1987 TEST WELL PROGRAM
FOR
THE CITY OF LAKE WORTH

September 1987

MOCK, ROOS & ASSOCIATES, INC.
5720 CORPORATE WAY
WEST PALM BEACH, FLORIDA 33407

September 28, 1987

Mr. J. C. L'Engle, P.E., Director
City of Lake Worth Utilities
114 College Street
Lake Worth, Florida 33460

SUBJECT: Report on 1987 Test Well Program for City of Lake Worth Utilities

Dear Mr. L'Engle:

Submitted herewith is the 1987 Test Well Program Report.

We are available to make a presentation on this subject to the City at such time as may be determined.

Very truly yours,

MOCK, ROOS & ASSOCIATES, INC.

Thomas A. Biggs, P.E.
Project Manager

TAB:cd
Enc.

1987 TEST WELL PROGRAM FOR CITY OF LAKE WORTH

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II. PURPOSE AND SCOPE OF WORK

The purpose of the 1987 Test Well Program was to evaluate the nature and condition of the aquifer at three prospective well sites within the City of Lake Worth, but outside the limits of the existing wellfield. The prospective well sites are located as follows: 1) at the northwest corner of the Lake Worth High School campus, where the north bound lane of I-95 passes over Lake Worth Road; 2) on the campus of Lake Worth High School near the southwest corner of the intersection of A Street and South 1st Avenue; and 3) upon the Searle Property, located due north of 6th Street South and due west of the I-95 corridor.

Tasks completed as part of the aquifer evaluation included:

1. Drilling of Lithologic Borings - A lithologic boring was drilled at each of the three sites to evaluate the composition of the subsurface materials and identify potential producing zones. Samples of the encountered materials were obtained for visual inspection and laboratory testing.

2. Particle-Size Analysis - Selected samples obtained from the lithologic borings were tested in the laboratory to establish their particle-size distribution.

3. Well Installation and Testing - A small diameter test well was installed at Site 3 (the Searle property) and pump tested to assess aquifer transmissivity.

4. Analysis of Results - Data obtained from the lithologic borings, the particle-size analyses and the pump test were analyzed so that potential ground water production can be appraised at each site.

III. LITHOLOGIC BORING PROGRAM

A lithologic boring program was undertaken between July 22 and July 24, 1987. Three borings (LWTB-1 through LWTB-3) were drilled at the locations shown on Exhibit 1. The borings were drilled by Youngquist Brothers Drilling of Fort Myers, Florida using a Failing 1500 rig and reverse rotary wash methods. Dames & Moore personnel provided full time observation of these activities.

Borings LWTB-1 and LWTB-3 were advanced to total depths of 183 and 180 feet below land surface while LWTB-2 was extended to a slightly greater depth of 203 feet. The borings were generally terminated when high amounts of gray, loose, very fine sand were encountered proximal to the bottom of potential water producing zones. Representative lithologic samples were collected at five foot intervals as the borings were advanced.

After the termination of LWTB-1 and LWTB-2, a neat cement mixture consisting of five to six gallons of water per 96-pound bag of Portland Type II cement was used to fill the abandoned boreholes. In each case, a 0.75 inch diameter PVC tremie pipe was extended to the bottom of the

boreholes and the neat cement pumped until grout return was noted at the ground surface.

Generally, the lithology encountered shows the aquifer's production zone to consist of a light gray to gray shell material mixed with layers of indurated and loose fine to medium sands. These materials extend from about 80 to 195 feet below land surface. The shell hash material grades in size from a fine gravel to medium sand. Isolated zones or layers of loose very fine sands were not encountered as was the case when replacement Wells 8 and 10 were recently constructed. Fine sands that were recovered from the borings were formational in nature, being intermixed with the shell hash material. Lithologic logs of the borings are presented in Exhibits 2A through 2C.

IV. PARTICLE-SIZE ANALYSIS

Selected samples of the materials recovered from the boreholes were tested in the laboratory to determine their particle-size distribution. Results of these tests are shown graphically on Exhibits 3A through 3C.

Reference to the information presented on these exhibits confirms the cemented sand and shell materials recovered from LWTB-1 and LWTB-2 to be coarse and comparatively well graded. By contrast, the sand and shell materials obtained from LWTB-3 are fine and uniformly graded.

V. AQUIFER TESTING

A. Test Well Construction

Following the completion of lithologic boring LWTB-3, its excavation was used for the installation of an 8-inch diameter test well. Details of the test well are furnished on Exhibit 4.

The test well was developed for approximately six hours utilizing straight air methods. After six hours the discharge was noted to be clear of sediment.

The well design included 72 lineal feet of 8-inch diameter, 40 slot PVC screen. The transmitting capacity of the well screen at an entrance velocity of 0.1 feet per second is 8.3 gallons per minute per foot. This allowed for a maximum discharge of nearly 600 gallons per minute from the formation into the well at the indicated flow velocity.

B. Pump Testing

Following development, a turbine pump was installed in the test well with the pump intake set at 90 feet below land surface. A 6-inch by 5-inch orifice plate and manometer tube were set up at the discharge point, which was about 200 feet north and down gradient of the well, to measure pumping discharge rates.

On August 3, 1987, a step-drawdown pump test was completed to determine specific yield and an optimum pumping rate for a constant head pump test. Two steps were employed. A pumping rate of 280 gallons per minute (gpm) was used for the first step and 345 gpm for the second step. A summary of the test results is presented below. Complete test data are furnished in Table 1.

C. Summary Of Step-Drawdown Test Results

Step 1:

Static water level before pumping:	17.18 feet below top of casing*
Pumping rate of Step 1:	280 gallons per minute
Water level after 160 minutes of pumping:	60.44 feet below top of casing*
Specific capacity:	6.5 gallons per minute per foot

Step 2:

Water level at beginning of Step 2:	60.44 feet below top of casing*
Pumping rate for Step 2:	344.5 gallons per minute
Water level after 100 minutes of pumping:	78.63 feet below top of casing*
Specific capacity:	5.6 gallons per minute per foot

* Top of casing is 1.3 feet above land surface.

On August 5, 1987, a constant rate pump test was performed on the well. The well was pumped at a constant rate of 310 gallons per minute. Water levels were recorded with an electrical measuring tape and a pressure transducer with an automatic data recorder. A summary of the test data is presented below. Complete test data are included in Table 2.

D. Summary Of Constant Rate Test Results

Static water level before pumping:	17.22 feet below top of casing*
Pumping rate:	310 gallons per minute
Water level after 420 minutes of pumping:	65.77 feet below top casing*
Recovery information:	Recovery recorded for 110 minutes after discontinuation of pumping. Water level at end of recovery period at 17.22 feet below top of casing.*
Specific capacity:	6.4 gallons per minute per foot

* Top of casing is 1.3 feet above land surface.

VI. DATA ANALYSIS AND DISCUSSIONS

A. Data Analysis

Drawdown data obtained from the constant rate pump test was corrected using the Hantush method (Hantush 1962) and evaluated by the Jacob straight line method (Jacob 1963) to assess the aquifer transmissivity for a partially penetrating well. On this basis, the aquifer transmissivity at the Searle site was determined to be about 50,000 gallons per day per foot (gpd/ft). Previously developed data for the Lake Worth Wellfield indicates that the aquifer has an average transmissivity of 250,000 gpd/ft, or five times that determined from the pump test conducted at the Searle site.

