Technical Publication SJ 88-5

An Investigation of the St. Johns Water Control District: Reservoir Water Quality and Farm Practices

ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

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An Investigation of the St. Johns Water Control District: Reservoir Water Quality and Farm Practices

By

Carol Fall

and

John Hendrickson

Department of Water Resources
St. Johns River Water Management District
P.O. Box 1429
Palatka, Florida 32078

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TABLE OF CONTENTS

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LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The St. Johns Water Control District reservoir provides irrigation water to, and stores excess water from, approximately 25,000 acres of citrus and pasture. Monthly water samples were collected from November 1984 to November 1985 at 5 locations, including the reservoir inlet and outlet. Statistically significant differences were observed between mean annual concentrations of nitrate-nitrite, ammonia and orthophosphate at the inlet and outlet. Mean annual concentrations of nitrate-nitrite, ammonia and orthophosphate were 80 percent, 62 percent and 72 percent less, respectively, at the reservoir outlet compared to the inlet. No significant differences were noted for total Kjeldahl nitrogen, total phosphorus or chloride concentrations.

Pump discharges to the reservoir from agricultural operations had relatively good water quality, averaging 0.09 mg/l total phosphorus, 0.14 mg/l nitrate-nitrite nitrogen, 1.19 mg/l total Kjeldahl nitrogen, 4.6 mg/l suspended solids and 5.4 mg/l dissolved oxygen. No detectable pesticide levels were measured at the pumps or in the reservoir. Discharges from the reservoir complied with Chapter 17-3 Florida Administrative Code (F.A.C.) Water Quality Standards for Class I water bodies.

INTRODUCTION

PURPOSE

In 1984, the St. Johns River Water Management District began a study to document water quality in the St. Johns Water Control District reservoir. The purpose of the study was twofold: to evaluate improvements in agricultural runoff quality provided by a large vegetated reservoir and to provide information which would aid the Water Management District in operating similar reservoirs proposed for construction under the Upper St. Johns River Basin Surface Water Management Plan. The innovative design and operation of the Water Control District provided a singular opportunity to observe the functioning of a long-established, multi-purpose reservoir.

BACKGROUND

The St. Johns Water Control District (SJWCD) is located in Indian River County, Florida, between Highway 60 and the county line, west of the Indian River Farms Water Control District (Figure 1). This local drainage district, covering 27,720 acres, was organized in 1962 pursuant to Chapter 298, Florida Statutes. Following court approval of a plan of reclamation, landowners within the SJWCD were taxed to construct and maintain a water management system. Despite the similarities in name and function, the St. Johns River Water Management District (SJRWMD) and St. Johns Water Control District (SJWCD) are distinct entities.

The SJWCD drainage works were constructed in 1965-1966. The primary features included a dike, north/south lateral canals, an east/west floodway, pumps, and a 1760 acre reservoir (Figure 2). Fields are irrigated on a rotational basis through gravity discharges from the elevated floodway. Large pumps lift water from the fields and north/south laterals for storage in the floodway. The reservoir stores excess water from the floodway and provides a source of irrigation water during dry conditions. Major discharges from the reservoir to the adjacent marsh occur infrequently and only when reservoir stages exceed approximately 26.5 ft. msl.

The entire Water Control District is located within the 100 year floodplain of the St. Johns River (SJRWMD, 1980). Approximately 5800 acres in the western portion were originally

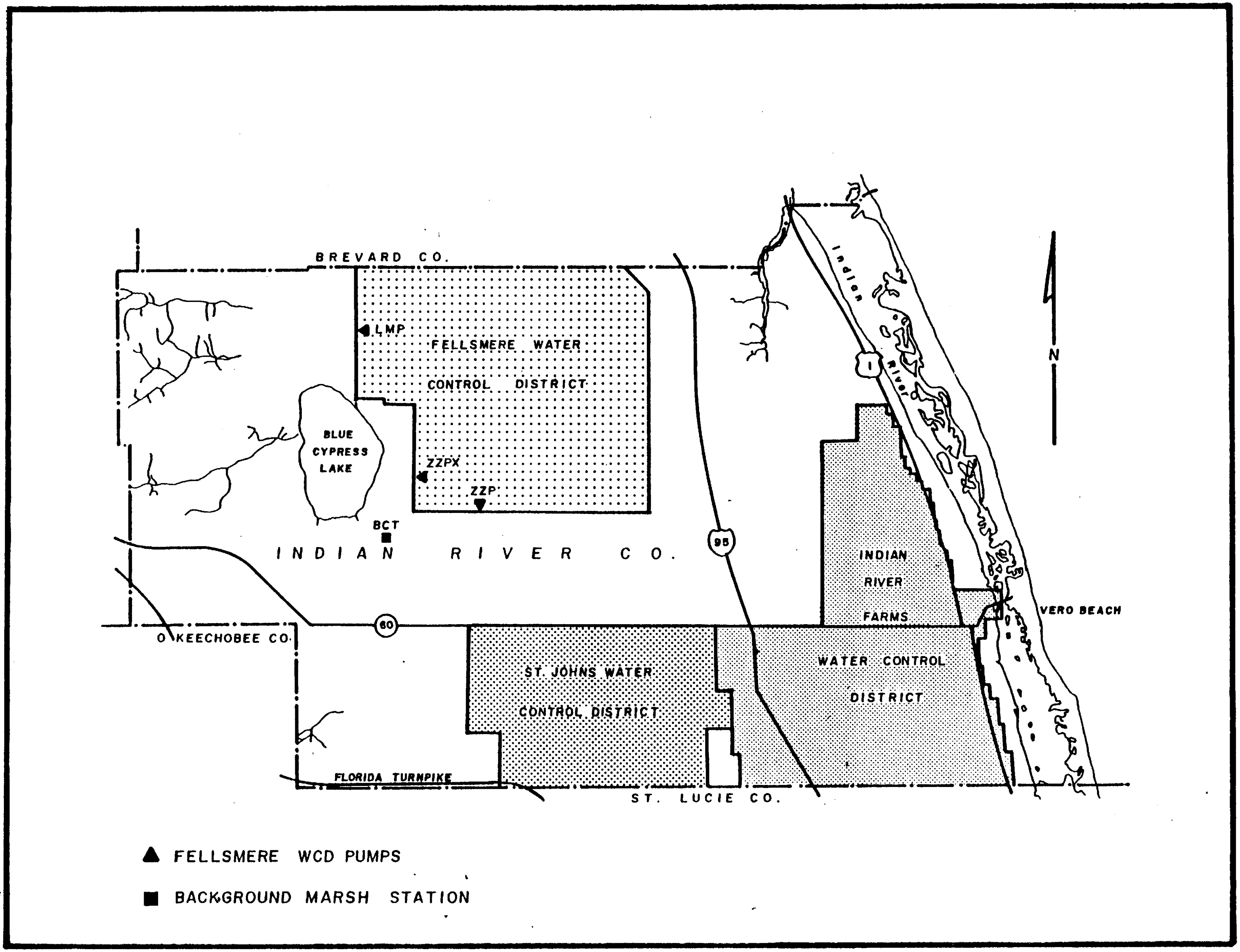
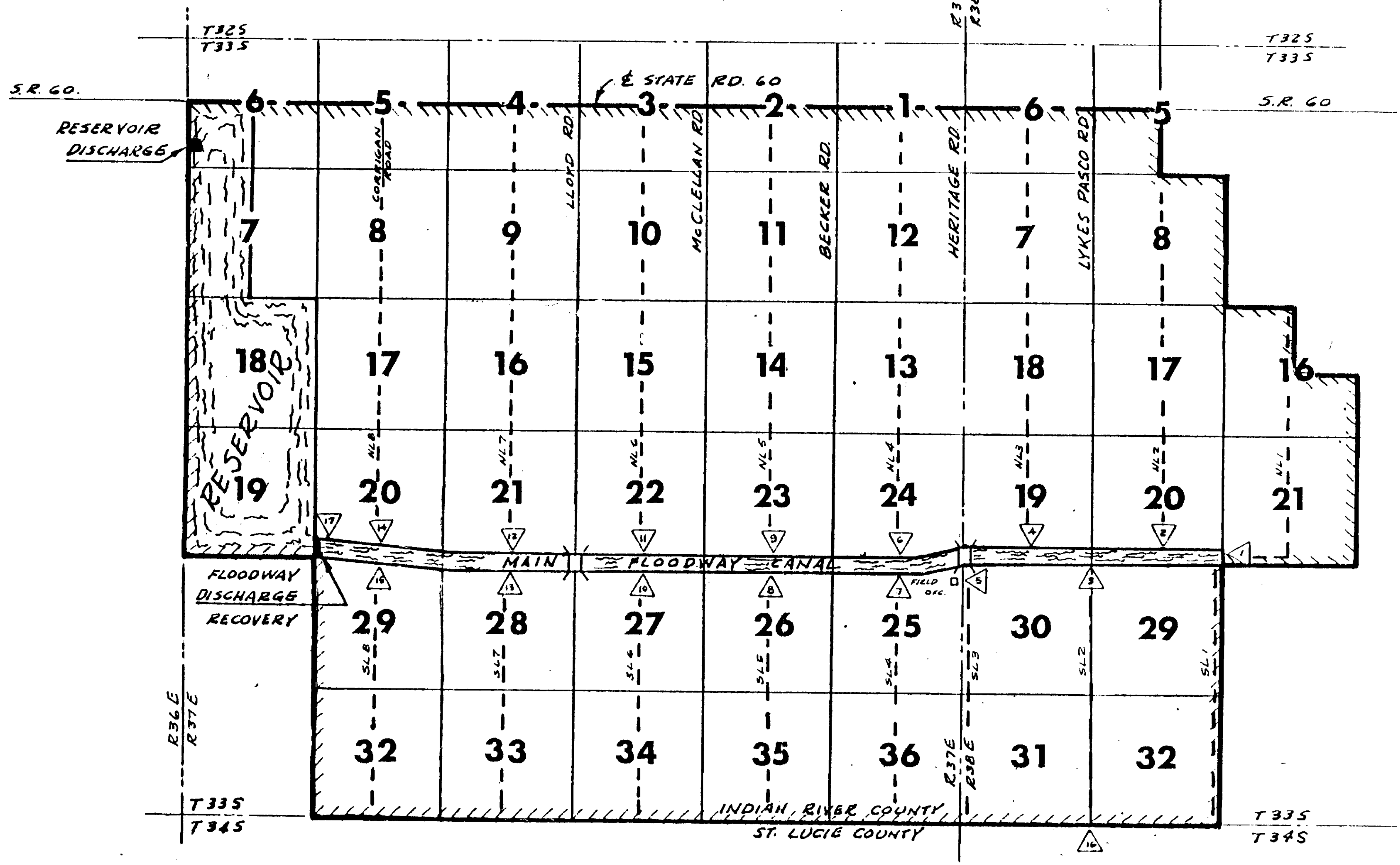


Figure 1
Location Map for St. Johns Water Control District



From: Lloyd and Associates, 1965

Figure 2

PUMP STATION

MAP OF THE

ST. JOHN'S WATER CONTROL DISTRICT

INDIAN RIVER COUNTY, FLA.

part of the annual floodplain and are underlain by highly organic Gator, Canova and Terra Ceia muck soils (Figure 3). Poorly drained fine sands (Riviera, Pineda, Winder and Wabasso series) dominate the eastern areas (Wettstein et al., 1987). The permeability of these fine sands is limited by a clay layer (>25% clay) which typically occurs at a depth of 23-48 inches. Prior to drainage, the depth to the water table was 10 inches to 40 inches for over 6 months of the year, and 10 inches or less for between 1 and 6 months. To adapt these fine sandy soils to citrus production, the Soil Conservation Service recommends drainage works to maintain the water table at a depth of 4 feet and bedding to improve surface drainage (Wettstein et al, 1987).

Historically, the SJWCD was a shallow marsh/wet prairie system with scattered hammocks and cypress domes (Palmer Kinser, SJRWMD, personal communication, 1986). The current major land use is citrus grove, approximately 22,000 acres. The remainder of SJWCD consists of improved pasture, small undeveloped tracts and drainage works.

The 1760 acre reservoir includes inlet and outlet structures, a levee system with an interior borrow canal and an impounded marsh. Reservoir vegetation is dominated by large emergent patches of sawgrass and cattails, interspersed with submerged coontail, bladderwort and musk grass (FGFWFC, 1982). Open water covers approximately 75 percent of the reservoir.

SOIL SURVEY

OF THE

ST. JOHNS WATER CONTROL DISTRICT

KEY

2 Chobee Loamy Find Sand
10 Riviera Fine Sand
13 Wabasso Fine Sand
14 Winder Fine Sand
15 Manatee Loamy Fine Sand
16 Pineda Fine Sand
24 Floridana Sand
31 Jupiter Fine Sand
36 Boca Fine Sand
40 Gator Muck
41 Canova Muck
42 Terra Ceia Muck
51 Riviera Fine Sand, depressional
55 Floridana Mucky Fine Sand, depressional
58 Samsula Muck
61 Delray Muck
62 Chobee Mucky Loamy Fine Sand, depressional

