Chapter 8A: Achieving Long-Term Water Quality Goals

Gary F. Goforth, Tracey T. Piccone, Stuart Van Horn,
Doug Pescatore and Cheol Mo

SUMMARY

The South Florida Water Management District (SFWMD or District), the Florida Department of Environmental Protection (FDEP or Department) and other parties are aggressively pursuing interim and long-term Everglades water quality goals. Interim measures to reduce phosphorus (P) levels include Everglades Agricultural Area (EAA) landowner Best Management Practices (BMPs) and construction and operation of Stormwater Treatment Areas (STAs). These phosphorus control programs have proven very effective at reducing the amount of P entering the Everglades. As of this date, the EAA BMPs and downstream STAs have removed more than 1,300 tons of P that otherwise would have entered the Everglades. The EAA BMPs have exceeded their 25 percent load reduction target by yielding more than a 50-percent reduction. Average outflow concentrations from the STAs have been less than 35 parts per billion (ppb), well below their 50-ppb target. The long-term water quality goal established by the Everglades Forever Act (EFA) pertains to water delivered to the Everglades Protection Area (EPA) to achieve state water quality standards by December 31, 2006. Investigations of how to improve STA performance, and exploration of new technologies, aided by research costing in excess of $35 million, have resulted in significant advances toward achieving this long-term goal. Even so, the effort to maintain water quality is an inexact science, particularly as it pertains to the extremely low levels of phosphorus associated with Everglades Forever Act mandates. Continuation of STA optimization research is needed to ensure that the long-term goal is achieved. This chapter describes the integration of research, planning, construction and other activities designed to achieve this long-term water quality goal and identifies the key remaining challenges.

INTRODUCTION

The Everglades Forever Act (EFA) establishes a long-term water quality goal for water delivered to the EPA to achieve state water quality standards by December 31, 2006. By December 31, 2003, the EFA requires the District to submit to the FDEP a permit modification to incorporate proposed changes to the Everglades Construction Project (ECP), as well as permits issued for the other structures that discharge into, through or from the EPA. By December 31, 2003, if discharges to the EPA are in compliance with state water quality standards, including the P criterion, then the permit application shall include a plan for maintaining compliance in the EPA with state water quality standards. If the ECP or other discharges to the EPA are not in compliance with state water quality standards by December 31, 2003, then the permit application shall include the following:

1. A plan for achieving compliance with state water quality standards in the Everglades Protection Area
2. Proposed cost estimates for the plan referred to in (1), above
3. Proposed funding mechanisms for the plan referred to in (1), above
4. Proposed schedules for implementation of the plan referred to in (1), above

The EFA intended "to provide a sufficient period of time for construction, testing and research so the benefits of the ECP will be determined and maximized prior to requiring additional measures." (373.4592(1)(g), F.S.). Presently, many scientific, engineering, regulatory and other uncertainties remain that will significantly influence the final plan. It is the District's intent to continue research and STA optimization efforts to address the remaining scientific and engineering uncertainties. Other sections of the *2003 Everglades Consolidated Report* (2003 ECR), particularly chapters 3, 4, and 8B, which provides information regarding the Everglades Stormwater Program (ESP), describe the numerous research, regulatory and construction activities.

WATER QUALITY IMPROVEMENT STRATEGIES

The District is currently developing water quality improvement strategies to determine the optimal combination of source-control, basin-level and regional solutions to achieve the long-term water quality goal for discharges to the EPA. Four primary components to the water quality improvement strategies are anticipated:

1. Improvement of source controls, including Best Management Practices (BMPs)
2. Optimization of Stormwater Treatment Areas (STAs)
3. Testing of Advanced Treatment Technologies (ATT)
4. Synchronization with Comprehensive Everglades Restoration Plan (CERP) projects

The District is conducting Basin-specific Feasibility Studies that will integrate information from research, regulation and planning to provide information necessary to allow policy makers to determine the optimal combination of source controls and basin-scale treatment to meet the final water quality objectives for the EPA. Of the 15 basins that discharge into the EPA, the Basin-specific Feasibility Studies will identify and evaluate alternative solutions for seven basins included in the ECP, and six basins covered by the ESP. The remaining two ESP basins (the C-111 basin and the Boynton Farms basin) will be addressed through other District and federal programs. A summary of the basins included in the Basin-specific Feasibility Studies is presented in **Table 8A-1**.

