Chapter 4: Status of Water Quality Criteria Compliance in the Everglades Protection Area

Kenneth Weaver[1], Temperince Bennett[1],
Grover Payne[1], Guy Germain[2], Steven Hill[2]
and Nenad Iricanin[2]

BACKGROUND

The Everglades Forever Act (Act; Section 373.4592(1)(a), Florida Statutes) found that "*the Everglades ecological system is endangered as a result of adverse changes in water quality, and in the quantity, distribution, and timing of flows, and, therefore, must be restored and protected*." As a part of the Everglades Program provided in the Act, the Florida Department of Environmental Protection (Department) and the South Florida Water Management District (District) are required to "*evaluate existing water quality standards applicable to the Everglades Protection Area and EAA canals* (Section 373.4592(4)(e)1.b, F.S.)." A report prepared by Limno-Tech, Inc., for the District, provided an initial summary and characterization of available water quality monitoring data collected in the Everglades Protection Area (EPA) and its tributary waters (Limno-Tech, 1995). The report identified the parameters most in need of further review and has helped guide further analyses. Further evaluations of water quality in the EPA and Everglades Agricultural Area (EAA) were provided in Gilbert and Feldman (1995) and in the *1999 Everglades Interim Report* (Bechtel et al., 1999) and *2000 Everglades Consolidated Report* (Bechtel et al., 2000). Over the past year, the Department has made significant progress towards evaluating the existing standards for dissolved oxygen and contemporary pesticides as well as priority pollutants (Weaver, 2000a; Weaver, 2000b). A proposed Site Specific Alternative Criterion (SSAC) for marsh dissolved oxygen is currently under review (**Appendix 4-2**). Additionally, chronic toxicity guidelines were developed to assist in the evaluation of pesticides and priority pollutants currently not listed in Chapter 62-302, Florida Administrative Code (F.A.C.).

The primary purpose of this chapter is to provide an overview of the status of compliance with water quality criteria in the EPA for Water Year 2000 (WY2000, May 1, 1999 through April 30, 2000). It builds on and provides an update to water quality analyses previously presented in 1999 Everglades Interim and 2000 Consolidated Reports

[1] Florida Department of Environmental Protection (Department)

[2] South Florida Water Management District (District)

and includes a simplified analysis of the water quality parameters not meeting the water quality criteria specified in Section 62-302.530, F.A.C. More specifically the chapter and its appendices will:

1. Briefly describe the Class III water quality criteria that apply to the EPA;
2. Summarize areas and times where water quality criteria are not being met and indicate trends in excursions over space and time;
3. Discuss factors contributing to excursions from water quality criteria and provide an evaluation of the natural background condition where existing standards are not appropriate;
4. Summarize total phosphorus and total nitrogen concentrations in the EPA and indicate spatial and temporal trends;
5. Present an analysis of dissolved oxygen Class III criterion violations and propose an alternative criterion that better reflects background conditions; and
6. Review all pesticide and priority pollutant data currently available and provide chronic toxicity based guidelines for screening future detected concentrations.

METHODS

An approach similar to the regional synoptic approach used in the *1999 Everglades Interim Report* (SFWMD, 1999a) and *2000 Everglades Consolidated Report* (SFWMD, 2000) was applied to the WY2000 data to provide an overview of the status of compliance with water quality criteria in the EPA. The consolidation of water quality data on a regional basis provides for analysis over time, but limits spatial analyses within each region. However, spatial analyses can be made between regions because the majority of inflow and pollutants enter the northern one-third of the EPA and the net water flow is from north to south.

WATER QUALITY DATA SOURCES

The large majority of the water quality data evaluated in this chapter were retrieved from the District's DBHYDRO database. Before water quality data are entered into the database, the District follows strict Quality Assurance/Quality Control (QA/QC) procedures approved by the Department for both data collection and analytical methods (**Appendix 4-1**). These methods are documented in the District Comprehensive Quality Assurance Plan #870166G (SFWMD, 1999b), which is annually reviewed, updated and approved by the Department. Contract laboratories used by the District must also have their comprehensive QA/QC plans approved by the Department. Water quality data from the nutrient gradient sampling stations monitored by the Everglades Systems Research Division in the northern part of Water Conservation Area 2A (WCA-2A) and the southwestern part of Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) were obtained from the Everglades Research Database.

EVERGLADES PROTECTION AREA WATER QUALITY SAMPLING STATIONS

Water quality sampling stations (n=111) in each region of the EPA were classified as inflow, interior, or outflow sites, in order to provide a more detailed analysis of each region for compliance with Class III water quality criteria and to assist in the evaluation of potential causes for observed excursions (**Figure 4-1**). There are several interior structures that convey water between EPA regions. Based on the current classification system, it was necessary to classify these structures conveying water from one region to another within the EPA as inflow stations. Thus, the S-10 structures were added as inflow sites to WCA-2, the S-11 structures as inflow sites to WCA-3, and the S-12 structures and S-333 as inflow sites to Everglades National Park (Park). The interior sites of each region consist of marsh and canal stations in addition to structures that convey water within the area. In contrast to the other regions, the Refuge has four components for analysis (inflow sites, rim canal sites, outflow sites and interior marsh sites) to account for inflows being conveyed in rim canals that border the east and west refuge levees and discharge into outflow structures in the south levee. Most of the water entering the Refuge through the S-5A and S-6 structures bypasses the marsh via the L-7 rim canal and is discharged to WCA-2A through the S-10 structures. The location and classification of stations used in this report are shown in **Figures 4-2** through **4-5**.

Although much of the data from the Non-ECP structures is used in the regional analysis of water quality conditions in the EPA, the Non-ECP structures are required by the permit to be analyzed individually. This individual analysis of data collected at the Non-ECP structures as well as all other permit required analyses and data presentations are provided in Chapter 11 of this Report to simplify and improve the readability of this chapter.

The current District Everglades monitoring programs are described in Germain (1998). Sampling frequency varies by site depending on site classification, parameter group, and hydrologic conditions (water depth and flow). In general inflow and outflow structures are monitored more frequently than interior marsh stations. Two examples will help illustrate the variation in sampling regimes. At the S-5A inflow structure to the Refuge, nutrients and physical parameters (e.g., dissolved oxygen, conductivity, pH), pesticides, and trace metals are monitored weekly (when flowing), quarterly, and biannually, respectively. Monitoring at marsh stations within the Refuge is conducted on a monthly basis for most parameter groups. However, trace metals are monitored quarterly and pesticides are not routinely sampled.

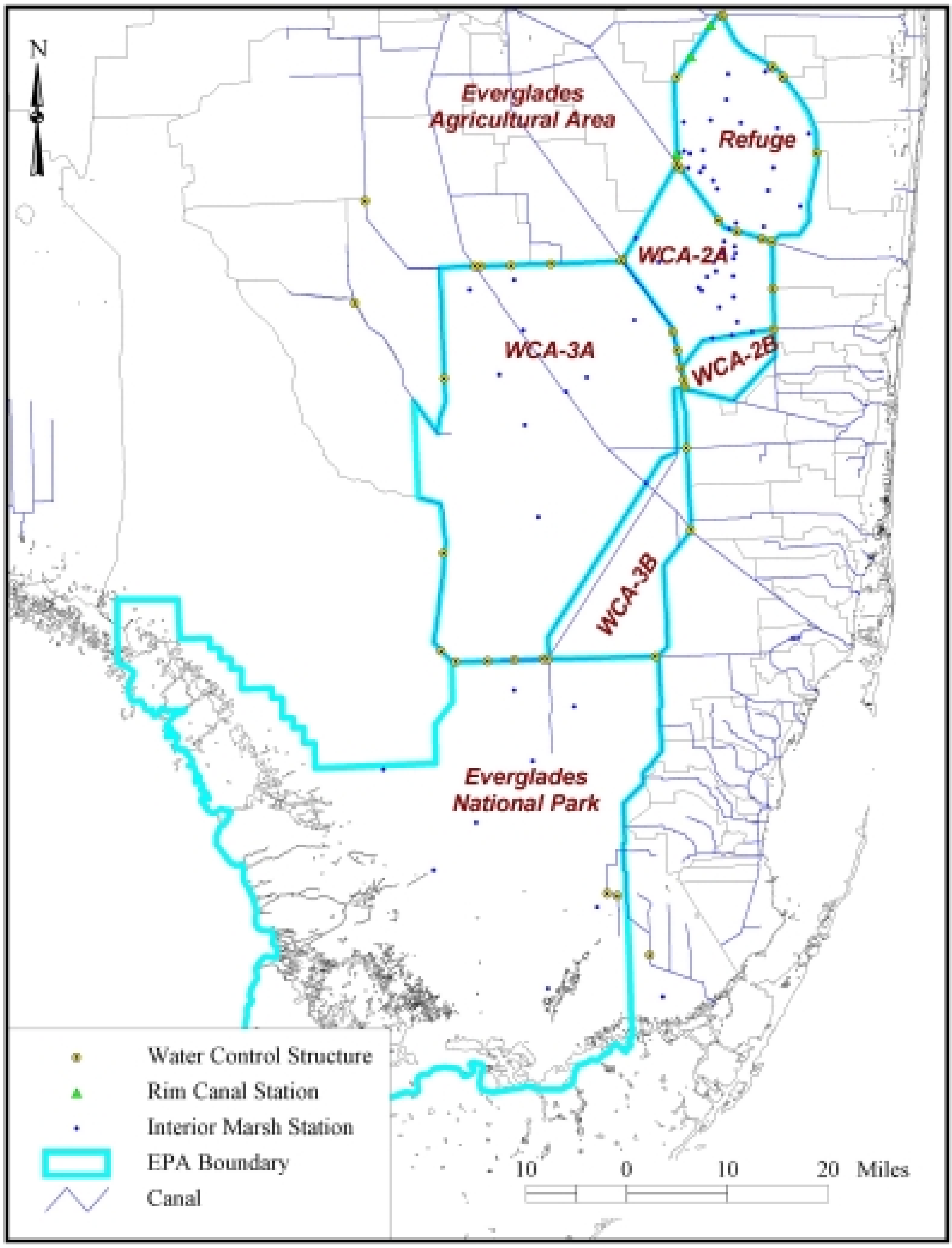


Figure 4-1. Everglades Protection Area regions and water quality monitoring stations.

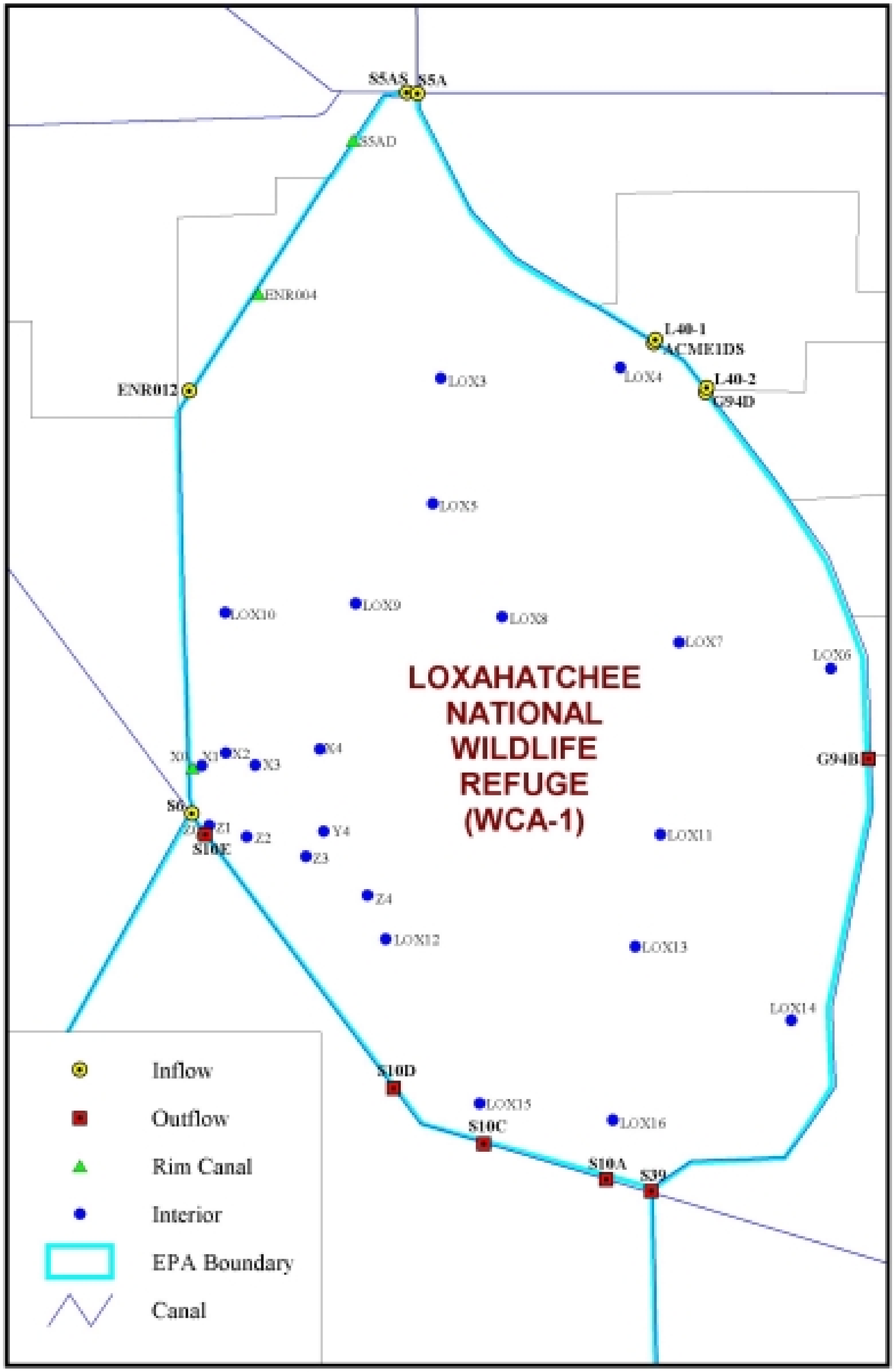


Figure 4-2. Location and classification of water quality monitoring stations in the Arthur R. Marshall Loxahatchee National Wildlife Refuge.

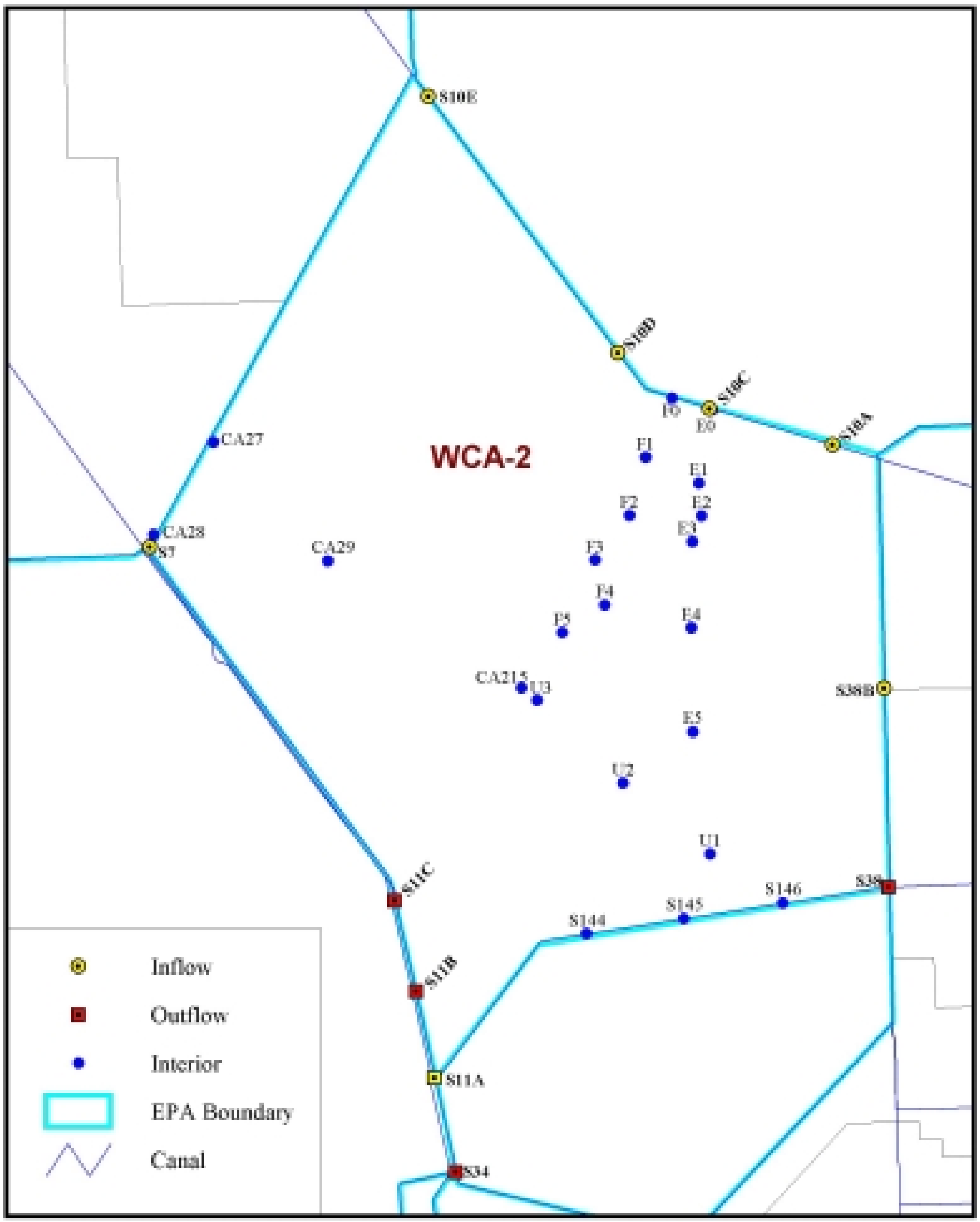


Figure 4-3. Location and classification of water quality monitoring stations in Water Conservation Area 2.

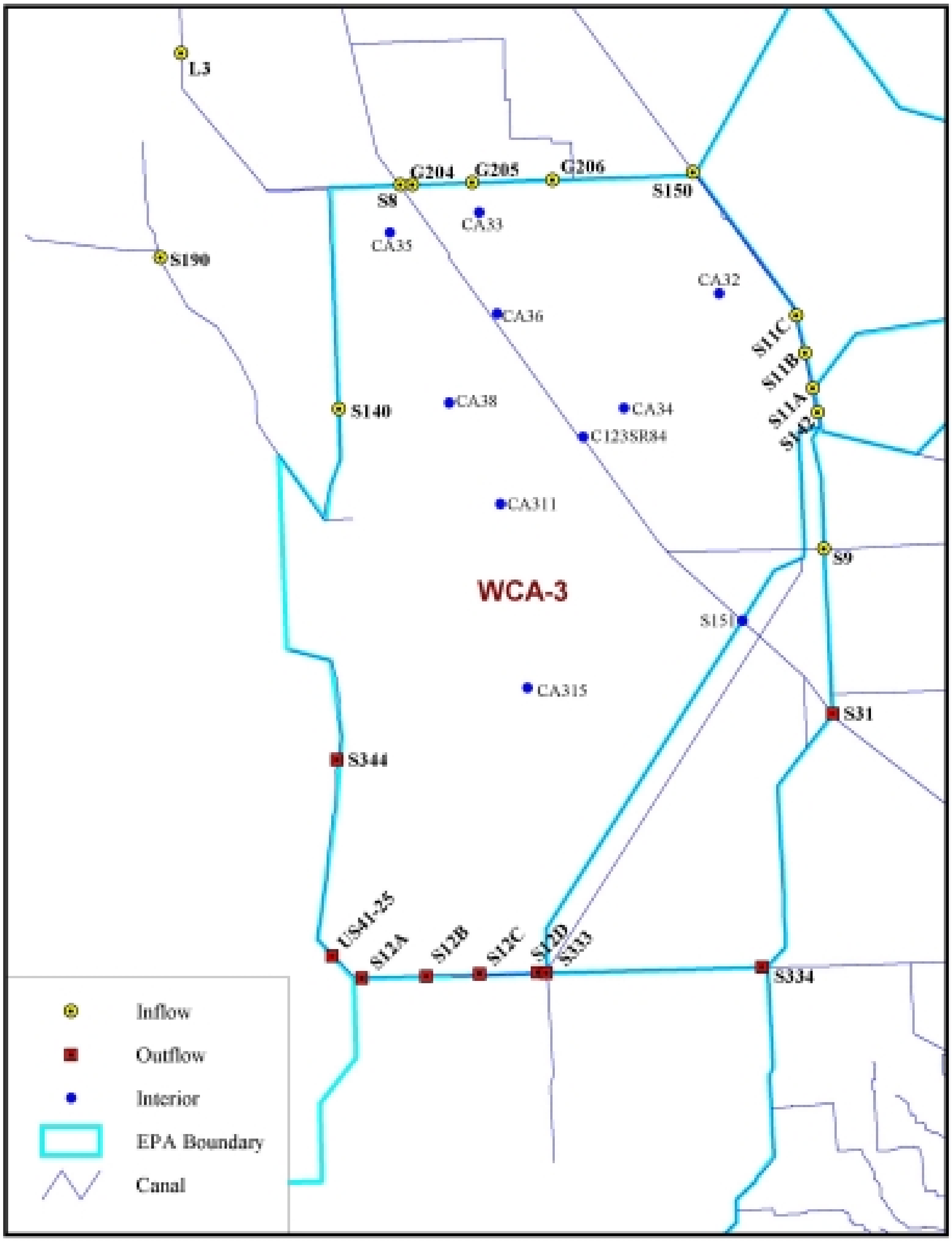


Figure 4-4. Location and classification of water quality monitoring stations in Water Conservation Area 3.