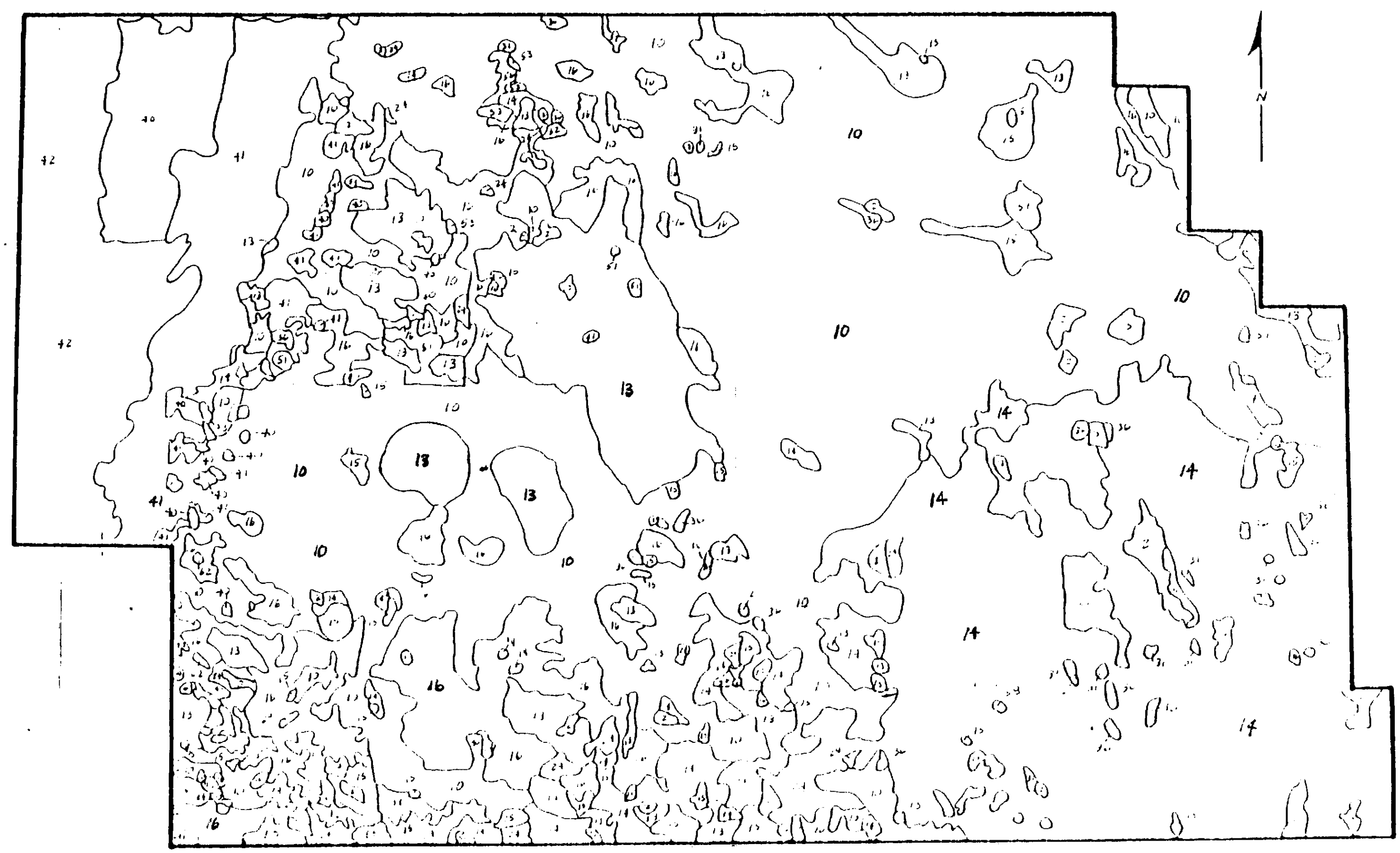


FIGURE 3

METHODS OF INVESTIGATION

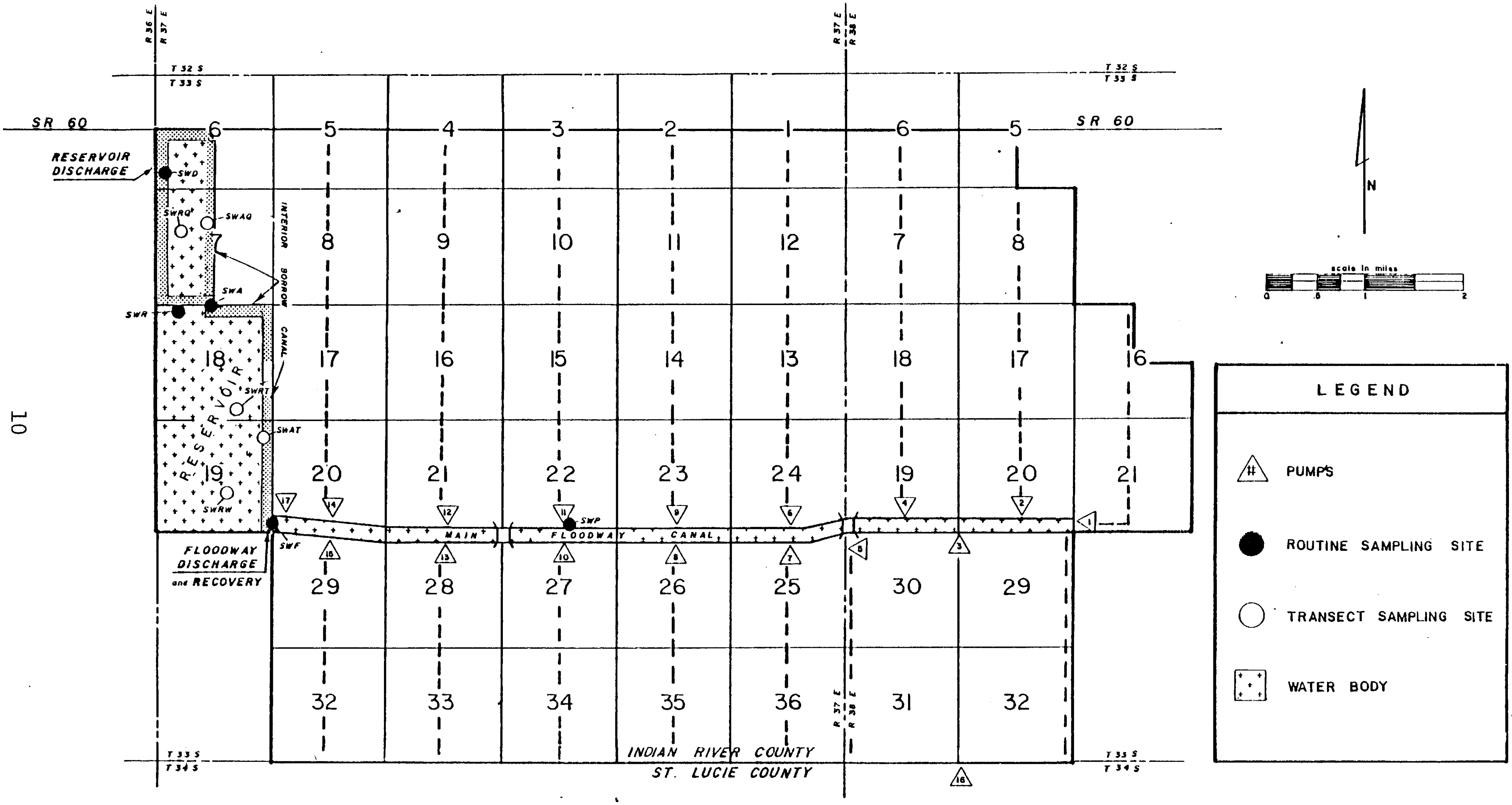
Monthly water quality samples were collected at 5 stations (Table 1, Figure 4) from November 1984 to November 1985 with the exception of July 1985. The District began water quality sampling in November 1984, anticipating that EPA Section 205(j) grant funds would be available in December 1984. Due to delays in finalizing a contact, sample collection under the Section 205(j) grant did not begin until April, 1985. Sample collection was discontinuned in November 1985, after 7 of the 8 projected events were sampled, due to access, personnel and laboratory limitations.

Pump samples were collected from pump station nos. 5, 6, 9 or 11, which drain citrus groves, depending on which was operating at the time. Pump stations consist of 3 to 5 25,000 GPM pumps. Samples were collected at the pump intake. In September 1985, 5 additional locations within the reservoir were sampled to examine spatial variations (Figure 4). Three of the additional samples were collected in the marsh and two were collected in a perimeter canal inside the reservoir. Samples were identified by a 14 character code which incorporates the three letter station name, a comment code, the date collected (YYMMDD) and time collected. Parameters sampled, analytical techniques and equipment used are summarized in Table 2. Pesticide samples were collected from the pumps, the reservoir inlet and the reservoir outlet in August through November, 1985.

TABLE 1

ST. JOHNS WATER CONTROL DISTRICT WATER QUALITY MONITORING STATIONS

LOCATION	NAME	LAT/LONG
ROUTINE STATIONS		
PUMP DISCHARGE AT PUMP STATIONS #5,6,9 OR 11	SWP	273520/803612 (PUMP #11)
WESTERN END OF FLOODWAY AT WEIR	SWF	273521/803938
INTERIOR MARSH OF RESERVOIR, MIDWAY BETWEEN INLET AND OUTLET	SWR	273704/804023
EAST PERIMETER CANAL, MIDWAY BETWEEN INLET AND OUTLET	SWA	273704/804011
RESERVOIR DISCHARGE STRUCTURE AT NORTHWEST CORNER	SWD	273822/804030
TRANSECT STATIONS		
INTERIOR MARSH OF RESERVOIR, SOUTH END	SWRW	–
INTERIOR MARSH OF RESERVOIR, MIDWAY BETWEEN INLET AND STATION SWR	SWRT	–
INTERIOR MARSH OF RESERVOIR, NORTH END	SWRQ	–
EAST PERIMETER CANAL, MIDWAY BETWEEN INLET AND WESTERLY TURN IN CANAL	SWAT	–
EAST PERIMETER CANAL, MIDWAY BETWEEN STATION SWA AND STAGE GAGE	SWAQ	–



ST. JOHN'S WATER CONTROL DISTRICT

Water Quality Monitoring Stations

Figure 4

TABLE 2

TECHNIQUES FOR CHEMICAL AND PHYSICAL ANALYSIS OF WATER SAMPLES

PARAMETER	STORET#	METHOD OF ANALYSIS OR FIELD EQUIPMENT USED
WATER TEMPERATURE (°C)	10	IN SITU, HYDROLAB 4041 OR Y.S.I. MODEL 57 D.O. METER
SECCHI DEPTH (IN)	77	IN SITU, PLASTIC DISK WITH ALTERNATING BLACK AND WHITE QUADRANTS
TRUE COLOR (CPU)	80	VISUAL COMPARISON, STD. METHODS 15TH ED., SECTION 204A, PG.61
CONDUCTANCE (UMHOS/CM)	94	DIRECT MEASUREMENT, EPA 120.1-1
DISSOLVED OXYGEN (MG/L)	299	MEMBRANE ELECTRODE, STD. METHODS, 15TH ED., SECTION 421F
B.O.D.5 (MG/L)	310	INCUBATION, 5 DAY, EPA 405.1
PH (S.U.)	400	IN SITU, HYDROLAB 4041 OR COLE-PARMER DIGISENSE PH METER
ALKALINITY, TOTAL (MG/L)	410	POTENTIOMETRIC TITRATION, EPA 310.1
TOTAL SUSPENDED SOLIDS (MG/L) (RESIDUE, NONFILTERABLE)	530	GRAVIMETRIC 180 C, EPA 160.2
AMMONIA NITROGEN, DISSOLVED(MG/L)	608	AUTOMATED PHENATE METHOD, EPA 350.1
AMMONIA NITROGEN, TOTAL (MG/L)	610	AUTOMATED PHENATE METHOD, EPA 350.1
TOTAL KJELDAHL NITROGEN, DISSOLVED (MG/L)	623	COLORIMETRIC, SEMI-AUTOMATED, EPA 351.2
TOTAL KJELDAHL NITROGEN (MG/L)	625	COLORIMETRIC, SEMI-AUTOMATED, EPA 351.2
NITRATE-NITRITE NITROGEN (MG/L) (NOX)	630	AUTOMATED CADMIUM REDUCTION, EPA 353.2
TOTAL PHOSPHORUS (MG/L)	665	COLORIMETRIC, SEMI-AUTOMATED, EPA 365.4
TOTAL PHOSPHORUS, DISSOLVED(MG/L)	666	COLORIMETRIC, SEMI-AUTOMATED, EPA 365.4
HARDNESS (MG/L)	900	EDTA TITRATION, EPA 140.2
CALCIUM, DISSOLVED (UG/L)	915	ATOMIC ABSORPTION, EPA 215.1
MAGNESIUM, DISSOLVED (UG/L)	925	ATOMIC ABSORPTION, EPA 242.1-1
SODIUM, DISSOLVED (UG/L)	930	ATOMIC ABSORPTION, EPA 273.1
POTASSIUM, DISSOLVED (UG/L)	935	ATOMIC ABSORPTION, EPA 258.1
CHLORIDE (MG/L)	940	AUTOMATED FERRICYANIDE, EPA 325.2
SULFATE (MG/L)	945	TURBIDIMETRIC, EPA 375.4
IRON, DISSOLVED (UG/L)	1046	ATOMIC ABSORPTION, EPA 236.1-1
CHLOROPHYLL A, UNCORRECTED (UG/L)	32210	SPECTROPHOTOMETRIC METHOD,
CHLOROPHYLL A, CORRECTED (UG/L)	32211	STD. METHODS,
CHLOROPHYLL B, UNCORRECTED (UG/L)	32212	
CHLOROPHYLL C, UNCORRECTED (UG/L)	32214	SECTION 1002G, PG 950
PHEOPHYTIN, UNCORRECTED (UG/L)	32218	
CHLOROPHYLL/PHEOPHYTIN RATIO	32219	
TOTAL DISSOLVED SOLIDS (MG/L) (RESIDUE, FILTERABLE)	70300	GRAVIMETRIC 180 C, EPA 160.1
ORTHOPHOSPHATE PHOSPHORUS (MG/L)	70507	SINGLE REAGENT METHOD, EPA 365.2
TURBIDITY (NTU)	82079	NEPHELOMETRIC, EPA 180.1

TABLE 3

PESTICIDE ANALYSIS PARAMETERS

PARAMETER	STORET NUMBER	MDL PROPOSED*	MDL ACHIEVED
ALDRIN	39330	0.003	0.004
CHLORDANE	39350	0.01	0.01
DDT	39900	0.001	0.01
DEMETON	39560	0.1	0.01
ENDOSULFAN 1	34361	0.003	0.01
ENDRIN	39390	0.001	0.001
GUTHION	39580	0.01	0.01
HEPTACHLOR	39410	0.001	0.003
LINDANE	39340	0.0005	0.0005
MALATHION	39530	0.02	0.01
METHOXYCHLOR	39480	0.01	0.01
MIREX	39755	0.001	0.001
PARATHION	39600	0.02	0.01
TOXAPHENE	39400	0.01	0.1

* METHOD 608 MINIMUM DETECTION LIMITS

Samples were analyzed for pesticides listed in Chapter 17-3, F.A.C. (Table 3) by Flowers Chemical Laboratories, Inc.

Samples were collected by hand or with a Van Dorn sampler at 0.5 M depth. Polyethylene bottles, acid washed when appropriate, were used for sample collection. Samples were stored in iced coolers and transported to the laboratory the same day of collection. Metal and nutrient samples were preserved with nitric and sulfuric acid, respectively, to a pH<2. Acid used to preserve samples was submitted to the laboratory for preparation of an acid blank. A field replicate sample was collected at 5 percent of the stations.

Measurements for dissolved oxygen, temperature, pH and specific conductance were made in situ with a Hydrolab 4041. On occasions when the Hydrolab malfunctioned, a Y.S.I. Model 33 S-C-T meter, Y.S.I. Model 57 D.O. meter and Cole-Parmer Digisense pH meter were substituted. Transparency was measured using a secchi disk with alternating black and white quadrants.

Instruments were calibrated before and after each daily sampling period. PH meters were calibrated with two pH buffers. D.O. meters were calibrated in saturated air chambers. Conductivity measurements were calibrated with a 1413 umhos/cm standard. Calibration results were recorded on the Field Calibration Check Sheet and reviewed by the project manager. For a more detailed description of sample collection techniques, refer to the St. Johns River Water Management District Water Quality Monitoring Field Manual (Fall and Osburn, 1985).

Surface water elevation within the reservoir was monitored using a Stevens A71 graphical stage recorder. From June 1981 to May 1985, the recorder was located on the reservoir's western levee, south of the outlet structure. Due to its location, this instrument did not record stages below 23 feet m.s.l. To correct this deficiency, a new recorder was installed in the northeast corner of the reservoir in May 1985.

Landowners within the SJWCD were surveyed regarding fertilizer and pesticide practices. Questionnaires developed for citrus and beef cattle operations (Appendix A) were mailed to 87 landowners, with postage paid return envelopes. Respondents had the option to remain anonymous.

Changes in vegetation in the reservoir were determined through examination of black and white aerial photographs from 1957, 1974, 1978 and 1984. Vegetation signatures were ground-truthed in January 1986.

RESULTS

WATER QUALITY

Water quality within the SJWCD floodway and reservoir was generally good (Tables 4-8, Appendix A). Water quality within the reservoir periodically exceeded Chapter 17-3, F.A.C. Class I Water Quality Standards for chloride, total dissolved solids and dissolved oxygen. During the three monthly sampling events which coincided with significant reservoir releases (November 1984, August 1985 and October 1985), discharges complied with Chapter 17-3, F.A.C. Water Quality Standards for Class I water bodies. Pesticide levels were at or below the achieved minimum detection level (Table 3) for all samples at all stations.

Suspended solids and turbidity levels at the pump intakes averaged 4.6 mg/l and 2.6 NTU, respectively. Nutrients were primarily dissolved. Filtered concentrations of total phosphorus, total Kjeldahl nitrogen and ammonia averaged 69, 89 and 99 percent, respectively, of the unfiltered concentrations at the pump discharge. These proportions did not vary significantly at the remaining sites.

A comparison of monthly concentrations for selected parameters at the reservoir inlet and outlet yielded significant differences (alpha = .05) for nitrate-nitrite, ammonia and orthophosphate (Figure 5). No significant differences between the inlet and outlet were found for total phosphorus, total Kjeldahl nitrogen or chloride.

TABLE 4

STATISTICAL SUMMARY FOR SJWCD PUMP WATER QUALITY

STATION NAME:SWP

PARAMETER	DATA MEAN	DATA MEDIAN	DATA STD DEV	DATA MINIMUM	DATA MAXIMUM	COUNT
WATER TEMP (C)	23.32	21.50	4.22	17.00	30.00	11
SECCHI (IN)	44.00	36.00	13.86	36.00	60.00	3
COLOR (CPU)	81.82	70.00	64.59	50.00	275.00	11
COND.(UMHOS/CM)	1216.91	1330.00	433.36	366.00	1690.00	11
D.O. (MG/L)	5.35	5.30	1.89	2.70	9.30	11
B.O.D. (MG/L)	2.07	2.00	0.92	0.80	3.70	11
PH (S.U.)	--	7.00	0.22	6.80	7.50	11
ALKALINITY(MG/L)	174.27	182.00	19.50	127.00	192.00	11
SUSP.SOL.(MG/L)	4.59	2.50	3.87	1.00	12.00	11
DISS.NH4 (MG/L)	0.16	0.09	0.19	0.01	0.60	11
TOT.NH4 (MG/L)	0.17	0.09	0.20	0.02	0.64	11
DISS.TKN (MG/L)	1.02	1.02	0.22	0.71	1.46	11
TOT.TKN (MG/L)	1.19	1.17	0.31	0.71	1.79	11
NOX (MG/L)	0.14	0.07	0.17	0.00	0.61	11
TOT.PHOS.(MG/L)	0.09	0.08	0.04	0.05	0.19	11
DISS.PHOS.(MG/L)	0.06	0.06	0.02	0.02	0.10	11
HARDNESS (MG/L))	396.30	414.00	64.30	260.00	468.00	10
CALCIUM (UG/L)	97.78	94.00	29.78	58.00	150.00	9
MAGNESIUM (UG/L)	22.67	18.00	7.16	15.00	35.00	9
SODIUM (UG/L)	99.33	76.00	47.76	44.00	185.00	9
POTASSIUM (UG/L)	7.26	6.90	3.23	3.40	15.00	9
CHLORIDE (MG/L)	210.73	228.00	72.50	100.00	308.00	11
SULFATE (MG/L)	117.82	126.00	34.37	61.00	165.00	11
IRON (UG/L)	234.56	174.00	193.72	88.00	723.00	9
CHL A (UG/L)	9.77	6.40	10.78	2.45	41.10	11
CHL A/C (UG/L)	8.06	4.81	11.40	1.34	41.43	11
T.D.S. (MG/L)	789.91	755.00	164.18	496.00	1010.00	11
ORTHOPHOS.(MG/L)	0.06	0.04	0.05	0.00	0.16	11
TURBIDITY (NTU)	2.63	1.70	2.32	0.90	8.20	11

