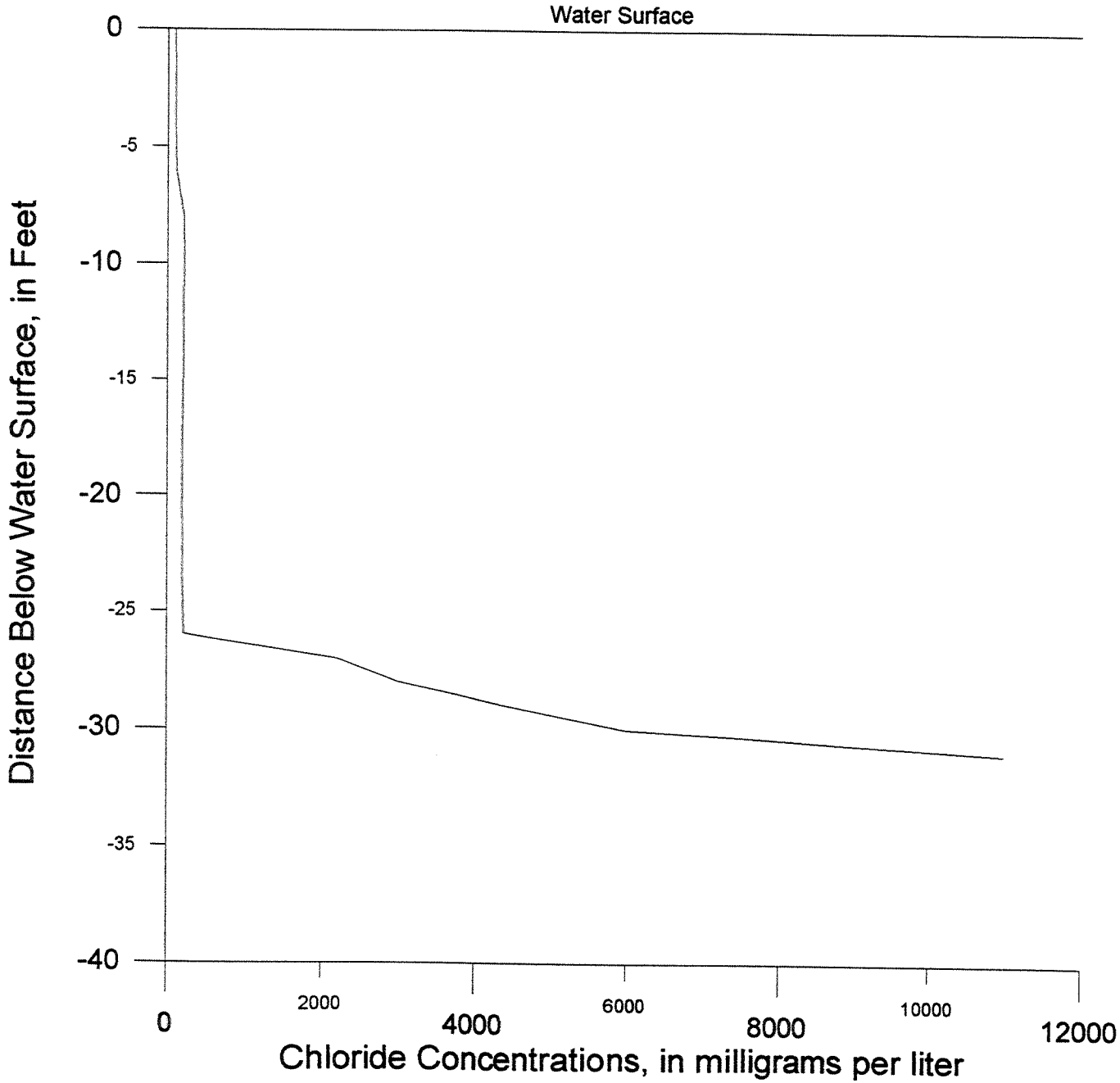
Big Pine Key
Freshwater Lens
Well: BPK 5
October 10, 2000