Aquifer transmissivity at the three sites investigated during this study was further evaluated using the grain-size distribution information obtained from the formational samples tested in the laboratory. Transmissivity can be expressed by the following equation:

$$T = Kh$$

where T is the transmissivity of the aquifer
K is the permeability of the aquifer
and h is the aquifer thickness

Permeability values were estimated from the grain size data using an empirical correlation developed by Powers (Powers 1981) which relates hydraulic conductivity to uniformity coefficient and D (the particle size at 50 percent passing). The following transmissivity values have been estimated for the finer grained materials tested, assuming a loose soil condition and an aquifer thickness of 300 feet:

Estimated Formation Transmissivity

Location	Estimated Permeability (Ft/day)	Estimated Transmissivity (gpd/ft)
LWTB - 1	150	335,500
LWTB - 2	79	176,800
LWTB - 3	27	60,400

From the above, it may be seen that the estimated values of transmissivity of the aquifer at the Lake Worth High School sites are in reasonable agreement with that determined for the wellfield area as a whole. In addition the transmissivity value estimated for the Searle site is in close agreement with that determined from the pump test data. One factor which appears to cause the lower transmissivity at the Searle site is a higher content of formational fine sands within the water

producing zone of the aquifer than exists within the wellfield footprint and at the locations of LWTB-1 and LWTB-2.

B. Estimated Productive Yield

We expect that 10-inch diameter wells constructed near the locations of LWTB-1 and LWTB-2 on the Lake Worth High School campus will provide long-term productive yields of about 800 gpm. Short-term productive yields will likely be about 25 percent greater. The wells should be screened and gravel packed. The screened interval for location LWTB-1 should extend from 85 feet to 145 feet below land surface while that for LWTB-2 should begin at 95 feet below land surface and continue to 195 feet. Laboratory grain-size analyses on formational materials indicate that screen slot sizes in the range of 0.080 to 0.100 inch will be appropriate.

The length of screen has been chosen to allow for the maximum penetration into the aquifer to improve the specific capacity and reduce convergence of flow. This will serve to reduce the entrance velocities and thus retard encrustation and corrosion. Careful attention was given to the presence of loose very fine sands, which were encountered as the depth of the lithologic borings increased. Fine sands were encountered throughout the aquifer; however, there sands were within the matrix of the shelly material and can be controlled with the filter pack.

Due to the low transmissivity of the aquifer, the long-term productive yield of a 10-inch diameter well constructed at the Searle site is not expected to exceed about 300 gpm. Construction of a water supply well at this location is not recommended.

VII. WATER QUALITY ANALYSIS

Water quality samples were collected by City of Lake Worth Personnel and submitted to McGinnes Laboratories for analysis. A copy of McGinnes' Report is included in the appendix.

The water quality from LWTW-3 is very good. Results indicate that the untreated ground water from this well meets or exceeds current standards for drinking water quality. Perhaps the most interesting test result was color which was measured at 11 APHA Units. The average color in existing Lake Worth Wells is 30-40 APHA Units (3-4 times greater). From a water quality perspective LWTW-3 is a very desirable location. Please refer to Appendix Exhibit 6 for complete report.

VIII. PROBABLE COSTS OF DEVELOPMENT FOR THE TESTED SITES

Development costs for these sites include the cost of the well, cost of raw water piping, and any land acquisition costs. Because these sites are outside the current wellfield limits, the costs will be higher than costs for replacement wells recently constructed.

A. LWTW - 1

This well site is located on school board property 900 LF North of the nearest point of connection to the raw watermain network, therefore, development costs for this well site include 900 LF of raw watermain.

	PROBABLE COST
Well and Appurtenances	$ 100,000
Raw Watermain 900 LF @$25/LF	22,500
Total	$ 122,500

Development costs could potentially be reduced by utilizing City crews to install the raw water piping.

B. LWTW - 2

This well site is located on school board property 400 LF east of the nearest point of connection to the raw watermain network, therefore, development costs include 400 LF of raw watermain.

	PROBABLE COST
Well and Appurtenances	$ 100,000
Raw Watermain 400 LF @$25/LF	10,000
Total	$ 110,000

Again, development costs could potentially be reduced by utilizing City crews to install the raw water piping.

C. LWTW - 3

This well site is located on private property approximately 1600 LF southwest of the nearest point of connection to the raw watermain network, therefore, development costs include 1600 LF of raw watermain and land acquisition costs.

	PROBABLE COST	
Well and Appurtenances	$ 100,000	
Raw Watermain 1600 LF @$25/LF	40,000	
Railroad Crossing	10,000	
Land Acquisition	?	
Total	$ 150,000	+ Land

D. Development Costs/Capacity

1. LWTW - 1 = $122,500/800 gallons per minute = $ 153.13/GPM

2. LWTW - 2 = $110,000/800 gallons per minute = $ 137.50/GPM

3. LWTW - 3 = $150,000 + Land Cost/300 gallons per minute
= $ 500.00/GPM + Land Cost

As can been seen from this simple analysis the cost/benefit ratio for LWTW-3 site is significantly higher than the other sites.

