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PESTICIDE RESIDUE MONITORING IN SEDIMENT AND SURFACE WATER BODIES WITHIN THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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By

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South Florida Water Management District
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Water Chemistry Division

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EXECUTIVE SUMMARY

A review of the historical and current programs of monitoring by the South Florida Water Management District (SFWMD) was undertaken to assemble the available information on pesticide, herbicide, and polychlorinated biphenyl (PCB) residues in the sediment and/or surface water bodies within the District boundaries.

Information was obtained from five distinct programs, spanning from 1976 through 1983. Each program is a separate monitoring effort, brought together in this document to provide a readily available source of information. The analyses in each program were performed by different contract labs. The first was the 1976 to 1980 joint SFWMD/USGS Water Quality Monitoring Network which sampled the water and/or sediment at different locations each year. A total of 111 locations throughout the District were sampled. The second program, the Caloosahatchee River Study, sampled the water column at three locations on the River in 1979 and 1981 to provide background information for this area. The information was obtained from Technical Publication 82-4, "A Survey of Water Quality Characteristics and Chlorophyll a Concentrations in the Caloosahatchee River System, Florida" by T.H. Miller, A.C. Federico, and J.F. Milleson, July 1982. The third monitoring program was a part of the Lake Okeechobee Temporary Operating Permit requirements. The water column in the lake and the structures around the lake were sampled for pesticides during the wet seasons in 1979 and 1980. The fourth programl, the Everglades National Park Memorandum of Agreement, requires a semi-annual water column and sediment sampling at the watershed and inflow structures of the park. This was initiated in 1980 and continues to the present time. Finally, in the last program, water and sediment samples were analyzed in 1982 and 1983 as part of the permit requirements for the backpumping of water from the North New River Canal into Water Conservation Area 3A. These results are found in the Technical Memorandum of March 1984 entitled "North New River Backpumping Water Quality Impact Study Report No. 1. Preconstruction and Initial Operation" by the Water Chemistry Division.

The residue data assembled were compared within each program and to other reported local, regional, or national data collection efforts.

Organophosphorus pesticide residues were not found above minimum laboratory detection limits in any of the sediment or water samples analyzed. A few chlorinated hydrocarbon pesticides (e.g., DDT, dieldrin, chlordane, and endrin) were regularly detected in sediments while the herbicide type compounds (e.g., 2,4-D, and 2,4,5-TP) were occasionally detected in the water samples

PCB residues were detected in sediment samples but not in any water column samples. The generally higher concentrations found were near highways or pumping structures.

The current analytical approach of scanning for chlorinated hydrocarbon and organophosphorus pesticides should be continued with the addition of measuring the organic carbon content of any sediment samples. This additional information will provide baseline data for correlating residue concentrations between different sampling locations. As more specific information on the use of a particular compound becomes available and analytical techniques are better refined, a more specific analytical program can be developed for residue detection.

INTRODUCTION

Pesticides and herbicides have been an important element in the agricultural revolution that has occurred during the past four decades in this country. This agricultural revolution has provided a means for feeding many more people per acre with less manpower than ever before. In the beginning, the pesticides used were so successful in controlling pests that a rapid proliferation of new pesticides resulted, yielding the thousands of pesticide chemicals commonly used today. It was believed during the early years of their use that the benefits which pesticides conferred on mankind were infallible. However, during the 1950's and the early 1960's reports of large residues of pesticides in soils, water, and bottom sediments began to appear in the literature. There were increasing reports that pesticides were accumulating in the biota, especially in the upper trophic levels of food chains, including man. These discoveries began to cause concern about the possible long-term ecological effects from the large quantities of pesticides being used. This sparked an interest in the pesticide degradation process and the environmental residue levels of pesticides.

The SFWMD (Figure 1) has participated in numerous programs or studies to ascertain levels of pesticide, herbicide, and polychlorinated biphenyl (PCB) residues in the sediment and/or surface water bodies within the District. The purpose of this report is to summarize and characterize the SFWMD's pesticide data collected, by comparison within itself and with other local, regional, or national data.

The programs presented in this report start from the 1976 joint program between the SFWMD and the United States Geological Service (USGS). The SFWMD/USGS Water Quality Monitoring Network sampled the water and/or sediment at 111 various locations throughout the District from 1976 to 1980. Each year a new location was surveyed. The Caloosahatchee River Study sampled the water column at three locations on the River (C-43) in 1979 and 1981 to provide baseline information on pesticide residues in this area. As part of the Lake Okeechobee Temporary Operating Permit, the water column in the Lake and the structures around the Lake were sampled during the wet season in 1979 and 1980 to provide background information for the permitting requirements. The Everglades National Park Memorandum of Agreement requires a semi-annual water column and sediment sampling at the watershed and inflow structures of the Park as part of the routine water quality monitoring to assure that the water delivered to the Park is of sufficient purity to prevent ecological damage or deterioration of the parks environment. This monitoring program began in 1980 and continues to today. Finally, water and sediment samples were analyzed in 1982 and 1983 as part of the permit requirements for the backpumping of water on the North New River Canal into Water Conservation Area 3A.

For sediment samples, numerous reports have suggested that differences in pesticide residue levels may be caused by numerous variables, some of which include land use differences, sediment types, and locations (Mattraw 1975; Carey et al. 1979). The sorption of pesticides to sediments is highly correlated with the organic carbon content of the sediments while at the same time relatively independent of other sorbent properties such as sediment concentration, pH, and ionic strength in the suspensions (Karickoff et al. 1979; Hassett et al. 1980). Therefore, variations in residue concentration could be attributed to sediment samples of differing organic matter content. Sediment consisting of primarily sand would have low residues whereas sediment high in organic matter has the potential for the accumulation of pesticides. Without information on the organic carbon content of sediment samples, relative comparisons among samples are difficult. For the purpose of this review, consideration will not be given to these variables due to the lack of information.

Tables listing the results of the laboratory analysis for the residue concentrations will show any detectable levels or the minimum detection limit (represented by less than some number) for that particular analytical technique. For compactness, the tables list only the compounds which had detectable residues with the compounds analyzed for but not detected being included in a footnote. However, for certain studies, this is not possible as the minimum detection limits vary due to methodology, differing analytical techniques and/or laboratories. As it is important to present minimum detection limits for comparison purposes, some tables have extensive compound lists and mostly minimum detection limits.

Appendix A provides a summary of Florida Administrative Code (FAC) 17-3 relating to the surface water quality criteria for pesticide and PCB's.

Appendix B provides some background information on each compound discussed in this document.

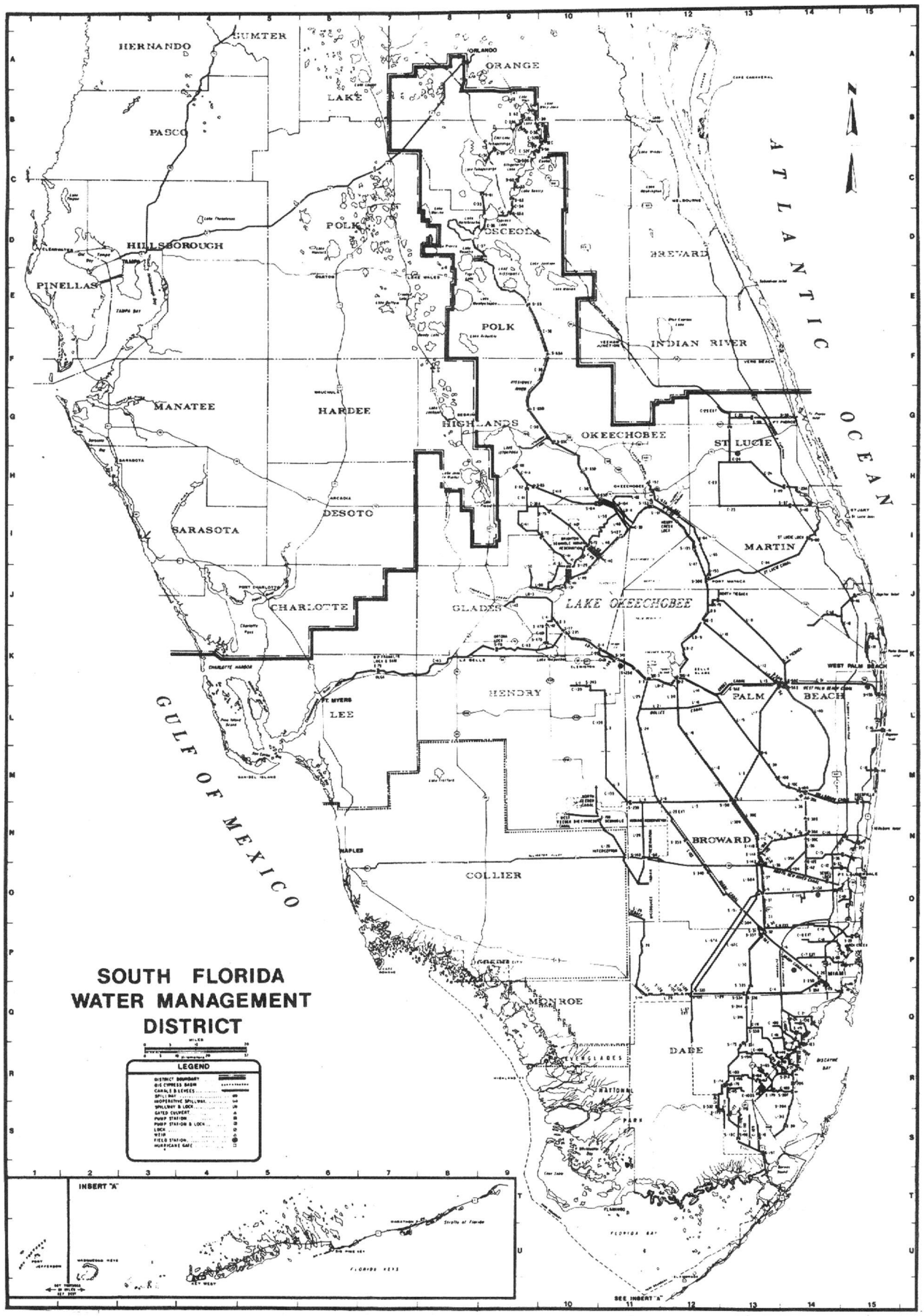

Figure 1 SOUTH FLORIDA WATER MANAGEMENT DISTRICT

SFWMD/USGS WATER QUALITY MONITORING NETWORK

The Water Quality Monitoring Network was a cooperative program between the District and the U.S. Geological Survey (USGS) that began in 1976 and continued until 1980. Baseline water quality data were collected at various locations not already sampled by other specific projects within the District. The information aided in the documentation of water quality conditions in actively developing drainage basins and documented the quality of water at major water control structures. One objective of the monitoring was to identify existing or potential problems relating to toxic or deleterious substances. Water and/or sediment samples were analyzed for pesticides, PCB's (polychlorinated biphenyl), and PCN's (polychlorinated naphthalene). Most of the analyses were done at the USGS National Water Quality Laboratory, Athens, Georgia, on samples collected by the District.

In 1976, 1977, and 1978, analyses were limited to sediment samples collected throughout the District's waterways. The 1976 sampling provided an overview of the District. The 1977 sampling covered Lake Okeechobee and the major east coast canals, while the 1978 program sampled the upper east coast and west coast canals and estuaries. The 1979 and 1980 programs involved water and sediment sampling at selected locations throughout the District. The 1979 program sampled throughout the southern portion of the District while the 1980 program concentrated in the Water Conservation Areas (WCA's).

During the first year (1976) of the reconnaissance, bottom sediments from 25 stations throughout the District (Table 1 and Figures 2 and 3) were analyzed for chlorinated hydrocarbon and organophosphorus pesticides, herbicides, PCB's, and PCN's. The majority of the analyses showed few detectable levels of any pesticides or herbicides except for DDD, DDE, PCBs, dieldrin, and chlordane (Table 2). Since the agricultural use of DDT was banned in 1973, and minimum DDD was used as a pesticide, the DDD and DDE residues could reflect the anticipated results of the environmental fate of DDT. The highest residue concentrations were at the structures around Water

TABLE 1. 1976 SFWMD/USGS WATER QUALITY MONITORING NETWORK STATION LOCATIONS

Map Code 1/		Station Code S.F.W.M.D.	Station Code U.S.G.S	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	■		02266500	Reedy Creek near Loughman	28 15 48	81 32 12
2	■		02264900	Lake Tohopekaliga	28 17 20	81 24 20
3	■		02266000	Cypress Lake near St. Cloud	28 03 40	81 19 58
4	■		02267400	Lake Hatchineha	28 00 00	81 22 50.01
5	■		02268900	Lake Kissimmee	27 48 09	81 11 50
6	■		02270500	Arbuckle Creek near De Soto City	27 26 32	81 17 51
7	■		02271700	Lake Istokpoga	27 19 55	81 15 05.01
8	■	S-84	02273300	Canal 41A at S-84	27 12 55	80 58 55
9	■		02274500	Taylor Creek above Okeechobee, FL	27 17 03	80 49 20
10	■		02275000	Taylor Creek at Okeechobee, FL	27 15 05	80 49 28
11	■	S-71	02257800	Harney Pond Canal at S-71	27 02 00	81 04 15
12	■		02256500	Fisheating Creek at Palmdale	26 55 56	81 18 54
13	■		270000080470000	Lake Okeechobee, near center	27 00 00	80 47 00
14	■		264700080420000	Lake Okeechobee where Rim Canal opens into the lake	26 47 00	80 42 00
15	■		264600080430000	Lake Okeechobee at Pelican Bay	26 46 00	80 43 00
16	■		264400080460000	Lake Okeechobee at South Bay	26 44 00	80 46 00
17	■	C51S5A	02278450	West Palm Beach Canal (C-51) above S-5A	26 41 05	80 22 15
18	■	S-6	02281200	Hillsboro Canal at S-6	26 28 20	80 26 45
19	■	S-10	262400080230000	Hillsboro Canal above S-10	26 24 00	80 23 00
20	■	S-7	02284300	North New River Canal at BrowardPalm Beach County Line at S-7	26 20 00	80 32 10
21	■		260945080533000	L-28 Interceptor below SR84	26 09 45	80 53 30
22	■	S-9	02285400	South New River Canal at S-9	26 03 40	80 26 30
23	■		254620080395000	L-67A, 0.5 Miles north of Tamiami Canal	25 46 20	80 39 50
24	■		02289040	Tamiami Canal outlets L-67 to 40-Mile Bend	25 45 42	80 43 34.02
25	■		02288990	Tamiami Canal at 40-Mile Bend	25 45 50	80 49 50.07

1/ ■ Sediment Samples Taken for Analyses

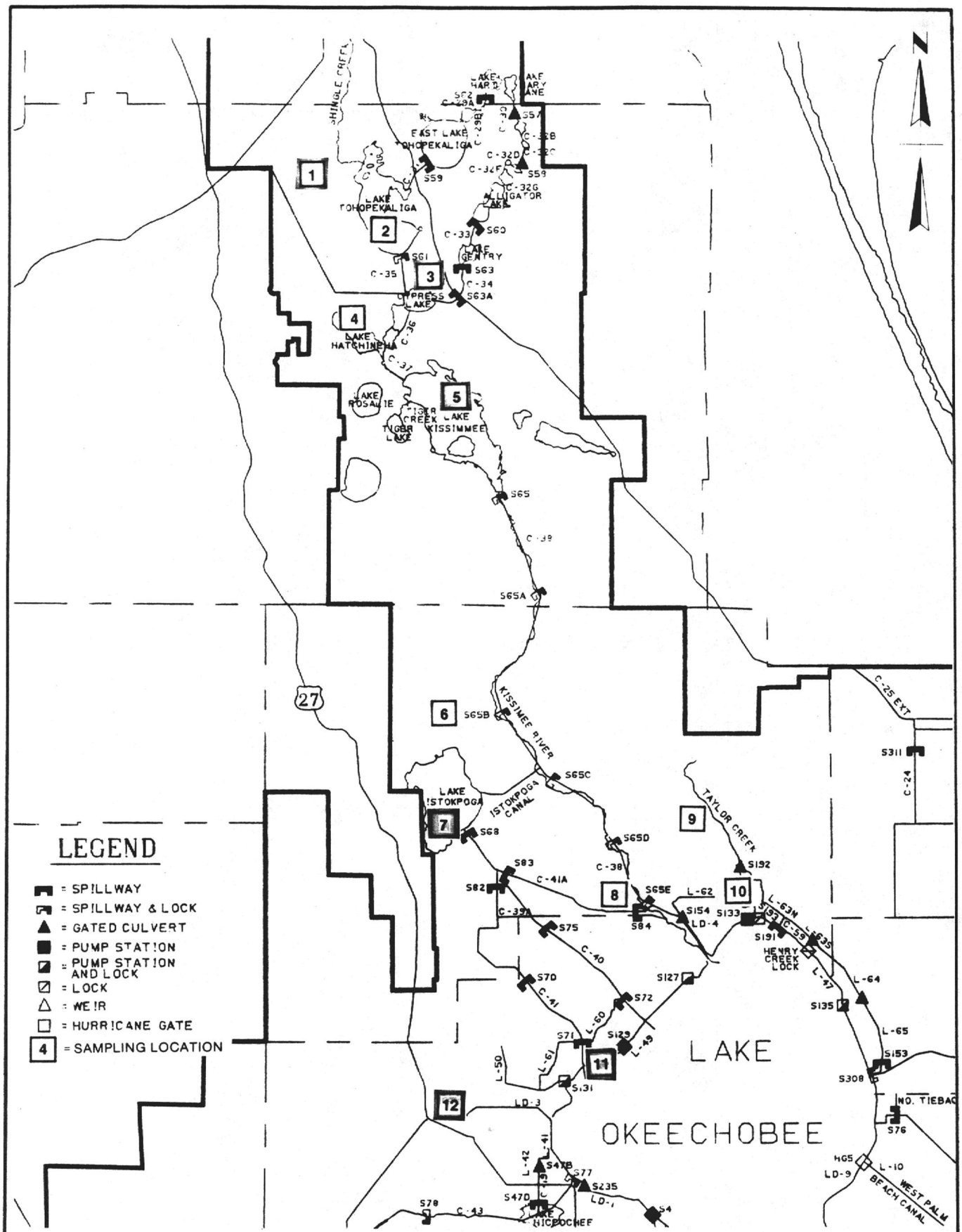

Figure 2 **1976 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 1 FOR KEY TO SYMBOLS**

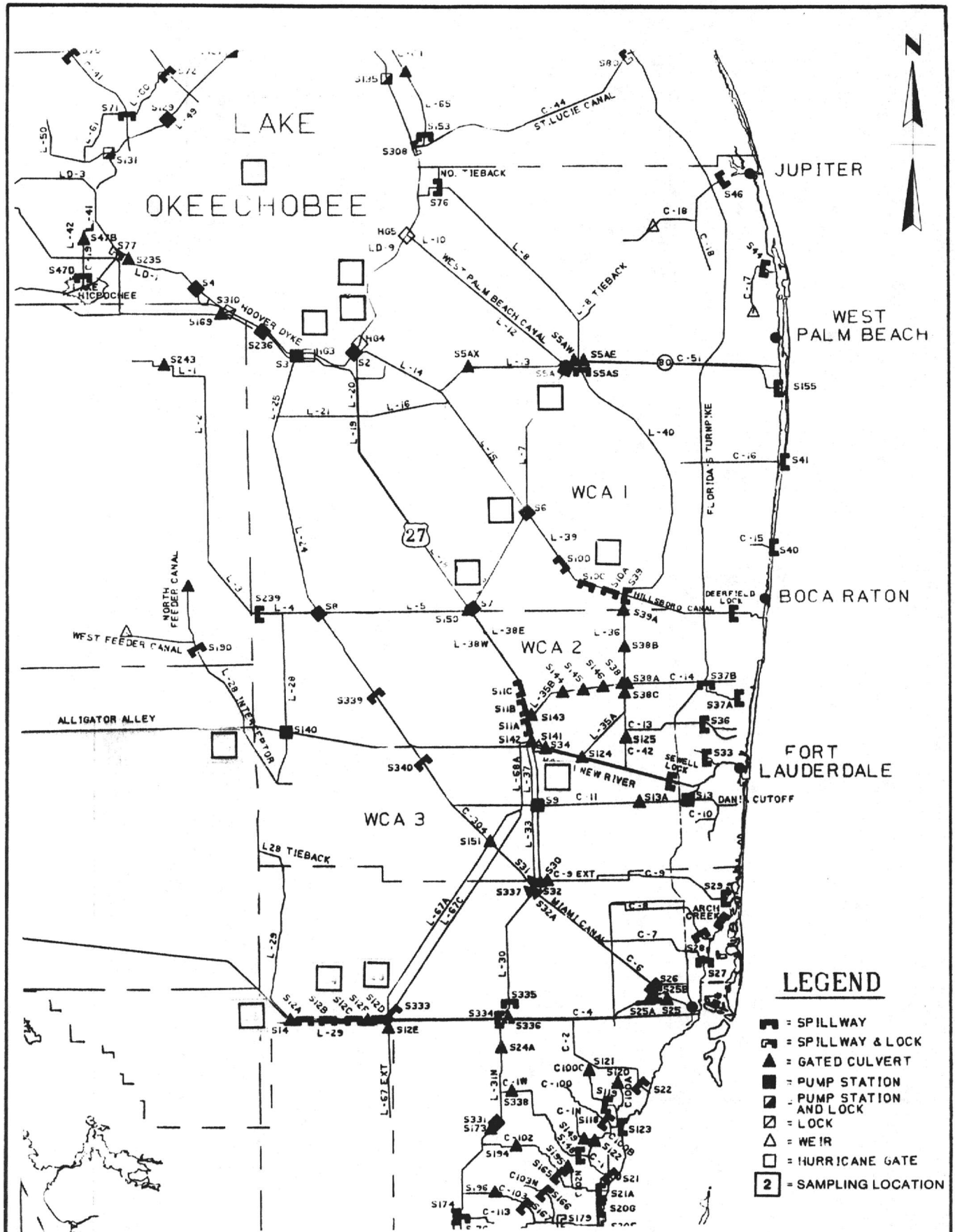

Figure 3 **1976 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 1 FOR KEY TO SYMBOLS**

TABLE 2. 1976 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING DATA FOR SEDIMENT SAMPLES[1/]

Map Code	Date Sampled	Chlordane	DDE	DDD	DDT	Dieldrin	PCB
1	04-30-76	<1.0	<0.1	<0.1	<0.1	<0.1	<1.0
2	04-23-76	<1.0	<0.1	<0.1	<0.1	<0.1	<1.0
3	04-23-76	<1.0	2.9	2.9	<0.1	<0.1	<1.0
4	04-23-76	<1.0	0.4	<0.1	<0.1	<0.1	<1.0
5	04-23-76	<1.0	4.9	3.1	<0.1	<0.1	<1.0
6	04-13-76	<1.0	<0.1	<0.1	<0.1	<0.1	<1.0
7	04-13-76	<1.0	20	8.2	<0.1	<0.1	<1.0
8 (S-84)	04-20-76	<1.0	1.9	2.3	<0.1	<0.1	<1.0
9	04-20-76	<1.0	0.2	0.8	<0.1	<0.1	<1.0
10	04-20-76	63	6.4	9.4	<0.1	3.1	57
11 (S-71)	04-20-76	<1.0	0.5	0.5	<0.1	<0.1	<1.0
12	04-20-76	<1.0	<0.1	<0.1	<0.1	<0.1	6
13	08-23-76	17	11	36	<0.1	<0.1	4
14	09-00-76	31	70	77	<0.1	<0.1	<1.0
15	09-00-76	.17	33	38	<0.1	4.5	<1.0
16	09-00-76	10	16	28	<0.1	<0.1	<1.0
17 (C51S5A)	04-19-76	<1.0	140	470	49	<0.1	<1.0
18 (S-6)	04-19-76	<1.0	71	110	<0.1	<0.1	<1.0
19 (S-10)	04-19-76	<1.0	140	340	<0.1	<0.1	<1.0
20 (S-7)	04-19-76	<1.0	26	31	<0.1	<0.1	210
21	04-19-76	<1.0	0.7	<0.1	<0.1	<0.1	<1.0
22 (S-9)	04-19-76	<1.0	0.7	<0.1	<0.1	<0.1	<1.0
23	04-21-76	<1.0	1.0	<0.1	<0.1	<0.1	<1.0
24	04-21-76	<1.0	7.0	<0.1	<0.1	<0.1	34
25	04-21-76	<1.0	3.3	<0.1	<0.1	<0.1	<1.0

1/ Units are micrograms per kilogram dry sediment. Numbers less than (<) represent minimum detection limits. Compounds analyzed for but not detected include: aldrin (<0.1), lindane (<0.1), diazinon (<0.1), endrin (<0.1), ethion (<0.1), heptachlor (<0.1), heptachlor epoxide (<0.1), malathion (<0.1), methyl parathion (<0.1), parathion (<0.1), PCN (<0.1), toxaphene (<0.1), trithion (<0.1), 2,4-D (<0.1), 2,4- DP (<0.1), 2,4,5-T (<0.1), and 2,4,5-TP (<0.1).

