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WATER QUALITY IN THE OLD PLANTATION WATER CONTROL DISTRICT, BROWARD COUNTY, FLORIDA PROGRESS REPORT, JULY 1976–JUNE 1977

no 78-411
Tallahassee

OPEN-FILE REPORT FL 78-411

Prepared by the U.S. GEOLOGICAL SURVEY
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OLD PLANTATION WATER CONTROL DISTRICT

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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER QUALITY IN THE OLD PLANTATION WATER CONTROL DISTRICT, BROWARD COUNTY, FLORIDA - PROGRESS REPORT, JULY 1976 - JUNE 1977

By Gary M. Russell, Chris E. Hanson, and William A. J. Pitt, Jr.

Open-File Report 78-411

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OLD PLANTATION WATER CONTROL DISTRICT

Tallahassee, Florida
1978

293175

UNITED STATES DEPARTMENT OF THE INTERIOR

CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY

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ABSTRACT

Water quality in the Old Plantation Water Control District in Broward County, Florida has been affected by effluent from sewage-treatment plants, agriculture, and storm-water runoff. Effect of the effluent from sewage-treatment plants on water quality was evident at 3 sites where concentrations of nutrients and bacteria in the Broward County canals exceeded state standards of 2,400 colonies per 100 milliliters for total coliform bacteria, and where at 2 of the 3 sites the fecal coliform/fecal streptococcus ratios indicated possible human contamination. The effect of agriculture on water quality was evident where relatively high levels of chlorinated hydrocarbon insecticides had concentrated in the bottom sediments of the canals. For example, DDD reached levels of 330 micrograms per kilogram at site 3. The effects of storm-water runoff on water quality were detected during the wet season when concentrations of several trace elements increased. For example, zinc averaged 30 micrograms per milliliter in the wet season compared with 20 micrograms per milliliter during the dry season.

INTRODUCTION

Drainage in Broward County is through a network of primary canals and control structures maintained by the South Florida Water Management District (SFWMD) and through a network of secondary canals and network structures maintained by 23 separate districts within the county, including the Old Plantation Water Control District (OPWCD). The general drainage act of 1947 authorized OPWCD to carry out the actual construction and operation of water management works. The OPWCD must abide by SFWMD regulations because storm waters from the district are discharged into the primary canals of the SFWMD. These regulations require OPWCD to minimize the quantity of objectionable materials carried in storm discharges.

This page revised November 1978.

Purpose and Scope

In July 1976, the OPWCD requested the U.S. Geological Survey to evaluate the quality of the surface waters in the canals within the District's boundaries. As a cooperative effort between the OPWCD and the U.S. Geological Survey, an investigation was designed to establish background water quality, define problem areas and monitor water-quality changes in the surface waters within OPWCD to aid the District with the short-and long-term planning and management of its water resources. In this, the first report of the investigation, all the data collected during the first year of the investigation are summarized and compared with established water-quality standards.

Acknowledgments

The authors thank OPWCD for its cooperation and assistance given in support of this water-resources investigation. Special acknowledgment is expressed to Les Bitting for help in furnishing valuable information for this study.

LOCATION AND HYDROLOGIC SETTING

The OPWCD is located in central Broward County (fig. 1). It comprises approximately 15 square miles of relatively low land with little relief. It is irregular in shape and contiguous to and north of the North New River Canal (Fig. 2). On the west it is bordered by West Holloway Canal (C-42), on the east by the Sunshine State Parkway, and on the north by the city of Sunrise at Plantation Canal (C-12) and 2L-3E Canal.

Drainage within the district is through six canals oriented southward and three eastward and several tributaries to each of these nine canals. Pump stations 1, 2, and 3 (fig. 2) discharge into North New River Canal to the south, and pump station 4 discharges into Plantation Canal to the east. The dominant drainage is generally to the southeast. During the wet season, from May to October, drainage is both by gravity flow and pumping, but during the dry season, from November to April, drainage is mostly by gravity flow in the canals and by subsurface flow to areas of lower head to the southeast.

DATA COLLECTION

Data Network

Sampling sites 1, 2 and 3 (fig. 2), were located to determine the general water quality of canal water in areas of special interest. The site locations, direction of canal flow, and type of area drained are described below:

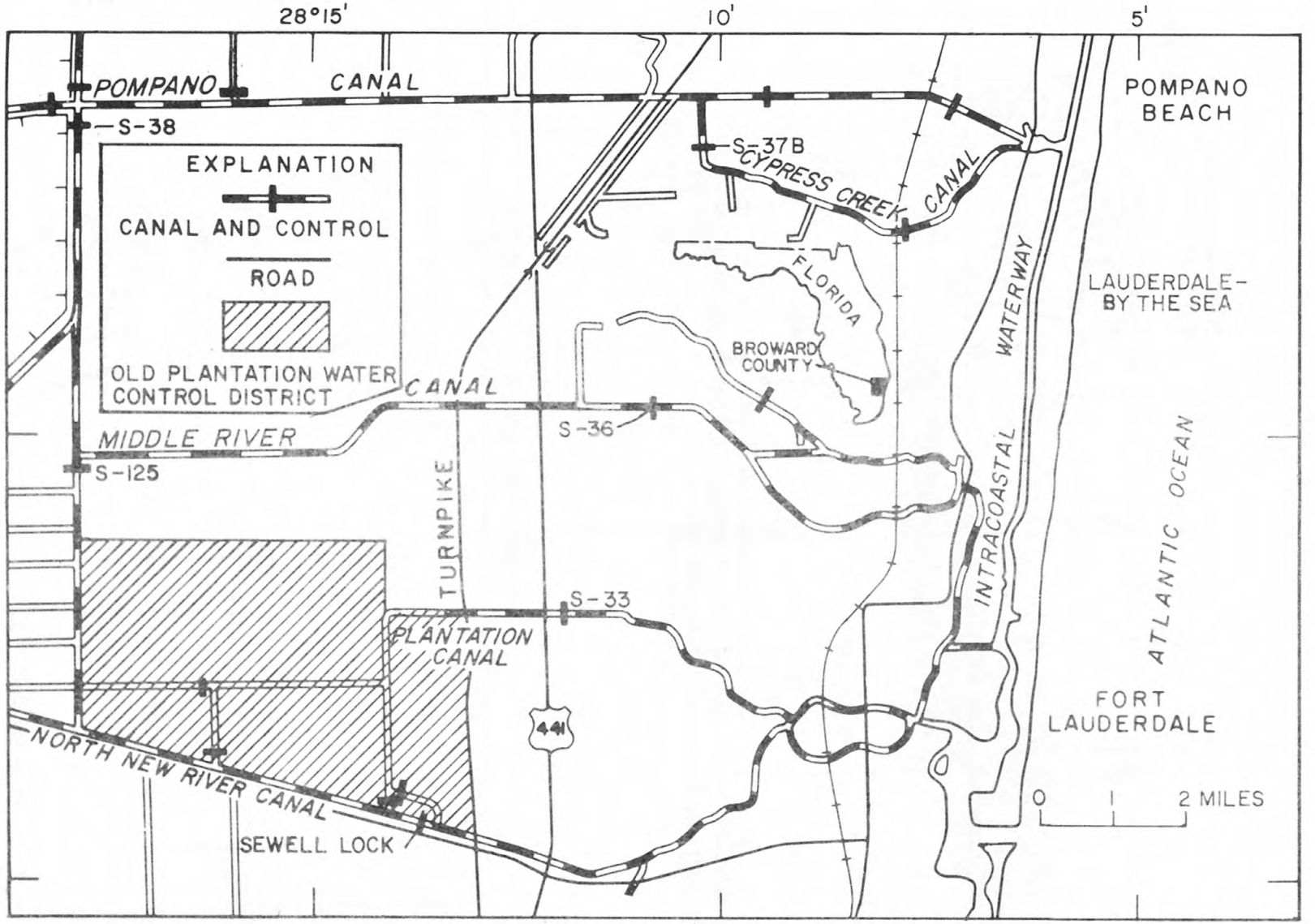

Figure 1.—Location of Old Plantation Water Control District in Eastern Broward County.