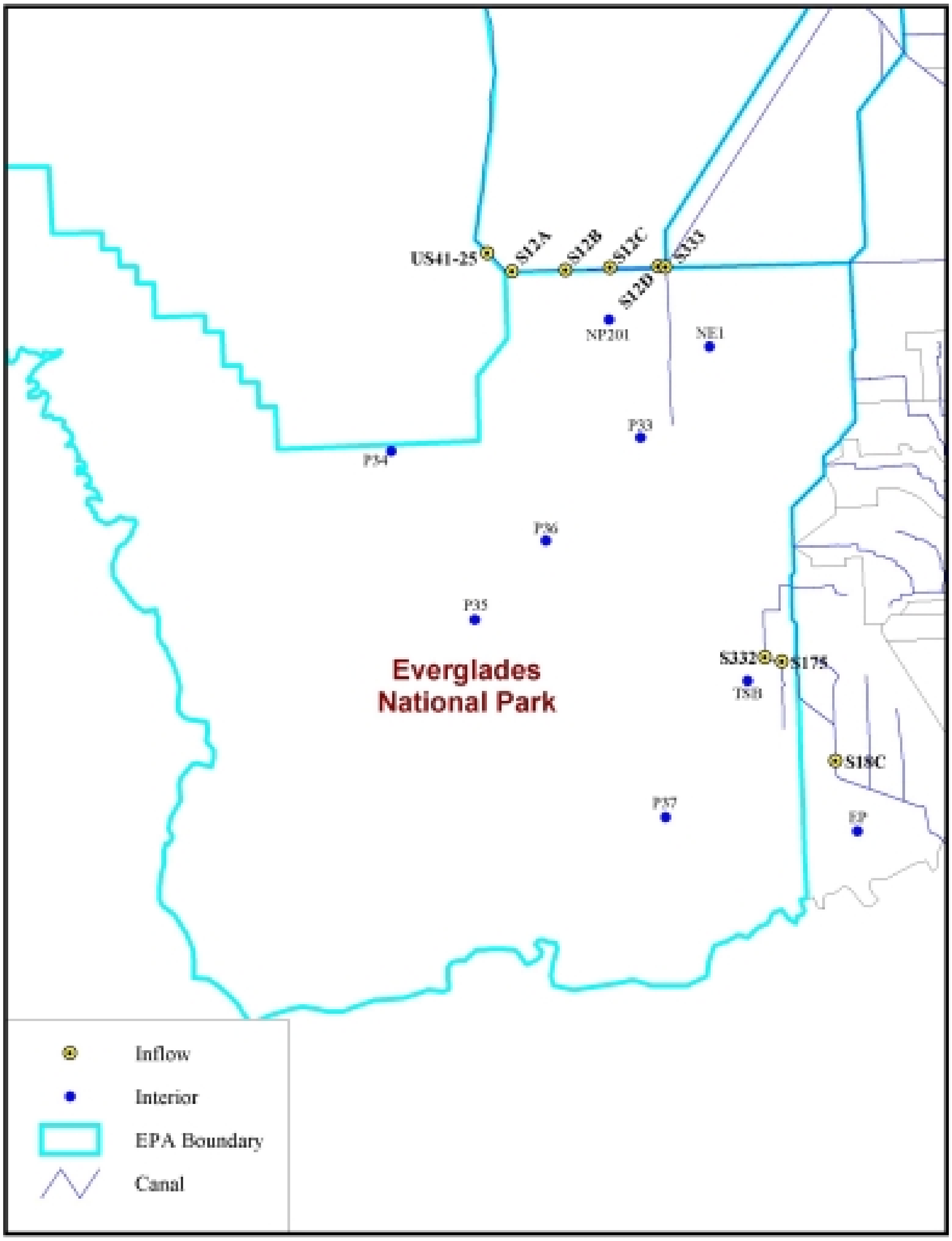


Figure 4-5. Location and classification of water quality monitoring stations in Everglades National Park.

EVERGLADES PROTECTION AREA DATA ANALYSIS PERIOD

Water quality data collected from monitoring stations within EPA regions during WY2000 (May 1, 1999 to April 30, 2000) are evaluated and discussed in this chapter. Additionally, pesticide data presented herein were collected during four quarterly sampling events (April, August, November 1999 and February 2000). The pesticides period of record was selected as an update to data presented in the *2000 Everglades Consolidated Report*, rather than reflecting a water year.

WATER QUALITY DATA EVALUATED

The District monitors approximately 109 water quality parameters within the EPA (Bechtel et al., 1999 and 2000). Given this chapter's focus on compliance with water quality criteria, the evaluation was limited to parameters with Class III criteria pursuant to Chapter 62-302, F.A.C. The parameters evaluated included total phosphorus, total nitrogen, 62 pesticides, and the following nineteen (19) water quality constituents:

- Alkalinity
- Dissolved Oxygen
- Specific Conductance
- pH
- Total Silver
- Total Antimony
- Total Arsenic
- Total Beryllium
- Total Cadmium
- Total Chromium
- Total Copper
- Total Iron
- Total Mercury
- Total Lead
- Total Selenium
- Total Thallium
- Total Zinc
- Turbidity
- Un-ionized ammonia

DATA SCREENING AND HANDLING

Water quality data were screened based on laboratory qualifier codes. Any datum with an associated fatal qualifier (e.g., contamination, out of holding time, matrix interference) was removed from the analysis. All data passing the qualifier screening were used in the analysis, including statistical outliers.

An additional consideration, in the handling of water quality data, is the accuracy of the utilized laboratory test. Each water quality constituent has a Method Detection Limit (MDL) that defines the minimum concentration or level at which the constituent can be identified. The MDL is usually statistically above the background noise level associated with a test and constituent concentrations at or near the MDL may not be quantified within established limits of accuracy or precision. The Practical Quantitation Limit (PQL) represents a practical and routinely achievable quantification level with a relatively good certainty that a reported value is reliable (APHA, 1995). For the analyses presented in this chapter, data reported to be less than the MDL were assigned a value of the MDL unless otherwise noted.

EXCURSION ANALYSIS

To evaluate compliance with water quality criteria in WY2000, constituent concentrations were compared to their respective Class III criteria provided in Chapter 62-302, F.A.C. In addition to Class III criteria, pesticides were evaluated based on chronic toxicity values. An excursion was recorded when a parameter exceeded the applicable numeric criteria or chronic toxicity guidelines. The excursions for each EPA region were tabulated providing both the total number of samples and percent of samples not in compliance with the criteria.

The three-category system previously employed in the *1999 Everglades Interim Report* and *2000 Consolidated Report* (Bechtel et al., 1999 and 2000) was utilized to rank the severity of excursion from water quality criteria. Parameters were categorized by region and class (i.e., inflow, outflow, rim and interior) as being Concerns, Potential Concerns, or of No Concern according to the frequency of excursions as specified in **Table 4-1**. Pesticides were additionally categorized based on detection (measurement > MDL) frequency. The excursion categories are meant to provide some guidance in the interpretation of monitoring results. Use of the 5 percent break point between parameters classified as Potential Concerns and those identified as Concerns parallels the common scientific practice of allowing a 5 percent rejection limit in statistical analyses. Furthermore, the categories provide a means to rank the severity of excursions from water quality criteria and allow tracking of temporal and spatial trends.

Table 4-1. Definitions of excursion categories for water quality constituents that had excursions in the EPA.

Excursion Category	Class III Waters	Pesticides
Concern	> 5% excursions	Class III criterion and/or toxicity levels exceeded
Potential Concern	Up to 5% excursions	>MDL[1]
No Concern	No excursions	≤MDL

[1] MDL = Method Detection Limit

Since there is no numeric criterion for phosphorus at this time, total phosphorus (TP) data were divided into three categories based on the frequency of measurements above 10 µg/L (micrograms per liter or parts per billion, ppb) and above 50 µg/L. This approach is consistent with the Settlement Agreement (1991), which requires the District's Stormwater Treatment Areas (STA) to achieve a long-term TP discharge concentration average of 50 µg/L, and also requires long-term TP averages of approximately 10 µg/L in the Refuge interior marshes and in the inflows to the Park. Furthermore, 10 µg/L is the default phosphorus criterion specified by the Act. This classification of measured phosphorus concentrations may be modified in future years once the nutrient threshold research is completed and a numeric nutrient criterion for TP is established.

SUMMARY OF PRIOR REPORT FINDINGS

1999 INTERIM REPORT

Chapter 4 of the 1999 Interim Report was prepared in compliance with the Act requirement that by January 1, 1999, a report summarizing the results of water quality monitoring efforts in the Everglades be submitted to the Governor, the President of the Senate, and the Speaker of the House of Representatives. The report provided a review of compliance with state water quality criteria in the EPA as of April 1998. Water quality data were divided into a baseline period (October 1, 1978 through September 30, 1988) and into individual recent water years (1990 through 1998) to determine if any changes in water quality were evident during the 1990s when compared to the baseline period. With a few exceptions, water quality during the 1990s was in compliance with existing state water quality criteria. For parameters that failed to meet state criteria, the relative severity of excursions in the different EPA regions was ranked according to the excursion categories described previously (**Table 4-1**). Dissolved oxygen, specific conductance, alkalinity, pH, un-ionized ammonia, iron, beryllium, chlorpyrifos ethyl, endosulfan, ethion, and parathion methyl were placed in the most severe excursion category (Concern) for one or more EPA areas. Of the parameters classified as Concerns, dissolved oxygen stood out as the most pervasive, being a Concern in every basin. However, a majority of the dissolved oxygen excursions were due to natural conditions within the marsh and therefore did not necessarily constitute violations of state water quality standards. The remaining parameters of Concern were localized to specific areas or sub-areas. Alkalinity and pH excursions were associated with natural rain-driven soft-water conditions within the interior of the Refuge. Conductivity excursions occurred in the inflows and canals associated with the Refuge and WCA-2, likely due to ground water intrusion.

Changes in TP loads and median concentrations were also analyzed following the direction of water flow from north to south through the EPA. When TP loads discharging into the EPA between the baseline (1978-1988) and recent water years (1990-1998) were compared, it appeared that the Refuge was the only region to receive a higher load in recent years. For inflows to WCA-2 and WCA-3, TP concentrations and loads differed relatively little from the baseline period, while average TP loads into the Park since WY90 decreased. Based on a 10 µg/L default standard and a 50 µg/L interim criterion specified in the Act, TP was placed in the Concern category in all EPA regions except for the Park and interior marsh sites in the Refuge, where it was placed in the Potential Concern category.

2000 CONSOLIDATED REPORT

The *2000 Everglades Consolidated Report* provided an update to the Interim Report with the addition of WY99 data. Additionally, it presented an analysis of water quality constituent data at Non-Everglades Construction Project (Non-ECP) structures during the second year of monitoring consistent with reporting requirements stated in Specific Conditions 5 and 12 of the Non-ECP Permit (FDEP No. 06,5025907098). The same categorical system used in the Interim Report, to rank excursions, was employed in the *2000 Everglades Consolidated Report*. As in WY98, dissolved oxygen, specific conductance, alkalinity, pH, un-ionized ammonia, iron, and total beryllium were placed in the Concern category in one or more areas within the EPA. Additionally, the pesticide diazinon was classified as a Concern for inflows to WCA-2. Dissolved oxygen continued to have high rates of excursions from the state criterion of 5.0 mg/L for all regions of the EPA. Similarly, the patterns noted in the Interim Report for alkalinity, pH, and conductivity largely persisted during WY99.

Total phosphorus loads and median concentrations in the inflows to each EPA region during WY99 were within the ranges observed in the previous nine water years. Concentrations of TP at non-ECP structures show no trends in comparison with previous periods with the exception of structures ACME1DS and G94D, where an increasing concentration trend was evident. As in WY98, TP was placed in the Concern category (>50 µg/L) in all EPA regions except for the Park and interior marsh sites in the Refuge, where it was placed in the Potential Concern (>10 µg/L) category.

WATER YEAR 2000 RESULTS

Comparison of the water quality data with applicable Class III water quality criteria found excursions for only eight parameters during WY2000. These excursions were localized to specific areas of the EPA, with the exception of dissolved oxygen, which exhibited excursions in all areas. For at least one EPA region; alkalinity, conductivity, dissolved oxygen, iron, pH, and turbidity were classified as parameters of Concern (**Table 4-2**). Alkalinity, conductivity, iron, pH and turbidity were also classified as Potential Concerns in one or more additional areas. Due to excursion rates less than five percent, lead and unionized ammonia were designated as parameters of Potential Concern, in specific EPA regions (**Table 4-2**). Additionally, the pesticides DDT, DDE, DDD, endosulfan (total alpha and beta), and diazinon each exceeded either Class III criteria or chronic toxicity values on one occasion. No other parameters exceeded state water quality criteria during WY2000 and therefore will not be discussed within this chapter, with the exception of cadmium and beryllium. Cadmium and beryllium are addressed because excursion rates reported for WY99 have been recalculated.

Parameters placed in the Concern or Potential Concern categories in previous reports or for WY2000 are presented in **Table 4-3** by three time periods (i.e., historical period encompassing WY79 through WY98, WY99, and the current WY2000) to evaluate any temporal trends present. Generally, excursion results for WY2000 were similar to WY99 and the historic period with a few exceptions. During WY2000, dissolved oxygen excursions declined slightly (2-31 percent), relative to one or both of the historic periods in all regions of the EPA except the interior of WCA-3. Additionally, in contrast to previous periods, no cadmium and beryllium measurements exceeded state criteria during WY2000. Turbidity excursions increased in frequency for some areas in the northern Everglades (Refuge inflow, outflow and rim-canal, WCA-2 inflow).

Parameters exhibiting excursions during either WY99 or WY2000 are reviewed in greater detail below. The review will include discussions concerning the environmental significance associated with the observed excursions, potential causes of the excursions, and any actions taken to resolve the associated concerns including the evaluation of the applicable criteria and natural background conditions within the EPA.

Table 4-2. Summary of water quality data and excursions from applicable criteria in the EPA for WY2000. Only parameters with excursions in the given region and class are listed. Excursion categories of Concern and Potential Concern are denoted by "C" and "PC", respectively.

Region	Class	Parameter	Class III Criteria	N	Mean	Std. Deviation	Min.	Max.	Excursion	
									Category	%
Refuge	Inflow	Conductivity (µmho/cm)	<1275[1]	246	953	282	52	1603	C	13
		DO (mg/L)	≥5.0	246	4.27	2.23	0.16	13.10	C	63
		Iron (mg/L)	≤1.0	49	0.39	0.76	0.01	4.12	C	6.1
		Turbidity (NTU)	≤29[2]	104	13.4	21.2	0.51	136.5	C	12
	Interior	Alkalinity (mg/L)	≥20	206	109	94	9.5	359	C	25
		Conductivity (µmho/cm)	<1275[1]	344	340	317	50	1279	PC	0.3
		DO (mg/L)	≥5.0	235	3.55	1.87	0.03	9.64	C	77
		pH	≥6.0, ≤8.5	240	6.66	0.53	5.20	7.87	C	15
	Outflow	Conductivity (µmho/cm)	<1275[1]	63	821	281	301	1396	C	7.9
		DO (mg/L)	≥5.0	63	3.49	2.26	0.30	8.86	C	70
		Un-ionized NH_3 (mg/L)	≤0.02	63	0.002	0.004	<0.0001	0.027	PC	1.6
		pH	≥6.0, ≤8.5	63	7.35	0.42	5.52	8.44	PC	1.6
		Turbidity (NTU)	≤29[2]	64	7.5	8.4	1.01	50.0	PC	3.1
	Rim	Alkalinity (mg/L)	≥20	50	225	81	2.5	387	PC	2.0
		Conductivity (µmho/cm)	<1275[1]	66	906	324	392	1564	C	15
		DO (mg/L)	≥5.0	43	4.38	2.30	0.32	8.40	C	54
		Turbidity (NTU)	≤29[2]	25	11.2	17.5	0.05	78.0	C	8.0
WCA-2	Inflow	Conductivity (µmho/cm)	<1275[1]	57	907	279	301	1396	C	8.8
		DO (mg/L)	≥5.0	57	3.73	2.26	0.33	8.86	C	68
		Un-ionized NH_3 (mg/L)	≤0.02	57	0.003	0.005	<0.0001	0.027	PC	1.8
		Turbidity (NTU)	≤29[2]	57	8.9	8.7	1.11	50.0	PC	3.5
	Interior	Conductivity (µmho/cm)	<1275[1]	348	793	248	60	1437	PC	1.1
		DO (mg/L)	≥5.0	294	3.62	2.10	0.13	11.28	C	76
		Un-ionized NH_3 (mg/L)	≤0.02	199	0.001	0.005	<0.0001	0.055	PC	1.0
		pH	≥6.0, ≤8.5	293	7.31	0.31	5.58	9.27	PC	0.7
	Outflow	DO (mg/L)	≥5.0	72	3.56	1.95	0.70	7.72	C	76
WCA-3	Inflow	DO (mg/L)	≥5.0	257	3.46	2.28	0.12	11.94	C	77
		Iron (mg/L)	≤1.0	44	0.20	0.22	<0.003	1.15	PC	2.3
		pH	≥6.0, ≤8.5	257	7.33	0.38	5.89	8.60	PC	0.8
	Interior	DO (mg/L)	≥5.0	194	3.15	1.52	0.29	12.03	C	92
	Outflow	DO (mg/L)	≥5.0	181	3.58	1.39	0.42	6.70	C	82
ENP	Inflow	DO (mg/L)	≥5.0	286	3.46	1.57	0.09	6.70	C	80
	Interior	DO (mg/L)	≥5.0	100	5.87	2.67	0.97	12.87	C	42
		Iron (mg/L)	≤1.0	94	0.27	0.40	<0.003	2.28	C	5.3
		Lead (µg/L)	Hardness Based[3]	98	0.84	0.16	<0.8	2.26	PC	1.0
		pH	≥6.0, ≤8.5	100	7.82	0.29	7.02	8.56	PC	1.0

1. Specific conductance shall not be increased 50% above background or to 1275 µmho/cm, which ever is greater.
2. Turbidity ≤ 29 NTU above natural background conditions.
3. Total lead criterion is ≤ $e^{(1.273[\text{Hardness}]-4.705)}$.

Table 4-3. Summary of excursions from Class III criteria in the Everglades Protection Area for WY2000, WY99, and historic data (1979-1998). Note: Number in front of parenthesis gives number of excursions while number within parenthesis specifies total number of samples collected (continued next page).

Region	Class	Parameter	Historic (1978-1998)		1999 Water Year		2000 Water Year	
			Percent Excursions	Number of Excursions	Percent Excursions	Number of Excursions	Percent Excursions	Number of Excursions
Refuge	Inflow	Beryllium	25	1 (4)	100	1 (1)/1 (1)	0	0 (0)/ 0 (0)
		Conductivity	29	424 (1453)	17	37 (223)	13	32 (246)
		DO	78	1134 (1457)	73	161 (222)	63	156 (246)
		Iron	3.3	12 (361)	3.3	2 (61)	6.1	3 (49)
		Turbidity	2.4	39 (1641)	2.6	3 (114)	12	12 (104)
	Interior	Alkalinity	32	351 (1103)	15	21 (144)	25	51 (206)
		Conductivity	0.5	5 (932)	0	0 (200)	0.3	1 (344)
		DO	74	640 (862)	83	164 (197)	77	182 (235)
		pH	11	110 (984)	6.1	12 (198)	15	35 (240)
		un-ionized NH3	0	0 (375)	1.1	1 (91)	0	0 (91)
	Outflow	Conductivity	15	129 (872)	0	0 (63)	7.9	5 (63)
		DO	66	576 (868)	76	48 (63)	70	44 (63)
		pH	0.2	2 (852)	0	0 (63)	1.6	1 (63)
		Turbidity	0.8	7 (893)	1.6	1 (63)	3.1	2 (64)
		un-ionized NH3	1.1	9 (822)	1.6	1 (63)	1.6	1 (63)
	Rim	Alkalinity	0	0 (370)	0	0 (67)	2	1 (50)
		Beryllium	0	0 (4)	100	1 (1)/1 (1)	0	0 (1)/ 0 (1)
		Conductivity	20	95 (478)	17	4 (98)	15	10 (66)
		DO	73	345 (474)	85	83 (98)	53	23 (43)
		pH	0	0 (467)	1	1 (96)	0	0 (45)
		Turbidity	2	6 (306)	0	0 (43)	8	2 (25)
		un-ionized NH3	0.3	1 (345)	1.4	1 (72)	0	0 (22)
WCA-2	Inflow	Conductivity	17	162 (951)	0	0 (54)	8.8	5 (57)
		DO	70	661 (946)	72	39 (54)	68	39 (57)
		Turbidity	0.9	10 (1090)	1.9	1 (53)	3.5	2 (57)
		un-ionized NH3	0.8	7 (902)	1.9	1 (54)	1.8	1 (57)
	Interior	Conductivity	9	191 (2113)	1.7	2 (233)	1.1	4 (348)
		DO	78	1579 (2033)	84	184 (219)	76	224 (294)
		pH	0.7	15 (2123)	1.4	3 (214)	0.7	2 (293)
		un-ionized NH3	1.5	25 (1657)	0.6	1 (159)	1	2 (199)
	Outflow	DO	66	750 (1134)	80	52 (65)	76	55 (72)

Table 4-3. Summary of excursions from Class III criteria in the Everglades Protection Area for WY2000, WY99, and historic data (1979-1998). Note: Number in front of parenthesis gives number of excursions while number within parenthesis specifies total number of samples collected (continued from previous page).

Region	Class	Parameter	Historic (1978-1998)		1999 Water Year		2000 Water Year	
			Percent Excursions	Number of Excursions	Percent Excursions	Number of Excursions	Percent Excursions	Number of Excursions
WCA-3	Inflow	Beryllium	0	0 (1)	25	1 (1)/ 0 (1)	0	0 (4)/ 0 (4)
		DO	68	1937 (2830)	86	204 (237)	77	199 (257)
		Iron	1.2	6 (496)	2.4	1 (42)	2.3	1 (44)
		pH	0.6	17 (2800)	0	0 (239)	0.8	2 (257)
		Turbidity	1.8	52 (2841)	0.7	1 (137)	0	0 (168)
		un-ionized NH3	0.2	4 (2589)	0.65	1 (155)	0	0 (178)
	Interior	DO	81	904 (1117)	87	138 (158)	92	178 (194)
		Turbidity	0.4	5 (1297)	0.9	1 (111)	0	0 (161)
	Outflow	DO	72	2105 (2915)	86	163 (191)	82	148 (181)
		pH	1.3	37 (2874)	1.6	3 (192)	0	0 (180)
		un-ionized NH3	0	1 (2169)	1.5	2 (134)	0	0 (131)
ENP	Inflow	DO	70	2446 (3484)	81	183 (226)	80	228 (286)
		pH	1.4	47 (3447)	3	7 (230)	0	0 (285)
		un-ionized NH3	0.2	6 (2705)	7.1	11 (154)	0	0 (225)
	Interior	Cadmium	0.3	3 (1025)	1.2	1 (81)	0	0 (98)
		DO	45	464 (1032)	60	49 (81)	42	42 (100)
		Iron	8.7	92 (1053)	8.6	7 (81)	5.3	5 (94)
		Lead	0.4	4 (1025)	0	0 (81)	1	1 (98)
		pH	2	18 (905)	1.2	1 (81)	1	1 (100)

DISSOLVED OXYGEN

As in previous water years, dissolved oxygen (DO) was classified as a parameter of Concern for all EPA regions and classes during WY2000. Overall, 75 percent of the 2,028 DO measurements collected during WY2000 were below the 5.0 mg/L Class III criterion. The frequency of DO measurements falling below 5.0 mg/L ranged from 42 to 92 percent among the EPA regions. The highest oxygen concentrations and consequently lowest excursion frequency (42 percent) were observed in the relatively minimally impacted interior of the Everglades National Park. The highest excursion rate occurred in the interior of WCA-3. Dissolved oxygen concentrations and excursion frequencies observed during WY2000 were generally within the ranges determined for the historical period and WY99. However, temporal trends were apparent for a few regions. Excursion frequencies declined (9.1-31.2 percent) in Refuge inflow and rim canal samples. Conversely, excursions in WCA-2 outflows and all regions of WCA-3 increased (9.6-10.8 percent) during WY2000, relative to the historic period, but not WY99.