Conservation Area (WCA) 1 (stations S-6, S-10, and S-5A), WCA-2 (station S-7), and in the sediments around the agricultural islands in Lake Okeechobee (stations 13, 14, 15, and 16). Smaller quantities of DDD and DDE (less that 10 ug/kg) were identified at almost every station. The chlordane was also detected in the sediment at the Lake Okeechobee stations.

PCB's were found at diverse locations, most notably along major highways and pumping structures (stations S-7, 12, 10, 24, and 13). The highest concentration of 210 ug/kg was measured at S-7. The mid-lake station in Lake Okeechobee had a low concentration of 4 ug/kg which could be due to the ubiquitous nature of the PCB's.

In 1977, the District sampled a total of 35 stations for chlorinated hydrocarbon pesticides, PCB's and PCN's in the sediments of Lake Okeechobee, the Miami Canal, and four east coast canals (Table 3 and Figures 4 and 5).

High concentrations of DDT, DDE, and DDD were found in the soil on the agricultural islands of Ritta, Torry, and Kreamer in Lake Okeechobee and in the sediments at the pumping stations S-2, S-3, and S-4 (Figure 4 and Table 4). These sampling stations around the islands had results corresponding with the high DDD and DDE concentrations found in 1976 in the lake sediments in the vicinity of the islands. Also, relatively large residues of dieldrin and endrin (greater than 300 ug/kg) were identified on Ritta and Torry Islands corresponding with the highest concentrations of DDT, DDD, and DDE. The chlordane residues were found at only two of the sampling stations within the lake, contrary to expectations from the previous years sampling where all four lake samples had residues.

The Hillsboro Canal sampling locations (stations HLS-4.2 and HLS-0.0) were areas of high concentrations of DDT, DDE, DDD, chlordane, and dieldrin. In 1977, the majority of this area was in agricultural production.

On the Miami Canal (stations US-27, MIA-26.4, MIA-69.0, and MIA-80.3) (Figure 5) the results showed no detectable levels of most compounds except DDT, DDE, and DDD, with the largest residues in the stations near Lake Okeechobee (MIA-80.3 and MIA 69.0). Comparing the results of MIA-80.3, which is downstream of S-3, with the results of the S-3 sampling, the S-3 sediment had higher concentrations of DDE, DDD, DDT, and residues of chlordane and dieldrin. The structure appears to be a sink for these compounds, possibly from an accumulation of suspended matter which settled here. One high concentration of PCB's (740 ug/kg) was detected at station MIA-7.0, an urbanized area near Hialeah.

No detectable levels of most compounds except DDD and DDE were found at the remaining stations.

TABLE 3. 1977 SFWMD/USGS WATER QUALITY MONITORING NETWORK STATION LOCATIONS

Map Code 1/		Station Code S.F.W.M.D	Station Code U.S.G.S.	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	■	LOK1	264505080434000	On Kreamer Island	26 45 05	80 43 40
2	■	LOK4	264349080432800	North Torry Island	26 43 49	80 43 28
3	■	LOK3	264235080430700	South Torry Island	26 42 35	80 43 07
4	■	LOK8	264319080481300	North Ritta Island	26 43 19	80 48 13
5	■	LOK9	264311080482700	South Ritta Island	26 43 11	80 48 27
6	■	LOK7	264528080453900	In Lake Okeechobee west of Kreamer Island	26 45 28	80 45 39
7	■	LOK6	264400080450000	In Lake Okeechobee northwest of Torry Island	26 44 00	80 45 00
8	■	LOK5	264202080441300	In Lake Okeechobee southwest of Torry Island	26 42 02	80 44 13
9	■	LOK11	264327080470600	In Lake Okeechobee northeast of Ritta Island	26 43 27	80 47 06
10	■	LOK10	264233080474400	In Lake Okeechobee southeast of Ritta Island	26 42 33	80 47 44
11	■	Ritta I	264400080500000	In Lake Okeechobee	26 44 00	80 50 00
12	■	LOK13	264417080494400	In Lake Okeechobee	26 44 17	80 49 44
13	■	LOK14	264344080493000	In Lake Okeechobee northwest of Ritta Island	26 43 44	80 49 30
14	■	LOK12	264300080492100	In Lake Okeechobee west of Ritta Island	26 43 00	80 49 21
15	■	S-3	264156080482300	At pump station S-3	26 41 56	80 48 23
16	■	S-2	264208080425700	At pump station S-2	26 42 00	80 42 55
17	■	S-4	264725080574200	At pump station S-4	26 47 25	80 57 42
18	■	HGS-5	265200080400000	In Lake Okeechobee west of HGS-5	26 52 00	80 40 00
19	■	LOK2	265700080591200	In Lake Okeechobee	26 57 00	80 59 12
20	■	LOK15	265500080580700	In Lake Okeechobee	26 55 00	80 58 07
21	■	BOUY7	265300080470000	In Lake Okeechobee at buoy #7	26 53 00	80 47 00
22	■	S-135	270500080430000	In Lake Okeechobee west of S-135	27 05 00	80 43 00
23	■	MIA-7	254900080150000	Miami Canal (C-123) 7.0 Miles from Beginning	25 49 00	80 15 00
24	■	US-27	260000080310000	Miami Canal (C-123) at US 27 at S-31	26 00 00	80 31 00
25	■	MIA-26.4	260800080370000	Miami Canal (C-123) 26.4 Miles from beginning--upstream of S-151	26 08 00	80 37 00
26	■	MIA-69.0	262500080490000	Miami Canal (C-123) 69.0 Miles from beginning	26 25 00	80 49 00
27	■	MIA-80.3	264132080462000	Miami Canal (C-123) 80.3 Miles from beginning--downstream of S-3	26 41 32	80 46 20
28	■	NNR-0.0	260524080131500	North New River Canal at beginning upstream of Sewell Lock	26 05 24	80 13 15
19	■	NNR-9.0	260734080220000	North New River Canal 9.0 Miles from beginning at Markham Park Bridge	26 07 34	80 22 00
30	■	HLS-4.2	261938080124901	Hillsboro Canal 4.2 Miles from beginning at SR7 (US 441) Bridge	26 19 38	80 12 49
31	■	HLS-0.0	261936080083400	Hillsboro Canal at beginning upstream of Deerfield Lock	26 19 36	80 08 34
32	■	C4-16.0	254535080291100	Canal 4, 16 Miles from beginning at HWY 27 Bridge	25 45 35	80 29 11
33	■	C4-6.5	254532080194500	Canal 4, 6.5 Miles from beginningat SW 82nd Avenue Bridge	25 45 32	80 19 45
34	■	C51-22.0	264057080230500	Canal 51 (West Palm Beach Canal) 22.0 Miles from beginning at Sucrose-Hatton Bridge, ½ Mile east of S-5AE	26 40 57	80 23 05
35	■	C51-12.0	264047080131200	Canal 51 (West Palm Beach Canal) 12.0 Miles from beginning at SR 7 (US 441) Bridge	26 40 47	80 13 12

1/ ■ Sediment Samples Taken for Analyses

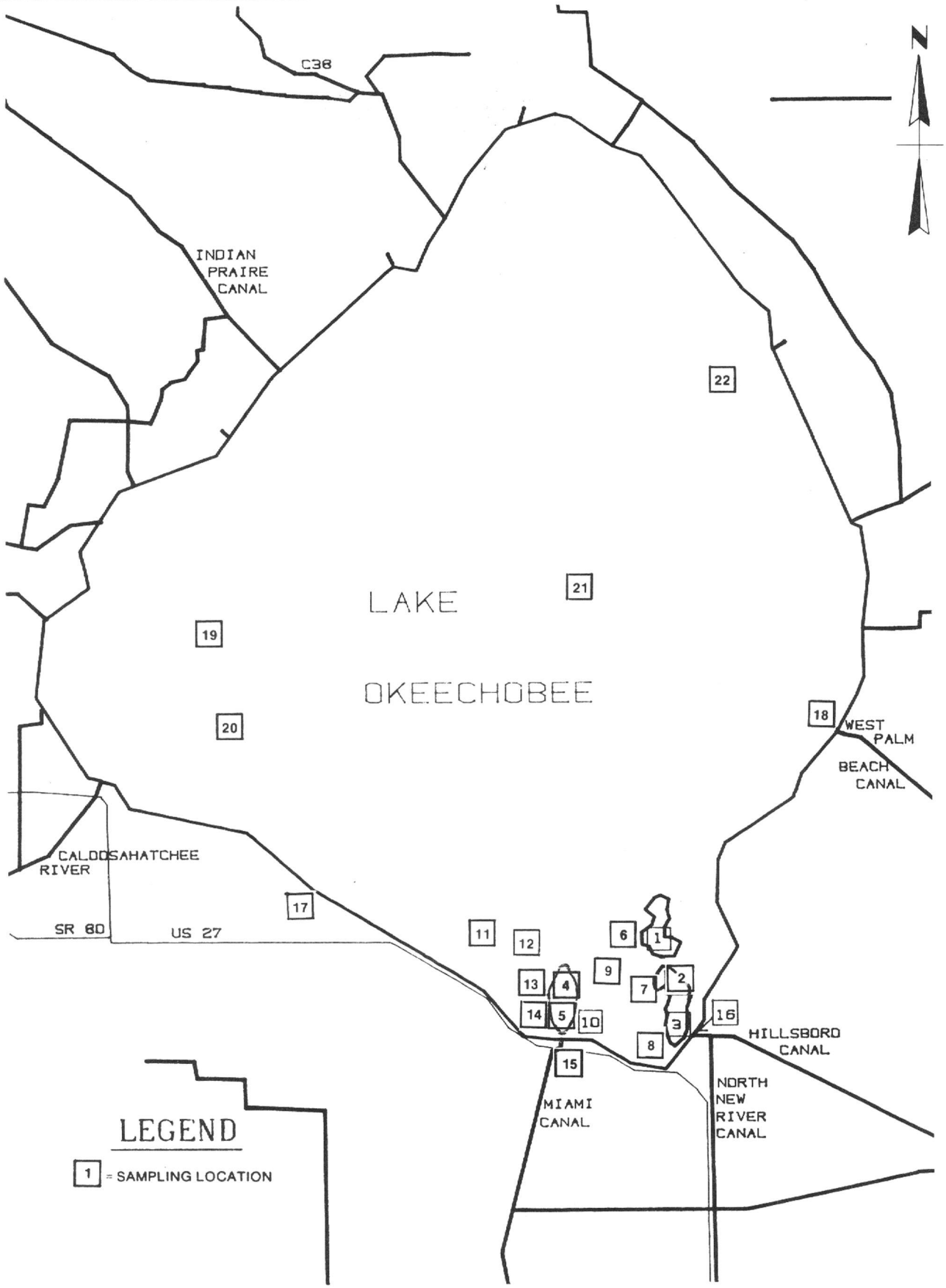

Figure 4 **1977 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 3 FOR KEY TO SYMBOLS**

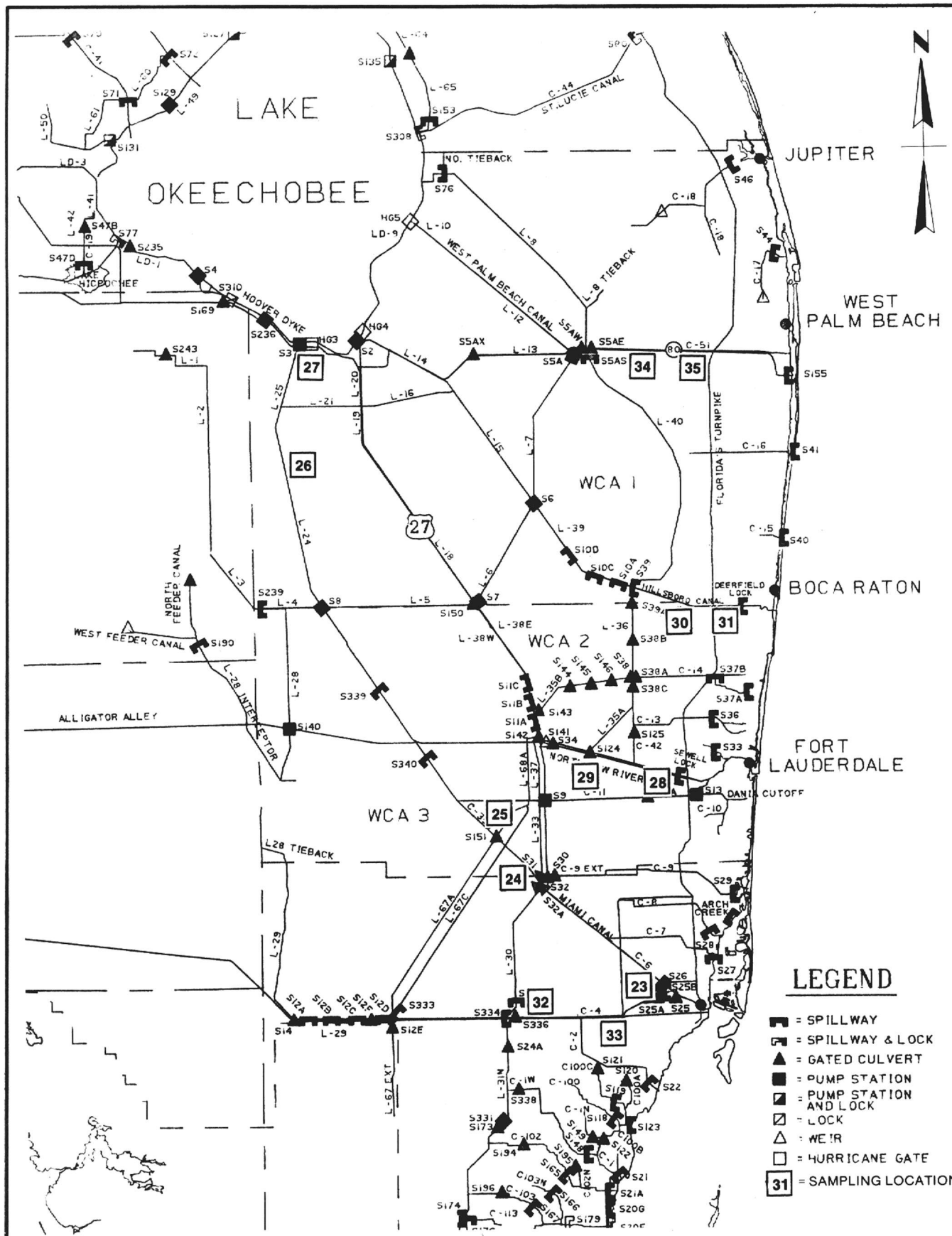

Figure 5 **1977 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 3 FOR KEY TO SYMBOLS**

TABLE 4. 1977 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING DATA FOR SEDIMENT SAMPLES[1/]

Map Code	Station Code	Date Sampled	Chlordane	DDE	DDD	DDT	Dieldrin	Endrin	Heptachlor Epoxide	PCB
1	LOK 1	05-30-77	<0.1	4800	13000	<0.1	330	<0.1	<0.1	<1.0
2	LOK 4	05-10-77	<0.1	1300	580	2200	17	620	<0.1	<1.0
3	LOK 3	05-10-77	<0.1	4600	9500	7400	310	300	110	<1.0
4	LOK 8	05-10-77	<0.1	9300	10000	15000	760	920	<0.1	<1.0
5	LOK 9	05-10-77	<0.1	7100	<0.1	110000	620	590	130	<1.0
6	LOK 7	05-10-77	<0.1	6.4	12	1.8	<0.1	<0.1	<0.1	<1.0
7	LOK 6	05-10-77	<0.1	27	22	47	0.5	<0.1	<0.1	<1.0
8	LOK 5	05-10-77	<0.1	120	95	<0.1	<0.1	<0.1	<0.1	<1.0
9	LOK 11	05-10-77	<0.1	49	41	<0.1	0.1	<0.1	<0.1	<1.0
10	LOK 10	05-10-77	21	38	40	5.7	<0.1	<0.1	<0.1	<1.0
11	RITTA I	05-12-77	<0.1	13	20	1.8	<0.1	<0.1	<0.1	<0.1
12	LOK 13	05-10-77	<0.1	120	100	14	5.0	3.2	<0.1	<1.0
13	LOK 14	05-11-77	13	130	28	2.2	3.0	<0.1	<0.1	<1.0
14	LOK 12	05-10-77	<0.1	20	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0
15	S-3	05-10-77	69	96	82	11	3.8	<0.1	<0.1	<1.0
16	S-2	05-10-77	68	550	120	17	2	<0.1	<0.1	<1.0
17	S-4	05-11-77	<0.1	6.9	5.6	3.4	<0.1	<0.1	<0.1	<1.0
18	HGS-5	05-12-77	<0.1	21	29	<0.1	<0.1	<0.1	<0.1	<1.0
19	LOK 2	05-11-77	<0.1	1.2	2.4	<0.1	<0.1	<0.1	<0.1	<1.0
20	LOK 15	05-11-77	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0
21	BOUY7	05-19-77	<0.1	16	30	2.4	<0.1	<0.1	<0.1	<1.0
22	S-135	05-12-77	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0
23	MIA-7.0	05-25-77	<0.1	11	<0.1	<0.1	<0.1	<0.1	<0.1	740
24	US-27	05-25-77	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0
25	MIA-26.4	05-25-77	<0.1	3.8	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0
26	MIA-69.0	05-25-77	<0.1	76	56	<0.1	<0.1	<0.1	<0.1	<1.0
27	MIA-80.3	05-25-77	<0.1	23	33	4.8	<0.1	<0.1	<0.1	<1.0
28	NNR-0.0	05-10-77	<0.1	150	62	<0.1	<0.1	<0.1	<0.1	<0.1
29	NNR-9.0	05-10-77	<0.1	6.0	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0
30	HLS-4.2	05-10-77	120	55	24	6.5	3.2	<0.1	<0.1	<1.0
31	HLS-0.0	05-10-77	<0.1	260	150	<0.1	27	<0.1	<0.1	<1.0
32	C4-16.0	05-10-77	<0.1	13	7.9	<0.1	<0.1	<0.1	<0.1	<1.0
33	C4-6.5	05-10-77	<0.1	11	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0
34	C51-22.0	05-11-77	<0.1	35	38	10	<0.1	<0.1	<0.1	<1.0
35	C51-12.0	05-11-77	<0.1	54	25	<0.1	<0.1	<0.1	<0.1	<1.0

1/ Units are micrograms per kilogram dry sediment. Numbers less than (<) represent minimum detection limits. Compounds analyzed for but not detected include: aldrin (<0.1), lindane (<0.1), endosulfan (<0.1), heptachlor (<0.1), PCN (<0.1), perthane (<0.1). and toxaphene (<0.1).

The 1978 annual reconnaissance for toxic substances in sediments was made at 14 estuarine stations covering both the east and west coast (Table 5 and Figures 6 and 7). The results are shown in Table 6. In general, most of the analyses for chlorinated hydrocarbon pesticides gave results below the limits of detection. The highest concentrations of pesticide residues were at the St. Lucie Lock and stations 2, 3, and 4, all of which are near the St. Lucie Canal, river and estuary, and Stuart. At these sites DDD, DDE, and chlordane were predominant. The highest concentrations were all at the St. Lucie Lock (Site 5). Dieldrin was the only other pesticide recorded at the St. Lucie Lock and S-79 (stations 5 and 8). The west coast stations 8 (S-79) and 9 (Caloosahatchee River at Edison Bridge) had the highest concentrations of residues of the western sampling stations.

PCB's were detected at the St. Lucie Lock, S-79, the Edison Bridge, and site 4 with the maximum concentration of 180 ug/kg at S-79 or the Franklin Lock and Dam.

The 1979 reconnaissance sampled the water and sediment in and around Lake Okeechobee, the east coast canals of C-18, C-23, C-24, and C-25 and the west coast canals (Table 7 and Figures 8 and 9) for chlorinated hydrocarbon and organophosphorus pesticides, herbicides, and PCB's.

At all locations where water samples were taken, residue concentrations were below the minimum detection limits except for the herbicide 2,4-D which was found in small concentrations at LZ-19 (0.02 ug/l), C-23 at S-48 (0.03 ug/l), and C-24 at S-49 (0.1 ug/l) and 2,4,5-TP in C-25 at S-50 (Table 8). State standards (FAC Chapter 17-3) (See Appendix A for complete criteria) have only been established for 2,4-D in Class IA waters which is applicable only to station LZ-19. The residue concentration is well below the maximum allowed. The water samples taken at these stations could have been in violation of the Class IA or III water standards for aldrin, chlordane, DDT, dieldrin, endosulfan, endrin, heptachlor, mirex, toxaphene, and PCB's as the limits of detection by this method of analysis were higher than the criteria. However, it cannot be absolutely determined that the standards were exceeded since the true value could also conceivably fall below the criteria levels.

Sediment samples taken in C-18 revealed detectable concentrations of chlordane, DDE, dieldrin, and PCB 's (Table 9). In contrast to the previous years sampling, chlordane was found in much higher concentrations and none of the other compounds were previously found. This variation may be attributed to differences in the organic matter content of the sediment.

The sediment samples at HGS-5 had only a small residue of DDD, 2 ug/kg. The other Lake Okeechobee stations, S-2 and S-3, had detectable residues of chlordane, DDD, DDE, DDT, and PCBs. With the exception of dieldrin, these are the same compounds detected in 1977. Quantities are much less however.