Table 8A-1. Everglades Protection Area tributary basins included in Basin-specific Feasibility Studies

Basin	Canal	STA	Receiving Water
S-5A (EAA)	West Palm Beach Canal	STA-1W, STA-1E, STA-2	A.R.M. Loxahatchee National Wildlife Refuge (WCA-1)
S-6 (EAA)	Hillsboro Canal	STA-2	WCA-2A
S-7 (EAA)	North New River Canal	STA-3/4	WCA-3A
S-8 (EAA)	Miami Canal	STA-3/4, STA-6	WCA-3A
C-51 West & L-8 Basin	C-51 West	STA-1E, STA-1W	A.R.M Loxahatchee National Wildlife Refuge (WCA-1)
C-139 (including Annex)	L-3 Canal	STA-5, STA-6	WCA-3A
ACME Basin B	N/A	N/A	WCA-1
North Springs Improvement District	N/A	N/A	WCA-2A
North New River Canal (G-123)	North New River Canal	N/A	WCA-3A
C-11 West	C-11 West	N/A	WCA-3A
Feeder Canal	L-28 Interceptor Canal	N/A	WCA-3A
L-28	L-28	N/A	WCA-3A

The Basin-specific Feasibility Studies are being conducted according to the following steps:

1. Develop baseline flow and phosphorus data sets.
2. Develop a methodology to evaluate alternative water quality measures, based on the factors established in the 1994 Everglades Forever Act, and other appropriate considerations.
3. Develop basin-specific alternative combinations of water quality solutions (e.g., source control, STA optimization and Advanced Treatment Technologies).
4. Evaluate alternative solutions developed in step 3 using the evaluation methodology developed in step 2.

For step 1, the District developed a Baseline Data Report consisting of baseline flow and P data sets for 13 basins covered by the Basin-specific Feasibility Studies (Goforth and Piccone, 2001). The 31-year baseline flow and P datasets developed for each basin are summarized in **Table 8A-2**. In general, the baseline data sets combine simulated flow values from the South Florida Water Management Model (SFWMM) for the period 1965 through 1995, with historic P concentrations developed from Water Years 1990 through 1999 (WY90 through WY99).

The Preliminary Baseline Data Report (Goforth and Piccone, 1999), including the methodology used to develop the 31 years of daily flow and phosphorus data sets for the 13 EPA tributary basins, was independently peer reviewed by the consulting firm of PB Water, a division of Parsons Brinckerhoff Quade and Douglas, Inc. Based on the recommendations received in the peer-reviewed document, as well as feedback received from various stakeholders, the Preliminary Baseline Data Report was revised, resulting in the 2001 version referenced above.

Table 8A-2. Summary of simulated baseline flows and phosphorus (1965 through 1995)

Basin / STA	Mean Annual STA Inflow (acre-feet)	STA Inflow Phosphorus (parts per billion)	Mean Annual Phosphorus Load (kg)	Mean Annual Discharge to EPA (acre-feet)	Discharge Phosphorus (parts per billion)	Mean Annual Phosphorus Load (kg)
C-51 West / STA-1 East	133,331	176	28,950	148,400	38	6,957
S-5A / STA-1 West	160,335	139	27,399	188,100	24	5,569
S-6 / STA-2	233,473	100	28,831	223,200	33	9,086
S-7, S-8 / STA-3/4	660,889	88	72,019	623,700	33	25,390
C-139 / STA-5	*132,113**	*178**	*29,039**	*125,900*	46	7,144
EAA, C-139 Annex / STA-6 (Sections 1 and 2)	*37,887**	*85**	*3,978**	*35,300*	30	1,306
Acme Basin B	N/A	N/A	N/A	31,499	94	3,660
North Springs Improvement District	N/A	N/A	N/A	6,168	39	293
N. New River Canal Basin	N/A	N/A	N/A	1,781	18	40
C-11 West Basin	N/A	N/A	N/A	194,167	17	4,063
L-28 Basin	N/A	N/A	N/A	83,806	39	3,982
Feeder Canal Basin	N/A	N/A	N/A	77,179	156	14,854

Reference: Goforth and Piccone, 2001

Notes:

1. Phosphorus concentrations are presented as flow-weighted means.
2. Inflow volumes, concentrations, and loads for STA-5 and STA-6 were revised since the 2001 Baseline Data Report. The results of a new SFWMM simulation (BASERR2R, Dec. 2001) are shown in italics.
3. All STA baseline discharge volumes, concentrations, and loads were revised since the 2001 Baseline Data Report. The values shown are the draft results of DMSTA simulations performed by the consultant using the SAV_C4 calibration set.

For step 2, the District, in concert with stakeholders and consultant teams, developed an evaluation methodology for evaluating alternative water quality solutions (Goforth and Piccone, 2002). The evaluation methodology was developed to assist in achieving the December 2003 (integrated water quality plans and permit applications) and December 2006 (compliance with water quality standards) Everglades Forever Act mandates. The evaluation methodology, which was independently peer reviewed and refined over a period of several months, contains technical, environmental and economic criteria summarized in **Table 8A-3**. The evaluation methodology can be viewed at the following online location:

http://www.sfwmd.gov/org/erd/bsfboard/bsfsboard.htm.

