Chapter 3A: Status of Water Quality in the Everglades Protection Area

Kenneth Weaver[1], Grover Payne[1] and Shi Kui Xue

SUMMARY

This chapter was prepared by the Florida Department of Environmental Protection, with the support of the South Florida Water Management District, to fulfill the requirement of the Everglades Forever Act that "the report shall identify water quality parameters, in addition to phosphorus, which exceed state water quality standards or are causing or contributing to adverse impacts in the Everglades Protection Area." More specifically, the chapter provides a review of water quality within the Everglades Protection Area (EPA) during Water Year 2007 (WY2007) (May 1, 2006 through April 30, 2007) and an update to the *2007 South Florida Environmental Report – Volume I*. The status of EPA water quality was determined by an analysis of the water quality parameters that did not meet water quality criteria as specified in Section 62-302.530, Florida Administrative Code. These criteria establish enforceable management and societal goals for water quality conditions within the state's waters including the EPA.

The analyses and summaries presented herein provide a synoptic view of water quality standards compliance on a regional scale, including Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge), Water Conservation Areas 2 and 3 (WCA-2 and WCA-3), and the Everglades National Park (ENP or Park) (see Figure 1A-2). Annual water quality criteria excursion rates were regionally summarized in a manner similar to methods employed in the 1999 Everglades Interim Report, previous Everglades Consolidated Reports, and 2005–2007 South Florida Environmental Reports – Volume I. For the *2008 South Florida Environmental Report – Volume I*, water quality parameters that did not meet existing standards were classified into three categories based on excursion frequencies that were statistically tested using the binomial hypothesis test. Any parameter with a criterion exceedance frequency statistically greater than 10 percent was categorized as a concern. Likewise, any parameter with an exceedance frequency statistically greater than five percent but less than 10 percent was categorized as a potential concern. Parameters with exceedance frequencies less than five percent but greater than zero were categorized as minimal concerns. With a few exceptions, water quality was in compliance with existing state water quality criteria during WY2007 (**Table 3A-1**).

[1] Florida Department of Environmental Protection, Water Resource Management, Water Quality Standards and Special Projects Program

Table 3A-1. Summary of Everglades Protection Area (EPA) water quality criteria excursions[1] for Water Year 2007 (WY2007).

PARAMETER	Refuge				WCA-2			WCA-3			Park	
	Inflow	Rim	Interior	Outflow	Inflow	Interior	Outflow	Inflow	Interior	Outflow	Inflow	Interior
Alkalinity			C[2]									
Dissolved Oxygen			C			C		MC	C	MC	PC	MC
pH			MC[3]									
Specific Conductance	C				MC	PC						
Turbidity	MC											
Unionized Ammonia	MC											

1 C=Concern, PC=Potential Concern, MC=Minimal Concern; an empty box indicates no exceedances during WY2007.

2 The low alkalinity levels in the Refuge are natural and therefore not considered by the FDEP to be violations of state water quality standards.

3 Because pH excursions within the interior of the marsh are linked to natural background alkalinity conditions, the FDEP does not consider pH levels within the interior of the Refuge to be in violation of state water quality standards.

Pesticides monitoring results were evaluated relative to Class III water quality criteria, chronic toxicity guidelines, and detected concentrations. Pesticides exceeding either the Class III criteria or chronic toxicity guideline concentrations were classified as concerns for the basin in which the exceedance occurred. Detected water quality constituents ($\geq$ MDL) that did not exceed either a guideline or criterion were categorized as a "potential concern." Sixteen pesticides, or pesticide breakdown products, were detected between May 2006 and March 2007 (**Table 3A-2**). Furthermore, five pesticides – atrazine, chlorpyrifos ethyl, p,p'-dichlorodiphenyldichloroethylene (DDE-P,P'), dieldrin, and endosulfan – were classified as concerns.

Table 3A-2. Summary of pesticide detection and exceedance categories[1] in the EPA inflows, canals, and structures between May 2006 and March 2007.

PARAMETER	REFUGE	WCA-2	WCA-3	PARK	C-111
Ametryn	PC	PC	PC		
Atrazine	PC	C	PC	PC	PC
Atrazine Desethyl	PC	PC	PC		
Atrazine Desisopropyl	PC	PC	PC		
Bromacil		PC			
Chlorpyrifos Ethyl		C			
DDE-P,P'	C				
2-4-D	PC	PC			
Dieldrin	C				
Diuron	PC				
Endosulfan Sulfate					PC
Endosulfan (alpha + beta)					C
Hexazinone	PC	PC	PC		
Metolachlor	PC	PC			
Norflurazon			PC		
Simazine	PC	PC	PC		

1 C=Concern, PC=Potential Concern, MC=Minimal Concern; an empty box indicates no exceedances during WY2007.

PURPOSE

This chapter provides an assessment of water quality constituents exceeding water quality standards or causing or contributing to adverse impacts in the Everglades Protection Area (EPA). It is designed to fulfill the requirement of the Everglades Forever Act that the annual report "shall identify water quality parameters, in addition to phosphorus, which exceed state water quality standards or are causing or contributing to adverse impacts in the Everglades Protection Area." The chapter provides an overview of the status of water quality, relative to Class III criteria, in the EPA during Water Year 2007 (WY2007) (May 1, 2006 through April 30, 2007). The water quality evaluation presented in this chapter updates previous analyses presented in the 1999 Everglades Interim Report; the 2000, 2001, 2002, and 2004 Everglades Consolidated Reports (ECRs); and the *2005–2007 South Florida Environmental Reports – Volume I* (SFER). More specifically, this chapter and its associated appendices use water quality data collected during WY2007 to achieve the following objectives:

1. Summarize areas and times where water quality criteria are not being met and indicate trends in excursions over space and time
2. Discuss factors contributing to excursions from water quality criteria and provide an evaluation of natural background conditions where existing standards may not be appropriate
3. Summarize sulfate concentrations in the EPA and indicate spatial and temporal trends
4. Present an updated review of pesticide and priority pollutant data made available during WY2007
5. Summarize water quality data in fulfillment of the non-Everglades Construction Project permit

METHODS

An approach similar to the regional synoptic approach used in previous ECRs and SFERs was applied to the WY2007 data to provide an overview of the status of compliance with water quality criteria in the EPA. Consolidating regional water quality data 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 third of the EPA and the net water flow is from north to south.

WATER QUALITY DATA SOURCES

The majority of the water quality data evaluated in this chapter was retrieved from the South Florida Water Management District's (SFWMD's or District's) DBHYDRO database. The DBHYDRO monitoring projects evaluated for WY2007 included C111D, CAMB, ENP, EVER, EVPA, HOLY, LOXA, NECP, STA1E, STA1W, STA2, and PEST. Additionally, water quality data from the nutrient gradient sampling stations monitored by the District in the northern part of Water Conservation Area 3A (WCA-3A), the southwestern part of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge), the west-central portion of WCA-3A, and Taylor Slough in the Everglades National Park (ENP or Park) were obtained from the SFWMD's Everglades Division Database.

EVERGLADES PROTECTION AREA WATER QUALITY SAMPLING STATIONS

A network of water quality monitoring stations was selected from existing long-term SFWMD monitoring projects to perform the water quality evaluations presented herein (**Figure 3A-1**). These stations were carefully selected to be representative of either the EPA boundary conditions (i.e., inflow or outflow) or ambient marsh conditions (interior). Furthermore, an effort has been made to utilize a consistent group of stations among previous ECRs and SFERs in order to ensure consistent and comparable results. Water quality sampling stations located throughout the WCAs and the Park were categorized as inflow, interior, or outflow sites within each region based on their location and function (**Figure 3A-1).** This organization of monitoring sites allowed a more detailed analysis of the water quality status in each region of the EPA and assisted in the evaluation of potential causes for observed excursions from Class III water quality criteria. Several interior structures convey water between different regions in the EPA and therefore are designated as both inflow and outflow stations based on this categorization system. For example, the S-10 structures act as both outflow stations for the Refuge and inflow sites to WCA-2. Additionally, the S-11 structures are designated as outflows from WCA-2, as well as inflow points to WCA-3. The S-12 structures, S-355A, S-355B, and S-333 are outflows from WCA-3 and are also inflow sites to the Park. The interior sites of each region consist of marsh and canal stations as well as structures that convey water within the area. In addition to inflow, outflow, and interior sites, the Refuge has an additional site category (Rim Canal sites) to account for the fact that much of the water entering the interior of the Refuge is conveyed in Rim Canals that border the east and west levees of the Refuge. Waters discharged to the L-7 Rim Canal will either overflow into the Refuge interior when canal stages exceed the levee height or will bypass the marsh and be discharged to WCA-3A through the S-10 structures. The extent (distance) to which Rim Canal overflows penetrate the marsh depends on the relative stages of the L-7 Rim Canal and the Refuge interior. The location and classification of monitoring stations used in this report are presented in **Figures 3A-2** through **3A-5**.

The current SFWMD monitoring programs were described by Germain (1998). Sampling frequency varies by site depending on site classification, parameter group, and hydrologic conditions (water depth and flow). Water control structures (inflows and outflows) were typically sampled biweekly when flowing; otherwise, sampling was performed monthly. Generally, interior monitoring stations were sampled monthly for most parameters reported in this chapter. Pesticide monitoring is conducted across the entire SFWMD at 34 sites on a quarterly basis. An overview of the water quality monitoring projects, including project descriptions and objectives with limited, site-specific information, is available on the District's web site at http://www.sfwmd.gov, under the *What We Do, Environmental Monitoring, Water Quality Monitoring* section.

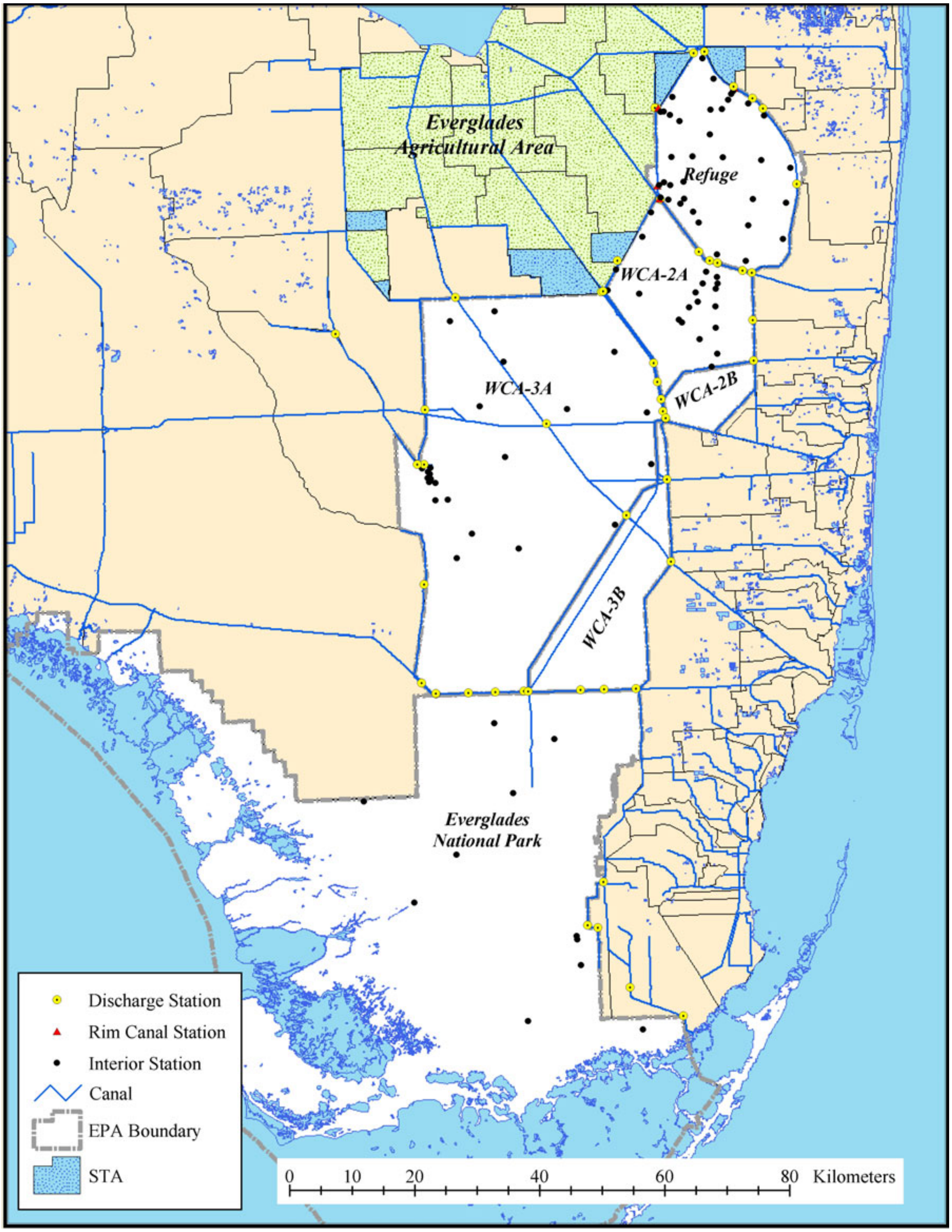

Figure 3A-1. EPA regions and water quality monitoring stations.