TABLE 5

STATISTICAL SUMMARY FOR SJWCD FLOODWAY WATER QUALITY
(RESERVOIR INLET)

STATION NAME: SWF

PARAMETER	DATA MEAN	DATA MEDIAN	DATA STD DEV	DATA MINIMUM	DATA MAXIMUM	COUNT
WATER TEMP (C)	24.40	22.75	4.55	16.50	31.50	12
SECCHI (IN)	54.86	54.00	11.07	36.00	68.00	7
COLOR (CPU)	82.50	65.00	40.09	50.00	175.00	12
COND.(UMHOS/CM)	1112.50	1050.00	296.99	740.00	1630.00	12
D.O. (MG/L)	4.36	4.15	1.69	2.70	8.50	12
B.O.D. (MG/L)	1.45	1.25	0.76	0.60	2.60	12
PH (S.U.)	--	7.20	0.25	6.80	7.70	12
ALKALINITY (MG/L)	142.58	148.00	24.37	110.00	171.00	12
SUSP.SOL. (MG/L)	2.17	2.00	1.76	0.50	7.00	12
DISS.NH4 (MG/L)	0.10	0.08	0.07	0.03	0.21	12
TOT.NH4 (MG/L)	0.10	0.08	0.07	0.03	0.21	12
DISS.TKN (MG/L)	1.10	0.99	0.31	0.71	1.72	12
TOT.TKN (MG/L)	1.18	1.20	0.24	0.78	1.50	12
NOX (MG/L)	0.26	0.17	0.31	0.01	0.92	12
TOT.PHOS.(MG/L)	0.07	0.07	0.04	0.01	0.14	12
DISS.PHOS.(MG/L)	0.05	0.05	0.03	0.00	0.08	12
HARDNESS (MG/L)	320.73	332.00	52.39	240.00	408.00	11
CALCIUM (UG/L)	83.00	80.00	20.94	54.00	121.00	10
MAGNESIUM (UG/L)	21.20	20.50	6.66	14.00	34.00	10
SODIUM (UG/L)	83.00	77.50	32.48	45.00	147.00	10
POTASSIUM (UG/L)	7.56	7.60	1.83	4.40	11.00	10
CHLORIDE (MG/L)	172.25	149.00	84.79	30.00	290.00	12
SULFATE (MG/L)	104.33	100.50	21.34	76.00	132.00	12
IRON (UG/L)	170.80	175.50	101.78	50.00	330.00	10
CHL A (UG/L)	4.11	3.24	1.86	1.85	7.80	11
CHL A/C (UG/L)	2.65	2.14	1.92	1.00	7.75	11
T.D.S. (MG/L)	681.58	655.50	154.21	462.00	901.00	12
ORTHOPHOS.(MG/L)	0.05	0.03	0.04	0.00	0.12	12
TURBIDITY (NTU)	1.12	1.10	0.48	0.50	2.20	12

TABLE 6

STATISTICAL SUMMARY FOR SJWCD RESERVOIR WATER QUALITY
(PERIMETER CANAL)

STATION NAME: SWA

PARAMETER	DATA MEAN	DATA MEDIAN	DATA STD DEV	DATA MINIMUM	DATA MAXIMUM	COUNT
WATER TEMP (C)	25.85	28.00	4.45	17.10	31.50	13
SECCHI (IN)	75.33	72.00	22.02	46.00	120.00	9
COLOR (CPU)	82.69	55.00	45.85	40.00	175.00	13
COND. (UMHOS/CM)	993.08	855.00	317.74	480.00	1545.00	13
D.O. (MG/L)	5.88	6.10	1.13	4.10	8.10	13
B.O.D. (MG/L)	2.37	2.40	0.93	0.50	4.00	13
PH (S.U.)	--	7.40	0.24	6.90	7.70	13
ALKALINITY(MG/L)	129.46	124.00	16.61	108.00	159.00	13
SUSP.SOL.(MG/L)	3.08	2.00	2.42	0.50	7.50	13
DISS. NH4 (MG/L)	0.03	0.03	0.01	0.02	0.06	8
TOT. NH4 (MG/L)	0.04	0.03	0.03	0.00	0.11	13
DISS.TKN (MG/L)	1.02	0.91	0.25	0.71	1.34	8
TOT.TKN (MG/L)	1.18	1.11	0.20	0.91	1.57	13
NOX (MG/L)	0.11	0.04	0.14	0.00	0.43	13
TOT.PHOS. (MG/L)	0.05	0.05	0.02	0.01	0.10	13
DISS.PHOS.(MG/L)	0.03	0.03	0.02	0.00	0.06	8
HARDNESS (MG/L)	294.83	290.00	60.62	188.00	380.00	12
CALCIUM (UG/L)	77.29	79.00	17.66	56.00	108.00	7
MAGNESIUM (UG/L)	20.43	20.00	7.37	11.00	32.00	7
SODIUM (UG/L)	80.57	71.00	41.17	26.00	141.00	7
POTASSIUM (UG/L)	7.66	7.30	1.79	5.70	11.00	7
CHLORIDE (MG/L)	140.69	126.00	94.92	23.00	286.00	13
SULFATE (MG/L)	92.15	84.00	27.88	47.00	132.00	13
IRON (UG/L)	68.14	50.00	33.38	50.00	135.00	7
CHL A (UG/L)	12.79	12.94	6.93	3.52	25.87	13
CHL A/C (UG/L)	11.01	10.16	6.73	1.07	22.99	13
T.D.S. (MG/L)	619.08	581.00	168.37	379.00	886.00	13
ORTHOPHOS.(MG/L)	0.02	0.01	0.02	0.00	0.07	13
TURBIDITY (NTU)	1.17	1.00	0.43	0.50	1.90	13

TABLE 7

STATISTICAL SUMMARY FOR SJWCD RESERVOIR WATER QUALITY
(INTERIOR MARSH)

STATION NAME: SWR

PARAMETER	DATA MEAN	DATA MEDIAN	DATA STD DEV	DATA MINIMUM	DATA MAXIMUM	COUNT
WATER TEMP (C)	26.37	28.75	5.13	16.20	31.50	14
SECCHI (IN)	43.91	34.00	20.79	24.00	84.00	11
COLOR (CPU)	71.07	57.50	31.88	40.00	150.00	14
COND.(UMHOS/CM)	930.14	768.50	349.63	400.00	1550.00	14
D.O. (MG/L)	7.19	6.80	1.76	5.00	11.60	14
B.O.D. (MG/L)	2.17	2.20	0.69	0.90	3.10	13
PH (S.U.)	--	7.50	0.16	7.30	7.80	14
ALKALINITY(MG/L)	120.64	121.50	15.30	98.00	144.00	14
SUSP.SOL.(MG/L)	3.88	3.00	3.46	0.50	12.00	13
DISS.NH4 (MG/L)	0.06	0.05	0.04	0.01	0.15	11
TOT.NH4 (MG/L)	0.06	0.05	0.04	0.00	0.14	14
DISS.TKN (MG/L)	1.03	0.99	0.17	0.78	1.34	11
TOT.TKN (MG/L)	1.16	1.08	0.22	0.93	1.64	14
NOX (MG/L)	0.02	0.02	0.02	0.00	0.06	14
TOT.PHOS.(MG/L)	0.03	0.04	0.02	0.01	0.05	14
DISS.PHOS.(MG/L)	0.02	0.02	0.02	0.00	0.05	11
HARDNESS (MG/L)	273.23	252.00	60.86	200.00	372.00	13
CALCIUM (UG/L)	70.22	60.00	16.47	55.00	99.00	9
MAGNESIUM (UG/L)	19.96	21.00	7.30	9.60	31.00	9
SODIUM (UG/L)	79.67	72.00	41.60	26.00	144.00	9
POTASSIUM (UG/L)	7.60	7.50	1.46	5.60	10.00	9
CHLORIDE (MG/L)	130.71	110.00	98.12	23.00	288.00	14
SULFATE (MG/L)	87.00	70.00	31.25	45.00	146.00	14
IRON (UG/L)	57.00	50.00	17.41	50.00	103.00	9
CHL A (UG/L)	7.23	4.55	7.88	2.44	33.36	14
CHL A/C (UG/L)	5.82	4.01	6.97	0.80	28.87	14
T.D.S. (MG/L)	583.93	503.00	173.70	398.00	871.00	14
ORTHOPHOS.(MG/L)	0.01	0.01	0.01	0.00	0.02	14
TURBIDITY (NTU)	1.09	0.90	0.56	0.40	2.00	13

TABLE 8

STATISTICAL SUMMARY FOR SJWCD DISCHARGE WEIR WATER QUALITY (RESERVOIR OUTLET)

STATION NAME: SWD

PARAMETER	DATA MEAN	DATA MEDIAN	DATA STD DEV	DATA MINIMUM	DATA MAXIMUM	COUNT
WATER TEMP (C)	25.22	23.25	4.95	16.50	32.00	12
SECCHI (IN)	75.78	72.00	12.47	54.00	96.00	9
COLOR (CPU)	66.15	55.00	33.30	40.00	150.00	13
COND.(UMHOS/CM)	986.67	945.00	316.22	455.00	1450.00	12
D.O. (MG/L)	6.05	6.35	0.93	4.60	7.20	12
B.O.D. (MG/L)	1.85	1.40	1.06	0.60	3.50	10
PH (S.U.)	--	7.35	0.13	7.20	7.60	12
ALKALINITY(MG/L)	120.23	115.00	18.01	97.00	161.00	13
SUSP.SOL. (MG/L)	3.01	2.00	2.56	0.10	9.00	12
DISS.NH4 (MG/L)	0.04	0.03	0.03	0.00	0.14	12
TOT.NH4 (MG/L)	0.04	0.03	0.04	0.00	0.14	12
DISS.TKN (MG/L)	0.94	0.88	0.19	0.65	1.25	12
TOT.TKN (MG/L)	1.11	1.05	0.23	0.78	1.57	12
NOX (MG/L)	0.05	0.02	0.10	0.01	0.38	13
TOT.PHOS.(MG/L)	0.04	0.03	0.04	0.00	0.13	12
DISS.PHOS.(MG/L)	0.02	0.02	0.01	0.00	0.04	12
HARDNESS (MG/L)	285.67	301.00	55.86	180.00	350.00	12
CALCIUM (UG/L)	69.60	65.00	17.42	53.00	111.00	10
MAGNESIUM (UG/L)	19.00	20.00	6.99	9.00	29.00	10
SODIUM (UG/L)	74.90	75.00	36.15	24.00	137.00	10
POTASSIUM (UG/L)	7.42	7.20	1.38	5.60	9.80	10
CHLORIDE (MG/L)	160.46	181.00	82.55	24.00	274.00	13
SULFATE (MG/L)	94.77	99.00	29.01	45.00	128.00	13
IRON (UG/L)	73.30	50.00	67.87	50.00	266.00	10
CHL A (UG/L)	9.26	5.95	10.28	2.82	38.99	11
CHL A/C (UG/L)	7.99	3.47	10.36	2.14	37.96	11
T.D.S. (MG/L)	614.17	559.00	182.18	363.00	879.00	12
ORTHOPHOS.(MG/L)	0.01	0.00	0.02	0.00	0.06	13
TURBIDITY (NTU)	0.80	0.75	0.29	0.50	1.50	12

FIGURE 5. COMPARISON OF MONTHLY CONCENTRATION AT THE RESERVOIR INLET AND OUTLET.

NITRATE + NITRITE NITROGEN

```
ANALYSIS OF VARIANCE
SOURCE     DF        SS         MS         F
FACTOR      1    0.2617     0.2617      4.87
ERROR      22    1.1823     0.0537
TOTAL      23    1.4439
                                      INDIVIDUAL 95 PCT CI'S FOR MEAN
                                      BASED ON POOLED STDEV
LEVEL       N      MEAN      STDEV   -------+---------+---------+---------
INLET      12   0.26175    0.31121                 (---------*---------)
OUTLET     12   0.05292    0.10309    (---------*---------)
                                      -------+---------+---------+---------
POOLED STDEV = 0.23182                      0.00      0.14      0.28
```

AMMONIA NITROGEN

```
ANALYSIS OF VARIANCE
SOURCE     DF        SS         MS         F
FACTOR      1   0.02233    0.02233      7.75
ERROR      22   0.06339    0.00288
TOTAL      23   0.08571
                                      INDIVIDUAL 95 PCT CI'S FOR MEAN
                                      BASED ON POOLED STDEV
LEVEL       N      MEAN      STDEV   ---------+---------+---------+-------
INLET      12   0.09825    0.06731                   (-------*-------)
OUTLET     12   0.03725    0.03509   (-------*-------)
                                      ---------+---------+---------+-------
POOLED STDEV = 0.05368                       0.040     0.080     0.120
```

TOTAL KJELDAHL NITROGEN

```
ANALYSIS OF VARIANCE
SOURCE     DF        SS         MS         F
FACTOR      1    0.0287     0.0287      0.51
ERROR      22    1.2353     0.0561
TOTAL      23    1.2640
                                      INDIVIDUAL 95 PCT CI'S FOR MEAN
                                      BASED ON POOLED STDEV
LEVEL       N      MEAN      STDEV   ---+---------+---------+---------+---
INLET      12     1.182      0.242          (-------------*-------------)
OUTLET     12     1.113      0.232    (-------------*--------------)
                                      ---+---------+---------+---------+---
POOLED STDEV = 0.237                     1.00      1.10      1.20      1.30
```

FIGURE 5. (CONT.)

ORTHOPHOSPHATE

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
FACTOR	1	0.00677	0.00677	6.44
ERROR	22	0.02310	0.00105	
TOTAL	23	0.02987		

LEVEL	N	MEAN	STDEV
INLET	12	0.04708	0.04253
OUTLET	12	0.01350	0.01706

POOLED STDEV = 0.03241

```
INDIVIDUAL 95 PCT CI'S FOR MEAN
BASED ON POOLED STDEV
---+---------+---------+---------+---
                 (---------*--------)
(---------*--------)
---+---------+---------+---------+---
 0.000     0.020     0.040     0.060
```

TOTAL PHOSPHORUS

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
FACTOR	1	0.00350	0.00350	2.68
ERROR	22	0.02875	0.00131	
TOTAL	23	0.03225		

LEVEL	N	MEAN	STDEV
INLET	12	0.06700	0.03719
OUTLET	12	0.04283	0.03508

POOLED STDEV = 0.03615

```
INDIVIDUAL 95 PCT CI'S FOR MEAN
BASED ON POOLED STDEV
----------+---------+---------+------
             (---------*----------)
 (---------*----------)
----------+---------+---------+------
        0.040     0.060     0.080
```

CHLORIDE

ANALYSIS OF VARIANCE

SOURCE	DF	SS	MS	F
FACTOR	1	1734	1734	0.24
ERROR	22	156616	7119	
TOTAL	23	158350		

LEVEL	N	MEAN	STDEV
INLET	12	172.2	84.8
OUTLET	12	155.2	84.0

POOLED STDEV = 84.4

```
INDIVIDUAL 95 PCT CI'S FOR MEAN
BASED ON POOLED STDEV
--------+---------+---------+--------
      (---------------*---------------)
 (---------------*--------------)
--------+---------+---------+--------
       128       160       192
```

Mean annual concentrations of ammonia, nitrate-nitrite and orthophosphate were 62, 80 and 72 percent less, respectively, at the reservoir outlet compared to the reservoir inlet (Table 9). Total phosphorus averaged 0.07 mg/l at the inlet and 0.05 mg/l at the outlet, a 43 percent difference. Mean total Kjeldahl nitrogen concentrations, which consisted of 95 percent organic nitrogen, varied 6 percent between the inlet and outlet. Conservative parameters, which are generally unreactive and unaffected by biological processes, usually varied less than 10 percent between the inlet and outlet.

Samples were collected along transects in September 1985 following a long period of discharge from the structure (approximately 75 days) and should reflect "flow through" conditions. Water quality at the reservoir outlet was more similar to water flowing across the marsh than water flowing through the canal (Figure 6). Inorganic nutrient levels were approximately 85 percent - 95 percent lower in the interior marsh than the perimeter borrow canal. Although some of the reduction in nutrient levels can be attributed to dilution (chloride levels were approximately 20 percent lower in the marsh), nutrient uptake processes appear to function more effectively in the marsh than the canal.