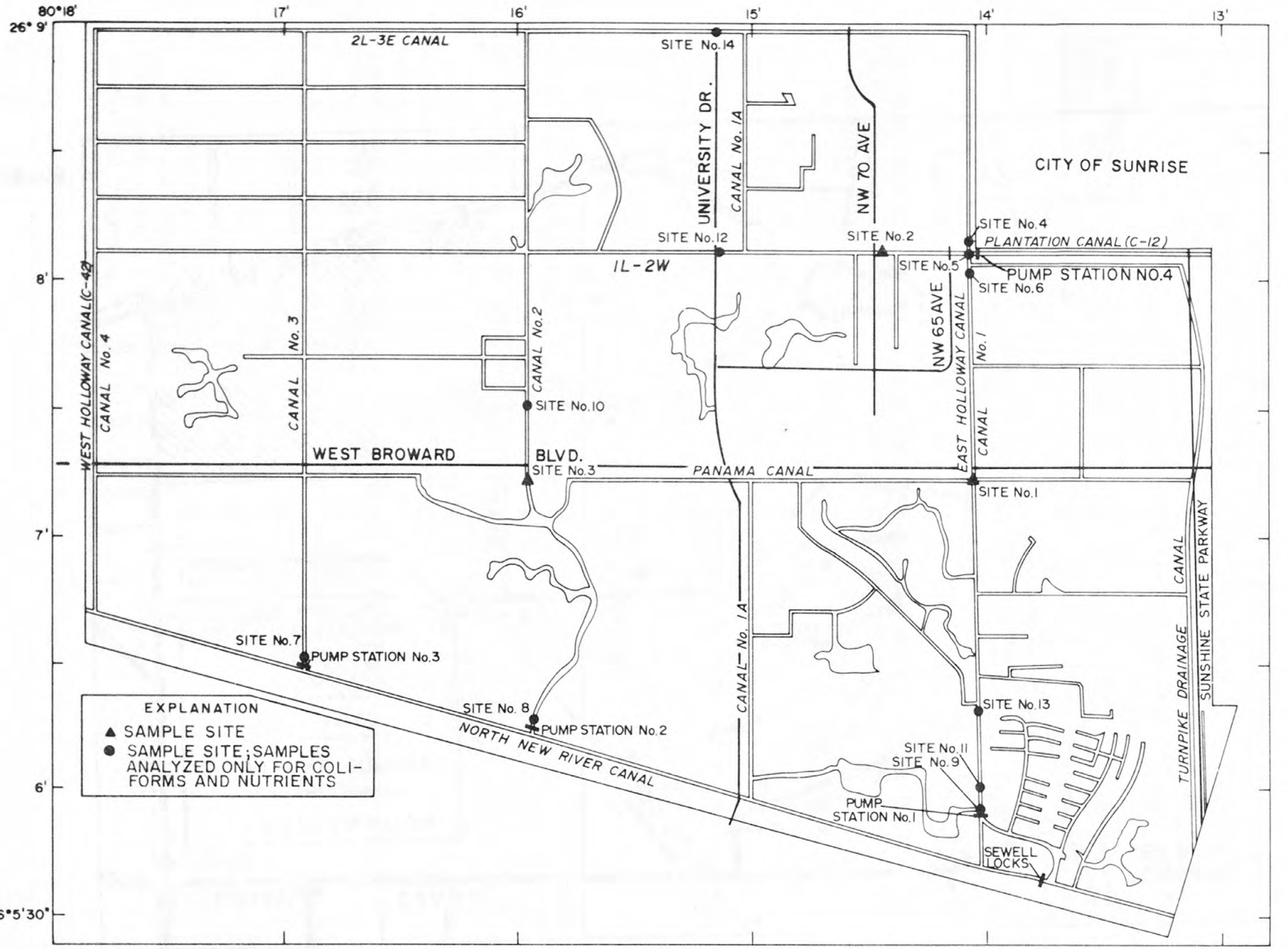

Figure 2.--Sampling sites and pump stations at Old Plantation Water Control District.

Site 1 — East Holloway Canal at Broward Boulevard –

Lat. 26°07'14" N, Long. 80°14'08" E. This canal drains mostly residential areas. Two waste-water treatment plants are located along its reaches. Flow is mostly southward except possibly at the north end where water is discharged into Plantation Canal through pump station No. 4 at N.W. 65th Avenue.

Site 2 — 1L-2W Canal at N.W. 70th Avenue –

Lat. 26°08'07" N, Long. 80°14'28" E. This canal drains residential areas and small parts of undeveloped and agricultural land. Flow is mostly toward the east.

Site 3 — Canal No. 2 at Broward Boulevard –

Lat. 26°07'13" N, Long. 80°16'59" E. Canal No. 2 primarily drains agricultural farming and grazing lands and a small amount of scattered residential land. Canal flow is normally southward.

Sites 4-14 were located throughout the district to provide good areal coverage. In June 1977 a sample was collected from each of these 11 sites and tested for a few constituents to determine whether detailed analysis would be needed to assess background chemical quality.

Sampling Frequency and Parameters

At sites 1-3 water samples were collected about quarterly in July and October 1976, and in January, February, and April 1977. All except those samples collected in February were analyzed for:

Field Measurements

Dissolved oxygen (DO)
Temperature
pH
Specific conductance
Biochemical oxygen demand (BOD)

Bacteria

Total coliforms
Fecal coliforms
Fecal streptococcus

Nutrients

Total organic carbon (TOC)
Total organic nitrogen
Ammonia
Nitrite
Nitrate
Ortho-phosphate
Total phosphorus

The samples collected in October 1976 and April 1977, were, in addition, analyzed for the following constituents, together with color and residue:

Major dissolved inorganic ions

Bicarbonate
Calcium
Carbonate
Chloride
Fluoride
Magnesium
Potassium
Silica
Sodium
Strontium
Sulfate

Total trace elements

Aluminum
Arsenic
Boron
Cadmium
Copper
Lead
Lithium
Manganese
Mercury
Molybdenum
Nickel
Vanadium
Zinc

During the April 1977 sampling bottom sediment samples were also collected at each of the three sites and analyzed for:

Insecticides

Aldrin
Chlordane
DDD
DDE
DDT
Dieldrin
Endrin
Heptachlor
Heptachlor Epoxide
Lindane
Toxaphene
Diazinon
Ethion
Malathion
Parathion
Trithion
Methyl parathion
Methyl trithion

Herbicides

2, 4D
2, 4, 5T
Silvex

Industrial Compounds

Polychlorinated Biphenyls (PCB's)

Trace elements

Arsenic
Cadmium
Chromium
Cobalt
Copper
Iron
Lead
Mercury
Manganese
Zinc

Nutrients and Other Chemical Constituents

Nitrite	Total Phosphorus	Residue
Nitrate	Carbon (inorganic)	Chemical Oxygen Demand (COD)
Kjehldahl Nitrogen	Carbon (organic)	

The February 1977 samples collected only one month after the regular quarterly sampling, were obtained because the January samples had increased significantly in coliform bacteria and nutrient concentration over the October quarterly samples. The February 1977 samples were analyzed for nutrients, bacteria, and some other constituents amenable to field determination.

