WATER SUPPLY FEASIBILITY TESTING PROGRAM FOR OKEECHOBEE BEACH WATER ASSOCIATION, INC.

Prepared for:

OKEECHOBEE BEACH WATER ASSOCIATION, INC.

JUNE, 1992

Prepared by:

Missimer & Associates, Inc.
600 Sandtree Drive, Suite 101
Lake Park, Florida 33403

PH1-257

Roger L. Robinet, P.G.
Registered Geologist No. 1305
State of Florida

TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

I. INTRODUCTION

Program Objectives

Okeechobee Beach Water Association, Inc. (OBWA) authorized Missimer & Associates, Inc. (M&A) to conduct a water-supply feasibility testing program on a parcel of land in Okeechobee County. The objectives of the program were to determine the potential for developing a 1.5 million gallon per day (mgd) wellfield from the Surficial Aquifer, analyze the water quality for public supply, estimate the potential for environmental impacts due to pumpage, and make recommendations for wellfield development.

Project Location and Description

The site comprises approximately 32 acres of undeveloped and agricultural land in Section 30, Township 37 South, Range 35 East. The site is situated approximately 2 to 3 miles southwest of Okeechobee. A project location map is presented as Figure 1.

Most of the land is covered with oak and palm trees with a small section in the north cleared for livestock grazing. A residential community exists along the property's northeast boundary and an abandoned borrow pit exists south of its eastern-most portion. A remnant cypress wetland exists on the southwest corner of the site. According to South Florida Water Management District (District) personnel, this is not considered a functional wetland. One poor-quality, functional wetland was found by District staff approximately 600 feet west of the northwest corner of the property.

II. CONCLUSIONS AND RECOMMENDATIONS

1) Based on current data, it will be necessary to construct at least seven (7) wells pumping 100 to 150 gpm each in order to produce a total of 1.5 MGD. Depending on OBWA's specific needs, backup wells may be necessary for actual operation and maintenance.

2) The transmissivity of the aquifer is low and, therefore, pumping 1.5 MGD from the site may create a cone of influence large enough to adversely impact the wetland west of the site. Keeping the wellsites as far to the east and south as possible will help, but probably not eliminate the impact.

3) Although the site should produce 1.5 MGD, the low transmissivity may make it necessary to construct numerous, low pumping-rate wells. The total number of wells required will depend on the final construction method, the pumping well drawdown or specific capacity, and the ability of each well to produce a sand free supply.

4) The complex hydrogeological picture at the site includes two layers which provide some confinement between the production zone and the surface. However, the effectiveness of the confinement is not fully known.

Additional testing will be required to determine confinement effectiveness and estimate the actual wetland impact.

5) Water quality at the site was found to be adequate for public supply and fairly consistent both areally and vertically.

6) The production zone, which is approximately 105 to 160 feet below ground level, is composed of a semi-consolidated, shelly sandstone. It may be possible to complete an open-hole type production well in this formation. However, it cannot be assumed that this type of construction will result in a well which will not cave or produce excessive sand. A test production well should be designed which will allow the placement of a screen and gravel pack if such is ultimately determined to be necessary.

7) Before final wellsites are chosen and production wells designed, a test-production well (TPW) with observation wells should be constructed and an aquifer performance test (APT) be performed. The test will provide additional information on the potential for wetland impact and actual production well capability. The APT should provide the data necessary to better estimate wetland impact, production capability, well design and wellfield layout. A meeting should be scheduled with South Florida Water Management District personnel prior to construction and

testing of a TPW. This should assist in design of a program that will meet the specific requirements of the District and allow for a smooth review period for the water use permit application.

III. INVESTIGATION OF THE SITE

Data Search

An M&A hydrogeologist conducted a data search of District files and United States Geological Survey reports, to obtain available data for the area. Based on these data plus water-quality and geologic data provided by OBWA's recent testing program, a site-specific testing program was designed.

Test Drilling and Observation Well Construction

Three (3) test wells (TW-1, TW-2 and TW-3) were constructed at the site for the purpose of collecting site-specific hydrogeologic information. Hydrogeologic information was determined through interpretation of drill cuttings, geophysical logs, and pumping test data. Initially, a six-inch-diameter borehole was drilled to 220 feet below ground level at site TW-1 by the mud-rotary method. Geologic samples were collected and described by an on-site M&A hydrogeologist. Geophysical logging then was conducted in the mudded borehole. Electric and gamma ray logs were run and used for correlation with the geologic data to choose the best production zone and to interpret other aquifer properties.

The best production zone was chosen, and a 2-inch-diameter test well was completed. The borehole was screened from 105 to 145 feet with blank PVC casing below as a sump. The well then was gravel-packed to approximately 5 to 10 feet above the screen, then grouted to the surface. The well was completed approximately 2 to 3 feet above grade.

TW-2 and TW-3 were constructed similarly. However, because approximately 40 to 60 feet of clay was encountered in the bottom of TW-1, boreholes for TW-2 and TW-3 were drilled to 190 feet and 175 feet, respectively. Clay was encountered at similar depths in all three wells. Wells TW-2 and TW-3 were completed with screen from 120 to 160 feet and 105 to 145 feet, respectively.

Observation wells were constructed near TW-1 and TW-2 for purposes of monitoring water levels during pumping tests in the test wells. The observation wells (OB-1 and OB-2) were constructed by driving 2-inch-diameter casing to the required depths. Driving the casing allowed water samples to be collected at different intervals from one boring. Also, water levels could be monitored in different zones for different pumping tests. Initially, OB-1 was located 40 feet from TW-1 and driven to 45 feet, washed out below the casing, and developed briefly so that a water sample could be collected for field analysis. Subsequently, the well was driven to 75 feet for collection of another water sample and for monitoring during one pumping test. Finally, the well was driven to 108 feet and washed out to 118 feet for pumping test monitoring.

Well OB-2 was located 30 feet from TW-2 and developed open-hole at intervals of 40 to 48 feet, 73 to 78 feet, and 120 to 130 feet, for the same purposes as OB-1. No observation well was constructed at TW-3.

One shallow well (OB-2S) was constructed between TW-2 and OB-2 to a depth of 8 feet. This well was used to monitor water levels at the water table during the pumping tests.

Pumping Tests

A total of five (5) pumping tests were conducted. Water levels in the wells were monitored by means of electronic pressure transducers.

TW-1 was pumped for four hours at 28.5 gallons per minute (gpm) while monitoring water levels in TW-1 and OB-1, 40 feet away. Well OB-1 was completed open-hole from 75 to 80 feet during this test. A second test on TW-1 was conducted for one hour at 25 gpm. OB-1 was completed open-hole from 108 to 118 feet during the one-hour test.