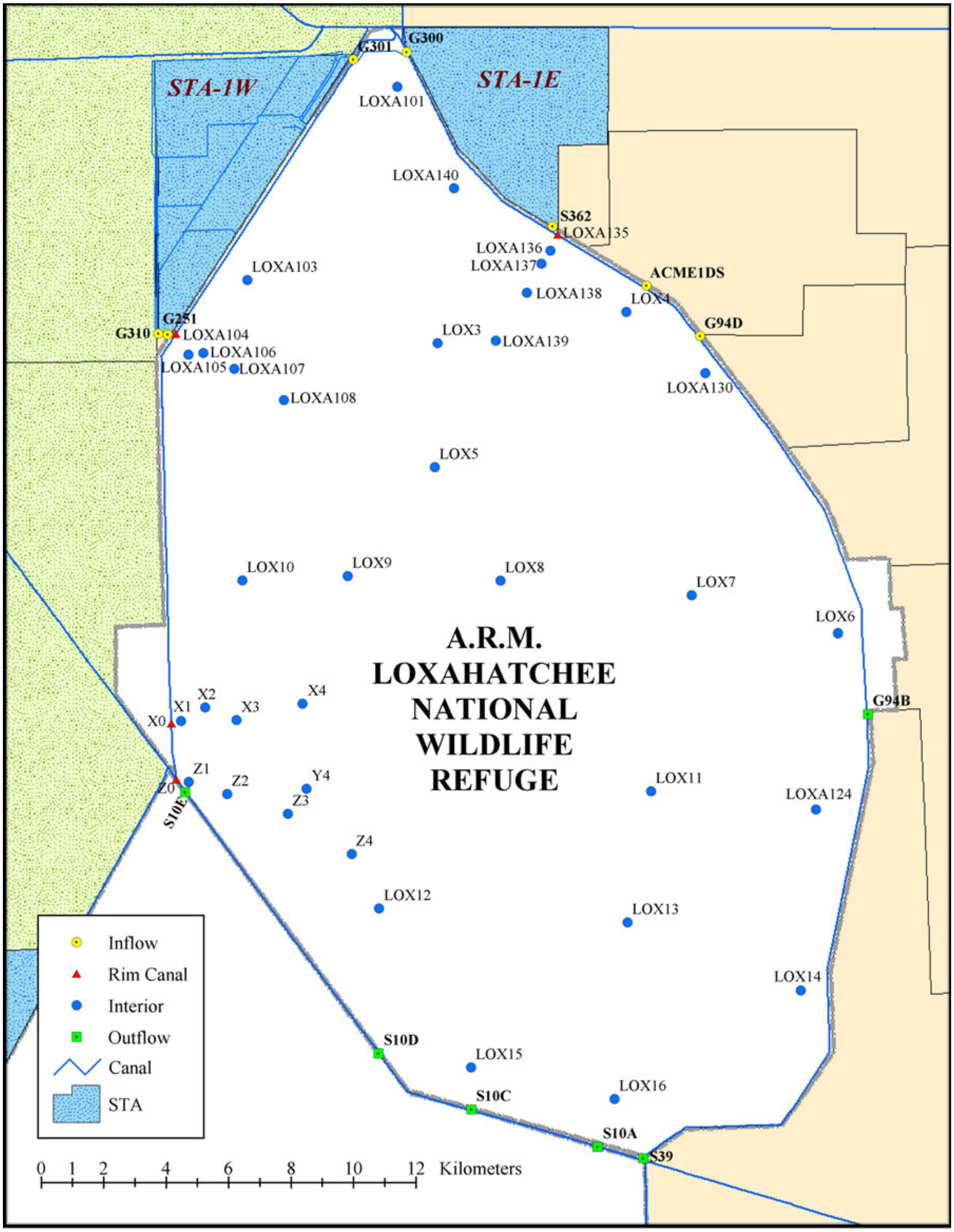

Figure 3A-2. Location and classification of water quality monitoring stations in the Arthur R. Marshall National Wildlife Refuge (Refuge).

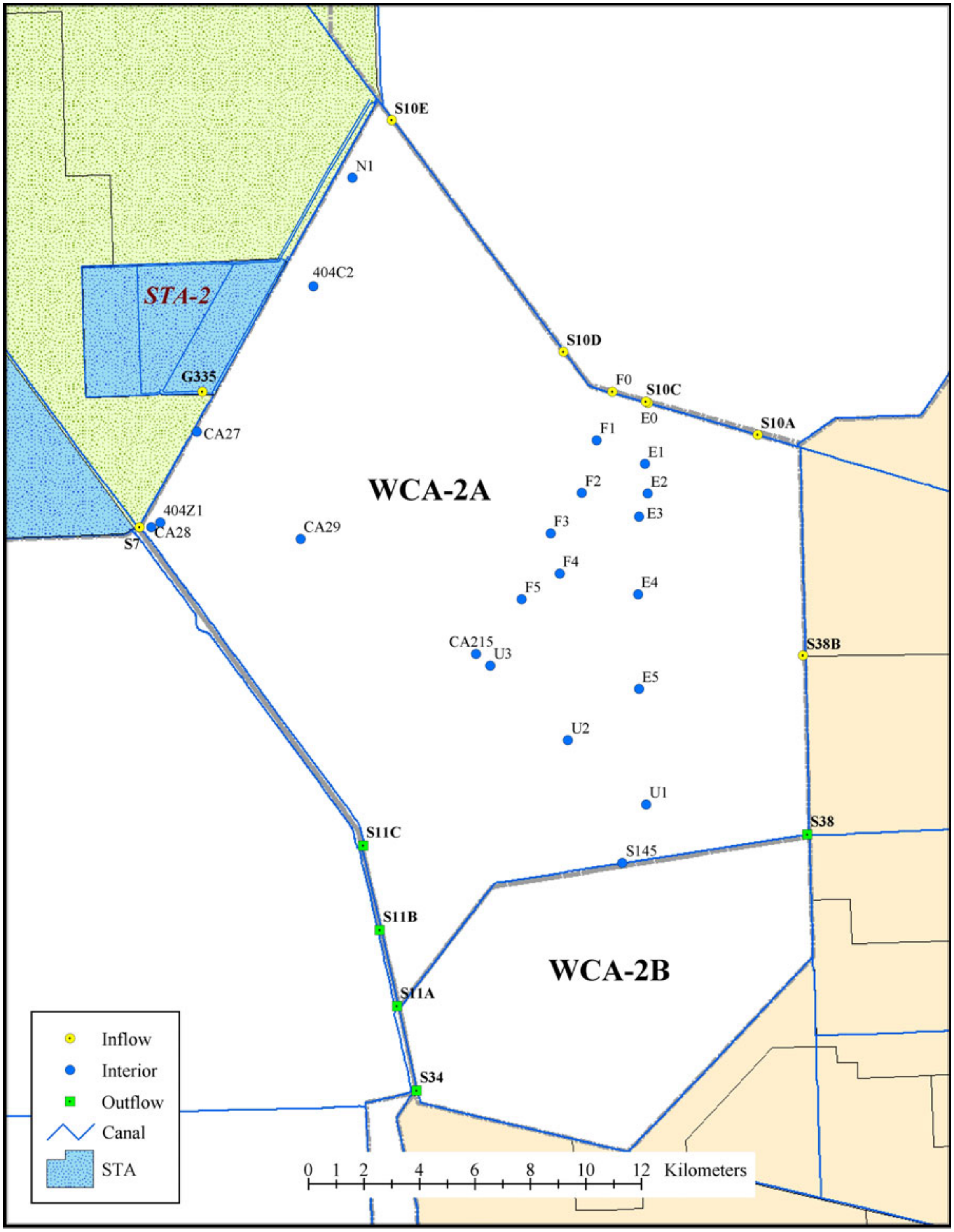

Figure 3A-3. Location and classification of water quality monitoring stations in Water Conservation Area 2 (WCA-2).

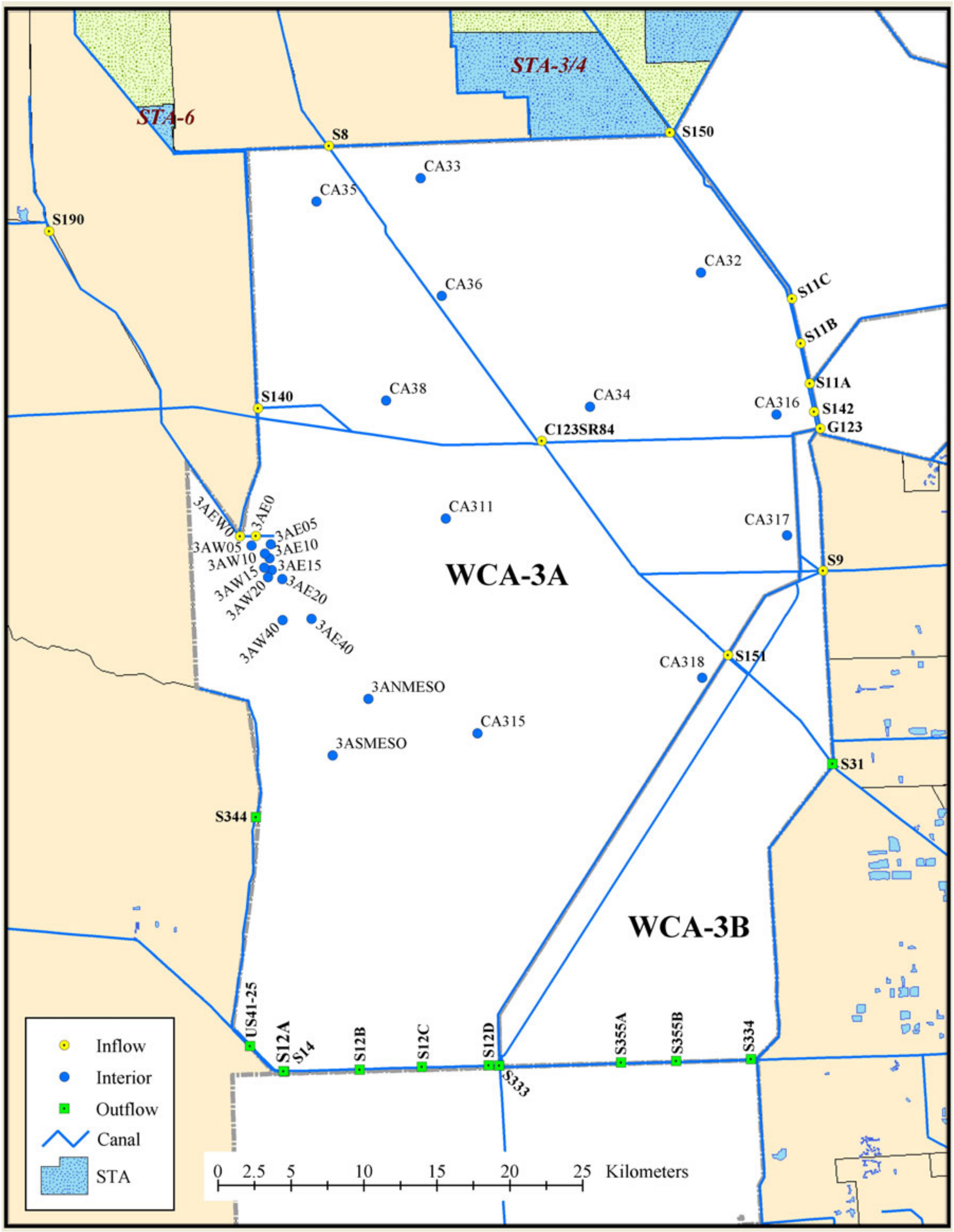

Figure 3A-4. Location and classification of water quality monitoring stations in Water Conservation Area 3 (WCA-3).