WATER QUALITY

Nutrients

The average concentration of ammonia at site 1 (1.9 mg/L)a/ was about six times greater than the county-wide average for canals, whereas average concentrations at sites 2 and 3 (0.31 and 0.18 mg/L) were about the same as the county-wide average (0.30 mg/L). The average nitrite concentration was also significantly higher at site 1 (0.11 mg/L) than at sites 2 and 3 (0.08 and 0.04 mg/L), but average nitrate concentrations at the three sites were virtually the same (0.46 mg/L). The average concentration of nitrate, however, was somewhat higher than the average of 0.1 mg/L reported by Bearden (1975) for Broward County canals.

Waters polluted by sewage or other organic matter usually have high concentrations of ammonia nitrogen. Under aerobic conditions ammonia nitrogen oxidizes first to nitrite and then to nitrate. The relatively high concentration of ammonia and the relatively low concentrations of nitrite and nitrate at site 1 indicate recent organic pollution (table 1).

Site 1 also had a relatively high concentration of phosphorus, another indicator of pollution (table 2). Orthophosphate phosphorus concentrations averaged 0.81 mg/L compared with 0.26 and 0.19 mg/L at sites 2 and 3 (table 1). Orthophosphate phosphorus concentrations at sites 2 and 3 were slightly higher than those reported for other canals in Broward County, but at site 1 the concentrations were one order of magnitude higher than at the other canals (Miller, 1975).

a/ In all chemical analysis performed by the U.S. Geological Survey in which nitrogen and phosphorus species are determined, nitrogen and phosphorus are reported in elemental form as N or P.

Table 1.--Maximum, minimum, and mean concentrations of nutrients in milligrams per liter and coliform bacteria in colonies/100 milliliters in water samples collected quarterly in Old Plantation Water Control District.

Site No. 1	Maximum	Minimum	Mean
Biochemical oxygen demand (BOD)	8.8	1.7	4.9
Total organic carbon (TOC)	40	17	30
Ammonia (NH_4-N)	5.0	0.31	1.9
Nitrite (NO_2-N)	0.16	.05	0.11
Nitrate (NO_3-N)	.60	.12	.42
Orthophosphate phosphorus (P)	1.6	.13	.81
Total coliforms (TC)	4,300	146	1,350
Fecal coliforms (FC)	2,230	40	466
Fecal streptococcus (FS)	270	26	103
FC/FS ratio	-	-	4.5
Site No. 2			
Biochemical oxygen demand (BOD)	3.6	1.5	2.1
Total organic carbon (TOC)	42	18	31
Ammonia (NH_4-N)	0.79	0.02	0.31
Nitrite (NO_2-N)	.17	.01	.08
Nitrate (NO_3-N)	.76	.0	.56
Orthophosphate phosphorus (P)	.86	.07	.26
Total coliform (TC)	1,300	70	408
Fecal coliform (FC)	4,260	30	1,100
Fecal streptococcus (FS)	530	30	266
FC/FS ratio	-	-	- 4.1
Site No. 3			
Biochemical oxygen demand (BOD)	7.5	1.3	3.2
Total organic carbon (TOC)	51	24	33
Ammonia (NH_4-N)	0.44	0.03	0.18
Nitrite (NO_2-N)	.07	.01	.04
Nitrate (NO_3-N)	.62	.32	.41
Orthophosphate phosphate (P)	.55	.0	.19
Total coliforms (TC)	11,700	78	2,844
Fecal coliforms (FC)	1,310	0	579
Fecal streptococcus (FS)	1,140	20	281
FC/FS ratio	-	-	2.1

Table 2.--BOD carbon, nutrients, and bacteria data collected at sites, 1, 2, and 3, July 1976 - April 1977.

DATE	BIO-CHEM-ICAL OXYGEN DEMAND 5 DAY (MG/L)	TOTAL ORGANIC CARBON (C) (MG/L)	TOTAL IN-ORGANIC CARBON (C) (MG/L)	TOTAL CARBON (C) (MG/L)	TOTAL ORGANIC NITRO-GEN (N) (MG/L)	TOTAL AMMONIA NITRO-GEN (N) (MG/L)	TOTAL NITRITE (N) (MG/L)	TOTAL NITRATE (N) (MG/L)	TOTAL PHOS-PHORUS (P) (MG/L)	TOTAL ORTHO PHOS-PHORUS (P) (MG/L)	IMME-DIATE COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM (COL. PER 100 ML)	FECAL COLI-FORM .7UM-MF (COL./ 100 ML)	STREP-TOCOCCI (COL-ONIES PER 100 ML)	FECAL STREP-TOCOCCI KF AGAR (COL. PER 100 ML)
Site 1															
JUL . 1976 07...	6.4	17	50	67	1.5	.74	.09	.54	.71	.67	B1700	B40	--	B60	--
SEP 21...	2.3	--	--	--	--	--	--	--	--	--	B600	104	--	36	--
OCT 27...	3.2	36	50	86	1.6	1.5	.16	.50	.80	.77	B146	E2230	--	B110	--
DEC 07...	--	--	--	--	--	--	--	--	--	--	B1400	340	--	66	--
07...	1.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN . 1977 28...	3.4	31	60	91	1.4	.31	.07	.62	.15	.13	B180	--	40	--	B26
FEB 14...	2.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--
14...	--	--	--	--	--	--	--	--	--	--	660	--	75	--	B4
24...	4.9	22	53	75	1.5	5.0	.15	.53	2.0	1.6	2300	--	--	--	270
MAR 22...	--	--	--	--	--	--	--	--	--	--	172	--	--	--	52
22...	--	32	58	90	1.4	.44	.05	.19	.20	.16	--	--	--	--	--
23...	8.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--
APR 18...	8.7	40	42	82	1.6	3.5	.13	.12	1.5	1.5	4300	--	40	--	200
Site 2															
JUL . 1976 07...	3.6	18	53	71	1.5	.79	.17	.76	.90	.86	B70	B30	--	B30	--
OCT 27...	1.6	37	60	97	1.2	.09	.01	.73	.09	.07	B230	E4260	--	410	--
JAN . 1977 28...	1.5	37	63	100	.97	.30	.09	.66	.13	.11	220	--	42	--	250
FEB 24...	2.0	21	59	80	1.4	.37	.14	.66	.16	.15	220	--	--	--	530
APR 18...	1.9	42	44	86	1.7	.02	.01	.00	.18	.13	1300	--	70	--	B110
Site 3															
JUL . 1976 07...	3.8	24	50	74	1.6	.44	.05	.32	.60	.55	610	<10	--	B20	--
OCT 27...	1.7	35	65	00	1.2	.22	.07	.37	.02	.01	B680	B850	--	66	--
JAN . 1977 28...	1.8	29	65	94	.84	.03	.03	.43	.02	.00	E1150	--	156	--	B18
FEB 14...	1.7	38	58	96	1.4	.08	.02	1.8	.87	.82	183	--	83	--	B4
24...	1.3	25	63	88	1.3	.04	.03	.32	.02	.01	78	--	--	--	B1140
APR 18...	7.5	51	42	93	2.0	.19	.01	.62	.48	.40	B11700	--	B1310	--	B160

Bacteria

High concentrations of coliform bacteria in water may or may not indicate that the water is contaminated. The sources of the coliform bacteria include plants, soil, or animals. The presence of fecal coliform bacteria in water, however, strongly suggests that the water is contaminated. Because these bacteria come from the feces of warm-blooded animals, they indicate that pathogenic bacteria such as Salmonella sp. (typhoid fever) and Shigella sp. (shigellosis) may be present in the water. Inasmuch as neither total coliform nor fecal coliform indicate human contamination conclusively, the fecal streptoccocus bacterium can be used to substantiate the source of the pollution. This bacterium is also endemic in the intestine of warm-blooded animals, does not multiply in surface waters, and is rarely found in natural soil or vegetation. The fecal coliform/fecal streptoccoci ratio (FC/FS) gives an indication of probable sources of contamination (table 3). According to Geldreich and Kenner (1969) a FC/FS ratio greater than 4.0 generally indicates waste from human sources exlusively, and a ratio of 0.7 or less indicates waste from animal sources exclusively.