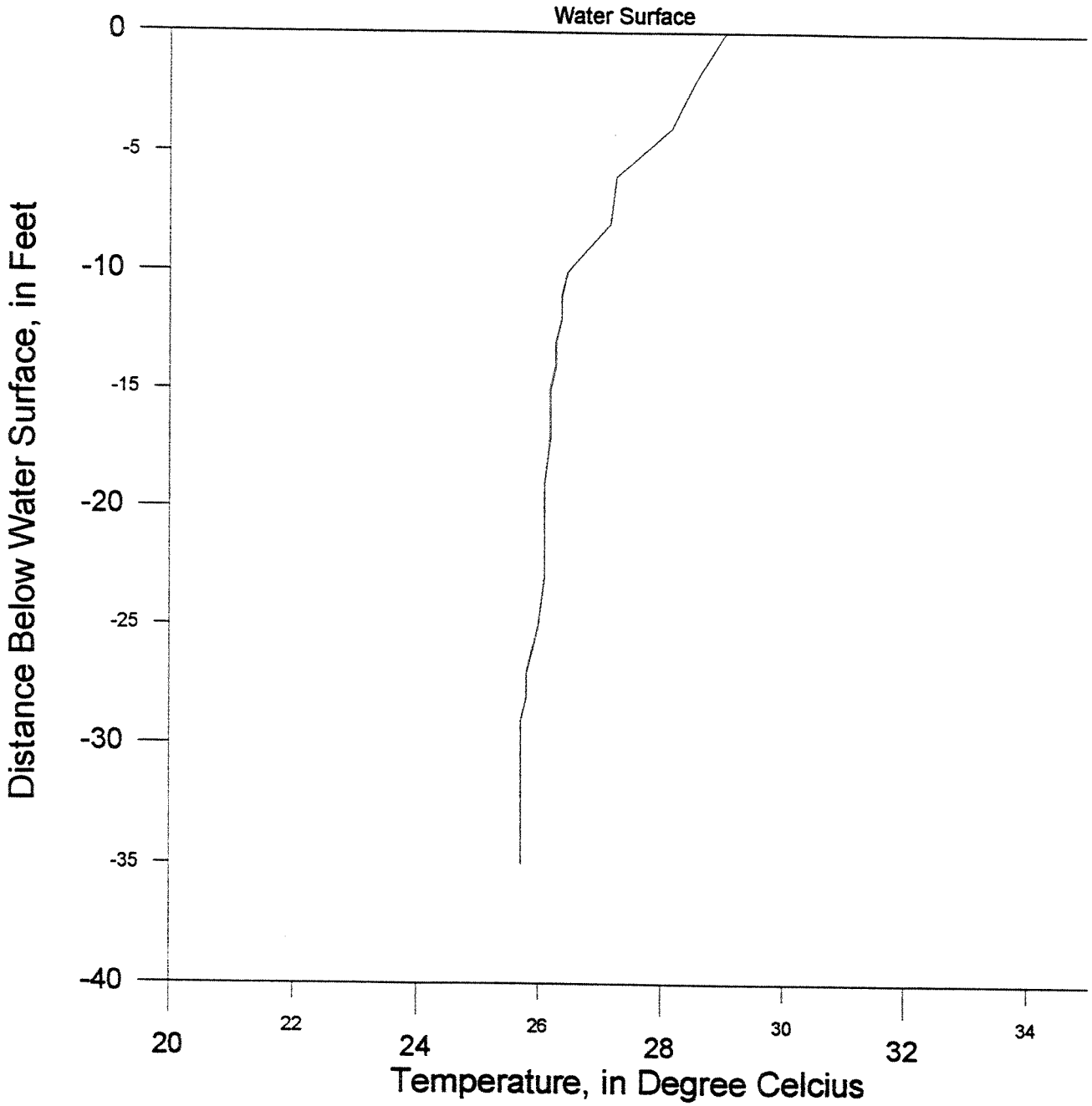
Big Pine Key
Freshwater Lens
Well: BPK 6 - Blue Hole
October 10, 2000