HYDROPERIOD AND VEGETATION

Sampling was conducted during a wet year, based on rainfall measurements at the Fellsmere NOAA weather station. The historic mean rainfall for November through November was 54.04 inches,

TABLE 9

COMPARISON OF MEAN ANNUAL CONCENTRATIONS AT SJWCD STATIONS

PARAMETER	SWP PUMP	SWF FLOODWAY	SWR RESERVOIR	SWA RESERVOIR	SWD WEIR	% REDUCTION (SWF->SWD)
WATER TEMP (C)	23.5	24.5	26.0	26.5	25.0	-
SECCHI (IN)	44.	55.	75.	44.	76.	-
COLOR (CPU)	82.	83.	71.	83.	66.	-20
COND.(UMHOS/CM)	1217.	1112.	930.	993.	987.	-11
D.O. (MG/L)	5.4	4.4	7.2	5.9	6.0	+36
B.O.D. (MG/L)	2.1	1.4	2.2	2.4	1.8	+28
PH (S.U.)	7.1	7.2	7.5	7.4	7.4	-
ALKALINITY(MG/L)	174.0	143.0	120.0	129.0	120.0	-16
SUSP.SOL.(MG/L)	4.6	2.2	3.9	3.1	3.0	+36
DISS.NH4 (MG/L)	0.16	0.10	0.06	0.03	0.04	-60
TOT.NH4 (MG/L)	0.17	0.10	0.06	0.04	0.04	-62
DISS.TKN (MG/L)	1.02	1.10	1.03	1.02	0.94	-14
TKN (MG/L)	1.19	1.18	1.16	1.18	1.11	-6
NOX (MG/L)	0.14	0.26	0.02	0.11	0.05	-80
TOT.PHOS (MG/L)	0.09	0.07	0.03	0.05	0.04	-43
DISS.PHOS (MG/L)	0.06	0.05	0.02	0.03	0.02	-60
HARDNESS (MG/L)	396.0	321.0	273.0	295.0	286.0	-11
CALCIUM (UG/L)	98.0	83.0	70.0	77.0	70.0	-16
MAGNESIUM (UG/L)	23.0	21.0	20.0	20.0	19.0	-9
SODIUM (UG/L)	99.0	83.0	80.0	81.0	75.0	-10
POTASSIUM (UG/L)	7.3	7.6	7.6	7.7	7.4	-3
CHLORIDE (MG/L)	211.0	172.0	131.0	141.0	160.0	-7
SULFATE (MG/L)	118.0	104.0	87.0	92.0	95.0	-9
IRON (UG/L)	234.0	171.0	57.0	68.0	73.0	-57
CHL A (UG/L)	9.8	4.1	7.3	12.8	9.3	+226
CHL A/C (UG/L)	8.1	2.6	5.8	11.0	8.0	+207
T.D.S. (MG/L)	790.0	682.0	583.0	620.0	614.0	-10
ORTHOPHOS(MG/L)	0.06	0.05	0.01	0.02	0.01	-72
TURBIDITY	2.6	1.1	1.1	1.2	0.8	-27

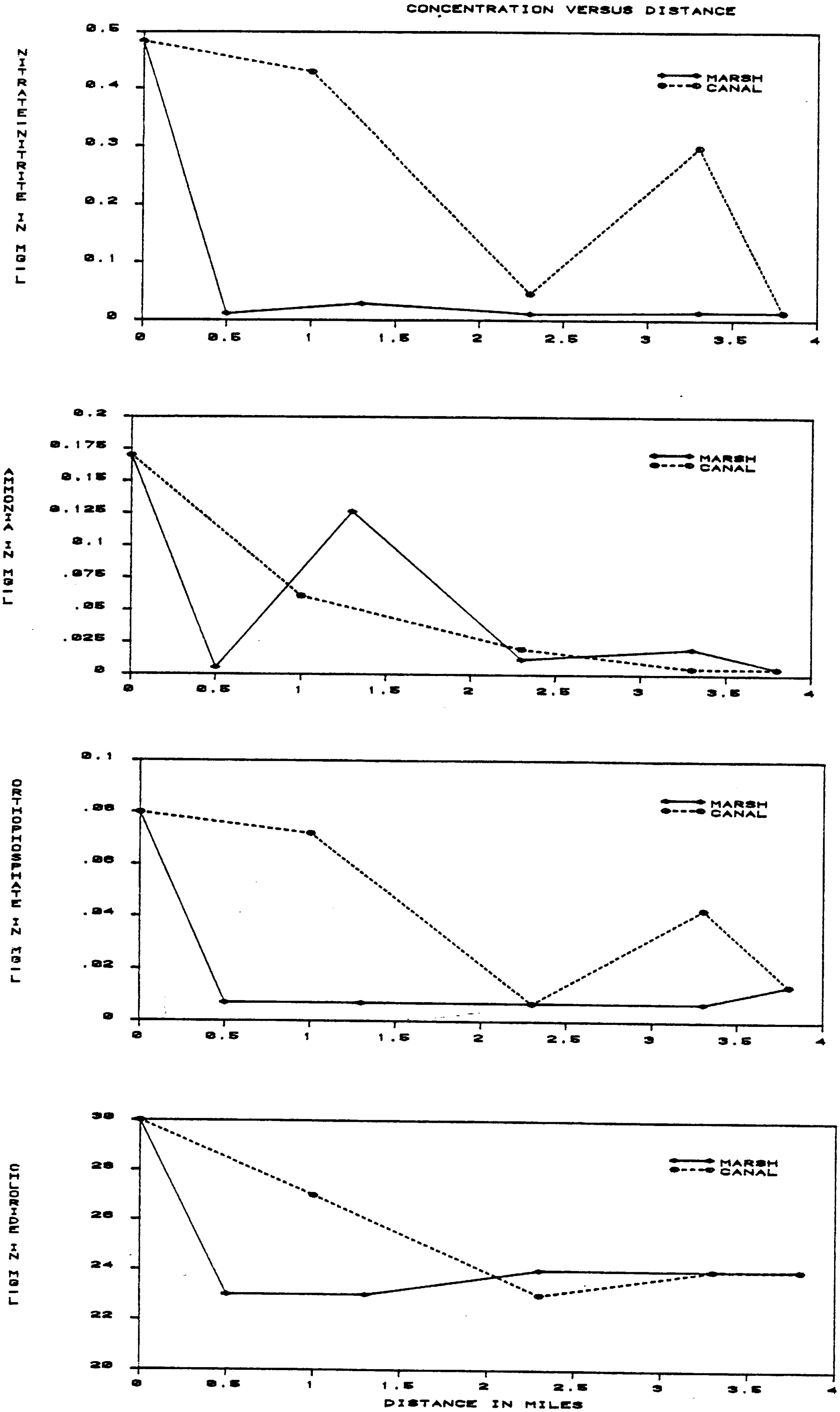


Figure 6

Concentration
Versus
Distance
Profiles:
September 12, 1985
Transect
Samples

while 63.15 inches were recorded during the study period. The area experienced a very dry winter/spring period, followed by high summer rainfall levels (Figure 7).

The stage recorder did not function for 3 1/2 months, from January 25, 1986 to May 13, 1986 (Figure 8). During the period for which data are available, water levels ranged from 24.7 feet msl to 29.1 feet msl, averaging 26.3 feet msl. Ground elevation in the reservoir is approximately 22 feet msl. Water depths measured during sample collection in the reservoir marsh ranged from 2 to 4 feet and no exposure of marsh sediments was noted. Due to leaks beside or under the outlet structure, a small discharge occurred continually.

Three sharp declines in water level occurred following the study period in December 1985, January 1986 and February 1986. Water was transferred from the reservoir to citrus groves for freeze protection and subsequently pumped back to the reservoir. Reservoir water levels were lowered 1.9 to 2.4 feet in 2 to 3 days and returned to pre-drawdown levels within a week. It is not known if similar events occurred during the study period. Reverse flows from the reservoir to the floodway, which were noted during sample collection in January, April and May 1985, apparently resulted from irrigation withdrawals.

Species routinely found in the adjacent shallow marsh, such as maidencane, buttonbush and pickerelweed, are rarely found in the reservoir. Large cypress trees within the reservoir are dead, although numerous small cypress trees became established following the 1981 drought. In the 20 years since impoundment,

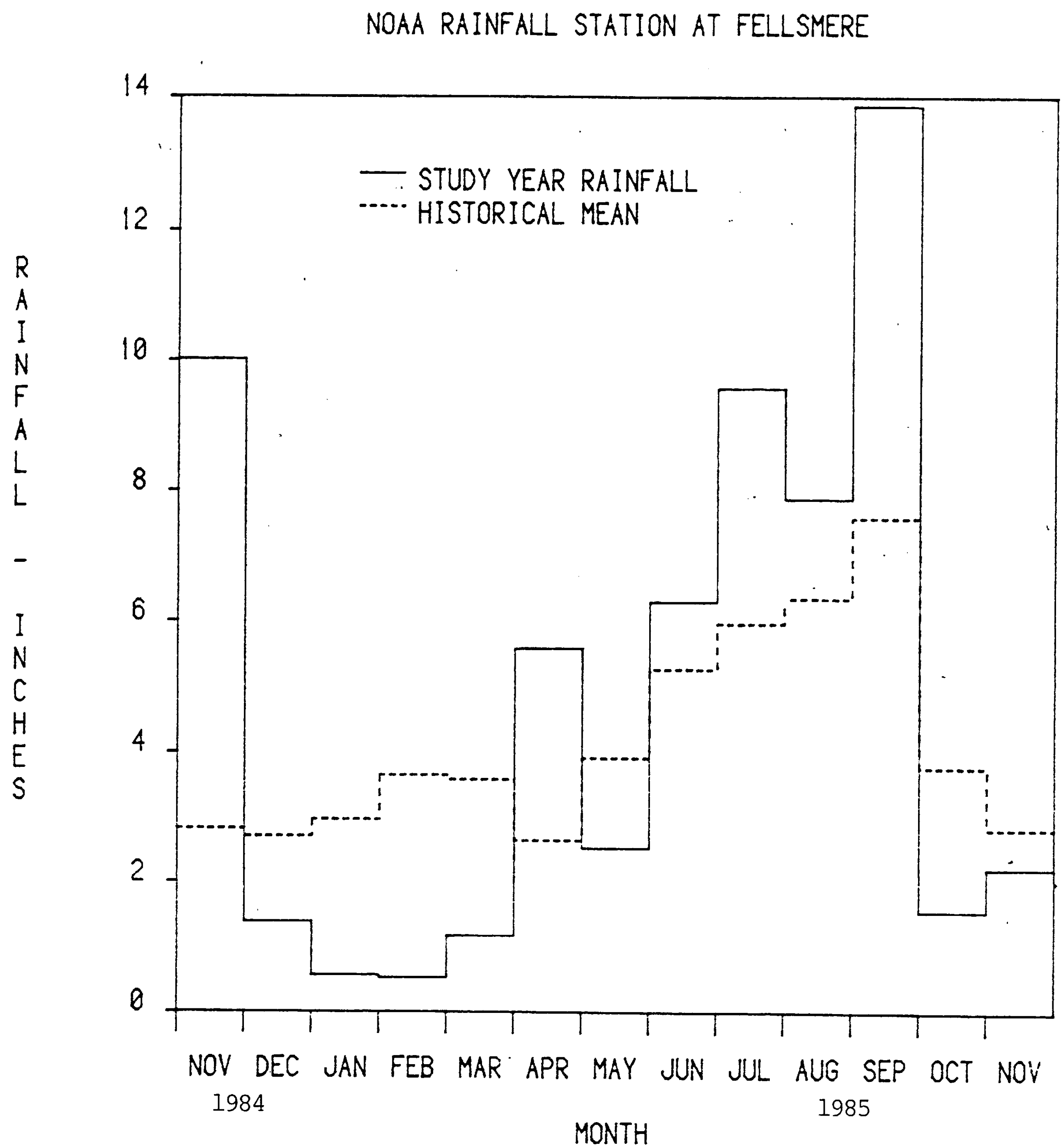
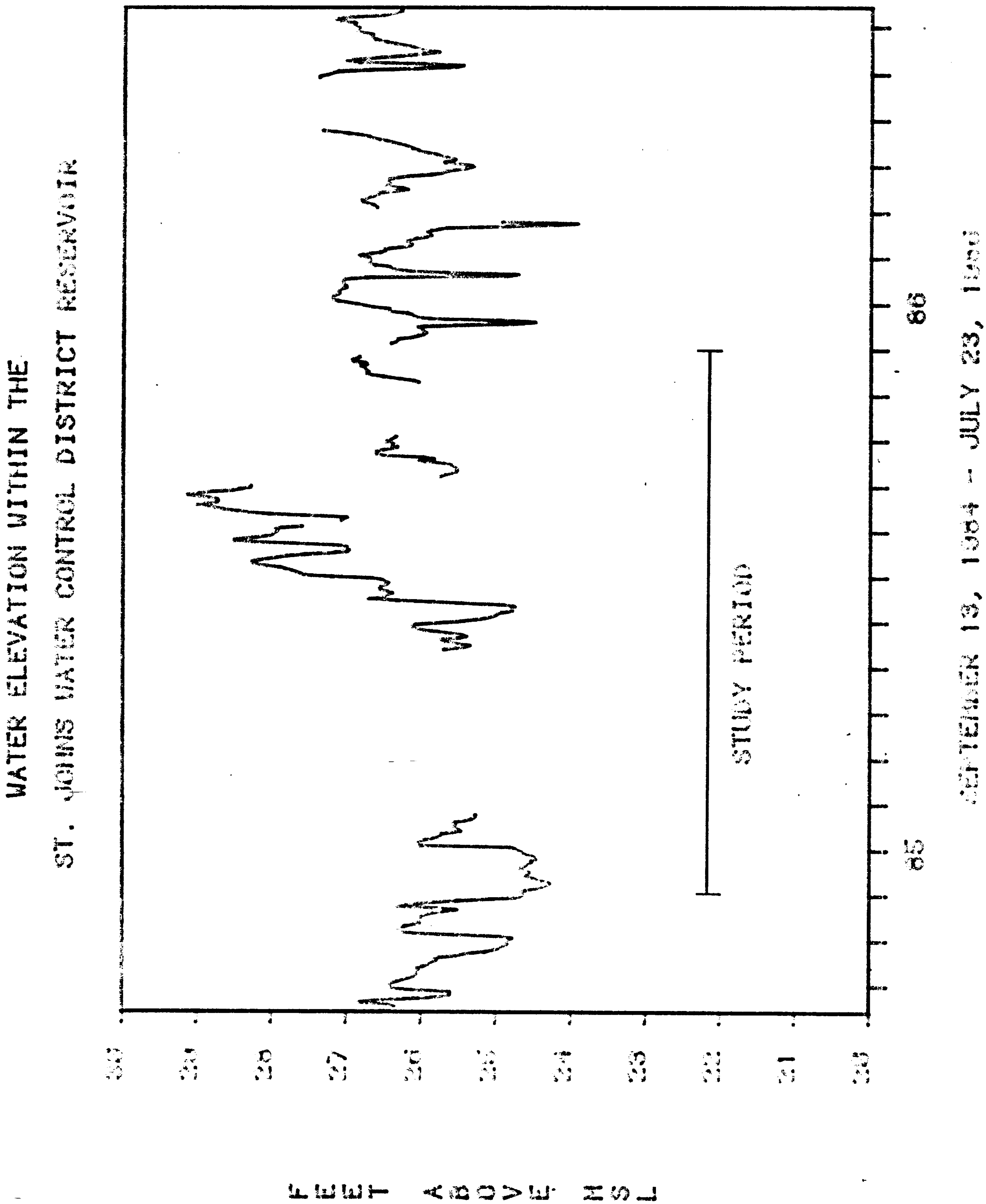


FIGURE 7

COMPARISON OF HISTORICAL AND STUDY PERIOD RAINFALL

Figure 8


WATER ELEVATION WITHIN THE
ST. JOHNS WATER CONTROL DISTRICT RESERVOIR
STUDY PERIOD
85
86
FEET ABOVE MSL

open water areas have increased from less than 10 percent of total reservoir area to approximately 75 percent.

PESTICIDE AND FERTILIZATION SURVEY

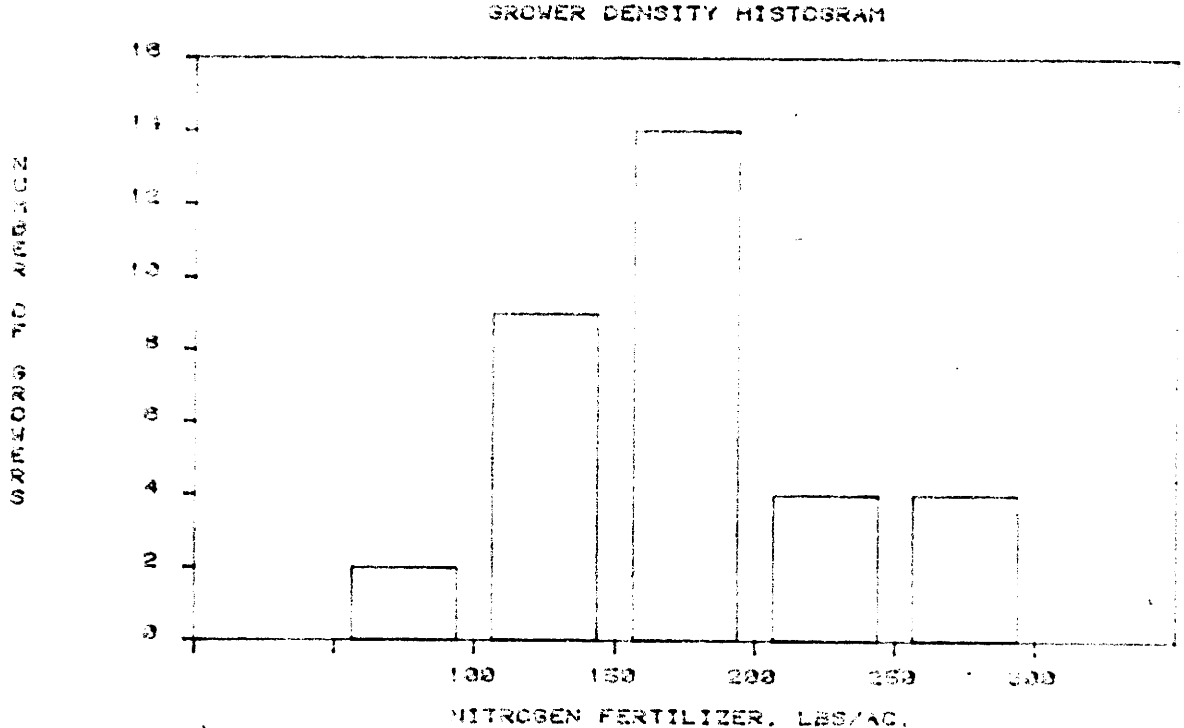
Thirty percent of the citrus surveys were returned. These represented 16,036 acres, or 73 percent of the citrus acreage. The average grove size of the survey respondents was 620 acres, although sizes ranged from 20 to 3000 acres.