Table 8A-3. Summary of evaluation factors

Evaluation Factor	Unit
Technical Performance Criteria	
Level of phosphorus load reduction	%
Long-term flow-weighted mean phosphorus concentration achieved	ppb
Long-term geometric mean phosphorus concentration achieved	ppb
Implementation schedule	Years
Operational flexibility, including adaptive management	-3 worst +3 best
Resiliency to extreme conditions	-4 worst +4 best
Assessment of full-scale construction and operation	-3 worst +3 best
Management of side streams	-3 worst +3 best
Environmental Criteria	
Level of improvement in non-phosphorus parameters	-19 worst +19 best
Economic Criteria	
50-yr Present Worth Cost	$
Cost-effectiveness	$/kg

For step 3, the District, in concert with stakeholders, developed approximately 40 alternative combinations of point source control, basin-level, and regional water quality treatment solutions for the 13 EPA tributary basins covered by the Basin-specific Feasibility Studies. In preparing these alternative solutions, the District used the baseline flow and P data sets and the results from BMP research, STA optimization research, ATT research and other ongoing research activities. The majority of Everglades tributary basins covered in the Basin-specific Feasibility Studies also contain components of the CERP. These components were taken into account when developing the alternatives because the components can significantly influence baseline flows and water quality characteristics, and because cost savings can be realized by integrating the long-term water quality solutions with the CERP components. The alternative solutions were independently peer reviewed by two consulting firms. The peer-reviewed reports and the documents describing the alternatives can be found at the online location cited previously.

To complete step 4, the District procured the services of two consulting firms to evaluate the alternatives described in step 3, above. The consulting firm Burns and McDonnell evaluated the ECP basin alternatives, while the consulting firm Brown and Caldwell evaluated ESP basin alternatives. Both firms used the evaluation methodology developed in step 2 to evaluate the alternatives shown in **Table 8A-4** (ECP basins) and **Table 8A-5** (ESP basins). The results of the evaluation of alternatives can be reviewed at the following online location:

http://www.sfwmd.gov/org/erd/bsfboard/bsfsboard.htm.

Table 8A-4. Summary of ECP basin alternatives

Basin/STA	Alt.	Source Controls	CERP Project	Regional Treatment	Regional Treatment Target Completion
STA-1E	Baseline	0% C-51W runoff and ~50% S-5A portion	N/A	STA-1E (existing)	2006
	1	0-25% for C-51W & 25-75% for S-5A	N/A	Optimize STA-1E by 2006	2006
STA-1W	Baseline	~50%	N/A	STA-1W (existing)	2006
	1	25-75%	N/A	Optimize STA-1W by 2006	2006
Combined STA-1E & STA-1W	2	0-25% for C-51W & 25-75% for S-5A	N/A	If needed, expand STA-1E and STA-1W by 2006	2006
	3	0-25% for C-51W & 25-75% for S-5A	N/A	If needed, expand STA-1E and STA-1W to treat Acme Basin B by 2006	2006
	4	0-25% for C-51W & 25-75% for S-5A	2011	Optimize STA-1E and divert Acme Basin B runoff to STA-1E by 2006, then if needed, divert/Treat Acme Basin B in Rock Pits by 2011	2006
STA-2	Baseline	~50%	N/A	STA-2 (existing)	2006
	1	25-75%	N/A	Optimize STA-2 by 2006	2006
	2	25-75%	N/A	If needed, construct chemical treatment facility within footprint of STA-2 by 2006	2006
STA-3/4	Baseline	~50%	N/A	STA-3/4 (existing)	2006
	1	25-75%	2014	Optimize STA-3/4 by 2014	2014
	2	25-75%	2014	Optimize STA-3/4 by 2006	2006
	3	25-75%	2014	If needed, expand STA-3/4 by 2006 using SAV	2006
	4	25-75%	2014	If needed, expand STA-3/4 by 2006 using PSTA	2006
STA-5 and STA-6	Baseline	50% for EAA; 0% for C-139	N/A	Existing STA-5 and STA-6, Sections 1 and 2	2006
	1	25-75% for EAA & 25% for C-139	2014	Optimize, if needed, STA-5 and STA-6, Sections 1 and 2, by 2014	2014
	2	25-75% for EAA & 25% for C-139	2014	Optimize treatment in STA-5 and STA-6 by 2006	2006
	3	25-75% for EAA & 25% for C-139	2014	Expand STA-5 to the west, optimize STA-5 and STA-6 Section 1, and size STA-6 Section 2 as needed	2014
	4	25-75% for EAA & 25% for C-139	2014	STA-5 and STA-6, Sections 1 and 2	2014

