Settlement Agreement
October - December 2008 Report

Prepared for the
Technical Oversight Committee
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ARTHUR R. MARSHALL LOXAHATCHEE NATIONAL WILDLIFE REFUGE

The 1991 Settlement Agreement ended the Everglades lawsuit and was entered into by the federal government, the State of Florida and the South Florida Water Management District. The subsequent Consent Decree, as modified in 1995, specified that interim and long-term total phosphorus (TP) concentration levels for the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) must be met by February 1, 1999, and December 31, 2006, respectively. Both the interim and long–term concentration levels vary monthly because they are calculated as a function of water stage measured at gauging stations 1-7, 1-8C and 1-9 within the Refuge. The stage range within which the interim and long-term concentration levels are applicable is 15.42 to 17.14 feet in National Geodetic Vertical Datum of 1929 (NGVD29). The monthly TP concentrations are determined from water samples collected at 14 interior marsh stations, LOX 3 through LOX 16 (**Figure 1**). As required in the Consent Decree, the concentrations are converted to a geometric mean, which is compared to the interim and long-term concentration levels.

Average stages in the Refuge were 17.42, 17.22 and 16.95 feet in October, November, and December 2008, respectively (**Figure 2** and **Table 1**). The geometric means, calculated from TP concentrations measured in water samples collected in October, November, and December 2008 were 7.2, 7.4 and 6.3 parts per billion (ppb), respectively. The geometric mean was equal to the long-term level, which became effective on December 31, 2006, for the month of October 2008; higher than the long-term level for the month of November 2008; and lower than the long-term level for the month of December 2008.

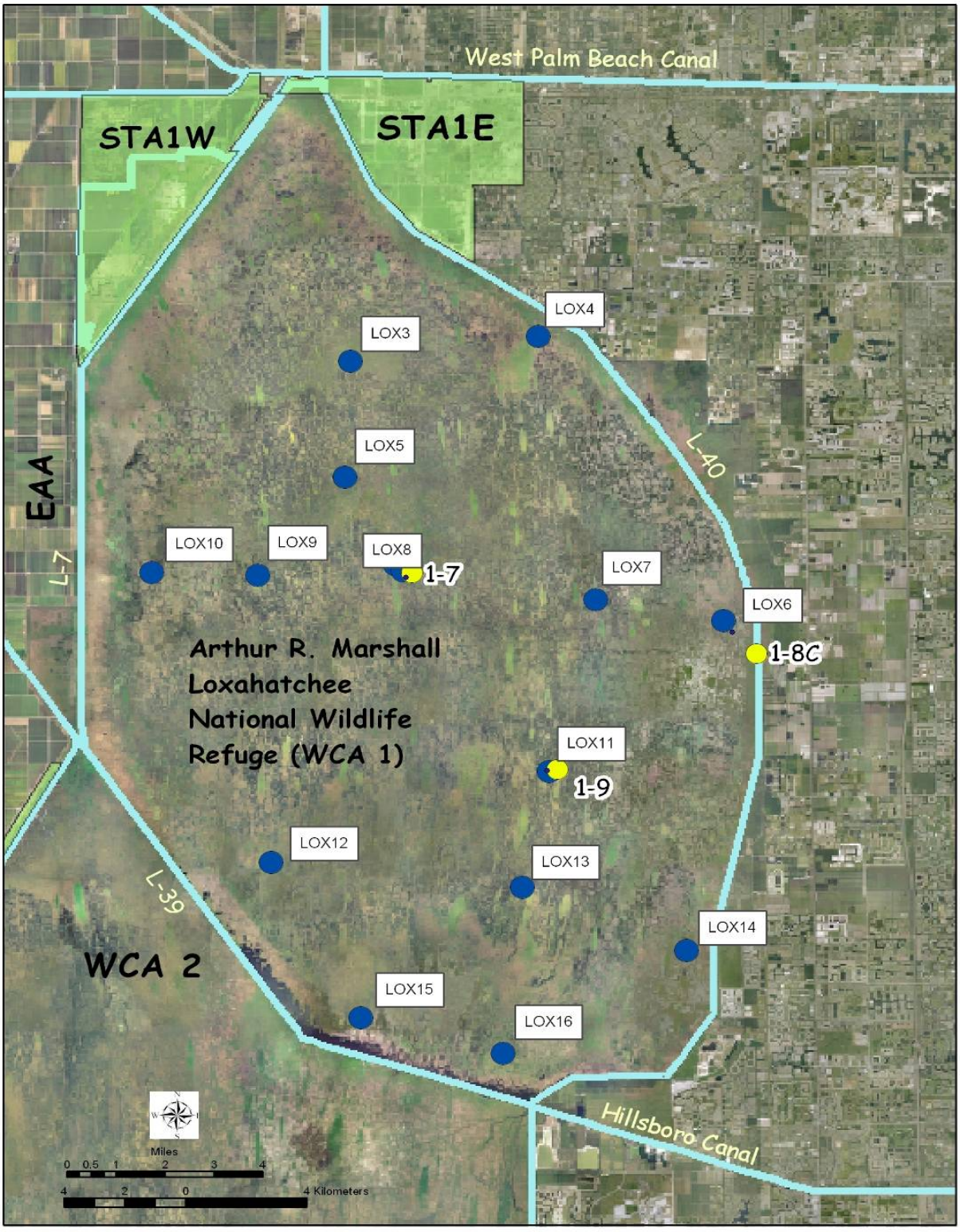

Figure 1. A.R.M. Loxahatchee National Wildlife Refuge Water Quality Sampling and Stage Measurement Sites