Ninety-two percent of the respondents (87 percent of the responding acreage) used visual observation, soil analysis or both to determine fertilizer requirements. A substantially lower percentage (56 percent of respondents, 61 percent of the responding acreage) used foliar analysis to aid in the determination. All respondents who ascribed to foliar analysis used it in conjunction with soil analysis. When respondents indicated that they used a method other than the specifically stated choices in the survey form (27 percent did so), 71 percent said that previous yield played a role in their determination. The frequency of use of that method was probably underestimated by the survey since it was not specifically indicated on the survey form.

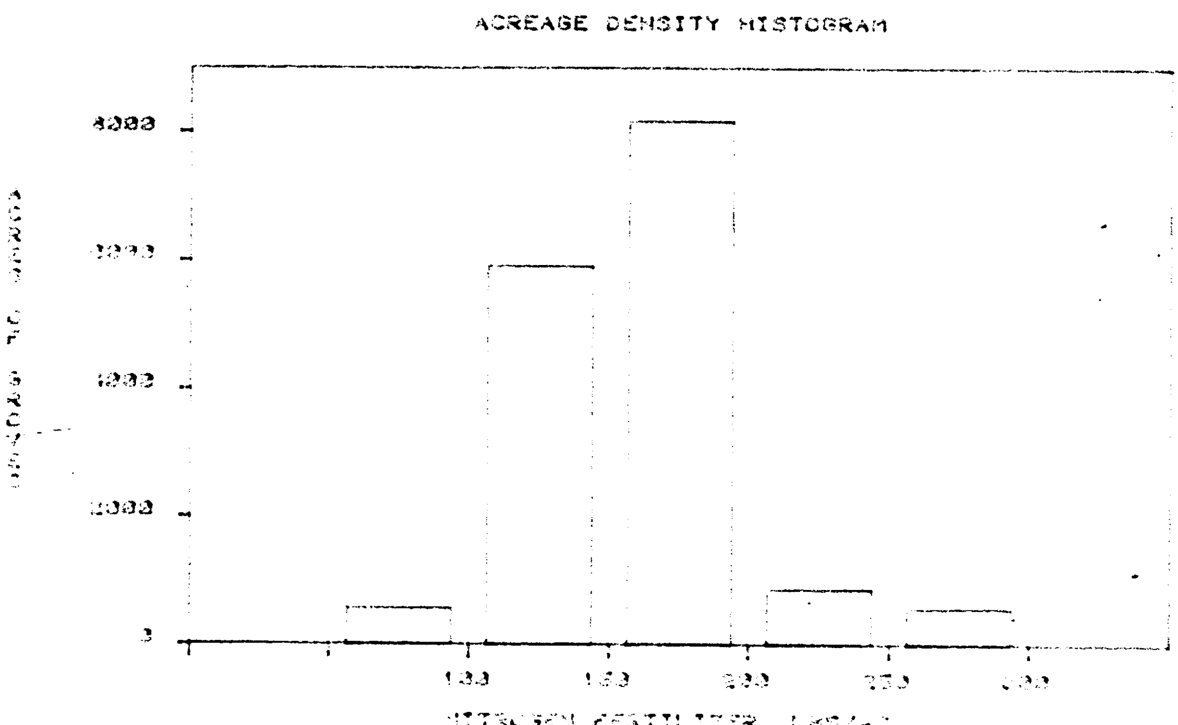
Application rates of nitrogen apparently varied widely among citrus groves, from less than 100 to up to 300 pounds per acre per year. The majority of growers applied between 100 to 200 pounds per acre per year (Figure 9a). While 31 percent of growers indicated that they used application rates of greater than 200 pounds per acre per year, this group represented only 9

Figure 9

Nitrogen Fertilizer Applications within St. Johns Water Control District



a)



b)

a) Number of Groves Indicating Application Rates within each Class
b) Number of Acres within Fertilizer Class

percent of the total survey acreage (Figure 9b). Thus, among the survey respondents, higher nitrogen application rates appear to be concentrated among smaller groves. While this tendency may reflect the preferences of smaller grove operators, it could also be a function of product or site differences.

A strong negative association was found between the number of applications of fertilizer and the total amount of nitrogen fertilizer applied (Figure 10). As the total amount of fertilizer added decreased, the number of applications of fertilizer increased. This probably reflects the more frequent and more sparing fertilization of young groves. Three applications per year appears to be the normal practice.

For phosphorus fertilization, 45 percent of the respondents used super phosphate, 34 percent used diammonium phosphate, and 21 percent used triple super phosphate. Diammonium phosphate was applied to 25 percent of the survey area, super phosphate to 51 percent of the area, and triple super phosphate to 24 percent. The majority of respondents (73 percent) added phosphorus fertilizer at least once per year (Figure 11).

To further evaluate fertilization practices, growers were divided into two classes, those basing their fertilizer requirements on soil analysis, observation and yield, and those incorporating, along with these indicators, foliar analysis. The distribution of growers within these classes (Figures 12a and 12b) suggests some strong differences in fertilizer management between the groups. Growers relying on leaf analysis appear to be much more consistent in their use of nitrogen, with the majority

Figure 10

Frequency of Nitrogen Application within each Fertilizer Rate Class

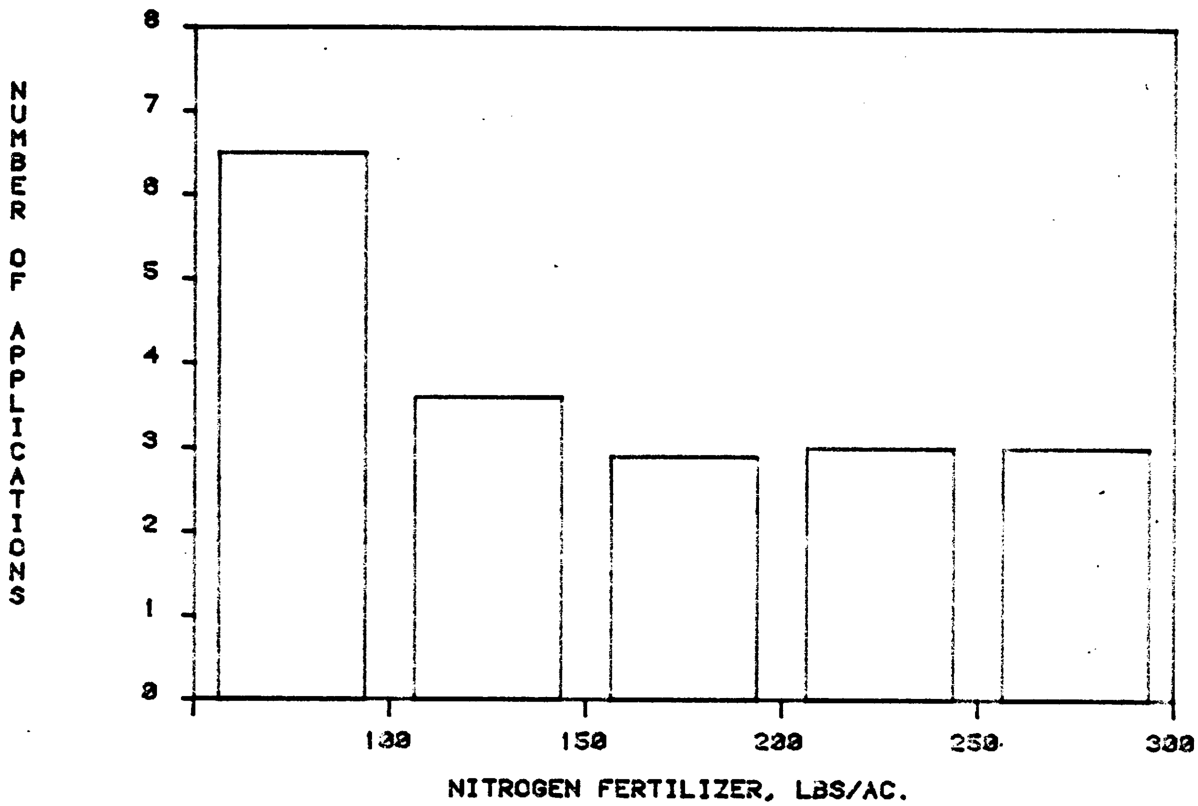


Figure 11

Number of Growers within each Phosphorus Fertilizer Rate Class

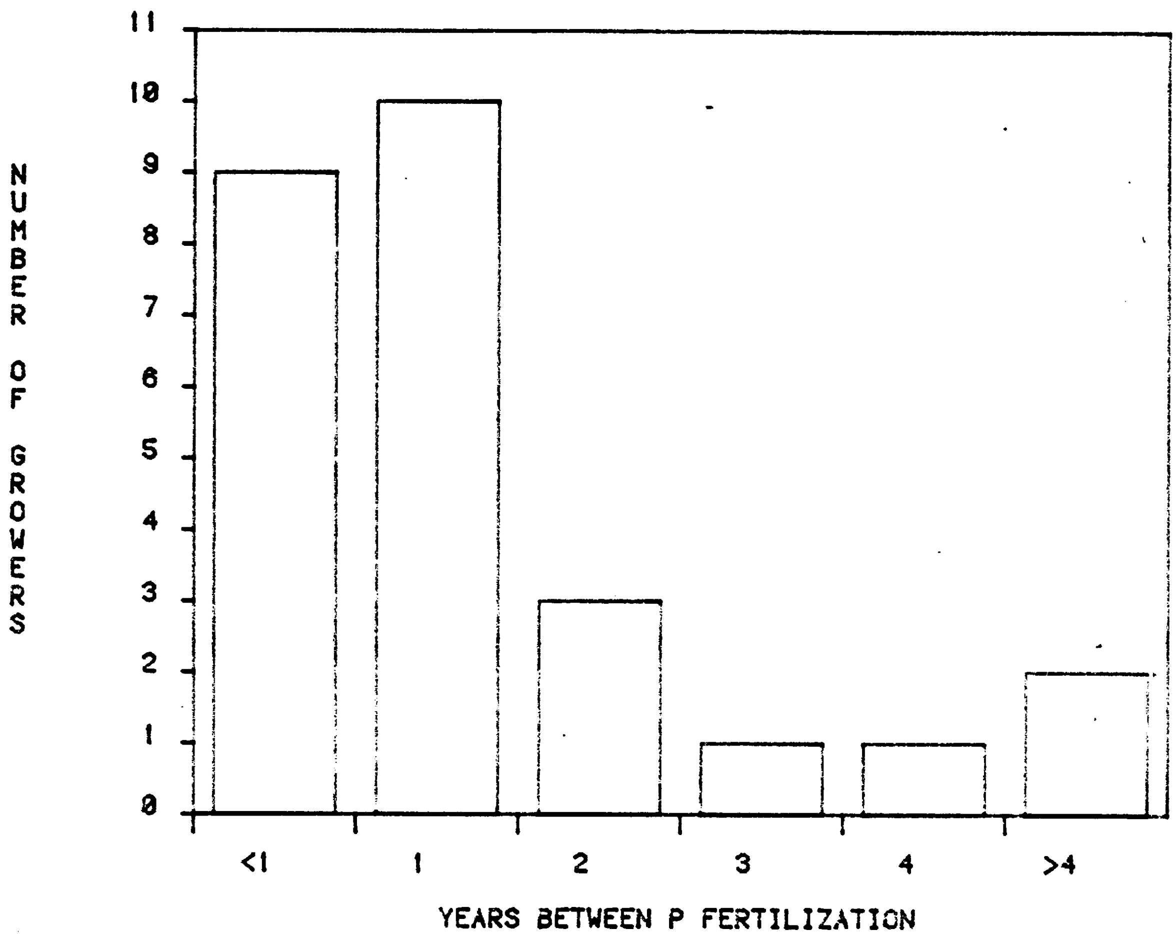
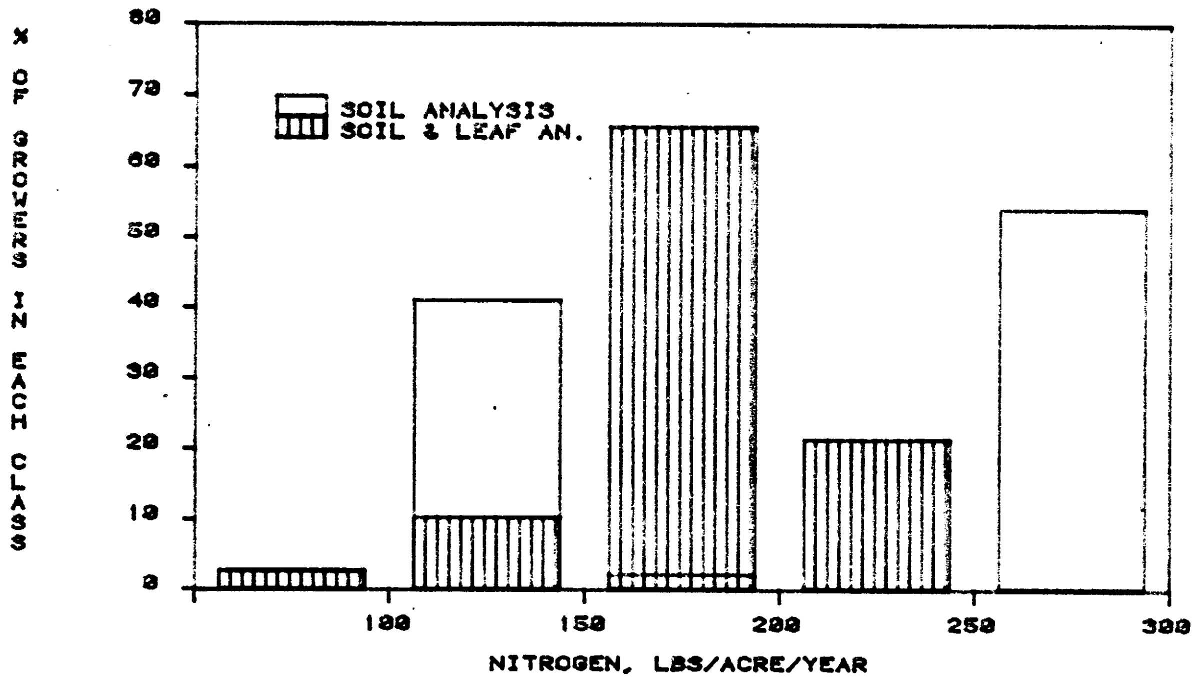
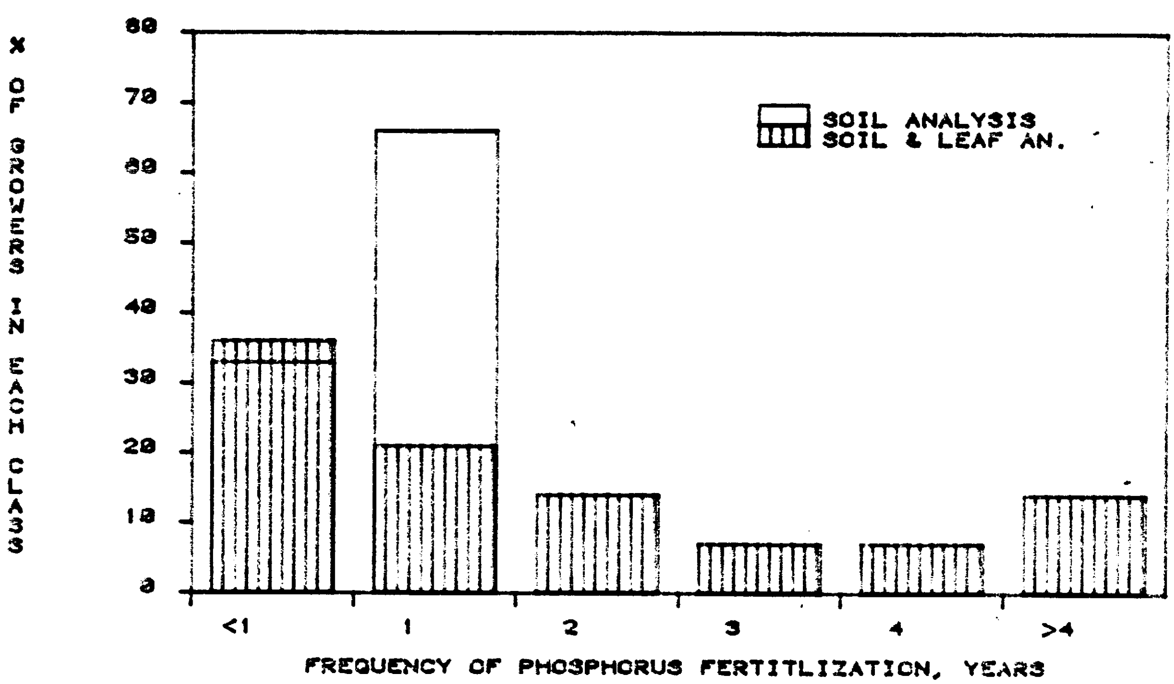


Figure 12

Percent Distribution of Growers Using Soil Analysis and Those Using Both Soil and Leaf Analysis



a) Nitrogen Fertilizer Rate Class



b) Phosphorus Fertilizer Frequency Class concentrated in the 150 to 200 pound per acre per year class. The opposite is true of this group in their frequency of phosphorus application, which ranges from more than once per year to less than once every four years. In general, survey respondents that rely on foliar analysis to aid in the determination of their fertilizer requirement tend to apply these nutrients at lower rates. None of the growers in this class used over 250 pounds per acre per year and many found it only infrequently necessary to apply phosphorus.