IX. RECOMMENDATIONS FOR FISCAL YEAR 1988

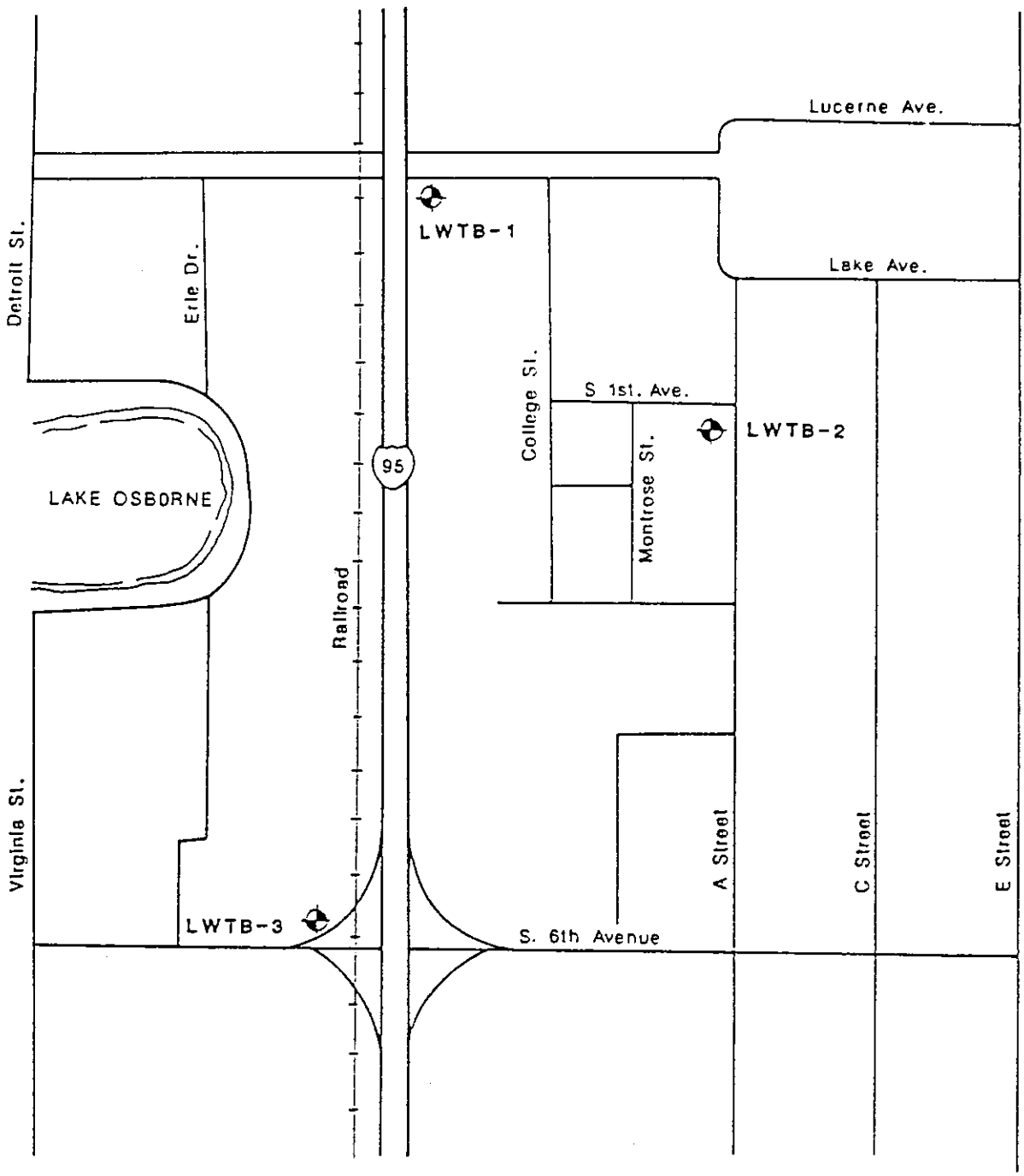
System expansion and upgrading for fiscal year 1988 should include the construction of at least two new water supply wells with a productive capacity of 800 gpm each. These wells could be drilled at or proximate to the locations of LWTB-1 and LWTB-2. In the event that, due to school board requirements, insufficient time is available for the construction of two wells on the high school campus, an alternative site should be considered for one of the two wells. Sites which appear suitable for this purpose are located west of the Lake Worth Utilities complex between existing Wells LW-7 and LW-10 and on the south side of Lake Worth Road immediately west of A Street.

Budgeting for Fiscal Year 1988 should provide for a FY 1988 lithologic exploration and aquifer testing program continuing the program initiated this year. Candidate areas for exploration and testing have previously been identified in the Wellfield Development Plan reported dated January 1987. Further discussions, are needed with the Utilities Staff and the Candidate Area Property Owners prior final selection of test program locations.

X. APPENDIX

The following Exhibits and Tables are attached and complete this report:

EXHIBIT	TITLE
1	Lithologic Boring Location Plan
2A	Log of Lithologic Boring LWTB-1
2B	Log of Lithologic Boring LWTB-2
2C	Log of Lithologic Boring LWTB-3
3A	Gradation Curve, LWTB-1
3B	Gradation Curve, LWTB-2
3C	Gradation Curve, LWTB-3
4	Test Well Construction at Searle Site
5A	Step-Drawdown Pump Test Data
5B	Constant Rate Pump Test Data
6	Water Quality Analysis Test Report



KEY :

LWTB-3 ⊕ LITHOLOGIC BORING

NOTE: LWTB-3 IS ALSO TEST WELL LOCATION

LITHOLOGIC BORING LOCATION MAP

PROJECT : CITY OF LAKE WORTH
LOCATION : LAKE WORTH, FLORIDA

DAMES & MOORE
EXHIBIT 1

JOB No. 13219006040(8/87)

BY _____ DATE _____ CHECKED _____ DATE _____ APPROVED _____ DATE _____

LITHOLOGIC LOG OF TEST BORING

LWTB-1

CITY OF LAKE WORTH, FLORIDA

Depth Below Land Surface (feet)	Description of Material
0-22	Sand, brown, fine to medium grained, some weakly cemented iron stained fine sand, traces white shell.
22-32	Sand, light gray, fine to medium grained, weakly to moderately cemented, some white shell.
32-38	Sand, light gray, fine to medium grained, very well cemented, traces white shell.
38-45	Sand, gray, fine to medium grained, moderately cemented, some white shell.
45-48	Sand and shell, gray, brown, fine to medium grained, well cemented.
48-60	Shell, white, some weakly to moderately cemented sand, fine to medium grained, light gray.
60-80	Shell and sand, light gray, moderately cemented.
80-85	Sand, light gray, weakly cemented, some white shell.
85-125	Shell, light gray, gray, some sand, fine to medium grained, generally moderately cemented.
125-130	Shell and sand, gray, fine grained, weakly cemented sands.
130-145	Shell, gray, white, medium to coarse grained, traces of cemented sand.

EXHIBIT 2A

LWTB-1 (Cont'd)

Depth Below Land Surface (feet)	Description of Material
145-160	Sand and shell, gray, fine to medium grained sand, generally loose, loose coarse shell.
160-165	Shell and sand, gray, loose coarse shell, weakly cemented fine to medium grained sand.
165-178	Sand and shell, gray, moderately cemented sand, loose coarse shell.
178-183	Sand, gray, fine to medium grained, well cemented, with inclusions of small shell.

LITHOLOGIC LOG OF TEST BORING

LWTB-2

CITY OF LAKE WORTH, FLORIDA

Depth Below Land Surface (feet)	Description of Material
0-15	Sand, brown, fine to medium grained, loose.
15-20	Sand, light gray, fine to medium grained, weakly cemented.
20-33	Sand, light gray, fine to medium grained, moderately cemented.
45-55	Sand, light gray, moderately cemented, some white shell.
55-60	Sand, light gray, moderately to, well cemented with shell, white, coarse grained.
60-73	Shell, light gray, white, traces of moderately cemented fine sand.
73-90	Sand and shell, light gray, fine to medium grained, well cemented.
90-105	Sand and shell, fine to medium grained, moderately to very well cemented, gray.
105-115	Shell, light gray, loose with some moderately cemented sand.
115-195	Shell, light gray to gray, loose with some weakly to moderately cemented fine to medium sands.
195-203	Sand, gray, fine to medium grained, loose to weakly cemented. Some loose shell.