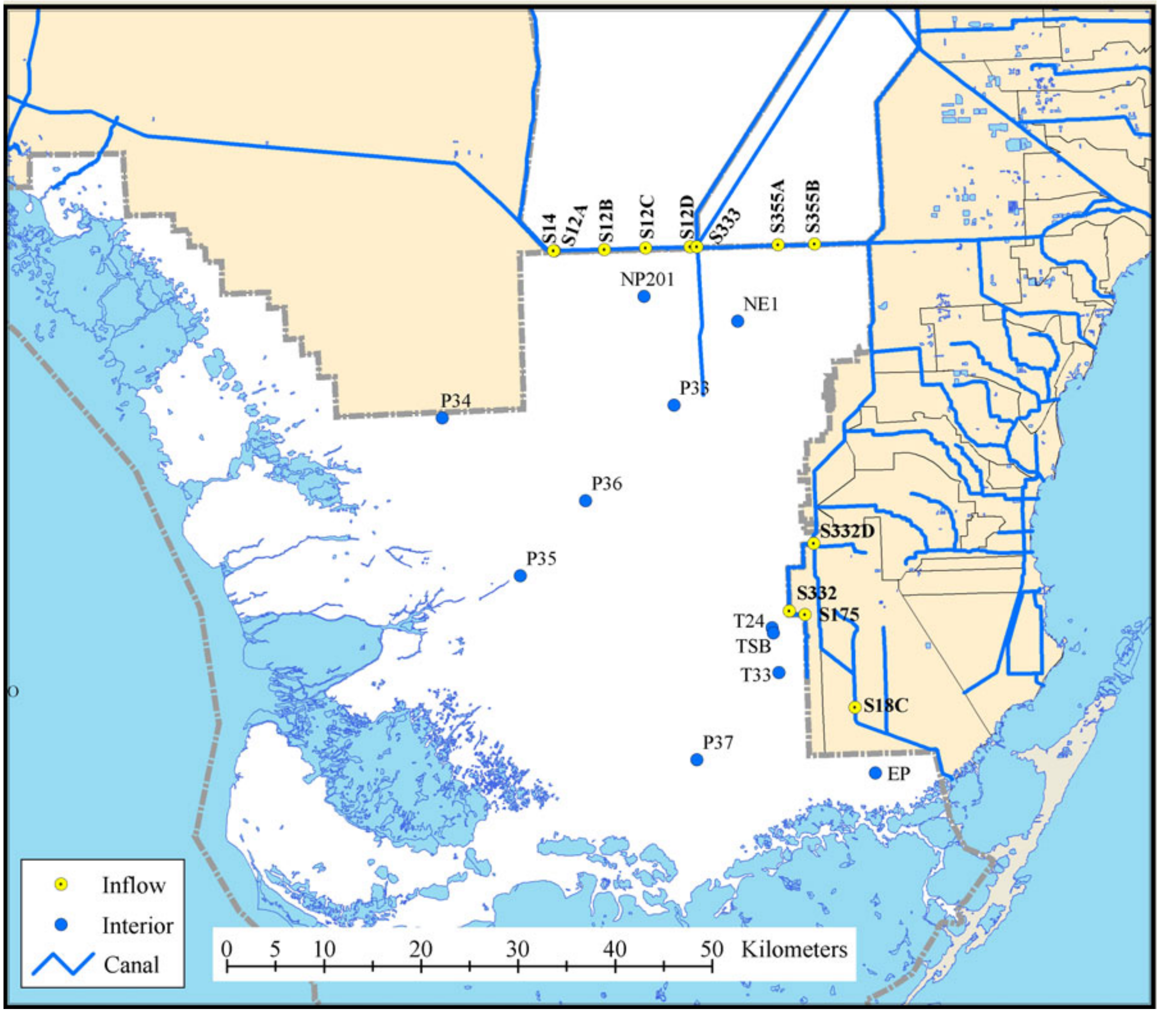

Figure 3A-5. Location and classification of water quality monitoring stations in Everglades National Park (ENP or Park).

ANALYSIS PERIODS

As previously noted, the primary focus of this chapter is to report on the status of water quality in the EPA during WY2007. Additionally, this chapter summarizes trends or changes in water quality criteria excursion rates in the EPA over time. Previous ECRs and SFERs accomplished this task by comparing excursion rates during the most recent water year to those during the previous water year and a historical period using all proceeding waters going back to WY1978. However, in this approach, the historical period expanded on an annual basis with each subsequent reporting year and therefore did not represent a constant baseline to assess changes over time nor did it reflect the iterative implementation of Everglades restoration efforts. Accordingly, the available period of record has been divided into two fixed periods corresponding to the initial implementation of the Everglades Agricultural Area's Best Management Practices (BMPs) and the Everglades Construction Project's (ECP) Stormwater Treatment Areas (STAs).

A 15-year historical period from WY1979–WY1993 was selected to serve as a baseline in this year's chapter as well as in future SFERs. This baseline period corresponds to the timeframe prior to implementation of the Everglades BMPs and ECP. A second period from WY1994 to WY2004 was select to represent the initial or Phase I implementation of the Everglades projects. This revised approach is intended to provide consistent baselines against which improvements in water quality conditions can be assessed annually. Additionally, the period after WY2004 (i.e., WY2005–WY2007) was also included for comparison and corresponds to the period in which the performance of the BMPs and STAs are being optimized and enhanced and various Long-Term Plan and CERP restoration projects are being implemented (Phase II BMP/STA implementation period). Since the optimization and enhancement of the STAs and BMP programs as well as other restoration activities are expected to continue for several years, the Phase II period will be expanded to include the current water year in future reports. Addition of the Phase II period in the analysis will allow evaluation of a longer term, as opposed to a single year, effects of the Long-Term Plan implementation on both nutrient levels into and within the EPA (see Chapter 3C of this volume) and overall water quality. This chapter presents comparisons among the earlier baseline and Phase I periods and the more recent WY2007 and Phase II periods. Direct comparisons between WY2007 and Phase II should be made with caution and a consideration of the fact that these two time periods are not completely independent.

WATER QUALITY DATA EVALUATION

The District monitors approximately 109 water quality parameters within the EPA (Bechtel et al., 1999 and 2000). Given this chapter's focus on water quality criteria, the evaluation was primarily limited to parameters with Class III criteria pursuant to Chapter 62-302, Florida Administrative Code (F.A.C.). The parameters evaluated included sulfate, 62 pesticides, and the following 18 water quality constituents:

- Alkalinity
- Dissolved oxygen (in situ)
- Specific conductance @ 25 degrees Celsius (°C) (in situ)
- pH (in situ)
- Total silver
- Total antimony
- Total arsenic
- Total beryllium
- Total cadmium
- Total copper
- Total iron
- Total lead
- Total nickel
- Total selenium
- Total thallium
- Total zinc
- Turbidity
- Un-ionized ammonia

DATA SCREENING AND HANDLING

Water quality data were screened based on laboratory qualifier codes, consistent with the state's Quality Assurance Rule (Chapter 62-160, F.A.C.). Any datum with an associated fatal qualifier (H, J, K, N, O, V, Q, Y, or ?) was removed from the analysis (SFWMD, 2005). Values that exceeded possible physical or chemical measurement constraints (e.g., if resulting pH is greater than 14) had temperatures well outside seasonal norms [e.g., 6 °C in July] or represented data transcription errors were excluded. Statistical outlier analysis was not performed for these data. Overall, 2.04 percent of the WY2007 data, including nutrients, were excluded due to quality assurance/quality control (QA/QC) issues (see Appendix 3A-1). All data passing the qualifier screening was used in the analysis. Multiple samples collected at the same location on the same day were considered as one sample, with the arithmetic mean used to represent the sampling period.

Additional considerations in the handling of water quality data are the accuracy and sensitivity of the laboratory method used. Each analytical method for a particular water quality constituent has a Method Detection Limit (MDL) that defines the minimum concentration or the level at which the constituent can be identified. The MDL is usually statistically above the background noise level associated with the analytical method. A constituent present in a concentration at or below the MDL may not be quantified within established limits of accuracy or precision using that method. The Practical Quantitation Limit (PQL) represents a practical and routinely achievable quantification level with a relatively good certainty that a value determined using that method is reliable (APHA, 1995). For purposes of summary statistics presented in this chapter, data reported as less than the MDL were assigned a value of one-half the MDL unless otherwise noted. All data presented in this chapter, including historical results, were handled consistently with regard to screening and MDL replacement. The percentages of results below detection (< MDL) for each constituent are reported in Appendix 3A-1.

EXCURSION ANALYSIS

The Florida Department of Environmental Protection (FDEP) and the District have developed and clearly documented an excursion analysis protocol for use in the annual South Florida Environmental Report (Weaver and Payne, 2005). The primary objective of the protocol is to provide a synoptic view of water quality standards compliance on a regional scale (i.e., Refuge, WCA-2, WCA-3, and Park). This protocol was developed to balance consistency with previous versions of the report, other state of Florida ambient water quality evaluation methodologies [e.g., Impaired Waters 303(d) designations], and the U.S. Environmental Protection Agency exceedance frequency recommendations, as well as to provide a concise summary to decision makers and the public. This methodology is being used in order to ensure that the results will be compatible with information from other sources, provided to water managers.

A multi-tiered categorical system was used in this chapter to rank the severity of excursions from state water quality criteria (**Table 3A-3**). Categories were assigned based on sample excursions frequencies evaluated using a statistically valid assessment methodology (i.e., binomial hypothesis test) that accounted for uncertainty in monitoring data. The basis for selecting the binomial approach is presented in Weaver and Payne (2004 and 2005). Parameters without excursions were categorized as "no concern" and are not discussed further in this chapter. For any parameter with excursions and at least 28 samples during the period of record, the binomial hypothesis test at the 90 percent confidence level was applied to evaluate whether the given parameter was a concern, that is, whether it exhibited an excursion rate greater than 10 percent. If the binomial hypothesis test failed to reject the null hypothesis (H_0: $f \leq 0.10$; H_A: $f > 0.10$), then the binomial test at the 90 percent confidence level was used to determine whether the parameter was a potential concern (excursion rate from 5 to 10 percent, i.e., H_A: $f > 0.05$) or a minimal concern (an excursion rate of 5 percent or less, i.e., H_0: $f \leq 0.05$).

Because the binominal hypothesis test does not adequately balance statistical error rates at sample sizes of less than 28, parameters with reported excursions and fewer than 28 samples were initially categorized as a concern and potential concern based on excursion frequencies (raw scores) of greater than 20 percent and less than 20 percent, respectively. It is assumed that an observed excursion frequency greater than 20 percent provides substantial reason to suspect that the true exceedance frequency may exceed 10 percent and warrants further investigation. Furthermore, given the high degree of uncertainty associated with small sample sizes (fewer than 28), any excursions warrant further review.

However, extreme caution must be exercised when interpreting results drawn from such small samplings. As a means to reduce uncertainty, any parameter initially identified as a concern or potential concern based on fewer than 28 samples was further evaluated based on longer term (five year) excursion rates. Utilization of a longer period of record assumes that exceedance frequencies are constant among years, that is, there is no trend. Parameters with human health-based criteria were evaluated under the assumption that the Class III criteria values represent instantaneous maximum concentrations for which any exceedance constitutes a non-attainment of designated use.

Additionally, methods to detect and delineate localized exceedance patterns within each water body were utilized to supplement and refine the regional analyses (Weaver and Payne, 2005). The binomial hypothesis test and excursion criterion were applied to individual station data. Individual station assessments were based on the previous five water years (WY2003–WY2007), rather than on the single year used for regional analyses. Use of a five-year period provided sufficient data for most parameters. No determination was made for any parameter with less than 28 samples. If one or more monitoring stations were categorized at a higher level of concern than the region as a whole, then a localized exceedance was recorded. Localized exceedances are noted in the summary tables of this chapter.

Because the U.S. Environmental Protection Agency recommended that a 10 percent excursion frequency does not apply to pesticides (USEPA, 1997 and 2002), the pesticide evaluation method presented in this chapter is identical to the method used in previous ECRs and SFERs. Pesticides were categorized based on the exceedance of Class III criteria or chronic toxicity values and detection (measurement ≥ MDL) frequency (see **Table 3A-3**).

Table 3A-3. Definitions of excursion categories for water quality constituents in the EPA. For conventional water quality constituents with at least 28 samples, frequencies were statistically tested using the binomial hypothesis test at the 90 percent confidence level.

Excursion Category	Conventional Water Quality Constituents	Pesticides
Concern	> 10% Excursion[1]	Class III criterion and/or toxicity levels exceeded
Potential Concern	> 5% and ≤ 10% Excursions[2]	≥ MDL[3]
Minimal Concern	≤ 5% Excursions	Not Applicable
No Concern	No Excursions	< MDL

1 For sample sizes fewer than 28, an excursion frequency of greater than 20 percent was used to define the concern category.

2 For sample sizes fewer than 28, an excursion frequency of less than or equal to 20 percent was used to define the potential concern category.