S-34 on the North New River Canal had small detectable concentrations of chlordane, DDD, DDE, DDT, and PCBs. The 1977 sediment sampling of the North New River Canal, downstream of S-34, revealed only DDD and DDE at NNR-0.0 and just DDE at NNR-9.0. However, the concentrations of the compounds found in 1977 were much higher than this sampling event.

DDT, DDD, and PCBs were found in small quantities at the Barron River Canal station and PCBs were found at the Faka River station. No residues were found at the Golden Gate Canal station.

TABLE 5. 1978 SFWMD/USGS WATER QUALITY MONITORING NETWORK STATION LOCATIONS

Map Code 1/		Station Code SFWMD	Station Code U.S.G.S.	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	■		271435080181000	North Fork St. Lucie River near Kitching Cove, near Stuart	27 14 35	80 18 10
2	■		271208080162000	Mouth of Bessy Creek near Stuart	27 12 08	80 16 20
3	■		271230080140000	St. Lucie River Estuary	27 12 30	80 14 00
4	■		271020080153300	South Fork St. Lucie River at SR 714 near Palm City	27 10 20	80 15 33
5	■	C44S80	02277001	St. Lucie Canal (C-44) Downstream of Lock (S-80)	27 06 39	80 17 06
6	■	C18S46DS	265611080082300	Loxahatchee River, downstream of S-46	26 56 11	80 08 23
7	■		265655080054200	Loxahatchee River Estuary	26 56 55	80 05 42
8	■	CR-40.3	02292900	Caloosahatchee River at S-79	26 43 25	81 41 55
9	■		263900081523000	Caloosahatchee River Estuary, Edison Bridge	26 39 00	81 52 30
10	■		263230081573000	Caloosahatchee River Estuary, Red Fish Cove	26 32 30	81 57 30
11	■		263230082034500	Caloosahatchee River Estuary, Matlacha Pass	26 32 30	82 03 45
12	■		262845082023000	Caloosahatchee River Estuary, San Carlos Bay	26 28 45	82 02 30
13	■		262730081523800	Estero Bay	26 27 30	81 52 38
14	■		260700081472800	Naples Bay	26 07 00	81 47 28

1/ ■ Sediment Samples Taken for Analyses

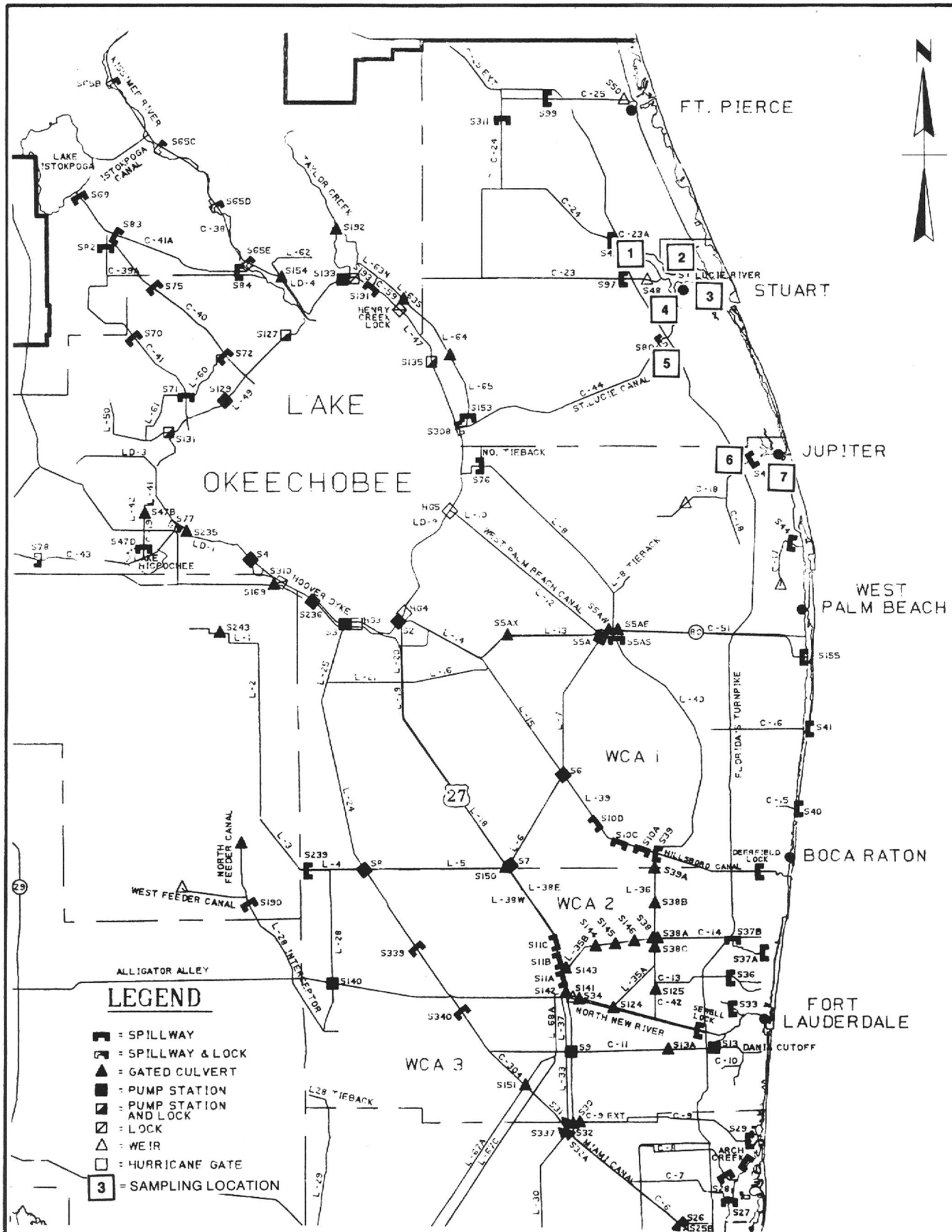

Figure 6 **1978 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 5 FOR KEY TO SYMBOLS**

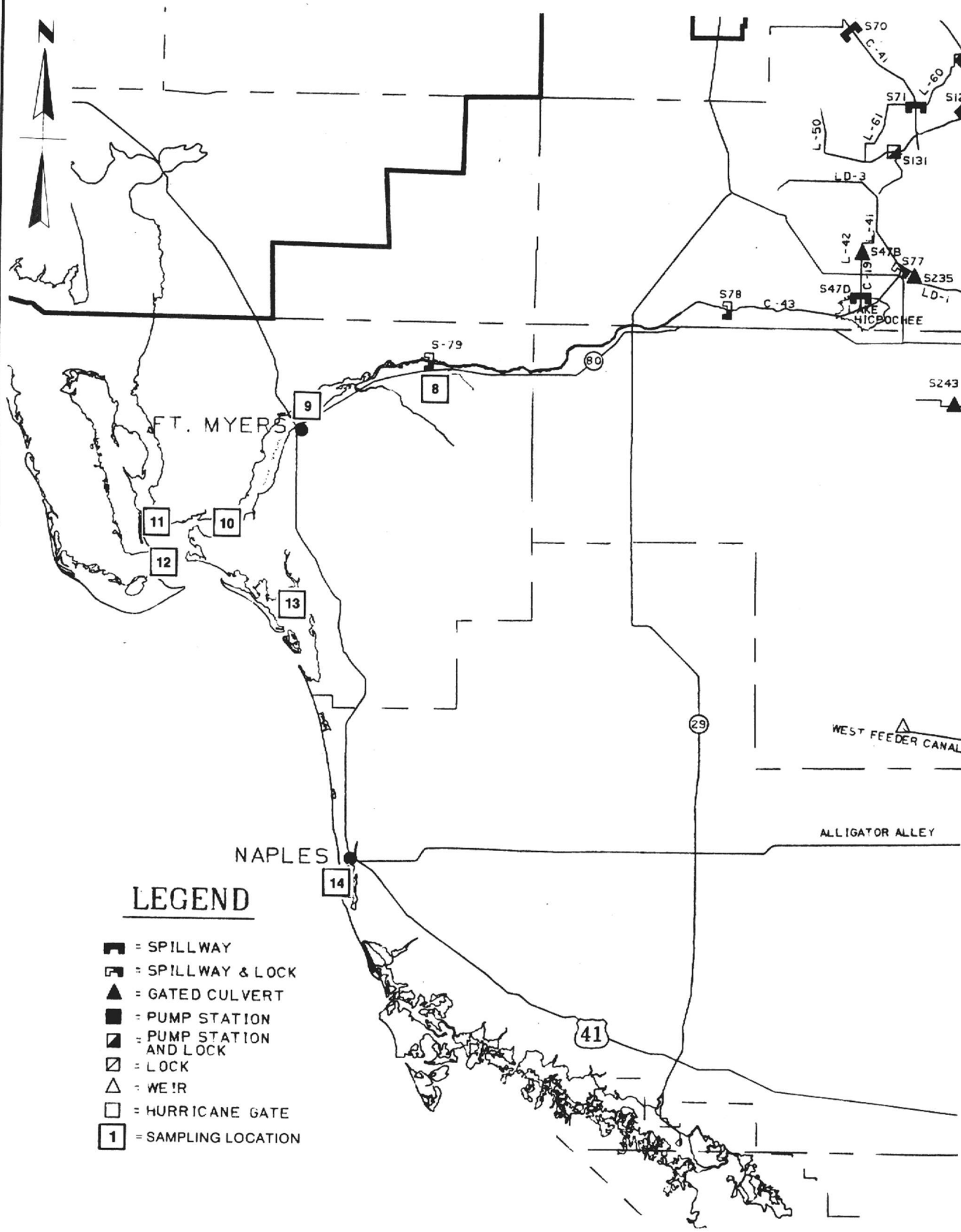

Figure 7 **1978 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 5 FOR KEY TO SYMBOLS**

TABLE 6. 1978 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING DATA FOR SEDIMENTS 1/

Map Code	Station Code	Date Sampled	Chlordane	DDE	DDD	Dieldrin	PCB
1		07-21-78	<1	<0.1	<0.1	<0.1	<1.0
2		07-21-78	14	9.2	6.0	<0.1	<1.0
3		07-21-78	<1	11	3.1	<0.1	<1.0
4		07-21-78	4	2.4	3.1	<0.1	15
5	C44S80	07-21-78	72	12	20	0.9	37
6	C18S46DS	09-08-78	1	<0.1	0.3	<0.1	<1.0
7		09-08-78	<1	<0.1	<0.1	<0.1	<1.0
8	CR-40.3	09-06-78	2	<0.1	0.7	1.1	180
9		09-06-78	10	0.6	0.5	<0.1	9
10		09-06-78	1	0.4	0.3	<0.1	<1.0
11		09-06-78	<1	<0.1	<0.1	<0.1	<1.0
12		09-06-78	<1	<0.1	<0.1	<0.1	<1.0
13		09-07-78	1	0.9	0.1	<0.1	<1.0
14		09-08-78	1	<0.1	<0.1	<0.1	<1.0

1/ Units are micrograms per kilogram dry sediment. Numbers less than (<) represent minimum detection limits. Compounds analyzed for but not detected include: aldrin (<0.1), lindane (<0.1), DDT (<0.1), endrin (<0.1), heptachlor (<0.1), heptachlor epoxide (<0.1), and toxaphene (<1.0).

TABLE 7. 1979 SFWMD/USGS WATER QUALITY MONITORING NETWORK STATION LOCATIONS

Map Code 1/		Station Code SFWMD	Station Code U.S.G.S.	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	●	C25S50	272807080201800	C-25 upstream of S-50	27 28 07	80 20 18
2	●	C24S49	271541080213500	C-24 upstream of S-49	27 15 40	80 21 34
3	●	C23S48	271218080202600	C-23 upstream of S-48 at Martin County line	27 12 18	80 20 26
4	●	C18SR710	265209080143700	C-18 at SR710 (upstream of the Weir)	26 52 09	80 14 37
5	■	C18S46	02277700	C-18 upstream of S-46	26 56 05	80 08 29
6	■	C181.9	265439080102100	C-18 approximately 1.9 Miles SW of the Turnpike at Small Bridge	26 54 39	80 10 21
7	●	LZ-37	265817081055700	Lake Okeechobee in Fisheating Bay	26 58 17	81 05 57
8	●	LZ-15	265906080392600	Lake Okeechobee 2 Miles West of Port Mayaca	26 59 06	80 39 26
9	●	LZ-19	02276416	Supply intake for the City of Pahokee	26 49 30	80 40 05
10	■	HGS-5	02278000	West Palm Beach Canal at HGS-5	26 51 50	80 37 55
11	■	S-2	02283498	North New River and Hillsboro Canals at S-2 and HGS-4	26 42 00	80 42 55
12	■	S-3	02285400	Miami Canal at HGS-3 and S-3	26 41 56	50 48 23
13	■	S-34	02284700	North New River Canal upstream of S-34	26 08 43	80 26 29
14	■	BARRON	02291000	Barron River Canal near Everglades City (at SR29 Near Copeland)	25 88 00	81 21 00
15	■	FAKA	02291143	Faka Union Canal at Remuda Ranch Upstream of US41 and Weir	25 57 59	81 30 23
16	■	GGCAT951	02291300	Golden Gate Canal near Naples at SR951	26 10 01	81 46 02

1/ ■ Sediment Samples Taken for Analyses
● Water Samples Taken for Analyses

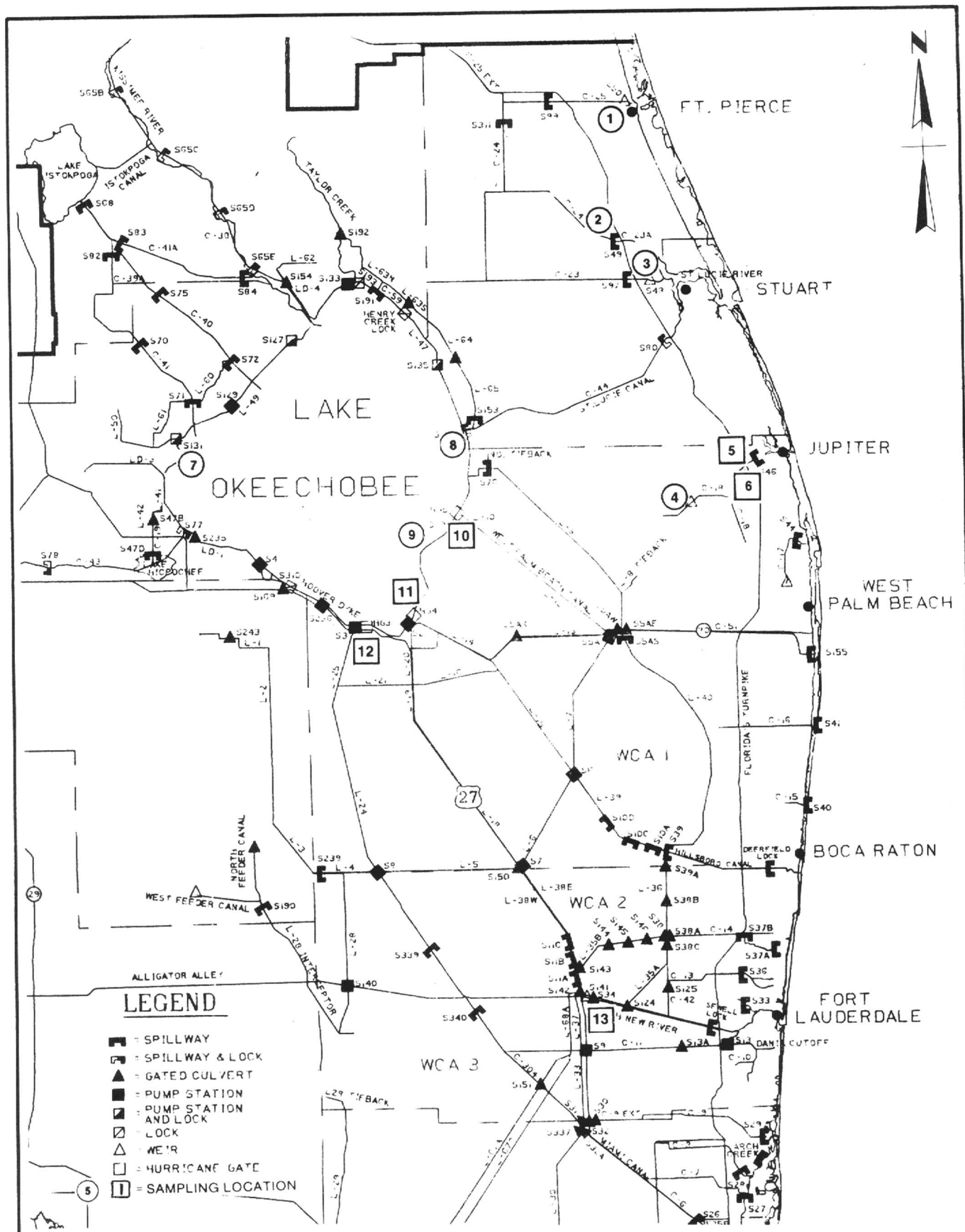

Figure 8 **1979 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 7 FOR KEY TO SYMBOLS**

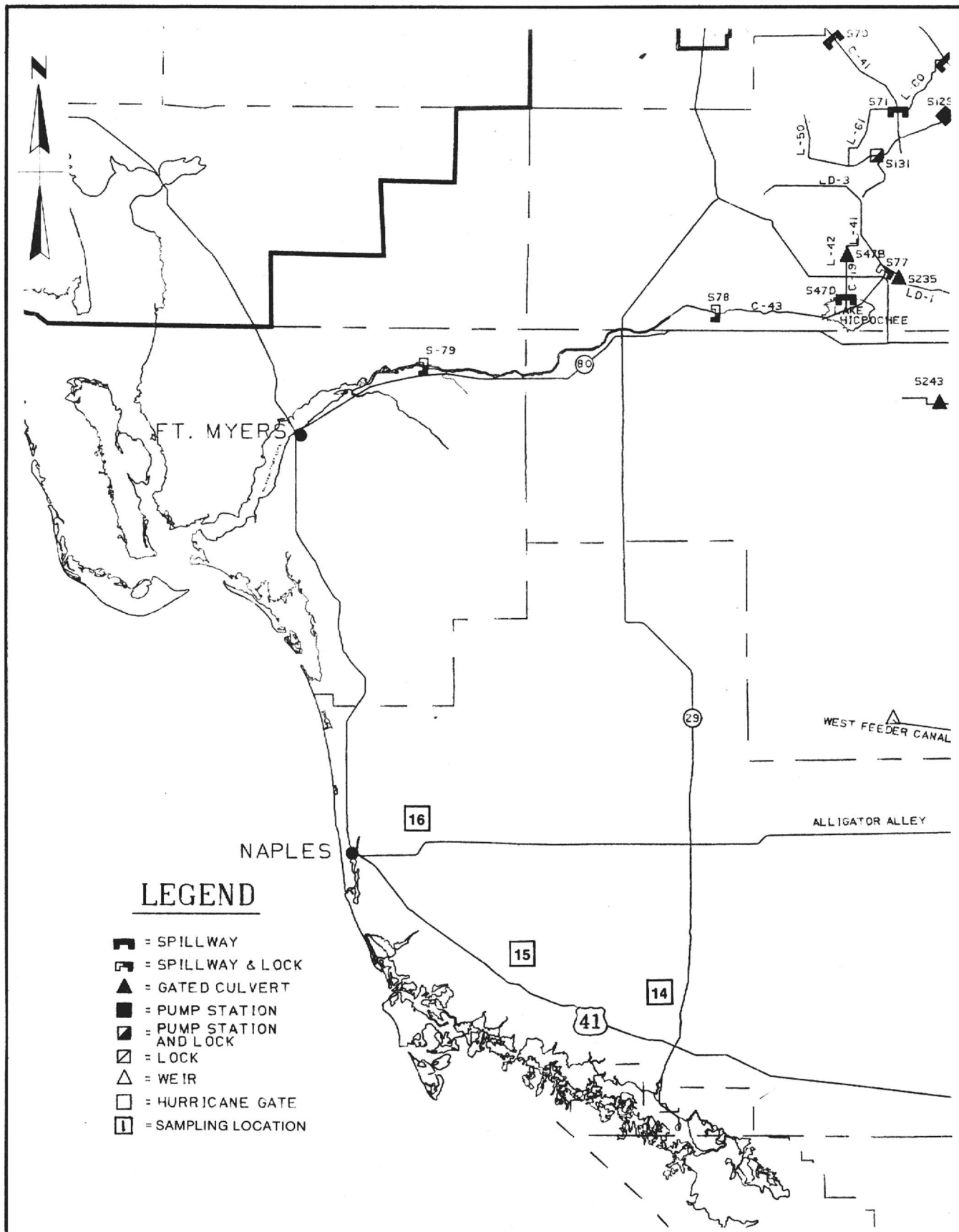

Figure 9 **1979 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 7 FOR KEY TO SYMBOLS**

TABLE 8. 1979 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING DATA FOR WATER SAMPLES[1/]

Map Code	Station Code	Water[2/] Class	Date Sampled	2,4-D	(Silvex) 2,4,5-TP
1	C25S50	III	11-21-79	<0.01	0.01
2	C24S49	III	11-21-79	0.10	<0.01
3	C23S48	III	11-21-79	0.03	<0.01
4	C18SR710	IA	11-21-79	<0.01	<0.01
5	C18S46	II	11-08-79	<0.01	<0.01
6	C181.9	IA	11-08-79	<0.01	<0.01
7	LZ-37	IA	11-08-79	<0.01	<0.01
8	LZ-15	IA	11-08-79	<0.01	<0.01
9	LZ-19	IA	11-08-79	0.02	<0.01

1/ Units are micrograms per liter. Numbers less than (<) represent minimum detection limits. Compounds analyzed for but not detected include: aldrin (<0.01), chlordane (<0.01), DDE (<0.01), DDD (<0.01), DDT (<0.01), diazinon (<0.01), dieldrin (<0.01), endosulfan (<0.01), endrin (<0.01), ethion (<0.01), heptachlor (<0.01), heptachlor epoxide (<0.01), lindane (<0.01), malathion (<0.01), methyl parathion (<0.01), methyl trithion (<0.01), methoxychlor (<0.01), mirex (<0.01), parathion (<0.01), PCB (<0.1), PCN (<0.1), perthane (<0.01), toxaphene (<0.1), trithion (<0.01), 2,4-DP (<0.01), and 2,4,5-T (<0.01).