It is widely accepted that DO concentrations are normally low in macrophyte dominated marsh environments such as the Everglades due to natural processes of photosynthesis and respiration (Belanger and Platko, 1986; McCormick et al., 1997). Since the low DO concentrations often measured in the Everglades represent the natural variability in this type of ecosystem, the Department does not consider these excursions violations of the DO standard. Therefore, the Class III criterion of 5.0 mg/L is not believed to be appropriate for the Everglades. This stance is supported by Paragraph 62-302.500(1)(f), F.A.C., which states that "*dissolved oxygen levels that are attributable to natural background conditions or man-induced conditions which cannot be controlled or abated may be established as alternative dissolved oxygen criteria for a water body or portion of a water body*."

Pursuant to Section 62-302.800, F.A.C., the Department has undertaken the development of a Site Specific Alternative Criterion (SSAC) for dissolved oxygen in the Everglades that formally recognizes the natural background DO regime. The SSAC will also allow a more accurate assessment of which sites are adversely impacted with respect to DO level. More detail concerning the Department's efforts in establishing a DO SSAC is provided in a technical report documenting the development of the SSAC (Weaver, 2000b) which is provided as **Appendix 4-2**. The development and application of the proposed SSAC is outlined below.

Development of a Dissolved Oxygen SSAC

Oxygen is a necessity for most life on Earth and all aerobic life, including plants and animals. Due to oxygen's importance to life, it is important to understand the processes that influence DO concentrations in the Everglades. In any aquatic system, water column DO concentrations are regulated by a variety of sources and sinks. These controlling factors are balanced in healthy systems. The primary oxygen sinks include chemical oxidation and aerobic respiration by vegetation, periphyton, and other organisms in both the water column and sediments. Photosynthesis and atmospheric exchange are the primary oxygen sources. In a marsh habitat, the principal photosynthetic contributors are periphyton and submerged aquatic vegetation (P/SAV) in open water sloughs with some minor contribution from phytoplankton. Additionally, DO concentrations within background areas fluctuate widely on a daily (diel) basis in response to varied respiration and photosynthetic rates (**Figure 4-6**). The factors influencing DO on a diel basis are discussed further in **Appendix 4-2**. These variations represent the normal diel variability typical for this type of ecosystem and therefore, must be maintained by any SSAC developed by the Department as specified by Section 62-302.800, F.A.C.

Although conditions in background areas of the Everglades represent natural variability, evaluation of DO concentrations along nutrient gradients in WCA-2A and the Refuge and mesocosm data in WCA-2A, indicate that phosphorus enriched areas of the marsh have DO concentrations that are significantly depressed below background conditions (McCormick et al., 2000, Chapter 3, this Report). The normal daily DO fluctuations are also depressed, in fact, nutrient-enriched sites barely exhibit any diurnal DO fluctuations (Belanger et al., 1989). Significant depression of DO concentrations and suppression of the normal daily and seasonal variability at nutrient-enriched sites do constitute violations of the Class III dissolved oxygen criterion.

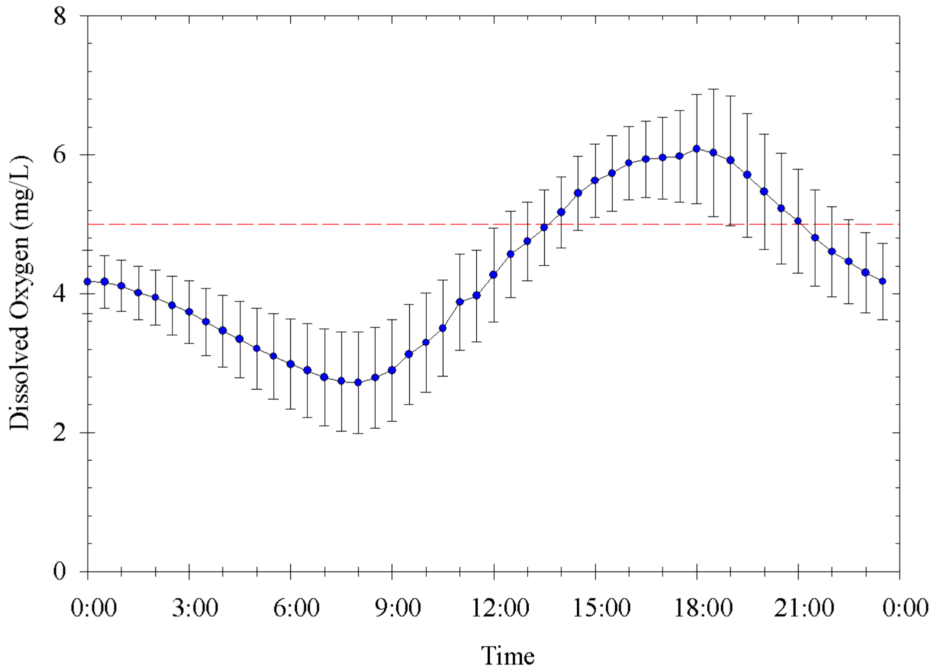


Figure 4-6. Average (mean ± 95% C.I.) diel dissolved oxygen fluctuation at a typical interior marsh station in the EPA. Data were taken from diel measurements collected at site E5 in WCA-2A during five sampling periods (4/24/95-4/29/95, 8/28/95-9/1/95, 9/3/96-9/6/95, 10/27/97-10/31/97, and 2/24/98-2/27/98). The dashed line shows the current Class III criterion at 5.0 mg/L.

In recognition of the natural background condition and to allow differentiation between impacted and background conditions, the Department is developing a SSAC for Everglades marsh DO in open water (slough and wet prairie) habitats. The proposed SSAC is not applicable to dense emergent macrophyte habitats (i.e., sawgrass, cattail) or canals, but would apply at inflow structures. Weaver (2000b) proposes a DO SSAC that utilizes a mathematical model describing the relationship between DO and time of day and temperature to define the compliance limit. This approach takes into consideration the wide daily variations. In contrast, a single number SSAC would not be representative of background conditions across all times and temperature ranges and for much of the day, would be either under-protective or over-protective depending on time of day. Compliance with the SSAC is to be based on an annual average concentration. Annual average DO, at any given station, must be maintained above an annual limit calculated from an equation defined by sample collection time and temperature (**Figure 4-7**, **Appendix 4-2**). The period of one year provides a characterization of the DO regime at a site and accounts for the infrequent occurrence of naturally low values. A detailed discussion of the proposed SSAC is provided in **Appendix 4-2**. It should be noted that the SSAC has not yet been formally adopted. Establishment of the SSAC requires further peer review, public notice and hearing, and finally approval by the Secretary of the Department.

The proposed SSAC was applied to WY2000 DO data from interior, rim canal, inflow, and outflow stations in the EPA. Although the SSAC was developed for open water marsh stations, water discharging to the Everglades should meet the SSAC in order to prevent violations in the receiving waters of the marsh. The Class III standard would still be applicable to canal waters that do not immediately discharge to the marsh. Utilizing the proposed SSAC on data from WY2000 yields a far lower excursion rate than did the analysis based upon the 5.0 mg/L criterion (**Table 4-4**, **Appendix 4-3**). The percentage of stations categorized as Concern declined sharply in most cases. Stations that failed to meet the SSAC generally fell into two groups. A high percentage of water control structures (i.e., inflow, outflow) failed the SSAC test. This high rate of non-compliance is likely due to disturbance of bottom sediments and the intrusion of low DO ground water into the surface water at these structures. Sediments are commonly mixed with canal surface waters during pumping events. These sediments typically increase oxygen demand within the water column and subsequently result in reduced DO concentrations (Environmental Services & Permitting, Inc., 1992). Ground water intrusion is a common occurrence at Everglades pumping stations and canals dug below the water table. The influence of ground water on DO at these structures potentially represents a “man-induced condition which cannot be “controlled or abated” and will need to be addressed separately. The second group of stations failing the SSAC is interior marsh stations known to be impaired due to phosphorus enrichment (e.g., E1, E2, Z1, CA28). Conditions at these stations are expected to remain impaired until sediment phosphorus concentrations are reduced and the biological communities recover.

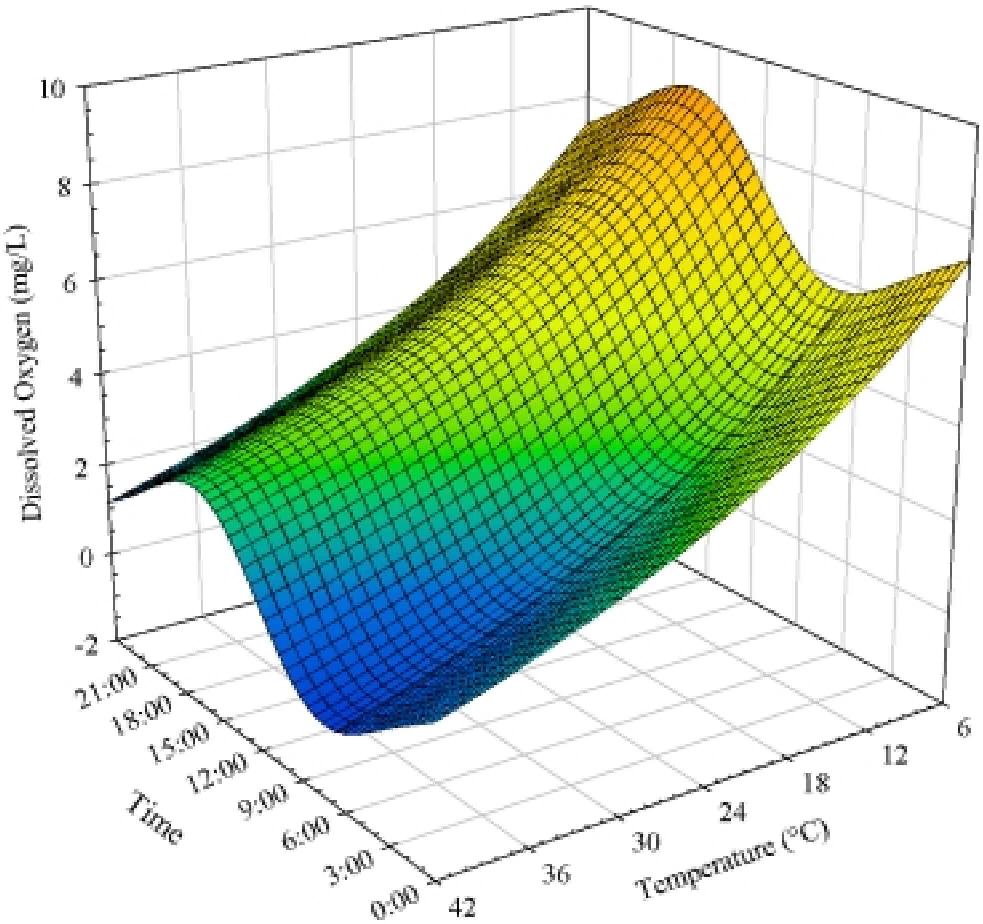


Figure 4-7. Annual dissolved oxygen compliance limit for interior mash stations in the EPA. The curve is a function of temperature and sample collection time (see Appendix 4-2).

Table 4-4. Comparison between the number of stations categorized as Concern using the current Class III Criterion and the proposed SSAC for WY2000.

Region	Class	Number of Stations	Class III Criterion	SSAC
			Percent/(Number)	Percent/(Number)
Refuge	Inflow	6	100 (6)	0 (0)
	Interior	23	100 (23)	26 (6)
	Outflow	6	100 (6)	17 (1)
	Rim	4	100 (4)	0 (0)
WCA-2	Inflow	6	100 (6)	0 (0)
	Interior	22	100 (22)	27 (6)
	Outflow	5	100 (5)	60 (3)
WCA-3	Inflow	14	100 (14)	36 (5)
	Interior	10	100 (10)	20 (2)
	Outflow	9	100 (9)	11 (1)
Park	Inflow	9	100 (9)	0 (0)
	Interior	9	67 (6)	0 (0)

ALKALINITY AND pH

Alkalinity is a measure of the acid neutralization capacity of water. It provides a measure of the buffering capacity of water. In most surface water bodies, the buffering capacity is primarily the result of the equilibrium between carbon dioxide and carbonate and bicarbonate ions (i.e., CO_2, HCO_3^-, CO_3^{2-}). The dissociation of calcium carbonate, magnesium carbonate, or other carbonate containing compounds entering the surface water through weathering of carbonate containing rocks and minerals (e.g., limestone, calcite, etc.) contribute to the buffering capacity of the water. Therefore, in areas influenced by canal inflows that are primarily composed of mineral rich agricultural runoff and groundwater such as WCA-2, WCA-3 and the Park, alkalinity levels are relatively high. Conversely, areas such as the interior of the Refuge, which receives most of its hydrologic load through rainfall, have very low alkalinities. Alkalinity protects aquatic life against dramatic pH changes. Rapid pH changes are difficult for living organisms to adapt to and thus result in severe stress and may be lethal to sensitive species. Therefore, it is important that surface waters exhibit some minimal level of alkalinity or buffering capacity to restrict dramatic pH swings. The current Class III criterion for alkalinity specifies that alkalinity shall not be depressed below 20 mg $CaCO_3$/L.

The pH value is defined as the negative $\log_{(\text{base } 10)}$ of the hydrogen ion activity ($[H^+]$). In low ionic strength freshwaters, the activity of the H^+ ion is approximately equal to the concentration of H^+ ions. Since pH is based on a log scale, each pH unit change represents a tenfold change in the concentration of H^+ ions (acidity). For example, a solution at pH 3 is ten times more acidic than one at pH 4. Most living organisms, especially aquatic life, function best in a pH range of 6.0 to 9.0, although individual species have specific ideal ranges. Below a pH of 5.0, most fish fail to spawn and below

4.0, many species die. Amphibians are particularly sensitive to extreme pH levels as well as drastic pH changes. Some amphibian declines have been attributed to declining pH (Wyman, 1990). Additionally, the pH of water affects the toxicity and solubility of other substances (e.g., ammonia, aluminum, copper, cadmium). The current Class III criterion specifies that pH shall not be lowered below 6.0 units or raised above 8.5 units in predominately fresh waters.

There are a number of interrelationships among pH, photosynthesis and carbon dioxide (CO_2) in the water (carbonate system). When CO_2 enters freshwater, small amounts of carbonic acid are formed which then dissociate into hydrogen ions and bicarbonate ions, resulting in a lowering of pH. Since photosynthesis and respiration alter CO_2 concentration in the water, these processes exert an influence on pH. During the day, while photosynthetic processes are consuming CO_2, the concentration of carbonic acid declines and pH will rise. The addition of CO_2 by respiration at night reverses the reactions and lowers pH. In poorly buffered systems (low alkalinity), daily changes in pH can be dramatic.

Because of the close relationship between alkalinity and pH, the two parameters will be evaluated here together. Violations of state Class III water quality criteria for both parameters, have historically occurred in the interior of the Refuge (Bechtel et al., 1999; Bechtel et al., 2000). As was the case in previous years, alkalinity was designated as a parameter of Concern for the interior of the Refuge during WY2000 due to an excursion rate of 25 percent. During WY2000, alkalinity was also classified as a Potential Concern in the Rim Canal of the Refuge due to a single excursion. Likewise, pH in the interior of the Refuge was identified as a parameter of Concern due to frequent values below the lower limit of 6.0 specified by the state criterion. Additionally, a couple of pH values above 8.5 in the interior of the Park, outflow of the Refuge, inflow to WCA-2 and interior of WCA-3 caused the parameter to be categorized as a Potential Concern for these areas for WY2000.

The low alkalinities and pH values in the Refuge are primarily caused by the hydrologic nature of the area. As mentioned previously, the majority (54 percent) of the water entering the Refuge is soft rainwater with low alkalinity (SFWMD, 1992). Along the western periphery of the area harder canal waters from the S-5A and S-6 structures permeate into the marsh along the L-7 rim canal. However, canal waters tend to penetrate only a few kilometers into the marsh and thus have little or no influence on the soft-water conditions within the interior. The dichotomy of the soft-water interior and hard-water periphery creates steep pH, alkalinity and other ionic gradients in the Refuge from the canals into the marsh (Swift and Nicholas, 1987; Richardson et al., 1990; **Figures 4-8** and **4-9**).

As shown in **Figure 4-8**, alkalinity within the Refuge decreases with distance from the rim canal and S-6 inflow structure. In fact, the central region (i.e., LOX5, LOX7, LOX9, LOX11, LOX13) has the lowest alkalinity levels with average concentrations at or below the state criterion of 20 mg $CaCO_3$/L. The alkalinity excursions within the Refuge are therefore not caused by a discharge or pollution source. Rather these excursions are a result of the natural soft-water, rainfall-driven nature of the system. The low values represent the normal background condition typical of this ecosystem, therefore the Department does not consider these variations violations of the state alkalinity standard.

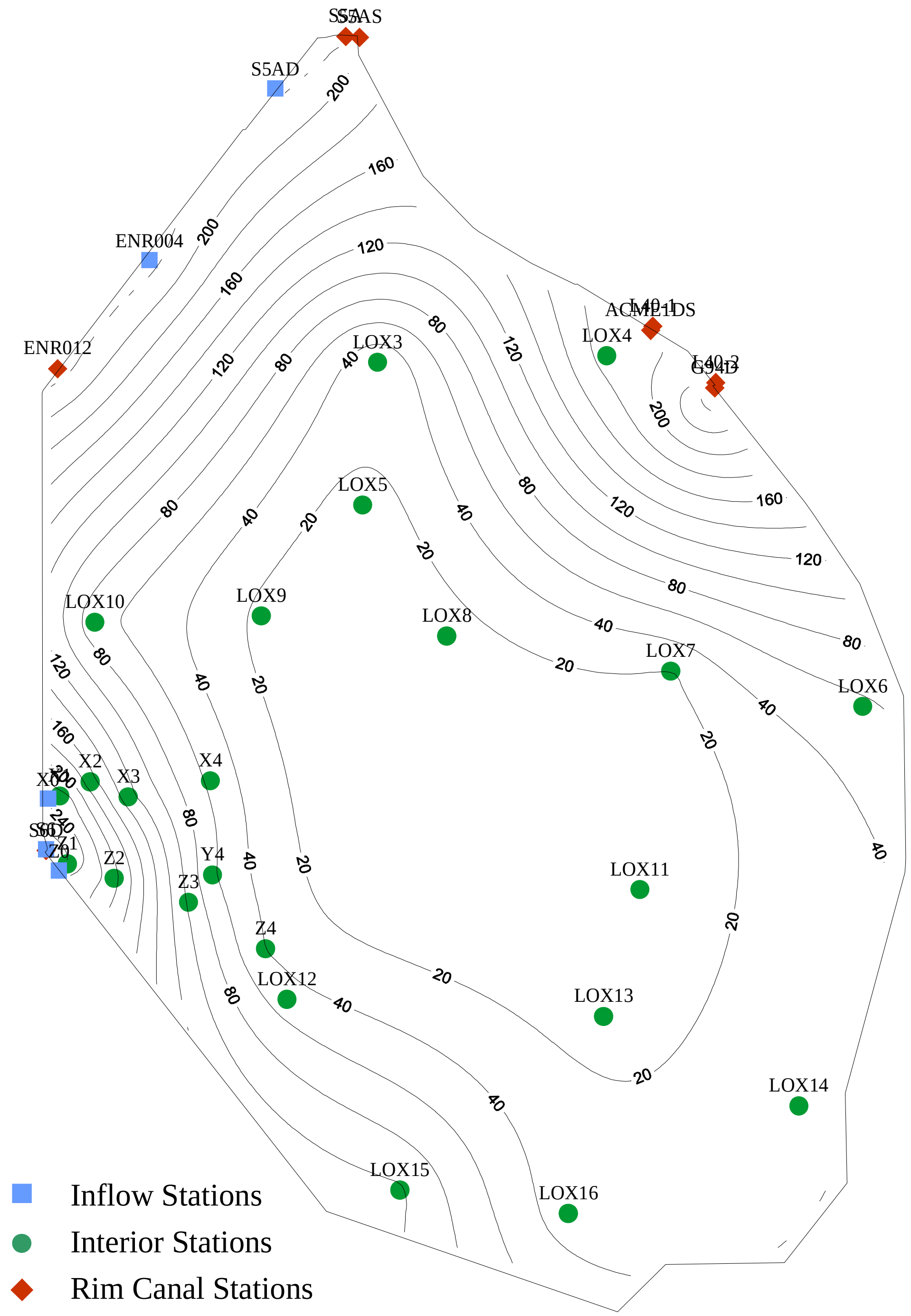


Figure 4-8. Alkalinity concentration contours within Loxahatchee National Wildlife Refuge. Values are expressed as the mean for data collected at rim canal, inflow and interior marsh stations between May 1994 and April 2000.