EXHIBIT 2B

LITHOLOGIC LOG OF TEST BORING

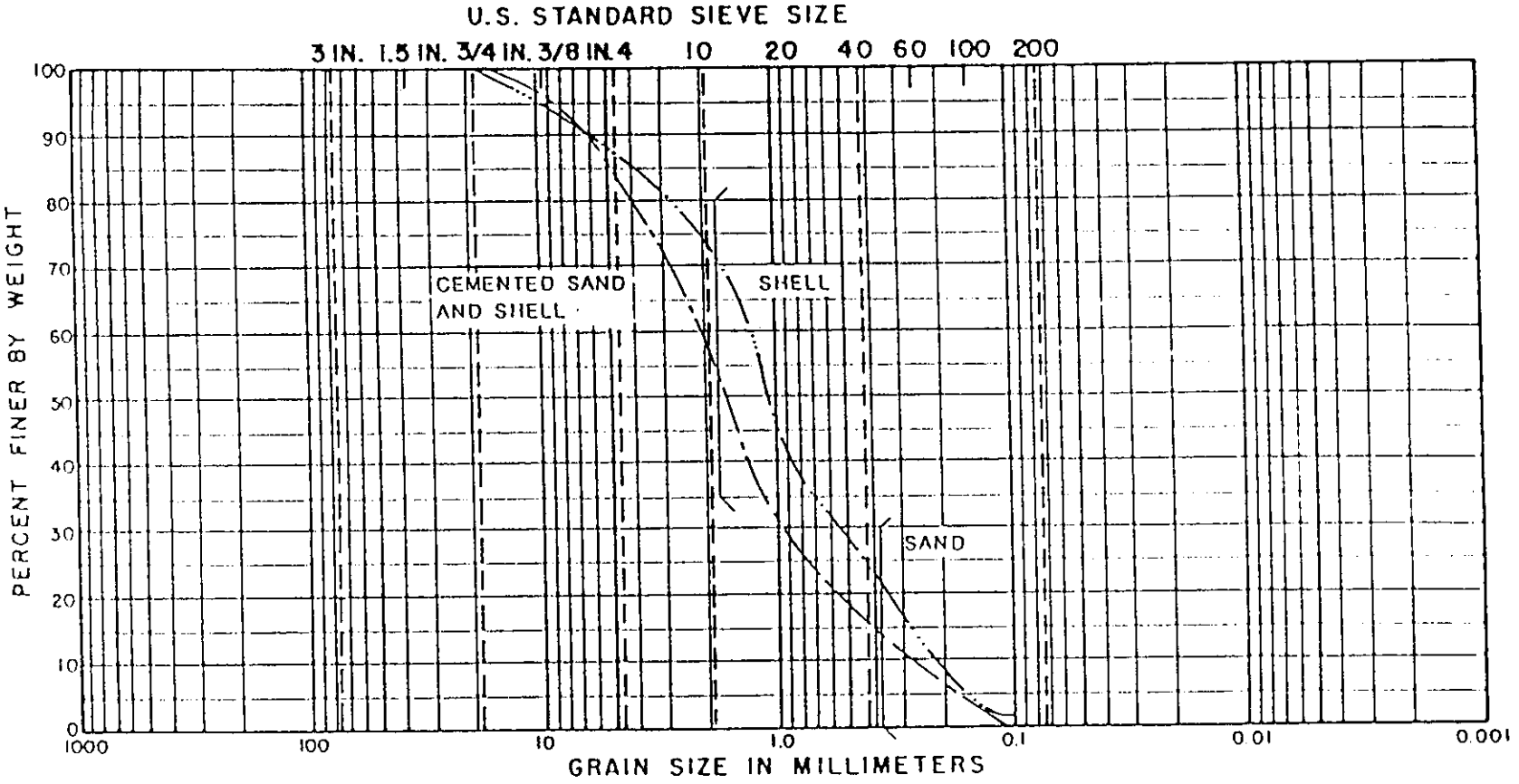
LWTB-3

CITY OF LAKE WORTH, FLORIDA

Depth Below Land Surface (feet)	Description of Material
0-39	Sand, light brown to brown, fine to medium grained.
29-41	Shell, white, some fine sand, some cementation.
41-55	Sand, light gray, fine to medium grained, moderately to well cemented, with some white shell.
55-60	Shell, white, with some gray sand.
60-70	Sand, brown, fine to medium grained, well cemented.
70-80	Shell, white, mixed with formational fine sand, traces cemented sand. Note: 75-80 ft. become very sandy with shell.
80-85	Shell, white, traces formational fine sand.
85-125	Shell, light gray to gray, with some fine sand, occasionally cemented.
125-160	Shell, gray to dark gray, with some fine sand, occasionally cemented. From 135-140, shell sizes increase.
160-180	Shell, gray to dark gray, and sand, fine grained, generally loose.

EXHIBIT 2C

1321900604O(8/87)



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH ft.	CLASSIFICATION		NAT. WC	LL	PL	PI	
LWTB-1	—— - 130-135							
	—— ··· 145-150							

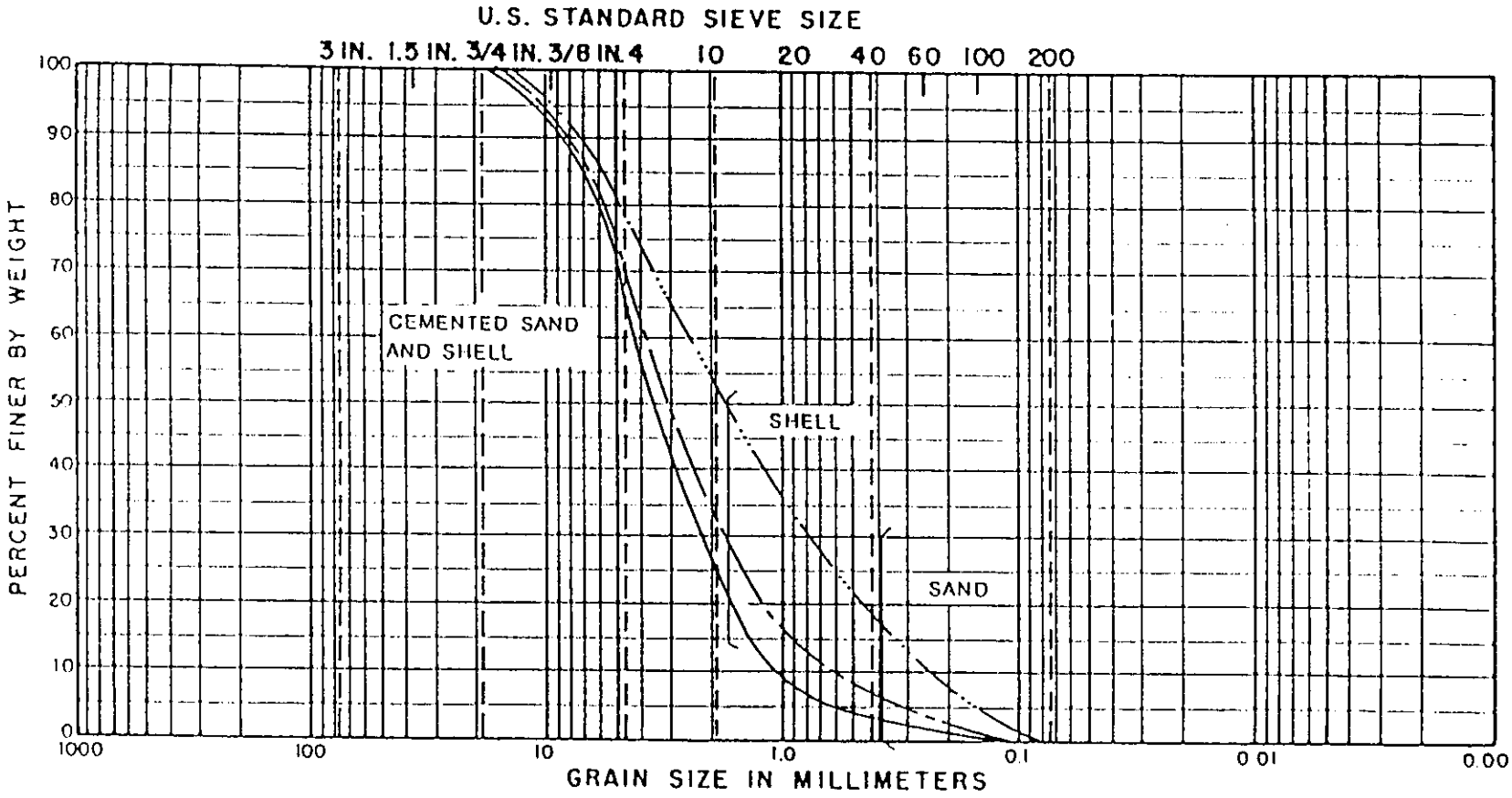
NOTE : DRILLED WITH A 5" BIT

GRADATION CURVE

DAMES & MOORE

EXHIBIT 3-A

1321900604O(8/87)