2/ FAC Chapter 17-3

In the last year of the Water Quality Monitoring Program (1980), water and sediment samples were taken in the Water Conservation Areas, C-18, C-24, and at S-2 and S-3 at Lake Okeechobee. (Table 10 and Figure 10). Samples were analyzed for chlorinated hydrocarbon and organophosphorus pesticides, herbicides, PCBs and PCNs. For the water samples, residue concentrations were below the minimum detection limits for all samples except one (Table 11). Silvex (2,4,5-TP) was found in the WCA-2A water column at station CA2-5 at a concentration of 0.01 ug/l. No state standards (FAC Chap. 17-3) have been established for 2, 4,5-TP in Class III waters. The water samples taken from WCA-2A and analyzed by the USGS lab could have been in violation of the Class III waters criteria as the limits of detection by this method of analysis were higher than the criteria for aldrin, chlordane, DDT, dieldrin, endosulfan, endrin, heptachlor, mirex, toxaphene, and PCBs. The water samples taken in WCA-3A and analyzed by Everglades Laboratory of West Palm Beach could also have been in violation of Class III waters for DDT, malathion, methoxychlor, mirex, toxaphene, and PCBs as methods of analysis were again not sensitive enough. The same holds true for chlordane, DDT, and PCBs for the water samples from C-24, S-2 and S-3 for Class III criteria and C-18 stations for Class IA criteria. However, as before, it cannot be absolutely determined that the standards

TABLE 9. 1979 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING DATA FOR SEDIMENT SAMPLES[1/]

Map Code	Station Code	Date Sampled	Chlordane	DDE	DDD	DDT	Dieldrin	PCB
5	C18S46	11-21-79	72	<1.0	<1.0	<0.1	4.4	54
6	C181.9	11-21-79	30	0.4	<1.0	<0.1	1.8	3
10	HGS-5	09-18-79	<1.0	<1.0	0.2	<0.1	<0.1	<1.0
11	S-2	09-19-79	58	8.7	45	3.7	<0.1	46
12	S-3	09-19-79	9	11	11	1.7	<0.1	
13	S-34	09-25-79	2	2.2	1	0.1	<0.1	16
14	BARRON	09-26-79	<1.0	<1.0	0.6	1	<0.1	2
15	FAKA	09-26-79	<1.0	<1.0	<1.0	<0.1	<0.1	2
16	GGCAT951	09-26-79	<1.0	<1.0	<1.0	<0.1	<0.1	<1.0

1/ Units are micrograms per kilogram dry sediment. Numbers less than (<) represent minimum detection limits. Compounds analyzed for but not detected include: aldrin (<0.1), diazinon (<0.1), endosulfan (<0.1), endrin (<0.1), ethion (<0.1), heptachlor (<0.1), heptachlor epoxide (<0.1), lindane (<0.1), malathion (<0.1), methyl parathion (<0.1), methyl trithion (<0.1), methoxychlor (<0.1), mirex (<0.1), parathion (<0.1), PCN (<1.0), perthane (<0.1), toxaphene (<1.0), trithion (<0.1), 2,4-D (<1.0), 2,4-DP (<1.0), and 2,4,5-T (<1.0).

TABLE 10. 1980 SFWMD/USGS WATER QUALITY MONITORING NETWORK STATION LOCATIONS

Map Code 1/		Station Code S.F.W.M.D.	Station Code U.S.G.S.	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	●	CA1-1	264000080220000	Inside WCA-1	26 40 00	80 22 00
2	●	CA1-16	262300080180000	Inside WCA-1	26 23 00	80 18 00
3	●	CA1-6	263000080140000	Inside WCA-1	26 30 00	80 14 00
4	●	CA1-8	263100080200000	Inside WCA-1	26 31 00	80 20 00
5	●	A-5	263000080130000	East of CA1-6 in the Rim Canal of WCA-1	26 30 00	80 13 00
6	▲	CA2-5	262202080224100	Inside WCA-2	26 22 02	80 22 41
7	▲	CA2-10	262004080233300	Inside WCA-2	26 20 04	80 23 33
8	▲	CA2-15	261716080244600	Inside WCA-2	26 17 16	80 24 46
9	▲	CA2-17	261510080272000	Inside WCA-2	26 15 10	80 27 20
10	▲	CA2-21	261141080263600	Inside WCA-2	26 11 41	80 26 36
11	▲	CA3-1		Inside WCA-3	26 12 10	80 27 43
12	▲	CA3-2		Inside WCA-3	26 14 23	80 13 12
13	▲	CA3-3		Inside WCA-3 upstream of S-339	26 18 38	80 42 43
14	▲	CA3-4		Inside WCA-3	26 10 00	80 36 40
15	▲	CA3-5		Inside WCA-3	27 14 40	80 47 08
16	●	C18SR710		C-18 at SR710 (upsteam of the weir)	26 52 09	80 14 37
17	▲	C181.9		C-18 approximately 1.9 miles SW of the Turnpike at Small Bridge	26 54 39	80 10 21
18	▲	C18S46		C-18 upstream of S-46	26 56 05	80 08 29
19	●	C24S49	271541080213500	C-24 upstream of S-49	27 15 40	80 21 34
20	▲	S-2	02283498	North New River and Hillsboro Canals at HGS-4 and S-2	26 42 00	80 42 55
21	▲	S-3	02285400	Miami Canal at HGS-3 and S-3	26 41 56	80 48 23

1/ ● Water Samples Taken for Analyses
▲ Water and Sediment Samples Taken for Analyses

were exceeded since the true value could also conceivably fall below the criteria levels. At station C24S49, 2,4-D was detected at 0.10 ug/l in 1979 but none was detected at this time.

Sediment samples from WCA-2A had residues of DDD, DDE, and PCBs (Table 12) Residue concentrations of similar value were found in the sediments of the canals surrounding WCA-2A (S-6, S-7, and S-10) in 1976.

Bottom sediments in WCA-3A had small residues of chlordane and DDE present. In 1977 the Miami Canal (which transverses WCA-3A) had sediments with larger residues of DDE along with DDT and DDD.

C-18 sediments contained residues of chlordane similar to those found the previous year at C181.9 and C18S46, but much higher than residues found in 1978 downstream of S-46.

S-2 and S-3 sediments contained DDT, DDE, and PCBs as in the sediment sampling of 1979, but no DDD. The 1977 sediment samples had at least DDT, DDD, and DDE, but no PCBs.

A summary review of the sediment pesticide residue data with regional or national data collection is presented in Table 13. Before reviewing the data, several considerations are necessary. First, considerable attention is given to the pesticide data at or below the limit of detection. Since the limit of detection varies between studies, all of the data below the limit of detection were considered in this review as being zero, and zero's were utilized in the computation of the arithmetic mean. Arithmetic means have been used in this review, as opposed to some other measure of central tendency, since all comparable studies included an arithmetic mean. The percentage of positive occurrences and the maximum values have also been presented.

Secondly, most of the data collected by the SFWMD were analyzed by the USGS laboratory. Data that the USGS analyzed were also reported in the Water Resources Data for South Florida. Before comparing the SFWMD data to the USGS data, all SFWMD data was removed from the USGS data set. In addition, the discussion will center on the most readily found compounds which have consistently been detected. In general, the organophosphorus pesticides were below minimum detection limits or were not monitored. The chlorinated hydrocarbon pesticides and PCB's have been uniformly found.

Finally, budgetary constraints at the SFWMD forced sampling at sites where pesticides might more commonly occur, whereas the USGS randomly samples numerous sites throughout Florida. These types of sampling attitudes may explain why some residue concentrations in the SFWMD data are somewhat higher than the USGS data.

Dieldrin

Collection of sediment samples throughout south Florida by the SFMWD for dieldrin averaged 22 ug/kg for all stations with the two highest values (760 ug/kg and 620 ug/kg) both being collected from the

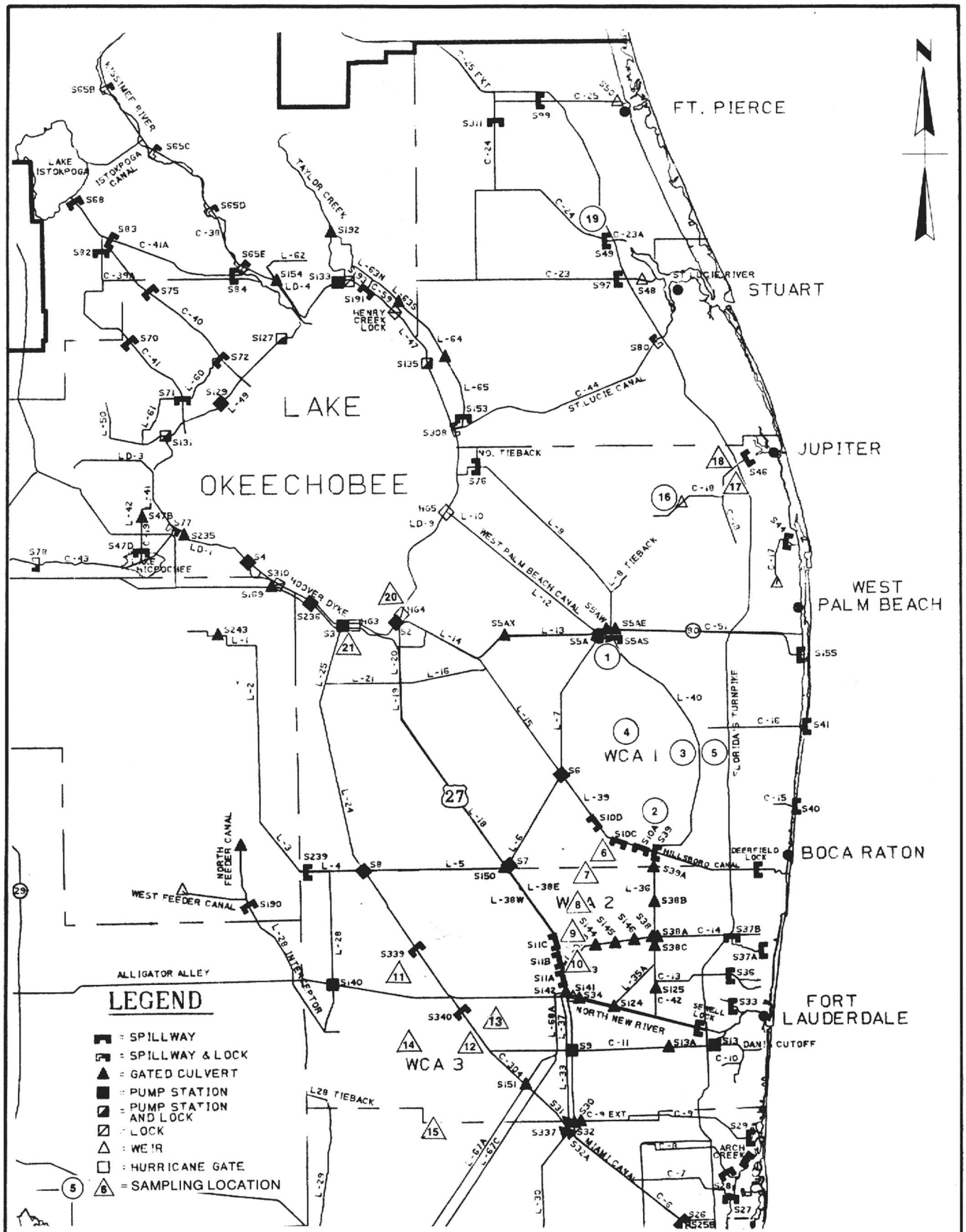

Figure 10 **1980 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING LOCATIONS. SEE TABLE 10 FOR KEY TO SYMBOLS**

TABLE 11. 1980 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING DATA FOR WATER SAMPLES1/

Station Code	CA1-1	CA1-6	CA1-8	CA1-16	A-5	CA2-5	CA2-10	CA2-15	CA2-17	CA2-21
Water Class	III	III	III	III	III	III	III	III	III	III
Date Sampled	01-18-80	01-18-80	01-18-80	01-18-80	01-18-80	01-21-80	01-21-80	01-21-80	01-21-80	01-21-80
Analytical Lab	USGS	USGS	USGS	USGS	USGS	USGS	USGS	USGS	USGS	USGS
Pesticides										
Aldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lindane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chlordane	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
DDE	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
DDT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Diazinon	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Dieldrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endosulfan	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Endrin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ethion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Heptachlor Epoxide	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Malathion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Methyl Parathion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Methyl Trithion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Methoxychlor	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mirex	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Parathion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCB	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PCN	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Perthane	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Toxaphene	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Trithion	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4-D	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4,5-T	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2,4,5-TP	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01

TABLE 11 (continued)

Station Code	CA3-1	CA3-2	CA3-3	CA3-4	CA3-5	S-2	S-3	C18SR710	C181.9	C18S46	C24S49
Water Class	III	III	III	III	III	III	III	IA	IA	IA	III
Date Sampled	12-23-80	12-23-80	12-23-80	12-23-80	12-23-80	11-12-80	11-12-80	11-25-80	11-25-80	11-25-80	11-25-80
Analytical Lab	EVER[2/]	EVER	EVER	EVER	EVER	EVER	EVER	EVER	EVER	EVER	EVER
Pesticides											
Aldrin	<0.001	<0.001	<0.001	<0.001	<0.001						
Lindane	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003						
Chlordane	<0.009	<0.009	<0.008	<0.008	<0.008	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
DDE	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
DDD	<0.0003	<0.0003	<0.0003	<0.0003	<0.003	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
DDT	<0.01	<0.01	<0.006	<0.008	<0.009	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Diazinon	<0.3	<0.3	<0.3	<0.3	<0.3						
Dieldrin	<0.002	<0.002	<0.001	<0.001	<0.001	<0.004	<0.004	<0.004	<0.004	<0.004	<0.00
Endosulfan	<0.003	<0.003	<0.002	<0.002	<0.003						
Endrin	<0.003	<0.003	<0.002	<0.002	<0.003						
Ethion	<0.5	<0.5	<0.5	<0.5	<0.5						
Heptachlor	<0.0009	<0.0009	<0.0008	<0.0008	<0.0009						
Heptachlor Epoxide	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004						
Malathion	<0.4	<0.4	<0.4	<0.4	<0.4						
Methyl Parathion	<0.5	<0.5	<0.5	<0.5	<0.5						
Methyl Trithion	<0.3	<0.3	<0.3	<0.3	<0.3						
Methoxychlor	<0.01	<0.01	<0.0009	<0.0009	<0.01						
Mirex	<0.009	<0.009	<0.007	<0.007	<0.008						
Parathion	<0.3	<0.3	<0.3	<0.3	<0.3						
Aroclor 1016	<0.07	<0.07	<0.07	<0.07	<0.07	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Aroclor 1242	<0.2	<0.2	<0.2	<0.2	<0.2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Aroclor 1248	<0.08	<0.08	<0.06	<0.06	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07
Aroclor 1254	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Aroclor 1260	<0.03	<0.03	<0.03	<0.03	<0.03	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Halowax 1000	<0.08	<0.08	<0.07	<0.07	<0.07						
Halowax 1099	<0.1	<0.1	<0.09	<0.09	<0.09						
Perthane	<0.1	<0.1	<0.1	<0.1	<0.1						
Toxaphene	<0.1	<0.1	<0.1	<0.1	<0.1						
Trithion	<0.6	<0.6	<0.6	<0.6	<0.6						
2,4-D	<0.056	<0.056	<0.056	<0.056	<0.056						
2,4-DP	<0.062	<0.062	<0.062	<0.062	<0.062						
2,4,5-T	<0.0093	<0.0093	<0.0093	<0.0093	<0.0093						
2,4,5-TP	<0.0099	<0.0099	<0.0099	<0.0099	<0.0099						

1/ Units are micrograms per liter. Values reported as less than (<) are minimum detection limits.
2/ Analyses performed by Everglades Laboratory Inc. of West Palm Beach Florida and by Method 608 as published in the Federal Register, Volume 44, No. 233, December 3, 1979.

TABLE 12. 1980 SFWMD/USGS WATER QUALITY MONITORING NETWORK SAMPLING DATA FOR SEDIMENT SAMPLES[1/]

Station Code	CA2-5	CA2-10	CA2-15	CA2-17	CA2-21
Date Sampled	01-21-80	01-21-80	01-21-80	01-21-80	01-21-80
Analytical Lab	USGS	USGS	USGS	USGS	USGS
Pesticides					
Aldrin	<0.1	<0.1	<0.1	<0.1	<0.1
Lindane	<0.1	<0.1	<0.1	<0.1	<0.1
Chlordane	<1.0	<1.0	<1.0	<1.0	<1.0
DDE	66	13	56	14	5.9
DDD	23	5.1	28	7	<0.1
DDT	<0.1	<0.1	<0.1	<0.1	<0.1
Diazinon	<0.1	<0.1	<0.1	<0.1	<0.1
Dieldrin	<0.1	<0.1	<0.1	<0.1	<0.1
Endrin	<0.1	<0.1	<0.1	<0.1	<0.1
Ethion	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor	<0.1	<0.1	<0.1	<0.1	<0.1
Heptachlor Epoxide	<0.1	<0.1	<0.1	<0.1	<0.1
Malathion	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl Parathion	<0.1	<0.1	<0.1	<0.1	<0.1
Methyl Trithion	<0.1	<0.1	<0.1	<0.1	<0.1
Methoxychlor	<0.1	<0.1	<0.1	<0.1	<0.1
Parathion	<0.1	<0.1	<0.1	<0.1	<0.1
PCB	7	<1.0	6	13	<1.0
Toxaphene	<1.0	<1.0	<1.0	<1.0	<1.0
Trithion	<1.0	<1.0	<1.0	<1.0	<1.0
2,4-D	<1.0	<1.0	<1.0	<1.0	<1.0
2,4,5-T	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.5-TP	<0.1	<0.1	<0.1	<0.1	<0.1

TABLE 12 (Continued)

Station Code	CA3-1	CA3-2	CA3-3	CA3-4	CA3-5	S-2	S-3	C181.9	C18S46	C24S49
Date Sampled	12-23-80	12-23-80	12-23-80	12-23-80	12-23-80	11-12-80	11-12-80	11-12-80	11-25-80	11-25-80
Analytical Lab	EVER2/	EVER	EVER	EVER	EVER	EVER	EVER	EVER	EVER	EVER
Pesticides										
Aldrin	<0.0003	<0.0004	<0.0001	<0.0004	<0.0003					
Lindane	<0.0003	<0.0003	<0.00005	<0.0003	<0.0003					
Chlordane	<0.01	0.03	0.005	0.07	0.03	<8.8	<5.4	37.0	105	<1.5
DDE	0.004	0.006	0.001	0.004	0.006	102	<0.82	<0.29	<0.92	<0.19
DDD	<0.002	<0.002	<0.0004	<0.002	<0.002	<2.6	<1.6	<0.56	<1.8	<0.36
DDT	<0.002	<0.003	<0.0005	<0.003	<0.003	120	40	<0.82	<2.6	<0.53
Diazinon	<0.05	<0.1	<0.02	<0.1	<0.09					
Dieldrin	<0.0004	<0.0004	<0.0001	0.01	F0.0009	<0.27	<0.15	<1.3	<1.0	<0.1
Endosulfan	<0.001	<0.001	<0.0002	<0.001	<0.001					
Endrin	<0.0004	<0.0005	<0.0001	<0.0005	<0.001					
Ethion	<0.09	<0.2	<0.03	<0.2	<0.1					
Heptachlor	<0.0003	<0.0004	<0.0001	<0.0004	<0.0003					
Heptachlor Epoxide	<0.005	<0.007	<0.0001	<0.0007	<0.0006					
Malathion	<0.07	<0.1	<0.02	<0.1	<0.1					
Methyl Parathion	<0.1	<0.2	<0.03	<0.2	<0.2					
Methyl Trithion	<0.06	<0.1	<0.02	<0.1	<0.09					
Methoxychlor	<0.007	<0.01	<0.002	<0.01	<0.01					
Mirex	<0.003	<0.003	<0.006	<0.004	<0.003					
Parathion	<0.05	<0.09	<0.01	<0.1	<0.08					
Aroclor 1016	<0.003	<0.004	<0.0007	<0.004	<0.004	<14.0	<8.6	<3.0	<9.7	<2.0
Aroclor 1242	<0.009	<0.01	<0.002	<0.01	<0.01	<27	<17	<6.0	<19.0	<3.9
Aroclor 1248	<0.01	<0.02	<0.003	<0.02	<0.01	19.0	<11.0	<4.1	<13.0	<2.7
Aroclor 1254	<0.004	<0.005	<0.0009	<0.005	<0.004	482	71.0	<3.5	<11.0	<2.3
Aroclor 1260	<0.01	<0.02	<0.003	<0.02	<0.02	<11.0	<10.4	<3.7	<11.7	<2.4
Halowax 1000	<0.07	<0.1	<0.02	<0.1	<0.09					
Halowax 1099	<0.027	<0.036	<0.006	<0.038	<0.032					
Perthane	<0.1	<0.1	<0.03	<0.2	<0.1					
Toxaphene	<0.073	<0.097	<0.016	<0.1	<0.1					
Trithion	<0.1	<0.2	<0.04	<0.2	<0.2					
2,4-D	<0.03	<0.06	<0.01	<0.06	<0.06					
2,4-DP	<0.008	<0.02	<0.003	<0.02	<0.01					
2,4,5-T	<0.001	<0.003	<0.0005	<0.003	<0.003					
2,4,5-TP	<0.001	<0.003	<0.005	<0.003	<0.003					

1/ Units are micrograms per kilogram dry sediment. Values reported as less than (<) are minimum detection limits.
2/ Analysis performed by Everglades Laboratory of West Palm Beach, Florida and methods described in Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue" with determination of the Extracts by Method 608 as published in the Federal Register, Volume 44, No. 233, December 3, 1979.

TABLE 13. CHLORINATED HYDROCARBON PESTICIDE RESIDUES-SEDIMENT SURVEY[1/]

Source	Year	PCB	Aldrin	Dieldrin	Chlordane	Endrin	DDT	DDE	DDD
SOUTH FLORIDA									
So. Fl. Water Mgmt. District	1976-81	21[2/] 23/740	ND	22 19/760	8 26/120	25.6 5.0/920.0	1421 27/110,000	312 76/9300	370 59/13,000
USGS	1976-81	40 40/810	<.1 1.6/1.8	1 30/52	18 55/230	<.1 <1.0/1.0	4 27/160	13 66/130	3 45/330
USGS	1970-81	1464 35/1,300,000	2 3/66	2 48/260	24 47/5000	<.1 1.0/2.1	3 30/420	18 76/1400	20 69/870
NOAA[3/]	1976	10 93/33	ND	ND	2 64/3	ND	4 50/22		
Everglades Park Adjacent Farms[3/]	1976	13 89/43	11 6/11	85 17/238	16 39/195	ND	58 44/761		
FLORIDA									
USGS	1975-81	2324 29/1,300,000	.1 2/53	1 30/160	16 45/1100	<.01 1.0/2.1	3 22/420		
EPA[6/]	1972	-	10 6/160	80 18/1090	30 24/220	-	370 65/3380		
EPA[7/]	1971	-	10 17/110	150 22/1700	10 6/100	60 11/1000	190 39/1890		
U.S.									
EPA Urban/Soils[5/]	1971	60 2/12,000	6 2/2000	66 16/6000	904 28/141,000	<0.1 4/170	342 69/18,000		
EPA, National[6/] Soils Monitoring	1972	<10[4/] <1/2000	30 9/13,000	40 27/6180	50 8/8000	<10 <1/2000	220 21/29,000		
EPA, National[7/]	1971		20 10/1880	50 28/9830	60 8/7000	10 <1/1000	610 24/388,000		

ND = None Detected - = Not Sampled

1/ All concentrations are in microgram/Kg

2/ Mean / (% positive occured/maximum)

3/ Requejo et al. 1979

4/ PCB national data collected from California and Iowa only

5/ 380 samples were taken from major areas of the U.S. and compiled to form a grand mean (Carey et al. 1979)

6/ Carey et al. 1979

7/ Carey et al. 1978

sediments found on Ritta Island in Lake Okeechobee (1977). The SFWMD average dieldrin concentration was greater than the USGS average concentration for either south Florida or Florida in general. Recomputing without the two highest values, the average dieldin concentration then becomes about 8 ug/kg which is similar to the USGS level of 1 ug/kg computed for the same time period (1976-81).