Table 8A-5. Summary of ESP basin alternatives

Basin/STA	Alt.	Source Controls	CERP Project	Regional Treatment	Regional Treatment Target Completion
Acme Basin B	1	25% by 12/31/06; use 0% and 50% in sensitivity analysis	2013	None - diversion away from Everglades	2013
	2	25% by 12/31/06; use 0% and 50% in sensitivity analysis	N/A	Construct chemical treatment facility	2006
	3	25% by 12/31/06; use 0% and 50% in sensitivity analysis	N/A	Construct STA on 375 acres owned by District	2006
	4	25% by 12/31/06; use 0% and 50% in sensitivity analysis	N/A	Construct STA on 375 acres + additional land if needed	2006
	Base Condition	Assumes 25% load reduction due to source controls	N/A	None	N/A
C-11W	1	0% by 12/31/06; use 25% in sensitivity analysis	2036	Construct chemical treatment facility	2005
	2	0% by 12/31/06; use 25% in sensitivity analysis	2036	Construct STA	2005
	Base Condition	0% by 12/31/06; use 25% in sensitivity analysis	2036	None - diversion of most of the runoff away from Everglades	N/A
NSID	1	N/A	2007	None - diversion away from Everglades	2006
	2	N/A	N/A	None - diversion away from Everglades	2006
	Base Condition	0% by 12/31/06; use 25% in sensitivity analysis	2007	None - diversion away from Everglades	N/A
NNRC	1	N/A	2018	Construct chemical treatment facility and operate through 2018 then divert away from Everglades	2006
	2	N/A	2018	None- discontinue use of G-123 by 2006	N/A
	Base Condition	0% by 12/31/06; use 25% in sensitivity analysis	2018	None - continue G-123 discharges until 2018, then divert away from Everglades	N/A
L-28	1	0% by 12/31/06; use 25% in sensitivity analysis	2015	Construct STA	2006
	Base Condition	0% by 12/31/06; use 25% in sensitivity analysis	2015	None	N/A
Feeder Canal	1	50, 75 and 100 ppb	2015	Construct STA	2006
	Base Condition	50, 75 and 100 ppb	2015	None	N/A

The consultants used the Dynamic Model for Stormwater Treatment Areas (DMSTA) to evaluate the P-removal performance of the alternatives that use biological systems, such as submerged aquatic vegetation (SAV), periphyton and cattails. DMSTA simulates daily water and mass balances in a user-defined series of wetland treatment cells, each with specified morphometry, hydraulics and phosphorus cycling parameters. Up to six treatment cells can be linked in series and/or parallel to reflect compartmentalization and management to promote specific vegetation types. Because there is ongoing scientific debate as to the most appropriate parameter data set to use for predicting the P-removal performance of SAV, the consultants used two different SAV parameter sets to present a range of performance for each of the biological alternatives. The evaluations also included sensitivity analyses to account for technical and other uncertainties. The evaluation of alternatives was completed in November 2002. This evaluation of alternatives is a fact-gathering activity and by itself will not determine or recommend an optimal combination of water quality treatment solutions. However, the results of the evaluation will provide the Florida Legislature, the District governing board, and other stakeholders with critical technical information necessary for making policy decisions regarding the optimal combination of water quality treatment solutions. It is anticipated that once policy makers determine the best solution and sufficient funds are appropriated, then individual water quality improvement solutions will be finalized for each basin, and design and construction will proceed. The next step in the process to achieving long-term water quality goals includes preparation of conceptual plans for the recommended solutions. The conceptual plans are scheduled to be completed by November 2003, to be included in the permit applications to be submitted to the FDEP by December 31, 2003.

CHALLENGES TO ACHIEVING LONG-TERM WATER QUALITY GOALS

Successful development and implementation of the water quality improvement strategies will require integration of numerous research, planning, regulatory and construction activities as introduced in Chapter 1. The District and the FDEP are committed to achieving the long-term water quality goals. Some of the more significant challenges for doing so include regulatory issues, uncertainties in source control and regional treatment technologies, synchronization with CERP projects, and a lack of funding. Subsequent design phases will include updates of the assumptions used in the Basin-specific Feasibility Studies to incorporate the best available information into the design process.