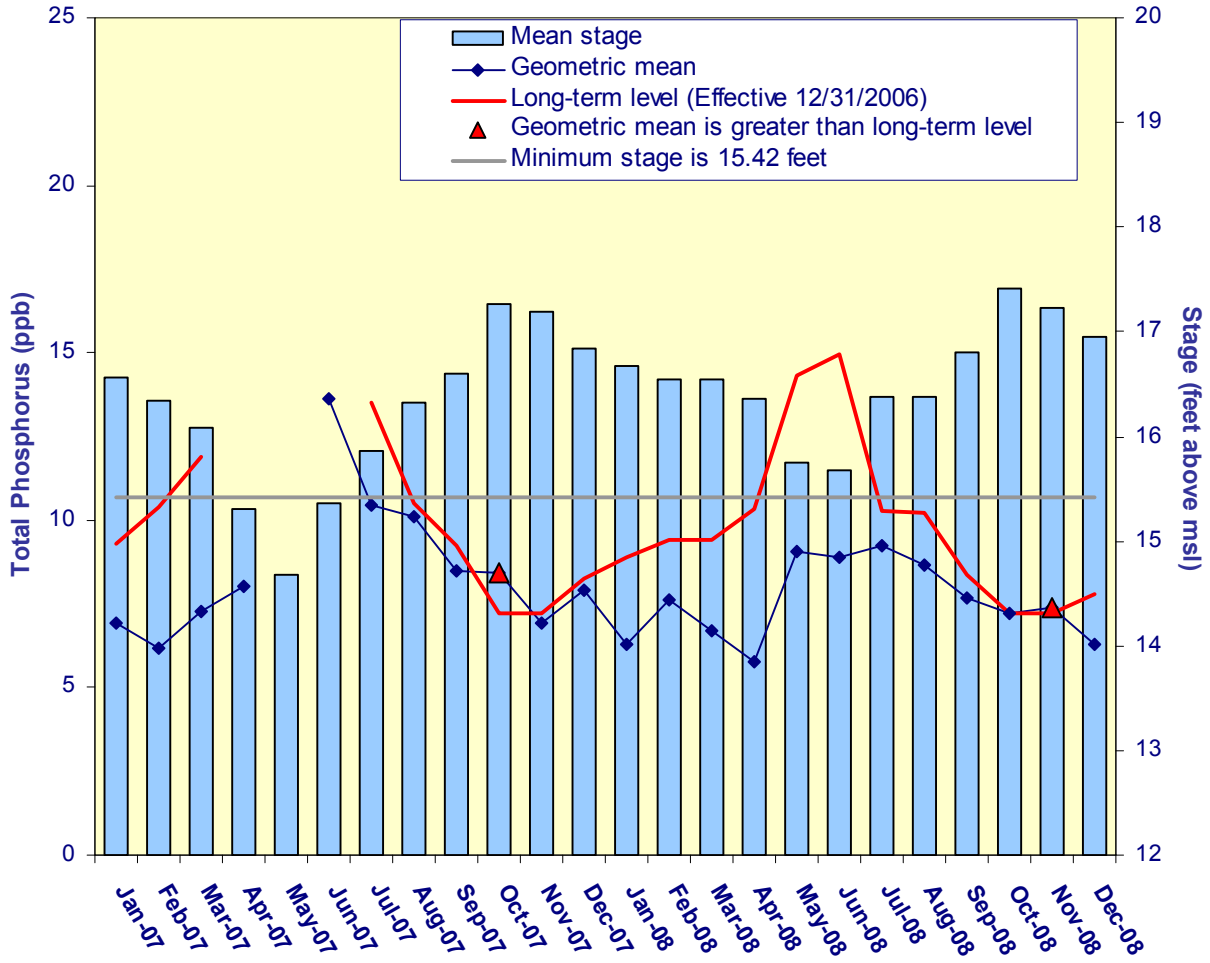

Figure 2. Monthly TP geometric mean concentrations for the Arthur R. Marshall Loxahatchee National Wildlife Refuge compared to the long-term levels. The calculated long-term levels are adjusted for fluctuations in stage. The long-term levels were not applicable for April 2007 through June 2007 because the average stage was less than 15.42 feet. The geometric mean was greater than the long-term level in October 2007 and in November 2008.

Table 1. Loxahatchee National Wildlife Refuge TP Compliance Tracking.

Month - Year	Geometric Mean Concentration (ppb)	Long-Term Level[a] (ppb) Effective 12/31/06	Average Stage[b] (ft NGVD)	Number of TP Samples	Number of Stage Measure-ments
Jan-2007	6.9	9.3	16.57	14	3
Feb-2007	6.2	10.4	16.34	13	3
Mar-2007	7.3	11.8	16.10	10	3
Apr-2007	8.0	N/A	15.30	3	3
May-2007	n/a	N/A	14.68	0	3
Jun-2007	13.6	N/A	15.37	4	3
Jul-2007	10.4	13.5	15.86	13	3
Aug-2007	10.1	10.5	16.33	13	3
Sep-2007	8.5	9.2	16.59	14	3
Oct-2007	**8.4**	**7.2**	**17.26**	**14**	**3**
Nov-2007	7.0	7.2	17.19	14	3
Dec-2007	7.9	8.2	16.84	14	3
Jan-2008	6.3	8.9	16.68	14	3
Feb-2008	7.6	9.4	16.55	14	3
Mar-2008	6.7	9.4	16.54	14	3
Apr-2008	5.8	10.3	16.36	14	3
May-2008	9.1	14.3	15.76	9	3
Jun-2008	8.9	14.9	15.68	8	3
Jul-2008	9.2	10.3	16.37	14	3
Aug-2008	8.6	10.2	16.39	14	3
Sep-2008	7.7	8.3	16.81	14	3
Oct-2008	7.2	7.2	17.42	14	3
Nov-2008	**7.4**	**7.2**	**17.22**	**14**	**3**
Dec-2008	6.3	7.8	16.95	14	3

[a] *N/A denotes that the level was not applicable because the average stage was less than 15.42 feet.*
[b] *Average stage is calculated using stage elevations at stations 1-7, 1-8C, and 1-9 on the sampling dates.*

Notes: Highlighted rows indicate the months when excursions over the long-term levels occurred.

EVERGLADES NATIONAL PARK

Shark River Slough

The Consent Decree of 1995 specified that interim and long-term total phosphorus (TP) concentration limits for discharges into the Everglades National Park (ENP) (**Figure 3**) through Shark River Slough be met by October 1, 2003, and December 31, 2006, respectively. It was specified that the TP concentrations be presented as 12-month flow-weighted means. Only the TP concentrations for the water year ending September 30th are evaluated for compliance with the Consent Decree limits. The long-term TP concentration limit for inflows to Shark River Slough through structures S12A, S12B, S12C, S12D and S333 represents the concentrations delivered during the Outstanding Florida Waters baseline period of March 1, 1978, to March 1, 1979, and is adjusted for variations in flow. Inflow concentrations of TP through Shark River Slough are compared to the interim and long-term limits at the end of each water year (October 1st through September 30th) from 1991 to 2008 (**Figure 4**). The 12-month flow-weighted mean TP concentration for October 2007 through September 2008 was 10.2 ppb[1]. The corresponding long-term limit, which became effective on December 31, 2006, was also 10.2 ppb.

Table 2 presents the 12-month flow-weighted mean concentrations for each month as well as the corresponding interim and long-term TP concentration limits, calculated using the 12-month period flow. Supplemental water quality samples were collected at some of the Shark River Slough monitoring sites from January 2006 through September 2007, but only the bi-weekly compliance monitoring grab concentration data were used for flow-weighted mean TP concentration calculations. Routine monitoring was changed to weekly[1] for all Shark River Slough sites beginning in October 2007. In accordance with Appendix A of the Consent Decree, only the every-other-week grab concentration data were used for the flow-weighted mean calculations from October 2007 forward[2]. For the 12-month periods ending in October, November, and December 2008, the 12-month flow-weighted mean TP concentrations were 8.0, 7.6 and 7.6 ppb, respectively. The long-term limits were 9.0, 8.2 and 7.9 ppb, respectively. The 12-month flow-weighted mean TP concentrations were lower than the long-term limits for October, November, and December 2008.