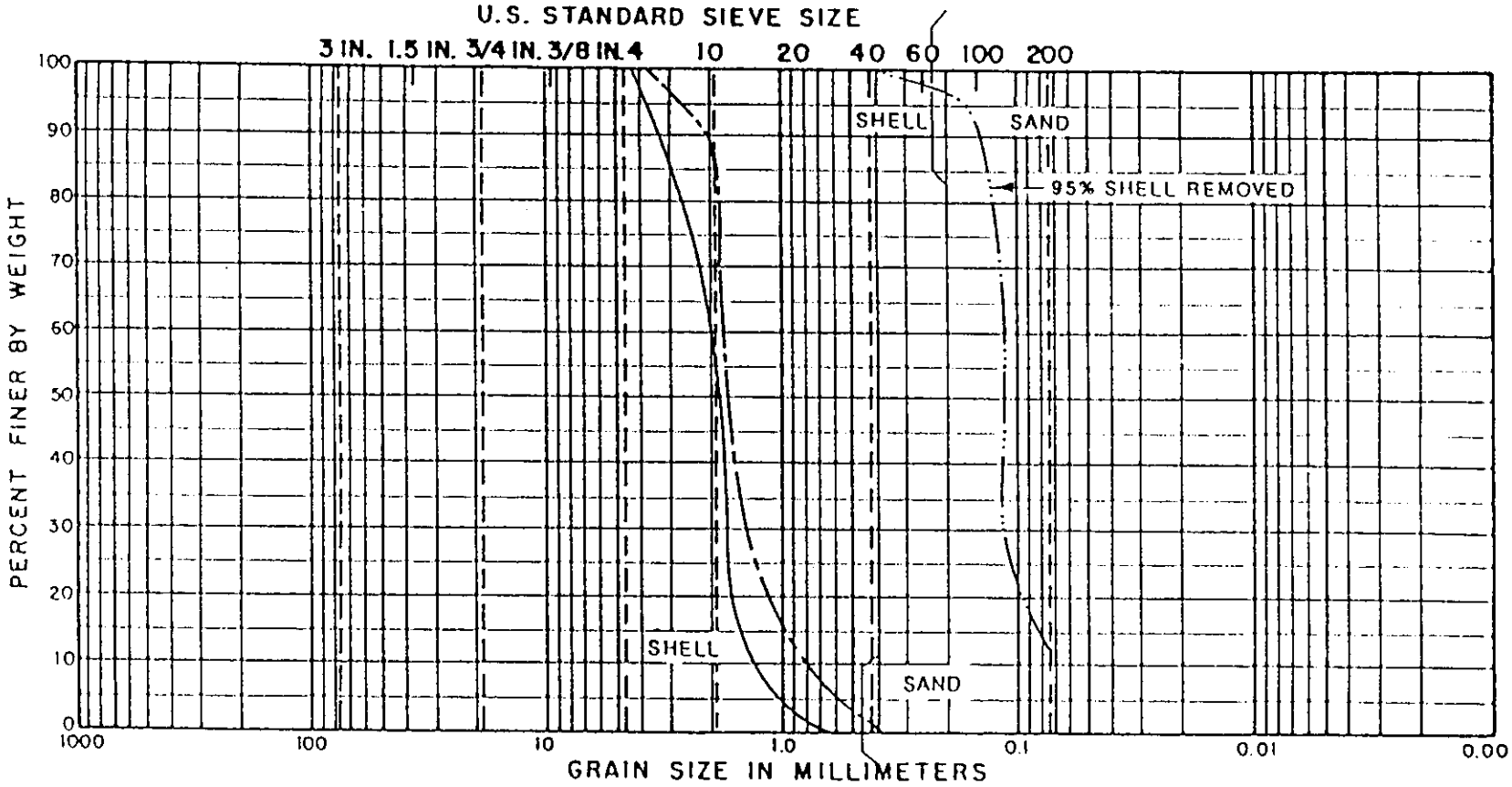
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH ft.	CLASSIFICATION		NAT. WC	LL	PL	PI	
LWTB-2	—— 90-95							
	—···— 130-135							
	—— 165-170							

NOTE: DRILLED WITH A 5" BIT

GRADATION CURVE

DAMES & MOORE
EXHIBIT 3-8



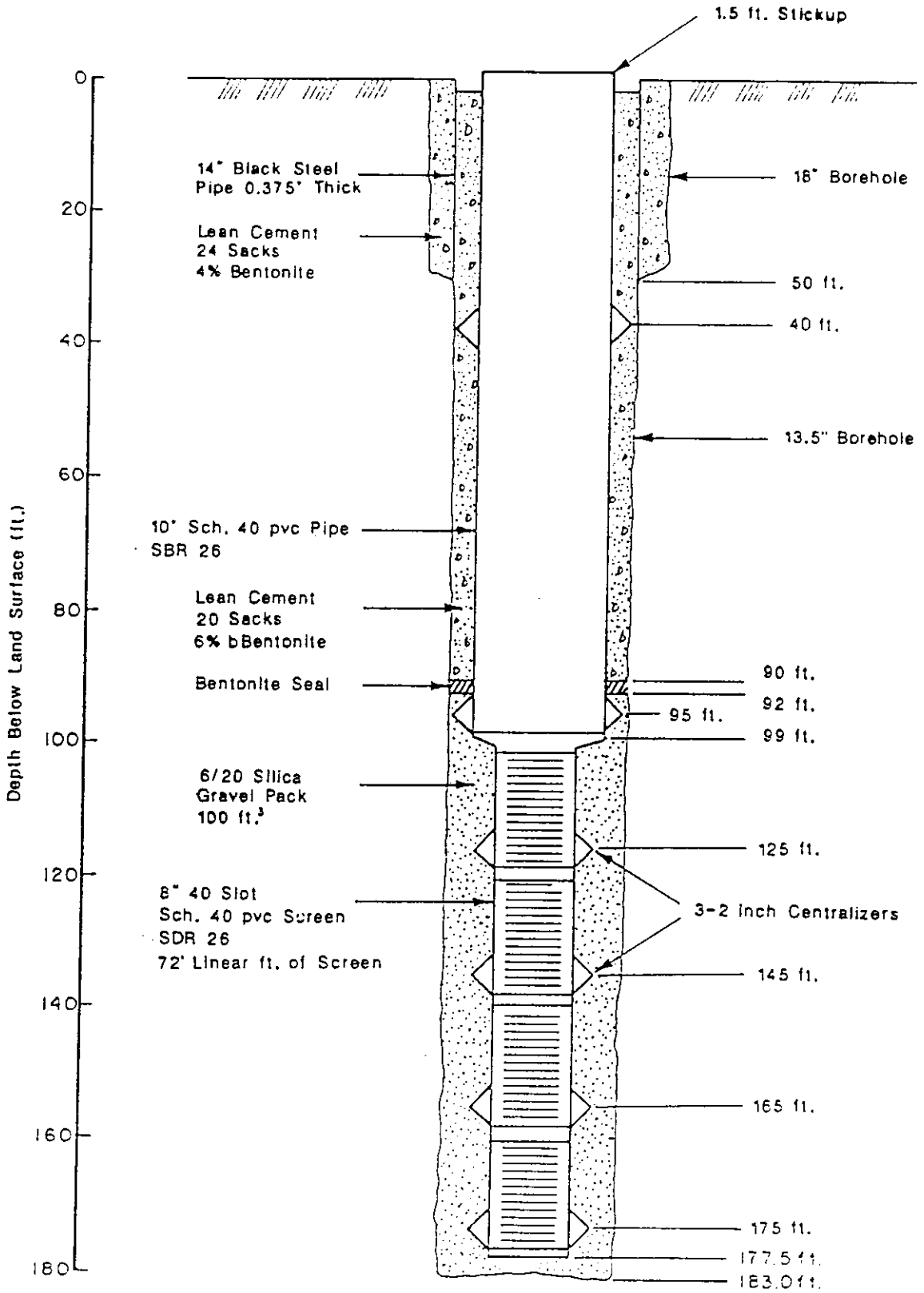
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH ft	CLASSIFICATION		NAT. WC	LL	PL	PI	
LWTB-3	110<115							
	140-145							
	150-155							