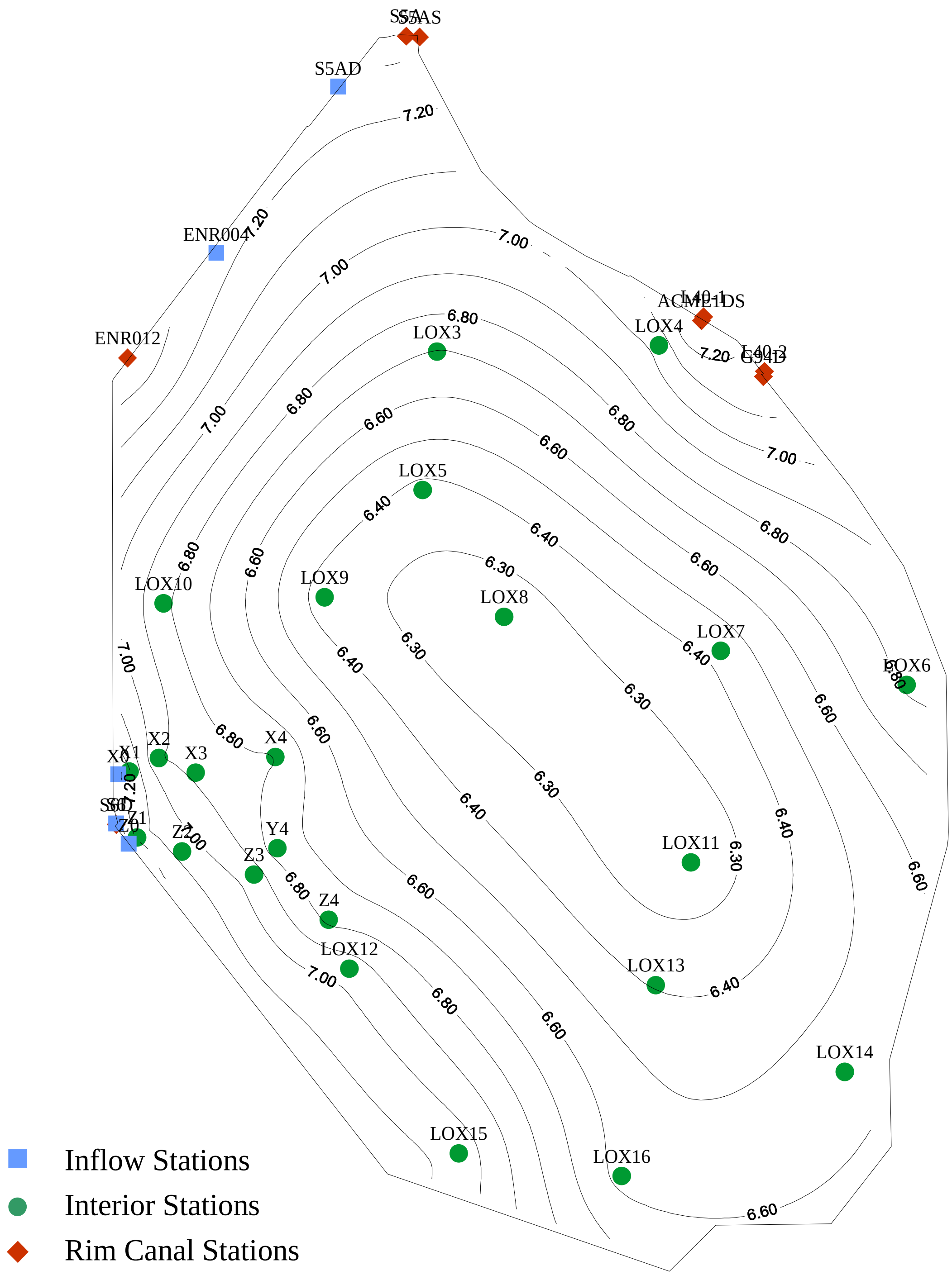


Figure 4-9. pH contours within Loxahatchee National Wildlife Refuge. Values are expressed as the mean for data collected at rim canal, inflow and interior marsh stations between May 1994 and April 2000.

Excursions in pH are closely linked to the naturally low alkalinities within the Refuge's interior marsh. Since the buffering capacity within the interior is low, small changes in H^+ ion concentration result in wide pH fluctuations. Nearly all the excursions from the pH criterion have occurred at alkalinities below 50 mg $CaCO_3$/L (**Figure 4-10**). Additionally, the greatest variability in pH has occurred at alkalinities less than 100 mg $CaCO_3$/L. Such fluctuations in pH at low alkalinity, in areas free of discharges, are typically caused by changes in CO_2 concentrations due to natural processes of photosynthesis and respiration within the environment. Since pH excursions within the interior of the marsh are linked to natural background alkalinity conditions, the Department does not consider pH levels in the Refuge to be in violation of state water quality standards.

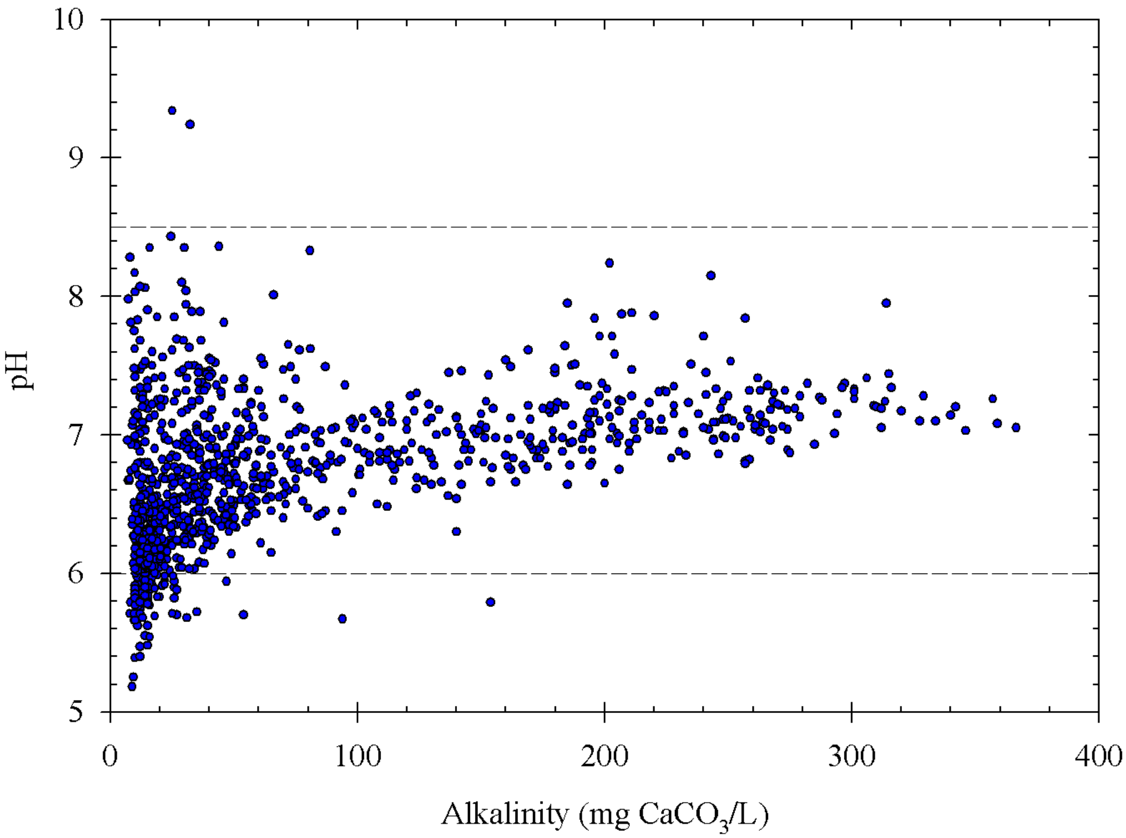


Figure 4-10. Relationship between pH values and alkalinity within the interior marsh of Loxahatchee National Wildlife Refuge from May 1994 to April 2000. Dashed horizontal lines show the lower (6.0) and upper (8.5) Class III pH criteria.

The infrequent pH levels exceeding the 8.5 upper limit of the Class III criterion that occur throughout the system are probably the result of increased photosynthetic rates. As discussed previously, during photosynthesis CO_2 is consumed which shifts the carbonate system equilibrium resulting in higher pH levels. These higher pH levels may reflect natural phenomena or may be indicative of higher productivity resulting from nutrient enrichment in areas influenced by canal inflows. High pH levels will continue to be monitored during future monitoring years to more fully evaluate their causes.

The Department intends to review the applicability of the current Class III criteria to the low alkalinity and pH observed within the interior portions of the Refuge over the next year to determine the best means of formally recognizing the natural background conditions. One possible approach, to be considered, is the establishment of a Site Specific Alternative Criterion (SSAC). A SSAC would likely utilize the distribution of alkalinity and pH within the interior region of the Refuge, as these areas are least influenced by outside water sources (e.g., inflows, rim canal). For example, a SSAC that accommodates the naturally low conditions within the marsh might require pH $\geq$5.0 (lowest recorded value between 1994 and 2000 was 5.18) and alkalinity $\geq$6.5 $CaCO_3$/L (lowest recorded value between 1994 and 2000 was 6.9 mg/L).

SPECIFIC CONDUCTANCE

Specific conductance (conductivity) is a measure of the ability of the water to conduct electrical current. It is an indirect measure of the total concentration of ionized substances (e.g., Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}, HCO_3^{-}, SO_4^{2-}) in the water, but can not differentiate between parameters. Conductivity will vary with the number and type of these ions in solution and in some cases can be used to differentiate among different water sources (i.e., groundwater, rainwater, agricultural runoff, municipal wastewater) as well as narrow down sources of pollution. Changes in conductivity beyond natural background variability can result in potentially deleterious effects to aquatic life and thus designated use. For example, very high conductivities would be detected under conditions of salt water intrusion; a situation which would be fatal to most fresh water organisms. The current state water quality criterion which allows a 50 percent increase in the specific conductance or 1275 µmho/cm, whichever is greater, is meant to preserve natural background conditions and thus protect aquatic organisms from stressful ion concentrations. Since background conductivities are assumed to be low within the EPA, excursions were calculated using the 1275 µmho/cm criterion.

Conductivity was categorized as a parameter of Concern for the inflow, outflow, and Rim Canal stations of the Refuge and inflow structures to WCA-2. Additionally, a few (1-4) excursion events within the interiors of the Refuge and WCA-2 led to conductivity being categorized as a Potential Concern for these areas. A total of 57 conductivity excursions above 1275 µmho/cm was recorded during WY2000. However, since sites S10D and S10E were classified as both outflows from the Refuge and inflows to WCA-2 several excursion events were counted twice. Actually, 54 unique conductivity excursions were observed during WY2000. Overall, the rate of conductivity excursions increased slightly from WY99, particularly in the inflows to WCA-2 (Refuge outflows), but have decreased relative to the historic period (**Table 4-3**). Spatially, excursions during WY2000 occurred in the same regions (Refuge and WCA-2) as in WY99 and WY79-WY98.

During WY2000 the majority of the conductivity excursions (51) occurred at either water control structures or within canals. Several factors probably contribute to the reported conductivity excursions. One of the major sources of the elevated conductivity levels is probably groundwater intrusion into the surface waters in the canals. Because groundwater tends to have a high mineral content and thus high conductivity, ground water intrusion would cause an increase in surface water conductivity. Because many of the canals are dug into bedrock and below the water table, seepage of groundwater into canals is a common occurrence in South Florida. Furthermore, normal operation of pumping stations can result in additional groundwater being pulled into the surface water. Additionally, agricultural activities such as the practice of field dewatering may contribute to the observed conductivity excursions. On a seasonal basis, the surficial aquifer is drawn down in some EAA agricultural areas to reduce flooding of low-lying fields. The water level in drainage ditches and canals in these areas are pumped to below the water table, causing groundwater to drain into these secondary canals which subsequently flow into the primary canals supplying water to the EPA (Miller, 1988). Because the water in the surficial aquifer has a high ionic content, resulting from the dissolution of soil minerals and inorganic fertilizers, the addition of this groundwater to surface waters results in elevated conductivity levels. Other factors such as direct storm water runoff from agricultural or urban areas, extended periods of drought (evaporation without dilution), and resuspension of sediments may also contribute to the reported conductivity excursions. The Department intends to continue its review of specific conductance with the goal of determining the source(s) of excursions. If the source of excursions is determined to be primarily the result of the normal operation of canals and water control structures, the situation may be deemed a man-induced condition that cannot be controlled and abated, and therefore does not constitute a violation of water quality standards.

UN-IONIZED AMMONIA

Ammonia (NH_3) is a colorless gas with a pungent odor that is very soluble in water at low pH. Ammonia can serve as an important source of nitrogen for plant life, but is deleterious when present in excess. In water at low temperature and pH, ammonia undergoes hydrolysis to produce ammonium (NH_4^+) and hydroxide (OH^-) ions. The ammonium ions produced during this reaction are not toxic to aquatic life. However, at high pH levels, the hydrolysis is not as complete with increasing amounts of un-ionized ammonia (NH_3) remaining. For example, in freshwater at 25°C, an increase in pH from 7 to 8 results in an increase in the percent of total ammonia in the un-ionized form from 0.5 to 5.4 percent, while at a pH of 9 more than a third (36 percent) of the total ammonia is un-ionized. The resulting un-ionized ammonia is able to diffuse across cell membranes more readily and, subsequently, is acutely toxic to aquatic life.

There are many sources of ammonia including natural, nonpoint, and point sources. Natural sources include animal and human excrement and bacteria, which produce ammonia during decomposition of proteins and other nitrogenous organic compounds. About three-fourths of the ammonia produced by the United States is used in fertilizers, which can enter aquatic systems in runoff from agricultural land including cropland and livestock operations. Known point sources include sewage and waste treatment plants, various manufacturing processes, strip mining, and food processing. Accidental releases can also contribute significantly to ammonia concentrations in localized areas.

Ammonia is unique among regulated pollutants because it is a source of nitrogen, a nutrient required for life, as well as, an endogenously produced toxicant that organisms have developed various strategies to excrete (i.e., waste product). Toxicity levels of ammonia are highly variable because they are affected by temperature, pH, dissolved oxygen concentrations, carbon dioxide concentrations, previous acclimation to ammonia, and the presence of other toxic compounds. Plants are more tolerant than animals, and invertebrates are more tolerant than fish. Increases in pH and temperature lead to increased levels of un-ionized ammonia. High external un-ionized ammonia concentrations reduce or reverse diffusion gradients utilized by organisms to excrete excess ammonia. This excess ammonia can accumulate in the organism resulting in alterations in metabolism, loss of equilibrium, hyperexcitability, increased respiratory activity and oxygen uptake, and increased heart rate. Even slightly elevated concentrations have been associated with a reduction in hatching success, reduction in growth rate and morphological development, and injury to gill tissue, liver, and kidneys. While extremely high levels can lead to convulsions, coma, and death in fish.

The current state Class III water quality criterion is ≤0.02 mg/L of un-ionized ammonia, calculated using pH, temperature, and total ammonia measurements from the same sample. Four measurements were above this criterion during WY2000. Because certain stations are classified as outflows from one region and inflows to another region, two of these excursions occurred at the same site during the same sampling event. On January 31, 2000, station S10E had a calculated un-ionized ammonia concentration of 0.027 mg/L, which resulted in an excursion for Refuge outflows and for WCA-2 inflows. The other two excursions occurred in the interior of WCA-2. One was barely an excursion with a calculated concentration of 0.021 mg/L. Data collected in association with the second excursion indicate that a high pH (9.27) was the primary cause for its high un-ionized ammonia concentration. The increased un-ionized ammonia concentrations reported for Park inflows during WY99 subsided in WY2000. During WY99 there were 11 excursions for un-ionized ammonia at Park inflows, while none were reported for Park inflows during WY2000. Overall, WY2000 excursion rates for un-ionized ammonia are lower than those reported for the Baseline Period (78-88) and are similar to or lower than those reported over the last decade (WY90-WY99).

IRON

Iron is the fourth most abundant element, by weight, composing the Earth's crust and is present in natural surface waters at varying concentrations depending upon the geology of the area and chemical properties of the water body. In surface waters iron is primarily found in two forms, the reduced ferrous (Fe^{2+}) iron and the oxidized ferric (Fe^{3+}) form, which can form a variety of other organic and inorganic compounds. The form of iron (ferric or ferrous) present in surface waters is influenced by pH and redox (reduction/oxidation) conditions. Most ferrous compounds, which are typically found under anaerobic and acidic conditions, are soluble in water. Whereas, ferric iron compounds found in most alkaline (pH > 7.0) and aerobic waters are relatively insoluble and therefore, relatively inactive chemically or physiologically. Ferric iron is commonly associated with sediments, organometallic compounds, and humic materials, and has little effect on aquatic life due to its insolubility (USEPA, 1976).

Iron is an essential trace nutrient for plants and animals and is vital in the oxygen transport systems of all vertebrates and some invertebrates. However, iron in water is a nuisance to many human uses. Water that is high in iron has a metallic or medicinal taste and can stain laundry, concrete, stucco, and other materials. Additionally, under certain conditions excess iron can have toxicological or deleterious effects on aquatic organisms. Iron has been found to be toxic to Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) at concentrations of 0.32 mg/L (Warnick and Bell, 1969). Healthy fish populations have been shown to be maintained at iron concentrations ranging from below 0.9 to 10 mg/L, depending upon species and pH of the water (USEPA, 1976). In streams polluted by acid mine wastes, a rusty colored flocculent of $Fe(OH)_3$ forms within a “zone of recovery” as pH and DO levels increase. This flocculent forms a precipitate that can clog fish gills and smother eggs and bottom-dwelling organisms (USEPA, 1976). The current Class III iron criterion of 1.0 mg/L is based upon field observations and is believed to be protective of aquatic life. In reality, the form and solubility of iron, and therefore its toxicity varies depending on factors such as the alkalinity, DO, pH, hardness, temperature, redox status and biological activity of the water (USEPA, 1976).

The frequency and location of iron excursions observed in WY2000 were comparable to the results for both the WY79-WY98 historic period and WY99. During WY2000 the state total iron criterion of $\leq$1.0 mg/L, was exceeded on nine occasions with the most frequent excursions occurring in the interior of the Park and inflows to the Refuge. A single excursion occurred at Site L3 (WCA-3 inflow) on July 7, 1999 when a concentration of 1.15 mg/L was recorded. Based on these results, iron was categorized as a parameter of Concern for the interior of Everglades National Park and inflows to the Refuge and a Potential Concern for inflows to WCA3. All WY2000 iron excursions were associated with pH >7.0 and aerobic conditions, although DO concentrations at site L3 (WCA-3 inflow) on July 15, 1999 were low (0.93 mg/L). As previously stated, under oxidizing conditions, iron is typically found in insoluble ferric forms that are largely non-toxic. Furthermore, the three iron excursions recorded for Refuge inflows (S-5A and S-5AS) were associated with high turbidities (71-137 NTU), suggesting that the elevated iron levels may have resulted from the inclusion of disturbed sediments in the sample during collection. Since the samples are acidified upon collection, the lowered pH potentially resulted in iron associated with sediment particles being released into the sample.

Although the criterion was exceeded on several occasions, it was commonly only exceeded by a small margin. Concentrations exceeding the criterion ranged from 1.05 to 4.12 mg/L. Given the infrequent excursions, low concentrations, and low toxicity of ferric iron, it is not likely that iron represents a significant threat to designated uses of the water body. Furthermore, iron excursions have occurred in the absence of anthropogenic influences (e.g., discharge, construction) within the interior of the Park. Therefore, it is likely that infrequent values above 1.0 mg/L represent a combination of natural variability and the disturbance of sediments during sample collection resulting in samples that are not representative of the true conditions in the southern Everglades. Iron concentrations in the surface waters within the EPA will continue to be monitored and evaluated in future reports.

LEAD

The primary natural source of lead is the mineral galena (lead sulfide). It can also occur naturally combined with carbonate or sulfate. The solubility of these minerals, lead oxides and other inorganic salts is low. Until the mid-1980’s the primary anthropogenic source of lead in the environment was the burning of leaded gasoline. Mining, smelting and other industrial emissions and combustion sources and solid waste incinerators are now the primary sources of lead contamination. Other common sources of lead in the environment include discarded wet cell batteries, shooting ranges, waterfowl hunting sites, metal bridges, and other structures. Lead reaches water bodies either through urban runoff or discharges such as sewage treatment plants and industrial plants. It also may be transferred from the air to surface water through precipitation.

In humans and other vertebrates (mammals, birds, fish), lead is a powerful neurotoxin that negatively affects almost all organs, particularly the kidneys, red blood cells, and central nervous system (USEPA, 1976). In young children, lead retards the development of the central nervous system and brain. Even tiny amounts can cause neurological damage, reading and learning disabilities, attention deficit disorder and behavioral problems. The heavy metal is toxic to both plant and animal life. Lead's toxicity in surface waters is dependent upon its solubility, which is inversely related to pH and hardness.

Due to its high potential for toxicological effects to both humans and aquatic life the Department has established a Class III water quality criterion for lead. The current lead criterion is a calculated value based on water hardness. Lead was designated a Potential Concern for the Park interior due to a measured concentration of 2.26 µg/L at site NE1 on October 25, 1999, which exceeded the calculated criterion of 0.52 µg/L. This excursion occurred in the absence of any apparent anthropogenic sources.

Site NE1 is located in the northern portion of Shark River Slough, an area that is remote from industrial or other discharges and automobile traffic (past or present). Furthermore, any atmospheric or discharge sources would have been detected at other stations, such as inflows, prior to being detected within the interior. Historically, lead has been detected throughout Shark River and Taylor Sloughs and has infrequently exceeded the state criterion. Between 1978 and 1999 the applicable criterion was exceeded a total of four times at varied interior marsh stations in the Park. Although data collected within the Park between 1978 and 1999, support the idea that low levels of lead occur within the relatively pristine southern Everglades, the single lead concentration of 2.26 µg/L, that was several times higher than levels typically measured, possibly resulted from contamination of the sample during collection or analysis. Lead concentrations will continue to be evaluated in future reports.

TURBIDITY

Turbidity is a measure of water clarity or cloudiness and thus is an indirect measure of particulates, water color and dissolved substances. It can be increased by soil erosion, waste discharge, urban runoff, bottom feeders like carp that stir up sediments, wind-induced resuspension of sediments, and algal growth. Turbid water can have ecological effects (USEPA, 1976). Turbid waters become warmer as suspended particles absorb heat from sunlight, causing oxygen levels to fall. Reflection and absorption of light on suspended particles can reduce light penetration through the water resulting in a decrease in photosynthesis and subsequent lowering of oxygen levels. Suspended solids in turbid water can clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. Settled particles smother eggs of fish and aquatic insects. Dependent upon particle composition, high turbidity can be indicative of elevated total phosphorus and total nitrogen concentrations.

The current state criterion for turbidity is $\leq$29 NTU above natural background conditions. For the Everglades, where natural marsh turbidities tend to be low (<1.0

NTU), natural background has been assumed to be 0 NTU for the purpose of this evaluation. There were 19 excursions above this criterion in WY2000. Because station S10E is classified as both an outflow from the Refuge and inflow to WCA-2, two excursion events were counted twice, thus there were actually only 17 unique excursion events in WY2000. As a result of these excursions, turbidity was categorized as a Concern for the rim canal and inflow structures of the Refuge. Additionally, turbidity was classified as a Potential Concern for the outflows from the Refuge and inflows to WCA-2. The frequency of turbidity excursions in the regions of the EPA during WY2000 occurred at frequencies at or above those for the historic period and WY99.

Excursions in WY2000 occurred in the vicinity of the S-5A, S-6 and S-10E pumping stations, with the majority occurring in December and January. The excursions are most likely explained by construction near these stations. Canal construction was being conducted on the Hillsboro and West Palm Beach Canals during this period, which would have had a substantial influence on the water quality at sites S6 and S5A, respectively. Additionally, work on the Inflow and Diversion Works of STA-2 was conducted in the L-7 canal in the vicinity of the S-10E structure. Although during WY2000 turbidity levels exceeding the state criterion occurred in some areas of the EPA at frequencies exceeding those historically observed, many of the exceedances can be tracked to temporary events that will not be repeated and ultimately contribute to the restoration of the Everglades and net improvement in water quality.