3 MDL = Method Detection Limit

WATER YEAR 2007 RESULTS

Water Year 2007 data for water quality parameters with Class III numeric criteria are summarized by region and monitoring station in Appendices 3A-1 and 3A-2, respectively. Comparisons of WY2007 water quality data with applicable Class III water quality criteria resulted in excursions for five identified water quality parameters: dissolved oxygen (DO), alkalinity and pH, specific conductance, and un-ionized ammonia. Similar to previous periods these excursions were localized to specific areas of the EPA, with the exception of DO, which exhibited excursions in all regions (**Table 3A-4**). Because Everglades DO is assessed as an annual station average rather than as point measures, there were insufficient data to confidently apply the binomial hypothesis test to the regional assessment units on an annual basis. Therefore, excursion categories for DO were assessed based on a five-year period of record (WY2003–WY2007) for all areas. Dissolved oxygen was categorized as a concern for the Refuge interior, WCA-2 interior, and WCA-3 interior. Additionally, DO was categorized as a potential concern for Park inflows. Similar to previous years, alkalinity was designated as a concern for the interior of the Refuge for WY2007. Additionally, pH and un-ionized ammonia were categorized as minimal concerns for several EPA regions due to infrequent and localized excursions. Water quality parameters that were classified as minimal concerns are not discussed further in this chapter unless significant localized exceedance patterns were additionally noted. Sixteen pesticides, or pesticide breakdown products, were detected between May 2006 and March 2006. Of these pesticides, atrazine, chlorpyrifos ethyl, DDE-P,P’, dieldrin, and endosulfan were classified as concerns. No other parameters exceeded state water quality criteria during WY2006, and therefore are not discussed in this chapter.

Excursion frequencies and categories for parameters with any recorded excursions in the last five water years (WY2003–WY2007) are summarized for four time periods (WY1979–WY1993, WY1996–WY2005, WY2006, and WY2007) to evaluate the presence of any temporal trends (**Table 3A-5**). Excursion categories for all periods are based on the methodology previously described in this chapter (**Table 3A-3**). Additionally, excursion frequencies and categories for individual monitoring stations are summarized in Appendix 3A-2. Excursion frequencies for WY2007 were generally within the range of the historical periods for most water quality parameters, with the a few notable exceptions. Alkalinity excursions in the Refuge interior declined significantly relative to both the baseline period (9.5 percent) and Phase I period from WY1994–WY2004 (8.9 percent). Specific conductance excursion frequencies in WCA-2 inflows declined significantly by 23.8 and 11 percent relative to both the baseline and Phase I periods, respectively. Likewise, excursion frequencies in Refuge inflows decreased by 25.2 percent relative to the baseline.

Table 3A-4. Summary of water quality data and excursions from applicable criteria in the EPA for WY2007. Only water quality parameters with excursions in the given region and class are listed.

Area	Class	Parameter	Units	Class III Criteria	N	Mean	Standard Deviation	Min	Max	Excursion	
										% ± 90% C.I.	Category[1]
Refuge	Inflow	Dissolved Oxygen	mg/L	SSAC[2]	5	3.90	2.51	0.02	10.1	20.0±29.4	C[3]/NA
	Inflow	Specific Conductance	µmho/cm	≤ 1,275[4]	187	988	263	297	1462	14.4±4.2	C
	Inflow	Turbidity	NTU	≤29[5]	83	5.53	5.27	0.9	35	1.2±2.0	MC
	Inflow	Un-ionized ammonia	mg/L	≤ 0.02	109	0.0051	0.0051	<0.0001	0.023	0.9±1.5	MC
	Interior	Alkalinity	mg/L	≥ 20	176	63	52	6	254	15.3±4.5	C[6]
	Interior	Dissolved Oxygen	mg/L	SSAC[2]	23	3.77	1.95	0.16	9.06	30.4±15.8	C[3]/C
	Interior	pH	Units	≥ 6.0, ≤ 8.5	208	6.74	0.436	5.7	7.9	1.4±1.4	MC (C)[7]
WCA-2	Inflow	Specific Conductance	µmho/cm	≤ 1,275[4]	148	927	268	222	1308	1.4±1.6	MC (C)
	Interior	Dissolved Oxygen	mg/L	SSAC[2]	19	3.55	2.17	0.30	11.7	42.1±18.6	C[3]/C
	Interior	Specific Conductance	µmho/cm	≤ 1,275[4]	206	1033	281	132	2753	11.2±3.6	PC (C)
WCA-3	Inflow	Dissolved Oxygen	mg/L	SSAC[2]	17	4.65	2.44	0.22	11.4	11.8±12.9	PC[3]/MC
	Interior	Dissolved Oxygen	mg/L	SSAC[2]	19	3.93	2.25	0.38	13.1	15.8±13.1	PC[3]/C
	Outflow	Dissolved Oxygen	mg/L	SSAC[2]	9	4.15	1.87	0.20	9.32	11.1±17.2	PC[3]/MC
Park	Inflow	Dissolved Oxygen	mg/L	SSAC[2]	8	4.56	2.29	0.26	12.2	12.5±19.2	PC[3]/PC
	Interior	Dissolved Oxygen	mg/L	SSAC[2]	8	4.48	2.33	0.62	9.81	12.5±19.2	PC[3]/MC

1 Category entries denote data not available (NA), and categories of concern (C), potential concern (PC), and minimal concern (MC). Parentheses indicate a localized exceedance rate greater than the regional (area and class) classification; that is, one or more stations had higher exceedance rates between WY2003–WY2007 than in WY2007.

2 The Everglades dissolved oxygen (DO) site-specific alternative criterion (SSAC) is based on a mathematical equation that models the sinusoidal diel cycle.

3 Insufficient sample size to apply binomial hypothesis test to WY2006 data alone; analysis was based on a five-year period of record from WY2003 through WY2007.

4 Specific conductance shall not be increased 50 percent above background or 1,275 microhos per centimeter (µmhos/cm), whichever is greater. Assessment presenedt in this report is based only on the 1,275 µmhos/cm component of the criterion.

5 The turbidity criterion is ≤ 29 NTU above background.

6 The low alkalinity levels in the Refuge are natural and therefore not considered by FDEP to be violations of state water quality standards.

7 Because pH excursions within the interior of the marsh are linked to natural background alkalinity conditions, FDEP does not consider pH levels within the interior of the Refuge to be in violation of state water quality standards.

Table 3A-5. Summary of excursions from Class III criteria in the EPA for WY2007, WY2005–WY2007, WY1994–WY2004, and the pre-BMP Baseline period (WY1979–WY1993).

Area	Class	Parameter	WY1979–WY1993		WY1994–WY2004		WY2005–WY2007		WY2007	
			Number of Excursions[1]	Percent Excursions[2]	Number of Excursions[1]	Percent Excursions[2]	Number of Excursions[1]	Percent Excursions[2]	Number of Excursions[1]	Percent Excursions[2]
Refuge	Inflow	Dissolved Oxygen	13 (61)	21.3 (C)	8 (68)	11.8 (PC)	3 (15)	20.0 (C[3])	1 (5)	20.0 (C[3])
		pH	9 (890)	1.0 (MC)	4 (1782)	0.2 (MC)	2 (509)	0.4 (MC)	0 (187)	0.0 (NC)
		Specific Conductance	355 (896)	39.6 (C)	258 (1786)	14.4 (C)	59 (505)	11.7 (PC)	27 (187)	14.4 (C)
		Turbidity	28 (1109)	2.5 (MC)	34 (1034)	3.3 (MC)	1 (240)	0.4 (MC)	1 (83)	1.2 (MC)
		Un-ionized ammonia	36 (867)	4.2 (MC)	2 (1255)	0.2 (MC)	2 (261)	0.8 (MC)	1 (109)	0.9 (MC)
	Rim	Specific Conductance	36 (118)	30.5 (C)	71 (634)	11.2 (PC)	4 (111)	3.6 (MC)	0 (23)	0.0 (NC[3])
	Interior	Alkalinity	91 (367)	24.8 (C[4])	477 (1971)	24.2 (C4)	99 (687)	14.4 (C[4])	27 (176)	15.3 (C[4])
		Dissolved Oxygen	0 (12)	0.0 (NC)	66 (210)	31.4 (C)	34 (94)	36.2 (C)	7 (23)	30.4 (C[3])
		pH	59 (238)	24.8 (C[5])	164 (2204)	7.4 (PC5)	27 (843)	3.2 (MC[5])	3 (208)	1.4 (MC[5])
		Un-ionized ammonia	0 (177)	0.0 (NC)	3 (1698)	0.2 (MC)	1 (639)	0.2 (MC)	0 (167)	0.0 (NC)
	Outflow	pH	1 (579)	0.2 (MC)	4 (692)	0.6 (MC)	0 (165)	0.0 (NC)	0 (55)	0.0 (NC)
		Specific Conductance	128 (595)	21.5 (C)	21 (696)	3.0 (MC)	0 (163)	0.0 (NC)	0 (55)	0.0 (NC)
		Turbidity	7 (572)	1.2 (MC)	4 (708)	0.6 (MC)	2 (164)	1.2 (MC)	0 (55)	0.0 (NC)
WCA-2	Inflow	Dissolved Oxygen	21 (51)	41.2 (C)	22 (84)	26.2 (C)	0 (22)	0.0 (NC[3])	0 (7)	0.0 (NC[3])
		pH	2 (621)	0.3 (MC)	6 (1230)	0.5 (MC)	0 (462)	0.0 (NC)	0 (147)	0.0 (NC)
		Specific Conductance	161 (640)	25.2 (C)	152 (1233)	12.3 (C)	44 (462)	9.5 (PC)	2 (148)	1.4 (MC)
		Turbidity	9 (732)	1.2 (MC)	6 (721)	0.8 (MC)	2 (221)	0.9 (MC)	0 (72)	0.0 (NC)
		Un-ionized ammonia	6 (616)	1.0 (MC)	62 (1012)	6.1 (PC)	17 (277)	6.1 (MC)	0 (88)	0.0 (NC)
	Interior	Dissolved Oxygen	17 (52)	32.7 (C)	97 (211)	46.0 (C)	28 (60)	46.7 (C)	8 (19)	42.1 (C[3])
		pH	17 (869)	2.0 (MC)	4 (3294)	0.1 (MC)	3 (728)	0.4 (MC)	0 (206)	0.0 (NC)
		Specific Conductance	86 (762)	11.3 (PC)	335 (3344)	10.0 (PC)	103 (741)	13.9 (C)	23 (206)	11.2 (PC)
		Un-ionized ammonia	6 (777)	0.8 (MC)	6 (2691)	0.2 (MC)	1 (574)	0.2 (MC)	0 (171)	0.0 (NC)
	Outflow	pH	2 (871)	0.2 (MC)	5 (687)	0.7 (MC)	0 (249)	0.0 (NC)	0 (77)	0.0 (NC)
		Specific Conductance	26 (884)	2.9 (MC)	1 (683)	0.1 (MC)	0 (252)	0.0 (NC)	0 (75)	0.0 (NC)

Table 3A-5. Continued.

Area	Class	Parameter	WY1979–WY1993		WY1994–WY2004		WY2005–WY2007		WY2007	
			Number of Excursions[1]	Percent Excursions[2]	Number of Excursions[1]	Percent Excursions[2]	Number of Excursions[1]	Percent Excursions[2]	Number of Excursions[1]	Percent Excursions[2]
WCA-3	Inflow	Dissolved Oxygen	51 (160)	31.9 (C)	42 (163)	25.8 (C)	4 (48)	8.3 (MC)	2 (17)	11.8 (PC[3])
		pH	19 (2300)	0.8 (MC)	16 (2814)	0.6 (MC)	1 (1202)	0.1 (MC)	0 (420)	0.0 (NC)
		Specific Conductance	59 (2354)	2.5 (MC)	7 (2803)	0.2 (MC)	0 (1202)	0.0 (NC)	0 (417)	0.0 (NC)
		Turbidity	48 (2284)	2.1 (MC)	8 (1963)	0.4 (MC)	0 (562)	0.0 (NC)	0 (169)	0.0 (NC)
		Un-ionized ammonia	3 (2141)	0.1 (MC)	8 (2125)	0.4 (MC)	1 (583)	0.2 (MC)	0 (176)	0.0 (NC)
	Interior	Dissolved Oxygen	1 (14)	7.1 (PC3)	50 (140)	35.7 (C)	22 (64)	34.4 (C)	3 (19)	15.8 (PC[3])
		pH	0 (427)	0.0 (NC)	0 (2102)	0.0 (NC)	2 (745)	0.3 (MC)	0 (203)	0.0 (NC)
	Outflow	Dissolved Oxygen	22 (91)	24.2 (C)	14 (100)	14.0 (PC)	2 (31)	6.5 (MC)	1 (9)	11.1 (PC[3])
Park	Inflow	Dissolved Oxygen	15 (95)	15.8 (C)	11 (105)	10.5 (PC)	2 (31)	6.5 (MC)	1 (8)	12.5 (PC[3])
		Specific Conductance	0 (2132)	0.0 (NC)	1 (2901)	0.0 (MC)	0 (815)	0.0 (NC)	0 (282)	0.0 (NC)
	Interior	Dissolved Oxygen	1 (62)	1.6 (MC)	2 (115)	1.7 (MC)	2 (25)	8.0 (PC[3])	1 (8)	12.5 (PC[3])
		pH	9 (456)	2.0 (MC)	13 (1085)	1.2 (MC)	0 (222)	0.0 (NC)	0 (72)	0.0 (NC)
		Specific Conductance	20 (542)	3.7 (MC)	2 (1117)	0.2 (MC)	0 (222)	0.0 (NC)	0 (72)	0.0 (NC)
		Un-ionized ammonia	17 (455)	3.7 (MC)	4 (1019)	0.4 (MC)	1 (203)	0.5 (MC)	0 (59)	0.0 (NC)

1. For the “Number of Excursions” columns, the number in front of the parentheses specifies the number of excursions, while the number inside the parentheses specifies the number of samples collected.
2. Excursion categories of concern, potential concern, and minimal concern are denoted by “C,” “PC,” and “MC,” respectively, and are provided within parentheses in the “Percent Excursions” columns.
3. Insufficient sample size (≤ 28) to confidently characterize the excursion frequency; categorization is preliminary, and further evaluation is required.
4. The low alkalinity levels in the Refuge are natural and therefore not considered by FDEP to be violations of state water quality standards.
5. Because pH excursions within the interior of the marsh are linked to natural background alkalinity conditions, FDEP does not consider pH levels within the interior of the Refuge to be in violation of state water quality standards.