Total coliform bacteria at sites 1-3 exceeded the recommended limit of 2,400 colonies/100 ml as established by the Florida Department of Environmental Regulation (DER) Chap. 17-3 (table 2). Mean total coliform counts, however, exceeded the recommended limit only at site 3.

Fecal coliforms exceed the DER recommended limit of 800 colonies/100 ml at sites 1-3 in October of 1976 (table 1). However, the mean for fecal coliforms exceeded this value only at site 2.

Mean FC/FS ratios at sites 1 and 2 (4.5 and 4.1, respectively) indicate contamination of the water by human wastes. At site 3 the mean FC/FS ratio of 2.1 indicates that the waste contaminating the water is mixed, but that human wastes predominate.

Dissolved Oxygen, Biochemical Oxygen Demand, and Total Organic Carbon

The DER and U.S. Environmental Protection Agency (EPA) have established criteria for several classes of water based on constituents and characteristics of the water (table 4). For water intended to be used for recreation (Class III water), both agencies essentially recommend that Dissolved Oxygen (DO) concentration should not be depressed below 4 mg/L. Where the natural level of DO is less than 4 mg/L, no further depression is desirable. Concentrations of DO dropped below 4.0 mg/L on several occasions at site 1 (table 5). Concentration at the other two sites were generally above 4.0 mg/L.

Low levels of DO are common throughout the Broward County canal system both during high and low flows and in natural and effluent-laden canals. During low-flow periods ground water with virtually no water containing DO seeps into the canals and may account for the depressed

Table 3.--Source of contamination determined from range and magnitude of fecal coliform/fecal streptococcus ratios.

Ratio range	
0 - 0.7	Pollution derived from livestock or poultry wastes.
0.7 - 1.0	Predominately of livestock or poultry wastes in mixed pollution.
1.0 - 2.0	Grey area of uncertain intepretation.
2.0 - 4.0	Predominately of human wastes in mixed pollution.
4.0 - above	Pollution derived from human wastes.

Table 4.--Florida Department of Environmental Regulation's classification and criteria for surface waters. (milligrams per liter except where noted).

The Florida Department of Environmental Regulation has established five classes for Florida's surface waters. The waters are classified according to their usage as follows:

Class I - Public water supplies
Class II - Shellfish harvesting
Class III - Recreation - Propogation and management of fish and wildlife.
Class IV - Agricultural and industrial water supply
Class V - Navigation, utility and industrial use.

Criteria for the different classes vary with the most stringent criteria for Class I, then Class II, etc. Because most of Florida's waters are used for recreation, fish, and wildlife, Class III was chosen for use in this report.

Criteria for All Classes (I - V):

Characteristic	Value Not to be	Mean of 3 sites		
CHEMICAL	Exceeded	No. 1	No. 2	No. 3
Arsenic	0.05	0.002	0.002	0.002
Chloride (freshwater)	250	105	107	115
Chromium	0.05	0.001	0.001	0.001
Copper	.5	.006	.004	.004
Cyanide	.00	-	-	-
Fluoride	10	.4	.35	.35
Iron	0.30	.127	.125	.170
Lead	.05	.019	.02	.014
Oil and Grease	15	-	-	-
Phenol	0.001	-	-	-
Dissolved solids 1/	500	456	465	494
Zinc	1	0.02	0.015	0.015

1/ Dissolved solids not to exceed 500 mg/L as a monthly average or 1000 mg/L at any time.

Table 4.--Florida Department of Environmental Regulation's criteria for surface waters (Continued). (milligrams per liter except where noted).

Additonal Criteria for Class III

	Characteristic	Value Not to be Exceeded	Mean of 3 sites No. 1	No. 2	No. 3
	pH (units)	6.0-8.5	7.7	7.9	7.9
1/	Temperature (°F)	93	69.6	65	67.8
	Turbidity (Jackson Turbidity Units)	50	5.3	9.2	5.0
	Specific conductance (micromhos per centimeter)	500	711	690	715
	Dissolved oxygen (DO)	2/	4.0	6.9	7.1
	Biochemical oxygen demand (BOD)	3/	4.9	2.1	3.2
	Toxic substances	4/	-	-	-
	Deleterious	5/	-	-	-

1/ Temperature shall be increased less than 10 percent from prevailing background temperature after reasonable mixing with 95°F (34°C) temperature maximum.

2/ Not be depressed below 4 mg/L.

3/ Not to cause DO to be depressed below 4 mg/L.

4/ Toxic substances - free from substances attributable to municipal, industrial, agricultural or other discharges in concentrations or combinations which are toxic and harmful to humans, animal, or aquatic life.

5/ Deleterious - free from materials attributable to municipal, industrial, agricultural, or other discharges producing color, odor, or other conditions in such a degree as to create nuisance.

Table 5.--Chemical analysis of water collected quarterly and semi-annually from sites 1, 2, and 3, July 1976 - April 1977.

Site 1

DATE	SAMPLING DEPTH (FT)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	ALKALINITY AS CACO3 (MG/L)	CARBONATE (CO3) (MG/L)	BICARBONATE (HCO3) (MG/L)	HARDNESS (CA,MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	DISSOLVED CALCIUM (CA) (MG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)
JUL , 1976																				
07...	--	29.4	5.1	8.3	560	7.6	190	--	232	--	--	8	--	--	--	--	--	--	--	--
OCT																				
27...	.5	24.5	3.1	5.2	650	7.9	213	0	260	250	33	7	10	86	7.3	46	3.4	75	22	411
27...	3.0	23.0	2.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
27...	6.0	23.5	2.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN , 1977																				
28...	.5	15.5	6.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	1.0	15.5	6.0	11	730	7.6	226	0	276	--	--	2	--	--	--	--	--	--	--	--
28...	3.0	15.5	5.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	6.0	15.2	4.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	9.0	15.2	4.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FEB																				
24...	.5	19.2	4.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	1.0	19.5	3.9	16	680	7.4	200	--	244	--	--	6	--	--	--	--	--	--	--	--
24...	3.0	18.5	3.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	6.0	18.2	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAR																				
22...	1.0	28.0	5.5	4.9	930	8.0	250	0	304	260	10	4	50	75	17	85	3.8	130	15	533
APR																				
18...	.5	23.0	3.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	1.0	24.7	3.2	8.2	715	7.6	167	0	204	210	43	5	40	64	11	64	5.5	110	23	423
18...	3.0	23.5	3.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	6.0	24.0	3.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Site 1

DATE	DISSOLVED SOLIDS (SUM OF CONSTITUENTS) (MG/L)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED STRONTIUM (SR) (UG/L)	DISSOLVED FLUORIDE (F) (MG/L)	TOTAL ALUMINUM (AL) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	TOTAL BORON (B) (UG/L)	TOTAL CADMIUM (CD) (UG/L)	TOTAL CHROMIUM (CR) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MANGANESE (MN) (UG/L)	TOTAL LITHIUM (LI) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL MOLYBDENUM (MO) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL VANADIUM (V) (UG/L)	TOTAL ZINC (ZN) (UG/L)
JUL , 1976																				
07...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OCT																				
27...	378	8.3	950	.6	50	2	200	1	<10	0	1	110	21	10	10	.0	2	4	10	30
27...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
27...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN , 1977																				
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FEB																				
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
MAR																				
22...	485	8.0	1500	.3	90	1	130	0	10	0	7	90	15	0	10	1.0	1	2	14	20
APR																				
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	383	4.1	1000	.3	160	2	210	0	<10	0	9	180	20	10	0	.0	0	3	.0	20
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 5.--Chemical analysis of water collected quarterly and semi-annually from sites 1, 2, and 3, July 1976 - April 1977 (Continued).