CADMIUM AND BERYLLIUM

Cadmium is a naturally occurring element widely distributed in the earth's crust. Pure cadmium is a soft, malleable, bluish-white metal, but is not commonly found in the environment in this form. Instead, it is found primarily as cadmium sulfide in ores containing zinc, lead, and copper. Its leading industrial source is as a byproduct in the smelting of ores, especially zinc. The cadmium-containing precipitates produced during smelting are processed electrolytically to produce cadmium metal. It is then used in nickel-cadmium batteries, for electroplating and coating corrosive metals, as a stabilizer in plastics, and as a pigment in plastics, paints, and lacquers. Because it is a trace element found in many ores, it is generated as a fugitive emission during the manufacture of iron and steel products and by electric power plants that burn fossil fuels. It is also present in varying concentrations in phosphate rock and is contained in inorganic phosphate fertilizers. Fertilizer application, as well as, waste streams and leaching of landfills are considered the primary sources of soil and water contamination.

Cadmium is considered a pollutant of concern by U.S. Environmental Protection Agency due to its persistence in the environment, potential to bioaccumulate, and toxicity to humans and the environment. It is widely recognized as a toxic metal that must be handled cautiously to avoid prolonged exposure to fumes or dust. Acute and chronic exposure tests in animals have shown it to be a reproductive and developmental toxicant, resulting in fetal malformations, decreased reproduction, impaired metabolism and neurological development, and reduced birth weights. Studies have demonstrated its ability to bioconcentrate in certain organs, including the kidney; however, the rate of accumulation varies widely between organisms.

Due to its potential for toxic effects in the environment, the Department has established a state water quality criterion for cadmium in Class III waters. The current state criterion is a calculated value, dependent on water hardness due to its effect on cadmium toxicity. In the past, cadmium excursions above the water quality criterion have been sporadic both temporally and spatially. During the period from 1990-1998, five samples out of 2,867 had cadmium concentrations above the criterion. These excursions occurred in the interior of WCA-2, WCA-3, and the Park, as well as, in the inflows to the Park. There was a single excursion reported in the interior of the Park during WY99. A review of the data associated with this excursion indicates that the hardness value used to calculate the criterion was missing an essential qualifier and should have been removed from analyses. Based on this information, recalculation of cadmium data indicates that no excursions occurred during WY99. Likewise, evaluation of the data collected during WY2000 indicates no excursions occurred anywhere in the EPA. Cadmium excursions in the past decade have been rare, intermittent, and demonstrate no observable trends. Therefore, they are likely unrelated to anthropogenic activities in the watershed and may represent sample contamination, and consequently are of minimal concern. Removal of cadmium from the list of parameters of Concern or Potential Concern in future reports is warranted based on data collected during recent water years.

Beryllium is a metal, which is found as a chemical component of certain rocks, coal and oil, soil, and volcanic dust. Most mined beryllium ore is used in making metal alloys for structural and instrument grade materials used in aerospace and defense. Pure beryllium is often used in nuclear weapons and reactors, aircraft and space vehicle instruments, X-ray tubes, integrated circuits, and mirrors. It is also used in inertial guidance systems and gyroscopes, high-performance aircraft brakes, and as an additive in solid propellant rocket fuels (Sax, 1987; Kirk-Othmer, 1978). Beryllium has been used in fiber optics and cellular network communication systems in more recent years and its increased use in this industry is expected (USDOI, 1991). Beryllium oxide is used in the manufacture of ceramics and as an additive to plastics and glass. It was also used in the past to manufacture the phosphors coating for fluorescent lamps.

Beryllium can enter the water, air, and soil as a result of natural and human activities such as weathering of rocks and soils, industrial waste discharges, and burning coal and oil. Fortunately, a large portion of beryllium found in soil is not water soluble, remaining bound to the soil, and therefore is not likely to affect groundwater. The majority of health risks associated with beryllium occur due to inhalation exposure, with oral exposure being less toxic. Acute inhalation exposure can lead to inflammation of the lungs or acute pneumonitis. Studies have also shown immunological effects in animals and effects on the adrenal gland in humans and animals.

The current state water quality criterion for beryllium in Class III waters is less than or equal to an annual average of 0.13 µg/L. This criterion was set based on the U.S. Environmental Protection Agency's Human Health Criterion for beryllium and is lower than the method detection limit reported by many labs. When an analyte is not detected in a sample, it is typically reported as "below the MDL". When calculations, such as annual average concentrations, must be done on the results, a common scientific convention is to replace the non-detect with a value of ½ the MDL. Problems with this convention arise when the criterion is below the value of ½ the MDL. In other words, an analysis resulting in a non-detect for a particular analyte would still result in an excursion if it were replaced by ½ the MDL. In the case of beryllium, several labs report MDL values of 0.5 µg/L or greater. However, ½ of 0.5 µg/L, is 0.25 µg/L. This value is above the criterion of 0.13 µg/L and would be considered an excursion. It is illogical to report an excursion beyond the criterion when the analyte was not detected in the sample. The ideal situation would permit detection levels sufficiently below the criterion; however, this is not always possible. Therefore, Department regulations (Subsection 62-4.246(5), F.A.C.) state that when MDLs are higher than the established water quality criteria, values reported as less than the MDL shall demonstrate compliance for that pollutant. However, during past evaluations, the application of the ½ MDL convention to beryllium measurements has resulted in beryllium excursions based on non-detected concentrations. Upon further review of the data and state regulations, it was deemed more appropriate to replace these beryllium non-detects with a value of zero instead. Based upon this decision, past water years with excursions were reevaluated using zero MDL replacement and the results are presented in **Table 4-5**.

Table 4-5. Total beryllium excursions based on ½ MDL replacement and zero replacement.

Water Year	Region	Class	½ MDL Replacement	Zero Replacement
WY99	Refuge	Inflow	Yes[1]	Yes[1]
	Refuge	Rim	Yes	Yes
	WCA-3	Inflow	Yes	No
WY98	Refuge	Inflow	Yes	Yes
	Refuge	Rim	Yes	No
	WCA-3	Inflow	Yes	No
WY95	Refuge	Inflow	Yes	No
	Refuge	Rim	Yes	No

[1] Yes indicates that the annual average of 0.13 mg/L was exceeded in this region.

Of the eight areas with previously reported beryllium excursions, only three remain after the MDL reevaluation. Reportable beryllium excursions occurred at Refuge inflows and rim canal sites in WY99 and at Refuge inflow stations during WY98. Furthermore, District and Department staff believes these excursions may be the result of sample collection, handling, or analysis problems. In past years, only inflows to the Refuge and WCA-3 were monitored for beryllium due to permit requirements. A recent permit modification was issued which removed beryllium from the list of parameters requiring monitoring at Refuge inflow and rim canal structures. This modification became effective April 28, 1997, and therefore, no beryllium data for the Refuge was collected during WY2000. The basis for the permit modification was that, other than its natural occurrence, there are no known sources of beryllium in the Everglades and no activities occurring that would be expected to cause or contribute to a beryllium problem. Monitoring of WCA-3 inflows continues due to permit requirements, however based on the reevaluation, no excursions have been reported since monitoring began in WY98.

TOTAL PHOSPHORUS AND TOTAL NITROGEN

Even though phosphorus and nitrogen do not have numeric criteria, the concentration of these nutrients in Class III waters is regulated by a narrative criterion that specifies that nutrient concentrations in a water body can not be altered so as to cause an imbalance in the natural populations of flora or fauna and shall be limited to prevent violations of other water quality standards. In an attempt to prevent further adverse biological impacts resulting from nutrient enrichment within the EPA, the Department is currently in the process of developing a numeric phosphorus criterion for the Everglades based on the interpretation of the narrative standard. Further details concerning the status of the Department's efforts are provided in Chapter 3 of this report (Payne et al., 2001). Due to the importance of nutrient levels within the EPA, the concentrations of nitrogen and phosphorus measured during the 2000 water year are discussed below and compared to results from previous monitoring years.

Total Phosphorus

Since no numeric criterion currently exists, phosphorus concentrations are summarized to provide an overview of the current nutrient status of the Everglades and demonstrate temporal and spatial patterns. No excursion analysis can be performed at this time; however, the 10 µg/L Everglades Forever Act default phosphorus criterion and the 50 µg/L long-term limit for the STAs is used as a basis for comparison. Total phosphorus (TP) concentrations observed in WY2000, WY99, and the historic period (WY79-WY98) are summarized in **Table 4-6**. Data for the current water year are presented against historical data for comparative purposes.

Median inflow TP concentrations were within the range of the two historic periods, with the exception of WCA-3 where inflow concentrations were slightly higher during WY2000. Overall, inflow concentrations decreased from north to south with the highest concentrations entering the Refuge (median = 68 µg/L) and the lowest flowing into the Park (median = 8 µg/L). Similar to previous periods, median interior marsh concentrations were low in WY2000 and ranged by area from 5 to 13 µg/L. The lowest interior marsh concentrations were observed in the Park, where a substantial proportion (22 percent) of the samples were less than the 4 µg/L MDL.

The distribution of TP concentrations in all EPA regions for WY2000 is presented in **Figure 4-11**. Over the entire EPA, 87 percent of TP measurements were below 50 µg/L with 45 percent of the measurements being at or below 10 µg/L. As with previous years, a decreasing north to south gradient, indicative of settling, sorptive (both adsorptive and absorptive), assimilative (biological) and other biogeochemical processes in the marsh, was apparent. Inflow stations to the Refuge and Water Conservation Areas had the highest percent of measurements above 50 µg/L (38-61 percent). In contrast, no values above 50 µg/L were observed in inflows to the Park and most values (92 percent) within the Park interior were less than 10 µg/L. High concentrations in the north are related to canal discharges composed primarily of agricultural runoff originating in the EAA. Water Conservation Area 2 is the most directly affected region and thus has the greatest occurrence of inflow and interior marsh concentrations above 50 µg/L. Although the Refuge also receives EAA discharges similar to WCA-2, hydrologic patterns within the Refuge substantially reduce the influence of canal inputs on interior marsh stations. Drainage from the EAA also enters the Refuge through the S-5A and S-6 structures, but largely circumvents the Refuge interior via the L-7 canal and enters WCA-2A instead through the S-10 structures.

Table 4-6. Summary of total phosphorus concentrations (µg/L) in the Everglades Protection Area for WY2000, WY99, and WY79-WY98.

Region	Class	Period	N	Mean (Arithmetic)	Std. Deviation	Minimum	Median	Maximum
Refuge	Inflow	WY78-WY98	2256	105	95.5	<4	79	1415
		WY99	329	69	52.2	13	58	295
		WY2000	359	83	71.1	10	68	418
	Rim	WY78-WY98	518	80	57.4	<4	66	564
		WY99	100	61	38.4	22	48	198
		WY2000	50	91	56.8	34	72	290
	Interior	WY78-WY98	1294	14	26.3	<4	8.5	494
		WY99	254	16	19.4	<4	9	200
		WY2000	273	16	18.7	5	11	140
	Outflow	WY78-WY98	903	81	136.5	6	56	3435
		WY99	62	64	39.8	12	51	159
		WY2000	64	76	43.5	24	62	210
WCA-2	Inflow	WY78-WY98	1337	83	118.3	7	62	3435
		WY99	66	66	44.7	10	54	254
		WY2000	83	74	51.0	14	59	319
	Interior	WY78-WY98	2645	36	65.1	<4	14	1253
		WY99	304	55	168.2	<4	16	2200
		WY2000	321	34	47.0	<4	13	380
	Outflow	WY78-WY98	1150	35	44.2	<4	21	556
		WY99	66	27	21.8	4	18	91
		WY2000	73	28	38.1	6	15	199
WCA-3	Inflow	WY78-WY98	3389	63	75.4	<4	41	933
		WY99	366	53	48.7	<4	39	263
		WY2000	398	67	65.1	4	48	347
	Interior	WY78-WY98	1524	20	31.6	<4	10	438
		WY99	144	19	30.8	<4	8	192
		WY2000	190	17	17.6	<4	11	103
	Outflow	WY78-WY98	3075	15	23.6	<4	10	593
		WY99	192	15	16.9	5	11	217
		WY2000	179	15	14.3	4	12	171
Park	Inflow	WY78-WY98	3653	14	21.6	<4	9	593
		WY99	233	12	15.0	<4	9	217
		WY2000	306	11	7.0	<4	8	51
	Interior	WY78-WY98	1048	13	47.4	<4	6	1137
		WY99	81	7	8.0	<4	5	75
		WY2000	94	7	4.4	<4	5	38

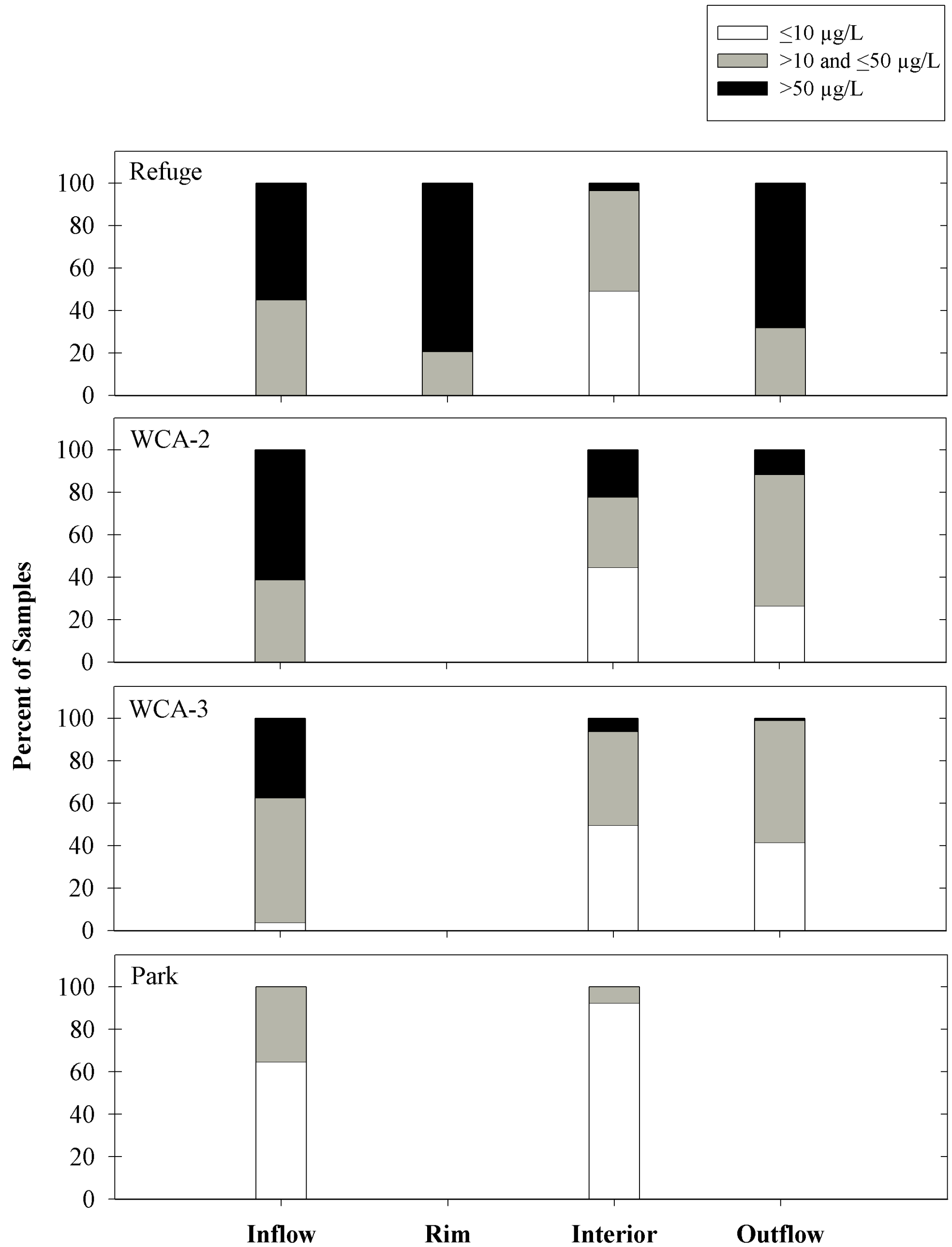


Figure 4-11. Distribution of total phosphorus concentrations in samples collected in the Everglades Protection Area during WY2000.

Total Nitrogen

No state numeric water quality criterion exists for total nitrogen (TN), although the narrative nutrient standard does apply. Most areas of the EPA are known to be phosphorus limited. There is no evidence that the Everglades is greatly affected by nitrogen enrichment. It is however still an important plant nutrient and component of agricultural discharge and was previously reported in the Interim and 2000 Consolidated Reports. Total nitrogen concentrations for WY2000, WY99 and WY79-WY98 are summarized in **Table 4-7.** Water Year 2000 TN concentrations fell within the range of the historic periods with small declines in most regions. As with TP, a north to south gradient is apparent in the TN data and likely reflects agricultural discharges in the north and assimilative processes within the marsh as water flows southward. The highest median concentrations were observed in the inflows to the Refuge (3.0 mg/L) and WCA-2 (2.7 mg/L). While the lowest median concentrations were observed in the inflows to and interior of the Park (0.7-0.8 mg/L).

Table 4-7. Summary of total nitrogen concentrations (mg/L) in the Everglades Protection Area for WY2000, WY99, and historic period (WY79-WY98).

Region	Class	Period	N	Mean	Std. Deviation	Minimum	Median	Maximum
Refuge	Inflow	WY78-WY98	2330	4.2	27.11	0.2	3.0	1303.4
		WY99	265	2.5	1.63	<0.5	2.0	13.1
		WY2000	235	2.6	1.31	<0.5	2.2	9.4
	Rim	WY78-WY98	527	2.8	1.49	0.5	2.4	10.9
		WY99	93	2.4	1.47	<0.5	1.9	9.7
		WY2000	50	2.5	1.29	<0.5	2.0	7.7
	Interior	WY78-WY98	1124	1.7	1.59	0.5	1.3	36.7
		WY99	144	1.4	0.77	0.5	1.2	4.7
		WY2000	206	1.5	0.73	<0.5	1.3	6.6
	Outflow	WY78-WY98	914	2.8	1.76	0.5	2.4	22.8
		WY99	63	2.3	1.21	0.8	1.8	5.1
		WY2000	64	2.3	1.07	0.9	1.9	4.9
WCA-2	Inflow	WY78-WY98	1359	3.0	1.68	0.5	2.7	22.8
		WY99	66	2.5	1.18	1.1	2.3	5.1
		WY2000	81	2.5	1.00	0.8	2.2	4.9
	Interior	WY78-WY98	2515	2.5	1.58	0.2	2.3	37.2
		WY99	214	2.0	0.78	<0.5	2.0	5.0
		WY2000	285	2.0	0.68	<0.5	1.9	5.0
	Outflow	WY78-WY98	1173	2.2	0.91	0.5	2.1	7.7
		WY99	66	1.6	0.47	1.0	1.5	3.7
		WY2000	74	1.6	0.71	<0.5	1.4	4.4
WCA-3	Inflow	WY78-WY98	3283	2.2	1.17	0.5	1.9	10.8
		WY99	246	1.7	0.61	0.8	1.6	4.7
		WY2000	278	1.8	0.92	0.7	1.5	6.4
	Interior	WY78-WY98	1567	1.7	0.94	0.2	1.5	10.0
		WY99	113	1.1	0.41	<0.5	1.0	2.3
		WY2000	161	1.2	0.43	<0.5	1.2	3.3
	Outflow	WY78-WY98	2381	1.5	0.70	0.3	1.4	14.9
		WY99	137	1.1	0.26	0.6	1.1	1.7
		WY2000	144	0.9	0.28	<0.5	0.9	2.0
Park	Inflow	WY78-WY98	2967	1.4	0.70	0.2	1.3	14.9
		WY99	157	1.0	0.27	<0.5	0.9	1.7
		WY2000	244	0.8	0.22	<0.5	0.7	1.4
	Interior	WY78-WY98	1075	1.5	1.68	0.05	1.3	40.8
		WY99	81	1.2	0.54	0.6	1.1	4.9
		WY2000	98	0.9	0.46	<0.5	0.8	2.7

PESTICIDES

Surface water concentrations of pesticides are regulated under criteria established in Chapter 62-302, F.A.C. Section 62-302.530, F.A.C., lists specific numeric criteria for a number of pesticides and herbicides (DDT, endosulfan, malathion). However, many contemporary pesticides (ametryn, atrazine, diazinon,) are not specifically listed. The Department has made significant progress, over the past year, towards establishing chronic toxicity guidelines for non-listed compounds. These guidelines were based on the requirement in Subsection 62-302.530(62), F.A.C. that surface waters of the state shall be free from "*substances in concentrations, which injure, are chronically toxic to, or produce adverse physiological or behavioral response in humans, plants, or animals.*" **Appendix 4-4** contains the guidelines and materials supporting their development. Additionally, the document provides an evaluation of EPA pesticide and priority pollutant monitoring results from 1986 to April 1999.

The District has maintained a pesticide-monitoring program in south Florida since 1984. The pesticide network includes sites designated in the Park Memorandum of Agreement, the Miccosukee Tribe Memorandum of Agreement, the Lake Okeechobee Operating Permit and the Non-ECP Structure Permit. The current monitoring program in the EPA consists of 25 sites (**Figure 4-12**). STA-1W and STA-6 outflow structures ENR012 and G600, respectively, were added to this year's report. Sites were grouped according to basin.

This report analyzes data collected during four sampling events (April, August, November 1999, and February 2000) at 25 monitoring sites. Monitoring results were evaluated relative to Class III criteria, chronic toxicity guidelines (**Appendix 4-4**), and detected concentrations. Pesticides exceeding either the Class III criteria or chronic toxicity guideline, were classified as a Concern for the basin in which the exceedance occurred. Parameters of Concern have a high likelihood of causing impairment to designated use. Detected parameters (>MDL) that did not exceed either a guideline or criteria were categorized as Potential Concerns. The Potential Concern classification signifies that the parameter is known to be present within the basin at levels which are reasonably believed to be below that resulting in biologic effects, but may at some future date or in interaction with other compounds become a problem (impair designated use). A third category (No Concern) was used for areas where a given parameter was not detected.