DISSOLVED OXYGEN

Dissolved oxygen conditions within the EPA were accessed against the Everglades DO site-specific alternative criterion (SSAC). Because a single value criterion does not adequately account for the wide-ranging natural daily fluctuations observed in the Everglades marshes, the SSAC provides a mechanism to account for the major factors (e.g., time of day and season) influencing natural background DO variation in the Everglades (Weaver, 2004). The SSAC is based on an algorithm that uses sample collection time and water temperature to model the observed natural sinusoidal diel cycle and seasonal variability. This model provides a lower DO limit (DOL) for an individual monitoring station and is described by the equation:

$$DOL_i = [-3.70 - \{1.50 \cdot \text{sine}(2\pi/1440 \cdot t_i) - (0.30 \cdot \text{sine}[4\pi/1440 \cdot t_i])\} + 1/(0.0683 + 0.00198 \cdot C_i + 5.24{\cdot}10^{-6} \cdot C_i^2)] - 1.1$$

Where:

DOL_i = lower limit for the i^{th} annual DO measurement in milligrams per liter (mg/L)

t_i = sample collection time in minutes (Eastern Standard Time) since midnight of the *i*th annual DO measurement

C_i = water temperature associated with the i^{th} annual DO measurement in °C

Furthermore, the SSAC is assessed based on a comparison between the annual average measured DO concentration and the average of the corresponding DO limits specified by the above equation. Dissolved oxygen excursion results for individual stations are provided in Appendix 3A-3.

Because DO is assessed as an annual station average rather than as point measures, there were insufficient data to confidently apply the binomial hypothesis test to the regional assessment units. Therefore, excursion categories for DO were assigned based on a five-year period of record (WY2003–WY2007) for all areas. Dissolved oxygen was categorized as a concern for the Refuge interior, WCA-2 interior, and WCA-3 interior. Additionally, DO was categorized as a potential concern for Park inflows. No conclusions regarding differences (trends) in DO excursion rates between individual water years and the previous periods can or should be made, given the large disparity in sample sizes among time periods. However, it will be possible in future reports, after the Phase I period has expanded sufficiently, to make valid comparisons between the Phase II and the baseline and Phase I periods.

The majority of interior marsh stations failing to achieve the SSAC during WY2007 are located within phosphorus impacted areas (e.g., E1, F1, N1, Z1, and 3AW05), that is, areas with long-term surface water total phosphorus (TP) above 10 ppb and sediment TP concentrations in excess of 500 milligrams per kilogram (mg/kg). In fact, when unenriched areas are evaluated separately, DO is classified as a minimal concern for unimpacted areas of WCA-2 (8.9 ± 7.0 percent) and Park (7.0 ± 6.4 percent), a potential concern for WCA-3 (14.3 ± 7.8 percent), but still a concern for the Refuge (16.0 ± 6 percent). The FDEP recognizes that DO impairments in the phosphorus impacted areas are related to biologically impaired conditions caused by the phosphorus enrichment (Weaver, 2004). Phosphorus levels in excess of the numeric phosphorus criterion produce a variety of system changes in the Everglades that ultimately depress the dissolved oxygen regime in the water column (Payne et al., 2000 and 2001; Weaver, 2004). To achieve the level of nutrients necessary to meet the numeric phosphorus criterion and the DO

SSAC, and to remedy the impairment, the SFWMD is implementing a comprehensive restoration program through the Long-Term Plan for Achieving Water Quality Goals in the EPA (see Chapter 8 of this volume). DO levels at the nutrient impacted sites are expected to remain below the SSAC levels until phosphorus concentrations in surface water and sediment are reduced and the biological communities recover.

Dissolved oxygen excursions within the unimpacted Refuge marsh were localized in one area. Between WY2003 and WY2007, a total of 15 exceedances were recorded among sites X3, X4, and Y4 on the west central side of the Refuge (**Figure 3A-3**). The cause of these exceedances is uncertain, although phosphorus enrichment does not appear to be a major factor. The five-year average geometric mean TP concentrations were less than or equal to 10 micrograms per liter (µg/L) at all three sites (1-sided Student's t-test: p = 0.17–0.96).

ALKALINITY AND PH

The current Class III water quality criteria specifies that alkalinity shall not be lowered below 20 milligrams of calcium carbonate per liter (mg $CaCO_3$/L). Excursions from this water quality criterion have historically occurred in the interior of the Refuge (Bechtel et al., 1999 and 2000; Weaver et al., 2001, 2002, 2003; Weaver and Payne, 2004, 2005, 2006; Weaver et al., 2007). Similar to previous years, alkalinity was designated as a concern for the interior of the Refuge for WY2007 due to an excursion rate of 15.3 ± 4.5 percent. However, as discussed in previous SFERs (e.g., Weaver and Payne, 2004; Weaver et al., 2007) the interior of the Refuge is hydrologically dominated by rainfall, which is naturally low in alkalinity. Therefore, the FDEP considers the low alkalinity values to be representative of the natural range of variability within the Refuge and, therefore, these should not be considered violations of state water quality standards. Excursion rates during WY2007 were very similar to previous periods with the exception of the Refuge interior where significant declines of 9.5 and 8.9 percent were observed relative to both the baseline and Phase I (WY1994–WY2004) periods, respectively.

Although pH was categorized as a minimal concern for the Refuge interior based on the aggregated regional analysis, localized excursions resulted in pH being classified as a concern at LOX11 and LOX13. The pH excursions occurred at sites well within the interior of the Refuge; as described in previous consolidated reports, these excursions related to pH are naturally low alkalinities within the Refuge's interior marsh. Because pH excursions within the interior of the marsh are linked to natural background alkalinity conditions, the FDEP does not consider pH levels within the interior of the Refuge to be in violation of state water quality standards.

SPECIFIC CONDUCTANCE

The current state water quality criteria for Class III freshwaters, which allows for a 50 percent increase in the specific conductance or 1,275 micromhos per centimeter (µmhos/cm), whichever is greater, is meant to preserve natural background conditions and protect aquatic organisms from stressful ion concentrations. Given that background conductivities are low within the EPA, excursions were calculated using the 1,275 µmhos/cm criterion (Weaver et al., 2001 and 2002). For WY2007, conductivity was categorized as a concern for Refuge inflows and a potential concern for the WCA-2 interior. Additionally, specific conductance was categorized as a concern for the G-335 inflow to WCA-2 and F1, F2, F3, CA27, CA28, CA29, and N1 WCA-2 interior sites, based on an evaluation of the last five water years. Previous ECRs and SFERs explained that the elevated conductivity levels at water control structures (e.g., G-335) and stations near canal inflows (e.g., CA27, N1) were probably linked to groundwater intrusion into canal surface waters (Weaver et al., 2001 and 2002). This groundwater intrusion can occur due to seepage into canals, via pumping station operation (which can pull additional groundwater into surface water), and as a result of agricultural dewatering practices.

All but one of the WY2007 exceedances at sites F1, F2, and F3 occurred during periods of no recorded flows through the upstream structures (S-10A, S-10C, and S-10D). Furthermore, over the previous five water years, the majority (86 percent) of exceedances at these stations occurred during periods of no flow. The excursions during these periods may be related to either the concentration of ions associated with the evaporation of marsh water or the seepage of groundwater into the WCA-2 marsh, practically near site F1. Recent studies south of the S-10 structures support the hypothesis that groundwater seepage occurs during dry periods (Krest and Harvey, 2003).

Specific conductance excursion frequencies in WCA-2 inflows declined significantly by 23.8 and 11 percent relative to both the baseline and Phase I periods, respectively. Likewise, excursion frequencies in Refuge inflows decreased by 25.2 percent relative to the baseline. The reductions in specific conductance excursions in inflows to the northern EPA are most likely related to reduced inflow volumes during WY2007 particularly during the October 2006–April 2007 period. Over the entire water year, discharges to the Refuge and WCA-2 were reduced by 57.6 and 12.6 percent, respectively, from the 1978–2004 historical averages. More dramatically, the inflows to the Refuge and WCA-2 during the October 2006–April 2007 period were only 11.1 and 3.03 percent, respectively, the historical averages for these months. Reductions in inflow volumes would have most likely reduced the amount and frequency of high conductivity canal water entering the EPA, thus reducing the exceedance frequency.

Although the dramatic WY2007 reductions in specific conductance excursions are most likely linked to hydrologic conditions, these reductions are also part of a steady long-term decrease in specific conductance within the Refuge and WCA-2 inflows since WY1979 (**Figure 3A-6**). In fact, median annual specific conductance levels in Refuge inflows have decreased by 200 to 300 µmhos/cm over the period of record. Similarly, specific conductance has decreased by approximately 100 µmhos/cm in WCA-2 inflows over the same period.

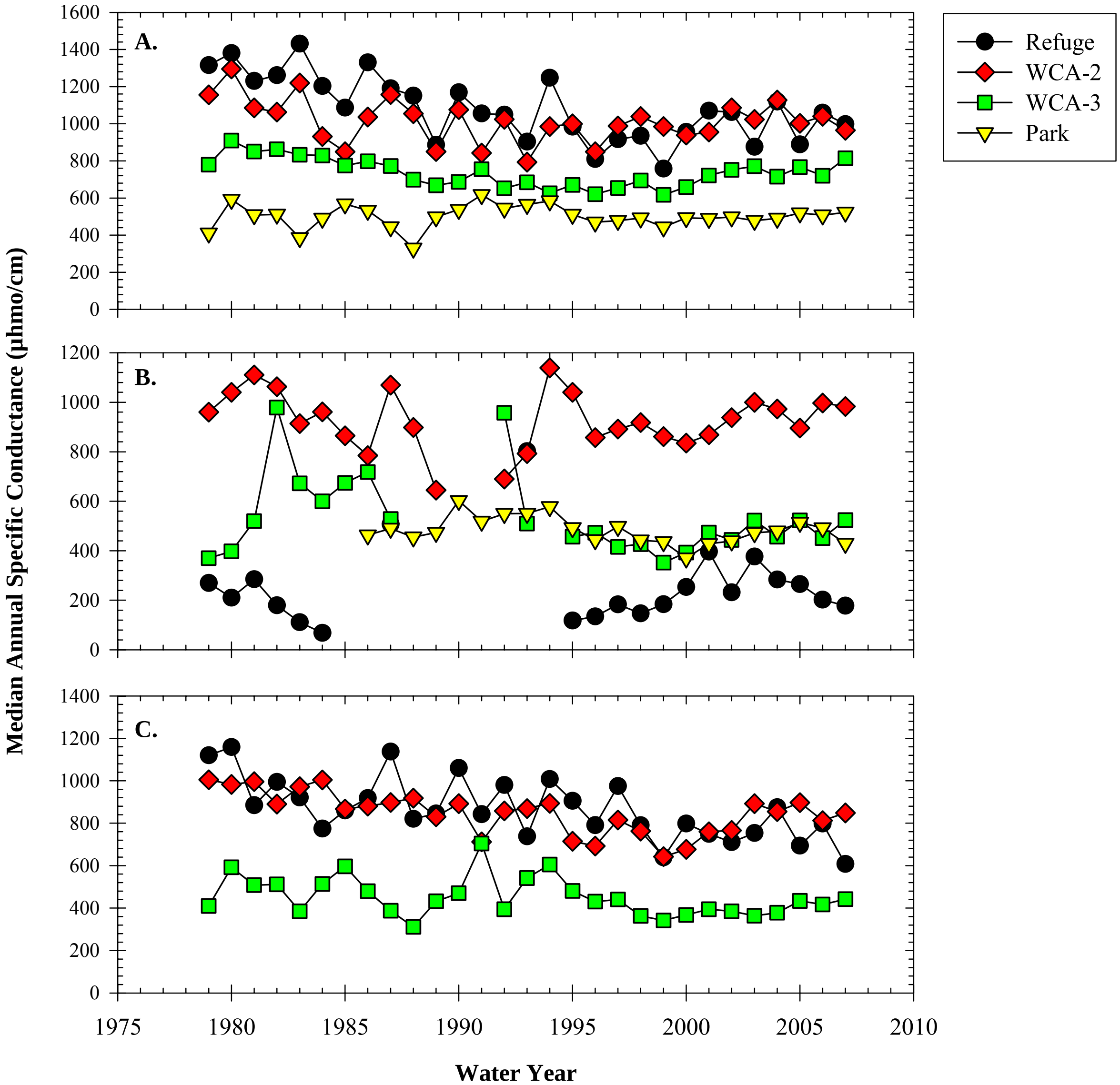

Figure 3A-6. Annual median specific conductance levels in EPA (A) inflows, (B) interior, and (C) outflows.