TW-2 was pumped for six hours at 27 gpm while monitoring TW-2, OB-2, and OB-2S. Well OB-2 was constructed 30 feet away from TW-2 and was completed open-hole from 73 to 78 feet. OB-2S was 15 feet from TW-2 and was completed at the water table. A second test was run in TW-2 at 27 gpm for one hour. TW-2 and OB-2 were monitored. OB-2 was completed open-hole from 120 to 130 feet during this test.

A one-hour pumping test was conducted in TW-3 at 27.5 gpm. No observation wells were constructed for this test.

At the end of each one-hour pumping test, water samples were collected for laboratory analysis of alkalinity, calcium, corrosivity, pH, total dissolved solids, chloride, conductivity, and total iron.

IV. RESULTS OF THE INVESTIGATION

Geology and Aquifer Descriptions

The regional geology of the surficial aquifer in Okeechobee County includes sand, shell, limestone and sandstone of the Anastasia and Caloosahatchee Formations. The limestones and sandstones exist in varying degrees of consolidation and are the main water-producing formations of the surficial aquifer in Okeechobee County.

The clays and fine sediments of the Hawthorn group make up the base of the surficial aquifer and provide upper confinement for the Floridan Aquifer System which produces brackish water under flowing conditions.

The geology of the site consists of approximately a three foot layer of sand and silty sand covering sandy shell beds which extend to about 25 feet below land surface. A shallow limestone ridge exists in the southwest corner of the property at the site of test well TW-3. The limestone is fairly continuous to a depth of about six feet with less-continuous beds to 15 feet.

A layer of marl exists below the shell beds from about 25 to 50 feet at TW-1 and TW-2, and 22 to 35 feet at TW-3. The marl is composed of shells and fine sand, silt and clay and may provide some confinement to deeper zones. Below the marl, to a depth of about 80 or 90 feet, are sand, shell, and sandstone beds of varying degrees of consolidation. The sandstone is generally fine-grained with moderate amounts of finely-fragmented shell.

A sandy-clay layer exists between about 80 to 105 feet at TW-1 and TW-3, and between about 88 to 117 feet at TW-2. This layer also provides some confinement for the producing zone below.

Extending from immediately below the sandy-clay layer to approximately 160 feet is an inverval composed of semi-consolidated shelly sandstone which becomes increasingly finer-grained with depth. This appears to be the best interval for completion of production wells.

Another layer of confining clay exists at the base of the producing interval. The clay existed to the total depth in each borehole which was 220, 190, and 175 feet in wells TW-1, TW-2, and TW-3, respectively. This is the upper limit of the confining beds of the Hawthorn Group. A typical geologic profile is presented as Figure 3. Geologic logs are provided as Appendix A.

Aquifer Hydraulic Properties

Analysis of the pumping test data from well TW-1 gave various results depending upon the analysis method used. Analysis of the data according to leaky or semi-unconfined aquifer theory using log-log curves indicate a transmissivity of the production zone of about 2500 gpd/ft and a leakance of about 0.3 gpd/ft^3. Analysis of the recovery data indicate that the transmissivity falls within the range of 5000 to 7000 gpd/ft. It is thought that the recovery data probably includes an element of contribution from the productive zone immediately above the zone pumped and therefore a higher transmissivity is represented. This value may be more indicative of aquifer behavior in response to long term pumpage.

Quantitative analysis of the pumpage data from wells TW-2 and TW-3 could only be meaningfully done during the recovery period. These analyses indicate a transmissivity in the range of 6000 to 8000 gpd/ft.

Additionally, it was possible to do some qualitative analysis of the data from wells OB-1 and OB-2 which were initially constructed into zones above the deeper wells TW-1 and TW-2. These wells experienced declines of about 0.2 feet in response to short term pumping from the deeper zone. The response indicates a relatively good connection between zones, however, the data cannot be quantitatively analyzed because the response of the zone immediately below is unknown.

Water Quality

Water samples were collected for laboratory analysis from each of the test wells at the end of the pumping tests. Additionally, water samples were collected from driven-wells at sites 1 and 2 for field analyses. The testing indicated total dissolved solids and chlorides below the drinking water standards. Iron concentrations are approximately 10 percent of the drinking water standard. A summary of water quality data is presented as Table 1. Copies of the laboratory data are provided as Appendix B.

V. REGULATORY CONSIDERATIONS AND PUMPING IMPACTS

There are three primary areas of concern with regard to siting a wellfield on this property. The first of these deals with the location of wells with respect to sanitary hazards as defined in Section 17-550.200 (46) Florida Administrative Code (FAC). The regulation requires a minimum 100 foot separation. The Florida Department of Environmental Regulation (FDER) may consider the borrow pond near the southeast corner of the property a sanitary hazard. Also, there should be no measurable hydraulic connection to the pond. The requirements are met by the proposed wellfield layout, since the shallow marl and the sandy clay layer which exists between 80 and 105 feet appear to provide a suitable level of separation.