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[1] *The 12-month flow-weighted mean TP concentration for September 2008 using all available weekly grab concentration data instead of bi-weekly grab data was 10.2 ppb; the 12-month flow-weighted mean TP concentration for September 2008 using the alternative set of bi-weekly grab concentration data was 9.9 ppb.*

[2] *S12A and S333 are sampled weekly if flowing, otherwise monthly. S12B, S12C, and S12D are sampled weekly if flowing.*

The Consent Decree stipulates that the percentage of flow-weighted mean TP concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a guideline value based on flow into Shark River Slough for the same 12-month period. For the 12-month periods ending October, November, and December 2008, the sampling event TP concentrations greater than 10 ppb were 55.0, 45.0 and 42.9 percent, respectively. The observed percentages of the sampling event flow-weighted mean TP concentrations greater than 10 ppb were more than the guidelines for October, November, and December 2008 (**Table 2**). The 12-month flow-weighted mean TP concentrations and the flow-weighted mean TP concentrations for individual sampling events are presented in **Figure 5**.

The daily flows through the individual Shark River Slough structures from January 2007 through December 2008 are presented in **Figure 6**.

The stage level at Water Conservation Area (WCA) 3A remained in Zone A of the Regulation Schedule until early December 2008. All S12s were utilized fully except that S12A was closed from November 2, 2008 through the end of reporting period. Stage level was dropped to Zone C in early December 2008 and flow at the system was reduced to a much lower level on December 10, 2008. About 62 percent of discharge through S333 was diverted through S334 (**Figure 7**).

For additional information on the WCA 3A regulation schedule, please refer to: http://www.saj.usace.army.mil/h2o/plots/wca3ahp.pdf

The relationship between the sum of the daily flows at Shark River Slough structures and corresponding flow-weighted mean TP concentrations for individual sampling events is presented in **Figure 8**. Flow and TP concentrations for waters entering the ENP through Shark River Slough had been following an inverse relationship in previous periods. TP concentrations continued to decline since last quarter as flow was increased; then, started to increase very slightly as flow was decreased, beginning in late October 2008. However, the sampling event flow-weighted mean concentrations remained very low. The sampling event flow-weighted mean TP concentrations were from 6 to 7 ppb during the quarter.