SULFATE

Currently, the state of Florida has no surface water criterion nor has the U.S. Environmental Protection Agency issued any guidance for sulfate (SO_4^{2-}). However, recent research has provided evidence of a link between sulfur biogeochemistry in sediment and pore water and mercury methylation (Atkeson and Parks, 2002; Atkeson and Axelrad, 2003; Axelrad et al., 2005; Axelrad et al., 2006). Sulfate in the surface waters of the Everglades is derived from a variety of natural and human sources. Furthermore, Chapter 3B of this volume and its appendices summarize the current state of scientific understanding and uncertainties of the effects of sulfate on the ecology and biogeochemical processes of the Everglades.

The sulfate monitoring results in the EPA are presented in this chapter to provide an overview of current concentrations and evaluate temporal and spatial patterns. Sulfate concentrations are summarized in **Table 3A-6** for, WY2007 and the WY1979–WY1993 baseline, WY1994–WY2004 Phase I and WY2005-WY2007 Phase II periods based on median, quartile, minimum, and maximum values. Individual station summaries are included in Appendix 3A-2. Given that one of the primary sources of sulfate entering the EPA is runoff from the north (e.g., EAA), sulfate concentrations in the inflow and interior marsh generally follow trends similar to those observed for total phosphorus and total nitrogen, that is, sulfate concentrations exhibit a general north-to-south gradient extending from the sources in the north to relatively unenriched areas in the south similar to those identified for nutrient levels (**Figure 3A-7**). High inflow concentrations in EAA runoff enter the Refuge, WCA-2, and, to a lesser extent, WCA-3. The highest concentrations within the EPA have been observed at the Refuge and WCA-2 inflow stations. However, a significant amount of the surface water entering the Refuge does not permeate deeply in the marsh but remains around the periphery of the area in the Rim Canal and is discharged to WCA-2 through STA-2 and the S-10 structures. Due to this hydrologic characteristic, the Refuge interior has remained relatively uninfluenced by the inflow of sulfate-rich water. Among the EPA marsh areas, the interior of WCA-2 exhibits the highest sulfate concentrations and is the area most affected by EAA runoff, with a WY2007 median concentration of 31 mg/L.

Table 3A-6. Summary of sulfate concentrations (mg/L) in the EPA for WY2007, WY2005–WY2007, WY1994–WY2004, and the pre-BMP Baseline period (WY1979–WY1993).

Region	Class	Period (Water Year)	N	Min.	25th Percentile	Median	75th Percentile	Max.
Refuge	Inflow	1979-1993	307	8.3	39	61	90	436
		1994-2004	589	<0.10	33	48	66	461
		2005-2007	216	2.4	41	53	68	116
		2007	86	2.4	35	47	59	112
	Rim	1979-1993	84	2.5	12	36	72	140
		1994-2004	524	1.6	38	50	69	140
		2005-2007	114	7.9	39	53	67	110
		2007	24	9.7	17	46	66	74
	Interior	1979-1993	325	2.5	5.5	9.8	16	663
		1994-2004	2040	<0.10	0.60	2.4	19	2900
		2005-2007	832	<0.10	0.54	1.6	5.6	84
		2007	208	<0.10	0.18	0.94	3.2	55
	Outflow	1979-1993	158	7.3	23	39	71	571
		1994-2004	232	1.4	28	41	58	419
		2005-2007	66	2.5	21	37	62	86
		2007	20	2.5	4.9	16	35	68
WCA-2	Inflow	1979-1993	194	7.3	35	51	72	644
		1994-2004	603	6.2	32	46	61	419
		2005-2007	197	3.7	33	45	64	106
		2007	60	3.7	24	39	49	85
	Interior	1979-1993	742	2.5	23	37	51	344
		1994-2004	2884	0.10	27	42	58	1400
		2005-2007	604	2.7	27	40	54	140
		2007	160	5.3	20	31	48	140
	Outflow	1979-1993	209	2.5	23	36	49	224
		1994-2004	190	2.3	19	28	37	73
		2005-2007	77	9.7	28	38	50	86
		2007	20	12	27	35	37	59
WCA-3	Inflow	1979-1993	580	1.0	11	22	45	286
		1994-2004	568	0.50	7.6	14	28	73
		2005-2007	225	0.80	6.3	18	37	86
		2007	62	0.80	5.7	15	36	59
	Interior	1979-1993	459	2.0	6.3	11	17	262
		1994-2004	1890	<0.10	1.3	3.4	10	120
		2005-2007	669	<0.10	1.1	3.1	15	84
		2007	164	<0.10	1.8	4.5	19	70
	Outflow	1979-1993	278	1.0	6.7	13	21	113
		1994-2004	300	<0.10	0.27	1.7	8.5	36
		2005-2007	126	<0.10	0.09	1.1	11	69

Table 3A-6. Continued.

Region	Class	Period (Water Year)	N	Min.	25th Percentile	Median	75th Percentile	Max.
Park	Inflow	1979-1993	265	1.0	6.6	12	21	113
		1994-2004	284	<0.10	0.49	2.2	8.1	36
		2005-2007	107	<0.10	0.10	1.7	9.6	36
		2007	30	<0.10	0.09	0.90	6.3	23
	Interior	1979-1993	568	0.75	2.5	4.3	7.3	206
		1994-2004	980	<0.10	1.0	2.2	4.9	403
		2005-2007	202	<0.10	0.60	1.8	4.8	242
		2007	58	<0.10	0.50	1.6	4.7	21

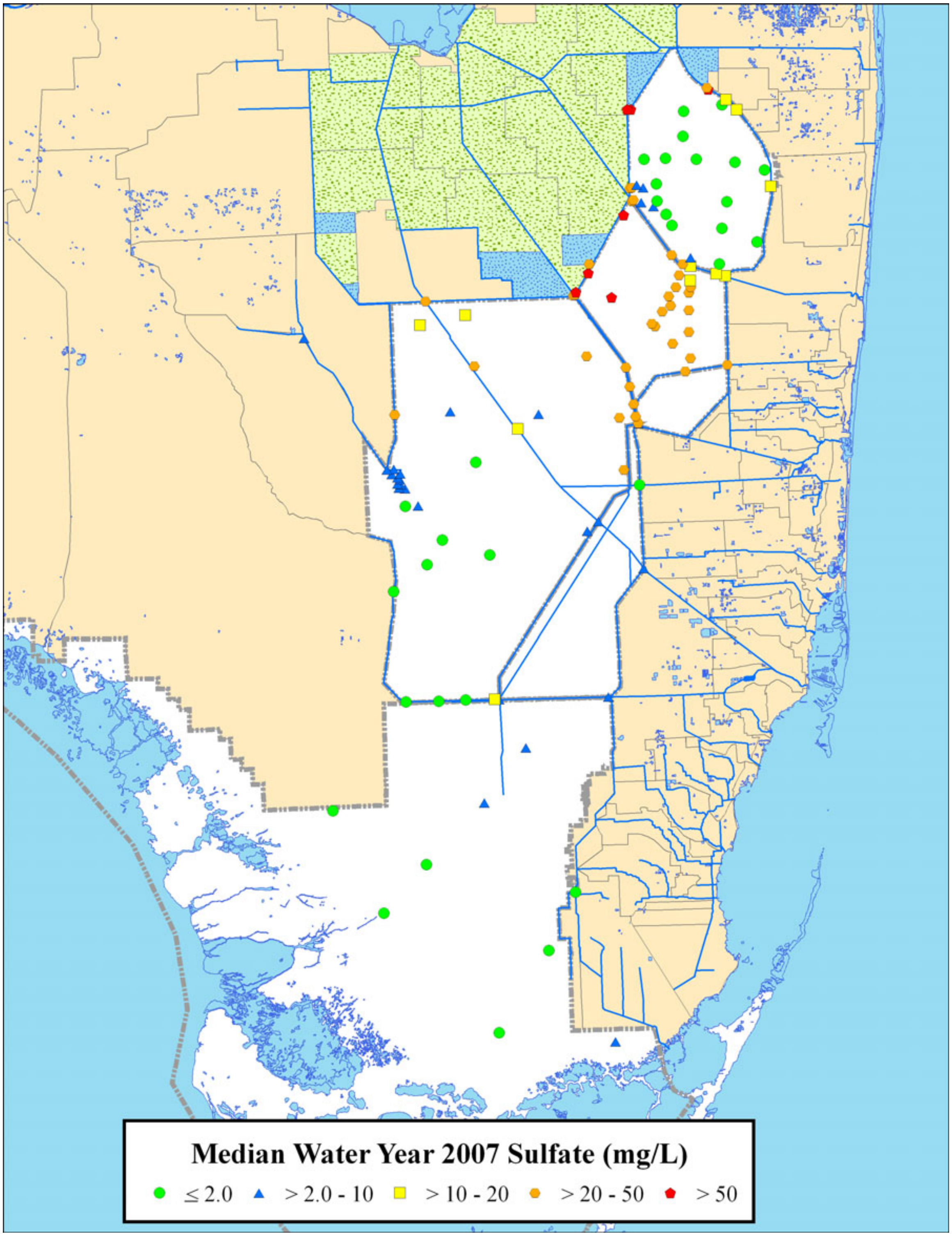

Figure 3A-7. Summary of median WY2007 sulfate concentrations (mg/L) at stations across the EPA. Median sulfate concentrations are classified utilizing five levels: ≤ 2 mg/L, > 2–10 mg/L, > 10–20 mg/L, > 20–50 mg/L, and > 50 mg/L.

PESTICIDES

The SFWMD has maintained a pesticide monitoring program in South Florida since 1984. The pesticide monitoring network includes sites designated in the Park Memorandum of Agreement (MOA), the Miccosukee Tribe MOA, the Lake Okeechobee Operating Permit, and the non-Everglades Construction Program (non-ECP) Structure Permit. The current monitoring program in the EPA consists of 21 sites and is conducted on a quarterly basis (**Figure 3A-8**). These sites were grouped by basin for analysis.

Surface water concentrations of pesticides are regulated under criteria established in Chapter 62-302, F.A.C. Chemical-specific numeric criteria for a number of pesticides and herbicides (e.g., DDT, endosulfan, and malathion) are listed in Section 62-302.530, F.A.C. Compounds not specifically listed, including many contemporary pesticides (e.g., ametryn, atrazine, and diazinon), are evaluated based on acute and chronic toxicity. A set of toxicity-based guidelines for non-listed pesticides were presented in the 2001 ECR (Weaver et al., 2001). These guideline concentrations were developed 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."

This chapter analyzes data collected during pesticide monitoring events conducted between May 2006 and March 2007. The period of record was selected as an update to the 2007 SFER and the availability of data at the time this report was written. Monitoring results were evaluated relative to Class III water quality criteria, chronic toxicity guidelines, and detected concentrations. Pesticides exceeding either the Class III criteria or chronic toxicity guideline concentrations were classified as concerns for the basin in which the exceedance occurred. Parameters classified as "concerns" have a likelihood of resulting in an impairment of the designated use of the water body. Detected water quality constituents (≥ MDL) that did not exceed either a guideline or criterion were categorized as a "potential concern." This classification signifies that the water quality constituent is known to be present within the basin at concentrations reasonably known to be below levels that can result in adverse biologic effects, but may only result in a problem at some future date or in interaction with other compounds. The "no concern" category was used to designate pesticides that were not detected at sites within a given area.