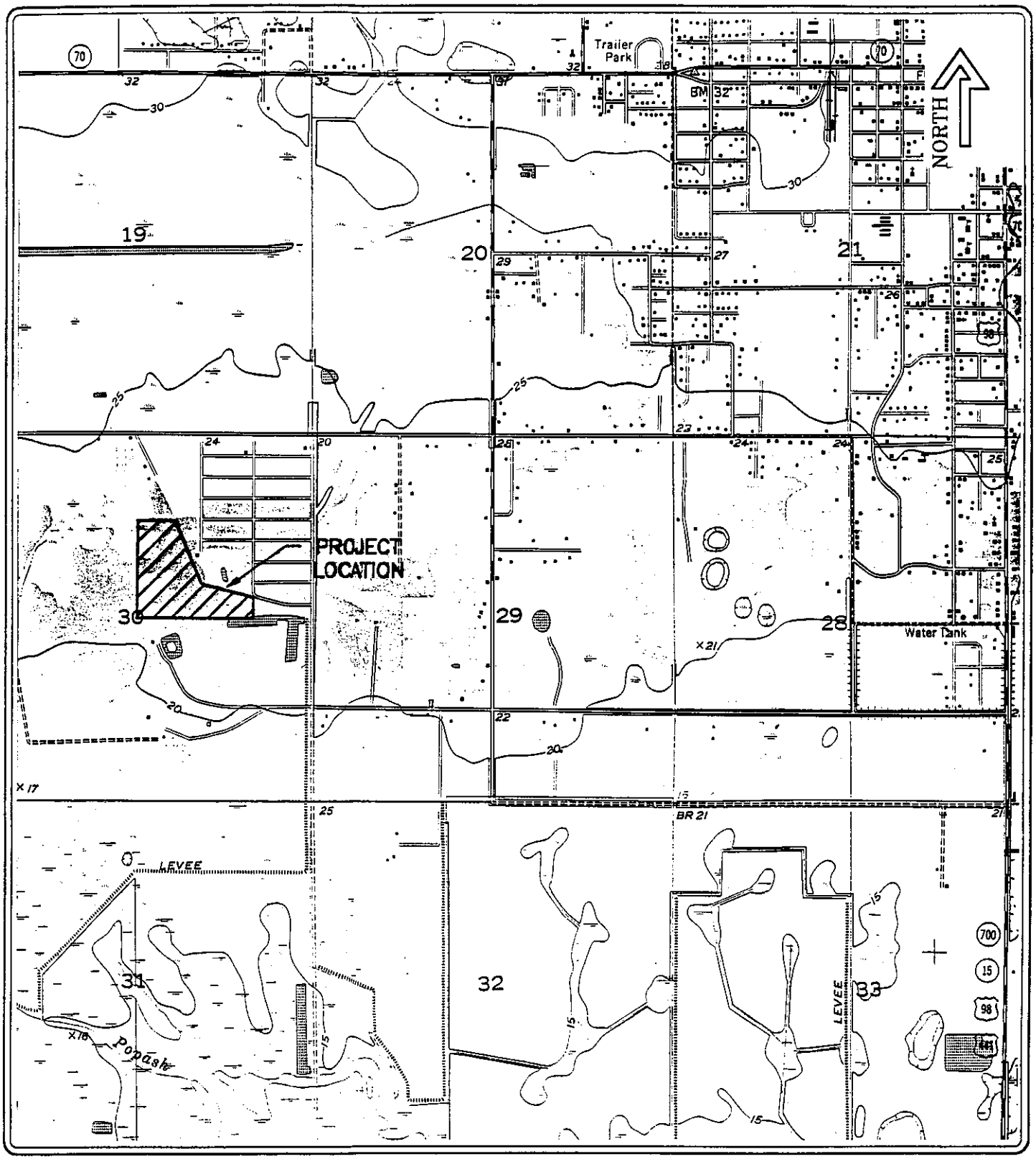
The second area of concern is residential septic tank drain fields. Production wells must be 200 feet from the drain fields as stated in Section 17-555.312 (1) FAC. The residential community along the northeastern boundary will limit well placement in this area.

Finally, the District has identified a "poor quality functional wetland" approximately 600 feet west of the northwestern corner of the property. The District considers drawdown beneath the wetland of more than one foot to be an adverse impact. A preliminary computer model was run to assess the impact of the proposed pumpage on the wetland area. The model was based on the results of the short term pumping tests. A water level drawdown of 2 to 3 feet was predicted beneath this wetland. While this result indicates a potential problem, we feel that the model does not accurately depict the confinement provided by the upper marl layer. The aquifer testing done to date was not able to measure the degree of confinement of that layer.

VI. PROPOSED WELLFIELD LAYOUT

Based on the criteria outlined in Section V, seven potential wellsites were chosen as shown on Figure 4. The wellsites are designed to avoid the drainfields and surface water by the minimum setback requirements, while minimizing impact to the wetland.

Final well placement will depend on results of TPW testing, the actual number of production wells required, and placement of the water treatment plant.



M&A

LEGEND:
USGS QUADRANGLE – OKEECHOBEE
TOWNSHIP – 37 SOUTH
RANGE – 35 EAST
SECTION – 30

0 2000' 4000'

DATE DRAWN: 6–2–92

DRAWN BY: ALLCAD

SITE LOCATION: OKEECHOBEE COUNTY

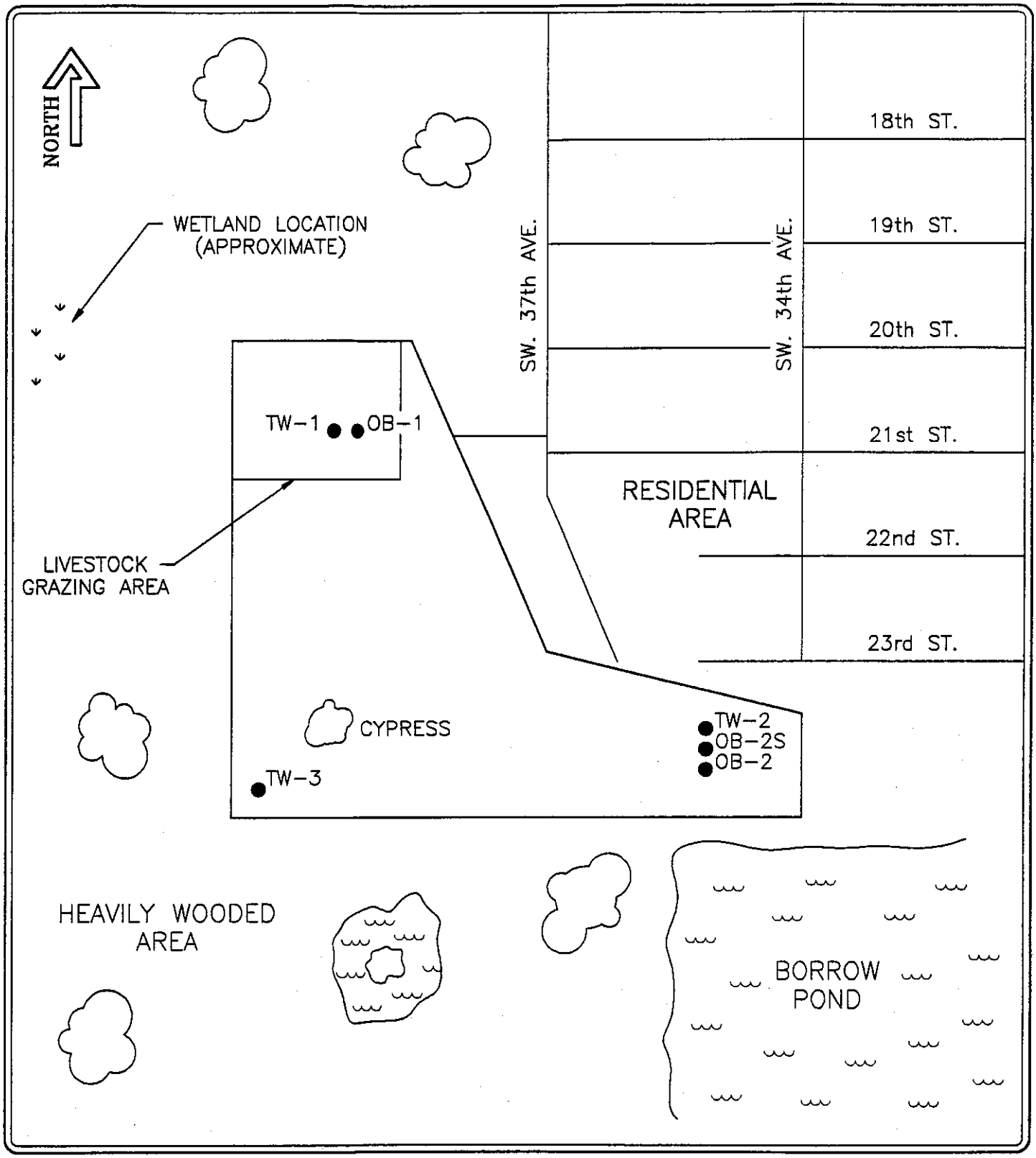
PREPARED FOR: OKEECHOBEE BEACH WATER ASSOCIATION, INC.