Site 2

DATE	SAMPLING DEPTH (FT)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	ALKALINITY AS CACO3 (MG/L)	CARBONATE (CO3) (MG/L)	BICARBONATE (HCO3) (MG/L)	HARDNESS (CA+MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	DISSOLVED CALCIUM (CA) (MG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)
JUL - 1976																				
07...	--	28.0	6.0	13	560	7.5	207	--	252	--	--	7	--	--	--	--	--	--	--	--
OCT																				
27...	.5	23.0	5.1	6.2	720	7.9	253	0	308	270	21	20	30	91	1	60	2.4	93	7.1	470
27...	3.0	23.0	4.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN - 1977																				
28...	.5	15.5	7.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	1.0	15.5	7.5	4.7	760	8.0	243	0	296	--	--	4	--	--	--	--	--	--	--	--
28...	3.0	15.3	7.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FEB																				
24...	.5	18.0	7.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	1.0	14.0	7.0	11	670	7.6	230	--	280	--	--	7	--	--	--	--	--	--	--	--
24...	3.0	18.0	6.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	4.0	18.0	7.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
APR																				
18...	.5	24.5	6.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	1.0	25.5	8.4	1.9	740	8.3	197	0	240	220	23	6	40	63	15	75	3.8	120	15	460
18...	3.0	24.0	6.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Site 2

DATE	DISSOLVED SOLIDS (SUM OF CONSTITUENTS) (MG/L)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED STRONTIUM (SR) (UG/L)	DISSOLVED FLUORIDE (F) (MG/L)	TOTAL ALUMINUM (AL) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	TOTAL BORON (B) (UG/L)	TOTAL CADMIUM (CD) (UG/L)	TOTAL CHROMIUM (CR) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MANGANESE (MN) (UG/L)	TOTAL LITHIUM (LI) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL MOLYBDENUM (MO) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL VANADIUM (V) (UG/L)	TOTAL ZINC (ZN) (UG/L)
JUL - 1976																				
07...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OCT																				
27...	427	8.8	1100	.4	100	1	150	0	<10	0	6	130	17	10	10	.2	2	4	10	20
27...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN - 1977																				
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FEB																				
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
APR																				
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	413	1.0	1500	.3	220	2	110	2	<10	0	2	120	23	10	0	.0	0	5	.0	10
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 5.--Chemical analysis of water collected quarterly and semi-annually from sites 1, 2, and 3, July 1976 - April 1977 (Continued).

Site 3

DATE	SAMPLING DEPTH (FT)	TEMPERATURE (DEG C)	DISSOLVED OXYGEN (MG/L)	CARBON DIOXIDE (CO2) (MG/L)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	ALKALINITY AS CACO3 (MG/L)	CARBONATE (CO3) (MG/L)	BICARBONATE (HCO3) (MG/L)	HARDNESS (CA+MG) (MG/L)	NONCARBONATE HARDNESS (MG/L)	TURBIDITY (JTU)	COLOR (PLATINUM-COBALT UNITS)	DISSOLVED CALCIUM (CA) (MG/L)	DISSOLVED MAGNESIUM (MG) (MG/L)	DISSOLVED SODIUM (NA) (MG/L)	DISSOLVED POTASSIUM (K) (MG/L)	DISSOLVED CHLORIDE (CL) (MG/L)	DISSOLVED SULFATE (SO4) (MG/L)	DISSOLVED SOLIDS (RESIDUE AT 180 C) (MG/L)
JUL + 1976																				
07...	--	29.2	4.8	10	550	7.6	207	--	252	--	--	8	--	--	--	--	--	--	--	--
OCT																				
27...	.5	22.5	4.8	8.6	750	7.8	279	0	340	270	0	5	30	88	13	65	1.9	100	4.9	491
27...	3.0	23.5	4.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
27...	5.0	23.5	3.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN + 1977																				
28...	.5	16.0	7.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	1.0	16.0	6.8	6.0	760	7.9	243	0	296	--	--	3	--	--	--	--	--	--	--	--
28...	3.0	15.5	6.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	6.0	15.2	5.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FEB																				
14...	1.0	18.0	8.0	--	669	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	.5	19.0	7.7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	1.0	19.0	7.8	5.9	740	7.9	239	--	292	--	--	3	--	--	--	--	--	--	--	--
24...	3.0	18.0	7.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	6.0	18.0	6.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
APR																				
18...	.5	25.5	11.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	1.0	25.8	10.5	1.3	775	8.5	217	12	240	250	33	6	40	71	17	80	4.5	130	18	496
18...	3.0	25.0	10.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	5.0	24.8	8.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Site 3

DATE	DISSOLVED SOLIDS (SUM OF CONSTITUENTS) (MG/L)	DISSOLVED SILICA (SIO2) (MG/L)	DISSOLVED STRONTIUM (SR) (UG/L)	DISSOLVED FLUORIDE (F) (MG/L)	TOTAL ALUMINUM (AL) (UG/L)	TOTAL ARSENIC (AS) (UG/L)	TOTAL BORON (B) (UG/L)	TOTAL CADMIUM (CD) (UG/L)	TOTAL CHROMIUM (CR) (UG/L)	TOTAL COBALT (CO) (UG/L)	TOTAL COPPER (CU) (UG/L)	TOTAL IRON (FE) (UG/L)	TOTAL LEAD (PB) (UG/L)	TOTAL MANGANESE (MN) (UG/L)	TOTAL LITHIUM (LI) (UG/L)	TOTAL MERCURY (HG) (UG/L)	TOTAL MOLYBDENUM (MO) (UG/L)	TOTAL NICKEL (NI) (UG/L)	TOTAL VANADIUM (V) (UG/L)	TOTAL ZINC (ZN) (UG/L)
JUL + 1976																				
07...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OCT																				
27...	452	10	1100	.4	50	1	130	0	30	0	4	250	18	10	10	.3	2	2	14	20
27...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
27...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
JAN + 1977																				
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
28...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
FEB																				
14...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
24...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
APR																				
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	453	.7	1500	.3	140	2	150	2	<10	0	3	90	9	10	0	.0	0	4	2.0	10
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
18...	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

levels of DO. Atmospheric reaeration is also low during these periods, because of laminar flow in deep, straight, well-protected channels. However, phytoplankton and submersed plant communities often have an opportunity to establish themselves, and these may increase the DO concentration at least during the day. During high-flow periods, phytoplankton is flushed from the canals and contributes little DO. Water from the Everglades Conservation areas as well as storm-water runoff from local low lands and farm areas introduces water containing large amounts of oxygen consuming organic material. These waters may utilize the remaining DO.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen consumed by living organisms in utilizing the organic matter present in the water. A high BOD lowers the DO levels in water. The DER requires that BOD concentration in Class III waters (table 4) not depress D.O. below 4 mg/L. In the low-velocity canals of Broward County a BOD of 5 mg/L might be enough to remove all the DO and create anaerobic conditions (Bearden, 1975).

Of the three sites, only site 1 had a mean BOD value (4.9 mg/L) close to this 5 mg/L value (table 2).

Total organic carbon is an estimate of the amount of organic matter in water and can be an indication of organic pollution. Water in Broward County canals generally had high concentrations of TOC due to the organic soils in the area. Background levels in the canals in the county are generally about 20 mg/L. At sites 1-3 the mean concentrations were about 30 mg/L, and values ranged from 17 to 51 mg/L. The high concentrations occurred during periods of high flow, when surface runoff was greatest.

Hardness and Dissolved Solids

Water in which calcium carbonate exceeds 180 mg/L is considered very hard (Rainwater and Thatcher, 1960). This value was exceeded at all three sites in the OPWCD except during April 1977 at site 1. The hard water is a result of large quantities of limestone being dissolved into the hydrologic system.