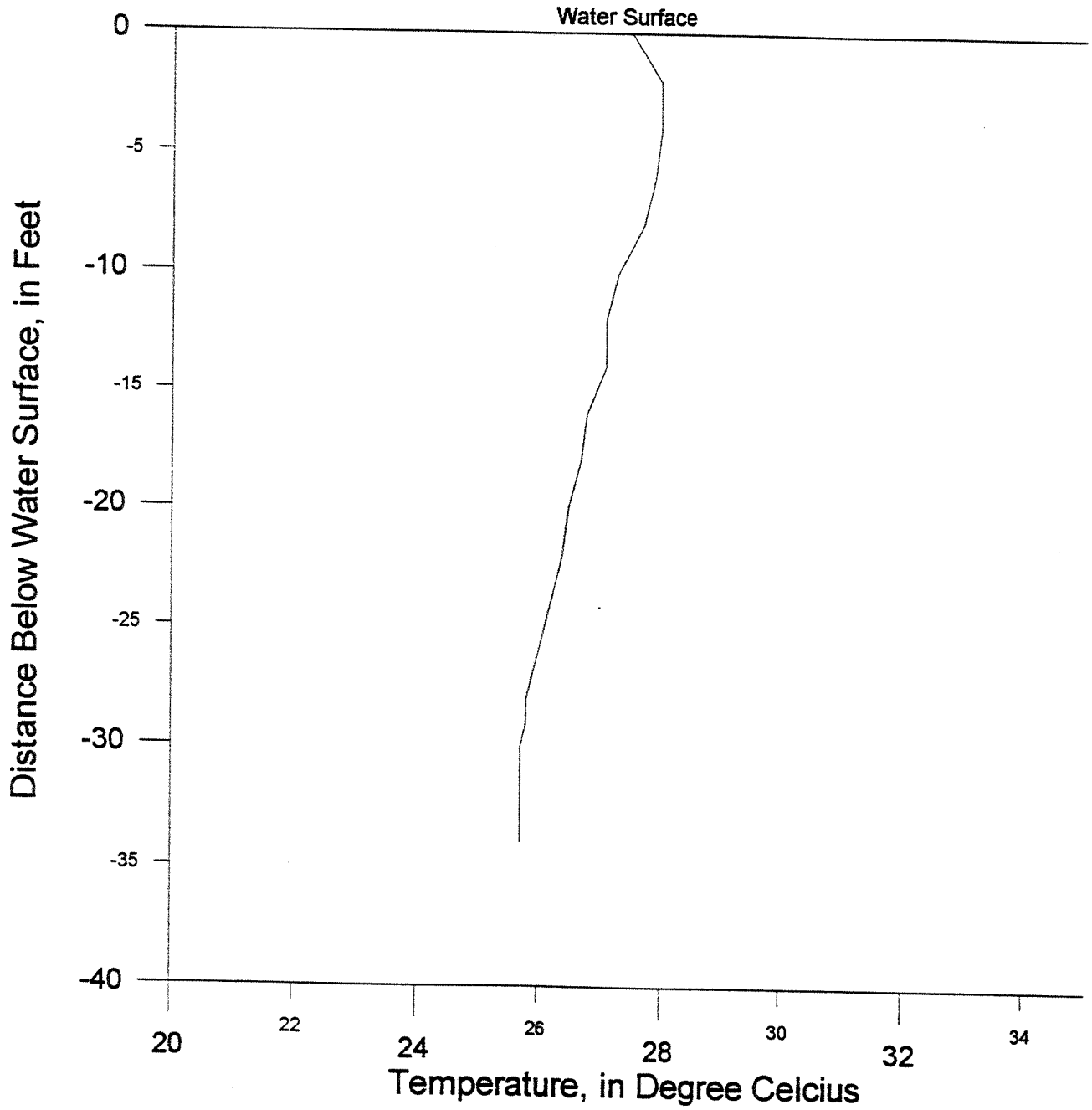
Big Pine Key
Freshwater Lens
Well: BPK 7
October 10, 2000