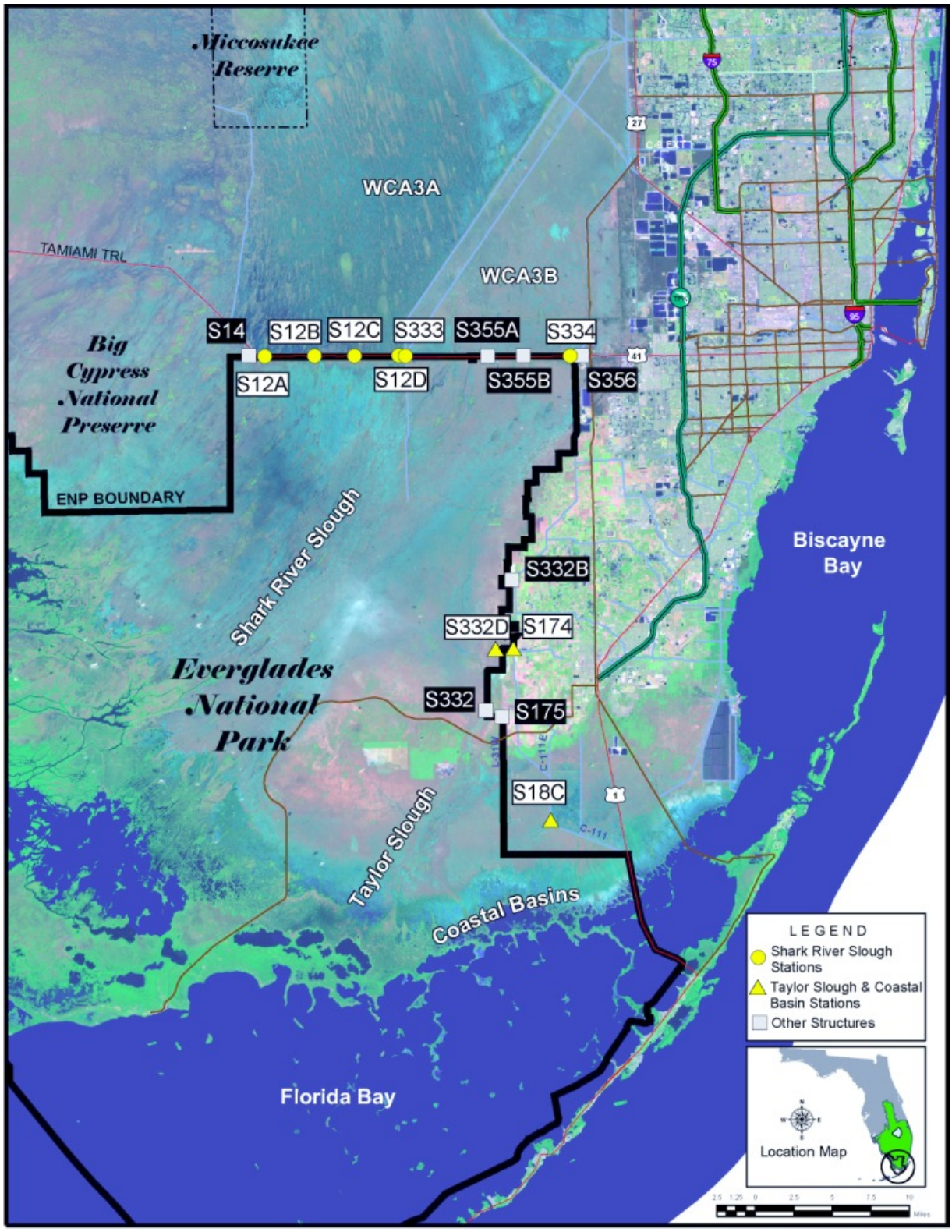

Figure 3. Everglades National Park flow structures

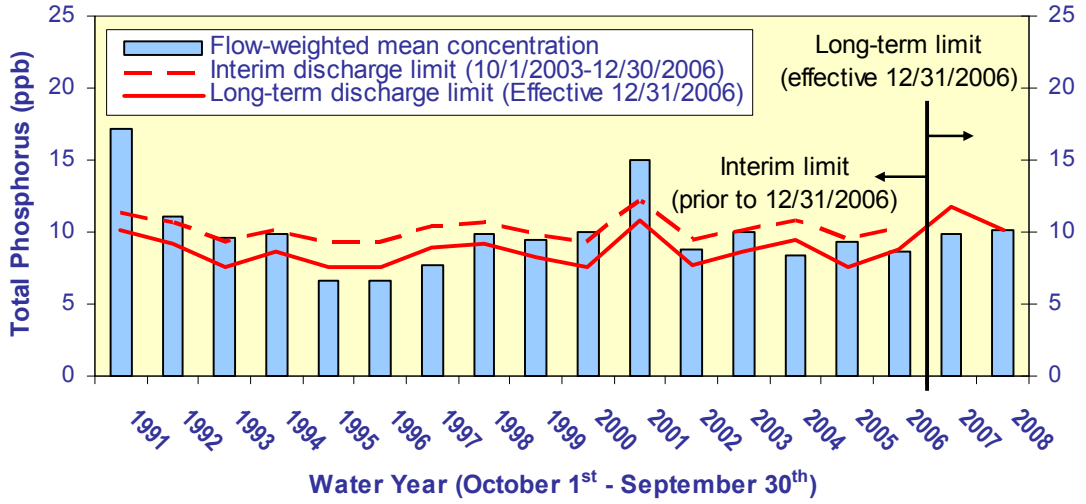

Figure 4. The 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Shark River Slough at the end of each water year compared to the TP interim and long-term limits. The 12-month flow-weighted mean concentrations had met the interim limits since they became effective on October 1, 2003. The 12-month flow-weighted mean TP concentration for the compliance year through September 2008 was 10.2 ppb and equal to the long-term limit.

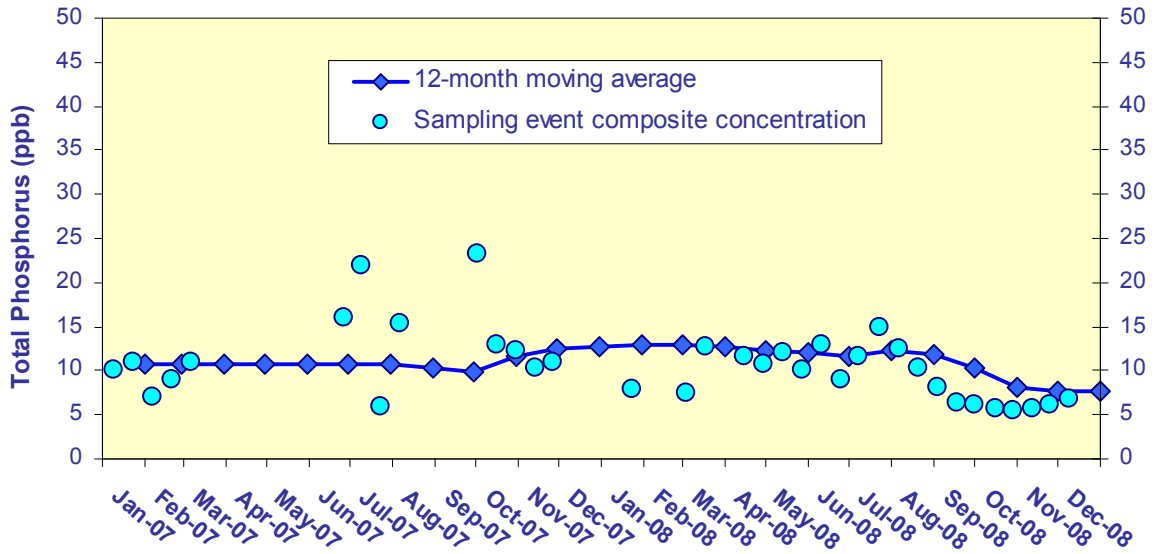

Figure 5. The 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Shark River Slough at the end of each month and the flow-weighted mean concentration for each sampling event. There are no sampling event values for some months because there was little or no flow in those periods.

Table 2. Shark River Slough TP Concentration Compliance Tracking.

12-Month Period	Total Flow (kac-ft)	TP Flow Weighted Mean (ppb)	Long-Term Limit (ppb) Effective 12/31/06	Percent of Sampling Events Greater than 10 ppb (%) Guideline	Observed
2/1/2006 - 1/31/2007	446.1[a,b]	10.7	10.9	57.0	55.0
3/1/2006 - 2/28/2007	442.4[b]	10.8	10.9	57.2	52.4
4/1/2006 - 3/31/2007	456.0[b]	10.8	10.8	56.7	***57.1***
5/1/2006 - 4/30/2007	449.5[b]	10.8	10.8	56.9	52.6
6/1/2006 - 5/31/2007	445.5[b]	10.7	10.9	57.1	47.1
7/1/2006 - 6/30/2007	447.6[b]	10.8	10.8	57.0	50.0
8/1/2006 - 7/31/2007	444.6[b]	10.6	10.9	57.1	47.4
9/1/2006 - 8/31/2007	401.0	10.3	11.1	58.6	44.4
10/1/2006 - 9/30/2007	**289.7**	**9.8**	**11.8**	**62.6**	**37.5**
11/1/2006 - 10/31/2007	147.9	11.7	12.7	67.9	50.0
12/1/2006 - 11/30/2007	121.2	12.6	12.8	68.9	62.5
1/1/2007 - 12/31/2007	118.2	12.8	12.8	69.1	***71.4***
2/1/2007 - 1/31/2008	115.8	12.9	12.9	69.2	69.2
3/1/2007 - 2/29/2008	106.8	12.9	12.9	69.5	***81.8***
4/1/2007 - 3/31/2008	88.9	12.8	13.0	70.2	***75.0***
5/1/2007 - 4/30/2008	110.9	12.4	12.9	69.4	***78.6***
6/1/2007 - 5/31/2008	142.3	12.2	12.7	68.1	***75.0***
7/1/2007 - 6/30/2008	153.6	11.8	12.6	67.7	***70.6***
8/1/2007 - 7/31/2008	227.4	12.4	12.2	64.9	***76.5***
9/1/2007 - 8/31/2008	356.8	12.0	11.4	60.1	***77.8***
10/1/2007 - 9/30/2008	**562.0**	**10.2**	**10.2**	**53.3**	***70.0***
11/1/2007 - 10/31/2008	775.9	8.0	9.0	47.0	***55.0***
12/1/2007 - 11/30/2008	935.4	7.6	8.2	43.0	***45.0***
1/1/2008 - 12/31/2008	1003.1	7.6	7.9	41.4	***42.9***

[a] *Flow of 1.82 kac-ft in February 2006 at S355A and S355B was included for the 12-month total flows.*
[b] *Flow of 3.33 kac-ft in August 2006 at S356 structure was included for the 12-month total flows.*

Notes: 1) Highlighted rows indicate the end of the water year, which are the compliance points.
2) Bold italicized values exceeded the guideline percentages.