Table 10. Synopsis of survey responses on the routineness of particular chemical control programs

Target Pest	Percent Response			
	Routine	When Necessary	No Response	Mean Response
Fungus	60	40	0	16.5
Weeds	52	48	0	9.5
Mites and Scale	38	62	0	10.3
Insects	24	72	4	6.0
Nematodes	4	64	32	4.0

Overall, growers used pesticides as needed rather than as a routine (Table 10). However, the application of herbicides and fungicides was often performed routinely. Pesticides commonly used by the growers included ethion and oil for control of mites, oil as an insecticide, Roundup and Krovar for weed control, copper fungicide, and Temik for nematode control.

There were two responses to the beef cattle questionnaire, representing 2190 acres, or approximately 75 percent of the pasture area. Five hundred forty acres were classified as woodland grazing (unimproved pasture). The remaining 1650 acres were considered improved pasture, defined as lands maintained in forage grass. Both respondents indicated that improved pasture was fertilized once yearly in October. The respondents' fertilization rates were similar; 40 and 64 pounds of nitrogen per acre per year, 32 and 40 pounds of phosphorus per acre per year.

DISCUSSION

Water Quality

Because of the lack of flow data and a detailed water budget, conclusions which can be drawn regarding water quality improvements provided by the reservoir were very limited. Data interpretation was especially difficult because flow at the reservoir inlet is bidirectional due to irrigation and freeze protection demands.

The reservoir apparently removed significant amounts of inorganic nitrogen, considering the differences in concentration at the inlet and outlet. Inorganic nitrogen concentrations were reduced 75 percent on a mean annual basis. During significant discharges from the reservoir, reductions in inorganic nitrogen concentrations between the inlet and outlet exceeded 90 percent. At the Willowbrook Farms reservoir, located 31 miles north of SJWCD, mean annual inorganic nitrogen concentrations were reduced 89 percent between the inlet and outlet (Hendrickson, 1987). The Willowbrook Farms reservoir retained 93 percent of the inorganic nitrogen load contributed during the study period.

Mean annual total nitrogen concentrations were 19 percent less at the reservoir outlet compared to the inlet. In comparison, at Willowbrook Farms reservoir, mean annual total nitrogen concentrations were reduced 6 percent between the inlet and outlet, a 40 percent reduction in total nitrogen load. At Strazulla Groves, which are located 12 miles southeast of SJWCD in St. Lucie County, the reservoir retained 28 percent of the annual total nitrogen load (Davis, 1982).

Because mean annual organic nitrogen concentrations were unchanged between the SJWCD reservoir inlet and outlet, the difference in total nitrogen concentrations was due to reductions in inorganic nitrogen levels. At Willowbrook Farms reservoir, organic nitrogen concentrations increased between the inlet and outlet, as inorganic nitrogen was converted to organic nitrogen (Hendrickson, 1987). Goldstein (1986) noted that south Florida wetlands which received agricultural runoff reduced total nitrogen loads slightly due to seepage and temporary water storage. The active uptake of inorganic nitrogen occurred simultaneously with detrital production, resulting in a steady state condition.

Mean annual total phosphorus and orthophosphate concentrations were reduced 43 and 80 percent, respectively, between the reservoir inlet and outlet. These reductions are similar to those found for other south Florida wetlands, which typically reduce total phosphorus concentrations less than 50 percent (Goldstein, 1986). Total phosphorus loads were reduced 42 to 49 percent at similar agricultural reservoirs (Davis, 1982; Hendrickson, 1987).

SJWCD pump discharges were much lower in nutrients than nearby pumps at Fellsmere Water Control District (Table 11, Figure 1). Despite similar soils and land use (approximately 80 percent citrus), mean phosphorus and nitrogen concentrations were 2 and 3 times higher for the Fellsmere pumps. SJWCD pump discharges were more mineralized than those of Fellsmere, perhaps due to the recycling of irrigation water within the floodway and

TABLE 11

COMPARISON OF ST. JOHNS AND FELLSMERE WATER CONTROL DISTRICTS
PUMP WATER QUALITY

PARAMETER	SJWCD PUMPS MEAN	SJWCD PUMPS MIN/MAX	FELLSMERE PUMPS* MEAN	FELLSMERE PUMPS* MIN/MAX
WATER TEMP (C)	23.5	17.0/30.0	25.5	20.5/28.5
SECCHI (IN)	44.	36./60.	21.	10./36.
COLOR (CPU)	82.	50./275.	242.	100./498.
COND.(UMHOS/CM)	1220.	370./1690.	850.	550./1450.
D.O. (MG/L)	5.4	2.7/9.3	3.5	0.5/9.5
B.O.D. (MG/L)	2.1	0.8/3.7	2.9	1.4/6.3
PH (S.U.)	--	6.8/7.5	--	6.2/7.5
ALKALINITY(MG/L)	174.3	127.0/192.0	147.5	99.0/220.0
SUSP.SOL.(MG/L)	4.6	1.0/12.0	27.6	1.5/114.0
DISS.NH4 (MG/L)	0.16	0.01/0.60	0.39	0.05/0.75
TOT.NH4 (MG/L)	0.17	0.02/0.64	0.48	0.06/1.50
DISS.TKN (MG/L)	1.02	0.71/1.46	3.28	1.40/5.78
TOT.TKN (MG/L)	1.19	0.71/1.79	3.25	1.34/5.93
NOX (MG/L)	0.14	0.00/0.61	0.61	0.01/2.36
TOT.PHOS (MG/L)	0.09	0.05/0.19	0.19	0.07/0.47
DISS.PHOS(MG/L)	0.06	0.02/0.10	0.13	0.03/0.33
HARDNESS (MG/L)	396.3	260.0/468.0	271.0	29.2/510.0
CALCIUM (UG/L)	97.8	58.0/150.0	90.1	62.5/129.0
MAGNESIUM (UG/L)	22.7	15.0/35.0	27.0	13.0/39.0
SODIUM (UG/L)	99.3	44.0/185.0	39.3	10.2/72.0
POTASSIUM (UG/L)	7.3	3.4/15.0	5.6	2.5/9.4
CHLORIDE (MG/L)	210.0	100.0/308.0	98.0	68.0/150.0
SULFATE (MG/L)	118.0	61.0/165.0	96.0	14.0/209.0
IRON (UG/L)	234.0	88.0/723.0	245.0	80.0/1020.0
CHL A (UG/L)	9.8	2.5/41.1	23.8	1.1/197.8
CHL A/C (UG/L)	8.1	1.3/41.4	40.4	0.0/178.5
T.D.S. (MG/L)	790.0	496.0/1010.0	624.0	381.0/1042.0
ORTHOPHOS (MG/L)	0.06	0.00/0.16	0.10	0.03/0.23
TURBIDITY (NTU)	2.6	0.9/8.2	9.1	1.5/73.0

* SOURCE: FALL, 1987

reservoir. During this study's data collection period Fellsmere had no reservoir for detention and recycling of tail water.

Nutrient levels at the reservoir outlet were similar to background levels in the adjacent marsh (Table 12, Figure 1, Station BCT) with the exception of nitrate-nitrite. Nitrate-nitrite levels, which averaged 0.05 mg/l at the reservoir outlet compared to 0.01 mg/l in the adjacent, unimpounded marsh, should be reduced rapidly to background levels by passage through the adjacent marsh. Conservative parameters, such as chloride and total dissolved solids, were 2 to 3 times higher at the reservoir outlet than in the adjacent marsh.

Nutrient concentrations, and presumably nutrient loads, were relatively low at the reservoir inlet. The predominance of cattails in the southern (inlet) portion of the reservoir and sawgrass in the northern (outlet) portion may indicate a vegetational shift in response to a nutrient gradient, similar to that observed in south Florida wetlands (Davis et al, 1985). However, cattails and sawgrass are indistinguishable on the historic black and white photographs and changes in plant species can not be documented. The photographs do document a drastic shift from an herbaceous marsh to an open aquatic system. This change in wetland plant communities is most likely due to the change in hydroperiod following impoundment.

TABLE 12

COMPARISON OF ST. JOHNS WATER CONTROL DISTRICT DISCHARGE AND BACKGROUND MARSH WATER QUALITY

PARAMETER	SJWCD DISCHARGE STATION SWD MEAN	SJWCD DISCHARGE STATION SWD MIN/MAX	BACKGROUND MARSH* STATION BCT MEAN	BACKGROUND MARSH* STATION BCT MIN/MAX
WATER TEMP (C)	25.	16.5/32.0	25.0	14.0/31.0
SECCHI (IN)	76.	54./96.	-	--
COLOR (CPU)	66.2	40.0/150.0	218.3	100.0/450.0
COND.(UMHOS/CM)	987.	455./1450.	330.	170./530.
D.O. (MG/L)	6.0	4.6/7.2	3.6	0.4/6.0
B.O.D.(MG/L)	1.8	0.6/3.5	2.5	0.9/6.5
PH (S.U.)	--	7.2/7.6	--	5.4/7.0
ALKALINITY(MG/L)	120.0	97.0/161.0	34.5	9.0/76.0
SUSP.SOL.(MG/L)	3.0	0.1/9.0	21.6	2.7/60.0
DISS.NH4 (MG/L)	0.04	0.00/0.14	0.03	0.03/0.04
TOT. NH4 (MG/L)	0.04	0.00/0.14	0.02	0.00/0.04
DISS.TKN (MG/)	0.94	0.65/1.25	1.40	0.94/1.91
TOT. TKN (MG/L)	1.11	0.78/1.57	2.12	1.11/3.37
NOX (MG/L)	0.05	0.01/0.38	0.01	0.00/0.01
TOT. PHOS.(MG/L)	0.04	0.00/0.13	0.05	0.02/0.08
DISS.PHOS.(MG/L)	0.02	0.00/0.04	0.03	0.01/0.04
HARDNESS (MG/L)	286.0	180.0/350.0	74.0	34.0/148.0
CALCIUM (UG/L)	69.6	53.0/111.0	22.3	9.8/46.0
MAGNESIUM (UG/L)	19.0	9.0/29.0	6.4	3.5/11.0
SODIUM (UG/L)	74.9	24.0/137.0	34.0	18.0/55.0
POTASSIUM (UG/L)	7.4	5.6/9.8	2.9	1.2/6.0
CHLORIDE (MG/L)	160.0	24.0/274.0	64.5	42.0/113.0
SULFATE (MG/L)	95.0	45.0/128.0	13.7	1.0/37.0
IRON (UG/L)	73.3	50.0/266.0	243.0	135.0/304.0
CHL A (UG/L)	9.3	2.8/39.0	15.9	2.3/61.6
CHL A/C (UG/L)	8.0	2.1/38.0	11.4	0.0/57.5
T.D.S. (MG/L)	614.0	363.0/879.0	226.0	161.0/344.0
ORTHOPHOS (MG/L)	0.01	0.00/0.06	0.01	0.00/0.02
TURBIDITY (NTU)	0.8	0.5/1.5	3.4	0.8/7.0

* SOURCE: SJRWMD PERMANENT MONITORING NETWORK (UNPUBLISHED DATA)

Because of the short study period, it is not known if the nutrient uptake capabilities of the reservoir have changed over time. In other Florida wetlands, the phosphorus removal efficiency has declined over time (Goldstein, 1986). The decline in efficiency, which is due to an expanding saturation zone with minimal uptake, appears to be inversely related to the loading rate (Kadlec, 1985). The St. Johns Water Control District reservoir has probably maintained a significant level of phosphorus removal after 20 years of operation due to the low loading rate.

PESTICIDE AND FERTILIZATION SURVEY

The results of survey responses from citrus growers represented 16,000 acres of groves of the Indian River Citrus area. Respondents indicated nitrogen fertilizer applications from less than 100 to up to 300 pounds per acre per year, with 31 percent of the respondents indicating the use of greater than 200 pounds per acre per year. However, this group represented only 8 percent of the acreage surveyed, suggesting that such higher rates are limited to smaller groves. Most respondents (76 percent) indicated they applied phosphorus at least annually and more frequently. Nitrogen fertilization rates greater than 200 pounds per acre per year are believed to increase fruit production less than 5 percent, and an even lower maximum of 150 pounds per acre per year is recommended for the Indian River area (Koo, 1984). Also, due to phosphorus accumulation in the soil, annual applications in older groves is seldom necessary. There appears to be some suggestion that growers relying on foliar analysis to assist in determining fertilizer requirements, fertilize at lower frequencies and total amounts. Several words of caution are necessary regarding this observation. While mean fertilizer use was less for respondents indicating the use of foliar analysis, the difference was not significant in this sample. Secondly, because no data on yield is available, it cannot be determined whether or not these lower levels are not also reflected in lower yields.

The primary chemical control agents used within citrus groves appear to be herbicides and fungicides. The frequent use of copper as a fungicide suggests the possibility of copper build-up in grove soils in cases where it is also used as a micronutrient. Despite the high susceptibility of soils of the survey area for citrus nematode infestation, the use of the nematicides ranked the lowest in the level of routine application.

According to the survey, the respondents did not apply any of the analyzed pesticides (Table 3). Although there may be other reasons why no pesticides were detected, such as an inappropriate samplying frequency, the inconsistency between pesticides applied and analyzed severely limits any conclusions regarding pesticide transport or uptake.

CONCLUSIONS

The St. Johns Water Control District reservoir significantly reduces inorganic nitrogen and orthophosphate levels in agricultural runoff, based on differences in reservoir inlet and outlet concentrations. Since the reservoir was designed to store irrigation water and to reduce the frequency and amount of discharge, the reductions in nutrient concentration should produce a greater reduction in nutrient loads to downstream water bodies.

Pump discharges to the reservoir had relatively good water quality. Lower than expected nutrient levels contributed by agricultural operations, combined with the nutrient removal provided by the reservoir, produced reservoir discharges consistent with background marsh nutrient levels. However, reservoir discharges were more mineralized than were the waters of the adjacent marsh.

Nutrient uptake processes in the reservoir appeared to function more effectively in the shallow marsh than in an interior borrow canal. A shift in the reservoir vegetation from herbaceous marsh to open water was probably due to a change in hydroperiod. Low nutrient loading rates and maintenance of natural water level fluctuations should reduce changes in plant communities in similar reservoirs.

Citrus growers within the Water Control District applied nitrogen fertilizer at widely varying rates, based on soil analysis or visual observation. Foliar analysis, which seemed to reduce the amount and frequency of fertilizer application, showed promise as a management practice. Pesticides were used as needed, although herbicides and fungicides were applied routinely.

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APPENDIX A

APPENDIX B

CITRUS QUESTIONNAIRE

Space is provided at the end of this questionnaire for questions or additional comments you may have on any section.

1) How many total acres do you have in citrus groves? _________

2) Please indicate the number of acres of groves under the levels of nitrogen fertilization given below, and the number of applications over which this total amount is spread.

Pounds of Nitrogen per acre per year	Number of acres	Number of applications
less than 100	________	_____
100 - 150	________	_____
150 - 200	________	_____
200 - 250	________	_____
250 - 300	________	_____
greater than 300	________	_____

3) Please indicate the type of phosphorus fertilizer preferred.

Diammonium phosphate	____
Superphosphate	____
Triple superphosphate	____
Rock Phosphate	____

4) Please indicate the number of acres receiving phosphorus fertilization at the rates given below.

	Acres
greater than one application every year	____
one application every year	____
one application every 2 years	____
one application every 3 years	____
one application every 4 years	____
over 4 years per application	____

5) In determining fertilizer requirements, do you use:
(Please check all that apply.)

a) Soil analysis ___ b) Leaf analysis __

c) Observation ___ d) Other (please specify) ____________

6) Please indicate which of the following products you use for the control of:

Mites and Scale		Insects (general)	
Ethion	___	Guthion	__
Trithion	___	Larsban	__
Oil	___	Malathion	__
Cornite	___	Cygon	__
Dicofol	___	Metasystox	__
Kelthane	___	Systox	__
Vendex	___	Supracide	__
Cygon	___	Diazinon	__
Dimethoate	___	Oil	__
Acaraben	___	Other (Please specify)	__
Carzol	__		
Plictran	__		
Sulfur	__		
Other (Please specify)	__		

7) Please indicate which of the following fungicides, nematicides and herbicides are used in your management schedule.