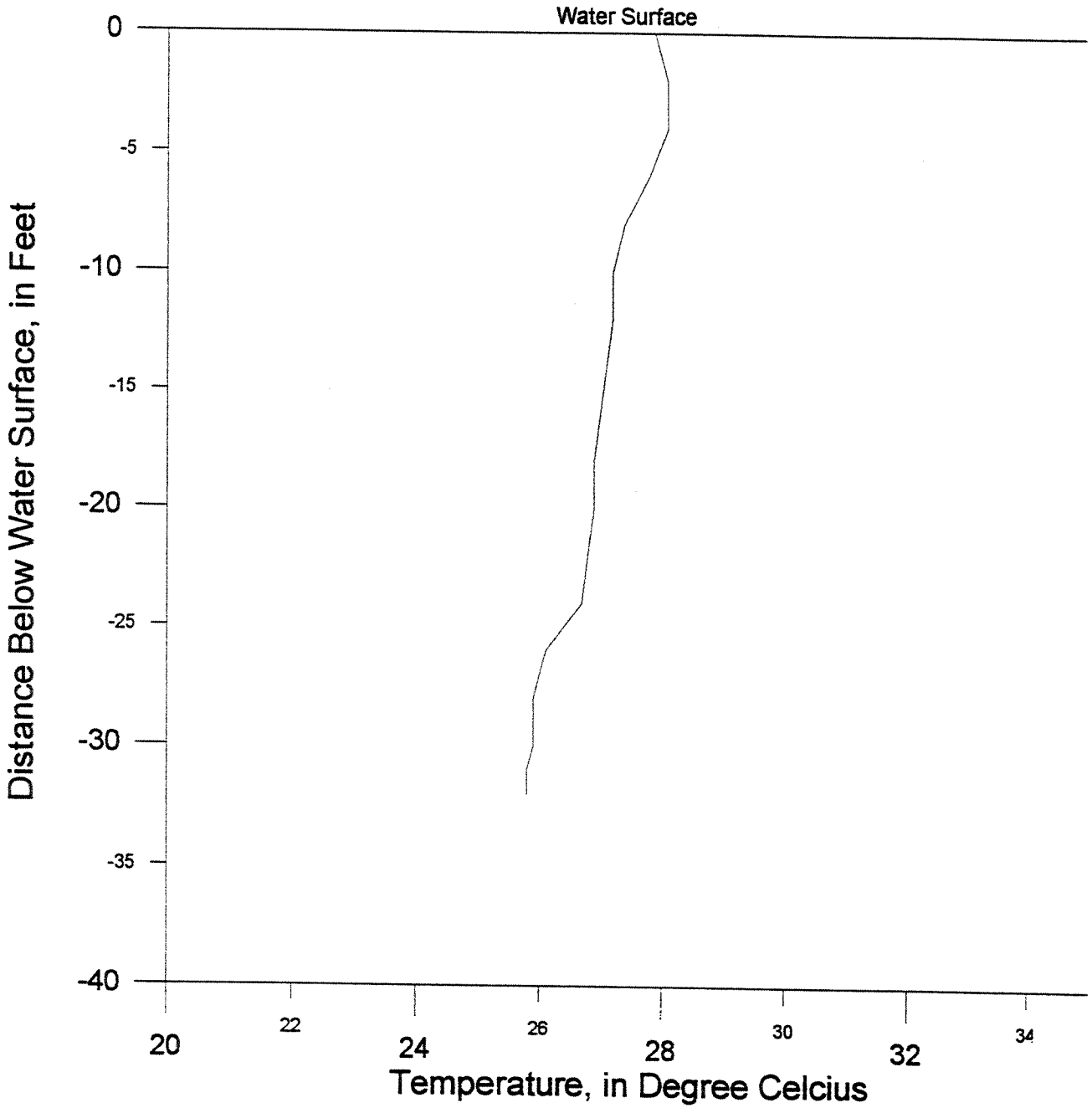
Big Pine Key
Freshwater Lens
Well: BPK 1
October 10, 2000