The SFWMD average dieldrin level found in the south Florida sediments was less than that found by the EPA for Florida in general. If the EPA average dieldrin level computed for 1972 (80 ug/kg) was recomputed without the maximum value of 1,090 ug/kg, the new mean of 17 ug/kg would correspond well with the SFWMD mean dieldrin level of 22 ug/kg.

The average dieldrin level of 22 ug/kg measured by the SFWMD is lower than the national average dieldrin concentrations reported by the EPA in three different studies. An analysis of variance was performed to test if the average dieldrin concentrations between all of the studies showed significant differences. Although there was no significant difference between the average dieldrin concentrations, the sampling is so small that this result gives only a weak confirmation of the null hypothesis.

Although there were no apparent significant differences between the study means, it is interesting that the USGS average dieldrin concentration is obviously lower than all other studies. Differences in analytical methodologies probably do not account for the differences between the SFWMD and the USGS study means, since most of the SFWMD sites were analyzed by the USGS. The reason for this difference, most probably, is that Florida has normally very low levels of dieldrin compared to the rest of the nation. This is evidenced by the fact that both the SFWMD and USGS average dieldrin levels were less than the EPA's national averages.

Overall, the dieldrin levels collected by the SFWMD appear to be consistent with those found by other agencies in south Florida, Florida, and throughout the nation (Carey et al. 1978; Carey et al. 1979 and USGS 1970-81).

Chlordane: Chlordane in south Florida, collected by the SFWMD, averaged 8 ug/kg and was lower than the average data collected by the USGS for south Florida and the state, or the EPA for Florida and the nation. The SFWMD percent of positive occurrences were consistent with the other data for south Florida and Florida. Nationally, the SFWMD percent of positive ocurrences (26%) was higher than either the 1971 or 1972 percent of positive occurrences found by the EPA (8% for each). However, the percent of positive occurrences found by the EPA at urban sites (28%) was essentially equal to that of the SFMWD

Endrin: Endrin levels collected by the SFWMD in south Florida sediments averaged 25.6 ug/kg. This level was higher than any other level determined for south Florida, Florida, or nationally by any other agency. The only exception was the EPA's national soils monitoring program in 1971, when a Florida average for endrin was computed to be 60 ug/kg.

The SFWMD average endrin concentration, however, was the result of four comparatively high concentrations which were all found on Torry and Kreamer Islands in Lake Okeechobee (1977). After removing the four high values (300 ug/kg, 590 ug/kg, 620 ug/kg, and 920 ug/kg), the average concentration for the remaining 91 stations became 0 1 ug/kg. This level was commonly found in south Florida and around the nation.

Although the percent of positive SFWMD occurrences for endrin is higher than either the USGS or national EPA data, it was similar to the EPA data for Florida and in the national urban areas. The SFWMD extreme value (920 ug/hg) was less than the extremes found by the EPA in Florida (1,000 ug/kg) and nationally (1,000 ug/kg and 2,000 ug/kg).

DDT, DDE, DDD: DDE and DDD were not measured by most other studies; therefore, no comparative discussion will be presented for these compounds. Since DDE and DDD are degradation products of DDT, the trends noted for DDT will probably follow for DDE and DDD as well.

The average concentration of DDT which has been isolated from the sediments in south Florida by the SFWMD was 1,421 ug/kg and was higher than the average DDT concentrations found by all other reports; however, this high SFWMD level was the result of four very high DDT levels (2,200 ug/kg, 7,400 ug/kg, 15,000 ug/kg, and 11,000 ug/kg) which, like endrin, were all found on Torry and Kreamer Islands in Lake Okeechobee (1977). Recomputing the mean DDT level to exclude these four high values produced a new mean for the remaining 91 stations in south Florida of 4.3 ug/kg, which is comparable to the reported USGS south Florida and Florida data, and the NOAA data for the Everglades National Park (Requejo et al. 1979). The range in SFWMD average DDT concentrations (4.3 ug/kg - 1,421 ug/kg), as well as the similarity between the percent of positive occurrences and the extreme values, suggests that the SFWMD data compares favorably to other studies.

Polychlorinated Biphenols (PCB's): PCB levels collected by the SFWMD in the sediments of south Florida averaged 21 ug/kg among all stations, with the highest value (740 ug/kg) isolated from the sediments in the Miami Canal in Hialeah (1977). The SFWMD's measured PCB levels occurred with a lesser frequency and averaged lower than the USGS data for south Florida, even after recomputing the USGS (1970-81) average to exclude the highest value of 1.3×10^6 ug/kg which was isolated from the sediments of the North New River near Ft. Lauderdale. The new USGS mean for 1970-81, although reduced to 84 ug/kg, is still four times greater than the average SFWMD level for PCB's.

Although the SFMWD average PCB concentration is greater than the NOAA average PCB concentration for the ENP and adjacent farms, if the SFWMD highest value is excluded from the average computation, the new mean becomes 13 ug/kg. This recomputed SFWMD average PCB level is essentially the same as the average PCB levels reported by NOAA for the ENP and the EPA as part of the 1972 national soils monitoring program. The frequency of positive occurrences for PCB's collected by the SFWMD was similar to that found by the USGS in south Florida and in Florida, in general. However, the percent of positive occurrences found nationwide was considerably less.

The percent of positive occurrences reported by NOAA for the ENP and vicinity was substantially greater than the percent of positive occurrences computed from the SFWMD data. For this case, it was suggested that if all the PCB's isolated from all the samples were combined, the pattern would be similar to that of plastic sheeting which was the suggested source of PCB's in this region (Requejo et al. 1979). Therefore, the percent of positive occurrences would be expected to be high.

CALOOSAHATCHEE RIVER STUDY

The Caloosahatchee River Study was initiated in January, 1978 "to develop a water quality data base for the river and its major tributaries, to generate comprehensive background and baseline data on chlorophyll a in the fresh water portion of the Caloosahatchee River, and to examine factors associated with nuisance algal blooms." This study was performed by the staff of the Resource Planning Department of the District. Information presented here can be found in Technical Publication 82-4, "A Survey of Water Quality Characteristics and Chlorophyll a Concentrations in the Caloosahatchee River System, Florida" by T.H. Miller, A.C. Federico, and J.F. Milleson, July 1982.

As part of the background data base, water samples for chlorinated hydrocarbon and organophosphorus pesticide and herbicide scans were collected from the surface at river stations CR-0.00 (the Lake Okeechobee Rim Canal at S-77), CR-16.0 (1.2 miles west of the Ortona Lock or downstream of S-78) and CR-40.3 (at the Franklin Lock adjacent to the surface water intake of the Olga water plant) in October 1979 (Table 14 and Figure 11). These samples were analyzed by the U.S. Geological Survey Laboratory in Georgia. A second set of samples were taken at the same locations in April 1981 for confirmation and analyzed by Everglades Laboratory Inc. The results are presented in Table 15.

The first pesticide scan found detectable residues of chlordane, DDD, DDT, dieldrin, 2,4,5-TP, and 2,4-D. All but chlordane and 2,4,5-TP were found at each sampling site. Stations CR-0.00 and CR-16.0, which are Class III, had FAC Chapter 17-3 criteria violations for dieldrin, chlordane, and DDT. However, numerous pesticides could have been in violation of the Class III criteria as the criteria were below the minimum limits of detection used in the analyses. Station CR-40.3, which is Class IA, also had violations for dieldrin and DDT. As before, other pesticides could have been in violation of the Class IA criteria since minimum detection limits were above the State criteria. However, in both cases (Class IA and III violations), it cannot be absolutely determined that the standards were exceeded since the true value could also conceivably fall below the criteria levels.

The second sample set was taken at the same locations in the beginning of April to confirm residue concentrations of those pesticides found in violation of the State criteria (Table 15). Minimum detection limits were set below the Class IA and III standards. Chlordane and dieldrin were found to still be in concentrations greater than the State criteria for both water classes.

A final triplicate sample set at the end of April at stations CR-00.0 and CR-40.3 reconfirmed the residue concentrations of chlordane were still in violation of State standards, with average concentrations of 0.12 and 0.05 ug/l, respectively.

The results of this sampling were brought to the attention of the Florida Department of Environmental Regulation (FDER) in May of 1981 at a meeting at the FDER headquarters in Fort Myers. The FDER determined it was necessary to substantiate this preliminary data by additional sampling at the same stations (CR-0.00 and CR-40.3) and the Lee County Utilities Water Plant finished water. Duplicate samples were collected and sent to Everglades Laboratory (analyzed in accord with EPA's Method for Organo-chlorine Pesticides in Industrial Effluents) and the HRS Jacksonville Central Laboratory. The results of the chlordane analysis, in ug/l, are as follows:

	Finished Water	CR-00.3	CR-40.3
Everglades Lab	0.08	0.08	0.07
HRS Lab	<0.3	<0.3	<0.3

Based upon information obtained from the Technical Assistance Data System 72T15092 and aforementioned laboratory results, the FDER concluded that it does not appear to indicate/require action as defined under 17-22.113, Imminent Hazards, Florida Safe Drinking Water Act. However, a violation of Water Quality Standards may be indicated under Chapter 17-3, FAC.

TABLE 14. CALOOSAHATCHEE RIVER STUDY SAMPLING STATION LOCATIONS

Map Code 1/		Station Code S.F.W.M.D.	Station Code U.S.G.S.	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	●	CR-00.0	265030081050900	Caloosahatchee River upstream of S-77	26 50 30	81 05 09
2	●	CR-16.0	264734081164700	Caloosahatchee River downstream of S-78	26 47 34	81 16 47
3	●	CR-40.3	264318081410900	Caloosahatchee River downstream of S-79	26 43 25	81 41 55

1/ ● Water Samples Taken for Analysis

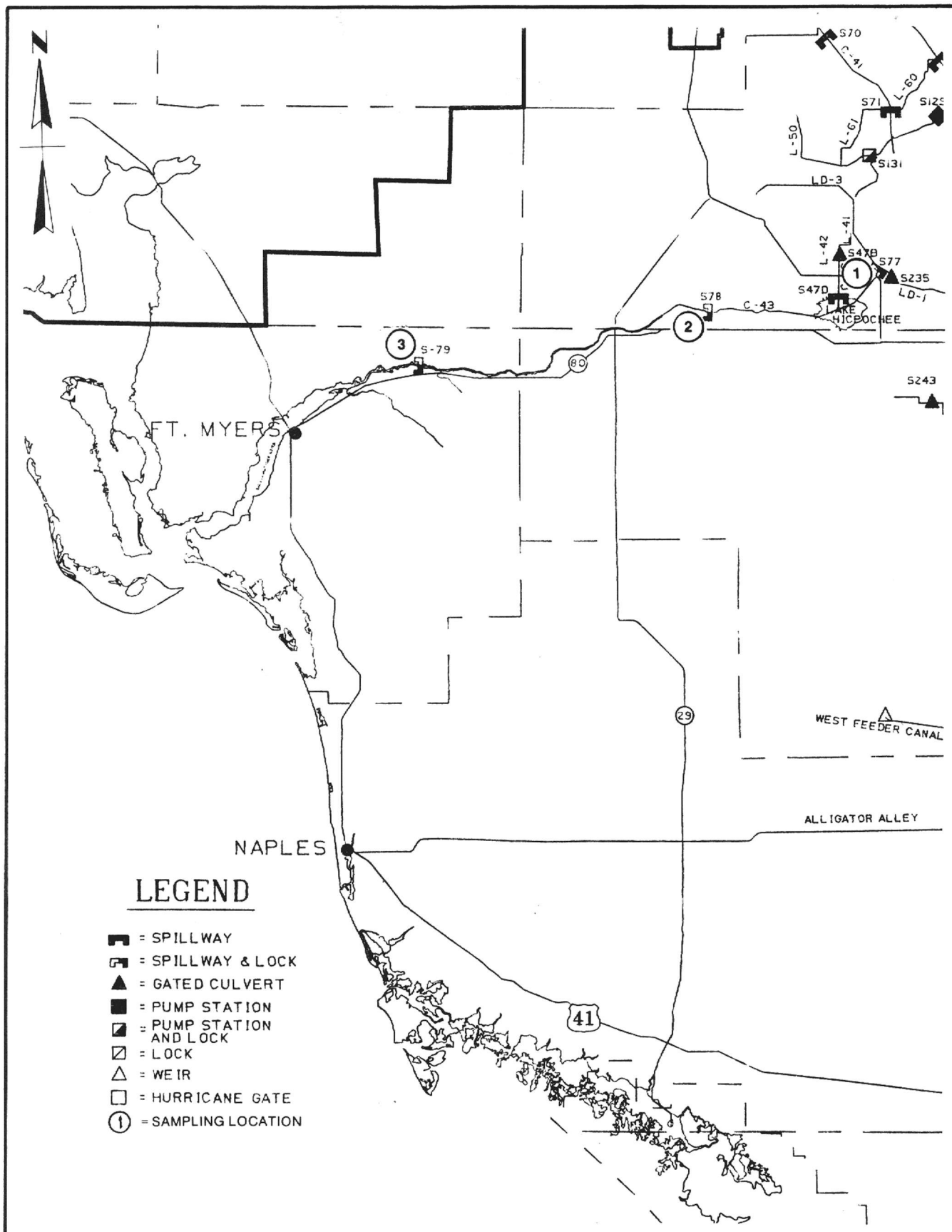

Figure 11 **CALOOSAHATCHEE RIVER STUDY SAMPLING LOCATIONS. SEE TABLE 14 FOR KEY TO SYMBOLS**

Since DDT registration for use on agricultural crops was canceled as of January 1, 1973, the persistent residual concentrations found may be attributed to the continued use of stock-piled supplies after the ban and the overall persistence in the environment. The dominant fate processes in aquatic environments are volatilization and sorption to biota and sediments, with the importance of sorption being determined by the amount of suspended particulate available in the water. Hydrolytic half-lives are approximately 12 years for solutions less than pH 12 and 81 days at pH 9. The ultimate transformation of DDT in the aquatic environment is probably by biotransformation (Calla-han et al. 1979).

Chlordane registration for agricultural crops was suspended on April 1, 1976. The persistant residual concentrations may be attributed to a heavy chlordane use prior to the suspension, the continued use of stock-piled supplies after the ban and other continued permitted uses. Hydrolysis has been demonstrated to not be an important degradation process for chlordane with a half-life in water estimated to be at least four years (Callahan et al. 1979). However, laboratory experiments suggest that volatilization may be an important loss process for the chlordane isomers in aquatic environments, although the information available is not useful for estimating volatilization half-lives.

The use and registration of dieldrin was cancelled in 1974. The literature information as well as analysis of numerous environmental samples indicates that dieldrin is persistant in the environment. The important fate processes in aquatic environments are sorption to sediment, bioaccumulation, and volatilization; the latter process may have half-lives of several hours to several days in some aquatic systems. Although direct photolysis of dieldrin in water is slow (approximately 1½ to 2 months) photosensitized processes may result in photolysis if sensitizers are available in aquatic environments. Hydrolyses of dieldrin in aquatic environments is probably very slow. Half-lives of greater than four years have been determined (Callahan et al. 1979).

PCB's were not detected in these water samples; however, the sediments may be a sink since the 1978 SFWMD/USGS Monitoring Network found residues at S-79 (180 ug/kg) and at the Edison Bridge (9 ug/kg).

The 1978 sediment samples at S-79 also had small quantities of chlordane (2 ug/kg), DDD (0.7 ug/kg), and dieldrin (1.1 ug/kg).

TABLE 15. RESULTS OF PESTICIDE ANALYSIS FOR THE CALOOSAHATCHEE RIVER STUDY[1]

Station Code	CR-00.0	CR-16.0	CR-40.3
Water Class	III	III	IA
Date Sampled	10-18-79	10-18-79	10-18-79
Analytical Lab	USGS[2]	USGS	USGS
Pesticides			
Aldrin	<0.01	<0.01	<0.01
Lindane (Gamma BHC)	<0.01	<0.01	<0.01
Chlordane	<0.1	0.1	<0.1
DDE	<0.1	<0.1	<0.1
DDD	0.1	0.2	0.1
DDT	0.1	0.2	0.1
Diazinon	<0.1	<0.1	<0.1
Dieldrin	0.03	0.04	0.03
Endosulfan	<0.1	<0.1	<0.1
Endrin	<0.1	<0.1	<0.1
Ethion	<0.01	<0.01	<0.01
Heptachlor	<0.01	<0.01	<0.01
Heptachlor Epoxide	<0.01	<0.01	<0.01
Malathion	<0.01	<0.01	<0.01
Methyl Parathion	<0.01	<0.01	<0.01
Methyl Trithion	<0.01	<0.01	<0.01
Methoxychlor	<0.01	<0.01	<0.01
Mirex	<0.01	<0.01	<0.01
Parathion (Ethyl Parathion)	<0.01	<0.01	<0.01
PCB	<0.01	<0.01	<0.01
PCN	<0.1	<0.1	<0.1
Perthane	<0.01	<0.01	<0.01
Toxaphene	<0.1	<0.1	<0.1
Trithion	<0.01	<0.01	<0.01
2,4-D	0.02	0.02	0.04
2,4,5-T	<0.01	<0.01	<0.01
(Silvex) 2,4,5-TP	<0.01	<0.01	0.01

Station Code	CR-00.0	CR-16.0	CR-40.3
Water Class	III	III	IA
Date Sampled	4-2-81	4-2-81	4-2-81
Analytical Lab	EVER[3]	EVER	EVER
Pesticides			
Aldrin	<0.0008	<0.0008	<0.0008
Chlordane	0.1	0.1	0.08
DDT	<0.004	<0.004	<0.004
Dieldrin	<0.002	<0.002	0.005

Station Code	CR-00.0	CR-40.3
Water Class	III	IA
Date Sampled	4-21-81	4-21-81
Analytical Lab	EVER	EVER
Pesticides		
Aldrin	<0.003	<0.003
Chlordane	0.12[4]	0.05[4]
Dieldrin	<0.003	<0.003

1/ Units are microgram per liter. Values less than (<) are minimum detection limits
2/ Analyzed by U.S. Department of the Interior, Geological Survey
3/ Analyzed by Everglades Laboratory Inc., West Palm Beach, Florida
4/ Average of triplicate samples

LAKE OKEECHOBEE TEMPORARY OPERATING PERMIT

The Lake Okeechobee Temporary Operating Permit (TOP) was issued to the District on December 10, 1979, pursuant to Chapter 403, Florida Statutes. Chapter 403 prohibits the discharge (without a permit) of wastes from stationary installations which may be sources of pollution to waters of the state.

A TOP was issued (not an operating permit) since sufficient information and/or data was not available to determine if the discharges were in compliance with the water quality standards. The purpose of this project was to monitor the water quality so the additional information could be made available to the FDER. Gathering this additional information involved collecting water quality data for two consecutive wet seasons from inflow control structures which are situated around the lake. Fourteen District owned and operated structures are covered by this TOP as well as six major private discharges (Table 16 and Figure 12). In addition, water samples are taken at the four public water supply intake structures, mid-lake, and at Fisheating Creek at SR78 (Figure 12).

The laboratory analyses were performed by the FDER laboratory in Tallahassee. For the 1979 sampling year, compounds which could be detected included:

(1)	Aldrin	(17)	Malathion
(2)	BHC	(18)	Methyl Parathion
(3)	Chlordane	(19)	Mirex
(4)	DDE	(20)	Methoxychlor
(5)	DDD	(21)	Parathion
(6)	DDT	(22)	PCBs
(7)	Dieldrin	(23)	Phosdrin
(8)	Demetron	(24)	Phorate
(9)	Diazinon	(25)	Ronnel
(10)	Endosulfan	(26)	Strobane
(11)	Endrin	(27)	Toxaphene
(12)	Ethion	(28)	Trifluralin
(13)	Guthion	(29)	Trithion
(14)	Heptachlor	(30)	2,4-D
(15)	Heptachlor Epoxide	(31)	2,4,5-TP
(16)	Lindane		

TABLE 16. LAKE OKEECHOBEE TEMPORARY OPERATING PERMIT SAMPLING STATION LOCATIONS

Map Code 1/		Station Code S.F.W.M.D.	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	●	S-2	Upstream of S-2	26 42 00	80 42 55
2	●	S-3	Upstream of S-3	26 41 56	80 48 23
3	●	S-4	Upstream of S-4	26 47 25	80 57 42
4	●	S-65E	Upstream of S-65E	27 13 35	80 57 42
5	●	S-191	Upstream of S-191	27 11 35	80 45 35
6	●	S-135	Upstream of S-135	27 05 10	80 39 41
7	●	S-133	Upstream of S-133	27 12 28	80 48 02
8	●	S-84	Upstream of S-84	27 12 55	80 58 55
9	●	S-154	Upstream of S-154	27 12 41	80 55 06
10	●	S-127	Upstream of S-127	27 07 19	80 53 46
11	●	S-72	Upstream of S-72	27 05 32	81 00 23
12	●	S-129	Upstream of S-129	27 01 47	81 00 06
13	●	S-71	Upstream of S-71	27 02 00	81 04 15
14	●	FECSR78	Fisheating Creek at SR78 Bridge	27 47 22	81 18 11
15	●	LZ2	In Lake Okeechobee at intake for Okeechobee Public Water Supply	27 11 30	80 49 52
16	●	LZ24	In Lake Okeechobee at intake for Belle Glade Public Water Supply	26 44 04	80 43 59
17	●	LZ26	In Lake Okeechobee at intake for South Bay Public Water Supply	26 40 59	80 43 53
18	●	LZ30	In Lake Okeechobee at intake for Clewiston Public Water Supply	26 47 54	80 51 38
19	●	LZ34,L008	Mid-Lake of Lake Okeechobee	26 56 80	80 53 29
20	●	CULV10*	Upstream at pump of East Beach Water Control District	26 47 53	80 41 46
21	●	CULV12A*	Upstream at pump of Pahokee Farms	26 46 30	80 41 40
22	●	CULV12*	Upstream at pump of East Shore Drainage District	26 44 55	80 41 05
23	●	CULV4A*	Upstream at pump of South Shore Drainage District	26 40 56	80 45 02
24	●	S-236*	Upstream at pump of South Florida Conservancy District	26 43 40	80 41 11
25	●	CULV11*	Upstream at pump of Mayaca Groves	26 57 56	80 36 44