Fungicides		Soil Treatments		Herbicides	
Ditolatan 80 Sprills	__	Methyl Bromide	___	Hyvar	__
Copper	___	Vapum	___	Karmex	__
Oil	___	Vorlex	___	Krovar	__
Other (Please specify)	___	Vemacur	___	Sinbar	__
		Temik	___	Princep	__
		Other (Please specify)	___	Treflan	__
				Evik	__
				Solicam	__
				Roundup	__
				Paraquat	__
				De Vine	__
				Other (Please specify)	__

8) Of the previous five categories of compounds, which are integrated into annual management programs routinely or when needed?

	When Needed	Routinely
Mite and scale control	___________	________
Insect control	___________	________
Fungicides	___________	________
Soil treatment	___________	________
Herbicides	___________	________

Would you like a summary of the results of this survey?
Yes ___ No __

If yes, please include your return address on the enclosed return envelope.

Comments: ____

____

____

BEEF CATTLE QUESTIONNAIRE

Space is provided at the end of this questionnaire for questions or additional comments you may have on any section.

1) Please indicate the total number of acres you devote to livestock production, and the approximate number of cattle produced on these acres.

Number of acres _________ Number of animals _______

For the purpose of this survey, consider woodland grazing to be the grazing of wooded areas without effort to produce forage grasses, improved pasture to be lands cleared and maintained in forage grasses which are grazed at periods throughout the year, and intensive pasture to be lands devoted to producing hay crops, and which may also be grazed in the off season.

2) Please indicate the approximate number of acres you maintain under each of the above-described uses:

	Acres
Woodland grazing	____
Improved Pasture	____
Intensive Pasture	____

3) If you maintain any lands designated as intensive pasture, please indicate the amount and timing of fertilizer applications.

	Fertilizer Mix	lbs/ac	Time of Cutting
1st crop	______________	__________	______________
2nd crop	______________	__________	______________
3rd (if any)	______________	__________	______________
4th (if any)	______________	__________	______________

4) For the lands designated as improved pasture, is some level of pasture fertilization practiced? Yes ___ No ___

If yes, please indicate the amount of this fertilization and the timing.

	Fertilizer Mix	lbs/ac	Timing (Month)
1st Application	_____________	______	____________
2nd (if any)	_____________	______	____________
3rd (if any)	_____________	______	____________

5) For intensive pasture lands, please indicate the insecticide used for control of army worm.

Sevin ___

Lannate ___

Other (please specify) _______________

No control __

Would you like a summary of the results of this survey?

Yes ____ No ___

If yes, please include your return address on the enclosed return envelope.

Comments: ____

____

____

____

____

____

APPENDIX B

F I E L D   D A T A   S U M M A R Y

S A M P L E	SAMPLE DEPTH 3/98 FT/MT	STREAM DEPTH 97/198 FT/MT	WATER TEMP 10 DEG C	AIR TEMP 20 DEG C	CLOUD COVER 32 %	WIND DIR 36 DEG	WIND SPEED 35 MPH	SECCHI 77 IN	FLOW 61 CFS	COND 94/95 UMHOS/CM	DO 299/300 MG/L	SALINITY 480 PPTH	PH 400 STD UNIT
SWPA8411071113	0.5 MT	1.6 MT	20.0	21.0	5.	0.0	10.	60.0		1100.	4.90		7.20
SWPA8412061115			24.0	22.0	80.	15.0	12.			366.	2.70		6.80
SWPA8501101100	0.5 MT		17.0	20.0	0.	300.0	2.			1330.	6.30		7.20
SWPA8502071115	0.5 MT		21.0		100.	0.0	5.			1545.	5.30		7.00
SWPA8503071100	0.5 MT		21.5	24.0	100.	45.0	12.			1680.	3.30		7.20
SWPA8504041110	0.5 MT	1.0 MT	20.5		0.	180.0	2.			1685.	5.30		7.40
SWPA8505091130	0.5 MT	2.0 MT	26.5	28.0	40.	90.0	8.	36.0		1500.	6.40		7.50
SWPA8506061115	0.5 MT		30.0	32.0	10.	270.0	5.			1560.	7.00		7.00
SWPA8508081145	0.5 MT		28.5	31.0	70.	180.0	5.			725.	3.10		6.90
SWPA8510041224	0.5 MT		27.5	27.0	70.					835.	5.00		7.10
SWPA8511061200	0.5 MT		20.0		0.	300.0	5.	36.0L		950.	9.20		6.90
SWFA8411071240	0.5 MT	2.0 MT	22.0	21.0	5.	0.0	10.	68.0		1000.	8.15		7.20
SWFA8412061210			22.5	22.0	80.	15.0	12.			850.	2.80		7.10
SWFA8501101130	0.5 MT	1.5 MT	16.5	20.0	0.	300.0	2.	52.0L		810.	8.50		7.70
SWFA8502071145	0.5 MT	1.3 MT	21.0		100.	0.0	5.	48.0L		1340.	5.90		7.40
SWFA8503071130	0.5 MT	1.0 MT	23.0	24.0	100.	45.0	12.			1420.	4.90		7.20
SWFA8504041155	0.5 MT	1.5 MT	21.3		0.	180.0	2.			1630.	4.60		7.20
SWFA8505091205	0.5 MT	1.5 MT	27.5	28.0	40.	90.0	8.	66.0L		1320.	3.60		7.40
SWFA8506061200	0.5 MT	1.0 MT	31.5	32.0	10.	270.0	5.	36.0L		1390.	5.10		7.10
SWFA8508081220	0.5 MT		30.0	31.0	70.	180.0	5.	54.0		740.	2.90		6.80
SWFA8509121429	0.5 MT		28.5		75.			60.0		950.	2.70		6.90
SWFA8510041310	0.5 MT		28.0	27.0	70.					800.	3.00		7.20
SWFA8511061300	0.5 MT	1.0 MT	21.0		0.	300.0	5.			1120.	4.70		7.00
SWRA8412061250			24.0	22.0	80.	15.0	12.	79.0L		640.	8.40		7.00
SWRA8501101240	0.5 MT	2.5 MT	16.2	20.0	0.	300.0	2.	84.0L		797.	6.20		7.40
SWRA8502071230	0.5 MT	0.8 MT	21.5		100.	0.0	5.	30.0L		1200.	6.40		7.40
SWRA8503071215	0.5 MT	0.7 MT	22.0	24.0	100.	45.0	12.			1245.	6.30		7.40
SWRA8504041240	0.5 MT	1.3 MT	22.0		0.	180.0	2.			1550.	5.30		7.40
SWRA8505091255	0.5 MT	1.3 MT	28.0	28.0	40.	90.0	8.	50.0L		1350.	5.60		7.40
SWRA8506061300	0.5 MT	0.8 MT	31.5	32.0	10.	270.0	5.	24.0L		1400.	8.50		7.60
SWRA8508081310	0.5 MT		31.0	31.0	70.	180.0	5.	54.0L		910.	7.20		7.50
SWRT8509121309	0.5 MT	1.0 MT	30.6		75.			24.0L		680.	11.60		7.70
SWRO8509121324	0.5 MT	1.0 MT	30.7		75.			36.0L		880.	7.70		7.80
SWRA8509121342	0.5 MT	1.0 MT	30.9		75.			34.0L		720.	8.60		7.60
SWRW8509121415	0.5 MT	1.0 MT	30.8		75.			34.0L		700.	7.90		7.80
SWRA8510041354	0.5 MT		29.5	27.0	70.					400.	5.00		7.10
SWRA8511061355	0.5 MT	1.0 MT	20.5		0.	300.0	5.	34.0L		750.	6.00		7.30
SWAA8412061255		2.0 MT	23.5	22.0	80.	15.0	12.			780.	6.10		7.30
SWAA8501101250	0.5 MT	3.0 MT	17.1	20.0	0.	300.0	2.	90.0		555.	8.10		7.60
SWAA8502071240	0.5 MT	2.0 MT	22.0		100.	0.0	5.	72.0L		1200.	9.60		7.50
SWAA8503071230	0.5 MT	3.0 MT	23.0	24.0	100.	45.0	12.			1240.	6.70		7.50
SWAA8504041250	0.5 MT	3.0 MT	22.0		0.	180.0	2.			1545.	5.30		7.40
SWAA8505091305	0.5 MT	5.0 MT	28.0	28.0	40.	90.0	8.	120.0		1350.	5.00		7.50
SWAA8506061310	0.5 MT	3.0 MT	31.5	32.0	10.	270.0	5.	84.0		1300.	8.20		7.20
SWAA8508081320	0.5 MT		31.0	31.0	70.	180.0	5.	92.0		920.	8.50		7.50
SWAU8509121253	0.5 MT	5.0 MT	29.5		75.			48.0		710.	4.50		7.20
SWAT8509121445	0.5 MT		28.7		75.			60.0		650.	4.10		6.90
SWAA8509121459	0.5 MT		28.8		75.			60.0		740.	4.45		7.10
SWAA8510041348	0.5 MT		29.0	27.0	70.					480.	3.50		7.70
SWAA8511061405	0.5 MT	4.0 MT	22.0		0.	300.0	5.	84.0		350.	6.00		7.40

FIELD DATA SUMMARY

SAMPLE	SAMPLE DEPTH 3/98 FT/MT	STREAM DEPTH 97/198 FT/MT	WATER TEMP 10 DEG C	AIR TEMP 20 DEG C	CLOUD COVER 32 %	WIND DIR 36 DEG	WIND SPEED 35 MPH	SECCHI 77 IN	FLOW 61 CFS	COND 94/95 UMHOS/CM	DO 299/300 MG/L	SALINITY 480 PPTH	PH 400 STD UNIT
SWDA8411071335	0.5 MT	2.5 MT	22.0	21.0	5.	0.0	10.	84.0		500.	5.40		7.30
SWDA8412061330		2.0 MT	22.5	22.0	60.	15.0	12.	72.0L		745.	4.70		7.20
SWDA8501101330	0.5 MT	2.0 MT	16.5	20.0	0.	300.0	2.	66.0		850.	7.20		7.50
SWDA8502071320	0.5 MT	2.0 MT	21.5		100.	0.0	5.	70.0L		1140.	7.20		7.00
SWDA8503071300	0.5 MT	1.5 MT	23.0	24.0	100.	45.0	12.			1220.	[illegible]		7.50
SWDX8503071315				24.0	100.	45.0	12.						
SWDA8504041330	0.5 MT	2.0 MT	23.5		0.	180.0	2.			1450.	5.20		[illegible]
SWDA8505091335	0.5 MT	2.1 MT	27.5	28.0	40.	90.0	8.	84.0L		1300.	6.50		7.50
SWDA8506061405	0.5 MT	2.0 MT	32.0	32.0	10.	270.0	5.	72.0L		1300.	[illegible]		7.30
SWDA8508081400	0.5 MT		31.5	31.0	70.	180.0	5.	96.0		1040.	[illegible]		[illegible]
SWDA8509121307	0.5 MT		30.7		75.			54.0		650.	6.30		7.20
SWDA8510041500	0.5 MT		30.0	27.0	70.					455.	5.50		7.40
SWDA8511061500	0.5 MT	2.2 MT	22.0		0.	320.0	5.	84.0		750.	4.60		7.50

L A B O R A T O R Y   D A T A   S U M M A R Y   (MINERALS AND BIOLOGICAL)

SAMPLE	TURB 82079 NTU	ALK 410 MG/L	HARD 900 MG/L	COLOR 80/81 PT-CO	SULFATE 945 MG/L	CHLORIDE 940/941 MG/L	FLUORIDE 950 MG/L	BOD 310 MG/L	RES DISS 70300 MG/L	RES SUS 530 MG/L	SULFIDE 745 MG/L	TOC 680 MG/L	CHL A 32210 UG/L	PHEO A 32218 UG/L
PA8411071113	1.1	150.0	336.0	70.	109.0	130.0		1.0	665.	2.0			2.15	2.03
PA8412061115	6.0	192.0	420.0	50.	144.0	150.0		0.8	735.	10.0			4.79	5.05
PA8501101100	0.9	179.0	404.0	55.	127.0	228.0		1.4	755.	1.0			3.36	1.26
PA8502071115	2.4	187.0	432.0	50.	144.0	265.0		2.0	860.	2.5			4.79	3.69
PA8503071100	1.5	182.0	460.0	60.	160.0	308.0		1.5	1010.	6.5			5.20	4.04
PA8504041110	1.3	184.0	460.0	60.	165.0	263.0		3.1	951.	1.0			6.40	3.05
PA8505091130	1.5	182.0	408.0	70.	126.0	258.0		2.4	932.	2.5			3.43	6.09
PA8506061115	1.7	174.0	430.0	70.	80.0	294.0		3.7	958.	3.0			11.25	4.41
PA8508081145	1.8	127.0	260.0	275.	61.0	100.0		3.0	496.	2.0			3.92	2.03
PA8510041224	2.5	170.0	345.0	70.	90.0	169.0		1.7	706.	12.0			6.77	1.79
PA8511061200	8.2	190.0		70.	90.0	125.0		2.2	621.	6.0			41.10	0.00
FA8411071240	1.2	111.0	260.0	70.	101.0	140.0		0.9	565.	2.0			2.59	1.76
FA8412061210	1.3	143.0	300.0	100.	85.0	116.0		1.0	547.	2.0			1.65	1.36
FA8501101130	0.6	120.0	260.0	55.	80.0	108.0		0.7	462.	0.5			3.24	2.89
FA8502071145	0.7	153.0	356.0	50.	125.0	248.0		0.6	734.	2.0			6.78	4.33
FA8503071130	1.0	161.0	372.0	60.	132.0	243.0		1.3	851.	3.5			4.75	4.40
FA8504041155	1.3	165.0	408.0	55.	122.0	271.0		2.4	901.	0.5			2.89	1.42
FA8505091205	0.5	125.0	352.0	55.	131.0	254.0		2.5	830.	2.5			5.30	3.93
FA8506061200	0.8	110.0	340.0	50.	125.0	290.0		2.6	871.	2.5			3.84	4.84
FA8508081220	0.8	117.0	240.0	175.	76.0	98.0		2.1	488.	1.0			5.05	1.15
FA8509121429	1.5	171.0	332.0	425.	87.0	30.0		1.5	629.	1.0				
FA8510041310	2.2	169.0	308.0	125.	88.0	111.0		1.2	619.	7.0			7.80	0.11
FA8511061300	1.5	167.0		70.	100.0	158.0		0.6	662.	1.5			3.07	1.50
RA8412061250	0.4	106.0	216.0	70.	60.0	82.0		1.1	415.	2.0			3.94	3.10
RA8501101240	0.9	127.0	252.0	55.	67.0	116.0		1.8	444.	1.0			2.93	1.42
RA8502071230	0.6	135.0	324.0	50.	119.0	194.0		0.9	667.	6.0			10.90	3.15
RA8503071215		121.0	336.0	40.	129.0	231.0			752.				6.14	2.75
RA8504041240	0.8	143.0	372.0	50.	106.0	263.0		3.1	836.	0.5			5.72	2.00
RA8505091255	0.8	130.0	340.0	55.	118.0	250.0		2.4	833.	3.0			3.57	4.62
RA8506061300	0.8	106.0	330.0	50.	146.0	268.0		1.8	871.	0.5			2.95	0.94
RA8508081310	1.0	107.0	290.0	55.	95.0	146.0		1.9	594.	5.0			3.03	1.39
RT8509121303	0.9	127.0	240.0	125.	63.0	23.0		2.8	483.	5.0			8.08	3.86
RG8509121324	2.0	98.0	200.0	60.	68.0	24.0		2.3	437.	7.0			4.29	0.46
RA8509121342	0.6	117.0	236.0	65.	68.0	24.0		2.0	476.	3.0			2.44	0.03
RA8509121415	2.0	102.0	216.0	100.	52.0	23.0		3.1	444.	3.0			4.43	1.12
RA8510041354	1.6	122.0	200.0	150.	45.0	60.0		2.8	398.	12.0			38.56	7.43
RA8511061355	1.8	144.0		70.	72.0	102.0		2.2	523.	0.5			4.68	1.04
AA8412061255	0.5	124.0	256.0	70.	74.0	90.0		0.5	462.	3.5			5.06	1.79
AA8501101250	1.0	139.0	272.0	55.	67.0	126.0		1.9	488.	1.5			14.71	2.17
AA8502071240	1.0	140.0	376.0	50.	119.0	198.0		1.3	663.	2.5			15.39	3.77
AA8503071230	0.9	115.0	324.0	40.	114.0	221.0		1.7	764.	7.5			12.03	2.39
AA8504041250	1.0	147.0	392.0	55.	125.0	256.0		3.2	861.	1.0			12.34	4.01
AA8505091305	0.6	130.0	340.0	55.	121.0	252.0		2.0	858.	2.2			[illegible]	4.17
AA8506061310	1.4	109.0	[illegible]	50.	132.0	286.0		3.2	786.	3.5			[illegible]	[illegible]
AA8508081320	1.1	112.0	280.0	55.	[illegible]	146.0		2.1	573.	1.0			[illegible]	1.94
AT8509121255	1.0	121.0	240.0	150.	63.0	24.0		3.1	491.	4.0			13.21	[illegible]
AT8509121445	1.8	159.0	300.0	175.	77.0	27.0		4.0	596.	6.0			25.87	5.27
AA8509121459	1.9	115.0	232.0	100.	57.0	23.0		3.0	491.	1.0			6.82	2.06
AA8510041348	1.4	120.0	198.0	150.	47.0	56.0		2.4	379.	5.0			25.09	3.39
AA8511061405	1.6	153.0		70.	84.0	119.0		2.4	581.	0.5			16.11	0.00