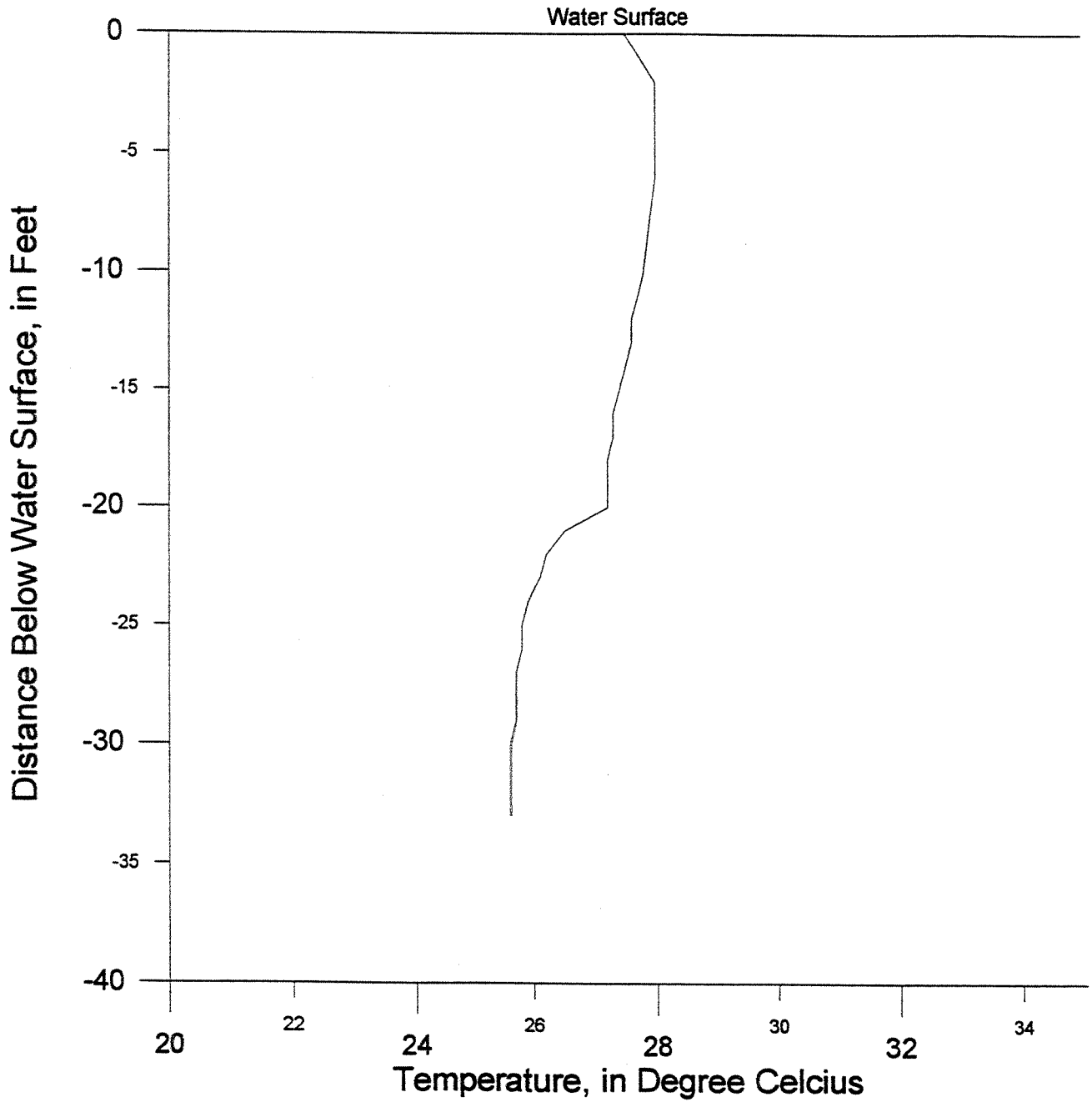
Big Pine Key,
Freshwater Lens
Well: BPK 2
October 10, 2000