FILE NAME: PH1–2571

FIGURE TITLE: SITE LOCATION MAP

JOB NUMBER: PH1–257

FIGURE NUMBER: 1



MSA

LEGEND:
TW-3 – WELL LOCATION

0 400' 800'

DATE DRAWN: 6-2-92

DRAWN BY: ALLCAD

SITE LOCATION: OKEECHOBEE COUNTY

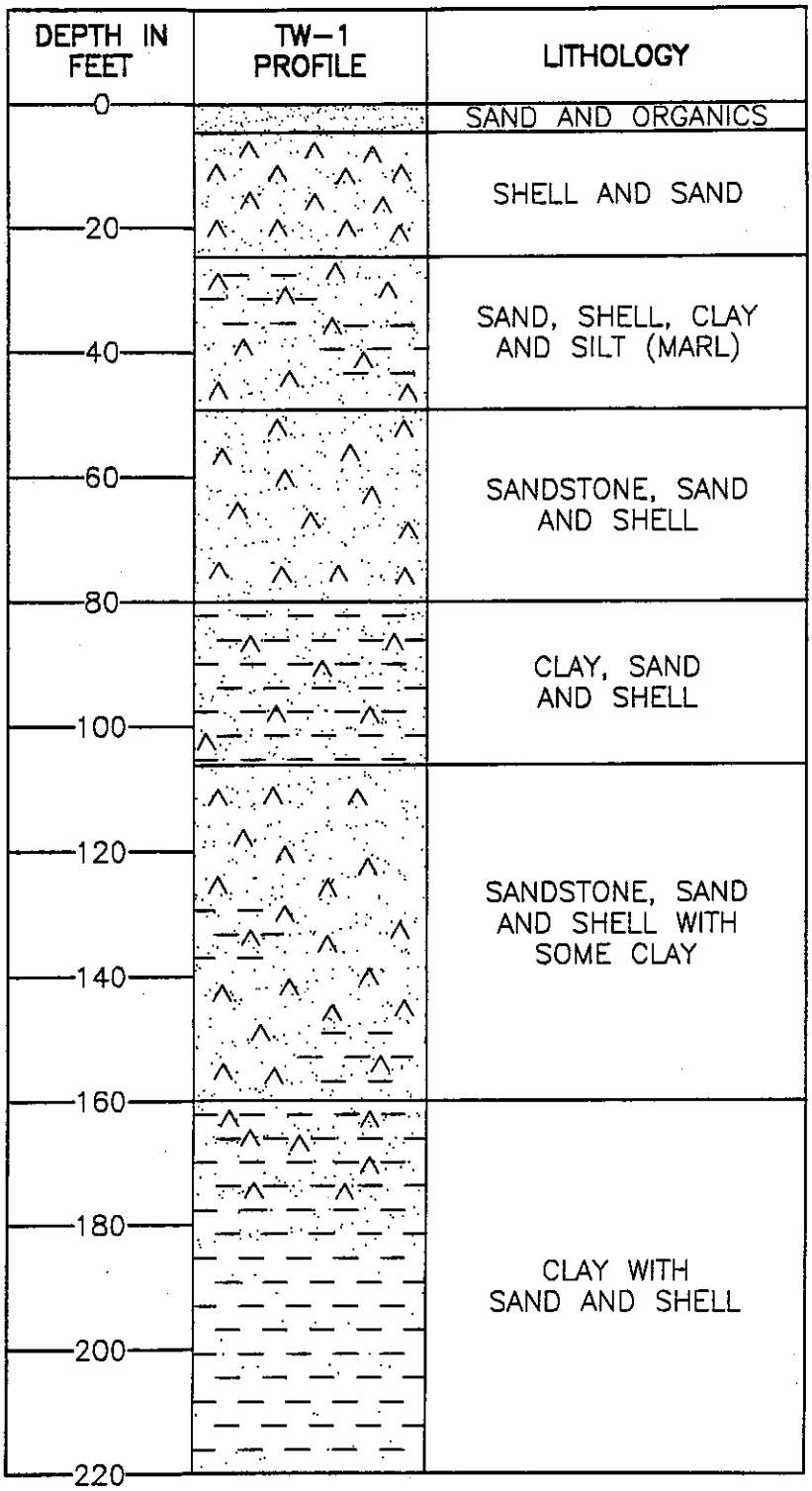
PREPARED FOR: OKEECHOBEE BEACH WATER ASSOCIATION, INC.