Exceedances of pesticide criteria and toxicity guidelines occurred at a few locations throughout the EPA throughout the period of record (**Table 3A-7**). An exceedance of the Class III total endosulfan (alpha and beta) criterion of 0.056 µg/L occurred on March 5, 2007, at C-111 station S-178. The total endosulfan concentration on this date was 0.057 µg/L. A measured dieldrin concentration of 0.003 µg/L at the S-5A inflow to STA-1W exceeded the single sample maximum criterion of 0.0019 µg/L on July 26, 2006. Additionally, on the same date at the S-5A structure, the DDE-P,P' concentration of 0.0051 µg/L exceeded the toxicity based guideline of 0.0006 µg/L. Exceedances of both atrazine (2.7 µg/L) and chlorpyrifos ethyl (0.017 µg/L) toxicity-based guidelines (1.8 and 0.002 µg/L, respectively) occurred at the S-6 inflow to STA-2 (WCA-2) on May 18, 2006.

Table 3A-7. Pesticide detection and exceedance categories in the EPA inflows, canals, and structures between May 2006 and March 2007. The categories of "concern" and "potential concern" are denoted by "C" and "PC," respectively; all others are considered "no concern." Number of detections and total number of samples are in parentheses. Typical Method Detection Limit (MDL) values are the media MDLs for the given period record.

Parameter	Refuge	WCA-2	WCA-3	Park	C-111	Typical MDL (µg/L)
Ametryn	PC (12:12)	PC (8:9)	PC (7:31)	(0:11)	(0:12)	0.0095
Atrazine	PC (12:12)	C (9:9)	PC (19:31)	PC (2:10)	PC (8:12)	0.0095
Atrazine Desethyl	PC (8:12)	PC (7:10)	PC (11:32)	(0:11)	(0:12)	0.0095
Atrazine Desisopropyl	PC (3:9)	PC (3:8)	PC (1:24)	(0:9)	(0:12)	0.0095
Bromacil	(0:12)	PC (1:11)	(0:32)	(0:11)	(0:12)	0.04
Chlorpyrifos Ethyl	(0:24)	C (1:21)	(0:64)	(0:22)	(0:24)	0.0095
DDE-P,P'	C (1:6)	(0:6)	(0:10)	(0:6)	(0:8)	0.0038
2-4-D	PC (1:11)	PC (1:12)	(0:23)	(0:10)	(0:8)	0.20
Dieldrin	C (1:9)	(0:11)	(0:26)	(0:11)	(0:12)	0.0019
Diuron	PC (2:12)	(0:10)	(0:23)	(0:5)	(0:8)	0.20
Endosulfan Sulfate	(0:7)	(0:8)	(0:26)	(0:11)	PC (3:12)	0.0046
Endosulfan (Alpha + Beta)	(0:9)	(0:11)	(0:26)	(0:11)	C (2:12)	0.0038
Hexazinone	PC (7:12)	PC (4:11)	PC (8:32)	(0:11)	(0:12)	0.01
Metolachlor	PC (1:12)	PC (2:11)	(0:29)	(0:9)	(0:12)	0.057
Norflurazon	(0:9)	(0:9)	PC (8:32)	(0:11)	(0:12)	0.019
Simazine	PC (3:12)	PC (2:10)	PC (3:32)	(0:11)	(0:12)	0.0095

1. ACME1DS, G-94D, and S-5A (via STA-1W)
2. S-38B, S-6 (via STA-2), and S-7
3. G-123, L3BRS, S-140, S-190, S-8, S-9, S-142, and S-31
4. S-12C, S-18C, and US41-25
5. S-176, S-177, S-178, and S-331

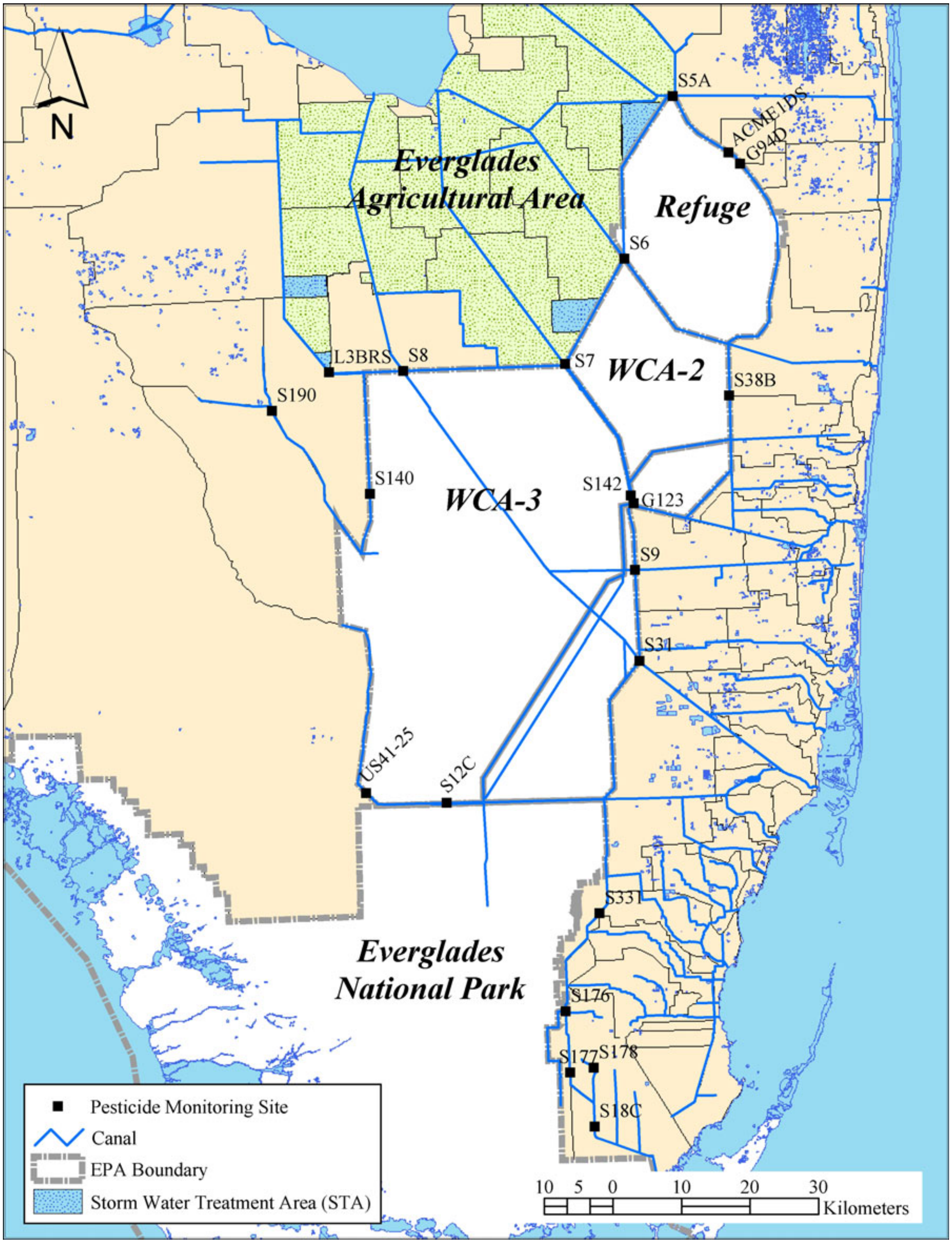

Figure 3A-8. SFWMD pesticide monitoring sites in the EPA.

WATER QUALITY MONITORING AND ANALYSIS FOR NON-ECP STRUCTURES

The non-Everglades Construction Project (non-ECP) permit requires District monitoring of all discharges for phosphorus, the parameter of primary concern, in addition to general water quality parameters to track the progress toward achieving compliance with water quality standards. The District is responsible for carrying out the programs mandated by the Everglades Forever Act (EFA) through compliance requirements stipulated in permits issued by the FDEP. On April 20, 1998, the FDEP issued the non-ECP permit (Permit No. 06.502590709) pursuant to Section 9(k) of the EFA. The permit authorizes the continued operation of water control structures that are operated, maintained, and controlled by the District that discharge waters "into," "within," or "from" the Everglades Protection Area but were not included in the permits issued for the ECP. Specific Condition 5 of the non-ECP permit requires the District to submit an annual report that includes results of the evaluation of water quality data and the Mercury Screening Program. Information contained in this volume fulfills the reporting requirements as detailed in the specific conditions of the non-ECP permit (see **Table 3A-8).** This information is further detailed in Chapter 11 of the 2000 Everglades Consolidated Report (SFWMD, 2001).

The purpose of this sub-section is to address water quality at the "into," "within," and "from" structures relative to the EPA. There are eight basins discharging directly to the EPA that are not part of the ECP. Five of these basins have "into" structures that are operated and maintained by the District and are permitted under the non-ECP permit: C-11 West, North New River Canal (NNRC), Feeder Canal, L-28, and C-111 basins. The three remaining non-ECP basins that discharge directly to the EPA are not permitted under the non-ECP permit because the discharge structures are not owned or operated by the SFWMD; these basins are the Village of Wellington's (VOW) ACME Improvement District, North Springs Improvement District (NSID), and Boynton Farms. These basins have structures that discharge to the EPA and are owned and operated by private or local drainage district entities. The location of non-ECP structures, the boundaries of the respective hydrologic contributing basins, and the EPA boundaries are presented in Appendix 3A-4, Figure 1.

Non-ECP permit conditions require the District to document the accuracy of collected data and to measure progress toward achieving and maintaining compliance with state water quality standards. The non-ECP water quality sampling sites, monitoring schedule, and flow volumes are presented in Appendix 3A-4a. Although phosphorus is of primary concern, the permit specifies that all state water quality standards should be met. To fulfill the requirements of the permit conditions, the District has completed an annual analysis of water quality data at non-ECP structures by comparing the data with state water quality standards. Unlike the ECP basins that are required to decrease TP levels in discharges based on historical loads, there is no phosphorus-specific requirement established at the point of discharge for the non-ECP basins in WY2007. Therefore, new technology based effluent limitations have been drafted for all non-ECP basins with discharge.

To document and measure progress toward achieving and maintaining compliance with state water quality standards, the District has compared WY2007 water quality data from non-ECP structures to state water quality standards. **Table 3A-9** provides the WY2007 summary of flow-weighted mean TP concentrations for each non-ECP basin. Results of all water quality analyses are included in Appendix 3A-4 of this volume.

Table 3A-8. Non-Everglades Construction Project (non-ECP) permit reporting requirements.

Specific Condition	Reporting Requirement	Location in 2008 SFER[2]
4[1]	New permit or permit modifications	Renewal in April 21, 2008
5	Submittal of Annual Report	Chapters 1, 3A, 3B, 4, 5, 7, and 8
6	Land acquisition and water treatment facility status update	2008 SFER – Volume II
7	First and second data evaluation reports	Completed in 1998 Annual Report
8	Regulatory Action Report	Chapter 4
9	Update on implementation of schedules and strategies	Chapters 1, 3A, 3B, 4, 5, 7, and 8
10	Laboratory Quality Assurance Manual	Current FDEP-approved manual
11	Mercury Screening Program Report	Chapters 3A and 3B
12	Annual Report, data requirements	See Specific Conditions 12 (b) – 12 (h)
12 (b)	Dates of sampling	Appendix 3A-4
12 (c)	Field Quality Assurance Manual	Current FDEP-approved manual
12 (d)	Map of sampling locations	Appendix 3A-4, Figure 1
12 (e)	Statement of sampling authenticity	Appendix 5-1
12 (f)	Quality Assurance Manual	Current FDEP-approved manual
12 (g) (i-v)	Water quality data and associated information	Appendix 3A-4
12 (g) (iv)	Monthly flow volumes	Appendix 3A-4
12 (h)	Water quality data evaluation	Appendix 3A-4
12(i)	Recommendations for improving water quality monitoring	Completed in 1998 Annual Report
12 (j)	Implementation of strategies	Chapters 1, 3A, 3B, 4, 5, 7, and 8
16	Monitoring Locations Report	Submitted to the FDEP in 1998
19	Additional strategies (if developed)	Not applicable at this time

[1] Specific conditions 1–3 do not deal with reporting requirements and, therefore, are not referenced in this table.

[2] All cross-referenced chapters and appendices are applicable to the 2008 SFER – Volume I unless noted otherwise.

Table 3A-9. Non-ECP basins annual flow-weighted mean total phosphorus (TP) concentrations and loads for WY2007.