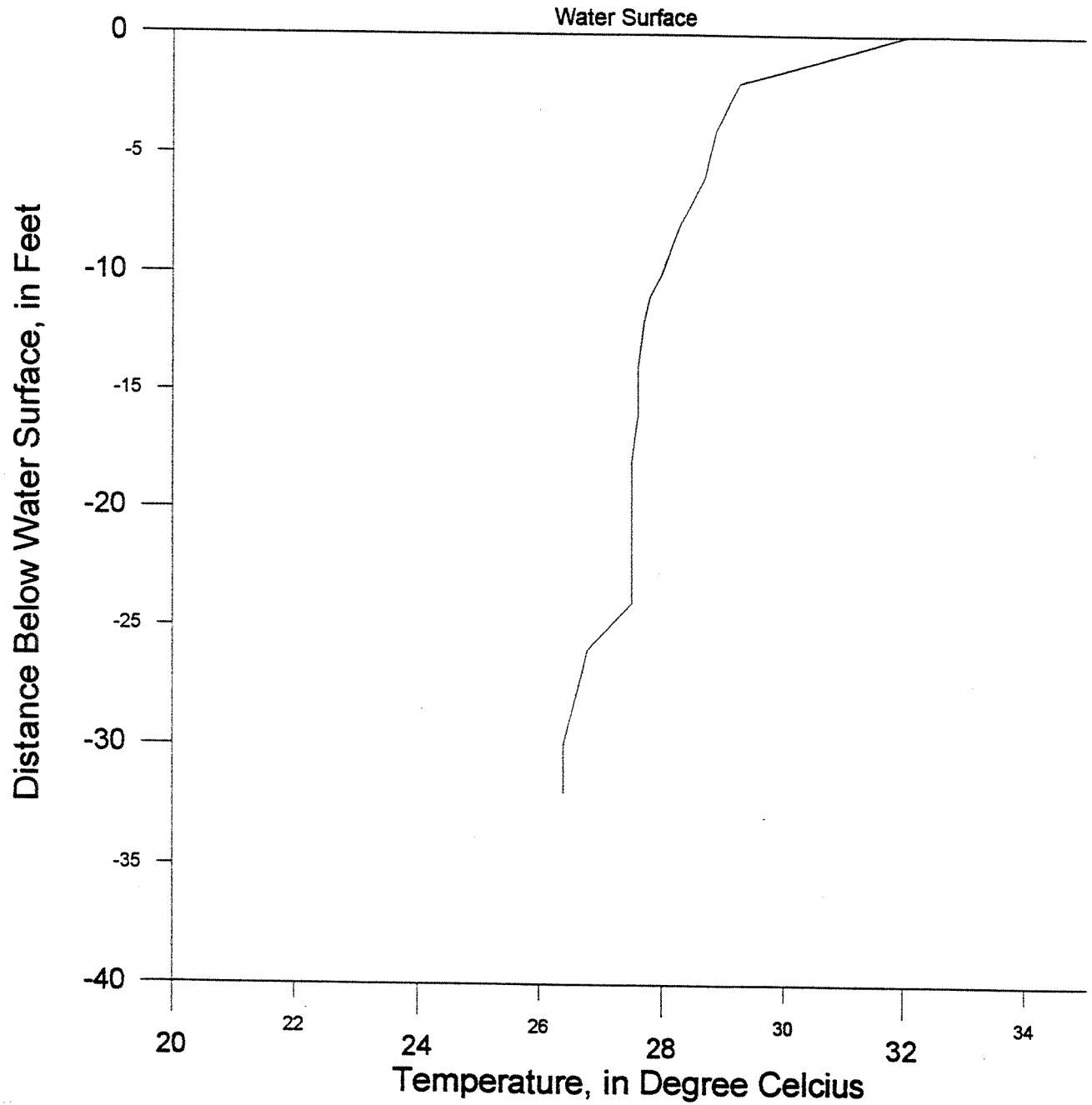
Big Pine Key
Freshwater Lens
Well: BPK 3
October 10, 2000



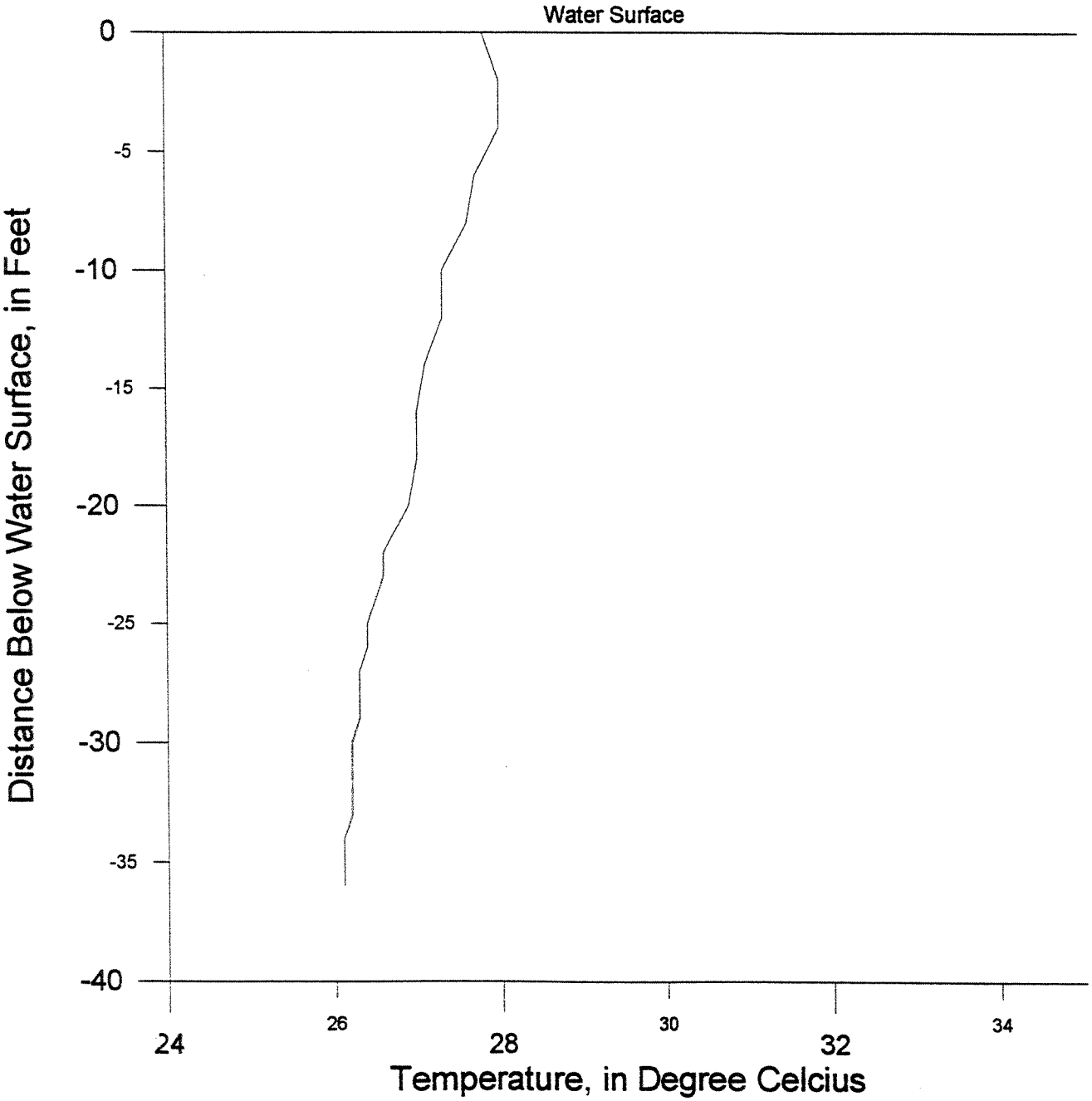
Big Pine Key
Freshwater Lens
Well: BPK 4
October 10, 2000