FILE NAME: PH1-2572

FIGURE TITLE: TEST WELL LOCATIONS

JOB NUMBER: PH1-257

FIGURE NUMBER: 2



M&A

LEGEND:
SAND OR SANDSTONE
CLAY OR SILT
SHELL

VERTICAL SCALE: 1 INCH = 30 FEET

DATE DRAWN: 6-2-92

DRAWN BY: ALLCAD

SITE LOCATION: OKEECHOBEE COUNTY

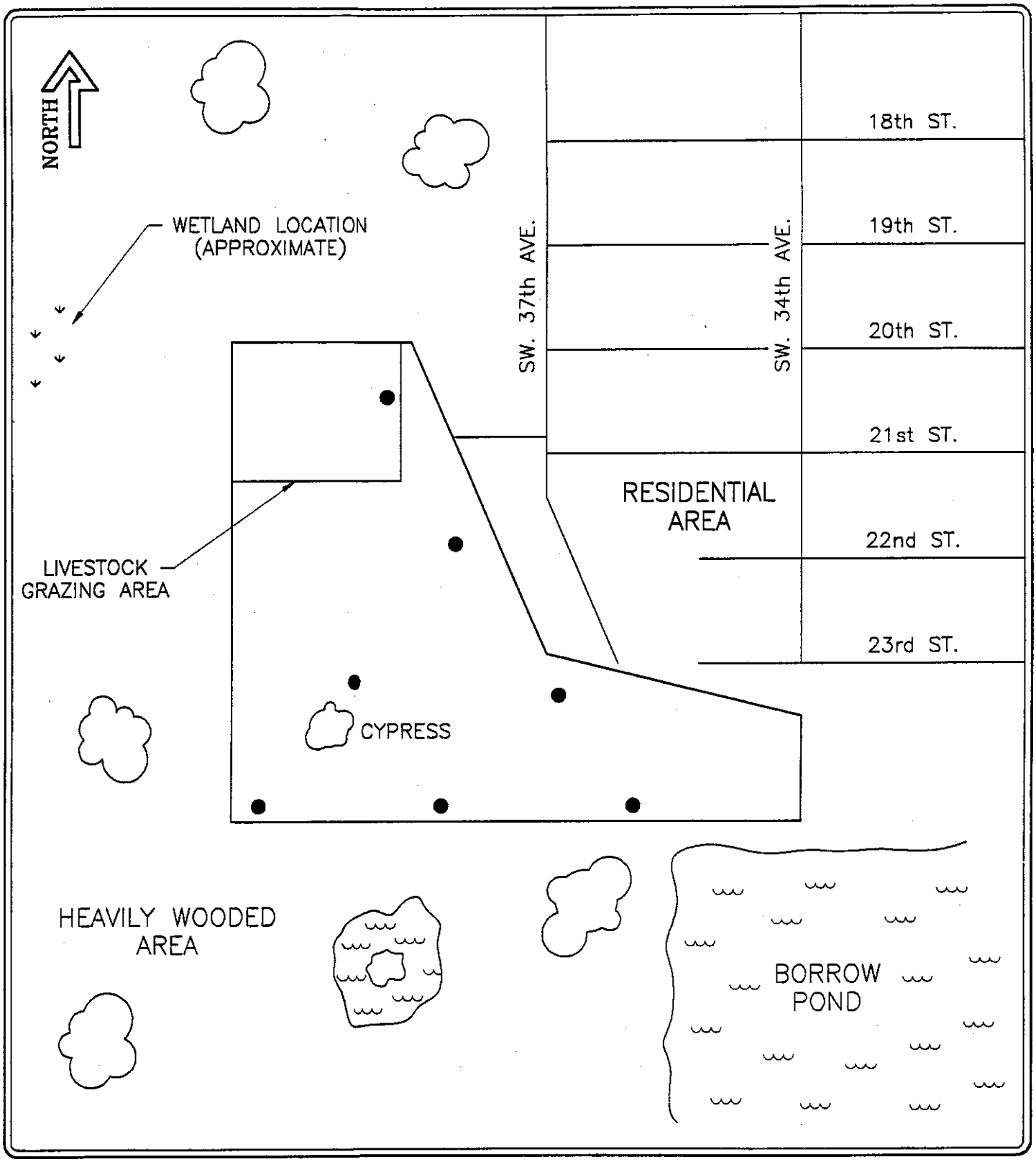
PREPARED FOR: OKEECHOBEE BEACH WATER ASSOCIATION, INC.

FILE NAME: PH1-2573

FIGURE TITLE: TYPICAL GEOLOGIC PROFILE

JOB NUMBER: PH1-257

FIGURE NUMBER: 3



M&A

LEGEND:

● – PROPOSED PRODUCTION WELL LOCATION

0 400' 800'

DATE DRAWN: 6–2–92

DRAWN BY: ALLCAD

SITE LOCATION: OKEECHOBEE COUNTY

PREPARED FOR: OKEECHOBEE BEACH WATER ASSOCIATION, INC.

FILE NAME: PH1–2574

FIGURE TITLE: PROPOSED WELLFIELD

JOB NUMBER: PH1–257

FIGURE NUMBER: 4

TABLE 1

SUMMARY OF WATER QUALITY DATA

Site Number	Sample Depth (feet)	Conductivity (umhos)	Chloride (mg/l)	TDS (mg/l)	Iron (mg/l)	pH
1*	45-48	590	22	-	-	6.89
1*	75-80	643	41	-	-	7.00
1**	105-145	680	44	403	0.03	6.83
2*	40-48	620	<50***	-	-	7.63
2*	73-78	867	<50***	-	-	-
2**	120-160	710	57	429	0.04	6.73
3**	105-145	710	54	429	0.04	6.80

Notes:

* Field analysis
** Laboratory analysis
*** Unable to determine accurately due to cloudy water sample
mg/l milligrams per liter

APPENDIX A
GEOLOGIC LOGS

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 1 **OF** 4

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-1 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
1	**Muck:** Muck, 100%, black, organic.		0-3	3
2	**Sand:** Sand, 100%, very fine, quartz.		3-6	3
3	**Shell and Sand:** Shell, 60%, tan; Sand, very fine, 40%.		6-10	4
4	**Shell and Sand:** Sand, 50%, very fine quartz; Shell, 50%, tan, finely crushed.		10-20	10
5	**Shell and Sand, as above:** Shell, 60%; Sand 40%.		20-25	5
6	**Sand, Shell, Silt:** Sand, 40%, fine, quartz; Shell, 30%, finely crushed; Silt, 30%, dark brown to black.		25-30	5
7	**Shell, Sand, Silt:** Shell, dark gray, 60%; Sand, fine, phosphatic, 30%; Silt, 10%.		30-37	7
8	As above, less silt.		37-40	3
9	As above, increasing shells, darker shells (dark blue-gray).		40-50	10

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 2 **OF** 4

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-1 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
10	**Sand and Shell:** Sand, fine, phosphatic, 60%; Shells, dark gray, 40%.		50-55	5
11	**Sand and Shell:** As above, coarser shells, 50/50.		55-60	5
12	**Sand and Shell:** Shell, 50%, coarse, gray and tan; Sand, 50%, fine, phosphatic.		60-65	5
13	**Shell, Sand and Sandstone:** Shell, 50%, gray and tan; Sand, 30%, fine; Sandstone, 20%, calcareous, gray-green.		65-70	5
14	**Shell, Sandstone and Sand:** Shell, 70%, coarse; Sandstone, 20%, gray-green, calcareous; Sand, 10%.		70-80	10
15	**Clay, Shell, Sand:** Clay, 50%, green-gray, sandy phosphatic; Shell, 30%; Sand, fine, 20%.		80-85	5
16	As above, more clay, 60%.		85-90	5
17	**Clay and Shell:** Clay, 80%, gray-green, soft, phosphatic, sandy; Shell, 20%.		90-100	10