Dissolved solid concentration is an overall indicator of the total amount of material dissolved in water. In Broward's freshwater canals, dissolved solid concentrations range from 256 mg/L to 610 mg/L and average about 485 mg/L (Bearden, 1975). At the 3 OPWCD sites, the mean dissolved solids concentration was 472 mg/L. One sample from site 1, collected March 1977 had a dissolved solid concentration of 533 mg/L, exceeding the EPA and DER standard of 500 mg/L by about 7 percent.

Trace Elements

Concentrations of trace elements in water collected from the three sites during the first year of the study did not exceed the Florida criteria for surface water (table 4).

Mean concentrations of iron (148 ug/L) and zinc (22 ug/L) at the three sites were less than the mean for the county of 280 and 113 ug/L respectively (Bearden, 1975). The mean lead concentration was the same as the county mean, 18 ug/L.

Concentrations of trace elements tended to be higher during October (the end of the wet season) than during April (near the end of the dry season). The higher concentrations were probably associated with storm runoff. At sites 1-3, aluminum averaged 83 mg/L in October 1976 compared with an average of 186 ug/L in April 1977. The concentrations of copper at site 1 increased from 1 ug/L to 9 ug/L over the same period (table 5).

Field Measurements of Water Quality Over 24-Hours (diel)

The concentrations of dissolved oxygen (table 6) were lowest during March, 1977 (1.8-3.9 mg/L at 3-ft depth), and highest during June 1977 (2.5-8.2 mg/L at 3-ft depth). This differs from most other areas in Broward County where the DO normally is highest during the dry season, when most of the canal flow is surface water from the conservation areas and lowest during the wet season, when most of the flow is ground water with low DO. Figure 3 shows the percentage of saturation of DO at site 1 over a 24-hour period. Diel measurements of DO, temperature, pH, and alkalinity were made quarterly at site 1. Fluctuations in DO is a result of the dynamic balance of production (photosynthesis) and decomposition (respiration) of organic matter.

Areal Nutrient and Bacteria Reconnaissance

On June 14, 1977, 14 sites within the OPWCD (fig. 2) were sampled for macronutrients (table 7) and bacteria (table 8).

Bacteria were most numerous at site 4, East Holloway Canal, where fecal coliform (FC) exceeded 1 million colonies per 100 ml and fecal streptococci (FS) numbered 83,000 colonies per 100 ml. The FC/FS ratio was 16.9. The high counts at site 4 are possibly attributable to effluent from a sewage treatment plant some 2,000 ft upstream. The numbers of bacteria decreased markedly downstream--at site 5, about 50 ft downstream of site 4, fecal coliform were 700,000 colonies per 100 ml and at site 6, about 3,000 ft downstream of the plant, they were 105,000 colonies per 100 ml. The FC/FS ratio ranged from 16.9 to 125 along the canal and indicate possible contamination from the sewage treatment plant.

Table 6.--Extremes of dissolved oxygen concentration over a 24-hour (diel) period at site no. 1. (concentrations in milligrams per liter).

Date	Depth	Maximum	Minimum
September 1976	Surface	6.3	3.9
	3'	5.3	2.1
	Bottom	3.7	0.9
December 1976	Surface	6.8	5.2
	3'	5.1	3.1
	Bottom	5.0	2.5
March 1977	Surface	7.8	2.0
	3'	3.9	1.8
	Bottom	2.6	0.5
June 1977	Surface	9.3	3.0
	3'	8.2	2.5
	Bottom	1.9	0.4

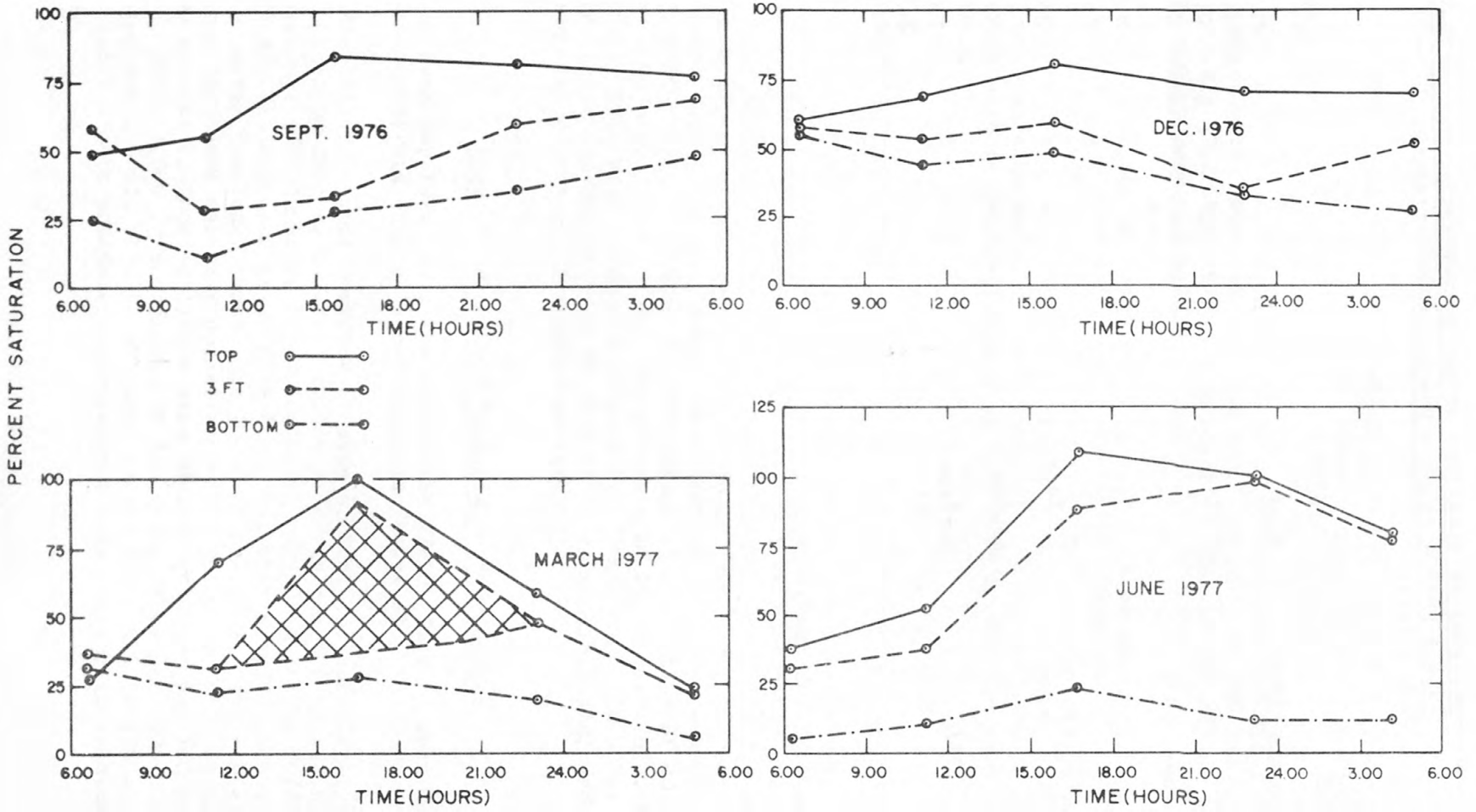

Figure 3.--Percentage saturation of dissolved oxygen in water from East Holloway Canal at site 1.