Between April 1999 and February 2000, 17 pesticides were detected in the EPA, most were categorized as Potential Concerns or No Concern (**Table 4-8**). DDT, DDE, DDD, endosulfan (total alpha and beta) and diazinon each had single exceedances of Class III criteria or chronic toxicity guidelines. On April 19, 1999, DDT exceeded the state Class III criterion of 0.001 µg/L at station G211 (C-111 basin). On the same date, DDD and DDE exceeded the chronic toxicity guidelines at site G211. While such exceedances of DDT and its breakdown products are generally associated with highly turbid waters, this was not observed in this case (Pfeuffer, 1999). Total alpha and beta endosulfan exceeded the state Class III criterion on February 7, 2000, at Station S178 (C-111 basin). Diazinon exceeded its chronic toxicity guideline at Station G38B (WCA-2 inflow) on November 8, 1999.

Review of the previous year's sampling data shows an apparent reduction in pesticide exceedances entering the northern Everglades from the EAA. During previous years, pesticide concentrations in excess of chronic toxicity guidelines have been detected in inflow waters to the Refuge, WCA-2 and WCA-3 (**Appendix 4-4**). Historically, the primary parameter of Concern originating from the EAA was atrazine. Over WY2000, no exceedances, including atrazine, were detected in waters discharging from the EAA. This improvement may be an unplanned benefit of nutrient Best Management Practices (BMP) implemented within the basin, however, several additional years of monitoring are required to make this determination. Conversely, patterns of exceedances within other basins remain relatively unchanged. Endosulfan continues to be a Concern within the agricultural C-111 basin. The diazinon exceedance observed at site S38B continues a recent pattern discussed in **Appendix 4-4**. Waters discharging from the North Springs Improvement District and ACME basins to WCA-2 and the Refuge, respectively, have contained diazinon concentrations in excess of the chronic toxicity guideline. Given the fact that the diazinon chronic toxicity guideline is below its MDL, there is substantial uncertainty in the severity of the problem. With the current MDL it is impossible to determine the actual frequency of biologically significant concentrations (excursions). As was suggested in **Appendix 4-4** a further review of diazinon is warranted to better understand the risks to the Everglades.

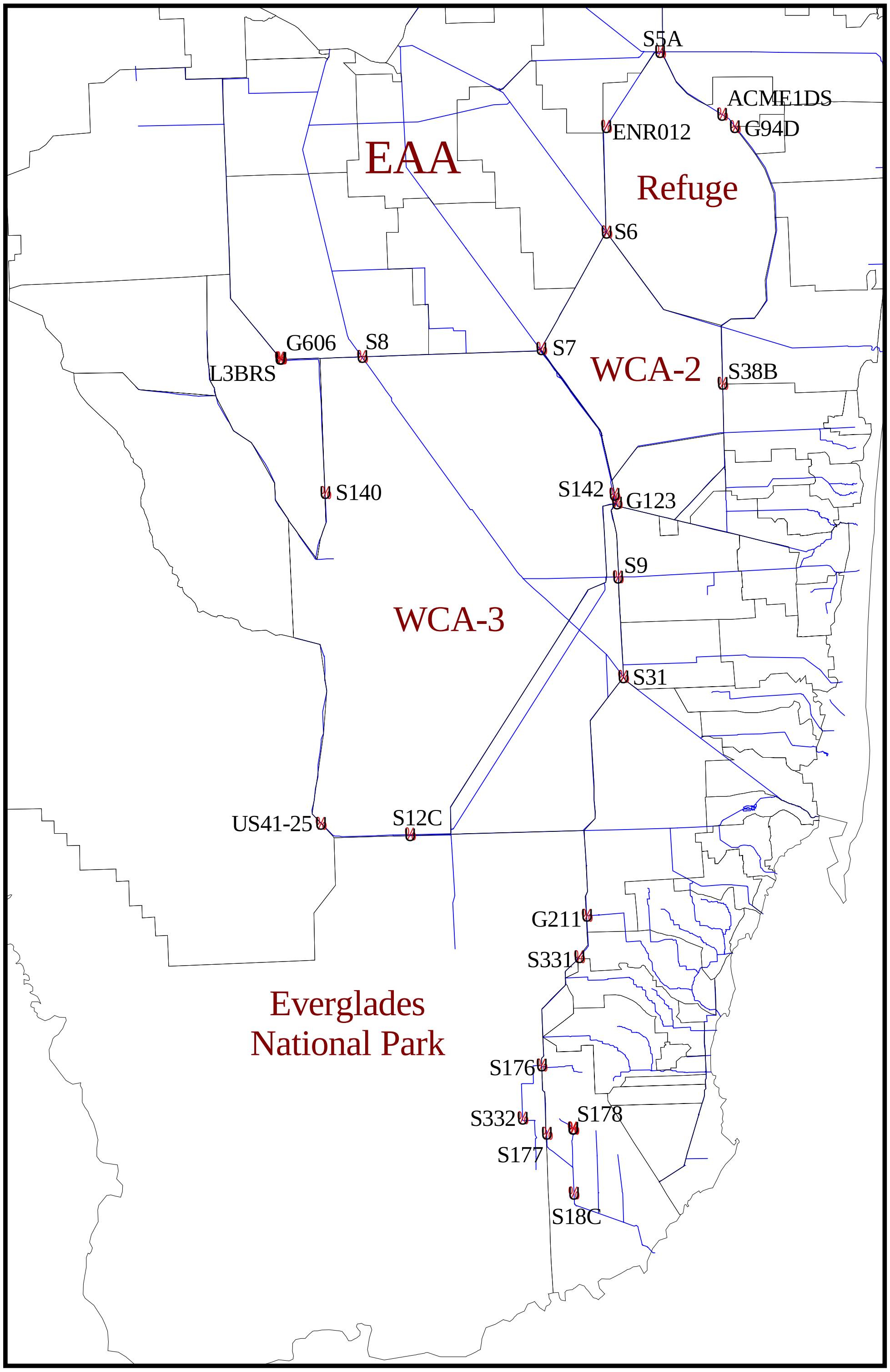


Figure 4-12. Pesticide monitoring sites in the Everglades Protection Area.

Table 4-8. Pesticide detections and exceedance categories in the EPA inflows, canals and structures between April 1999 and February 2000. The categories of "Concern" and "Potential Concern" are denoted by "C" and "PC", respectively, all others are considered "No Concern". Values within the parentheses are the number of detections and total number of samples.

Parameter	C-111[1]	Park[2]	Refuge[3]	WCA-2[4]	WCA-3[5]
DDD-P,P'	C[6] (1:69)	(0:41)	(0:21)	(0:8)	(0:32)
DDE-P,P'	C[6] (1:69)	(0:41)	(0:21)	(0:8)	(0:32)
DDT-P,P'	C[6] (1:69)	(0:41)	(0:21)	(0:8)	(0:28)
ametryn	(0:69)	(0:41)	PC (19:23)	PC (5:8)	PC (13:35)
atrazine	PC (61:65)	PC (36:39)	PC (18:21)	PC (7:8)	PC (25:32)
bromacil	(0:69)	(0:41)	PC (1:21)	(0:8)	PC (1:32)
diazinon	(0:69)	(0:41)	(0:21)	C (1:8)	(0:32)
diuron	(0:26)	(0:19)	PC (2:18)	(0:7)	(0:32)
endosulfan (total alpha and beta)	C[6] (3:69)	PC (2:41)	(0:21)	(0:8)	(0:28)
endosulfan sulfate	PC (3:68)	PC (1:40)	(0:21)	(0:8)	(0:32)
heptachlor epoxide	PC (1:67)	(0:41)	(0:21)	(0:8)	(0:32)
hexazinone	PC (26:69)	PC (7:41)	PC (5:21)	(0:8)	PC (5:35)
metolachlor	(0:69)	(0:41)	PC (6:21)	(0:8)	(0:32)
metribuzin	(0:69)	(0:41)	(0:21)	(0:8)	PC (1:32)
norflurazon	(0:69)	(0:41)	(0:21)	(0:8)	PC (6:35)
prometryn	(0:69)	(0:41)	PC (1:21)	(0:8)	(0:32)
simazine	(0:69)	(0:41)	PC (1:21)	(0:8)	(0:32)

1. G211, S176, S177, S178 and S331.
2. S12C, S18C, S332 and US41-25.
3. ACME1DS, ENR012, G4D, and S5A.
4. S38B and S7.
5. G123, G606, L3BRS, S140, S190, S8, S9, S142, and S31.
6. Classification of Concern is based on exceedance of state Class III criterion.

SUMMARY

The focus of this chapter is to provide an update concerning the water quality status for each region of the EPA for WY2000 (i.e., May 1, 1999 through April 30, 2000). This report builds on the water quality analyses previously presented in the 1999 Interim and 2000 Consolidated Reports. An analysis of the water quality parameters not meeting the water quality criteria specified in Section 62-302.530, F.A.C. and a discussion of any temporal or spatial trends observed for the parameters identified as concerns or potential concerns are also provided. Annual excursion rates are summarized in a manner consistent with methods employed in the *1999 Everglades Interim Report* and *2000 Everglades Consolidated Report* with parameters not meeting existing standards being classified into two categories based on excursion frequencies. Unlike previous reports, this chapter also provides a discussion of the factors contributing to excursions from applicable water quality criteria and an evaluation of the natural background condition where existing standards are not appropriate. The results of the evaluation detailed in this chapter are summarized below.

- Dissolved Oxygen (DO) was placed in the Category of Concern for all EPA regions and classes due to ubiquitous concentrations below the current 5.0 mg/L criterion. However, a draft SSAC is being developed by the Department to recognize the naturally low DO regime characteristic of macrophyte dominated wetlands such as the Everglades. Application of the proposed SSAC to the DO data collected during WY2000 resulted in a reduction in the number of monitoring stations at which DO was identified as being a Concern from 120 to 24. Most of the remaining 24 sites can be shown to be influenced by either nutrient enrichment or groundwater infiltration and are accurately designated as not being in compliance with the SSAC.
- As was the case in previous years, alkalinity was classified as a Concern for the interior of the Refuge due to an excursion rate of 25 percent. Alkalinity was also classified as a Potential Concern in the Rim Canal (Refuge) due to a single excursion. The low alkalinity levels in the interior portions of the Refuge result from natural hydrologic pattern and should not be considered in violation of the current criterion. In contrast to other portions of the Everglades, the interior of the Refuge is a soft-water system that receives most of its hydrologic load from rainfall instead of canal inflows.
- Similar to alkalinity, pH was classified as a Concern in the interior of the Refuge due to frequent values below the lower limit of the state criterion. The low pH levels within the Refuge are associated with low alkalinity levels and the fact that the hydrologic budget for this area is driven by rainfall. Since they depict natural background conditions, the low pH levels within the Refuge are not considered as violating the current standard. Additionally, infrequent (1-2) pH values above 8.5 were observed at sites within the interior of the Park, outflow of the Refuge, inflow to WCA-2, and interior of WCA-3 resulting in pH being categorized as a Potential Concern for these areas.

- Conductivity (specific conductance) was categorized as a Concern for the inflow, outflow and rim canal stations of the Refuge and inflow structures to WCA-2. Additionally, a few (1-4) excursion events within the interiors of the Refuge and WCA-2 led to conductivity being categorized as a Potential Concern for these areas. Most of the excursions for conductance occurred at either water control structures or within canals and are likely associated with the pumping or seepage of high ionic strength groundwater into the surface water in the canals. Groundwater can be introduced to the surface water through the normal operation and morphology of the water conveyance system and as the result of agricultural activities in the EAA. The importance of each of these factors in contributing to the observed conductivity excursions is unclear and warrants further evaluation.
- Un-ionized ammonia was placed in the Potential Concern category for inflows and interior of WCA-2 and outflows from the Refuge. Excursions from the un-ionized ammonia criterion generally result from high pH levels resulting from periods of high photosynthetic activity with the frequency of exceedances being within the ranges reported previously.
- Iron was categorized as a Concern for the interior of the Park and inflows to the Refuge. Due to a single event, iron was classified as a Potential Concern for inflows to WCA-3. Given the infrequent excursions, low concentrations, absence of anthropogenic sources, and low toxicity potential of ferric iron, it is unlikely that iron represents a significant threat to designated uses of the water body. It is believed that the infrequent values above 1.0 mg/L represent a combination of the natural variability and disturbance of sediments resulting in samples that are not representative of the true conditions in the southern Everglades.
- Turbidity was categorized as a Concern for the rim canal and inflow structures of the Refuge. Additionally, turbidity was classified as a Potential Concern for the outflows from the Refuge and inflows to WCA-2. Most of the turbidity excursions can likely be related to construction activities near these stations. Although during WY2000 turbidity levels exceeding the state criterion occurred in some areas of the EPA at frequencies exceeding those historically observed, many of the exceedances can be tracked to temporary events that will not be repeated and will ultimately contribute to the restoration of the Everglades and net improvement in water quality.
- Concentrations of neither cadmium nor beryllium measured during the WY2000 exceeded the applicable state criteria. Additionally, a review of historic data indicates that excursions for both cadmium and beryllium may have been inaccurately reported in previous years.
- In the interior of the Park, lead was placed in the Potential Concern category due to a single value above the state criterion and likely results from sample contamination.
- Endosulfan (total alpha and beta) and DDT were categorized as Concerns for the C-111 basin due to exceedance of state Class III criteria.

- Chronic toxicity values were provided by the Department to assist in the evaluation of contemporary pesticides and priority pollutants not specifically listed in Section 62-302.530, F.A.C.
- Diazinon was classified as a Concern in WCA-2 because of an exceedance of its chronic toxicity value, originating from the North Springs Improvement District.

The Department, with assistance from the District, intends to continue evaluation of background water quality in the EPA as it relates to current standards. Where current standards prove to be inappropriate, means of formally recognizing the unique nature of the Everglades will be pursued. For example, natural conditions within the Refuge lead to frequent excursion from alkalinity and pH standards. The Department recognizes these conditions to be natural characteristics of the Refuge, and thus, does not consider the excursions to be violations of state standards. Formal recognition of these conditions within the marsh (e.g., development of a SSAC) would eliminate the necessity of investigating, documenting and reporting naturally occurring low pH and alkalinity values in the Refuge, an Outstanding Florida Water. Other parameters that may require further evaluation include conductivity and iron. Evaluation of existing water quality standards is being pursued in order of relevance, that is, parameters with the most persistent and pervasive excursion frequency (e.g., dissolved oxygen, alkalinity and pH) being addressed first.

ANNUAL REPORT ON STORMWATER TREATMENT AREA OPERATIONAL PERFORMANCE

INTRODUCTION

The Department has issued individual operating permits for STA-6, Section 1, STA-1 West and STA-5. A water quality monitoring program has been initiated in each completed STA to fulfill requirements of these operating permits. The data evaluations corresponding to the water quality monitoring programs for the period of record of this report (May 1, 1999-April 30, 2000) are presented below. These data are provided to document compliance with appropriate conditions of the operating permits.

STA-1 WEST

Operational Status

The primary objective of this section is to provide an update on operations of STA-1 West since last year's report and to document compliance with appropriate conditions of the Act (FDEP No. 503074709) and NPDES permits (FDEP No. FL0177962-001). A complete description of STA-1 West is provided in Chapter 6 of the *2000 Everglades Consolidated Report.*

Inflows into STA-1 West from the S-5A pump station have been and will continue to be directed into the ENR portion of STA-1 West (Treatment Cells 1-4) via the G-302 and G-303 structures. Accordingly, full flow-through operations through the Treatment Cells 1-4 have occurred since permit issuance in May 1999. Treated waters from Treatment Cells 1-4 have been discharged into the Refuge via the G-251 pump station. The water quality compliance section below provides moving 12-month flow-weighted mean concentrations for total phosphorus and other parameters for project discharges from the G-251 pump station.

Treatment Cell 5 (Cell 5) of STA-1 West was in start-up phase of operation from initial flooding in March 1999 through the demonstration of a net reduction in phosphorus (as described in specific condition 13 of the Act permit) in February 2000. On February 3, 2000, the District provided the Department with appropriate data to demonstrate that Cell 5 had achieved a net reduction in total phosphorus, total mercury and methyl mercury, in accordance with Act and NPDES permit startup requirements. Consequently, the project was considered to be in the stabilization phase of operation.

Although permit criteria that allow discharges to begin were met, Cell 5 has experienced fluctuations in TP values during the early plant grow-in stages of the stabilization phase of operation. The District has decided that until more consistent net reductions in phosphorus levels in Cell 5 are experienced, or if high stages are experienced in Cell 5, routine discharges will only occur through Treatment Cells 1-4 (via pump station G-251). Consequently, routine discharges from Cell 5 were not initiated during the period of record of this Report. The present operational intent is to continue to manage water depths in Cell 5b to continue the establishment of Submerged Aquatic Vegetation (SAV).

No discharges occurred at the G-310 pump station during the period of this Report. The water quality compliance section below provides the moving 12-month flow weighted mean concentrations for total phosphorus and other parameters for project discharges from the G-251 pump station.

Specific condition 27 of the Act permit requires that the laboratory performing the sampling and analysis has a Department-approved Comprehensive Quality Assurance Plan (CompQAP). The District is currently performing all sampling and analysis under the June 1999 Department-approved CompQAP No. 870166G.

Specific condition 27 of the permit also requires a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, accuracy of the data, and minimum detection limits. The individual responsible for implementation of the program is Maxine Cheesman, Director, Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, South Florida Water Management District. A statement prepared and signed by Maxine Cheesman is included **Appendix 4-1**.

Specific condition 27 of the permit also requires all data and monitoring records associated with the period of record of annual reports to be submitted. Data utilized in support of the analysis completed in Chapter 4 for STA operational performance are being provided on CD-ROM (to the Department) in compliance with Department-issued operational permits for the STAs. The data are not included in the appendix, but are available on request.

Specific condition 27 of the permit also requires the District to report information regarding the application of herbicides and pesticides used to exclude undesirable vegetation and pests within the treatment cells. From October 13 to October 15, 1999, a total of 15 gallons of the herbicide Arsenal was applied to control torpedo grass (*Panicum repens*) to an area in Cell 5 approximately 30 acres in size. The herbicide was applied using airboat-mounted spray equipment. Additional herbicide treatments for the control of undesirable vegetation in STA-1 West have been completed after the period of record of this Report. A detailed description of these applications will be provided in the *2002 Everglades Consolidated Report*.

WATER QUALITY COMPLIANCE MONITORING

Since the time STA-1W passed the startup phase and began the stabilization phase of operation in February 2000, there has only been three months of non-phosphorus parameters collected. There is available non-phosphorus data sampled on a weekly basis from when the permit was issued in May 1999, these data are shown on **Table 4-9.** For compliance, the non-phosphorus parameters are required to be reported as an annual average. The only parameter that was not in compliance with state criterion was Dissolved Oxygen. However, the administrative orders associated with the Act and NPDES permits for STA-1W acknowledge that dissolved oxygen levels fluctuate naturally in marsh environments and routinely fall below the Class III water quality criterion of 5.0 mg/l. The administrative orders require the District to follow a process that will lead to either a revised state criterion for dissolved oxygen in marsh systems, a site specific alternative criterion, or some other form of moderating provision to state criterion. The Department has taken the lead in developing an alternative site specific criterion for DO (described in a previous section of this chapter).

The available non-phosphorus data are being provided on CD-ROM (to the Department) in compliance with Department-issued operational permits for the STAs. The data are not included in the appendix, but are available on request.

Total phosphorus (TP) samples have been collected since the permit was issued in May of 1999. Results from these samples are shown on **Figure 4-13.** For compliance, TP is required to be reported as a 12-month moving flow-weighted mean concentration. As shown on the figure TP has been in compliance for the entire reporting period. Construction of the G-310 outflow site was not completed during the reporting period, and therefore, no discharge has occurred from this outflow site.

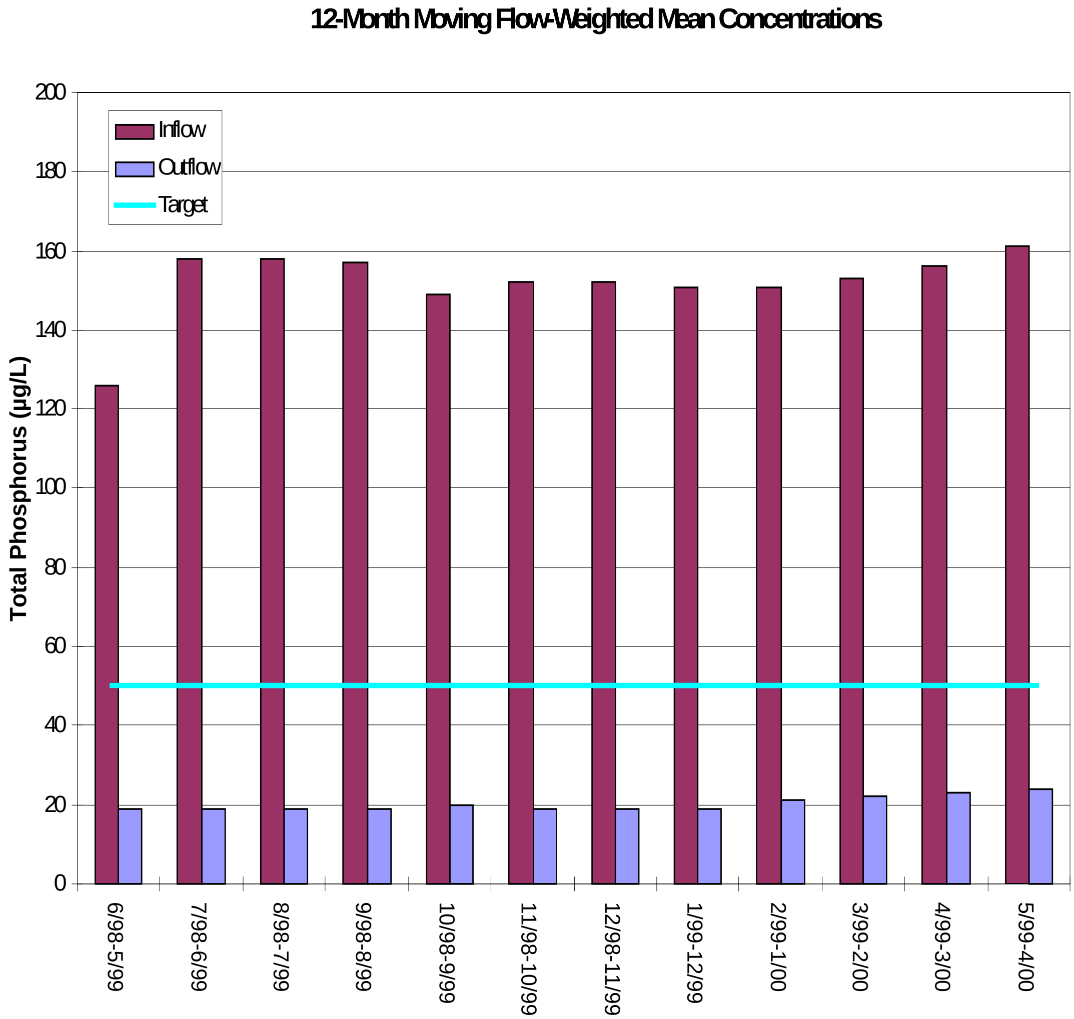


Figure 4-13. 12-Month moving flow-weighted mean total phosphorus concentrations (µg/L) at STA-1 W inflow (S-5A pump station) and outflow (G-251 pump station).