1/ ● Water Samples Taken for Analysis
*Privately Owned Structures

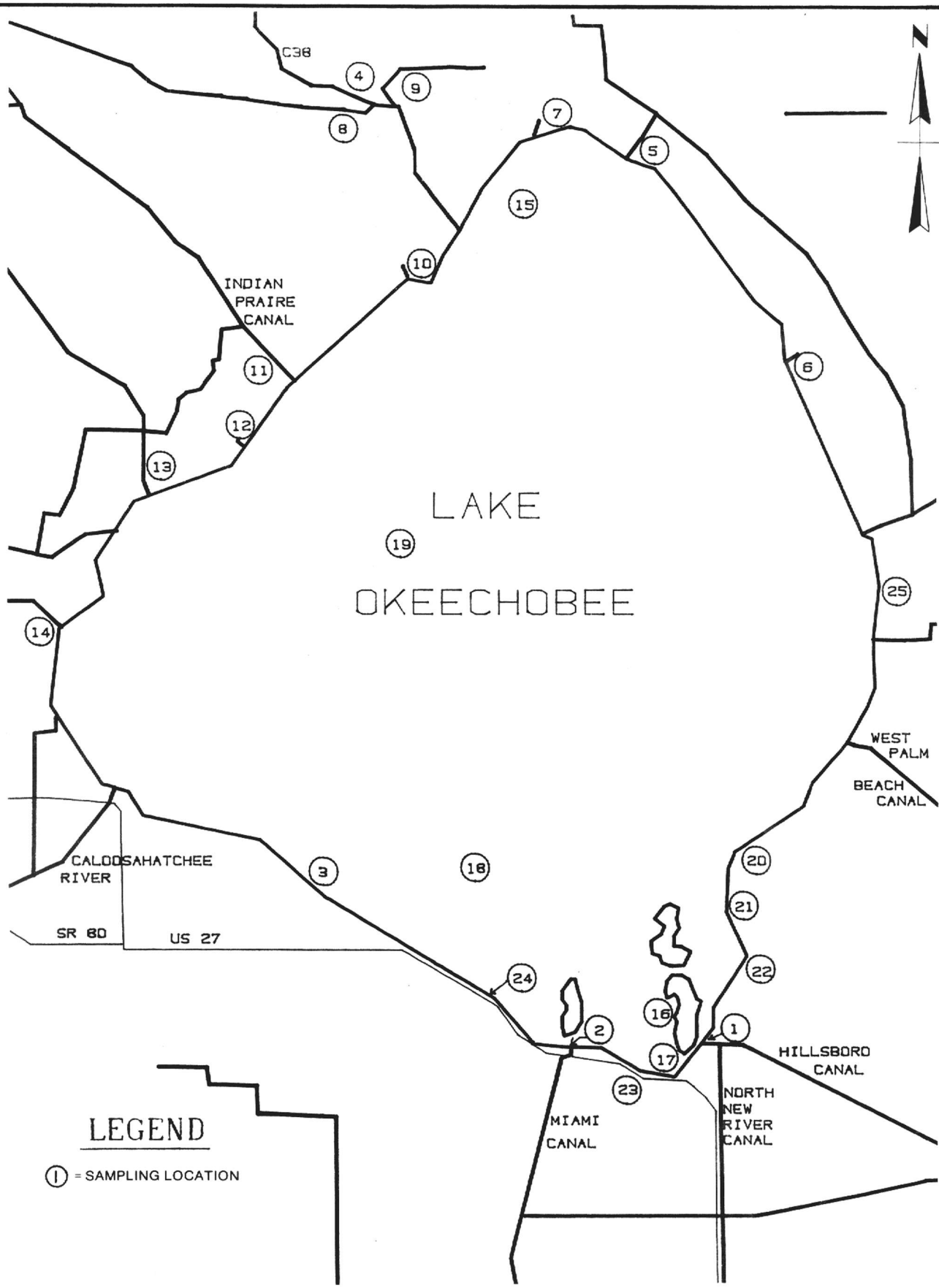

Figure 12 **LAKE OKEECHOBEE TEMPORARY OPERATING PERMIT SAMPLING LOCATIONS. SEE TABLE 16 FOR KEY TO SYMBOLS**

The detection limits ranged from 0.006 to 0.06 ug/l for the chlorinated pesticides and from 0.01 to 1.0 ug/l for athe nitrogen and phosphorus containing pesticides at the specified settings on the instruments as follows:

Chlorinated Pesticides

Instrument	HP 5730 GC
Detector	Electron Capture-Temp 300°C
Column	3% SP2100-Temp 200°C
Flow Rates	40 ml/min N_2

Nitrogen Phosphorus Pesticides

Instrument	HP 5710 GC
Detector	N-P-D Tamp 300°C
Column	2% OV-101 Temp 200°C
Flow Rates	40 ml/min He
	3 ml/min H_2
	50 ml/min Air

For the 1980 sampling year the compounds, followed by the minimum detection limits (ug/l) which could be detected, included:

(1) Aldrin (<0.01)
(2) BHC (<0.007)
(3) Lindane (<0.007)
(4) Chlordane (<0.25)
(5) DDE (<-.02)
(6) DDD (<0.02)
(7) DDT (<0.02)
(8) Dieldrin (<0.02)
(9) Endosulfan (<0.02)
(10) Endrin (<0.02)
(11) Guithion (<0.02)
(12) Heptachlor(<0.007)
(13) Heptachlor Epoxide (<0.01)
(14) Malathion (<0.07)
(15) Methoxychlor (<0.3)
(16) Mirex (<0.05)
(17) Parathion (<0.3)
(18) PCB (<0.25)
(19) Toxaphene (<0.25)
(20) 2,4-D (<0.2)
(21) 2,4,5-TP (<0.09)

The results of the sampling detected no nitrogen or phosphorus containing pesticides at any of the stations and only two chlorinated compounds 2,-4-D and 2,4,5-TP (Table 17). The herbicide 2,4,5-TP was detected only once in May of 1979 at S-4 with the concentration measured (0.27 ug/l) being below the Class I-A standard of 10 ug/l. The herbicide 2,4-D was detected at almost all stations in 1979 and only four times in 1980 (S-2, S-191, CULV10, and CULV12A) (Table 18). The highest 2,4-D level recorded was 4.36 ug/l at the Okeechobee Public Water Supply intake in 1979. This value, however, is still below the Class I-A standard of 100 ug/l. No Class III water quality standards have been established for 2,4-D or 2,4,5-TP.

TABLE 17. RESULTS OF THE 2,4-D HERBICIDE ANALYSIS FOR THE 1979 LAKE OKEECHOBEE T.O.P. MONITORING PROGRAM 1/

Station	May	June	July	Aug.	Sept.
S-2	0.19 3/	ND 2/	1.02 4/	1.06	-
S-3	0.27 3/	0.18 3/	ND	0.42	-
S-4	0.21 3/	ND	0.29	ND	-
S-65E	-	ND	0.17	0.97	-
S-191	-	0.98 3/	ND	ND	-
S-135	-	-	-	ND	-
S-133	-	-	-	0.23	-
S-84	-	-	-	0.80	-
S-154	-	-	-	0.71	-
S-127	-	-	-	0.73	-
S-72	-	-	-	0.83	-
S-129	-	-	-	ND	-
S-71	-	-	-	1.5	-
S-131	-	-	-	0.69	-
FECSR78	-	-	-	ND	-
LZ2	-	-	-	-	4.36
LZ24	-	-	-	-	3.85
LZ26	-	-	-	-	1.35
LZ30	-	-	-	-	0.60
LZ34	-	-	-	-	1.87
CULV10	ND	-	-	-	-
CULV12A	ND	-	-	-	-
CULV44	ND	-	-	-	-
S-236	ND	-	-	-	-
CULV11	ND	-	-	-	-

1/ Units are Nicrograms/liter
2/ ND = None Detected
3/ Duplicate Data Average Used
4/ Triplicate Data Average Used

TABLE 18. RESULTS OF THE 2,4-D HERBICIDE ANALYSIS FOR THE 1979 LAKE OKEECHOBEE T.O.P. MONITORING PROGRAM 1/

Station	May	June	July	Aug.	Sept.
S-2	ND 2/	0.9	ND	ND	ND
S-3	ND	ND	ND	ND	ND
S-4	ND	ND	ND	ND	ND
S-65E	-	ND	ND	ND	-
S-191	ND	ND	ND	3.3	-
S-135	-	-	-	ND	-
S-133	-	-	-	ND	-
S-84	-	-	-	ND	-
S-154	-	-	-	ND	-
S-127	-	-	-	ND	-
S-72	-	-	-	ND	-
S-129	-	-	-	ND	-
S-71	-	-	-	ND	-
S-131	-	-	-	ND	-
FECSR78	-	-	-	ND	-
LZ2	-	-	-	ND	-
LZ24	-	-	-	ND	-
LZ26	-	-	-	ND	-
LZ30	-	-	-	ND	-
LZ34	-	-	-	ND	-
CULV10	ND	-	-	-	0.8
CULV12A	ND	-	-	-	2.3
CULV12	ND	-	-	-	ND
CULV44	ND	-	-	-	ND
S-236	ND	-	-	-	ND
CULV11	ND	-	-	-	ND

1/ Units are Nicrograms/liter
2/ ND = None Detected

EVERGLADES NATIONAL PARK MEMORANDUM OF AGREEMENT

The purpose of this project is to protect the quality of water entering the Everglades National Park through routine water quality monitoring. The U.S. Congress directed the Army Corps of Engineers (COE) and the National Park Service (NPS) "to reach an early agreement on measures to assure that the water delivered to the park is of sufficient purity to prevent ecological damage or deterioration of the park's environment" (River Basin Monetary Authorizations and Miscellaneous Civil Works Amendments, Senate Report No 91-895, p. 24).

The first joint Memorandum of Agreement (MOA) in January 1979, between the SFWMD, COE, and NPS, established non-degradation standards for the quality of water delivered to the Everglades National Park through District water control structures along L-67A (S-12D), L-31W (S-332), and C-111 (S-18C) (Table 19 and Figure 13). The MOA established upper limits for 41 water quality parameters based upon historical data. The concentration of pesticides in park delivery waters was agreed to be 0.0, with actual concentrations below the limits of detection. Twenty-two different pesticides, herbicides, and PCB's were screened for in the water column on a semi-annual basis. During the initial five years of the MOA, from 1979 to 1983, the responsibility for the water quality sampling and analytical services resided with the COE. The MOA provided for quarterly meetings between the three agencies to discuss results of sampling and identify parameters which fall beyond the specified limits.

A second joint MOA was signed in February 1984 which reflected changes in the monitoring program based on experiences during the previous five years and a review of the data collected. The concentration of pesticides in the delivery water is still the same as in the previous MOA; however, both the sediments and the water column are now being analyzed for pesticides, herbicides, and PCB's. Allowable concentrations of pesticide residues in the sediment were not estab-lished, as the information obtained from the current sampling will be used to establish the criteria.

The COE is sampling at the previous stations and additionally at the Tamiami Trail Canal between 40 mile bend and the jetport (Figure 13) on a quarterly basis for the water column and semi-annually for the sediments.

The results of the initial water column pesticide/herbicide/PCB sampling are shown in Table 20. Analyses were performed by the U.S. Army Engineer Division Laboratory. Aldrin, heptachlor, and toxaphene were detected, which was technically a violation of the established water quality criteria of the MOA during this sampling. However, the sample containers used at stations S-333 (ENP16) and S-332 (LEC30) on January 22, 1980, were not the containers supplied for the sampling. Contamination may have occurred in these samples.

Succeeding samples of the water column showed no detectable residues with the stations sampled at the following times:

DATE SAMPLED	STATION CODE		
	S-333 ENP 16	S-332 LEC 30	S-18C LEC 31
09-29-80			X
10-13-80		X	
10-31-80	X		
01-28-81	X		
02-13-81		X	X
04-21-81	X	X	X

The compounds analyzed for (followed by their minimum detection limits, ug/l) are as follows:

(1) Aldrin (<0.007)
(2) Lindane (<0.005)
(3) Chlordane (<0.07)
(4) DDE (<0.01)
(5) DDD (<0.02)
(6) DDT (<0.04)
(7) Diazinon (<0.05)
(8) Dieldrin (<0.02)
(9) Endrin (<0.02)
(10) Ethion (<0.07)
(11) Heptachlor (<0.005)
(12) Heptachlor Epoxide (<0.01)
(13) Malathion (<0.15)
(14) Methyl Parathion (<0.05)
(15) Methyl Trithion (<0.05)
(16) Parathion (<0.05)
(17) PCB (<0.1)
(18) Toxaphene (<0.6)
(19) Trithion (<0.05)
(20) 2,4,5-T (<0.2)
(21) 2,4,5-TP (<0.2)

With the water column sampling consistently not detecting any pesticide residues, it was terminated and replaced with sediment sampling.

In the MOA it was determined that information on pesticide residues in the sediments should be

TABLE 19. EVERGLADES NATIONAL PARK MEMORANDUM OF AGREEMENT SAMPLING STATION LOCATIONS

Map Code 1/	Station Code SFWMD	Station Code COE	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1 ▲	S-333	ENP16	Upstream of S-333	27 12 28	80 48 02
2 ▲	S-332	LEC30	Upstream of S-332	25 45 42	80 40 27
3 ▲	S-18C	LEC31	Upstream of S-18C	25 19 50	80 32 03
4 ▲	S-12A	ENP14	Tamiami Trail between 40 Mile Bend and Jetport	25 45 41	80 49 17

1/ ▲ Water and Sediment Samples Taken for Analysis

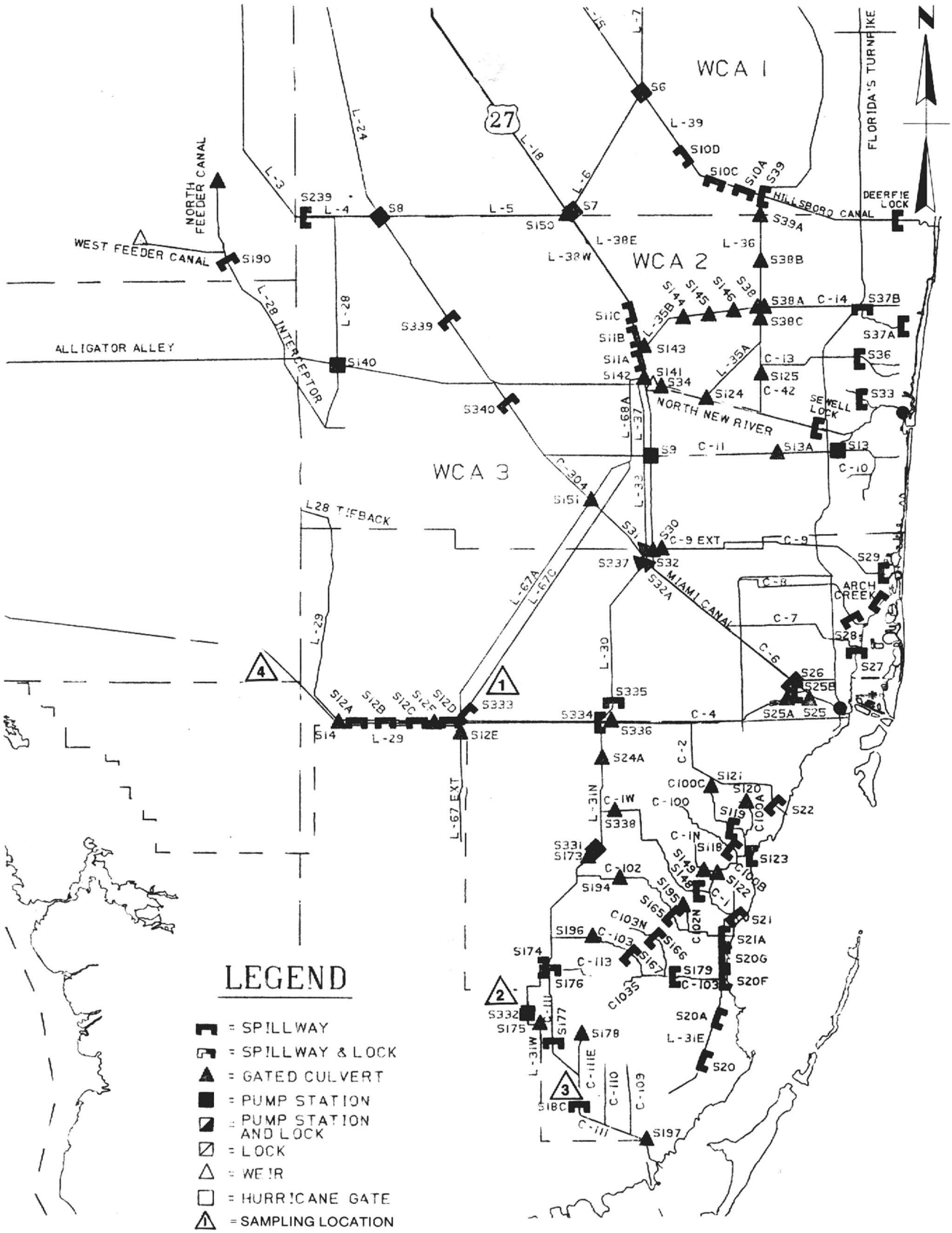

Figure 13 **EVERGLADES NATIONAL PARK MEMORANDUM OF AGREEMENT SAMPLING LOCATIONS. SEE TABLE 19 FOR KEY TO SYMBOLS**

TABLE 20. RESULTS OF THE INITIAL WATER COLUMN SAMPLING FOR PESTICIDE ANALYSIS FOR THE EVERGLADES NATIONAL PARK[1/]

Station Code	Water Class	Date Sampled	Aldrin	Heptachlor	PCB	Toxaphene	2,4,5-T	(Silvex) 2,4,5-TP
S-333	III	01-22-80	ND[2/]	0.017	<0.1	ND	<0.1	<0.1
S-332	III	01-22-80	ND	0.023	<0.1	ND	<0.1	<0.1
S-18C	III	01-22-80	ND	0.004	<0.1	ND	<0.1	<0.1
S-333	III	03-05-80	0.040	0.026	ND	ND	<0.1	<0.1
S-332	III	03-05-80	ND	ND	ND	8.6	<0.1	<0.1
S-18C	III	03-05-80	ND	0.020	ND	ND	<0.1	<0.1
S-333	III	07-15-80	ND	ND	<0.1	ND	<0.1	<0.1
S-332	III	08-05-80	ND	ND	<0.1	ND	<0.1	<0.1
S-18C	III	07-25-80	ND	ND	<0.1	ND	<0.1	<0.1

1/ Units are micrograms per liter. Numbers less than (<) represent minimum detection limits. Compounds analyzed for but not detected include: chlordane, DDE, DDD, DDT, diazinon, dieldrin, endrin, ethion, heptachlor epoxide, lindane, malathion, methyl parathion, methyl trithion, parathion, and trithion. Minimum detection limits were not listed for the above compounds.

2/ None detected.

documented to provide baseline information to establish an allowable sediment concentration criteria. Sediment sampling was initiated in April 1981 and has continued. Pesticide analysis on the sediments was done by the James H. Carr laboratory in Columbia, South Carolina. The pesticide procedure used was "Chlorinated Hydrocarbons, Procedure for Sediment Samples, Method I: Acetone/Hexane Extraction," p 3-307 in the EPA/Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material Procedures for Handling and Chemical Analysis of Sediment and Water Samples, May 1981. The herbicide procedure used was "Chlorinated Phenoxy Acid Herbicide Procedure for Sediment Samples, Method I: Acetone/Hexane Extraction p. 3-271 in the previously mentioned Procedures for Handling and Chemical Analysis of Sediment and Water Samples, May 1981.

In 1981 the sediment samples were analyzed for the following compounds:

(1) Aldrin
(2) Lindane
(3) Chlordane
(4) DDE
(5) DDD
(6) DDT
(7) Diazinon
(8) Dieldrin
(9) Endrin
(10) Ethion
(11) Heptachlor
(12) Heptachlor Epoxide
(13) Malathion
(14) Methyl Parathion
(15) Methyl Trithion
(16) Parathion
(17) PCB
(18) Toxaphene
(19) Trithion
(20) 2,4,5-T
(21) 2,4,5-TP

The initial samples showed no detectable residues; however; analytical techniques were not sensitive as minimum detection limits for all compounds were less than 5 ug/kg.

The following year, the COE lab analyzed for numerous additional compounds not specified in the MOA at lower minimum detection limits (Table 21). Various chlorinated hydrocarbon pesticide residues or degradation products were detected. No organophosphorus pesticides were detected in the sediment. In general, higher residue concentrations where found in the sediment samples analyzed in 1982 than in 1983 (minimum detection limits are the same for both years), with the exception of the herbicides at S-332 and S-18C. High chlordane residues were found in both years, however, 1982 concentrations were greater than those in 1983.

Sampling stations S-332 and S-18C had higher residue concentrations in the November 1982 samples than in April/May 1982 samples, except for endosulfan, heptachlor, and heptachlor epoxide, which are reversed at S-18C. Sorption can be an important fate for endosulfan in aquatic systems and sediments may be a sink for endosulfan (Callahan et al. 1979).

Without information on the organic carbon content of the sediments, relative comparisons are difficult to make. The sorption of pesticides to sediment has been shown to be highly correlated with the organic carbon content of the sediments while at the same time relatively independent of other sorbent properties such as sediment concentration, pH, and ionic strength in the suspensions (Hassett et al. 1980; Karickhoff et al. 1979). Variations in residue concentration could be attributed to sediment samples of differing organic matter content. Sediment consisting of primarily sand would have little residues, whereas sediment high in organic matter has the potential for the accumulation of pesticides.

Comparing the sediment data obtained at S-332 with the soil data of Requejo et. al. (1979) collected in May 1976 in Taylor Slough just west of S-332, similar values are found for chlordane, DDT, and PCB's. However, at an agricultural site just east of S-332, none of these compounds were found. This site is used for winter crops only (Requejo et al. 1979). In addition, this study found lindane, heptachlor epoxide, aldrin, and endrin which were not detected by Requejo et al. (1979) at the same sites.

Waller and Earl (1975) collected sediment samples from Levee 31W Canal above S-175 four times between October 1972 and April 1974. Small concentrations (less than 0.5 ug/kg) of DDD, DDE, and dieldrin were found on occassion.

The canals appear to be a sink for these compounds; however, the residue concentrations have not been accumulating.