Table 7.--Concentrations of nitrogen (as N) and phosphorus (as P) at 14 sites, June 14, 1977. (All values in mg/L)

Site	Site description	Total organic nitrogen	Ammonia (NH_4+)	Nitrite (NH_2-)	Nitrate (NO_3-)	Ortho phos-phorus	Total phos-phorus
1	E. Holloway Canal at W. Broward Blvd.	1.1	1.2	0.04	0.1	0.55	0.61
2	1L-2W Canal at N.W. 70th Ave.	1.1	0.07	.03	0.06	.02	.07
3	Canal 2 at W. Broward Blvd.	1.9	.12	.05	3.8	.71	.86
4	E. Holloway Canal North of Plantation Canal	2.0	10.0	.01	0.0	3.5	3.5
5	Plantation Canal above Pumphouse at N.W. 65th Ave.	1.0	3.2	.02	.04	1.2	1.2
6	E. Holloway Canal South of Plantation Canal	1.0	3.3	.02	.03	1.3	1.6
7	Canal 3 above Pump-house at NNRC+	1.4	0.02	.01	.01	0.07	0.09
8	Canal 2 north of Pumphouse at NNRC	1.3	0.01	.01	.0	.06	.08
9	E. Holloway Canal above Pumphouse at NNRC	0.8	2.5	.07	.13	.84	.84
10	Canal 2 north of Gulfstream Utilities Plant	1.4	0.12	.05	.4	.02	.06
11	E. Holloway Canal North of Secondary Lat. Canal near Pumphouse at NNRC	1.3	1.7	.07	.19	.64	.70
12	1L-2W Canal at University Dr.	1.3	0.16	0.04	0.26	0.02	0.05
13	E. Holloway Canal at 16th St. Bridge	0.91	.56	.04	.15	.28	.32
14	2L-3E Canal at University Dr.	.88	.31	.06	.46	.04	.06

+NNRC - North New River Canal

Table 8.--Coliform and streptococci bacteria at 14 sites, June 14, 1977
(Numbers are colonies per 100 mL)

Site	Site Description	Total Coliforms	Fecal Coliforms	Fecal Streptococci	Fecal Coliforms/ Fecal Streptococci
1	E. Holloway Canal at W. Broward Blvd.	500	6,300	140	45
2	1L-2W Canal at N.W. 70th Ave.	2,700	6,200	240	25.8
3	Canal 2 at W. Broward Blvd.	560	1,400	160	8.8
4	E. Holloway Canal, North of Plantation Canal	*TNTC	1,400,000	83,000	16.9
5	Plantation Canal above Pumphouse at N.W. 65th Ave.	TNTC	700,000	5,600	125.0
6	E. Holloway Canal South of Plantation Canal	TNTC	105,000	5,800	18.1
7	Canal 3 above pump-House at NNRC+	230	2,400	160	15.0
8	Canal 2 north of Pumphouse at NNRC	1,600	40	20	2.0
9	E. Holloway Canal Above pumphouse at NNRC	130	4,900	230	21.3
10	Canal 2 north of Gulf-Stream Utilities Plant	240	250	60	4.2
11	E. Holloway Canal north of secondary lat. Canal Nr pumphouse at NNRC	0	0	0	-
12	1L-2W Canal at University Drive	210	520	80	6.5
13	E. Holloway Canal at 16th St. Bridge	340	1,170	200	5.8
14	2L-3E Canal at University Dr.	430	1,000	290	3.5

*TNTC - Too numerous to count.

+NNRC - North New River Canal.

Concentrations of ammonia nitrogen and phosphorus were also highest at site 4 (10.0 mg/L and 3.5 mg/L) and decreased downstream in the East Holloway Canal (table 7). At sites 5 and 6 concentrations of ammonia were about 3.0 mg/L and concentrations of phosphorus were slightly above 1.0 mg/L. Concentrations of these nutrients were generally higher in the East Holloway Canal (site 1, 4, 5, 6, 9, 11) than at most other sites. Effluent from sewage-treatment plants upstream of sites 4 and 11 may contribute to the high concentrations of nutrients in the East Holloway Canal.

BOTTOM SEDIMENTS

The low velocity of flow in the canals of OPWCD is conducive to the deposition of sediment on the channel bottom. These sediments are generally organic and come primarily from vegetation.

Nearly 40 percent of the area within the OPWCD is agricultural (fig. 4) and consequently chemicals associated with agricultural activities can be expected to enter the canals. Pesticides and trace elements are known to be absorbed in bottom sediments and accumulate within canals.

An interim alert system has been established by the U.S. Geological Survey to flag values for selected water quality constituents which exceed specific limits. Selection of constituents to be included in the alert system was based on one or more of the following: (a) a maximum contaminant level (MCL) has been established under the Safe Drinking Water Act, (b) maximum levels for several water uses have been recommended by the Environmental Protection Agency in "Quality Criteria for Water," 1976, (c) the constituent is included in the 65 classes of toxic substances (129 compounds) identified by EPA pursuant to Section 307 of Public Law 92-500, or (d) the constituent is included in state water-quality standards or criteria. The alert levels that are applicable to this reconnaissance of bottom sediments are given in tables 7 and 8.

Pesticides

Chlorinated hydrocarbon insecticides were found in bottom sediment at all three sampling sites (tables 9 and 10). The highest concentrations were at site 3. The insecticide concentrations found at sites 1 and 2 fall within ranges often found in similar agricultural areas of south Florida (Mattraw, 1975). No specific criteria or standards have yet been established for pesticides in sediments by any regulatory agency.

Trace Elements and Nutrients

Concentrations of trace elements, nutrients and other parameters in bottom sediments are given in Table 10. Concentrations of trace elements in bottom sediment at sites 1-3 were below the USGS alert levels (table 11).