Table 4-9. Summary of annual averages for all parameters other than phosphorus monitored in STA-1 West.

Parameter	Class III Standard Inflow S5A	Class III Standard Outflow G251	Exceeds Standard?	Sampling Results Inflow S5A	Sampling Results Outflow G251	Sampling Results In Compliance
Temperature (°C)	NA		N/A	25.4	24.1	N/A
Dissolved Oxygen (mg/L)	Greater than or equal to 5.0 mg/L		YES	4.3	3.5	NO
Specific Conductivity (µmhos/cm)	Not greater than 50% of background or greater than 1,275 µmhos/cm		NO	995	1001	YES
pH	Not less than 6.0 and not greater than 8.5		NO	7.5	7.4	YES
Turbidity (NTU)	Less than or equal to 29 NTU above background conditions		NO	22.0	1.3	YES
Total Dissolved Solids (mg/L)	NA		N/A	652	624	YES
Unionized Ammonia (mg/L)	Less than or equal to 0.02 mg/L		NO	0.004	0.0005	YES
Orthophosphate as P (mg/L)	NA		N/A	0.066	0.010	YES
Total Dissolved Phosphorus (mg/L)	NA		N/A	0.074	0.016	YES
Sulfate (mg/L)	NA		N/A	63.1	59.3	YES
Alkalinity (mg/L)	Not less than 20 mg/L		NO	226	210	YES
Dissolved Chloride (mg/L)	NA		N/A	143	183	NO
Total Nitrogen (mg/L)	NA		N/A	3.41	1.92	YES
Total Dissolved Nitrogen (mg/L)	NA		N/A	2.68	1.81	YES
Nitrate + Nitrite (mg/L)	NA		N/A	0.577	0.074	YES
Total Silver (µg/L)	Less than or equal to 0.07 µg/L		NO	<0.05	<0.05	YES
Ametryn (µg/L)	NA		N/A	0.052	0.047	YES
Atrazin (µg/L)	NA		N/A	0.637	0.121	YES

Diel Dissolved Oxygen Monitoring

Dissolved oxygen concentrations fluctuate naturally in marsh environments such as the Everglades, and routinely fall below the Class III water quality criterion of 5 mg/L. The STA-1W marshes are also expected to experience these same fluctuations. Department findings in Administrative Orders AO-003-EV (Exhibit C of Everglades Forever Act Permit No. 503074709), and AO-004-EV (associated with NPDES Permit No. 0131842-001-GL) recognized this phenomena. To address this, Section II.2 of the administrative orders require~~s~~ the District to provide the Department, in an annual report, an analysis of dissolved oxygen demonstrating that dissolved levels in the STA-1W discharge do not adversely change the downstream Everglades ecological system or downstream water quality based on the following:

- Comparison of dissolved oxygen levels in STA discharges with background conditions in receiving waters;
- Evaluation of dissolved oxygen levels at representative interior Everglades marsh stations, demonstrating that STA discharges fully maintain and protect the existing designated uses of the downstream waters and the level of water quality consistent with applicable anti-degradation requirements;
- Evaluation of whether discharges are necessary or desirable, and otherwise in the public interest;
- Depiction of the daily and seasonal diel cycles for STA-1W dissolved oxygen discharges during the annual period covered by the annual report;
- Comparison of STA-1W effluent with other historic DO data from the Everglades Protection Area, including data from interior marsh stations within the Loxahatchee Refuge, and locations downstream of the STA-1W discharges; and
- Consideration of the influences of temperature, seasonal weather conditions, aquatic community type, and hydropatterns upon the diel cycle of the STA-1W discharges.

The following plan was developed by the District to comply with the requirements of the administrative order.

When STA-1W begins full flow-through operations, i.e., discharges occur through both G251 and G310, the District will comply with the administrative order by measuring dissolved oxygen concentrations with Hydrolab Mini Sondes at 30-minute intervals upstream of pump station S5A, downstream of discharge structures G251 and G310 and at background locations in the Arthur R. Marshall Loxahatchee National Wildlife Refuge for four consecutive days on a quarterly basis at the following locations:

- On south side of the canal upstream of S5A
- Downstream of the G251 and G310 discharge structures
- At sites on X, Y, and Z transects in the periphery of the interior marshes within the Loxahatchee National Wildlife Refuge downstream of the combined discharges (**Figure 4-14**).

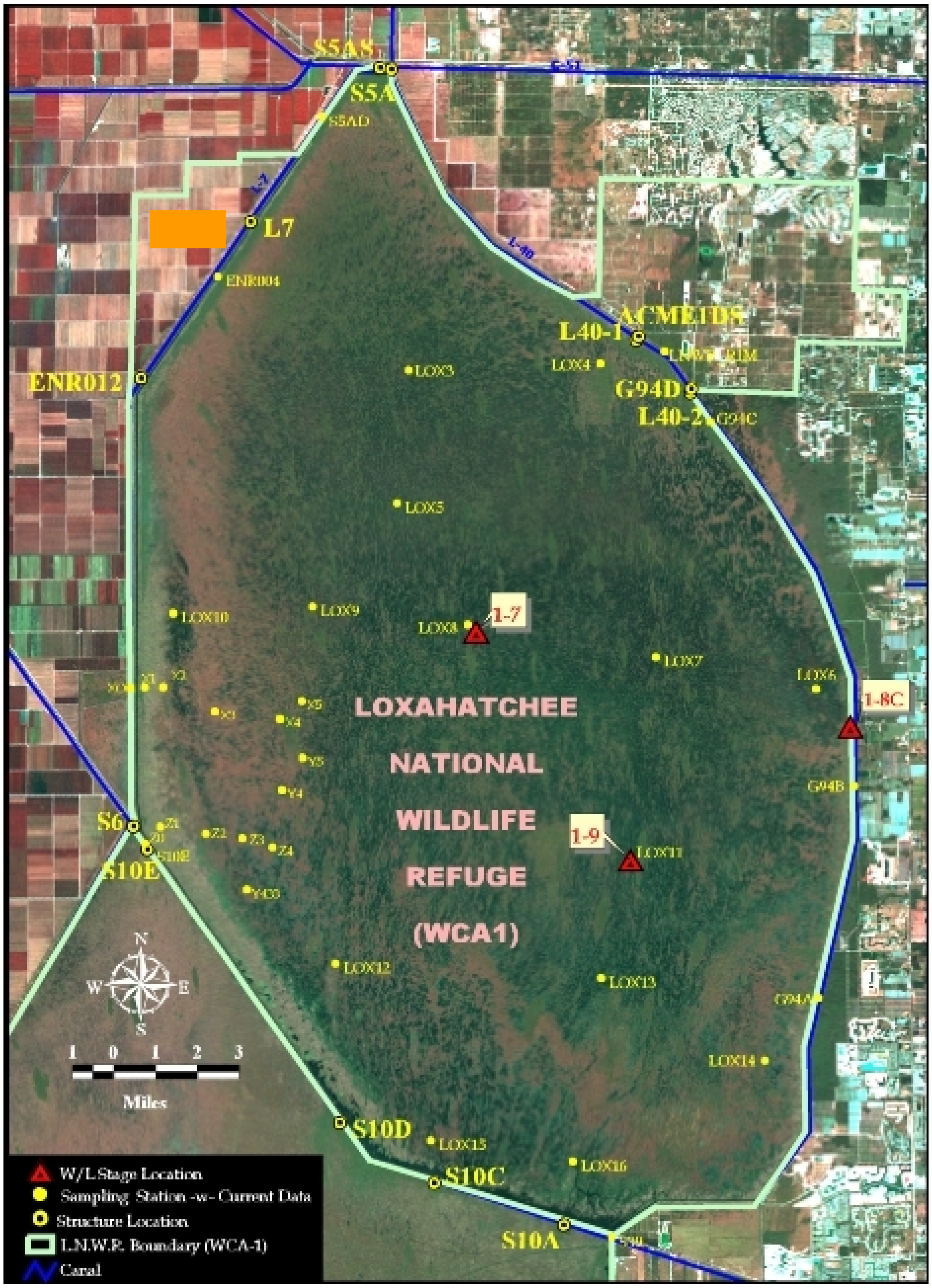


Figure 4-14. Water quality sampling sites in the Refuge.

STA-1 EAST

Operational Status

STA-1E is being designed by the U.S. Army Corps of Engineers. There are no operational data to report at this time.

STA-2

Operational Status

For a complete description of STA-2 please refer to Chapter 6 of the *2000 Everglades Consolidated Report*. Startup operations began in June 1999, with the initial flooding of treatment Cell 3. Upon achieving the target depth of two feet, the flooding of Cells 2 and 1 began. No discharges have occurred from the treatment cells. The Act and NPDES operating permits for this facility have not been issued to the District as of this report. There are no operational data from STA-2 to report at this time.

STA-3 / 4

STA-3/4 is in early design stages. There are no operational data from STA-3/4 to report at this time.

STA-5

Operational Status

The primary objective of this section is to provide an update on operations of STA-5 since last year's report and to document compliance with appropriate conditions of the Act (FDEP No. 0131842) and NPDES permits (FDEP No. FL0177954). A complete description of STA-5 is provided in Chapter 6 of the *2000 Everglades Consolidated Report*.

Construction of STA-5 was completed in December 1998. The Everglades Forever Act permit was issued on February 29, 2000. Authorization for interim operations of STA-5 under the terms and conditions of the Department's NPDES permit was recommended by the Division of Administrative Hearings and granted by the Department on March 20, 2000.

STA-5 was in the startup phase of operations from initial flooding in January 1999 through October 1999. On October 15, 1999, due to emergency conditions caused by Hurricane Irene the Department issued an emergency order to the District authorizing discharges from STA-5. Based on startup water quality data submitted by the District, the Department indicated that the permit's startup compliance had been satisfied and a demonstration of net reduction in phosphorus, mercury and methyl mercury (as identified in specific condition 13 of the Act permit) was achieved. The Department indicated that in the startup phase of operation was considered completed. Emergency discharges from STA-5 associated with Hurricane Irene were authorized for a 14-day period until October

29, 1999. These operations were initiated on October 15, 1999, and ceased on October 28, 1999.

Since October 28, 1999 STA-5 was not in a flow-through operational mode until the southern flow-way of STA-5 (Cells 2A/2B) began routine flow-through operations in June 2000. The northern flow-way of STA-5 (Cells 1A/1B) began routine flow-through operations in August 2000. The present target is to maintain water levels in the treatment cells to continue the establishment of desired wetland vegetation (emergent macrophytes in Cells 1A, 2A and 2B and SAV in Cell 1B). Accordingly, since flow through operation did not begin for the period of record for this report, there are no operational data from STA-5 to report at this time. However, all available STA-5 data are being provided on CD-ROM (to the Department) in compliance with Department-issued operational permits for the STAs. The data are not included in the appendix, but are available on request.

Specific condition 28 of the Act permit requires the laboratory performing the sampling and analysis to have a Department-approved CompQAP. The District is currently performing all sampling and analysis under the June 1999 Department-approved CompQAP No. 870166G.

Specific condition 28 of the Act permit also requires a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, accuracy of the data, and minimum detection limits. The individual responsible for implementation of the program is Maxine Cheesman, Director, Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, South Florida Water Management District. A statement prepared and signed by Maxine Cheesman is included in **Appendix 4-1** of this Report.

Specific condition 28 of the Act permit also requires all data and monitoring records associated with the period of record of annual reports to be submitted. This information is being provided on CD-ROM (to the Department) in compliance with Department-issued operational permits for the STAs. The data are not included in the appendix, but are available on request.

Specific condition 28 of the permit also requires the District to report information regarding the application of herbicides and pesticides used to exclude undesirable vegetation and pests within the treatment cells. There were no herbicide treatments for the control of undesirable vegetation at STA-5 during the period of record for this Report. A detailed description of herbicide and pesticide applications at STA-5 from May 1, 2000 to April 30, 2001, will be provided in the *2002 Everglades Consolidated Report*.

STA-6

Stabilization period of operation

The primary objective of this section is to provide an update on operations of STA-6 since last year's report and to document compliance with appropriate conditions of the Act (FDEP No.262918309). A complete description of STA-6 is provided in Chapter 6 of the *2000 Everglades Consolidated Report*.

Specific Condition 7(a) of the Everglades Forever Act operating permit for STA-6, Section 1 (FDEP #262918309) specifies that following a start-up period of operation, discharge from this facility shall be allowed to continue only if, after a stabilization period, the District demonstrates that the following three conditions are met:

- STA-6, Section 1 is achieving the design objectives of the Act for TP removal
- For water quality parameters other than TP, outflow water quality is of equal or better quality than at the inflow
- Discharges do not pose a serious danger to the public health, safety, or welfare.

On December 9, 1997, Department concurred with the District that the startup compliance criteria for STA-6, Section 1 had been achieved and authorized the District to begin flow-through operations. The initial flow-through phase of project operation is referred to as the Stabilization Period. Furthermore, specific condition 7(a) authorizes continued discharge from the project during the Stabilization Period, provided that the following criteria are met:

7(a)(i) - For all water quality parameters other than TP listed in **Table 4-10**, a water quality monitoring program must be conducted to demonstrate that either:

1. The four-quarter moving average value for each parameter at the outflow meets the State of Florida’s Class III water quality standards, or
2. The four-quarter moving average value for each parameter at the outflow is better than or equal to the four-quarter moving average value at the inflow.

7(a)(ii) - Water quality monitoring must be conducted to evaluate progress toward achieving the design objectives for TP removal. Satisfactory progress will be demonstrated if either condition (1) or (2) below are met:

1. The rolling 12-month flow-weighted mean TP concentration at the outflow is less than or equal to 50 µg/L; or
2. The rolling 12-month flow-weighted mean TP concentration at the outflow is less than the concentration at the inflow and a trend toward achieving an average outflow concentration of 50 µg/L is indicated.

The District initiated a water quality monitoring program in STA-6, Section 1 in December 1997 for the purpose of demonstrating compliance with the above mentioned conditions of the operating permit. **Tables 4-10** and **4-11** summarize all water quality parameters, sampling frequencies and analytical methodologies that are part of this program.

Table 4-10. Water quality parameters monitored in STA-6, Section 1.

	STORET Code	Water Quality Parameters	Unit of Measure
Physical Characteristics	10	Temperature	°C
	300	Dissolved Oxygen	mg/L
	94	Conductance	µmhos/cm
	400	pH	STD units
	82078	Turbidity	NTU
	80	Color	PCU
	530	Total Suspended Solids	mg/L
Nutrients - Flow-proportioned	665	Total Phosphorus	mg P/L
Nutrients - Grabs	612	Ammonia – unionized	mg N/L
	625	Total Kjeldahl Nitrogen	mg N/L
	660	Ortho-phosphorus	mg P/L
Major Ions	74010	Iron - total	mg/L
	956	Silica	mg/L
	945	Sulfate	mg/L
	410	Alkalinity	mg $CaCO_3$/L
	940	Chloride - dissolved	mg/L
	929	Sodium - dissolved	mg/L
	937	Potassium - dissolved	mg/L
	916	Calcium - dissolved	mg/L
	927	Magnesium - dissolved	mg/L
Metals	1097	Antimony	µg/L
	1105	Aluminum	µg/L
	1012	Beryllium	µg/L
	1027	Cadmium - total	µg/L
	1042	Copper - total	µg/L
	1051	Lead – total	µg/L
	1067	Nickel – total	µg/L
	1147	Selenium	µg/L
	1077	Silver - total	µg/L
	1059	Thallium	µg/L
	1092	Zinc - total	µg/L
	900	Hardness	mg/L
Pesticides	82184	Ametryn	µg/L
	39033	Atrazine	µg/L
	38815	Hexazinone	µg/L
	78064	Norflurazon	µg/L

Table 4-11. Sample locations, sampling frequency, and sample type for flow and water quality parameters monitored in STA-6, Section 1.

Sample Location	Parameters	Sampling Frequency	Sample Type
Inflow Pump Station (G600)	Flow	DAV	PR
	Physical Characteristics	Bi-W	G
	Nutrients - Flow-proportioned	W	FPC
	Nutrient - Grabs	Bi-W	G
	Major Ions	QTR	G
	Metals	QTR	G
	Pesticides	QTR	G
Outflow site (G607)	Flow	DAV	UVM
	Physical Characteristics	Bi-W	G
	Nutrients - Flow-proportioned	W	FPC
	Nutrient - Grabs	Bi-W	G
	Major Ions	QTR	G
	Metals	QTR	G
	Pesticides	QTR	G

Bi-W = biweekly (26 sample/yr)
DAV = daily average of continuous sampling
QTR = quarterly (4 samples/yr)
W = weekly (52 sample/yr)
FPC = flow-proportioned composite sample
G = grab sample
PR = based on pump records
UVM = ultrasonic velocity meter

Compliance with Stabilization Period Criteria

Water quality parameters other than total phosphorus

The four-quarter averages for all non-phosphorus parameters with Class III criteria were in compliance with state standards with the exception of beryllium at the outflow site **(Table 4-12)**. The results for beryllium, although above the method detection limit (MDL) of the District’s laboratory, were below the practical quantitative limit for environmental samples. This may be an analytical artifact or simply represent variation within the experimental error of the analytical method.

For non-phosphorus parameters without Class III standards, all four-quarter averages at the outflow were equal to or less than at the inflow **(Table 4-12)**.

Table 4-12. Summary of quarterly results for all water quality parameters other than total phosphorus and pesticides monitored in STA-6, Section 1 (continued next page).

Parameter	Sampling Episode	Class III Standard		Exceeds Standard?	Sampling Results		
		Inflow G600	Outflow G606		Inflow G600	Outflow G606	In Compliance
Alkalinity (mg/L)	1st Quarter of WY2000	Not less than 20 mg/L		NO	ND	ND	
	2nd Quarter of WY2000				258.4	221.1	
	3rd Quarter of WY2000				283.0	254.1	
	4th Quarter of WY2000				253.6	254.5	
	Four Quarter Mean				***265.0***	***243.2***	***Yes***
Dissolved Chloride (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				67.4	59.7	
	3rd Quarter of WY2000				63.9	63.6	
	4th Quarter of WY2000				59.0	65.3	
	Four Quarter Mean				***63.4***	***62.9***	***Yes***
Dissolved Sodium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				52.3	46.7	
	3rd Quarter of WY2000				50.4	49.7	
	4th Quarter of WY2000				50.9	49.7	
	Four Quarter Mean				***51.2***	***48.7***	***Yes***
Dissolved Potassium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				4.3	3.5	
	3rd Quarter of WY2000				3.7	3.5	
	4th Quarter of WY2000				3.4	3.3	
	Four Quarter Mean				***3.8***	***3.4***	***Yes***
Dissolved Calcium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				103.0	84.1	
	3rd Quarter of WY2000				112.4	95.2	
	4th Quarter of WY2000				93.1	91.0	
	Four Quarter Mean				***102.8***	***90.1***	***Yes***
Dissolved Magnesium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				8.1	7.2	
	3rd Quarter of WY2000				8.3	8.2	
	4th Quarter of WY2000				8.4	8.6	
	Four Quarter Mean				***8.3***	***8.0***	***Yes***
Antimony (µg/L)	1st Quarter of WY2000	Less than 4,300 µg/L		N/A	ND	ND	
	2nd Quarter of WY2000				<2.2	<2.2	
	3rd Quarter of WY2000				<2.2	<2.2	
	4th Quarter of WY2000				<2.2	<2.2	
	Four Quarter Mean				***<2.2***	***<2.2***	***Yes***
Aluminum (µg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				74.3	4.0	
	3rd Quarter of WY2000				80.0	4.9	
	4th Quarter of WY2000				107.6	21.0	
	Four Quarter Mean				***87.3***	***10.0***	***Yes***
Beryllium (µg/L)	1st Quarter of WY2000	Less than or equal to 0.13 µg/L as an annual average		Unknown values between MDL and PQL	ND	ND	
	2nd Quarter of WY2000				<0.1	0.107	
	3rd Quarter of WY2000				<0.1	0.158	
	4th Quarter of WY2000				0.129	0.192	
	Four Quarter Mean				***0.110***	***0.152***	***No***
Total Cadmium (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	2.6	2.3		<0.3	0.7	
	3rd Quarter of WY2000	2.8	2.5		<0.3	<0.3	
	4th Quarter of WY2000	2.5	2.4		<0.3	<0.3	
	Four Quarter Mean	2.5	2.4		***<0.3***	***0.4***	***Yes***
Total Copper (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	29.4	25.0		1.2	<1.2	
	3rd Quarter of WY2000	31.5	27.8		<1.2	<1.2	
	4th Quarter of WY2000	27.4	27.0		<1.2	<1.2	
	Four Quarter Mean	29.4	26.6		***1.2***	***<1.2***	***Yes***
Total Lead (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	12.4	9.7		<0.8	<0.8	
	3rd Quarter of WY2000	13.7	11.3		<0.8	<0.8	
	4th Quarter of WY2000	11.1	10.9		<0.8	<0.8	
	Four Quarter Mean	12.4	10.6		***<0.8***	***<0.8***	***Yes***

Table 4-12. Summary of quarterly results for all water quality parameters other than total phosphorus and pesticides monitored in STA-6, Section 1 (continued next page).