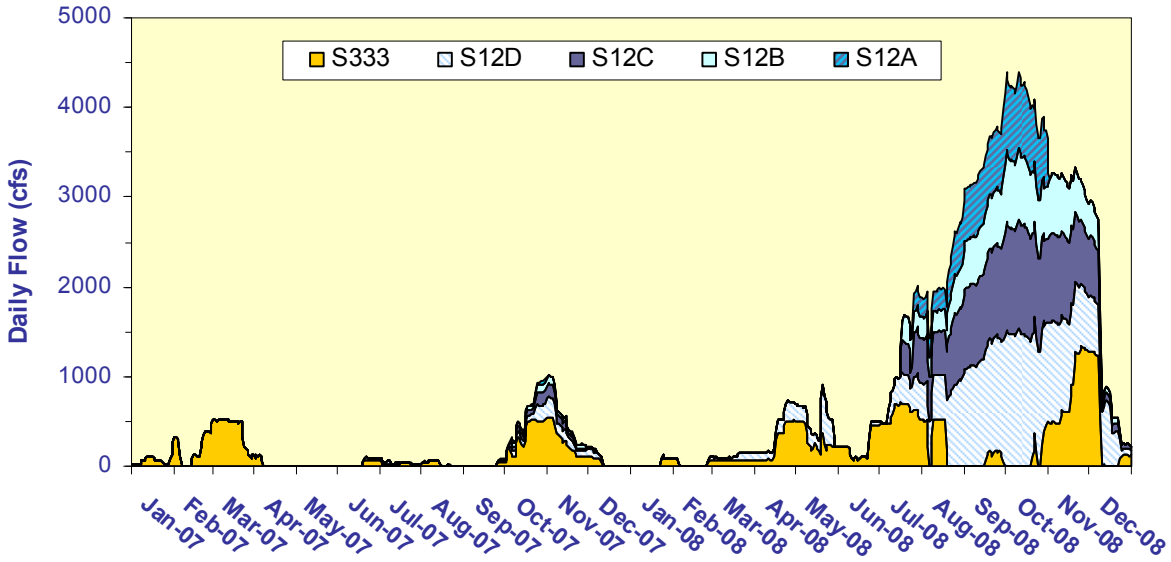

Figure 6. Daily flows into Shark River Slough by structure.

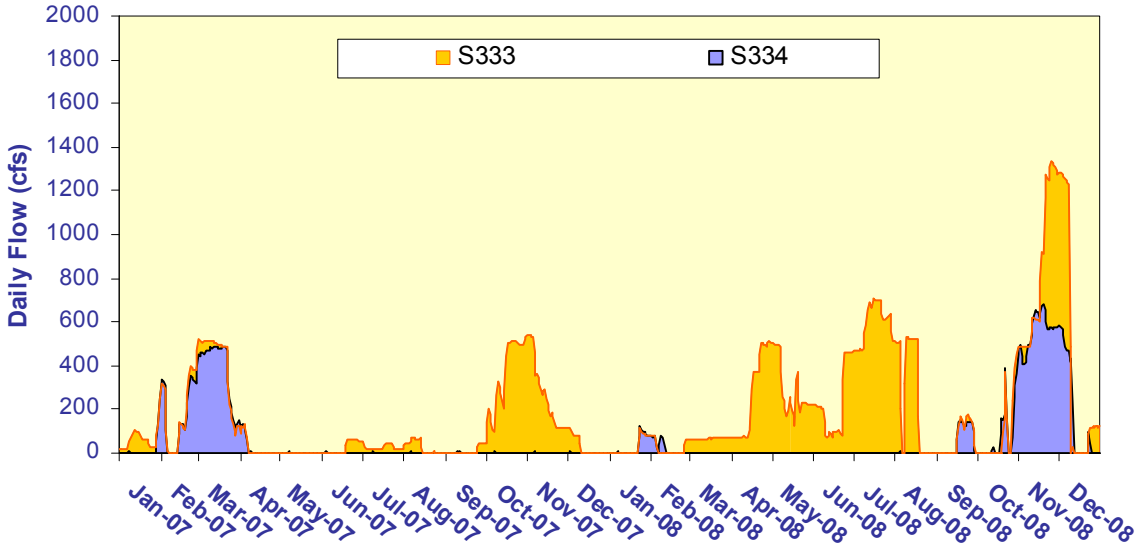

Figure 7. Daily flows comparison between S333 and S334.

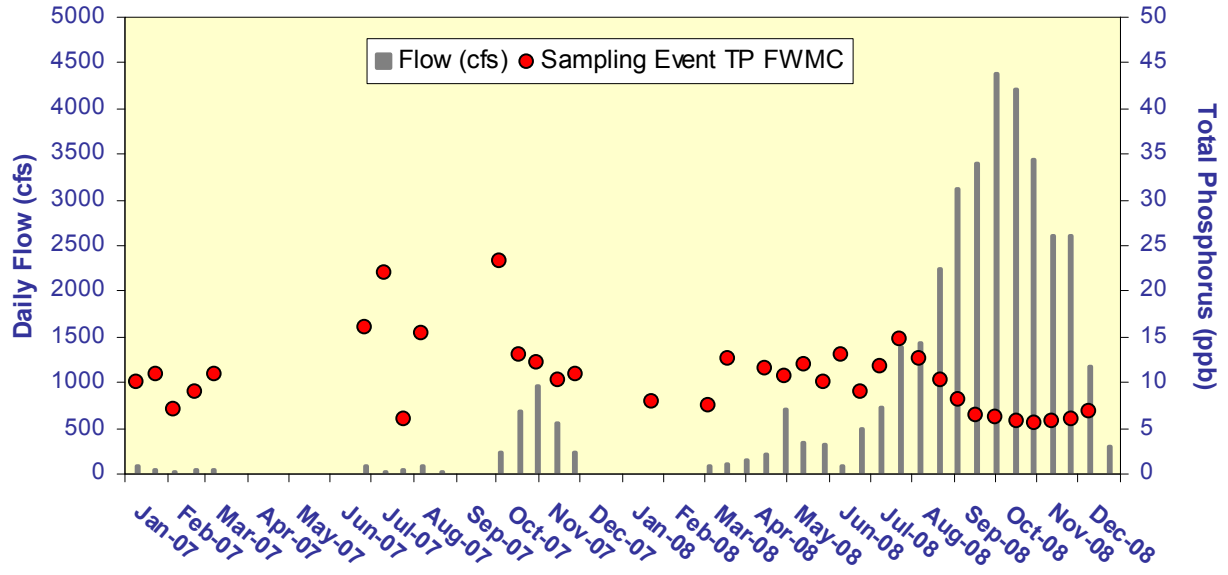

Figure 8. The relationship between daily flow at Shark River Slough structures and the corresponding flow-weighted mean TP concentrations for individual sampling events.

Taylor Slough and the Coastal Basins

Under the Consent Decree, a single total phosphorus (TP) long-term limit of 11 ppb, to be met by December 31, 2006, was set for the two points of inflow to Taylor Slough (S332 and S175) and the inflow point to the Coastal Basins (S18C). The 12-month flow-weighted mean concentrations have consistently been lower than the long-term limit of 11 ppb.