REGULATORY ISSUES

The State of Florida's Environmental Regulation Commission is addressing two relevant regulatory issues:

1. Establishing a numeric criterion for phosphorus in the Everglades
2. Establishing the measurement methodology (locations and monitoring frequency) for compliance with the phosphorus standard

The EFA requires the FDEP to initiate P criterion rulemaking by December 2001. Efforts toward rule development were begun during the summer of 2001. The EFA establishes a default P criterion of 10 ppb if rulemaking is not completed by December 31, 2003. Concurrent with P criterion rulemaking, the method for determining compliance with these criteria will be finalized in accordance with the framework described in the EFA (section 373.4592(4)(e)3, F.S.):

> Compliance with the phosphorus criterion shall be based upon a long-term geometric mean of concentration levels to be measured at sampling stations recognized from the research to be reasonably representative of receiving waters in the Everglades Protection Area, and so located so as to assure that the Everglades Protection Area is not altered so as to cause an imbalance in natural populations of aquatic flora and fauna and to assure a net improvement in the areas already impacted.

Once the numeric criterion and measurement methodology are established, the FDEP will be able to establish discharge limits for waters entering the EPA. To establish these limits the FDEP will consider the relationship between waters entering the Everglades and the resulting water quality in the Everglades. Details on P criterion development are presented in Chapter 5.

In addition, the FDEP must complete rulemaking to revise water quality standards for parameters other than P for the EPA and the EAA canals, recognizing the existing beneficial uses of the EAA canals. Although the EFA does not set a specific deadline for this rulemaking, it is assumed it will be completed by December 31, 2003. Other regulatory issues are discussed in Chapter 3.

STA OPTIMIZATION AND ATT RESEARCH

Current research results have yet to identify full-scale Advanced Treatment Technologies (ATTs) that reliably and consistently produce P levels of 10 ppb at the point of discharge (referred to as “end-of-pipe”). Chapter 4 presents a summary of STA optimization and ATT research. While critical research is continuing on STA optimization and ATTs, the Basin-specific Feasibility Studies and subsequent design phases will use a combination of best available information and sensitivity analyses to deal with these key uncertainties.

SOURCE CONTROL MEASURES

It is anticipated that long-term Everglades water quality solutions will contain a combination of source control and regional treatment technologies. While landowners within the EAA have implemented effective source control BMPs, comparatively little is known about the technical efficacy and economics of controlling P loads from urban and other rural basins. The Basin-specific Feasibility Studies used sensitivity analyses to predict the influence of source controls on overall basin phosphorus performance.

SYNCHRONIZATION WITH CERP PROJECTS

The majority of Everglades tributary basins contain proposed CERP projects to be completed between 2002 and 2038 (based on July 2001 CERP schedules). There is significant potential for both taxpayer and private cost savings by synchronizing and possibly integrating water quality improvement strategies with the CERP projects. Opportunities exist to integrate the results of the Basin-specific Feasibility Studies into the early planning phases of many of the CERP projects to assist in realizing the goals of both projects. This may require working with the Florida Legislature and other parties to synchronize timeframes and funding mechanisms.

FUNDING ISSUES

Funds must be appropriated for implementation (land acquisition, design, construction and operation) of the recommended long-term water quality solution for each basin. The EFA allocated several state sources for funding the implementation of the interim solution (e.g., the ECP). However, funding for implementation of long-term solutions has not been appropriated. Preliminary cost estimates for the alternative solutions were developed as part of the Basin-specific Feasibility Studies. Funding schedules for recommended solutions, necessary for appropriation by the Florida Legislature, will be included in the conceptual plans to be completed by November 2003.

STRATEGY FOR LONG-TERM SOLUTIONS

The EFA establishes an orderly process of research and rulemaking to develop a sound foundation for decision making regarding long-term water quality solutions. This process was described above and remains the current strategy for achieving long-term compliance with all water quality goals. If the interim water quality program alone cannot achieve the long-term goals, then the orderly approach should further enable the determination of sound, science-based decisions regarding additional water quality treatment options.