NOTE : DRILLED WITH A 13 1/2" BIT

GRADATION CURVE

DAMES & MOORE
EXHIBIT 3-C



TEST WELL CONSTRUCTION AT SEARLE SITE

JOB No. 13219006040 (8/87)

PROJECT: CITY OF LAKE WORTH
LOCATION: LAKE WORTH, FLORIDA

DAMES & MOORE
EXHIBIT 4

BY _____ DATE _____ CHECKED _____ DATE _____ APPROVED _____ DATE _____

EXHIBIT 5A

AQUIFER TEST DATA

City of Lake Worth

Well No.: LWTB-3
Type of Test: STEP-DRAWDOWN
Date: August 4, 1987

Time Since Pump Started (Minutes)	Time Since Pump Stopped (Minutes)	Water Level Change (Feet)	Pumping Rate (gpm)
Step 1			
0		0	280
1		28.10	
2		47.32	
3		43.82	
4		42.32	
5		40.74	
6		41.44	
7		43.38	
8		44.02	
9		44.18	
10		44.30	
12		47.44	
14		43.53	
16		43.44	
18		43.45	
20		43.40	
25		43.36	
30		43.35	
35		43.28	
40		43.17	
50		42.90	
60		42.93	
70		43.04	
80		43.09	
90		43.00	
100		43.27	
120		43.09	
140		43.17	280
160		43.26	

EXHIBIT 5A (cont'd)

Time Since Pump Started (Minutes)	Time Since Pump Stopped (Minutes)	Water Level Change (Feet)	Pumping Rate (gpm)
Step 2			
0		43.26	344.5
1		-	
2		-	
3		72.84	
4		-	
5		61.42	
6		-	
7		-	
8		60.93	
9		61.00	
10		61.07	
12		60.94	
14		61.01	
16		60.85	
18		61.40	
20		61.04	
25		61.20	
30		61.19	
35		60.75	
40		60.90	
50		61.31	
60		61.31	
70		61.19	
80		60.70	
90		60.79	
100		61.45	
120		60.87	344.5
143		60.91	

EXHIBIT 5A (cont'd)

Time Since Pump Started (Minutes)	Time Since Pump Stopped (Minutes)	Water Level Change (Feet)	Pumping Rate (gpm)
Recovery			
	0	60.91	
	0.5	1.94	
	1	1.56	
	2	1.23	
	3	0.95	
	4	0.79	
	5	0.67	
	6	0.59	
	7	0.53	
	8	0.48	
	9	0.44	
	10	0.40	
	12	0.33	
	14	0.29	
	16	0.26	
	18	0.23	
	20	0.21	
	22	0.17	
	24	0.16	
	26	0.14	
	28	0.12	
	30	0.11	

Static water level recorded at 15.88 feet below land surface.

EXHIBIT 5B

AQUIFER TEST DATA

City of Lake Worth

Well No.: LWTB-3
Type of Test: CONSTANT RATE
Date: August 5, 1987

Time Since Pump Started (Minutes)	Time Since Pump Stopped (Minutes)	Water Level Change (Feet)	Pumping Rate (gpm)
Drawdown			
0		0	
1		-	
2		-	
3		(Adjusting Rate)	
4		-	
5		-	
6		-	
7		47.78	
8		47.78	305
9		47.89	
10		48.28	
12		48.25	
14		48.40	
16		46.98	
18		46.64	
20		46.61	
25		49.12	
30		49.26	
35		49.28	
40		49.30	
50		49.48	310
60		49.51	
70		49.31	
80		49.48	
90		49.20	
100		49.39	
120		49.56	
140		48.88	
160		49.31	310
180		49.11	

EXHIBIT 5B (cont'd)

Time Since Pump Started (Minutes)	Time Since Pump Stopped (Minutes)	Water Level Change (Feet)	Pumping Rate (gpm)
200		49.26	
250		48.86	
300		48.66	
350		49.12	
400		48.92	
410		49.72	
420		48.55	310
Recovery			
	0	0	
	.020	1.75	
	.030	3.24	
	.050	6.88	
	.083	13.05	
	.100	16.30	
	.150	24.14	
	.200	27.73	
	.250	29.88	
	.300	32.40	
	.500	42.82	
	.750	43.95	
	1.00	44.51	
	1.25	45.11	
	1.50	45.38	
	1.75	45.59	
	2.0	45.75	
	2.5	45.98	
	3.0	46.13	
	3.5	46.25	
	4.0	46.33	
	4.5	46.36	
	5.0	46.44	
	5.5	46.52	
	6.0	46.57	
	6.5	46.63	
	7.0	46.70	
	7.5	46.76	
	8.0	46.78	
	8.5	46.81	
	9.0	46.89	
	9.5	46.97	
	10.0	47.03	

EXHIBIT 5B (cond't)

Time Since Pump Started (Minutes)	Time Since Pump Stopped (Minutes)	Water Level Change (Feet)	Pumping Rate (gpm)
	12	47.21	
	14	47.40	
	16	47.52	
	18	47.60	
	20	47.65	
	22	47.67	
	24	47.68	
	26	47.70	
	28	47.73	
	30	47.75	
	34	47.79	
	40	47.94	
	44	48.05	
	50	48.05	
	60	48.08	
	70	48.12	
	80	48.15	
	90	48.16	
	100	48.18	
	110	48.19	

Static water level recorded at 15.92 feet below land surface.