C-111 Project Structures and Detention Areas

Beginning in August 1999, structure S332D, a pump station constructed by the U.S. Army Corps of Engineers (USACE), began operation. The structure is adjacent to spillway S174 and pumps water from the L31N Canal into the L31W Canal. The S332D and S174 structures became the new inflow compliance monitoring sites for Taylor Slough on October 1, 1999, replacing S332 and S175. However, there had been almost no flow at S174 since March 2006. The site was plugged in September 2007, preventing any flow through S174.

The USACE completed construction of the remaining C-111 project structures and detention areas along the eastern boundary of the ENP in June 2002. The project was authorized by the USACE in 1995 to restore more natural hydrologic conditions in Taylor Slough and to maintain flood protection to the east of the L31N and C-111 canals. Project facilities consist of pump stations S332B, S332C and S332D, detention cells, Cell 1 through Cell 5, a connector cell between Cell 2 and Cell 3, a flow way cell originating at Berm 3 of Cell 5, and four diversion structures, DS1 through DS4 (**Figure 9**). The flow way cell is the only location to routinely discharge surface water into the ENP from this project.

The construction of these facilities was accelerated to respond to U.S. Fish and Wildlife requirements to give immediate relief to water conditions that threaten the Cape Sable Seaside Sparrow, an endangered species. The USACE signed a Record of Decision on July 2, 2002, that authorizes the implementation of an Interim Operational Plan (IOP) to govern the operation of the new facilities. Since July 31, 2002, the USACE has been operating the project under Emergency Orders issued by the Florida Department of Environmental Protection (FDEP).

The USACE and the South Florida Water Management District (District) will monitor the implementation of the IOP under the terms and conditions of the C-111 Project Cooperation Agreement executed in 1995. The District, on behalf of the USACE, has implemented a monitoring plan approved by FDEP that assesses the hydrologic, environmental, and surface and ground water quality changes that may occur as a result of the IOP. The District started the routine sampling in September 2003.

The diversion structures DS2 and DS4 would discharge into the ENP if utilized. Overflows periodically occurred at DS2 between September 2001 and September 2003. Data from these overflows were presented graphically in previous reports.

Discharges from the diversion structures DS1 and DS3 would flow onto District property and eventually into the L31N Canal. The majority of the water pumped into the detention cells, as well as rainfall, is expected to seep into the Biscayne Aquifer directly below the project site and provide a hydrologic "curtain" to reduce groundwater seepage in an easterly direction from ENP.

A total of 16,792 acre-feet water was pumped from S332B to West Pond (Cell 2) during the 4th quarter. However, the maximum stage for the quarter was 7.92 feet, well below the weir elevation of 8.36 feet at Cell 2. Therefore, there was no overflow at the diversion structures.

That overflow weir was the only surface water discharge point into the ENP for the S332B and S332C features. However, the levees are being rebuilt or raised to have the same height as the rest of the C-111 features. The emergency overflow weir is being demolished as well.

The S332B area construction tasks are the final pieces for the current C-111 Project, which is expected to be finished in 2009. When the project is finished, there will be a continuous detention cell from S332B to the single surface water outflow into the ENP at Berm B3.

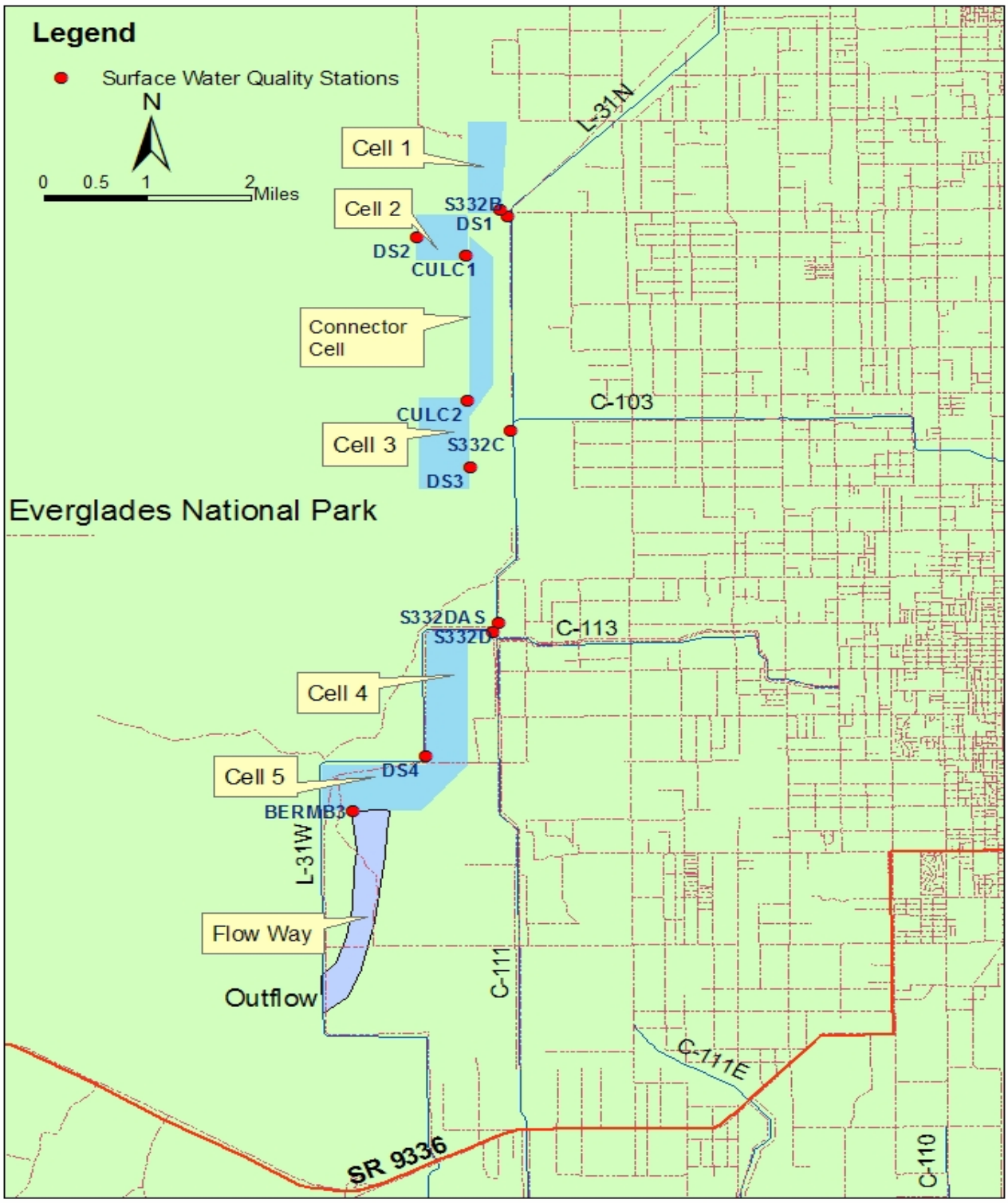

Figure 9. C-111 Project facilities.