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 3 OF 4

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-1 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
18	**Clay and Shell:** Clay, 80%, sandy, olive green, very soft, phosphatic; Shell, 20%, tan, finely crushed.		100-105	5
19	**Sandstone, Shell, Sand and Clay:** Sandstone, 60%, calcareous, moderate hard to hard, gray-green phosphatic; Shell, 20%; Clay, 10% as above; Sand, 10%.		105-115	10
20	As above, less clay.		115-120	5
21	**Sandstone and Shell:** Sandstone, 50%, calcareous, greenish gray; Shell, 30%, coarse; Sand, 10%, fine, moderately phosphatic; Clay, 10%.		120-130	10
22	**Sandstone, Shell and Phosphate:** Sandstone, 40%, gray, calcareous; Shells, 30%; Sand, phosphatic grains, 20%, very coarse, black, hard; Sand, 10%, coarse.		130-135	5
23	As above, with more sandstone.		135-140	5

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 4 OF 4

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-1 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
24	**Sandstone, Clay and Shell:** Sandstone, calcareous, 30%, hard, gray; Clay, 30%, grayish green, soft, phosphatic; Shell, 30%; Sand, 10%.		140-145	5
25	**Sandstone, Shell, Sand:** Sandstone, 50%, calcareous, gray, hard, phosphatic; Shell, 30%; Sand, medium to coarse, 10%; Clay, 10%.		145-160	15
26	**Clay and Shell:** Clay, 70%, gray green, very soft, sandy; Shell, 30%, tan, crushed.		160-170	10
27	**Clay:** Clay, 100%, dark olive green, very soft.		170-220	50

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 1 OF 6

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-2 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
1	**Sand:** Sand, 100%, clayey, dark brown.		0-3	3
2	**Shells and Clay:** Shells, whole & fragments, tan, 70%; Clay, 30%, dark brown, as above.		3-10	7
3	**Shells with Clay:** Shells, 80%, tan, larger than above; Clay, 20%, as above.		10-15	5
4	**Shells, Sandstone, Sand:** Shells, 60%, coarse; Sandstone, 30%, shelly; Sand, 10%, fine, quartz; Clay, trace, grayish green.		15-20	5
5	**Shells and Sand:** Shells 75%, much coarser; Sand, 25%, fine, quartz.		20-25	5
6	**Clay, Shells, Sand:** Clay, 40%, dark brown, soft; Shell, 40%, tan, coarse fragments; Sand, 20%, very fine, quartz.		25-30	5
7	**Sand, Clay and Shell:** Sand, 85%, quartz, very fine to coarse; Clay and shell, 15%.		30-35	5

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 2 OF 6

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-2 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
8	As above, with black organic material, friable.		35-37	2
9	Black organic material, with dark gray to black clay, soft.		37-40	3
10	**Sand, Clay, Shells:** Sand, 40% very fine, quartz, phospatic; Clay, 40% dark brown, soft; Shell, tan, 20%, finely crushed.		40-43	3
11	**Shells, Clay, Sand:** Shells, dark gray/black, finely crushed, 60%; Clay, 25%, dark brown, soft, sandy; Sand, 15%, fine, quartz, gray.		43-45	2
12	As above, with more gray shells, and coralline fragments.		45-50	5
13	**Shell, Sand, Sandstone:** Shells, 60%, finely crushed, gray; Sand, quartz, grayish, phosphatic, 20%; Sandstone with shell, 10%, phosphatic, moderately hard, gray; Clay, 10%, light gray-green, soft.		50-55	5
14	As above, with increasing cemented sand (20%).		55-60	5

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 3 OF 6

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-2 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
15	As above crushed shell, gray and tan, 50-60%; Sand, very fine, 10%, Clay, 20%, light gray, moderately stiff.		60-65	5
16	As above, less clay (5%), with calcareous sandstone, moderately hard to friable and cemented sand, hard.		65-70	5
17	**Shell, Clay, Sandstone:** Crushed shell, gray and tan 30%; Sand, quartz, 20%, fine; Clay, 10%, light gray; Calcareous sandstone, moderately hard, 40%.		70-75	5
18	As above, with increasing sandstone.		75-80	5
19	**Sandstone and Shell:** Sandstone, dark gray, with shell, phosphatic, 50%; Shells, 40%; Sand, phosphatic, quartz, 10%.		80-85	5
20	As above with increasing shells (50%).		85-88	3
21	As above, with clay 20%, phosphatic, light greenish gray, soft.		88-90	2

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 4 OF 6

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-2 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
22	**Clay, Shell, Sandstone:** Clay, 50%, greenish gray, phosphatic, soft to moderately stiff; Shell fragments, tan, crushed, 40%; Sandstone, 10%, dark gray to grayish green, phosphatic, friable to moderately hard.		90-95	5
23	**Clay, Shells, Sandstone:** Clay, 50%, grayish green, phosphatic, soft to moderately stiff; Shells, tan and gray, 30%; Sand fine, 10% phosphatic; Sandstone, 10%, dark gray, moderately hard.		95-100	5
24	**Clay and Shells:** Clay, light greenish gray, very phosphatic, soft to moderately stiff, 70%; Shells, 20%, Sand, 5%; Sandstone, 5%.		100-105	5
25	**Clay, Shells, Sandstone:** Clay, dark green, 50%; Shells, moderately coarse, 20%; Sandstone, dark gray, 20%; Sand, 10%.		105-110	5
26	As above, more shells.		110-117	7

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 5 OF 6

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-2 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
27	**Sandstone, Shells, Clay:** Calcareous sandstone, 60% phosphatic, light gray, hard to moderately hard, shells cemented within; Clay, green, 20%; Shells 10%; Sand, 10%.		117-125	8
28	As above, larger pieces of sandstone with fine sand (10-20%).		125-130	5
29	As above, with more sand, (30%), and finely phosphatic.		130-135	5
30	**Sandstone, Shells, Sand:** Sandstone, 40%, phosphatic, light gray, hard; Sandstone, 10%, as above, clayey; Clay, green, 20%, soft; Shells, 20%; Sand, 10%.		135-145	10
31	**Shells, Sand, Sandstone:** Shells, crushed, smaller than above, 40%; Sand, phosphatic grains, coarse, 20%; Sand medium to coarse, rounded, 20%; Sandstone, 20%, phosphatic, hard, calcareous (shells cemented within).		145-150	5

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 6 OF 6

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-2 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
32	**Sand, Shells, Sandstone:** As above, Sand coarse, with phosphate 40%; Shell fine, crushed, 30%; Sandstone, 30%.		150-155	5
33	As above, less coarse sand, some clay, 10-20%, 30% clayey sandstone.		155-160	5
34	**Sandstone, Shell, Sand:** Sandstone, 60%, friable, phosphatic; Shell fragments, 20%; Sand fine, phosphatic, 20%.		160-165	5
35	**Clay, Sandstone, Phosphate, Sand:** Clay, 50%, dark green-gray, soft; Shell, 20%, medium to large fragments; Sandstone, 20%, dark gray, hard to very hard; Sand, phosphatic grains, round, medium to coarse; Sand, 10%.		165-180	15
36	**Clay with Shells:** Clay, 90%, dark green-gray, soft, phosphatic; Shells, 10%.		180-190	10