Parameter	Sampling Episode	Class III Standard		Exceeds Standard?	Sampling Results		
		Inflow G600	Outflow G606		Inflow G600	Outflow G606	In Compliance
Silica (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				9.0	10.2	
	3rd Quarter of WY2000				8.7	6.6	
	4th Quarter of WY2000				5.8	3.9	
	Four Quarter Mean				***7.9***	***6.9***	***Yes***
Sulfate (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				28.8	21.8	
	3rd Quarter of WY2000				27.2	18.1	
	4th Quarter of WY2000				14.4	13.2	
	Four Quarter Mean				***23.5***	***17.7***	***Yes***
Alkalinity (mg/L)	1st Quarter of WY2000	Not less than 20 mg/L		NO	ND	ND	
	2nd Quarter of WY2000				258.4	221.1	
	3rd Quarter of WY2000				283.0	254.1	
	4th Quarter of WY2000				253.6	254.5	
	Four Quarter Mean				***265.0***	***243.2***	***Yes***
Dissolved Chloride (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				67.4	59.7	
	3rd Quarter of WY2000				63.9	63.6	
	4th Quarter of WY2000				59.0	65.3	
	Four Quarter Mean				***63.4***	***62.9***	***Yes***
Dissolved Sodium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				52.3	46.7	
	3rd Quarter of WY2000				50.4	49.7	
	4th Quarter of WY2000				50.9	49.7	
	Four Quarter Mean				***51.2***	***48.7***	***Yes***
Dissolved Potassium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				4.3	3.5	
	3rd Quarter of WY2000				3.7	3.5	
	4th Quarter of WY2000				3.4	3.3	
	Four Quarter Mean				***3.8***	***3.4***	***Yes***
Dissolved Calcium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				103.0	84.1	
	3rd Quarter of WY2000				112.4	95.2	
	4th Quarter of WY2000				93.1	91.0	
	Four Quarter Mean				***102.8***	***90.1***	***Yes***
Dissolved Magnesium (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				8.1	7.2	
	3rd Quarter of WY2000				8.3	8.2	
	4th Quarter of WY2000				8.4	8.6	
	Four Quarter Mean				***8.3***	***8.0***	***Yes***
Antimony (µg/L)	1st Quarter of WY2000	Less than 4,300 µg/L		N/A	ND	ND	
	2nd Quarter of WY2000				<2.2	<2.2	
	3rd Quarter of WY2000				<2.2	<2.2	
	4th Quarter of WY2000				<2.2	<2.2	
	Four Quarter Mean				***<2.2***	***<2.2***	***Yes***
Aluminum (µg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				74.3	4.0	
	3rd Quarter of WY2000				80.0	4.9	
	4th Quarter of WY2000				107.6	21.0	
	Four Quarter Mean				***87.3***	***10.0***	***Yes***

Table 4-12. Summary of quarterly results for all water quality parameters other than total phosphorus and pesticides monitored in STA-6, Section 1 (continued from previous page).

Parameter	Sampling Episode	Class III Standard		Exceeds Standard?	Sampling Results		
		Inflow G600	Outflow G606		Inflow G600	Outflow G606	In Compliance
Beryllium (µg/L)	1st Quarter of WY2000	Less than or equal to 0.13 µg/L as an annual average		Unknown values between MDL and PQL	ND	ND	
	2nd Quarter of WY2000				<0.1	0.107	
	3rd Quarter of WY2000				<0.1	0.158	
	4th Quarter of WY2000				0.129	0.192	
	Four Quarter Mean				***0.110***	***0.152***	***No***
Total Cadmium (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	2.6	2.3		<0.3	0.7	
	3rd Quarter of WY2000	2.8	2.5		<0.3	<0.3	
	4th Quarter of WY2000	2.5	2.4		<0.3	<0.3	
	Four Quarter Mean	2.5	2.4		***<0.3***	***0.4***	***Yes***
Total Copper (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	29.4	25.0		1.2	<1.2	
	3rd Quarter of WY2000	31.5	27.8		<1.2	<1.2	
	4th Quarter of WY2000	27.4	27.0		<1.2	<1.2	
	Four Quarter Mean	29.4	26.6		***1.2***	***<1.2***	***Yes***
Total Lead (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	12.4	9.7		<0.8	<0.8	
	3rd Quarter of WY2000	13.7	11.3		<0.8	<0.8	
	4th Quarter of WY2000	11.1	10.9		<0.8	<0.8	
	Four Quarter Mean	12.4	10.6		***<0.8***	***<0.8***	***Yes***
Total Nickel (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	389	330		0.7	0.9	
	3rd Quarter of WY2000	416	367		<0.5	<0.5	
	4th Quarter of WY2000	362	357		1.0	0.7	
	Four Quarter Mean	389	352		***0.7***	***0.7***	***Yes***
Selenium (µg/L)	1st Quarter of WY2000	Less than or equal to 5.0 µg/L		NO	ND	ND	
	2nd Quarter of WY2000				<1	<1	
	3rd Quarter of WY2000				<1	<1	
	4th Quarter of WY2000				<1	<1	
	Four Quarter Mean				***<1***	***<1***	***Yes***
Total Silver (µg/L)	1st Quarter of WY2000	Less than or equal to 0.07 µg/L		NO	ND	ND	
	2nd Quarter of WY2000				<0.05	<0.05	
	3rd Quarter of WY2000				<0.05	<0.05	
	4th Quarter of WY2000				<0.05	<0.05	
	Four Quarter Mean				***<0.05***	***<0.05***	***Yes***
Thallium (µg/L)	1st Quarter of WY2000	Less than or equal to 6.3 µg/L		NO	ND	ND	
	2nd Quarter of WY2000				<0.5	<0.5	
	3rd Quarter of WY2000				<0.5	<0.5	
	4th Quarter of WY2000				<0.5	<0.5	
	Four Quarter Mean				***<0.5***	***<0.5***	***Yes***
Total Zinc (µg/L)	1st Quarter of WY2000	ND	ND	NO	ND	ND	
	2nd Quarter of WY2000	262	222		5.0	8.0	
	3rd Quarter of WY2000	280	247		<4	<4	
	4th Quarter of WY2000	244	240		<4	<4	
	Four Quarter Mean	262	237		***4.3***	***5.3***	***Yes***
Hardness (mg/L)	1st Quarter of WY2000	N/A		N/A	ND	ND	
	2nd Quarter of WY2000				290	240	
	3rd Quarter of WY2000				315	271	
	4th Quarter of WY2000				267	263	
	Four Quarter Mean				***291***	***258***	***Yes***

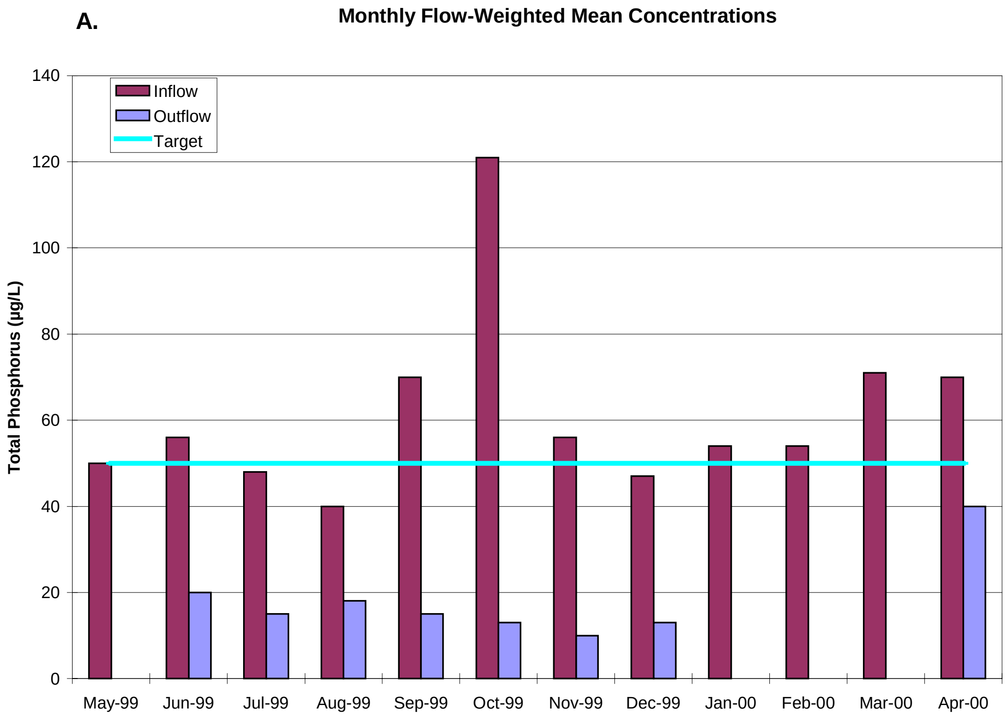
Total phosphorus

Specific condition 7(b) of the STA-6, Section 1 operating permit states that the project will be considered stabilized and operations will move to the post-stabilization phase when the rolling 12-month flow-weighted average TP concentration at the outflow is less than or equal to 50 µg/L for 12 consecutive periods. This criterion has been met, and is shown on **Figure 4-15**. In accordance with this permit condition, the project is considered to be in the Post Stabilization Period. All compliance analysis in next year's report will be based on post stabilization compliance criteria.

Although not a permit requirement, it is significant to note that the individual monthly TP concentrations at the outflow consistently have been below inflow concentrations and less than the target value of 50 µg/L since discharge operations began in December 1997 (**Figure 4-15**). The lack of rain from mid-April through mid-July 1998 and in March and April of 1999 prevented discharges from STA-6, Section 1 during these periods. Accordingly, we were unable to calculate monthly flow-weighted means for these months.

Pesticides

Table 4-13 lists the four herbicides that were analyzed in surface waters from STA-6, Section 1. The four-quarter average at the outflow for all compounds was lower than or equal to the corresponding inflow concentrations. Although not a permit requirement, it is significant to note that during all four quarters, herbicide concentrations at the outflow were less than at the inflow. The herbicides detected are typical of areas with nearby intensive agricultural activity but are not used for vegetation management at STA-6, Section 1.



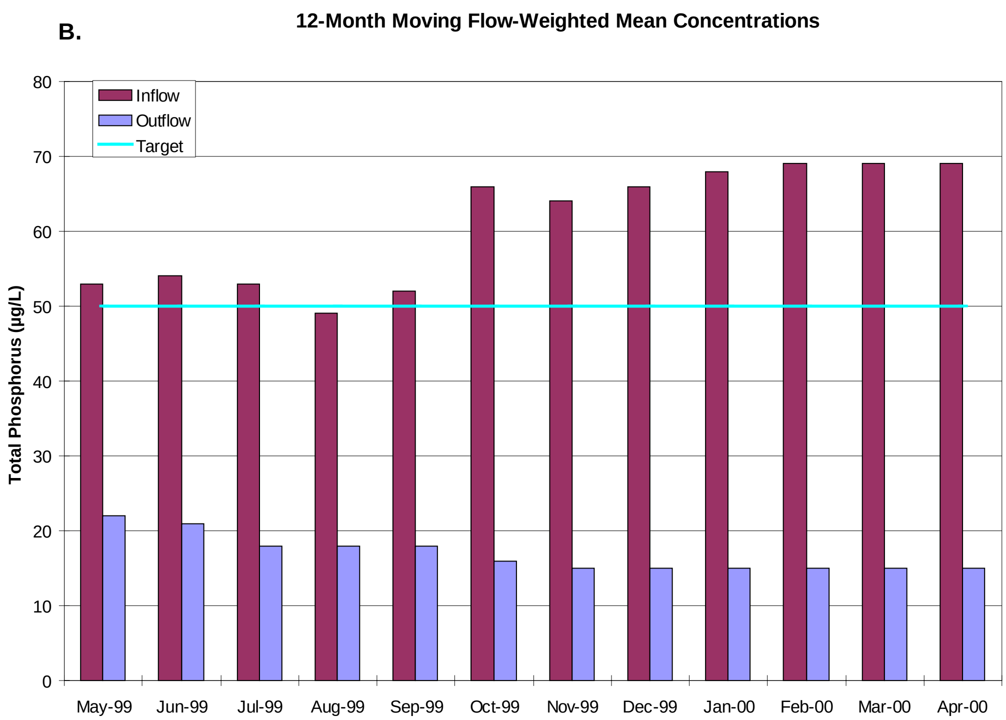


Figure 4-15. Total phosphorus concentrations (ppb) at the inflow and outflow of STA-6, Section 1. Panel A: individual monthly flow-weighted mean concentrations. Panel B: rolling 12-month flow-weighted mean concentrations. See text for discussion of missing data points. Heavy solid line indicates the target total phosphorus target concentration of 50 ppb.

Table 4-13. Summary of results from quarterly surface water pesticide monitoring program conducted in STA-6.

WY2000 STA6 surface water			units are µg/L
ametryn		**inflow G600**	**outlfow G606**
04/26/99	2nd	< 0.0095	< 0.0095
09/21/99	3rd	0.015 I	0.012 I
12/20/99	4th	0.012 I	< 0.0095
03/20/00	1st	0.013 I	0.012 I
four quarter mean		0.012	0.011
atrazine		**inflow G600**	**outlfow G606**
04/26/99	2nd	0.32	0.26
09/21/99	3rd	0.026 I	0.012 I
12/20/99	4th	0.21	0.026 I
03/20/00	1st	0.23	0.22
four quarter mean		0.20	0.13
hexazinone		**inflow G600**	**outlfow G606**
04/26/99	2nd	< 0.019	< 0.019
09/21/99	3rd	< 0.019	< 0.019
12/20/99	4th	< 0.019	< 0.019
03/20/00	1st	< 0.020	< 0.020
four quarter mean		< 0.019	< 0.019
norflurazon		**inflow G600**	**outlfow G606**
04/26/99	2nd	< 0.029	< 0.028
09/21/99	3rd	< 0.028	< 0.029
12/20/99	4th	< 0.029	< 0.029
03/20/00	1st	0.040 I	< 0.029
four quarter mean		0.032	< 0.029

I value reported is less than the minimum quantitation limit, and greater than or equal to the minimum detection limit
< value reported is the minimum quantitation limit
Four quarter mean is calculated using actual value or minimum quantitation limit

Maintenance – Herbicide Use

Specific Condition 13(b) of the Everglades Forever Act permit requires that the annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation in the wetted area of the treatment cells. Accordingly, the use of herbicides within the project from May 1, 1999 through April 30, 2000 is described below and summarized in **Tables 4-14** and **4-15.**

The objectives of the maintenance program within the confines of the STA-6, Section 1 Project are to (1) maintain the levees, the areas around structures, and the supply canal

Figure 4-15. Total phosphorus concentrations (ppb) at the inflow and outflow of STA-6, Section 1. Panel A: individual monthly flow-weighted mean concentrations. Panel B: rolling 12-month flow-weighted mean concentrations. See text for discussion of missing data points. Heavy solid line indicates the target total phosphorus target concentration of 50 ppb.

weirs, herbicide treatments to water hyacinth and water lettuce in the supply canal were made to prevent flow blockage at the inflow weirs. Herbicide treatments and mechanical removal of Brazilian pepper trees were conducted on the west bank of the supply canal.

A potential vegetation problem, which may need to be addressed during the next reporting period, is the encroachment of Brazilian Pepper (Schinus terebinthifolius) trees into the STA Project. These exotic woody species are extant between the perimeter levee and Florida Power and Light (FPL) power line levee. The District will continue to monitor these exotics, treat as necessary, and include in next year's report if these measures are taken.

Table 4-14. Products Used and Active Ingredients

Garlon 3A	Triclopyr: 3, 5, 6 trichloro – 2 pyridnyloxyac – etic acid, as the triethylamine salt acid equivalent triclopyr – 31.8% - 3 lb/gal
Arsenal	Isopropylamine salt of Imazapyr C2-I4,5-dithydro-4 methyl-4 (1-Methylethy 1) –5-oxo-1H-imidazo 1-2-ylj-3 pyridinocarboxylic acid)* Equivalent to 22.6% 2-j4, 5 dihydro-4methyl-4-(methylethyl-5-oxo-1H-imidazo1-2-ylj-3-pyridine carboxylic acid or 2 lbs. acid per gallon.
Corsair	No permissible exposure limits (TLV) have been established by ACGIM or OSHA.
Meth Oil	100% Blend of Methylated Sunflower seed Oil and Emulsifiers
Weedar 64	2, 4-Dichlorophenoxyacetic acid, dimethylamine salt* 46.8% Inert Ingredients:.53.2% *2, 4-Dichlorophenoxyacetic acid equivalent 38.9% by weight or 3.8 pounds per gallon. *Isomer specific by AOAC method No. 978.05
Rodeo	Active Ingredient: *Glyphosate, N(Phosphomomethyl) glycine, in the form of its isopropylamine salt . . 53.8% INERT INGREDIENTS .. 46.2%

Table 4-15. Herbicide Use in STA-6 Project May 1, 1999 to April 30, 2000

Date	**Location**	**Application**	**Acres**	**Herbicide**	**Gallons**
May 1, 1999 to April 30, 2000	Brazilian pepper trees and miscellaneous vegetation along road way and inside area.	spray truck V690 and airboat	31.75 acres	Garlon 3A Arsenal Meth Oil Corsair Weedar 74 Rodeo	27.75 0 6.75 2 2 3.5

Water Quality Data: Specific Conditions 14(b) and 14(f) of the Department permit require the submittal of all sample collection data. This information is being provided to the Department as part of this Report and is available to other interested parties upon request.

Specific Condition 14(c) of the permit requires a statement describing the methods used in collection, handling, storage and analysis of the samples. All samples are collected, handled and stored in accordance with Sections 6.0 and 7.0 of the 1999 Department-approved District Comprehensive Quality Assurance Plan (CompQAP) No. 870166G.

Specific Condition 14(d) of the permit requires a statement by the individual responsible for implementation of the sampling program concerning the authenticity, precision, accuracy of the data, and minimum detection limits. The individual responsible for implementation of the program is Maxine Cheesman, Director, Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, South Florida Water Management District. A statement prepared and signed by Maxine Cheesman is included as **Appendix 4-1**.

Specific Condition 14(e) of the permit requires documentation that the laboratory performing the sampling and analysis has an approved CompQAP on file with the Department. The District performs the sampling and analysis and has an approved CompQAP No. 870166G on file with the DEP.

SUMMARY

The data presented demonstrate compliance of STA-6, Section 1 with the Stabilization Period criteria established in the operating permit. Outflow water quality was consistently better than at the inflow. Similarly, both the frequency of detection and the concentration of pesticides at the outflow station were far below levels warranting concern. The District will continue its water quality monitoring program and is working closely with Department to implement long-term operating strategies to bring STA-6, Section 1 into full compliance with all water quality standards. STA-6, Section 1 discharges are providing significant benefits to the Everglades ecosystem and do not pose any serious danger to public health, safety, or welfare. Since compliance with specific conditions 7(a)(i) and 7(a)(ii) has been achieved, information required in specific condition 7(a)(iii) is not required at this time.

LITERATURE CITED

APHA, 1995. Standard Methods for the Examination of Water and Wastewater, 19th Edition. A.D. Eaton, L.S. Clesceri and A.E. Greenberg, (eds). American Public Health Association, Washington, DC.

Bechtel, T., S. Hill, N. Iricanin, C. Mo, and S. Van Horn, 2000. Status of Water Quality Criteria Compliance in the Everglades Protection Area and at Non-ECP Structures. Chapter 4 in G. Redfield, editor. Everglades Consolidated Report. South Florida Water Management District, West Palm Beach, FL.

Bechtel, T., S. Hill, N. Iricanin, K. Jacobs, C. Mo, V. Mullen, R. Pfeuffer, D. Rudnick, and S. Van Horn, 1999. Status of Water Quality Criteria Compliance in the Everglades Protection Area and Tributary Waters. Chapter 4 in G. Redfield, editor. Everglades Interim Report. South Florida Water Management District, West Palm Beach, FL.

Belanger, T.V., and J.R. Platko, 1986. Dissolved oxygen budgets in the Everglades WCA-2A. SFWMD, West Palm Beach, Florida.

Belanger, T.V., D.J. Scheidt and J.R. Platko II, 1989. Effects of nutrient enrichment on the Florida Everglades. Lake and Reservoir Management, North American Lake Management Society, 5(1):101-111.

Environmental Services & Permitting, Inc., 1992. Preliminary Review of Potential Water Quality Enhancements from a Main Canal Maintenance Program. Environmental Services & Permitting, Inc., Gainesville, FL.

Gilbert, D.K. and V. Feldman, 1995. Everglades Agricultural Area, Summary of Water Quality. Florida Department of Environmental Protection, Tallahassee, FL.

Kirk-Othmer Encyclopedia of Chemical Technology, Third Edition. Vol. 3. New York, NY: John Wiley and Sons, 1978.

Limno-Tech, Inc., 1995. Data Analysis in Support of the Everglades Forever Act: Final Report. Limno-Tech, Inc, Washington, DC.

McCormick, P.V., M.J. Chimney, and D.R. Swift, 1997. Diel oxygen profiles and water column community metabolism in the Florida Everglades, USA. Arch. Hydrobiol. 140:117-129.

Miller, W.L., 1988. Description and Evaluation of the Effects of Urban and Agricultural Development on the Surficial Aquifer System, Palm Beach County, Florida. Water-Resources Investigations Report 88-4056, USGS, Denver, Co.

Payne, G., T. Bennett, and K. Weaver, 2001. Ecological Effects of Phosphorus Enrichment. Chapter 3 in G. Redfield, editor. Everglades Interim Report. South Florida Water Management District, West Palm Beach, FL.

Pfeuffer, R., 1999. Pesticide Surface Water Quality Report: April 1999 Sampling Event. SFWMD, West Palm Beach, FL.

Richarson, J.R., W.L. Bryant, W.M. Kitchens, J.E. Mattson, and K.E. Pope, 1990. An Evaluation of Refuge Habitats and Relationships to Water Quality, Quantity, and Hydropattern. Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, FL.

Sax, N.I. and Lewis, R. Hazardous Chemicals Desk Reference. New York, NY: Van Nostrand Reinhold Company, 1987, p. 732.

Settlement Agreement, 1991. USA v. SFWMD et al. Lawsuit; Case No. 88-1886-CIV-HOEVELER.

SFWMD, 1992. Surface Water Improvement and Management Plan for the Everglades, Supporting Information Document. SFWMD, West Palm Beach, Florida.

SFWMD, 1999b. Comprehensive Quality Assurance Plan No. 870166G for South Florida Water Management District South Florida Water Management District, West Palm Beach, FL.

SFWMD, 1999a. Everglades Interim Report, South Florida Water Management District, West Palm Beach, FL.

SFWMD, 2000. Everglades Consolidated Report, South Florida Water Management District, West Palm Beach, FL.

Swift, D. R. and R.B. Nicholas, 1987. Periphyton and Water Quality Relationships in the Everglades Water Conservation Areas, 1978-1982. South Florida Water Management District Technical Publication 87-2, West Palm Beach, FL.

U.S. Department of Interior, Bureau of Mines, 1991. Mineral Commodity Summaries 1991. USDOI, Washington, DC.

U.S. Environmental Protection Agency, 1976. Quality Criteria for Water. USEPA, Washington, DC

Warnick, S.L., and H.L. Bell, 1969. The acute toxicity of some heavy metals to different species of aquatic insects. Jour. Water Poll. Cont. Fed. 41(2):280.

Weaver, K., 2000b. Everglades Marsh Dissolved Oxygen Site Specific Alternative Criterion Technical Support Document-DRAFT. Florida Department of Environmental Protection, Tallahassee, FL.

Weaver, K., 2000a. Evaluation of Chronic Toxicity Based Guidelines for Pesticides and Priority Pollutants in the Florida Everglades-DRAFT. Florida Department of Environmental Protection, Tallahassee, FL.

Wyman, R.L., 1990. What's happening to the amphibians? Conservation Biology 4:350-352.