Compliance with Consent Decree

Inflow TP concentrations to the ENP through Taylor Slough and the Coastal Basins are compared to the 11 ppb limit at the end of each water year using data from both the old (S175, S332, S18C) and new (S174, S332D, S18C) combinations of structures (**Figure 10**). The bars in **Figure 10** represent the 12-month flow-weighted mean TP concentrations from S332, S175 and S18C for water years 1989 through 2002. The diamond point values for water years 1999 through 2008 represent the new combination of structures.

TP and flow data from both sets of structures presented in prior editions of this report through December 2001 (April 2002 report) showed that, beginning in October 2000, the 12-month moving total flow for S332D, S174 and S18C was consistently greater than flow at S332, S175 and S18C. There was also a shift in flow-weighted mean TP concentration data whereby S332D, S174 and S18C concentrations became equal to and then consistently lower than the concentrations at S332, S175 and S18C. These changes reflected the switch made from S332 to S332D for water delivery to Taylor Slough between July 3 and July 5, 2000. Consequently, as of the July 2002 report, only S332D, S174 and S18C data are presented for monthly tracking of data in **Figure 10.** However, there had been almost no flow at S174 since March 2006. The site was plugged in September 2007, preventing any flow through S174.

Figure 11 presents the 12-month and individual sampling event flow-weighted mean TP concentrations at the S332D and S18C structures. All TP grab sample concentrations taken on positive flow days reported for surface water monitoring at the sites were used for the compliance calculations.

The daily flows into the ENP through S332D, S174 and S18C are presented in **Figure 12**.

For the combined flow through S332D and S18C, the 12-month flow-weighted mean TP concentrations were 5.7, 5.7 and 5.6 ppb, respectively, for the 12-month periods ending in October, November, and December 2008 (**Table 3**).

The Consent Decree stipulates that the percent of flow-weighted mean TP concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a fixed guideline of 53.1 percent. The sampling event flow-weighted mean concentrations remained very low. There was no sampling event flow-weighted mean TP concentration greater than 11 ppb since December 2006 except 23 ppb at S18C on July 14th, 2008. **Figure 13** shows the relationship between the daily inflows and the corresponding flow-weighted mean TP concentrations for each sampling event.

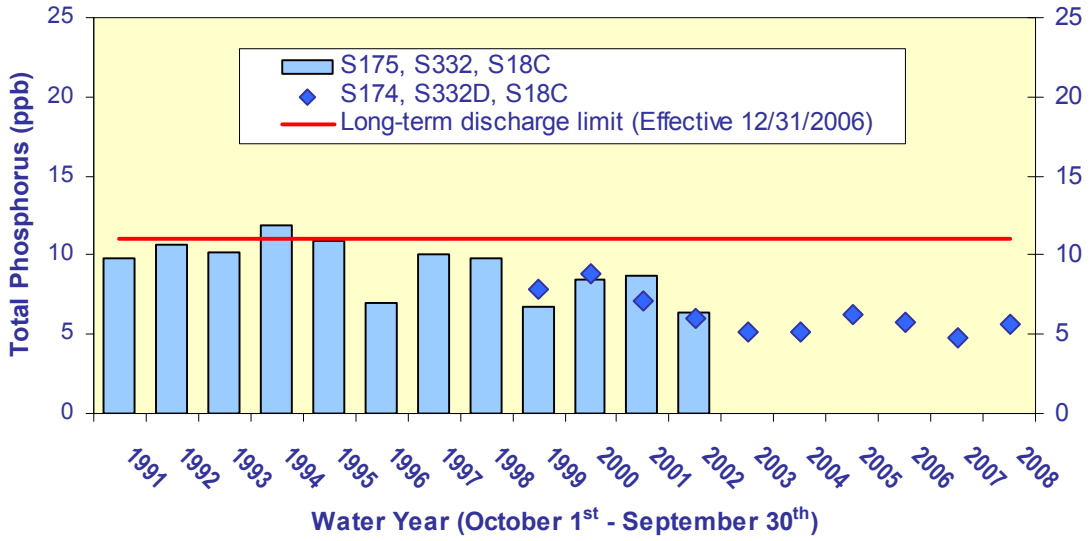

Figure 10. The 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each water year compared to the 11 ppb long-term TP limit.

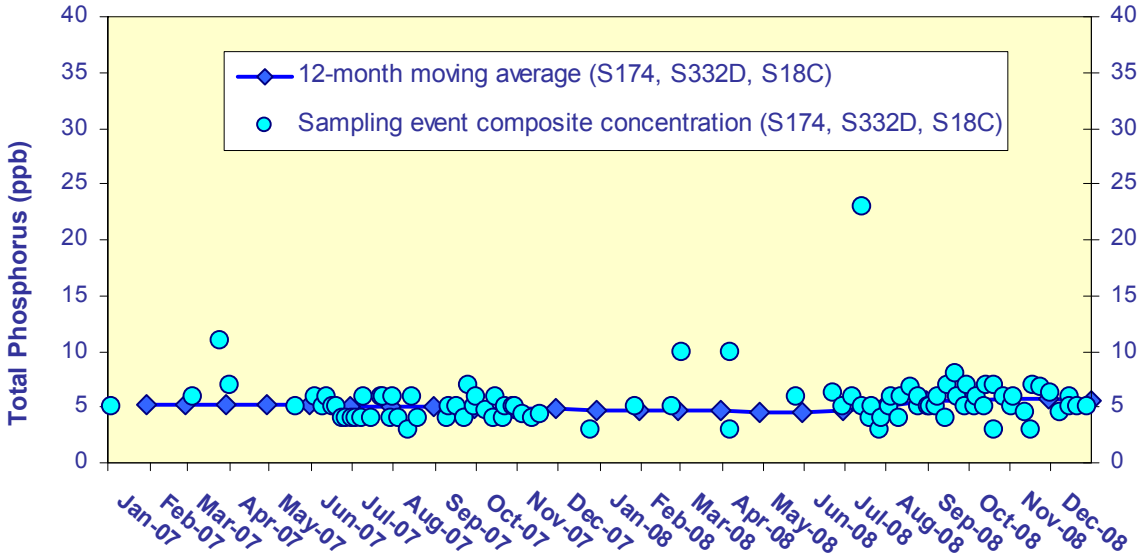

Figure 11. 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each month and the flow-weighted mean TP concentration for each sampling event.

Table 3. Taylor Slough and the Coastal Basins TP Concentration Compliance Tracking.