EXHIBIT 6

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE · WEST PALM BEACH, FLORIDA 33407 · (305) 842-2849

Client: City of Lake Worth Utilties
114 S. College Street
Lake Worth, FL 33460

August 26, 1987

Sample: Test well samples collected 8-5-87 by client in lab-supplied containers.

Job No. 87-8-5-LW-41

Location: LWTW 3

Analysis:

FAC 17-22 PRIMARY INORGANICS & TURBIDITY

*Maximum contaminant level for drinking water shown here for reference only.

Parameter	MCL*	Result	Date/Tech
Arsenic, mg/L As	0.05	<0.005	8-6 HW
Barium, mg/L Ba	1.0	<0.05	8-7 HW
Cadmium, mg/L Cd	0.010	<0.002	8-7 HW
Chromium, mg/L Cr	0.05	<0.01	8-7 HW
Lead, mg/L Pb	0.05	<0.05	8-7 HW
Mercury, mg/L Hg	0.002	<0.001	8-14 BK
Selenium, mg/L Se	0.01	<0.005	8-20 HW
Silver, mg/L Ag	0.05	<0.01	8-7 HW
Sodium, mg/L Na	160	18	8-7 HW
Nitrate, mg/L N	10.0	<0.1	8-6 JM
Fluoride, mg/L F	1.4	0.07	8-6 BK
Turbidity, N.T.U.	1	0.59	8-6 BK

FAC 17-22 PRIMARY ORGANICS

Parameter	MCL*		
Endrin, mg/L	0.0002	---	---
Lindane, mg/L	0.004	---	---
Methoxychlor, mg/L	0.1	---	---
Toxaphene, mg/L	0.005	---	---
2,4-D, mg/L	0.1	---	---
2,4,5-TP Silvex, mg/L	0.01	---	---

Methods: See attached Methods Sheet.

Gerald McGinnes

DHRS Laboratory I.D. No. 86140 /T860 D

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE · WEST PALM BEACH, FLORIDA 33407 · (305) 842-2849

Client: City of Lake Worth Utilties
114 S. College Street
Lake Worth, FL 33460

August 26, 1987

Sample: Test well samples collected 8-5-87 by client in lab-supplied containers.

Job No. 87-8-5-LW-41

Location: LWTW1

Analysis:

FAC 17-22 PRIMARY INORGANICS & TURBIDITY

*Maximum contaminant level for drinking water shown here for reference only.

Parameter	MCL*	Result	Date/Tech
Arsenic, mg/L As	0.05	<0.005	8-6 HW
Barium, mg/L Ba	1.0	<0.05	8-7 HW
Cadmium, mg/L Cd	0.010	<0.002	8-7 HW
Chromium, mg/L Cr	0.05	<0.01	8-7 HW
Lead, mg/L Pb	0.05	<0.05	8-7 HW
Mercury, mg/L Hg	0.002	<0.001	8-14 BK
Selenium, mg/L Se	0.01	<0.005	8-20 HW
Silver, mg/L Ag	0.05	<0.01	8-7 HW
Sodium, mg/L Na	160	18	8-7 HW
Nitrate, mg/L N	10.0	<0.1	8-6 JM
Fluoride, mg/L F	1.4	0.07	8-6 BK
Turbidity, N.T.U.	1	0.59	8-6 BK

FAC 17-22 PRIMARY ORGANICS

Parameter	MCL*		
Endrin, mg/L	0.0002	---	---
Lindane, mg/L	0.004	---	---
Methoxychlor, mg/L	0.1	---	---
Toxaphene, mg/L	0.005	---	---
2,4-D, mg/L	0.1	---	---
2,4,5-TP Silvex, mg/L	0.01	---	---

Methods: See attached Methods Sheet

THESE SAMPLES WERE NOT COLLECTED BY McGINNES LABORATORIES PERSONNEL AND THE RESULTS ARE WARRANTED TO REPRESENT SAMPLES ONLY AS RECEIVED

Gerard A. Rouse

DHRS Laboratory I.D. No. 86140 / 78607

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE · WEST PALM BEACH, FLORIDA 33407 · (305) 842-2849

Client: City of Lake Worth Utilities
114 S. Congress Avenue
Lake Worth, FL 33460

August 26, 1987

Sample: Test well samples collected 8-5-87 by client in lab-supplied containers.

Job No. 87-8-5-LW-41

Location: LWTW1

Analysis:

FAC 17-22 CORROSIVITY CHARACTERISTICS

*Maximum contaminant level for drinking water shown here for reference only.

Parameter	MCL*	Result	Date/Tech
Collection Time	--	1300hrs	8-5 LW staff
Temperature, °C	--	26	8-5 LW staff
Alkalinity, Total, mg/L as $CaCO_3$	--	141	8-5 BK
Alkalinity, Bicarbonate, mg/L as $CaCO_3$	--	141	Calc.RG
Calcium, mg/L Ca	200	73	8-7 HW
Carbon Dioxide, mg/L (nomographic)	--	3.2	Calc.RG
Chloride, mg/L Cl^-	250	27	8-7 BK
Conductivity, μMHOS	--	580	8-5 ME
Corrosivity, Langlier Index	±0.2	-0.15	Calc.RG
Hardness, Calcium, mg/L as $CaCO_3$	--	213	8-10 BK
Oxygen, Dissolved, mg/L O_2	--	5.4	8-5 ME
pH, units	min.6.5	7.2	8-5 LW staff
pHs, units	--	7.35	Calc.RG
Sodium, mg/L Na	160	18	8-7 HW
Sulfate, mg/L SO_4	250	38	8-11 BK
Solids, Total Dissolved, mg/L	500	294	8-7/10 BK
Turbidity, N.T.U.	1.0	0.59	8-5 BK

Methods: See attached sheet.

DHRS Laboratory I.D. Nos. 86140; T86070

PAUL R. MCGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE · WEST PALM BEACH, FLORIDA 33407 · (305) 842-2849

Client: City of Lake Worth Utilities
114 S. Congress Avenue
Lake Worth, FL 33460

August 26, 1987

Sample: Test well samples collected 8-5-87 by client in lab-supplied containers.

Job No. 87-8-5-LW-41

Location: LWTW1

Analysis:

FAC 17-22 CORROSIVITY CHARACTERISTICS

*Maximum contaminant level for drinking water shown here for reference only.

Parameter	MCL*	Result	Date/Tech
Collection Time	--	1300hrs	8-5 LW staff
Temperature, °C	--	26	8-5 LW staff
Alkalinity, Total, mg/L as $CaCO_3$	--	141	8-5 BK
Alkalinity, Bicarbonate, mg/L as $CaCO_3$	--	141	Calc.RG
Calcium, mg/L Ca	200	73	8-7 HW
Carbon Dioxide, mg/L (nomographic)	--	3.2	Calc.RG
Chloride, mg/L Cl^-	250	27	8-7 BK
Conductivity, µMHOS	--	580	8-5 ME
Corrosivity, Langlier Index	±0.2	-0.15	Calc.RG
Hardness, Calcium, mg/L as $CaCO_3$	--	213	8-10 BK
Oxygen, Dissolved, mg/L O_2	--	5.4	8-5 ME
pH, units	min.6.5	7.2	8-5 LW staff
pHs, units	--	7.35	Calc.RG
Sodium, mg/L Na	160	18	8-7 HW
Sulfate, mg/L SO_4	250	38	8-11 BK
Solids, Total Dissolved, mg/L	500	294	8-7/10 BK
Turbidity, N.T.U.	1.0	0.59	8-5 BK

Methods: See attached sheet.