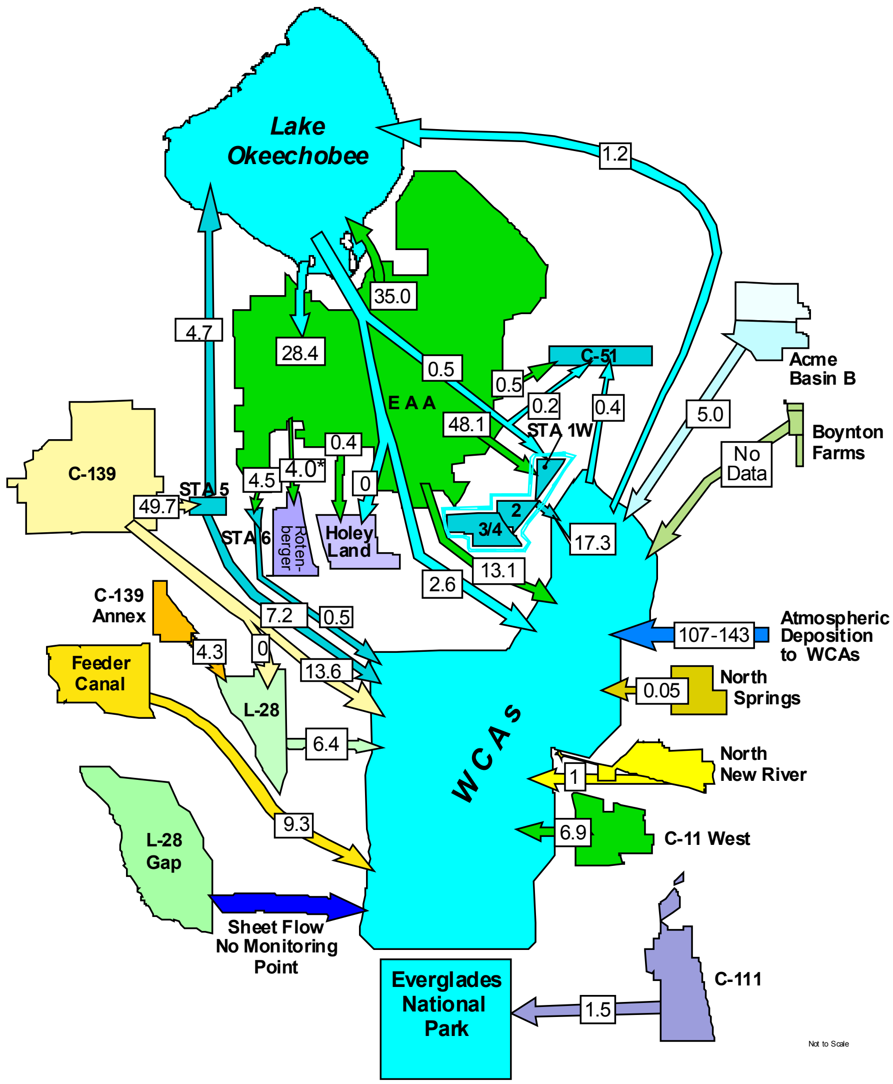
PHOSPHORUS LOADS TO THE EVERGLADES PROTECTION AREA

The Everglades Protection Area (EPA) is a complex system of marsh areas, canals, levees, and inflow and outflow water control structures covering almost two million acres. In addition to rainfall inputs, surface water inflows regulated by water control structures from agricultural tributaries, such as the Everglades Agricultural Area (EAA) and the C-139 basin, feed the EPA from the north and western boundary. The EPA also receives surface water inflows originating from Lake Okeechobee to the north and from predominantly urbanized areas to the east. The timing and distribution of the surface inflows from the tributaries to the EPA are based on a complex set of operational decisions that account for natural and environmental system requirements, water supply for urbanized and natural areas, aquifer recharge, and flood control.

Each year the EPA receives amounts of surface water inflows based on hydrologic variability. These inflows, regulated according to previously mentioned operational decisions, also contribute a certain amount of phosphorus loading to the EPA system. The load schematic presented in **Figure 8A-1** depicts a generalized overview of surface water inflow sources and relative contributions of phosphorus loading to the EPA for Water Year 2002 (WY02). **Figure 8A-1** also illustrates all connecting tributaries to the EPA: Lake Okeechobee, the EAA, the C-139 basin, other agricultural and urbanized areas and the STAs. In some cases, surface water inflows represent a mixture of water from several sources as the water passes from one area to another before finally arriving in the EPA. For example, water discharged from Lake Okeechobee can pass through the EAA, and then through an STA before arriving in the EPA. As another example, runoff from the C-139 basin can pass through STA-5, and then into the EAA before ultimately arriving in the EPA. Because of the complex nature of the conveyance and delivery system, the schematic in **Figure 8A-1** attempts to identify the amount of the phosphorus load and its associated pathway to the EPA.

It is also recognized that a certain amount of phosphorus loading to the EPA emanates from atmospheric deposition. **Figure 8A-1** depicts a long-term average range of atmospheric deposition of phosphorus of between 107 and 143 tons as the total contribution to the Water Conservation Areas (WCAs). This range is based on data obtained from long-term monitoring that was evaluated and reported in a District technical publication (Redfield, EMA-403, February 2002). The phosphorus loads and the relative percent contribution to the region from each source, including and excluding the contribution of atmospheric deposition, are tabulated in **Table 8A-6**. Detailed estimates of P loads by structure are presented in **Table 8A-7**.