LABORATORY DATA SUMMARY (MINERALS AND BIOLOGICAL)

SAMPLE	TURB 82079 NTU	ALK 410 MG/L	HARD 900 MG/L	COLOR 80/81 PT-CO	SULFATE 945 MG/L	CHLORIDE 940/941 MG/L	FLUORIDE 950 MG/L	BOD 310 MG/L	RES DISS 70300 MG/L	RES SUS 530 MG/L	SULFIDE 745 MG/L	TOC 680 MG/L	CHL A 32210 UG/L	PHEO A 32218 UG/L
PA8411071113	1.1	150.0	336.0	70.	109.0	180.0		1.0	665.	2.0			2.15	2.93
PA8412061115	6.0	192.0	420.0	50.	144.0	150.0		0.3	735.	10.0			4.79	5.05
PA8501101100	0.9	179.0	404.0	55.	127.0	228.0		1.4	755.	1.0			3.36	1.26
PA8502071115	2.4	187.0	432.0	50.	144.0	265.0		2.0	860.	2.5			4.79	3.69
PA8503071100	1.5	182.0	460.0	60.	160.0	308.0		1.5	1010.	6.5			5.20	4.04
PA8504041110	1.3	184.0	466.0	60.	165.0	263.0		3.1	951.	1.0			6.40	3.05
PA8505091130	1.5	182.0	408.0	70.	126.0	258.0		2.4	932.	2.5			3.43	6.09
PA8506061115	1.7	174.0	430.0	70.	80.0	294.0		3.7	958.	3.0			11.25	4.41
PA8508081145	1.8	127.0	260.0	275.	61.0	100.0		3.0	496.	2.0			9.92	2.03
PA8510041224	2.5	170.0	345.0	70.	90.0	169.0		1.7	706.	12.0			6.77	1.79
PA8511061200	8.2	190.0		70.	90.0	123.0		2.2	621.	6.0			41.10	0.00
FA8411071240	1.2	111.0	260.0	70.	101.0	140.0		0.9	565.	2.0			2.59	1.76
FA8412061210	1.3	143.0	300.0	100.	85.0	116.0		1.0	547.	2.0			1.65	1.36
FA8501101130	0.6	120.0	260.0	55.	80.0	108.0		0.7	462.	0.5			3.24	2.89
FA8502071145	0.7	153.0	356.0	50.	125.0	248.0		0.6	734.	2.0			6.78	4.33
FA8503071130	1.0	161.0	372.0	60.	132.0	243.0		1.3	851.	3.5			4.75	4.40
FA8504041155	1.3	165.0	408.0	55.	122.0	271.0		2.4	901.	0.5			2.89	1.42
FA8505091205	0.5	125.0	352.0	55.	131.0	254.0		2.5	830.	2.5			5.30	3.93
FA8506061200	0.8	110.0	340.0	50.	125.0	290.0		2.6	871.	2.5			3.84	4.84
FA8508081220	0.8	117.0	240.0	175.	76.0	98.0		2.1	488.	1.0			5.05	1.15
FA8509121429	1.5	171.0	332.0	425.	87.0	30.0		1.5	629.	1.0				
FA8510041310	2.2	169.0	308.0	125.	88.0	111.0		1.2	619.	7.0			7.80	0.11
FA8511061300	1.5	167.0		70.	100.0	158.0		0.6	662.	1.5			3.07	1.60
RA8412061250	0.4	106.0	216.0	70.	60.0	82.0		1.1	415.	2.0			3.34	3.10
RA8501101240	0.9	127.0	252.0	55.	67.0	116.0		1.8	444.	1.0			2.93	1.42
RA8502071230	0.6	135.0	324.0	50.	119.0	194.0		0.9	667.	6.0			10.30	3.15
RA8503071215		121.0	336.0	40.	129.0	231.0			752.				6.14	2.75
RA8504041240	0.8	143.0	372.0	50.	106.0	263.0		3.1	836.	0.5			5.72	2.00
RA8505091255	0.8	130.0	340.0	55.	118.0	250.0		2.4	833.	3.0			3.57	4.62
RA8506061300	0.8	106.0	330.0	50.	146.0	268.0		1.8	871.	0.5			2.95	0.94
RA8508081310	1.0	107.0	230.0	55.	95.0	146.0		1.9	594.	5.0			3.03	1.39
RT8509121300	0.9	127.0	240.0	125.	63.0	23.0		2.8	463.	5.0			8.08	3.86
RC8509121324	2.0	98.0	200.0	60.	68.0	24.0		2.3	437.	7.0			4.29	0.48
RA8509121342	0.6	117.0	236.0	65.	63.0	24.0		2.0	476.	3.0			2.44	0.03
RA8509121415	2.0	102.0	216.0	100.	52.0	23.0		3.1	444.	3.0			4.41	1.12
RA8510041354	1.6	122.0	200.0	150.	45.0	60.0		2.8	398.	12.0			38.36	7.43
RA8511061355	1.8	144.0		70.	72.0	102.0		2.2	523.	0.5			4.68	1.04
AA8412061255	0.5	124.0	256.0	70.	74.0	90.0		0.5	462.	3.5			5.06	1.79
AA8501101250	1.0	139.0	272.0	55.	67.0	126.0		1.9	488.	1.5			14.71	2.17
AA8502071240	1.0	140.0	376.0	50.	119.0	198.0		1.3	663.	2.5			15.39	3.77
AA8503071230	0.9	115.0	324.0	40.	114.0	221.0		1.7	764.	7.5			12.03	3.39
AA8504041250	1.0	147.0	392.0	55.	125.0	259.0		3.2	861.	1.0			12.34	4.51
AA8505091305	0.6	130.0	340.0	55.	121.0	252.0		2.0	682.	2.2			[illegible]	[illegible]
AA8506061310	1.4	109.0	350.0	50.	132.0	266.0		3.2	788.	3.5			[illegible]	[illegible]
AA8508081320	1.1	112.0	230.0	55.	[illegible]	146.0		2.1	573.	1.0			[illegible]	0.94
AT8509121255	1.0	121.0	240.0	150.	53.0	24.0		3.1	491.	4.0			13.21	5.10
AT8509121445	1.8	159.0	300.0	175.	77.0	27.0		4.0	596.	6.0			25.87	5.27
AA8509121459	1.9	115.0	232.0	100.	57.0	23.0		3.0	491.	1.0			6.82	2.06
AA8510041348	1.4	120.0	198.0	150.	47.0	56.0		2.4	379.	5.0			25.09	3.39
AA8511061405	1.6	153.0		70.	94.0	119.0		2.4	581.	0.5			16.11	0.00

LABORATORY DATA SUMMARY (MINERALS AND BIOLOGICAL)

SAMPLE	TURB 82079 NTU	ALK 410 MG/L	HARD 900 MG/L	COLOR 80/81 PT-CO	SULFATE 945 MG/L	CHLORIDE 940/941 MG/L	FLUORIDE 950 MG/L	BOD 310 MG/L	RES DISS 70300 MG/L	RES SUS 530 MG/L	SULFIDE 745 MG/L	TOC 680 MG/L	CHL A 32210 UG/L	PHEO A 32218 UG/L
DA8411071305	0.9	104.0	248.0	50.	94.0	116.0		1.1	485.	1.5			[illegible]	1.09
DA8412061300	0.7	120.0	260.0	70.	74.0	91.0			473.	1.5			4.29	2.30
DA8501101330	1.1	135.0	240.0	55.	60.0	126.0		0.6	476.	2.5			7.85	2.54
DA8502071320	0.5	135.0	324.0	50.	115.0	181.0		0.7	633.	1.0			8.39	2.41
DA8503071300	0.7	113.0	312.0	40.	126.0	225.0		1.3	772.	6.5			5.05	4.20
DA8503071315		115.0	324.0	40.	123.0	223.0								
DA8504041330	0.5	161.0	344.0	50.	99.0	249.0		2.8	842.	0.1K			2.02	1.23
DA8505091335	0.6	125.0	340.0	55.	128.0	250.0		1.4	853.	1.6			4.05	0.69
DA8506061405	0.8	106.0	350.0	50.	127.0	274.0		2.4	879.	[illegible]				
DA8508081400	0.6	97.0	290.0	55.	101.0	189.0			550.	4.0			[illegible]	[illegible]
DA8509121307	0.6	109.0	216.0	125.	73.0	24.0		3.5	461.	4.0			[illegible]	1.02
DA8510041500	1.5	108.0	180.0	150.	45.0	52.0		3.3	363.	9.0			56.99	1.04
DA8511061500	1.0	138.0		70.	64.0	87.0		1.4	483.	1.5			7.56	1.10

LABORATORY DATA SUMMARY (NUTRIENTS AND METALS)

SAMPLE	P ORTHO 70507 MG/L	P TOTAL 665 MG/L	TKN 625 MG/L	NH3N 610 MG/L	MOX 630 MG/L	NITRATE 620 MG/L	POT 935 MG/L	MAG 925 MG/L	IRON 1040 UG/L	CALCIUM 915 MG/L	SODIUM 930 MG/L	SR 1080 UG/L
SWPA8411071110	0.269	0.078	1.170	0.095	0.165		6.10	18.00	193.00	94.00	78.00	
SWPA8412061115	0.133	0.192	1.430	0.637	0.279		6.00	15.00	138.00	119.00	73.00	
SWPA8501101100	0.010	0.069	0.920	0.038	0.085							
SWPA8502071115	0.024	0.047	0.710	0.100	0.060		6.90	30.00	115.00	123.00	185.00	
SWPA8503071100	0.051	0.053	0.840	0.141	0.036							
SWPA8504041110	0.005K	0.080	1.150	0.089	0.072		7.70	27.00	88.00	150.00	106.00	
SWPA8505091130	0.034	0.054	1.220	0.023	0.005K		8.10	27.00	174.00	66.00	106.00	
SWPA8506061115	0.034	0.094	1.160	0.111	0.032		15.00	35.00	143.00	107.00	167.00	
SWPA8508081145	0.165	0.135	1.790	0.502	0.608		7.00	17.00	723.00	53.00	44.00	
SWPA8510041224	0.076	0.098	1.180	0.065	0.146		3.40	18.00	284.00	76.00	64.00	
SWPA8511061200	0.036	0.081	1.460	0.061	0.059		5.10	17.00	253.00	57.00	78.00	
SWFA8411071240	0.085	0.097	1.110	0.097	0.252		7.50	16.00	171.00	77.00	73.00	
SWFA8412061210	0.120	0.141	1.210	0.207	0.780		7.00	14.00	180.00	79.00	58.00	
SWFA8501101130	0.007	0.056	0.970	0.035	0.018							
SWFA8502071145	0.014	0.033	0.780	0.036	0.020		7.70	28.00	50.00K	92.00	111.00	
SWFA8503071130	0.015	0.013	0.840	0.099	0.030							
SWFA8504041155	0.005K	0.059	1.460	0.044	0.196		8.50	26.00	64.00	121.00	107.00	
SWFA8505091205	0.007	0.023	1.190	0.032	0.028		9.10	22.00	50.00K	54.00	95.00	
SWFA8506061200	0.010	0.039	1.020	0.041	0.011		11.00	34.00	118.00	81.00	147.00	
SWFA8508081220	0.097	0.073	1.420	0.204	0.924		7.30	16.00	257.00	57.00	45.00	
SWFA8509121429	0.080	0.087	1.350	0.170	0.484		5.40	23.00	330.00	103.00	66.00	
SWFA8510041310	0.060	0.102	1.500	0.146	0.260		4.40	14.00	300.00	66.00	54.00	
SWFA8511061300	0.045	0.081	1.340	0.068	0.136		7.70	19.00	188.00	98.00	82.00	
SWRA8412061250	0.007	0.053	0.930	0.044	0.059		7.50	11.00	103.00	55.00	42.00	
SWRA8501101240	0.005K	0.044	0.970	0.069	0.044							
SWRA8502071230	0.007	0.040	0.940	0.060	0.040		7.90	25.00	50.00K	38.00	125.00	
SWRA8503071215	0.005K	0.027	1.230	0.081	0.005							
SWRA8504041240	0.005K	0.053	1.210	0.136	0.020		8.60	25.00	50.00K	99.00	127.00	
SWRA8505091255	0.005K	0.008	1.330	0.074	0.014		8.70	24.00	50.00K	57.00	134.00	
SWRA8506061300	0.005K	0.055	1.060	0.048	0.005K		10.00	31.00	50.00K	63.00	144.00	
SWRA8508081310	0.025	0.039	1.000	0.047	0.024		7.50	21.00	50.00K	60.00	72.00	
SWRT8509121309	0.007	0.032	1.350	0.126	0.023							
SWRQ8509121324	0.007	0.015	0.990	0.020	0.014							
SWRA8509121342	0.007	0.011	1.020	0.012	0.011		5.60	20.00	57.00	59.00	48.00	
SWRW8509121415	0.007	0.015	1.100	0.005K	0.011							
SWRA8510041354	0.020	0.052	1.640	0.008	0.009		5.70	9.00	50.00K	56.00	26.00	
SWRA8511061355	0.014	0.036	1.480	0.119	0.054		6.70	13.00	53.00	75.00	51.00	
SWAA8412061255	0.060	0.067	1.100	0.113	0.317							
SWAA8501101250	0.005K	0.067	1.060	0.025	0.005K							
SWAA8502071240	0.007	0.053	1.040	0.026	0.020		7.90	25.00	50.00K	56.00	117.00	
SWAA8503071230	0.005K	0.013	0.910	0.060	0.018							
SWAA8504041250	0.005K	0.066	1.100	0.031	0.039		8.60	25.00	50.00K	103.00	103.00	
SWAA8505091305	0.005K	0.012	1.130	0.052	0.025							
SWAA8506061310	0.005K	0.039	1.060	0.018	0.014		11.00	32.00	50.00K	52.00	141.00	
SWAA8508081320	0.021	0.034	1.130	0.047	0.044		7.30	20.00	50.00K	50.00	71.00	
SWAC8509121253	0.043	0.053	1.540	0.005K	0.308							
SWAT8509121445	0.072	0.056	1.430	0.061	0.430							
SWAA8509121459	0.007	0.023	1.130	0.020	0.047		6.00	16.00	135.00	71.00	46.00	
SWAA8510041348	0.016	0.040	1.570	0.032	0.031		5.70	11.00	50.00K	56.00	26.00	
SWAA8511061405	0.045	0.065	1.110	0.055	0.079		7.10	14.00	52.00	79.00	58.00	

L A B O R A T O R Y   D A T A   S U M M A R Y   (NUTRIENTS AND METALS)

SAMPLE	P ORTHO 70507 MG/L	P TOTAL 665 MG/L	TKN 625 MG/L	NH3N 610 MG/L	NOX 630 MG/L	NITRATE 620 MG/L	POT 935 MG/L	MAG 925 MG/L	IRON 1046 UG/L	CALCIUM 915 MG/L	SODIUM 930 MG/L	SR 1080 UG/L
SWDA8411071335	0.007	0.019	1.310	0.017	0.038		7.20	14.00	65.00	68.00	57.00	
SWDA8412061330	0.065	0.083	1.060	0.137	0.376		7.10	12.00	266.00	62.00	46.00	
SWDA8501101330	0.005K	0.044	0.970	0.025	0.011							
SWDA8502071320	0.005K	0.027	0.840	0.012	0.012		7.20	25.00	50.00K	77.00	102.00	
SWDA8503071300	0.005K	0.005K	0.780	0.035	0.009							
SWDX8503071315	0.005K				0.018							
SWDA8504041330	0.005K	0.038	1.030	0.041	0.026		8.90	25.00	50.00K	111.00	105.00	
SWDA8505091335	0.005K	0.012	1.260	0.035	0.018		8.70	23.00	50.00K	53.00	95.00	
SWDA8506061405	0.005K	0.129	0.950	0.035	0.011		9.80	29.00	50.00K	81.00	137.00	
SWDA8508081400	0.017	0.024	1.040	0.059	0.012		7.60	24.00	50.00K	62.00	93.00	
SWDA8509121307	0.014	0.032	1.170	0.005K	0.014		5.60	17.00	50.00K	57.00	45.00	
SWDA8510041500	0.020	0.069	1.570	0.008	0.049		5.70	9.00	50.00K	53.00	24.00	
SWDA8511061500	0.009	0.032	1.380	0.038	0.059		6.40	12.00	52.00	72.00	45.00	