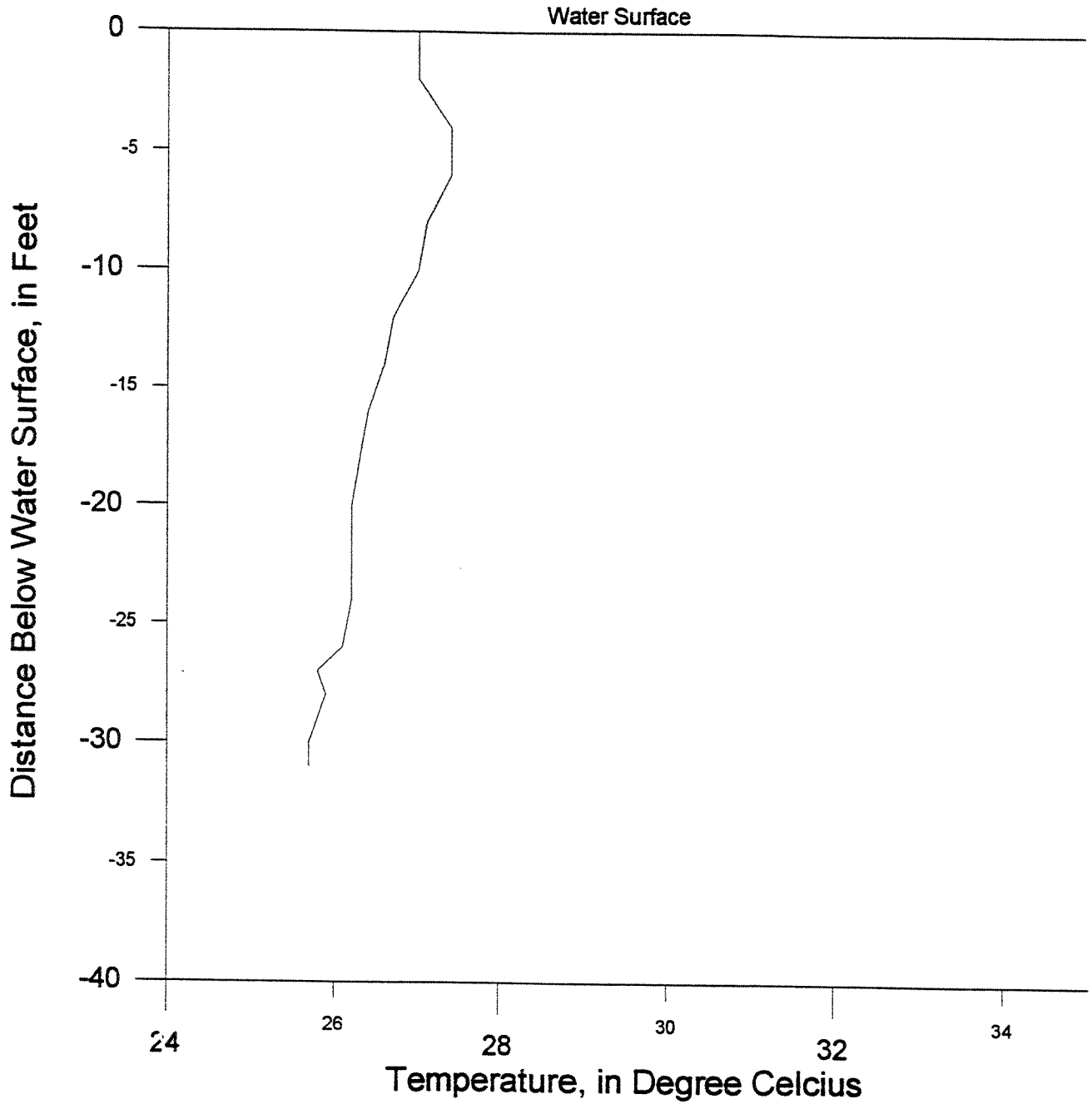
Big Pine Key
Freshwater Lens
Well: BPK 5
October 10, 2000