DHRS Laboratory I.D. Nos. 86140; 186070

THESE SAMPLES WERE NOT COLLECTED BY McGINNES LABORATORIES PERSONNEL AND THE RESULTS ARE WARRANTED TO REPRESENT SAMPLES ONLY AS RECEIVED BY McGINNES LABORATORIES.

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE · WEST PALM BEACH, FLORIDA 33407 · (305) 842-2849

Client: City of Lake Worth Utilities
114 S. College Street
Lake Worth, FL 33460

August 26, 1987

Sample: Test well samples collected 8-5-87 by client in lab-supplied containers.

Job No. 87-8-5-LW-41

Location: LWTW1

Analysis:

FAC 17-22 SECONDARY INORGANICS

*Maximum contaminant level for drinking water shown here for reference only.

Parameter	MCL*	Result	Date/Tech
Collection Time	---	1300hrs	8-5 LW staff
Temperature, °C	---	26	8-5 LW staff
Alkalinity, Total, mg/L as $CaCO_3$	---	141	8-5 BK
Calcium, mg/L Ca	200	73	8-7 HW
Chloride, mg/L Cl^-	250	27	8-7 HW
Color, APHA units	15	11	8-6 HW
Copper, mg/L Cu	1.0	<0.01	8-7 HW
Corrosivity, L.I.	±0.2	-0.15	Calc.RG
Foaming Agents, mg/L MBAS	0.5	<0.02	8-5 BK
Iron, mg/L Fe	0.3	0.23	8-7 HW
Manganese, mg/L Mn	0.05	<0.005	8-7 HW
Odor, threshold	3	3 (sulfur)	8-5 BK/ME
pH, units	≥ 6.5	7.2	8-5 LW staff
pHs, units	---	7.35	Calc.RG
Sulfate, mg/L SO_4	250	38	8-11 BK
Solids, Total Dissolved, mg/L	500	294	8-7/10 BK
Zinc, mg/L Zn	5	0.018	8-7 HW
Sulfide, mg/L $S^=$	---	<0.05	8-5 BK

Methods: All analyses per Standard Methods.
See attached Methods Sheet.

DHRS Laboratory I.D. No. 86140/7660

PAUL R. McGINNES AND ASSOCIATES
CONSULTING LABORATORIES, INC.

4168 WESTROADS DRIVE · WEST PALM BEACH, FLORIDA 33407 · (305) 842-2849

Client: City of Lake Worth Utilities
114 S. College Street
Lake Worth, FL 33460

August 26, 1987

Sample: Test well samples collected 8-5-87 by client in lab-supplied containers.

Job No. 87-8-5-LW-41

Location: LWTW1

Analysis:

FAC 17-22 SECONDARY INORGANICS

*Maximum contaminant level for drinking water shown here for reference only.

Parameter	MCL*	Result	Date/Tech
Collection Time	---	1300hrs	8-5 LW staff
Temperature, °C	---	26	8-5 LW staff
Alkalinity, Total, mg/L as $CaCO_3$	---	141	8-5 BK
Calcium, mg/L Ca	200	73	8-7 HW
Chloride, mg/L Cl^-	250	27	8-7 HW
Color, APHA units	15	11	8-6 HW
Copper, mg/L Cu	1.0	<0.01	8-7 HW
Corrosivity, L.I.	±0.2	-0.15	Calc.RG
Foaming Agents, mg/L MBAS	0.5	<0.02	8-5 BK
Iron, mg/L Fe	0.3	0.23	8-7 HW
Manganese, mg/L Mn	0.05	<0.005	8-7 HW
Odor, threshold	3	3 (sulfur)	8-5 BK/ME
pH, units	≥ 6.5	7.2	8-5 LW staff
pHs, units	---	7.35	Calc.RG
Sulfate, mg/L SO_4	250	38	8-11 BK
Solids, Total Dissolved, mg/L	500	294	8-7/10 BK
Zinc, mg/L Zn	5	0.018	8-7 HW
Sulfide, mg/L $S^=$	---	<0.05	8-5 BK

Methods: All analyses per Standard Methods. See attached Methods Sheet.

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DHRS Laboratory I.D. No. 86140/18607

Paul R. McGinnes and Associates
Consulting Laboratories, Inc.

Laboratory I.D. No. 86140

Analysis	Collection/Storage	Analysis Method	ECR II/FAC 17-22 mg/l allowed in Drinking Wat
PRIMARY INORGANICS:			
Arsenic; Selenium.....	0.5%HNO_3/<6 mos.	Hydride generation into hydrogen argon flame	0.05;0.01
Mercury	0.5%HNO_3/<14 days	Cold vapor atomic absorption	0.002
Chromium; Lead	0.5%HNO_3/<6 mos.	Atomic Absorption	0.05;0.05
Barium; Cadmium; Silver	0.5%HNO_3/<6 mos.	Atomic Absorption	1.0;0.010;0. 5
Nitrate	Refrigerate/<24hrs	Brucine sulfate colorimetric	10.0
Fluoride	Refrigerate/<7 days	Specific ion probe	1.4
PRIMARY ORGANICS:			
Endrin; Lindane	Extract <7 days	Gas chromatography	0.0002;0.004
Methoxychlor; Toxaphene	Extract <7 days	Gas chromatography	0.1;0.005
2,4-D; 2,4,5-TP Silvex	Extract <7 days	Gas chromatography	0.1;0.01;0.1
Trihalomethanes	<7 days	Solvent extraction GC	0.10
SECONDARY INORGANICS:			
Total Dissolved Solids	Refrigerate/<7 days	Gravimetric difference	500
pH	On site	Corning 610A meter	6.5 min.
Magnesium; Iron; Copper	0.5%HNO_3/<6 mos.	Atomic absorption	--;0.3;1.0
Zinc; Manganese ; Calcium ..,	0.5%HNO_3/<6 mos.	Atomic absorption	5;0.05; 200
Sulfate	Refrigerate/<7 days	Turbidimetric	250
Sulfide	ZnAc pres./<24hrs	$Na_2S_2O_3$ titrimetric	--
Hydrogen Sulfide	ZnAc pres./<24hrs	Calc.from sulfide	0.05
Chloride	<7 days	$Hg(NO_3)_2$ titrimetric	250
Sodium	0.5%HNO_3/<6 mos.	Atomic emission	160
Detergents(MBAS)	Refrigerate/<24hrs	Chloroform extraction/ colorimetric	0.5
Hardness	Refrigerate	EDTA titrimetric	--
Color	Refrigerate/<24hrs	Colorimetric	15
Odor	Immediate	Panel evaluation	3.0
Turbidity	Refrigerate/<24hrs	Hach 2100A turbidimeter	1.0
Alkalinity	Immediate	H_2SO_4 titrimetric	--
D.O/Conductivity	Immediate	YSI SCT meters	--
Corrosivity	--	Calculation	-0.2 to +0.2
pHs	--	Calculation	--
Carbon Dioxide	--	Nomograph	--

Note: Detection limits for each analysis vary with nature and condition of sample analyzed

Rev.2-85/10-86