Schematic of Total Phosphorus Inflows to WCAs from Various SFWMD Controlled Structures - WY02



Values presented are metric tons, 1000 kg = 1 metric ton, 2205 lb = 1 metric ton
Refer to accompanying table for detailed break down

NOTE:
1. STAs 1W, 2, 5 and 6 were operational in Water Year 2002.
2. Atmospheric Deposition P Loads to the WCAs are based on Redfield Manuscript EMA 403, "Atmospheric Deposition Phosphorus: Concepts, Constraints and Published Deposition Rates for Ecosystem Management", Page 21, SFWMD, Feb 2002.
3. Total Phosphorus loads into STAs 1W and 2 (from EAA and Lake) and into WCAs (from STAs 1W and 2) have been aggregated. STA 1W discharges to WCA 1 (Refuge) and STA 2 discharges into WCA 2A

* Load to Rotenberger comes from STA5 via EAA Canal

Figure 8A-1. Overview of surface water inflow sources and relative contributions of phosphorus loading to the EPA for Water Year 2002

Table 8A-6. Water Year 2002 phosphorus loads to the EPA and other waters

Data provided by Everglades Regulation Division

Source Water	Receiving Water	Phosphorus Load (metric tons)	Portion of EPA Surface Inflows	Portion of Total Inflows
Lake Okeechobee	EPA (WCAs)	2.6	3.1%	0.9%
	EAA	28.4		
	STAs	0.5		
	C-51 Canal	0.2		
	Holey Land	0.0		
	Total from Lake O	31.7		
Everglades Agricultural Area	EPA (WCAs)	13.1	15.5%	4.7%
	Lake Okeechobee	35.0		
	STAs	52.6		
	C-51 Canal	0.5		
	Holey Land	0.4		
	Total from EAA	101.6		
Stormwater Treatment Areas (STAs)	EPA (WCAs)	24.8	29.5%	8.9%
	Lake Okeechobee (from STA-5)	4.7		
	EAA (from STA-5)	0.8		
	Holey Land and Rotenberger (from STA-5)	4.1		
	Total from STAs	34.4		
Acme Basin B	EPA (WCAs)	5.0	5.9%	1.8%
Boynton Farms	EPA (WCAs)	No data		
North Springs Improvement District	EPA (WCAs)	0.05	0.1%	0.0%
North New River Canal Basin	EPA (WCAs)	1.0	1.2%	0.4%
C-11 West Basin	EPA (WCAs)	6.9	8.2%	2.5%
C-111 Basin	EPA (ENP)	1.5	1.8%	0.5%
Feeder Canal Basin	EPA (WCAs)	9.3	11.0%	3.4%
L-28 Canal Basin	EPA (WCAs)	6.4	7.6%	2.3%
C-139 Basin	EPA (WCAs)	13.6	16.1%	4.9%
	STAs	49.7		
	L-28 Canal	0.0		
		63.3		
C-139 Annex	L-28 Canal	4.3		1.5%
L-28 Gap Basin	EPA (WCAs)	No data		
Total Surface Inflows		84.2	100.0%	30.3%
Atmospheric Deposition				
	WCA-1	20.0		
	WCA-2	18.8		
	WCA-3	70.4		
	ENP	84.1		
	Total	193.3		69.7%
Total Loads to Everglades Protection Area		277.5		100.0%

Notes on atmospheric deposition:
1: ENP area is by coastal line coverage and does not includes Florida Bay.
2: Estimates of areal deposition rates from "Atmospheric Deposition Phosphorus: Concepts, Constraints and Published Deposition Rates for Ecosystem Management", Page 21, SFWMD, Feb 2002. (EMA Report No. 403)

Table 8A-7. Water Year 2002 summary of flow and total phosphorus, by structure

Into STA-1W Inflow Basin

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S5A PUMP STATION	268	34728	105
from EAA		*30978*	
from Lake O		*550*	
from East Beach		*3200*	
S5AS *(from L8 & C-51W)*	12	873	58
G300 *(from Refuge)*	43	2496	47
G301 *(from Refuge)*	2	404	214
Total	**325**	**38500**	**96**

From STA-1W Inflow Basin

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S5AS	45	4739	85
G300	11	1570	113
G301	0	37	187
G302	237	43336	148
Total	**293**	**49682**	**137**

Into A. R. M. Loxahatchee National Wildlife Refuge (Refuge)

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
G300 & G301	11	1607	114
from EAA		*768*	
from Lake O		*220*	
from Refuge		*31*	
from East Beach		*40*	
from Inflow Basin		*549*	
G251 *(from STA-1W)*	7	171	20
G310 *(from STA-1W)*	261	12029	37
ACME1 *(from Basin B)*	16	1720	89
ACME2 *(from Basin B)*	18	3286	152
Total	**312**	**18814**	**49**