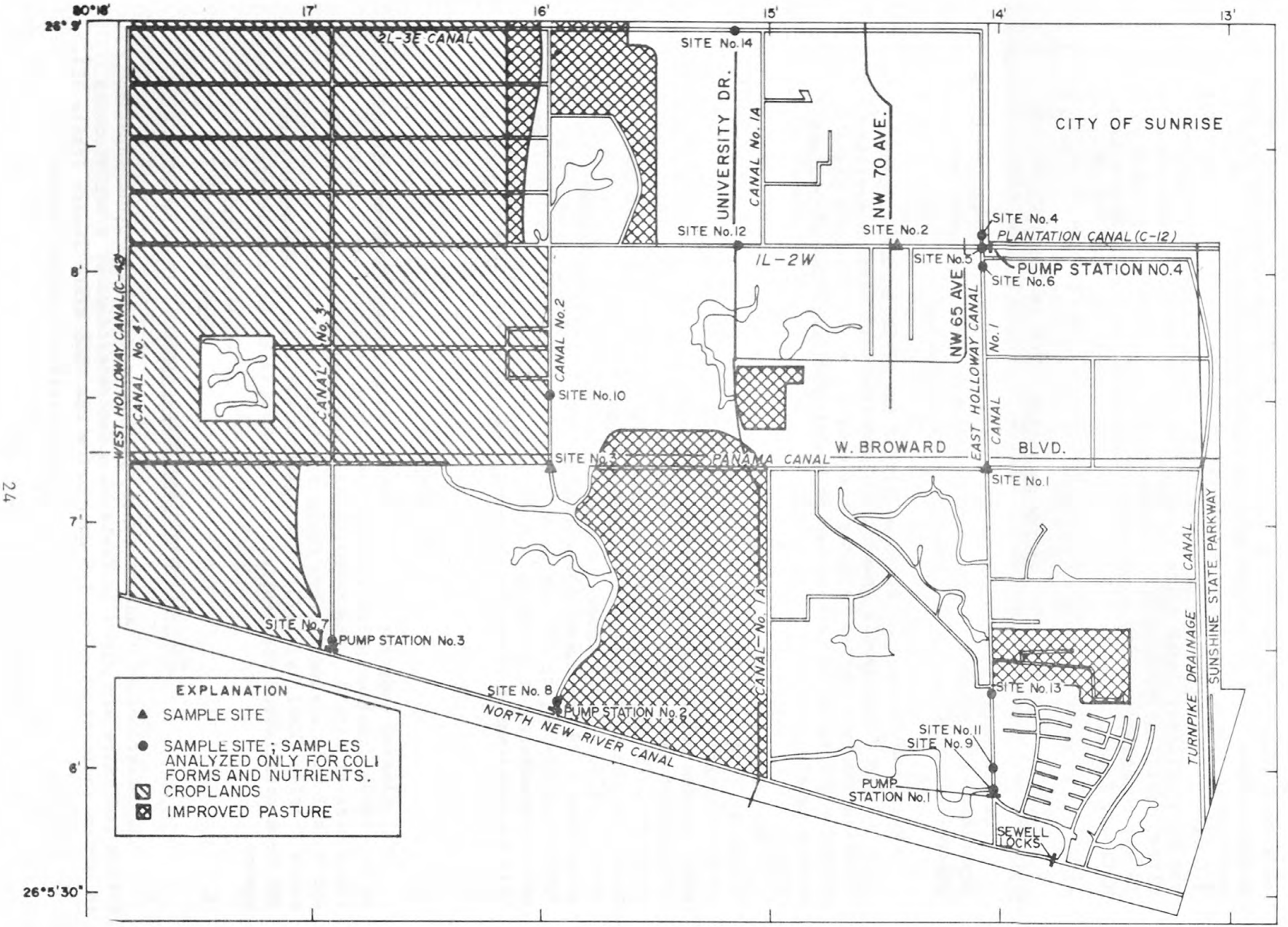

Figure 4.--Agricultural land use at Old Plantation Water Control District.

Table 9.--Pesticides in bottom sediments at three sites in the Old Plantation Water Control District, April 1977.
(in micrograms per kilogram)

Sites	Chlordane	DDD	DDE	DDT	Dieldrin	PCB
1	0	43	55	0	0	91
2	39	11	25	0	5.3	0
3	91	330	130	24	1.1	0
USGS Alert Level	20	-	-	20	20	20

Table 10.--Chemical analysis of bottom sediment samples collected annually at sites 1, 2, and 3.

DATE	ALDRIN IN BOTTOM MATERIAL (UG/KG)	CHLORDANE IN BOTTOM MATERIAL (UG/KG)	DDD IN BOTTOM MATERIAL (UG/KG)	DDE IN BOTTOM MATERIAL (UG/KG)	DDT IN BOTTOM MATERIAL (UG/KG)	DIELDRIN IN BOTTOM MATERIAL (UG/KG)	ENDRIN IN BOTTOM MATERIAL (UG/KG)	HEPTACHLOR IN BOTTOM MATERIAL (UG/KG)	HEPTACHLOR EPOXIDE IN BOTTOM MATERIAL (UG/KG)	LINDANE IN BOTTOM MATERIAL (UG/KG)	METHYL TRITHION IN BOTTOM MATERIAL (UG/KG)	TRITHION IN BOTTOM MATERIAL (UG/G)	TOTAL ARSENIC IN BOTTOM MATERIAL (UG/G)	TOTAL CADMIUM IN BOTTOM MATERIAL (UG/G)	TOTAL CHROMIUM IN BOTTOM MATERIAL (UG/G)	TOTAL COBALT IN BOTTOM MATERIAL (UG/G)	TOTAL COPPER IN BOTTOM MATERIAL (UG/G)	TOTAL IRON IN BOTTOM MATERIAL (UG/G)	TOTAL LEAD IN BOTTOM MATERIAL (UG/G)	TOTAL MANGANESE IN BOTTOM MATERIAL (UG/G)
									Site 1												
APR , 1977 18...	.0	0	43	55	.0	.0	.0	.0	.0	.0	.0	.0	3	<10	10	<10	<10	1900	<10	<10
									Site 2												
APR , 1977 18...	.0	39	11	25	.0	5.3	.0	.0	.0	.0	.0	.0	2	<10	<10	<10	<10	1700	<10	<10
									Site 3												
APR , 1977 18...	.0	91	330	130	24	1.1	.0	.0	.0	.0	.0	.0	6	<10	<10	<10	<10	1200	<10	<10

DATE	TOXAPHENE IN BOTTOM MATERIAL (UG/KG)	PCB IN BOTTOM MATERIAL (UG/KG)	2,4-D IN BOTTOM MATERIAL (UG/KG)	2,4,5-T IN BOTTOM MATERIAL (UG/KG)	SILVEX IN BOTTOM MATERIAL (UG/KG)	DIAZINON IN BOTTOM MATERIAL (UG/KG)	ETHION IN BOTTOM MATERIAL (UG/KG)	MALATHION IN BOTTOM MATERIAL (UG/KG)	METHYL PARATHION IN BOTTOM MATERIAL (UG/KG)	PARATHION IN BOTTOM MATERIAL (UG/KG)	TOTAL MERCURY IN BOTTOM MATERIAL (UG/G)	TOTAL ZINC IN BOTTOM MATERIAL (UG/G)	LOSS ON IGNITION IN BOTTOM MATERIAL (MG/KG)	INORGANIC CARBON IN BOTTOM MATERIAL (G/KG)	ORGANIC CARBON IN BOTTOM MATERIAL (C) (G/KG)	COD IN BOTTOM MATERIAL (MG/KG)	TOTAL KJEL. NITROGEN IN BOTTOM MAT. (MG/KG)	TOTAL NITRITE PLUS NITRATE IN BOT. MAT. (MG/KG)	TOTAL PHOSPHORUS IN BOTTOM MATERIAL (MG/KG)
									Site 1										
APR , 1977 18...	0	91	0	0	0	.0	.0	.0	.0	.0	.0	10	46900	21	16	44000	6300	2.9	450
									Site 2										
APR , 1977 18...	0	0	0	0	0	.0	.0	.0	.0	.0	.0	30	53400	25	15	51000	6400	2.5	620
									Site 3										
APR , 1977 18...	0	0	0	0	0	.0	.0	.0	.0	.0	.0	<10	70600	21	18	46000	5400	2.9	530

Table 11.--Trace elements in bottom sediments at three sites in the Old Plantation Water Control District, April, 1977

(values in micrograms per gram)

Trace Elements	Site 1	Site 2	Site 3	Alert Level
Arsenic	3	2	6	200
Cadmium	10	10	10	20
Chromium	10	10	10	200
Copper	10	10	10	2,000
Lead	10	10	10	500
Mercury	0	0	0	20
Zinc	10	30	10	5,000

SUMMARY AND CONCLUSIONS

As part of the cooperative agreement between the OPWCD and the U.S. Geological Survey, a sampling network was established to provide a data base for sampling the water quality of surface waters within the jurisdiction of OPWCD. This report summarizes the data collected between July 1976 and June 1977.

The report points out several areas of concern. Of greatest concern are the high bacterial and nutrient concentrations noted on June 14, 1977 at site 4, East Holloway Canal, north of Plantation Canal. The generally high FC/FS ratios in water from sites along East Holloway Canal indicate possible contamination from the effluent of nearby sewage-treatment plants. The effects of the effluent were also evident at three sites; 4, 5, and 6, where concentrations of nutrients and bacteria were higher than the average for Broward County canals and where total coliform bacteria exceeded state standards of 2400 colonies per 100 milliliters.

Also of concern are the relatively high levels of the chlorinated hydrocarbon insecticides, dieldrin, DDD, DDE, DDT, and chlordane, found in bottom sediments at site 3. Concentrations of these insecticides were lower at sites 1 and 2. The industrial chemical, PCB (polychlorinated biphenyl) was detected at site 1 at a concentration of 91 ug/kg.

Because several areas of concern were determined during the first year of this program, it may be desirable to reorient and expand the program toward further definition of these constituents in the future. Data over a larger area is needed in order that more extensive interpretive conclusions can be made.

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