Big Pine Key
Freshwater Lens
Well: BPK 6 - Blue Hole
October 10, 2000



Big Pine Key
Freshwater Lens
Well: BPK 7
October 10, 2000



WATER QUALITY ANALYSES

KAPPA LABORATORIES, INC.
2577 N.W. 74th Avenue, Miami, Florida 33122
Phone (305) 599-0199 • Fax (305) 592-1224

LABORATORY REPORT
DOH #E86515

Hydrologic Associates USA
Attn: Brad Waller
8925 S.W. 148 Street
Miami, Florida 33176

October 19, 2000

Re: Results of Seven (7) Potable Water samples. The samples were delivered to Kappa Laboratories, Inc., 2577 N.W. 74th Ave., Miami, Florida on October 11, 2000. Seven samples from different locations were taken and tested for the following analyses.
Lab Ref. No: 623489/623491.

Methods Environmental Water: Total Coliform - 9222B, Membrane Filtration MPN - 9221B, Fecal Coliform Membrane Filtration - 9222D, Most Probable Numbers (MPN) - 9221C.

Methods Safe Drinking Water: Membrane Filtration - SM9222B, Most Probable Numbers (MPN) - SM9221B, Fecal Coliform - SM9221E.

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RESULTS

Sample #1 - Groundwater Well BPK-1

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1920 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #2 - Groundwater Well BPK -2

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 564 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #3 - Groundwater Well BPK -3

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 791 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #4 - Groundwater Well BPK-4

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1240 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #5 - Groundwater Well BPK-5

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1930 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #6 - Groundwater Well BPK-6

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 744 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

Sample #7 - Groundwater Well BPK-7

Coliform Count - <1 cts. per 100 ml
Fecal Coliforms - <1 cts. per 100 ml

BOD - <0.4 mg/L (Det. Limit: 0.4 mg/L, Method: SM5210B)
Chloride - 1340 mg/L (Det. Limit: 1 mg/L, Method: 325.3)

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Controls

Coliform Count - Negative

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Kappa Laboratories has been inspected and previously recognized by the U.S. Department of Agriculture (USDA Microbiology-#0093, Chemistry-#1282); certified by the Florida Dept. of Health, Drinking Water including Microbiology, Pesticides and PCB's; Environmental Certification as Basic Environmental Laboratory (DOH #E86515), Comp QAP#940109; Registered with the U.S. Food and Drug Administration (FDA-#1039389) and is an FDA Accepted Laboratory for Import Testing. Kappa Laboratories is currently a Contract Laboratory to the U.S. Centers for Disease Control (CDC), Atlanta, Georgia; Vessell Sanitation Program.

signed: Dr. Peter J. Kmieck
Dr. Peter J. Kmieck
Director, Kappa Laboratories, Inc.

PHOTOS OF INSTALLATIONS

Site 1. Well Installation and View Looking West

Site 2: Well Installation and View Looking West

Site 3: Well Installation and View Looking West (Note Yellow Gate Post on Entrance to Main Access Road)

Site 5. Well Installation and View Looking North.

Site 6. Well Installation and View Looking East.

Site 7. Well Installation and View Looking West (Mahogany Lane in Foreground).