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 1 OF 5

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-3 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
1	**Sand and Limestone:** Sand, quartz, 50%, very fine; Limestone, sandy, 50%, buff to tan, moderately hard.		0-4	4
2	**Limestone and Sand:** Limestone, 70%, hard, sandy, buff; Sand, 30%, very fine, quartz.		4-6	2
3	**Shell and Sand:** Shell, 60%, finely crushed, tan; Sand, 40%, fine, quartz.		6-9	3
4	**Shells, Clay and Limestone:** Shells, tan, 50%; Clay 30%, greenish-gray, sandy, moderately soft; Limestone, 20%, orange with increasing sand and embedded shells, hard.		9-15	6
5	**Clay, Shells, Sand:** Clay, 60%, light grayish green, soft; Shells, 30%, crushed, tan; Sand, 10%, fine, quartz.		15-17	2
6	As above, less clay (40%), more shells (50%); Sandstone, 10%.		17-18	1
7	**Shells and Sand:** Shells, 80%, large, some white; Sand, very fine, 20%.		18-20	2

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 2 OF 5

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-3 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
8	**Sand and Shells:** Sand 70%, very fine, quartz; Shells, 30%.		20-22	2
9	**Clay, Shells, Sand:** Clay, 50%, dark brown to black with organic material; Shells, coarse, 30%; Sand, 20%, very fine.		22-25	3
10	**Clay and Sand:** Clay, dark brown to black, 70%; Sand, very fine, 30%.		25-30	5
11	**Clay and Sand:** Clay, dark brown to black, 50%; Sand, 50%, fine.		30-35	5
12	**Shells and Sand:** Shells, dark blue to gray and tan, finely crushed, 65%; Sand, fine to medium, 35%.		35-45	10
13	As above, larger shells, whole; fine to medium sand, decreasing (20%).		45-50	5
14	**Shells, Clay, Sand:** Shells, fine, 40%; Clay, 30%; Sand, 30% grayish green.		50-55	5
15	**Shells and Clay:** Shells, 60%, finely crushed, gray and tan; Sand, 20%; Clay, 20%, grayish green, soft, sandy.		55-65	10

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 3 **OF** 5

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-3 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
16	**Clay, Shells, Sand:** Clay, green, 30%, some cemented; Shells, finely crushed, 30%; Sand, fine, 20%; Sandstone, 20%, calcareous, light gray green, moderately hard.		65-70	5
17	As above increasing sandstone.		70-80	10
18	**Shells, Sandstone, Clay:** Shells, 40% increasing in size; Sandstone, 30%, shelly, light gray to dark gray, hard; Cemented clay, sand, shell, 20%, light gray-green; Clay, light gray-green, 10%.		80-85	5
19	**Shells, Clay, Sand, Sandstone:** Shells, 40%, mainly tan, coarse, more whole shells; Clay, 30%, green, soft as clumps, phosphatic; Sand, 10%, quartz, fine to coarse, phosphatic, poorly sorted, smoky color; Sandstone, 20%, friable, tan to light green-gray.		85-90	5

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 4 **OF** 5

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-3 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
20	**Clay, Shells, Sandstone:** Clay, 60%, light gray-green, phosphatic, very soft, sandy (very fine); Shells, 20% coarse; Sandstone, 10%, dark gray, very hard; Sand, phosphatic, 10%, coarse, black, very hard.		90-105	15
21	**Sandstone, Clay and Shell:** Sandstone, 50%, shelly, light gray-green, phosphatic, medium hard; Shell, finely crushed, 10%; Clay, 30%, light green, soft, phosphatic; Sand, fine to medium grained, 10%.		105-110	5
22	As above, with very little clay (10%), and finer shells (5-10%).		110-115	5
23	**Sandstone, Shells:** Sandstone, 90%, clayey, greenish gray, moderately hard; Shells, 10%.		115-120	5
24	As above, more shells (20%).		120-130	10

WELL LOG

PROJECT OBWA **DATE** 4/22/92 **SHEET** 5 OF 5

LOCATION Mixen Property **DRILLING CONTRACTOR** Domer's

WELL NUMBER TW-3 **DRILLING METHOD** Mud Rotary

SAMPLE DESCRIPTION S. Bernardini **SAMPLING METHOD** Grab

Sample Number	Sample Description	Drilling Comments	Depth Interval (feet)	Thickness (feet)
25	**Sandstone, Shells and Sand:** Sandstone, 40%, clayey, gray-green; Shells, 30%, crushed; Sand and phosphate, 30%, coarse, sub-rounded.		130-160	30
26	**Clay and Shell:** Clay, 80%, green-gray, very soft, sandy; Shell fragments, 20%, tan.		160-170	10
27	**Clay and Shells:** Clay, 90%; Shells, 10%.		170-175	5

APPENDIX B
LABORATORY REPORT

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE - WEST PALM BEACH, FLORIDA 33407-1241 - (407) 842-2849

MISSIMER & ASSOCIATES
600 SANDSTREE DRIVE
SUITE 101
PALM BEACH GARDENS, FL 33410
Attn: ROGER ROBINET

9204347-01A
Report Date: 05/11/92

Project ID: OKEECHOBEE BEACH PH1-257
Sample ID: TW-1 MIXEN PROPERTY
CORROSIVITY (LANGLIER INDEX)

Date Received: 04/29/92
Date Collected: 04/29/92 12:15:00

Water sample submitted by Roger Robinet of Missimer and Associates using laboratory supplied containers.

Test Name	Method	Result	Units	Detection Limit	Date Analyzed	Analyst
Total Alkalinity, CaCO3	EPA 310.1	284	mg/L	3	05/04/92	LNJ
Bicarbonate Alkalinity		284	mg/L	3	05/04/92	LNJ
Carbonate Alkalinity		0	mg/L	3	05/04/92	LNJ
Non-carbonate Alkalinity		0	mg/L	3	05/04/92	LNJ
Total Alkalinity, CaCO3	EPA 310.1	284	mg/L	4	04/30/92	CEB
Calcium, Ca	EPA 215.1	83	mg/L	1	05/07/92	GDP
Corrosivity, L.I.	CALC.	-0.27	Units	calc.	05/08/92	LNJ
pH	EPA 9040	6.83	units	---	04/29/92	Client
pHs	CALC	7.10	Units	---	05/08/92	LNJ
Total Dissolved Solids	EPA 160.1	403	mg/L	1	05/01/92	JYD
Temperature	EPA 170.1	23.5	deg. C	---	04/29/92	Client

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #870232. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE - WEST PALM BEACH, FLORIDA 33407-1241 - (407) 842-2849

MISSIMER & ASSOCIATES
600 SANDSTREE DRIVE
SUITE 101
PALM BEACH GARDENS, FL 33410
Attn: ROGER ROBINET

9204347-01B
Report Date: 05/11/92

Project ID: OKEECHOBEE BEACH PH1-257
Sample ID: TW-1 MIXEN PROPERTY

Date Received: 04/29/92
Date Collected: 04/29/92 12:15:00

Water sample submitted by Roger Robinet of Missimer and Associates using laboratory supplied containers.