TABLE 21. RESULTS OF SEDIMENT SAMPLING FOR PESTICIDE ANALYSIS FOR THE EVERGLADES NATIONAL PARK IN THE YEARS OF 1982 AND 1983

Station Code	Date Sampled	Aldrin	Alpha BHC	Beta BHC	(Lindane) Gamma BHC	Delta BHC	Chlordane	DDE	DDD	OP-DDT	PP-DDT	Endosulfan
S-333	05-13-82	35.7	5.7	19.5	2.3	24.4	52.5	<0.15	<0.19	<0.20	11.6	29.4
S-332	05-13-82	1.3	5.0	<0.20	1.3	<0.12	19.6	<0.15	<0.19	<0.20	<0.20	<0.5
S-18C	05-13-82	<0.16	<0.10	21.3	14.617	62.2	<0.15	<0.19	<0.20	<0.20	<0.20	229.8
S-333	11-15-82	5.59	6.08	7.40	4.74	6.17	23.8	0.63	0.52	1.02	0.28	<0.5
S-332	11-16-82	7.49	6.62	14.8	8.45	18.9	76.0	<0.15	6.69	<0.20	1.47	1.85
S-18C	11-16-82	5.03	<0.10	40.6	34.2	35.2	155	4.86	1.29	1.85	1.03	<0.5
S-333	04-08-83	<0.16	<0.10	<0.20	<0.10		<0.12	0.78	<0.19	<0.20	<0.20	<0.5
S-332	04-08-83	<0.16	<0.10	<0.20	<0.10		<0.12	0.62	0.47	<0.20	<0.20	<0.5
S-18C	05-17-83	<0.16	<0.10	<0.20	0.19		1.25	0.46	<0.19	<0.20	<0.20	<0.5
S-333	10-11-83	0.2	1.1	1.4	1.7		0.2	<0.15	<0.19	<0.20	<0.20	<0.5
S-332	10-11-83	0.7	<0.10	<0.20	<0.10		1.2	1.7	2.3	<0.20	0.7	<0.5

Station Code	Date Sampled	Endrin	Heptachlor	Hepta-chlor Epoxide	Hexa-chloro-Benzene (HCB)	1-Hydroxy-Chlor-dene	Mirex	Aroclor 1016	Aroclor 1254	2,4-D	2,4,5-T	(Silvex) 2,4,5-TP
S-333	05-13-82	<0.2	12.9	<1.2	5.3	<1.4	<0.2	235.4	<1.0	333.6	<1.3	4.1
S-332	05-13-82	<0.2	<0.1	<1.2	<0.14	<1.4	<0.2	<1.4	<1.0	<4.0	<1.3	<1.0
S-18C	05-13-82	<0.2	8.8	35	<0.14	<1.4	<0.2	<1.4	<1.0	<4.0	<1.3	<1.0
S-333	11-15-82	0.87	0.25	1.53	1.53	<1.4	<0.2		<1.0	<4.0	<1.3	<1.0
S-332	11-16-82	2.12	0.78	8.59	<0.14	<1.4	<0.2		<1.0	<4.0	<1.3	<1.0
S-18C	11-16-82	0.22	0.53	<1.2	<0.14	<1.4	15.7		<1.0	<4.0	<1.3	<1.0
S-333	04-08-83	<0.2	1.3	<1.2	0.28	<1.4	<0.2		<1.0	12.8	<1.3	48.4
S-332	04-08-83	<0.2	4.1	<1.2	<0.14	<1.4	<0.2		2.3	<4.0	<1.3	23.1
S-18C	05-17-83	<0.2	0.31	<1.2	<0.14	<1.4	<0.2		<1.0	<4.0	25.0	<1.0
S-333	10-11-83	<0.2	<0.1	<1.2	<0.14	<1.4	<0.2		<1.0	<4.0	<1.3	1.9
S-332	10-11-83	<0.2	<0.1	<1.2	<0.14	0.4	<0.2		1.3	<4.0	1.4	<1.0

1/ Units are micrograms per kilogram dry sediment. Numbers less than (<) represent minimum detection limits. Compounds analyzed for but not detected include: atrazine (<200), captan (<2), chlordecone (<20), diazinon (<1), dichlone (<20), dieldrin (<0.15), dilan (<2), dimethoate (<1), ethion (<1.4), guthion (<10), malathion (<3), methyl parathion (<1), methoxychlor (<2), parathion (<1), Aroclor 1260 (<1), perthane (<200), phosdrin (<1), Phorate (<2), ronnel (<2), simazine (<200), tetradifon (<2), toxaphene (<2), and trithion (<1).

NORTH NEW RIVER BACKPUMPING PROJECT

The purpose of this project is to collect water quality data near pump station G-123 and in Water Conservation Area 3A to meet the FDER permit requirements for determining the water quality impacts from the backpumped water. Construction on pump station G-123 was initiated in March 1982 for the purpose of backpumping water from the North New River Canal (C-13) into WCA-3A. The water quality program was initiated in February 1982 to determine any localized impacts of back-pumping on WCA-3A. Water and sediment samples were collected during March 1982 before construction of pump station G-123, and once during the operation of G-123 in January 1983. Water and sediment samples were analyzed for chlorinated hydrocarbon and organophosphorus pesticides, herbicides, and polychlorinated biphenyls (PCB's). This study was performed by the staff of Resource Planning Department of the District. This information can be found in the Technical Memorandum "North New River Backpumping Water Quality Impact Study Report No. 1, Preconstruction and Initial Operation" by the Water Chemistry Division, March 1984.

Sampling locations are shown in Table 22 and Figure 14 and the data results are shown in Table 23 and 24. For all stations, all compounds were below minimum detection limits in both the water and sediment samples with the exception of the herbicide 2,4,5-TP (or Silvex) being found in a water sample from L-38-1 during March 1982. No criteria (FAC 17-3) for Class III waters has been established for 2,4,5-TP. Currently registered uses in Florida of 2,4,5-TP are for rice, rangeland, noncrop sites (fencerows, industrial sites, vacant lots, etc.) and sugarcane. In 1979, 2,4,5-TP was banned for use for forestry, rights-of-way, pasture, home gardens, aquatic weed control, and turf uses.

The small concentration found in the water and a lack of 2,4,5-TP in the sediments does not demonstrate a contamination problem.

The 1979 sampling upstream of S-34, as part of the SFWMD/USGS Monitoring Network, revealed small quantities of chlordane DDE, DDD, DDT, and PCB's in the sediments. The 1977 sediment sampling further downstream identified only DDE contamination, a constituent not sampled for this time. The historic sediment contamination. appears to have dissipated over time. Additional sampling would be necessary to confirm this.

Within the conservation areas, sediment sampling in 1980 as part of the SFWMD/USGS Monitoring Network identified small quantities of DDD, DDE, and PCB's in WCA-2A and chlordane and DDE in WCA-3A. These or similar compounds could have still been present since the quantities identified in 1980 are much less, 10 to 100 times than the minimum detection limit provided by this study's analytical technique.

TABLE 22. NORTH NEW RIVER BACKPUMPING PROJECT SAMPLING STATION LOCATIONS

Map Code 1/		Station Code SFWMD	LOCATION DESCRIPTION	LATITUDE	LONGITUDE
1	▲	L-38-1	West side of US27 in L-38 Canal below S-142	26 09 21	80 26 45
2	▲	Marsh-2	In WCA-3A	26 09 18	80 26 50
3	▲	NNR2	Downstream of S-34	26 08 44	80 26 29

1/ ▲ Water and Sediment Samples Taken for Analysis

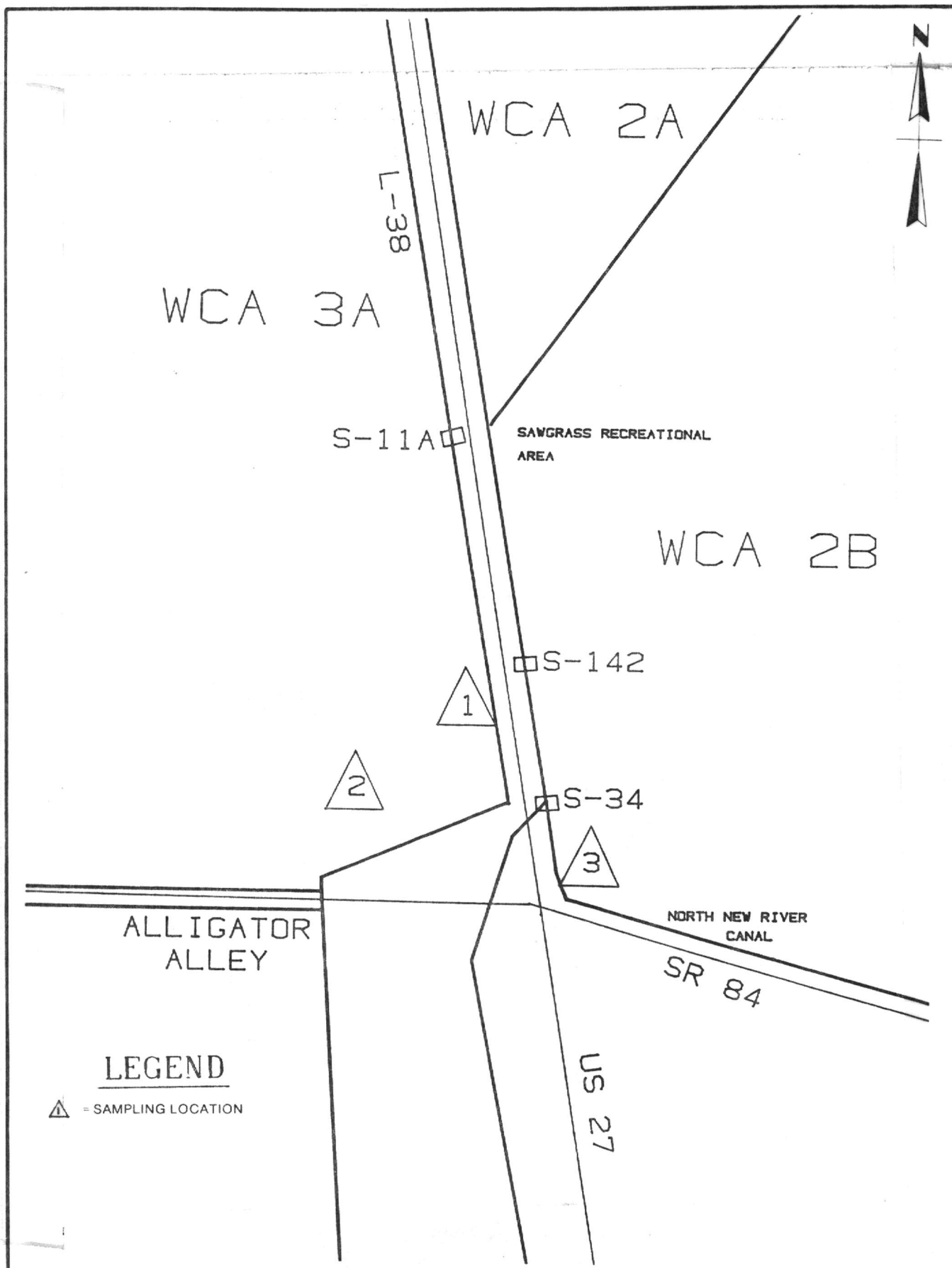

Figure 14 NORTH NEW RIVER BACKPUMPING STUDY SAMPLING LOCATIONS. SEE TABLE 22 FOR KEY TO SYMBOLS

TABLE 23. RESULTS OF THE WATER SAMPLE PESTICIDE ANALYSIS FOR THE NORTH NEW RIVER BACKPUMPING PROJECT[1/]

Station Code	L-38-1	Marsh-2	NNR 2
Water Class	III	III	III
Date Sampled	03-23-82	03-23-82	03-23-82
Pesticides			
Aldrin	<0.0003	<0.0003	<0.0003
Lindane (Gamma BHC)	<0.0002	<0.0007	<0.0002
Chlordane	<0.004	<0.004	<0.004
DDT	<0.001	<0.001	<0.001
Demeton	<0.01	<0.01	<0.01
Dieldrin	<0.001	<0.001	<0.005
Endosulfan	<0.0005	<0.0009	<0.0005
Endrin	<0.0005	<0.0005	<0.0003
Guthion	<0.01	<0.01	<0.01
Heptachlor	<0.0002	<0.0002	<0.0002
Malathion	<0.03	<0.03	<0.03
Methoxychlor	<0.001	<0.001	<0.004
Mirex	<0.001	<0.001	<0.001
Parathion (Ethyl Parathion)	<0.02	<0.02	<0.02
Aroclor 1016	<0.001	<0.001	<0.001
Aroclor 1242	<0.001	<0.003	<0.001
Aroclor 1254	<0.004	<0.003	<0.001
Aroclor 1260	<0.001	<0.001	<0.001
Toxaphene	<0.002	<0.004	<0.002
2,4-D	<0.09	<0.09	<0.09
(Silvex) 2,4,5-TP	0.79	<0.02	<0.02

Station Code	L-38-1	Marsh-2	NNR 2
Water Class	III	III	III
Date Sampled	01-07-83	01-07-83	01-07-83
Pesticides			
Aldrin	<0.001	<0.001	<0.001
Lindane (Gamma BHC)	<0.004	<0.004	<0.004
Chlordane	<0.004	<0.004	<0.004
DDT<0.001	<0.001	<0.001	
Demeton	<0.1	<0.1	<0.1
Dieldrin	<0.001	<0.001	<0.001
Endosulfan	<0.001	<0.001	<0.001
Endrin	<0.004	<0.004	<0.004
Guthion	<0.01	<0.01	<0.01
Heptachlor	<0.001	<0.001	<0.001
Malathion	<0.1	<0.1	<0.1
Methoxychlor	<0.03	<0.03	<0.03
Mirex	<0.001	<0.001	<0.001
Parathion (Ethyl Parathion)	<0.04	<0.04	<0.04
Aroclor 1016	<0.001	<0.001	<0.001
Aroclor 1242	<0.001	<0.001	<0.001
Aroclor 1248	<0.001	<0.001	<0.001
Aroclor 1254	<0.001	<0.001	<0.001
Aroclor 1260	<0.001	<0.001	<0.001
Toxaphene	<0.005	<0.005	<0.005
2,4-D	<0.1	<0.1	<0.1
(Silvex) 2,4,5-TP	<0.02	<0 02	<0.02

1/ Units are micrograms per liter. Values less than (<) are minimum detection limits. Analysis performed by the Everglades Laboratory, West Palm Beach, Florida in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" EPA 1979, and other EPA references.

TABLE 24. RESULTS OF THE SEDIMENT SAMPLE PESTICIDE ANALYSIS FOR THE NORTH NEW RIVER BACKPUMPING PROJECT[1/]

Station Code	L-38-1	Marsh-2	NNR-2
Date Sampled	03-23-82	03-23-82	03-23-82
Pesticides			
Aldrin	<0.03	<0.1	<0.1
Lindane (Gamma BHC)	<0.02	<0.1	<0.1
Chlordane	<0.6	<1.6	<1.0
DDT	<0.2	<0.5	<0.3
Demeton	<1.0	<6.0	<2.0
Dieldrin	<0.1	<0.3	<0.01
Endosulfan	<0.1	<0.3	<0.01
Endrin	<0.1	<0.1	<0.1
Guthion	<6.0	<15.0	<9.0
Heptachlor	<0.02	<0.1	<0.04
Malathion	<2.0	<4.0	<2.0
Methoxychlor	<0.2	<0.6	<0.5
Mirex	<0.1	<0.4	<0.3
Parathion (Ethyl Parathion)	<1.0	<3.0	<2.0
Aroclor 1016	<4.0	<7.0	<5.0
Aroclor 1242	<2.0	<5.5	<3.5
Aroclor 1254	<0.9	<3.7	<1.6
Aroclor 1260	<0.4	<0.8	<0.5
Toxaphene	<3.3	<9.1	<5.0
2,4-D	<4.0	<7.0	<6.0
(Silvex) 2,4,5-TP	<1.0	<1.0	<1.0

Station Code	L-38-1	Marsh-2	NNR-2
Date Sampled	01-07-83	01-07-83	01-07-83
Pesticides			
Aldrin	<0.03	<0.2	<0.05
Lindane (Gamma BHC)	<0.02	<0.09	<0.03
Chlordane	<0.4	<2.2	<0.7
DDT	<0.2	<0.9	<1.6
Demeton	<0.7	<3.7	<1.4
Dieldrin	<0.1	<0.3	<0.1
Endosulfan	<0.1	<0.4	<0.1
Endrin	<0.1	<0.4	<0.1
Guthion	<2.0	<11.5	<4.3
Heptachlor	<0.02	<0.1	<0.04
Malathion	<2.8	<7.8	<2.9
Methoxychlor	<0.2	<1.1	<0.3
Mirex	<0.1	<0.7	<0.2
Parathion (Ethyl Parathion)	<1.5	<8.4	<3.2
Aroclor 1016	<0.4	<2.3	<0.7
Aroclor 1242	<0.4	<2.4	<0.7
Aroclor 1248	<0.5	<2.9	<0.9
Aroclor 1254	<0.7	<3.9	<1.2
Aroclor 1260	<0.3	<1.6	<0.5
Toxaphene	<3.7	<21.6	<6.8

1/ Units are micrograms per kilogram dry sediment. Values less than (<) are minimum detection limits. Analysis performed by Everglades Laboratory, West Palm Beach, Florida in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes EPA 1979", and other EPA references.

FINDINGS AND RECOMMENDATIONS

A total of 118 distinct stations throughout the District were sampled for pesticides, herbicides, PCB's, and/or PCN's from 1976 to the end of 1983. The stations shown in Table 25 were sampled more than once in the various programs.

A total of 42 stations had water taken for analysis, 83 had sediment taken for analysis, and 21 stations had both water and sediment taken for analysis. The number of sediment and/or water samples taken for each program are listed in Table 26.

The organophosphorus pesticides were not routinely found to be above minimum detection limits in any of the studies. Neither the water column nor sediment samples were found to contain any residues.

The chlorinated hydrocarbon pesticides were consistently detected in sediment samples. The compounds most often detected included DDT, DDD, DDE, dieldrin, chlordane, and endrin. However, sediment residue concentrations were similar to levels found on a national basis.

The extremely high concentrations of DDT, DDD, DDE, dieldrin, endrin, and heptachlor epoxide found on the formerly agricultural islands in Lake Okeechobee in 1977 may have dissipated over time through volatilization, oxidation, hydrolysis, biotransformation, and biodegradation. The agricultural islands present a unique environment for pesticide residue degradation in that they are periodically flooded. This variation causes the soil/sediment to change from aerobic to anaerobic conditions and back. For example, with DDT, degradation to DDD is favored by anaerobic conditions, although DDD has also been found to occur along with DDE in aerobic conditions (Callahan et al. 1979). DDE is found to be stable to further microbial metabolism and there is no evidence to indicate that DDE is reduced to DDD. Some papers note that the ultimate transformation of DDT via DDD requires cycling through anaerobic and aerobic systems, so that metabolism and transport via

TABLE 25. DUPLICATE SAMPLING LOCATIONS

Station Programs	USGS 1976	USGS 1977	USGS 1978	USGS 1979	USGS 1980	CR[1/]	LOTOP[2/]
S-2		X		X	X		X
S-3		X		X	X		X
S-4		X					X
C18SR710				X	X		
C181.9				X	X		
C18S46				X	X		
C24S49				X	X		
S-79 (CR-40.3)			X			X	
S-84	X						X
S-71	X						X

1/ Caloosahatchee River Study
2/ Lake Okeechobee Temporary Operating Permit

TABLE 26. NUMBER OF SAMPLE TYPES FOR EACH PROGRAM

Program	Sediment Samples	Water Samples
USGS 1976	25	
USGS 1977	35	
USGS 1978	14	
USGS 1979	9	9
USGS 1980	15	21
Caloosahatchee River Study		8
Lake Okeechobee Temporary Operating Permit		92
Everglades National Park	14	18
North New River Backpumping Project	6	6

sorption/desorption will be required for total DDT degradation.

Dieldrin, on the other hand, has been reported as being one of the more nonbiodegradable of the chlorinated pesticides. Sorption to the sediments may be the long-term fate since biotransformations may be very slow and oxidation highly unlikely under environmental conditions due to the highly chlorinated bridgehead structure. No information is available on the fate of endrin due to oxidation, volatilization, or sorption. Hydrolysis is found to not be an important degradation process. Heptachlor epoxide, the oxidation product of heptachlor, is almost as nonbiodegradable as dieldrin in view of the lack of reactivity toward biological and chemical transformation processes.

At least the compounds are strongly bound to the sediments and are not being resuspended back into the water column in quantities large enough to be detected. This was evidenced by a lack of these compounds during the 1979 USGS water sampling and for the Lake Okeechobee TOP in '79 and '80.

These large residue concentrations may be of concern, however, when bioaccumulation is considered. Milleson (1980) concluded that on a relative scale, total DDT residues in fish sampled from Lake Okeechobe in 1978 (northeast of the islands) were nearly as high as from the agriculturally inflenced portions of the WCA's. In addition, small quantities of dieldrin were present. Callahan et al. (1979) listed the bioaccumulation factor for DDT ranging up to 10^6 in aquatic systems, dieldrin ranges from 10^2 to 10^4, endrin 10^3 to 10^4, and heptachlor epoxide moderately accumulated in some biological systems.

The results of the fish survey correlate with the bioaccumulation factors presented and indicate that bioaccumulation may be an important process in the ultimate fate of some of these compounds due to their relative environmental stability.

Further studies are needed to determine current residue levels on the islands and in the fish population nearby. Comparisons between the historical data and the new data may determine what has been the fate of these compounds.

The water column sampling most often revealed only the herbicide type compounds (e.g., 2,4-D and 2,4,5-TP) compared with the variety of compounds contained in the sediments. The 2,4-D compound is among the most extensively used herbicides, having major turf, forestry, industrial, and aquatic uses as well as crop and pastureland uses. It is relatively rapidly degraded in the environment with residue half-lives generally not exceeding several weeks in plants, soil, and water. It is rapidly eliminated by animals and is not bioaccumulated.

Of the herbicide compounds used in the District's Aquatic Weed Management Program for aquatic weed control, 2,4-D is the only compound that is scanned for in routine herbicide analysis. The other herbicides that are used for aquatic or terrestrial weed control would require a unique, specific analytical technique. To facilitate future data analysis, summaries of the application reports are being sent to the Water Chemistry Division for correlation with routine field monitoring as required by ongoing programs or for any future residue detection.

PCB residues were detected in sediment samples but not in any water column samples. The generally higher concentrations found were near highways or pumping structures. Further studies are needed to determine what practices, if any, at the pump stations have been or could be contributing PCB's into the environment.

The current analytical approach of scanning for chlorinated hydrocarbon and organophosphorus pesticides should be continued with the addition of measuring the organic carbon content of any sediment samples. This additional information will provide baseline data for correlating residue concentrations between different sampling locations. Currently, the relative comparision of sediment residues is not entirely accurate since the amount of organic matter can influence the adsorbing capacity of a given sediment. In addition, as more specific information on the use of a particular compound becomes available and analytical techniques are better refined, a more specific analytical program can be developed for residue detection. Instead of scanning for all compounds, detection would be limited to one or two compounds of interest.

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APPENDIX A

A summary table of Florida Administrative Code 17-3 relating to pesticides, PCB's, and water classifications.

See Table A-1

TABLE A-1. SUMMARY OF FLORIDA ADMINISTRATIVE CODE (FAC) 17-3

Compound	I-A Potable Water Supplies Surface Waters	I-B Potable and Agricultural Water Supplies and Storage Ground Water	II Shellfish Propagation or Harvesting Surface Water	III Propagation and Management of Fish and Wildlife Waters	IV Agricultural Water Supplies Surface Waters	V-A Navigation Utility and Industrial Use Surface Waters	V-B Freshwater Storage Utility Industrial Use Ground Water
Aldrin plus Dieldrin	0.003	0.003	0.003				
Chlordane	0.01	0.004	0.01 2/ 0.04 3/				
2,4-D	100	100					100
2,4,5-TP	10	0.01					10
DDT	0.001		0.001	0.001			
Demeton	0.1		0.1	0.1			
Endosulfan	0.003		0.001	0.003 2/ 0.001 3/			
Endrin	0.004	0.2	0.004	0.04			0.2
Guthion	0.01		0.01	0.01			
Heptachlor	0.001		0.001	0.001			
Lindane	0.01	4	0.004	0.01 2/ 0.004 3/			4
Malathion	0.1		0.1	0.1			
Methoxychlor	0.03	100	0.03	0.03			100
Mirex	0.001		0.001	0.001			
Parathion	0.04		0.04	0.04			
Toxaphene	0.005	5	0.005	0.005			5
Polychlorinated Biphenyls	0.001		0.001	0.001			

1/ Units are micrograms per liter (ug/l)
2/ Fresh waters
3/ Marine waters

APPENDIX B

Each of the compounds screened for and listed in this document is given a brief descriptive paragraph:

Aldrin: Aldrin is a chlorinated hydrocarbon insecticide used primarily to control soil insects (Berg 1979). Its manufacture has been discontinued in the United States Volatilization half-lives of less than a few days are likely in aquatic systems when sorption to biota and subsequent biotransformation to dieldrin do not occur rapidly. Photosensitized and photooxidation processes may also be important fates for aldrin, but insufficient information is available to assess how general and reliable these processes are for environmental assessments (Callahan et al. 1979).