12-Month Period	Total Flow (kac-ft)	TP Flow Weighted Mean (ppb)	Long-Term Limit (Effective 12/31/06) (ppb)	Percent of Sampling Events Greater than 10 ppb (%)	
				Guideline	Observed
2/1/2006 - 1/31/2007	127.6	5.2	11.0	53.1	6.4
3/1/2006 - 2/28/2007	125.4	5.2	11.0	53.1	7.0
4/1/2006 - 3/31/2007	123.8	5.2	11.0	53.1	10.0
5/1/2006 - 4/30/2007	125.4	5.2	11.0	53.1	10.0
6/1/2006 - 5/31/2007	126.1	5.2	11.0	53.1	7.5
7/1/2006 - 6/30/2007	153.0	5.1	11.0	53.1	6.5
8/1/2006 - 7/31/2007	153.4	5.1	11.0	53.1	6.4
9/1/2006 - 8/31/2007	143.6	5.0	11.0	53.1	6.4
10/1/2006 - 9/30/2007	**120.8**	**4.8**	**11.0**	**53.1**	**4.6**
11/1/2006 - 10/30/2007	150.5	4.8	11.0	53.1	4.2
12/1/2006 - 11/30/2007	155.8	4.8	11.0	53.1	4.3
1/1/2007 - 12/31/2007	154.8	4.7	11.0	53.1	2.3
2/1/2007 - 1/31/2008	155.5	4.7	11.0	53.1	2.3
3/1/2007 - 2/29/2008	156.1	4.7	11.0	53.1	2.3
4/1/2007 - 3/31/2008	155.4	4.7	11.0	53.1	0.0
5/1/2007 - 4/30/2008	157.1	4.6	11.0	53.1	0.0
6/1/2007 - 5/31/2008	155.9	4.6	11.0	53.1	0.0
7/1/2007 - 6/30/2008	145.0	4.8	11.0	53.1	0.0
8/1/2007 - 7/31/2008	130.0	5.0	11.0	53.1	2.6
9/1/2007 - 8/31/2008	165.6	5.5	11.0	53.1	2.5
10/1/2007 - 9/30/2008	**207.7**	**5.6**	**11.0**	**53.1**	**2.2**
11/1/2007 - 10/31/2008	234.8	5.7	11.0	53.1	2.3
12/1/2007 - 11/30/2008	273.0	5.7	11.0	53.1	2.2
1/1/2008 - 12/31/2008	308.8	5.6	11.0	53.1	2.0

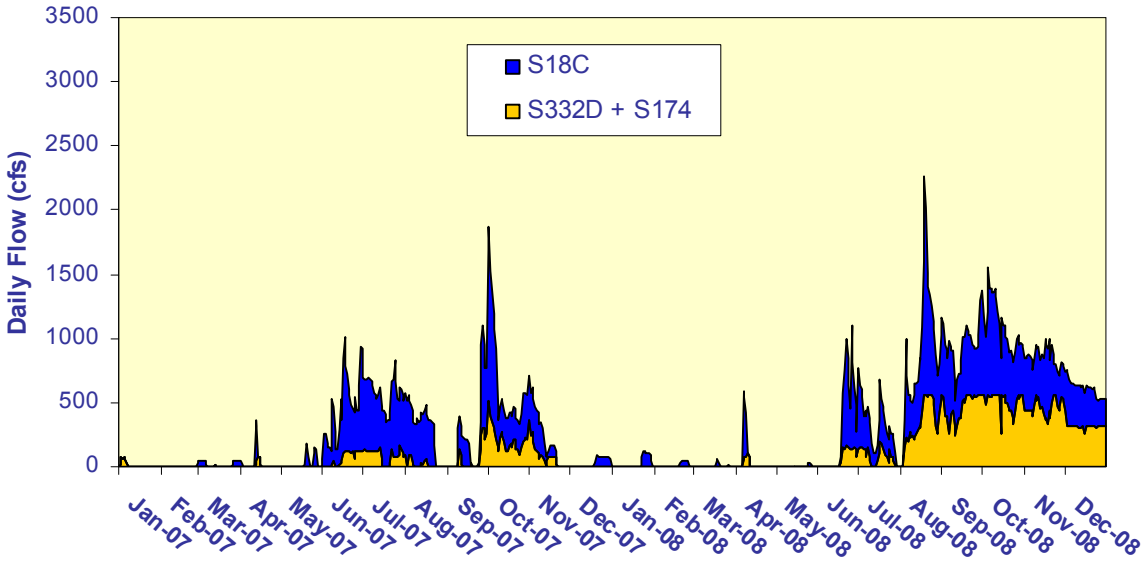

Figure 12. Daily flows into Everglades National Park through Taylor Slough (S332D+S174) and S18C; S174 was plugged in September 2007.

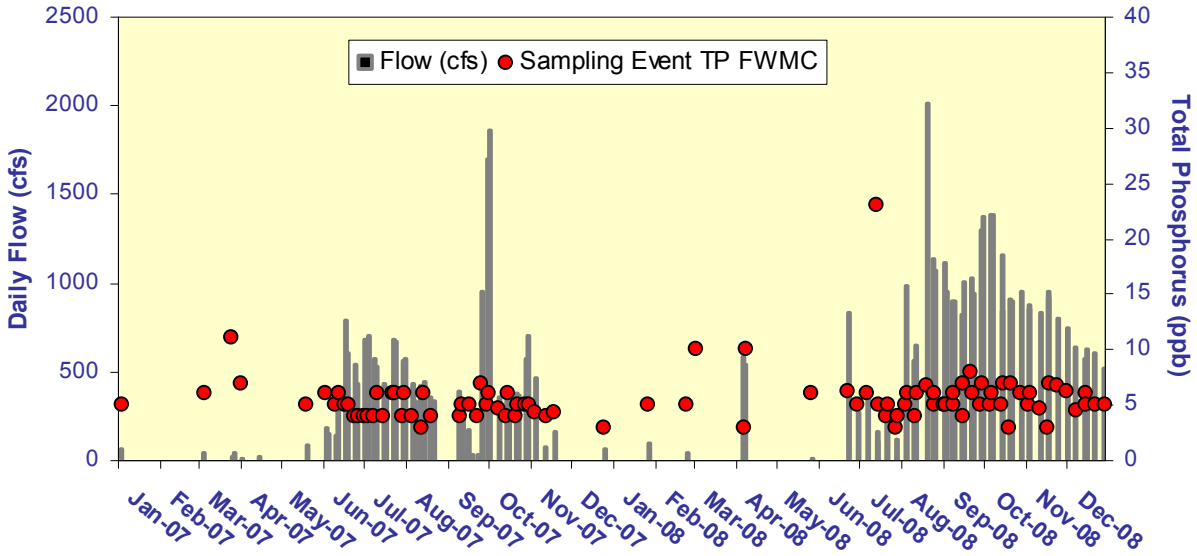

Figure 13. The relationship between daily flows at Taylor Slough structures (S332D + S174) and S18C and the corresponding flow-weighted mean TP concentrations for individual sampling events.