Hydrologic Basin	Structure	Water Quality Station ID	Total Flow Volume (ac-ft)	Number of Days with Positive Flow	Sample Type	Sample Size (Grab)	Arithmetic Average (Grab) (ppb)	Sample Size (Comp)	Flow-Weighted Mean[1] Concentration (ppb)	Flow-Weighted Mean[2] Concentration (ppb)	TP Load (kg)
ACME Improvement District	ACME1DS	ACME1DS	13,611[3]	93[3]	G	15	62	0	93[4]	101[4]	1,701
	ACME1	VOW1	13,611	93	A, G	20	79	23	116	117	1,968
	G-94D	G94D	12,711[3]	95[3]	G	13	105	0	135[4]	161[4]	2,517
	ACME2	VOW2	12,711	95	A, G	20	144	23	159	141	2,217
North Springs Improvement District	NSID1	NSIDSP01	0	0	A, G	27	20	2	NDF	NDF	0
		S-38B (WCA-2A near NSID1)	0[5]	0[5]	G	0	0	0	NDF	NDF	0
North New River Canal	G-123	G123	0	0	A, G	52	20	0	N/F	N/F	0
C-11 West	S-9	S9	42,459	40	A, G	51	12	16	19	19	999
	S-9A	S9A	81,353	313	A, G	51	13	45	13	13	1,307
C-111	S-174	S174	1	3	A, G	17	11	0	N/F	5	0
	S-332D	S332D	45,048	161	A, G	45	7	23	7	7	375
	S-18C	S18C	80,357	153	A, G	43	7	19	7	7	693
L-28	S-140	S140	88,518	142	A, G	51	36	33	47	47	5,117
Feeder Canal	S-190	S190	70,727	121	A, G	49	46	14	215	215	19,759
Boynton Farms	Various[6]	Various[6]	N/D	N/D	G	16	1,433	N/D	N/D	N/D	N/D

1 Based on days of flow and monitored TP data only

2 Based on estimation algorithm to determine TP concentration on non-monitored days combined with monitored days

3 Flow data from upstream pump structures, ACME1 and ACME2, is representative of the flow through the ACME1DS and G94D culverts, respectively

4 Calculated using the flow data at upstream structures

5 Flow data from upstream structure NSIDSP01 is representative of flow into the EPA at S-38B

6 Pumps that have no flow recording devices attributed include the following: BFBAFCP, BFBAFNP, FBAFSP, BFBDFCP, BFBDFNP, BFBDFSP, BFBDFWP, and BFBMFSP.

G Samples collected by grab sampling methodology.

A Samples collected by automatic composite samples

NDF No data with flow available

N/F No flow

N/D No data available

In compliance with Specific Condition 5, the appendices of this chapter include an annual update of the non-ECP permit monitoring program, report non-ECP program monitoring results, and a comparison of WY2007 water quality data from samples collected at non-ECP structures to state water quality standards. The comparisons fulfill non-ECP permit requirements to document the accuracy of the collected data and measure progress toward achieving and maintaining compliance with state water quality standards. The data for the groups of water quality parameters, including physical parameters, nutrients, major ions, and trace metals, were evaluated for WY2007. The evaluation indicated that few excursions from Class III water quality standards were found in samples collected at non-ECP structures, except for various incidences of DO. The excursions include results for turbidity at G-94D and S-178. Based on the analysis provided in Appendix 3A-4 of this volume, the quarterly surface water and semiannual sediment pesticide sampling events at the 14 non-ECP sites for WY2007 were conducted during May 2006, July 2006, October/November 2006, and March 2007. The only pesticide detection of concern was the endosulfan (alpha and beta) concentration of 0.057 µg/L at S-178. This concentration slightly exceeds the Chapter 62-302, F.A.C., Class III surface water quality standard of 0.056 µg/L. Pesticides detected in the sediment samples collected during WY2007. Pesticides with concentrations greater than the PQL were assigned to the "potential concern" excursion category. Dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE), both environmental dehydrochlorination product of dichlorodiphenyltrichloroethane (DDT), as well as endosulfan sulfate, were detected at two locations at levels of "potential concern," in the sediment samples at S-177 and S-178 from the C-111 basin.

The non-ECP permit was amended on January 21, 2005, to remove the S-10E structure because it is no longer needed and has been decommissioned. The non-ECP permit was also amended on May 18, 2005, to remove monitoring of all trace metals and all major ions (except sulfate), and some nutrient and physical parameters. Therefore, monitoring reporting for these parameters was discontinued in WY2007. The non-ECP permit was amended on July 13, 2006, to (1) reclassify the S-332 and S-175 structures as "within" structures, (2) incorporate the S-332D and S-174 structures as "into" structures, (3) add Berm B3 as a "within" structure, and (4) take out the G-71 structure as a structure required to be monitored because this structure has been decommissioned and removed in 2002.

Chapter 11 of the 2001 ECR; Chapter 8B of the 2002, 2003, and 2004 ECRs; Chapter 3 of the *2005 SFER – Volume I*, and Chapter 3A of the 2006 and *2007 SFER – Volume I* included comparisons of state water quality standards to water quality data obtained from non-ECP structures. These historical analyses found that few excursions from Class III numeric water quality criteria for any parameter in the eight non-ECP contributing basins except for DO. There were excursions from the existing standard for DO, but the FDEP has completed an evaluation of DO levels in the EPA and developed a site-specific alternative criterion to formally recognize the natural background conditions in the EPA marshes. Additional information on the DO SSAC can be found in this chapter.

As phosphorus is the primary parameter of concern for Everglades restoration, it is the focus of water quality considerations for the non-ECP basins. Although no load limitations have been established for the basins, TP concentrations are monitored to determine progress toward the goals established in the non-ECP permit. **Table 3A-9** summarizes the flow-weighted mean TP concentrations, total flow volumes, and TP loads for all non-ECP basins during WY2007.

The WY2007 flows reported in **Table 3A-9** from ACME Improvement District were slightly lower than in WY2006; however, there was a slightly increase of the TP load from this basin in WY2007, when compared to the WY2006 TP load. Some of the highest TP concentrations for non-ECP structures discharging directly to the EPA during WY2007 were observed for the Feeder Canal through S-190 and the ACME Improvement District basin through monitoring locations at the G-94D culverts and ACME1DS and at the upstream pump stations: (1) ACME1 (auto-sampler VOW1) and (2) ACME2 (auto-sampler VOW2). The ACME1DS and G-94D culverts, operated by the Village of Wellington, closed from 1/18/07 and no long discharge to the Refuge when upstream pump stations ACME1 or ACME2 are operating. The monitoring agreement with VOW resulted in a sufficient number of samples (43 at VOW1 and 43 at VOW2) collected by both grab and auto-sampler techniques upstream of the pump stations to cover a broad range of flows. The samplings at VOW1 and VOW2 have been stop on 1/2/2007 because there was no flow at the structures.

As shown in Appendix 3A-4b, Table 3, more than 75 percent of the data collected at the upstream VOW1 monitoring sites were below 110 parts per billion (ppb), with median TP values ranging between 89 ppb (auto) and 66 ppb (grab). More than 75 percent of the data collected at the upstream VOW2 monitoring sites were below 175 ppb, with median TP values ranging from 130 ppb (auto) to 125 ppb (grab). Discharge data were not available for the ACEM1DS and G-94D culverts, although discharge data from the upstream pump stations during WY2007 [13,611 acre-feet (ac-ft) and 12,711 ac-ft for ACME1 and ACME2, respectively] can be used as an indication of the magnitude and occurrence of flow through the downstream culverts.

As there were no flows, there were no TP loads from the NNRC and NSID basins for WY2007. A comparison to last year's data indicated a slightly increase of TP load from the ACME Improvement District and a decrease of TP loads from C-11 West, the Feeder Canal, L-28, and C-111 basins. The changes in loads from these basins are predominantly associated with changes in flow volumes which were lower for C-11W through S-9 and S-9A, Feeder Canal through S-190, L-28 through S-140, and C-111 through S-174, S-332D, and S-18C.

The flow-weighted mean TP concentrations vary greatly among different basins. In WY2007, the highest TP concentrations are identified in the Feeder Canal basin and ACME Improvement District, whereas the C-11 West basins have TP concentrations below 50 ppb. There was a slightly decrease in TP concentration for the L-28 basin (flow-weighted mean TP of 47 ppb for WY2007 versus 50 ppb in WY2006). The TP concentrations observed for the Feeder Canal basin showed median TP concentrations of 30 ppb for grab samples, and 52 ppb for auto samplers; the TP concentrations observed for the L-28 basin showed median TP concentrations of 35 ppb for grab samples and 45 ppb for auto samplers. During WY2007, the Feeder Canal basin discharged 70,727 ac-ft, and the L-28 basin discharged 88,518 ac-ft into the western portion of WCA-3A. Though many of these concentrations are relatively low, all concentrations greater than approximately 10 ppb will have to be addressed further (as discussed in Chapter 3C of this volume).

Table 3A-7 also presents information for the S-9A and S-9 pump stations. In WY2007, the flow-weighted mean TP concentration of water discharged from the S-9A pump station was 13 ppb, compared with a flow-weighted mean TP concentration of 19 ppb through the S-9 pump station. The total flows pumped through both the S-9 and S-9A stations were increased by 33 percent at S-9A and decreased by 67 percent at S-9 respectively for WY2007 (42,459 ac-ft for S-9 and 81,353 ac-ft for S-9A) compared with WY2006 (128,470 ac-ft for S-9 and 61,345 ac-ft for S-9A). Furthermore, the total flow through both structures combined had a flow-weighted mean TP concentration of 15 ppb in WY2007, which was slightly lower than in WY2006 (18 ppb).

Similar to WY2006, there was no flow into the EPA that occurred at the NSID1 and G-123 structures due to the operational changes implemented by the NSID and the District, respectively. The C-111 basin has the lowest TP concentrations observed at S-174, and S-332D and S-18C, which discharge to the Park, specifically to Taylor Slough (via the L-31N borrow and L-31W borrow canals) and the Park's panhandle (via the C-111 canal). The TP data for these monitoring locations had an observed median concentration of 6 ppb (grab) and 9 ppb (auto) for S-18C; 6 ppb (grab) and 7 ppb (auto) for S-332D; 9 ppb (grab) for S-174; 75 percent of the samples having concentrations below 7 ppb (grab); 10 ppb (auto) for S-18C; 11 ppb (grab) for S-174; and 9 ppb (grab) and 10 ppb (auto) for S-332D. During WY2007, the S-174 discharged only 1 ac-ft, and S-332D discharged 45,048 ac-ft to the Park. The S-18C structure discharged approximately 80,357 ac-ft to the lower C-111 canal, significantly lower than WY2006 (7,203 ac-ft at S-174; 153,803 ac-ft at S-332D and 188,505 ac-ft at S-18C).

Historically, the Boynton Farms basin exhibits the highest TP concentrations (average of 973 ppb, see the *2005 SFER – Volume I, Chapter 3A*) of any basin. This average is based on a total of 63 samples at 11 locations, on 18 sampling events from April 2000 to November 2003. In WY2006, three sampling locations, representing one farm, have been eliminated as the farm has removed the pumps and were not discharging to the refuge anymore. As there was no flow for this basin, no flow-weighted mean TP concentrations could be determined. The Boynton Farms basin water quality monitoring program is still ongoing, and 16 grab samples were collected with average TP concentration of 1,433 ppb for WY2007.

It is anticipated that the implementation of the water quality improvement plans as recommended in the Long-Term Plan for the non-ECP basins will significantly contribute to achieving long-term water quality standards in the EPA. Water quality data is tracked for increasing and decreasing trends so that the action plan may be modified, as necessary, through an adaptive management process to ensure optimization measures for TP reduction and for other parameters of concern.

An evaluation of the non-ECP basin data indicates that the quality of water discharging into the EPA is generally acceptable. However, there are exceptions for phosphorus, DO, and occasional excursions from standards for turbidity. The only pesticide detection of concern was the endosulfan (alpha and beta) concentration of 0.057 μg/L at S-178. Dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE), both environmental dehydrochlorination product of dichlorodiphenyltrichloroethane (DDT), as well as endosulfan sulfate, were detected at two locations at levels of "potential concern", in the sediment samples at S-177 and S-178 in the C-111 basin.

Analysis of TP concentrations in WY2007 continues to indicate significant differences between non-ECP basins. Phosphorus is categorized as a concern (above 50 ppb) for the ACME Improvement District and Feeder Canal; and a potential concern (10 ppb < TP < 50 ppb) for the L-28 and C-11 West basins. There was no concern (TP < 10 ppb) at the C-111 basins. There was no discharge in the NSID and NNRC basins. Except for phosphorus levels, the quality of water discharging into the EPA is generally acceptable. The portion of the District's water quality monitoring program that has been implemented as a result of the EFA and the non-ECP permit indicates that TP concentrations are greater than 10 ppb in discharges from four of the eight non-ECP basins (Feeder Canal, ACME, L-28, and C-11 West). There was no discharge from three basins (NSID, NNRC, and Boynton Farms). The average TP concentration was 1,433 ppb but no discharge from Boynton Farms in WY2007. The District will continue to monitor water quality in accordance with the non-ECP permit to measure progress toward achieving compliance with state water quality standards.

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