Atrazine: Atrazine is a selective triazine herbicide registered for use in controlling weeds in numerous crops including corn, sorghum, sugarcane, soybeans, range grass, and pineapple (Berg 1979). Atrazine is only slightly toxic on an acute basis. The rate of degradation is very dependent on soil type, moisture content, atrazine concentration, temperature, and soil depth. Although atrazine is somewhat persistent because of strong adsorption to clay or organic matter, it is degraded to hydroxy-atrazine, as well as other metabolites, in soils, water, tolerant plants, and animals (US DHHS 1981).

BHC (Hexachlorocyclohexane or Benzene Hexachloride): BHC is chlorinated hydrocarbon insecticide composed of several isomers. Technical BHC is a mixture of alpha, beta, gamma, and delta-isomers. Production of technical BHC was suspended in 1976 (US DHHS 1981). All domestic registrations for BHC have been voluntarily cancelled and the registrants have amended their registrations and reformulated their products to incorporate lindane (at least 99 percent pure gamma isomer) rather than BHC. The fate of the alpha, beta, and delta-isomers in aquatic systems is determined by their availability to biotransformation processes. Although sorption to suspended sediment and biota is not extensive, sorption is probably an important process for ultimately transporting BHC to anaerobic sediments where transformations occur (Callahan et al. 1979).

Lindane (Gamma BHC): Lindane is a chlorinated hydrocarbon insecticide registered for foliar or soil applications on nearly 40 fruit and vegetable crops and on lawns and turf. Additional registrations allow seed treatments on a variety of field crops, dips, and sprays to control pests on livestock and pets, agricultural premise treatments, and topical treatments for control of human parasites (Berg 1979). The U.S. production of lindane was halted in 1976, and all unformulated lindane has been imported since that time. The fate of lindane in aquatic systems will be controlled by the availability of and to biotransformation processes. Lindane transformation will be favored in biologically rich, anaerobic environments. Although sorption to suspended sediment and biota is not extensive, sorption is an important process for ultimately transporting lindane to anaerobic sediments where transformation occurs. Hydrolysis and oxidation do not appear to be important fate processes for lindane; data on the photolysis of lindane are contradictory and confusing. Lindane is only slightly bioaccumulated in organisms (Callahan et al 1979).

Captan: Captan is a mercaptan fungicide registered for use for the control of plant diseases or organisms on fruit, nut, vegetable, ornamental, field crops, or seeds (US DHHS 1981). A high health hazard has not been demonstrated for captan, but there is evidence of possible high risk toxicity effects combined with the potential for significant human dietary exposure (US DHHS 1981). Captan does not persist in water and readily undergoes hydrolysis nor does it accumulate in tissues of high order food chain members such as fish. With captan uniformly distributed in the soil, its half-life is one to two weeks at most (US DHHS 1981).

Chlordane: Chlordane is a chlorinated hydrocarbon used as a stomach and contact insecticide. Technical chlordane is a mixture of numerous isomers of chlordane and closely related compounds and by-products. About one-half of the composition consists of the two major isomers of chlordane; no other individual component exceeds about one-tenth of the total product. The oil solution type formulation is used almost exclusively for subterranean termite control applications, and emulsifiable concentrates, granules, dusts, and wettable powders for termite control and certain agricultural purposes (Berg 1979). Volatilization, sorption to sediments, and bioaccumulation are important fates for the chlordane isomers in aqueous environments. The chlordane isomers also undergo photosensitized isomerizations, but no information is available to determine whether such reactions may occur in aquatic systems. Although biotransformations of chlordane may be important for the ultimate transformation of chlordane, these processes are likely to be very slow in the environment (Callahan et al. 1979).

Chlordecone (Kepone): Chlordecone is a chlorinated hydrocarbon insecticide formerly used for the control of cockroaches and ants. Production of chlordecone ceased in 1975 and registered uses were cancelled in 1977. Chlordecone has been found to be very stable in the environment. Residue studies show essentially no decline in soil residue levels 154 days after application.

DDE: DDE is formed as a degradation product of DDT and is not manufactured as a commercial product. The major fate processes for DDE in aquatic environments are bioaccumulation and sorption to sediments and biota. Laboratory studies suggest that in aquatic environments, DDE may have volatilization half-lives of several hours and photolyses half-lives of several days; the observed persistence of DDE in such environments may be due to the fact that DDE is mainly formed from DDT under biological conditions in which DDE in the sorbed state is then not available for volatilization or photolysis (Callahan et al. 1979).

DDD: DDD, although considered a degradation product of DDT, is also a chlorinated hydrocarbon insecticide formerly used on many fruits and vegetables. The major fate processes for DDD in aquatic environments are bioaccumulation and sorption to sediments and biota. Volatilization will also be an important process for loss of DDD from aquatic systems, with DDD half- lives on the order of a few days to several weeks. DDD is quite stable to chemical transformations in aquatic environments, and biotransformation is probably the process resulting in the ultimate degradation of DDD in the environment (Callahan et al. 1979).

DDT: DDT is a chlorinated hydrocarbon compound formerly used as an insecticide. All uses have been cancelled as of January 1, 1973. Technical DDT comprises mainly of a mixture of two DDT isomers: pp' and op' with the pp' isomer being the dominant isomer. There is ample evidence to demonstrate that DDT is very persistent in the environment. The dominant fate processes in aquatic environments are volatilization and sorption to biota and sediments, with the importance of sorption being determined by the amount of suspended particulate available in the water body. The ultimate transformation of DDT in the aquatic environment is probably by biotransformation, although one study indicates that indirect photolysis may also be a significant loss process for DDT in a natural water, with a photolysis half-life on the order of a week. Photolysis of DDT in the gas phase has also been reported, but since DDT has been widely found throughout the biosphere, atmospheric transformations appear to be slow. There is also abundant evidence to demonstrate that bioaccumulation of DDT is a significant process in the environment (Callahan et al. 1979).

Demeton: Demeton is an organophosphorus systemic insecticide-acaricide registered for foliar application to a variety of fruit, vegetable, and field and forage crops. Demeton is not a persistent pesticide but it is systemic. Residues are subject to degradation via hydrolysis to phosphorothioic acid and similar compounds of lesser toxicological concern.

Diazinon: Diazinon is an organophosphorus insecticide and nematicide used for the control of soil insects such as cutworms, wireworms, and maggots. Also effective against many pests of fruits, vegetables, forage, field crops, range, pasture, grassland, and ornamentals. It is used extensively in controlling cockroaches and many other household insects; grubs and nematodes in turf; seed treatment and fly control (Berg 1979).

Dichlone: Dichlone is a naphthoquinone fungicide. Registered uses are for the control of plant diseases on strawberries, beans, celery, tomatoes, peaches, and several ornamentals. It is also registered as a herbicide for the control of certain blue-green algae in non-potable waters (Berg 1979). Degradation and metabolism data are limited for this compound. Dichlone is stable to hydrolysis in neutral or acidic aqueous media but reacts readily in alkaline media. Dichlone has a half-life of one day in moist soil and almost three months in dry soil (US DHHS 1981).

Dieldrin: Dieldrin is a chlorinated hydrocarbon insecticide. Manufacture and use have been discontinued in the U.S. since 1974. Dieldrin was previously used for the control of soil insects, public health insects, termites, and many other pests. The literature information, as well as analysis of numerous environmental samples, indicates that dieldrin is persistent in the environment. The important fate processes in aquatic environments are sorption to sediment, bioaccumulation, and volatilization; the latter process may have half-lives of several hours to several days in some aquatic systems. Although direct photolysis of dieldrin in water is slow ($1\frac{1}{2}$ ~ 2 months), photosensitized processes may result in photolysis if sensitizers are available in aquatic environments. Although dieldrin is quite resistant to biotransformation, this process will probably be an important fate for dieldrin in sediment and biota (Callahan et al. 1979)

Dilan: Dilan is a chlorinated hydrocarbon insecticide. Currently the product has been discontinued (Berg 1979).

Dimethoate: Dimethoate is an organophosphorus systemic insecticide-acaricide. Registered uses are to control a wide range of insects and mites on ornamental plants, many vegetables, watermelons, lemons, oranges, grapefruit, tangerines, melons, tomatoes, and corn (Berg 1979). Leaching is not substantial, but the water solubility of dimethoate allows some movement, particularly in moist sandy soils. The hydrolysis rate has been found to be dependent on pH of the water and half-lives ranging from three days to twenty two days have been reported for residues in various soil types (US DHHS 1981).

Endosulfan: Endosulfan is a chlorinated hydrocarbon insecticide-acaricide. Technical endosulfan is a mixture of the two steroisomeric forms, the alpha and the beta forms. Registered uses are to control aphids, thrips, beetles, foliar feeding larvae, mites, borers, cutworms, bollworms, bugs, whiteflies, leafhoppers, and slugs on deciduous, citrus and small fruit, vegetables, and ornamentals (Berg 1979). Data are incomplete regarding the important processes for determining the fate of endosulfan in aquatic systems. The hydrolysis half-life of endosulfan at 20°C is about a month at pH 7 and about six months at pH 5.5. Other information suggests that photolysis, oxidation, biodegradation, sorption, and volatilization may be occurring under some environmental conditions, but data for predicting the rates and relative importance of these processes in aquatic systems are not available (Callahan et al. 1979).

Endrin: Endrin is a chlorinated hydrocarbon insecticide used on certain field crops. Little information is available for evaluating the fate of endrin in aquatic systems. Photolysis and biotransformation of endrin occur under environmental conditions, but no data are available to assess the rates of these processes in aquatic environments; biotransformation will also be affected by the microbial types and populations available to utilize endrin. No information on the sorption or volatilization of endrin from aquatic systems is available, although bioaccumulation does appear to be significant with concentration factors on the order of 10^3 - 10^4.

Ethion: Ethion is an organophosphorus insecticide-acaricide registered for use in the control of aphids, mites, scales, thrips, leafhoppers, maggots, and foliar feeding larvae, on a wide variety of food, fiber, and ornamental crops (Berg 1979).

Guthion: Guthion is an organophosphorus insecticide registered for use on a wide variety of fruit, vegetable, melon, and field crops as well as ornamentals, forest, and shade trees to control many insect pests (Berg 1979).

Heptachlor: Heptachlor is a chlorinated hydrocarbon insecticide registered for subterranean termite control. In 1975, the use of heptachlor for certain pests on agricultural crops was suspended due to its potential carcinogenicity. The major fate of heptachlor in the solution phase of aquatic systems will be hydrolysis to give 1-hydroxchchlordene (1-HC) with a half-life of about one to three days; 1-HC will then be biotransformed to give 1-hydroxy-2, 3-chlordene epoxide (1-HCE). Although literature information also indicates that heptachlor photolysis, volatilization, and sorption to sediments may also occur in aquatic environments, no data are available to compare these proceses with the hydrolysis transformation rate (Callahan et al. 1979).

Heptachlor Epoxide: Heptachlor epoxide is the oxidation product of heptachlor which occurs in soil and in, or on, crops when treatments with heptachlor have been made. Heptachlor epoxide is resistant to chemical and biological transformations in aquatic environments, and half-lives of over several years are probable. Although sediment sorption and bioaccumulation are not appreciable, they may ultimately be relatively important processes in view of the stability of heptachlor epoxide in the environment. Photosensitized reactions and biotransformations in anaerobic sediments are possibly important processes for eventual transformation of heptachlor epoxide in aquatic environments (Callahan et al. 1979).

Hexachlorobenzene (HCB): Hexachlorobenzene is a chlorinated hydrocarbon used as a seed protectant (Berg 1979).

1-Hydroxychlordene (1-HC): 1-hydroxychlordene is the hydrolysis product of heptachlor with a half-life of about one to three days; 1-HC will then be biotransformed to give 1-hydroxy-2, 3-chlordene epoxide (1-HCE) (Callahan et al. 1979).

Malathion: Malathion is an oganophosphorus insecticide used for the control of a wide variety of insects including aphids, spider mites, scale insects, houseflies, and mosquitoes, as well as a large number of other sucking and chewing insects attacking fruits, vegetables, ornamentals, and stored products (Berg 1979).

Methyl Parathion: Methyl parathion is an organophosphorus insecticide registered for use in the control of many insects of economic importance (Berg 1979).

Methyl Trithion: Methyl trithion was an organophosphorus insecticide- acaricide no longer in use (Berg 1979).

Methoxychlor: Methoxychlor is a chlorinated hydrocarbon insecticide. It is widely used because of its long residual action against many species of insects and its low toxicity to humans and warm-blooded animals. Methoxychlor is registered for the control of certain insect pests on fruit and shade trees, vegetables, dairy and beef cattle, home gardens, and around farm buildings (Berg 1979).

Mirex: Mirex is a chlorinated hydrocarbon stomach insecticide whose use has been discontinued. Mirex was used as an insecticide in baits for control of the imported fire ant (Berg 1979).

Parathion: Parathion is an organophosphorus insecticide which has a wide range of applications on many crops against numerous insect species (Berg 1979).

PCB (Polychlorinated biphenyls): PCB's are a diverse family of compounds with low vapor pressure, high dielectric contants, chemical inertness, and extreme thermal stability. All these properties made PCB's useful in a wide variety of applications. Commercial PCB mixtures were manufactured under a variety of trade names. The chlorine content of any product may vary from 18 to 79 percent and depends on the extent of chlorination during the manufacturing process or on the amount of isomeric mixing engaged in by individual procedures. For example, in the designation of the individual Aroclors (Monsanto TM) a set of four digits was used: the first two digits, 12, to designate that the preparation is a mixture and the second set of two numbers is used to denote the approximate chlorine content by weight. Thus, Aroclor 1242 is a mixture having an average chlorine content of 42 percent. The following table summarizes the uses of the various mixtures analyzed for in this study (National Research Council 1979).

TABLE B-1. USES OF AROCLOR BY TYPE

Current (uses)	1016	1221	1232	1242	1248	1254	1260
Capacitors	x	x		x		x	
Transformers				x		x	x
Die casting -- Feneclor - 79% Cl							
Former Uses							
Heat transfer				x			
Hydraulic lubricants							
Hydraulic Fluids			x	x	x	x	x
Vacuum Pumps					x	x	
Gas-transmission Turbines		x		x			
Plasticizers							
Rubbers		x	x	x	x	x	
Synthetic Resins					x	x	x
Carbonless Paper				x			
Miscellaneous							
Adhesives		x	x	x	x	x	x
Wax Extenders				x		x	
Dedusting Agents						x	
Inks						x	x
Cutting Oils						x	
Pesticide Extenders						x	
Sealants and Caulking Compounds					x		

Non-destructive processes which affect the distribution and transport of polychlorinated biphenyls are adsorption, volatilization, and bioaccumulation. In natural water systems, the greatest

concentration of these compounds is sorbed to suspended and bed sediments due to the very low solubility in water. The tendency of polychlorinated biphenyls for adsorption increases with the degree of chlorination and with the organic content of the absorbent. The biota are another environmental compartment into which these compounds are strongly partitioned (measured bioconcentration factors range up to 10^6). Volatilization and transport as an aerosol, followed by fallout with dust or rain, is the probable cause of the ubiquitous distribution of polychlorinated biphenyls. The more highly chlorinated species are less volatile than the lighter species. The presence of suspended solids tends to reduce volatilization, presumably because the solids adsorb the polychlorinated biphenyls and reduce the concentration in solution.

The available empirical evidence indicates that polychlorinated biphenyls, especially those with four or more chlorines, are persistent in the environment. The composition of polychlorinated biphenyls in the atmosphere is similar to that of Aroclor 1242 or 1016, while those in surface waters (mostly adsorbed to suspended solids) approach the composition of Aroclor 1254. Polychlorinated biphenyls in biota are heavier and more chlorinated still, and approximate the composition of Aroclor 1260. Thus the processes controlling distribution are somewhat selective, with the lighter species more likely to volatilize and the heavier species more likely to be incorporated into sediments and biota (Callahan et al. 1979).

PCN (polychlorinated napthelenes or 2-chloronapthalene): PCN's are a diverse family of compounds similar in structure to the PCB's. PCN's are usually a complex misture of napthalenes having varying degrees of chlorination. Commercial preparations are marketed under the trade name Halowax. As a group, chlorinated naphthalenes are not as widely distributed in the environment as the PCB's, however, they were widely used in synthetic waxes, electrical insulating materials, and as lubricants. Very little data specific to PCN's are available. The aquatic fate of these compounds are inferred from data summarized for naphthalene. The results of the data summary, which includes theoretical and empirical evidence, suggest that 2-chloronapthalene, a compound only slightly soluble in water (6.74 mg/l), will be adsorbed onto suspended particulates and biota and that its transport will be largely determined by the hydrogeologic conditions of the aquatic system. That portion of 2-chloronaphthalene dissolved in the water column may undergo direct photolysis. The ultimate fate of the 2-chloronaphthalene which accumulates in the sediment is believed to be biodegradation and biotransformation by benthic organisms (Callahan et al. 1979).

Perthane: Perthane is a chlorinated hydrocarbon insecticide used on certain vegetable crops for looper control. The product has been discontinued (Berg 1979). It is also used in various formulations for the control of moths and carpet beetles in the dry cleaning and textile markets.

Phosdrin: Phosdrin is an organophosphorus systemic insecticide-acaricide used for the control of aphids, mites, grasshoppers, cutworms, leafhoppers, caterpillars, and many other insects on a broad range of field, forage, vegetable, and fruit crops (Berg 1979). The primary route of degradation of phosdrin is via hydrolysis. For aqueous degradation, phosdrin is rapidly hydrolyzed in alkaline solutions. At pH 7 and 9, phosdrin has half-lives of 30 days and 70 hours, respectively. In the soil, degradation is by chemical hydrolysis with a half-life of 12 hours. Volatilization is also an important factor in the initial decline of residues (US DHHS 1981).

Phorate: Phorate is an organophosphorus soil and systemic insecticide. Registered uses are to control a wide range of insects on various vegetables including beans, lettuce, sweet corn, and tomatoes (Berg 1979). Phorate undergoes hydrolysis, particularly in alkaline solutions, and initial volatility losses may be high when applied to the surface of sandy soils (US DHHS 1981).

Ronnel: Ronnel is an organophosphorus insecticide (animal systemic and premise residual spray). Contact and systemic action controls flies and cockroaches as a residual treatment. Oral administration to livestock controls cattle grub, lice, horn fly, facefly, screwworm, ticks, sheep ked, and wool maggot. No data is available on the aqueous or soil degradation rate or soil mobility (US DHHS 1981).

Simazine: Simazine is a selective triazine herbicide used for the control of most annual grasses and broadleaf weeds in corn, established bermuda grass, citrus, certain ornamental and tree nursery stock, and in turf grass sod production. At higher rates, it is used for nonselective weed control in industrial areas (Berg 1979).

Strobane: Strobane is a discontinued insecticide comprised of a mixture of polychlorinates of camphene, pinene, and related terpenes (Berg 1979).

Tetradifon: Tetradifon is a chlorinated hydrocarbon acaricide which has larvicidal and ovicidal activity on spider mites. It produces sterility in female mites contacting or feeding on deposit. Used on many species of fruits (including citrus), vegetables, and ornamentals (Berg 1979).

Toxaphene: Toxaphene is an insecticide consisting of a complex mixture of polychlorinated camphene derivatives containing 67-69 percent chlorine. Toxaphene is registered for use on a wide variety of insects of most fruits and vegetables. Special livestock formulations are available for the control of livestock pests, including horn flies, lice, ticks, scab mites, and mange (Berg 1979). An inclusive assessment of the fate of the pesticide toxaphene in aquatic environments is complicated because toxaphene is a complex mixture of polychlorinated camphene derivatives of different physical properties and environmental behavior. Toxaphene is very stable to biological and chemical processes in aerobic environmental systems, but it does undergo partial reduction (loss of chloride content) in anaerobic environments. A dominant process in aquatic environments is direct sorption on sediments or sorption onto particulates followed by deposition into sediment where biological and possibly chemical reduction occurs. The rate of loss of toxaphene from aquatic systems will then be partially determined by particulate loading and quality of the water body; shallow, particulate-laden, eutrophic waters give maximum transformation rates of toxaphene, with half-lives on the order of a few months for some components. The physical properties and chlorinated functionality of the individual toxaphene structures will govern which components will be sorbed and then subsequently reduced. The finding of some toxaphene components in aquatic sediments and species after several years indicates that bioaccumulation in the food chain may occur. Unless clear evidence proves otherwise, the absence of acute toxicity effects of toxaphene should not be interpreted as indicating that all toxaphene has been degraded and chronic toxic effects are absent (Callahan et al. 1979).

Trifluralin: Trifluralin is a nitroaniline selective pre-emergent herbicide registered for once a year control of annual grasses and some annual broadleaf weeds. It is also used on ornamental trees and shrubs, roses, and fruit trees after planting (Berg 1979). Trifluralin readily decomposes when aqueous solutions are exposed to sunlight and readily volatilized and photodegraded in the soil environment (US DHHS 1981).

Trithion: Trithion is an organophosphorus insecticide-acaricide registered for use on a wide variety of fruits, nuts, vegetables, corn, and soybeans. There are numerous non-food registrations on turf and ornamentals (Berg 1979).

2,4-D: 2,4-D is a phenoxy-aliphatic selective herbicide widely used for control of broadleaf weeds in sugarcane, pastures, and in aquatic weed control. It is also used to delay preharvest dropping of some fruits and postharvest to control the ripening of bananas and citrus (Berg 1979). The esters of 2,4-D have generally been considered to be readily hydrolyzed in the environment. Reported half-lives in environmental waters range from a few days to several months depending on factors such as temperature, pH, light intensity, formulation, and oxygen concentration (US DHHS 1981).

2,4-DP (dichorprop): 2,4-DP is a chlorinated hydrocarbon systemic herbicide used for brush control on rangeland, rights-of-way, and aquatic weeds (Berg 1979).

2,4,5-T: 2,4,5-T is a phenoxy-aliphatic selective herbicide with registered uses for rice, range, and noncrop sites (fencerows, industrial sites, vacant lots, etc.). Uses in the United States are restricted at this time (US DHHS 1981).

2,4,5-TP (Silvex): 2,4,5-TP is a phenoxy-aliphatic herbicide with registered uses for rice, rangeland, noncrop sites (fencerows, industrial sites, vacant lots, etc.), and sugarcane. In February 1979, the EPA ordered the emergency suspension of the use of silvex for forestry, rights-of-way, pasture, home gardens, aquatic weed control, and turf uses (Berg 1979).