Test Name	Method	Result	Units	Detection Limit	Date Analyzed	Analyst
Chloride, Cl-	EPA 325.3	44	mg/L	4	05/04/92	CEB
Conductivity @ 25 Deg. C	EPA 120.1	680	umhos/cm	10	04/30/92	KRS
Total Iron, Fe	EPA 236.1	0.03	mg/L	0.01	05/01/92	GDP

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #870232. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE - WEST PALM BEACH, FLORIDA 33407-1241 - (407) 842-2849

MISSIMER & ASSOCIATES
600 SANDSTREE DRIVE
SUITE 101
PALM BEACH GARDENS, FL 33410
Attn: ROGER ROBINET

9204347-02A
Report Date: 05/11/92

Project ID: OKEECHOBEE BEACH PH1-257
Sample ID: TW-2 MIXEN PROPERTY
CORROSIVITY (LANGLIER INDEX)

Date Received: 04/29/92
Date Collected: 04/29/92 14:50:00

Water sample submitted by Roger Robinet of Missimer and Associates using laboratory supplied containers.

Test Name	Method	Result	Units	Detection Limit	Date Analyzed	Analyst
Total Alkalinity, CaCO3	EPA 310.1	277	mg/L	3	05/04/92	LNJ
Bicarbonate Alkalinity		277	mg/L	3	05/04/92	LNJ
Carbonate Alkalinity		0	mg/L	3	05/04/92	LNJ
Non-carbonate Alkalinity		0	mg/L	3	05/04/92	LNJ
Total Alkalinity, CaCO3	EPA 310.1	277	mg/L	4	04/30/92	CEB
Calcium, Ca	EPA 215.1	65	mg/L	1	05/07/92	GDP
Corrosivity, L.I.	CALC.	-0.50	Units	calc.	05/08/92	LNJ
pH	EPA 9040	6.73	units	---	04/29/92	Client
pHs	CALC	7.25	Units	---	05/08/92	LNJ
Total Dissolved Solids	EPA 160.1	429	mg/L	1	05/01/92	JYD
Temperature	EPA 170.1	23.4	deg. C	---	04/29/92	Client

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #870232. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE - WEST PALM BEACH, FLORIDA 33407-1241 - (407) 842-2849

MISSIMER & ASSOCIATES
600 SANDSTREE DRIVE
SUITE 101
PALM BEACH GARDENS, FL 33410
Attn: ROGER ROBINET

9204347-02B
Report Date: 05/11/92

Project ID: OKEECHOBEE BEACH PH1-257
Sample ID: TW-2 MIXEN PROPERTY

Date Received: 04/29/92
Date Collected: 04/29/92 14:50:00

Water sample submitted by Roger Robinet of Missimer and Associates using laboratory supplied containers.

Test Name	Method	Result	Units	Detection Limit	Date Analyzed	Analyst
Chloride, Cl-	EPA 325.3	57	mg/L	4	05/04/92	CEB
Conductivity @ 25 Deg. C	EPA 120.1	710	umhos/cm	10	04/30/92	KRS
Total Iron, Fe	EPA 236.1	0.04	mg/L	0.01	05/01/92	GDP

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #870232. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE - WEST PALM BEACH, FLORIDA 33407-1241 - (407) 842-2849

MISSIMER & ASSOCIATES
600 SANDSTREE DRIVE
SUITE 101
PALM BEACH GARDENS, FL 33410
Attn: ROGER ROBINET

9204347-03A
Report Date: 05/11/92

Project ID: OKEECHOBEE BEACH PH1-257
Sample ID: TW-3 MIXEN PROPERTY
CORROSIVITY (LANGLIER INDEX)

Date Received: 04/29/92
Date Collected: 04/29/92 09:30:00

Water sample submitted by Roger Robinet of Missimer and Associates using laboratory supplied containers.

Test Name	Method	Result	Units	Detection Limit	Date Analyzed	Analyst
Total Alkalinity, CaCO3	EPA 310.1	289	mg/L	3	05/04/92	LNJ
Bicarbonate Alkalinity		289	mg/L	3	05/04/92	LNJ
Carbonate Alkalinity		0	mg/L	3	05/04/92	LNJ
Non-carbonate Alkalinity		0	mg/L	3	05/04/92	LNJ
Total Alkalinity, CaCO3	EPA 310.1	289	mg/L	4	04/30/92	CEB
Calcium, Ca	EPA 215.1	75	mg/L	1	05/07/92	GDP
Corrosivity, L.I.	CALC.	-0.37	Units	calc.	05/08/92	LNJ
pH	EPA 9040	6.80	units	---	04/29/92	Client
pHs	CALC	7.17	Units	---	05/08/92	LNJ
Total Dissolved Solids	EPA 160.1	429	mg/L	1	05/01/92	JYD
Temperature	EPA 170.1	22.5	deg. C	---	04/29/92	Client

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #870232. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE - WEST PALM BEACH, FLORIDA 33407-1241 - (407) 842-2849

MISSIMER & ASSOCIATES
600 SANDSTREE DRIVE
SUITE 101
PALM BEACH GARDENS, FL 33410
Attn: ROGER ROBINET

9204347-038
Report Date: 05/11/92

Project ID: OKEECHOBEE BEACH PH1-257
Sample ID: TW-3 MIXEN PROPERTY

Date Received: 04/29/92
Date Collected: 04/29/92 09:30:00

Water sample submitted by Roger Robinet of Missimer and Associates using laboratory supplied containers.

Test Name	Method	Result	Units	Detection Limit	Date Analyzed	Analyst
Chloride, Cl-	EPA 325.3	54	mg/L	4	05/04/92	CEB
Conductivity @ 25 Deg. C	EPA 120.1	710	umhos/cm	10	04/30/92	KRS
Total Iron, Fe	EPA 236.1	0.04	mg/L	0.01	05/01/92	GDP

Methods: All analyses by McGinnes Laboratories were performed using EPA and DER approved methods per McGinnes Laboratories Quality Assurance Plan #870232. All quality assurance samples met regulatory and in-house quality control limits unless otherwise specified.

Analyst

Project Manager
DHRS Laboratory ID Nos.86140/E86070