From Refuge

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S10A	32	1271	32
S10C	48	2408	41
S10D	78	3824	40
S10E	0	0	n/a
S39	103	2399	19
G300	43	2496	47
G301	2	404	214
Total	**305**	**12801**	**34**

Into WCA2

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
G335 *(from STA-2)*	241	4895	16
S7	98	5783	48
from EAA		*5581*	
from Lake O		*202*	
S10A *(from Refuge)*	32	1271	32
S10C *(from Refuge)*	48	2408	41
S10D *(from Refuge)*	78	3824	40
S10E *(from Refuge)*	0	0	n/a
N. Springs Improv. District	2	49	16
Total	**499**	**18230**	**30**

From WCA2

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S7	69	2630	31
S11A	94	1171	10
S11B	113	1434	10
S11C	186	6612	29
S38	0	1	7
S34	70	1531	18
Total	**532**	**13378**	**20**

Into WCA3

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S140 *(from L28 Canal)*	110	6460	48
S190 *(from Feeder Canal)*	85	9270	88
L3 (G88+G155) *(from C139)*	79	12020	123
S8	136	10015	60
from EAA		*770*	
from Lake O		*2124*	
from C-139		*1010*	
from STA-5		*6071*	
from Rotenberger		*40*	
S150 *(from EAA)*	21	977	37
G204 *(from Holey Land)*	0	1	18
G205 (*from Holey Land)*	0	0	n/a
G206 *(from Holey Land)*	0	0	n/a
G404	113	6146	44
from EAA		*4947*	
from C-139		*124*	
from STA-5		*1053*	
from Rotenberger		*22*	
S11A *(from WCA2)*	94	1171	10
S11B *(from WCA2)*	113	1434	10
S11C *(from WCA2)*	186	6612	29
G123 *(from N. New River)*	52	1057	16
S9 *(from C-11 West)*	284	6918	20
Total	**1273**	**62081**	**40**

From WCA3

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S150	0	1	21
S8	4	579	112
G204+G10	0	0	72
S31	27	449	14
S337	12	364	24
S343A	12	159	11
S343B	13	182	11
S344	9	141	12
S12A	57	698	10
S12B	110	969	7
S12C	188	1656	7
S12D	225	2660	10
S333	250	4685	15
S14	0	0	n/a
Total	**907**	**12542**	**11**

FWMC = flow weighted mean concentration

Table 8A-7. (Cont'd.)

Into Everglades National Park (ENP)

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S12A *(from WCA3)*	57	698	10
S12B *(from WCA3)*	110	969	7
S12C *(from WCA3)*	188	1656	7
S12D *(from WCA3)*	225	2660	10
S333 *(from WCA3)*	250	4685	15
S14 *(from WCA3)*	0	0	n/a
S174 *(from L-31W)*	14	134	8
S332D *(from L-31W)*	144	939	5
S18C *(from C-111 Canal)*	173	1525	7
Total	**1161**	**13265**	**9**

From ENP

Structure	Flow	Phosphorus	
	1000 ac-ft	Load (kg)	FWMC (ppb)
S334	33	354	9
S197	21	269	10
Total	**54**	**623**	**9**

FWMC = flow weighted mean concentration

LITERATURE CITED

Walker, W.W. and R.H. Kadlec. 2002. *Development of a Dynamic Model for Stormwater Treatment Areas*. Report and model prepared for the U.S. Department of the Interior.

Goforth, G. and T. Piccone. 1999. Preliminary baseline data for the Basin-specific Feasibility Studies to Achieve the Long-term Water Quality Goals for the Everglades. South Florida Water Management District, West Palm Beach, FL.

Goforth, G. and T. Piccone. 2001. *Baseline Data for the Basin-specific Feasibility Studies to Achieve the Long-term Water Quality Goals for the Everglades*. South Florida Water Management District, West Palm Beach, FL.

Goforth, G. and T. Piccone. 2002. *Evaluation Methodology for the Water Quality Improvement Strategies for the Everglades*. South Florida Water Management District, West Palm Beach, FL.

PB Water, a division of Parsons Brinckerhoff Quade and Douglas, Inc. 1999. *Peer Review of Preliminary Baseline Data for the Basin-specific Feasibility Studies to Achieve the Long-term Water Quality Goals for the Everglades*. Report prepared for the South Florida Water Management District, West Palm Beach, FL.

Redfield, G. 2002. *Atmospheric Deposition of Phosphorus: Concepts, Constraints and Published Deposition Rates for Ecosystem Management*. Report No. EMA 403, SFWMD. February 2002.