

# Settlement Agreement July - September 2007 Report

**Updated January 3, 2008**

**An explanation regarding the Refuge water quality sampling in  
September 2007 was added (page 1).**



**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 15.86, 16.33 and 16.59 feet in July, August and September 2007, respectively (Figure 2 and Table 1). Water samples were not collected at station LOX10 in July and at station LOX13 in August because total depth was less than 0.1 meter. The mean of two values for LOX11 was used in the geometric mean calculation for September 2007\*.

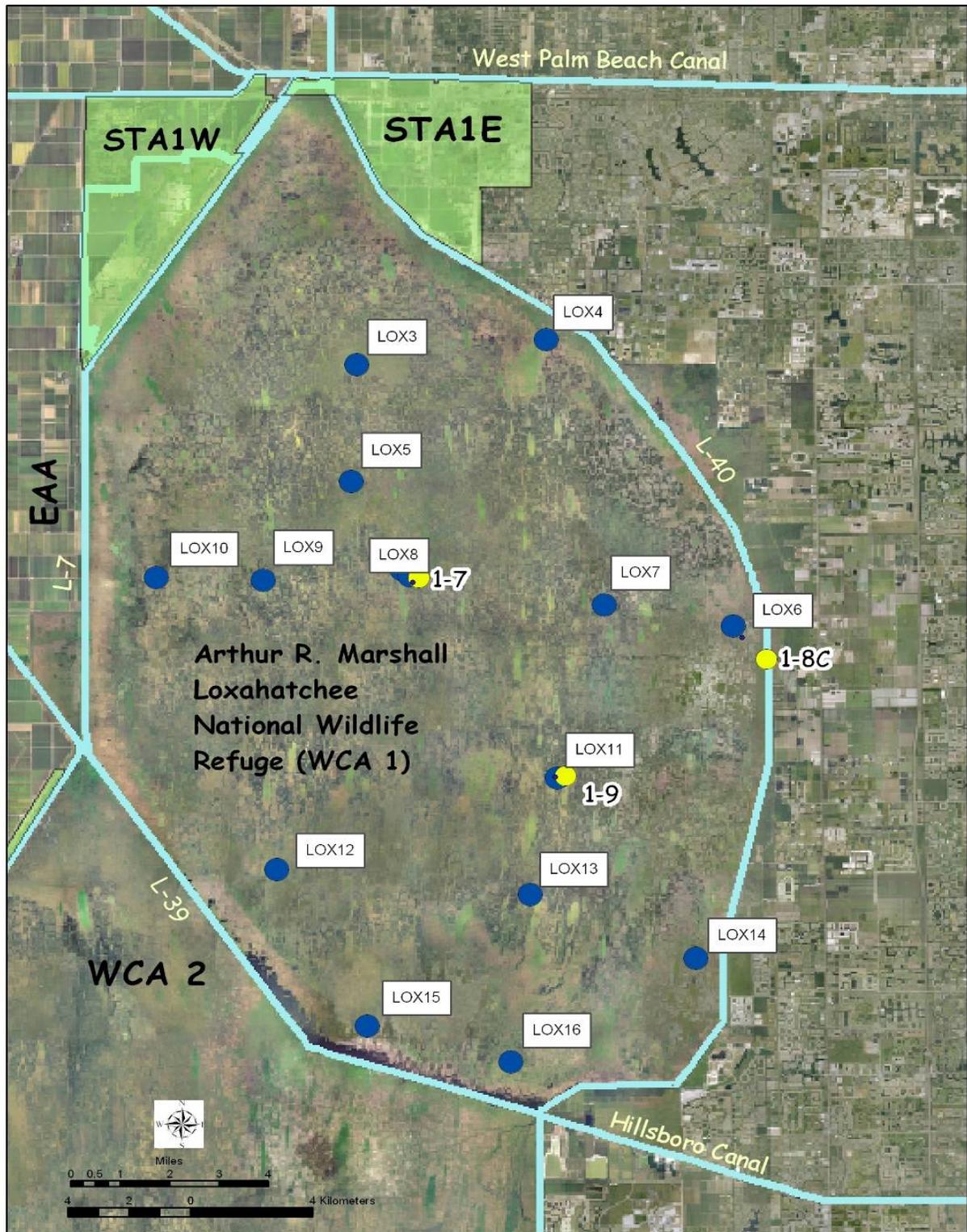
The geometric means, calculated from TP concentrations measured in water samples collected in July, August and September 2007 were 10.4, 10.1 and 8.5 ppb, respectively. The geometric means were less than the long-term levels, which became effective on December 31, 2006.

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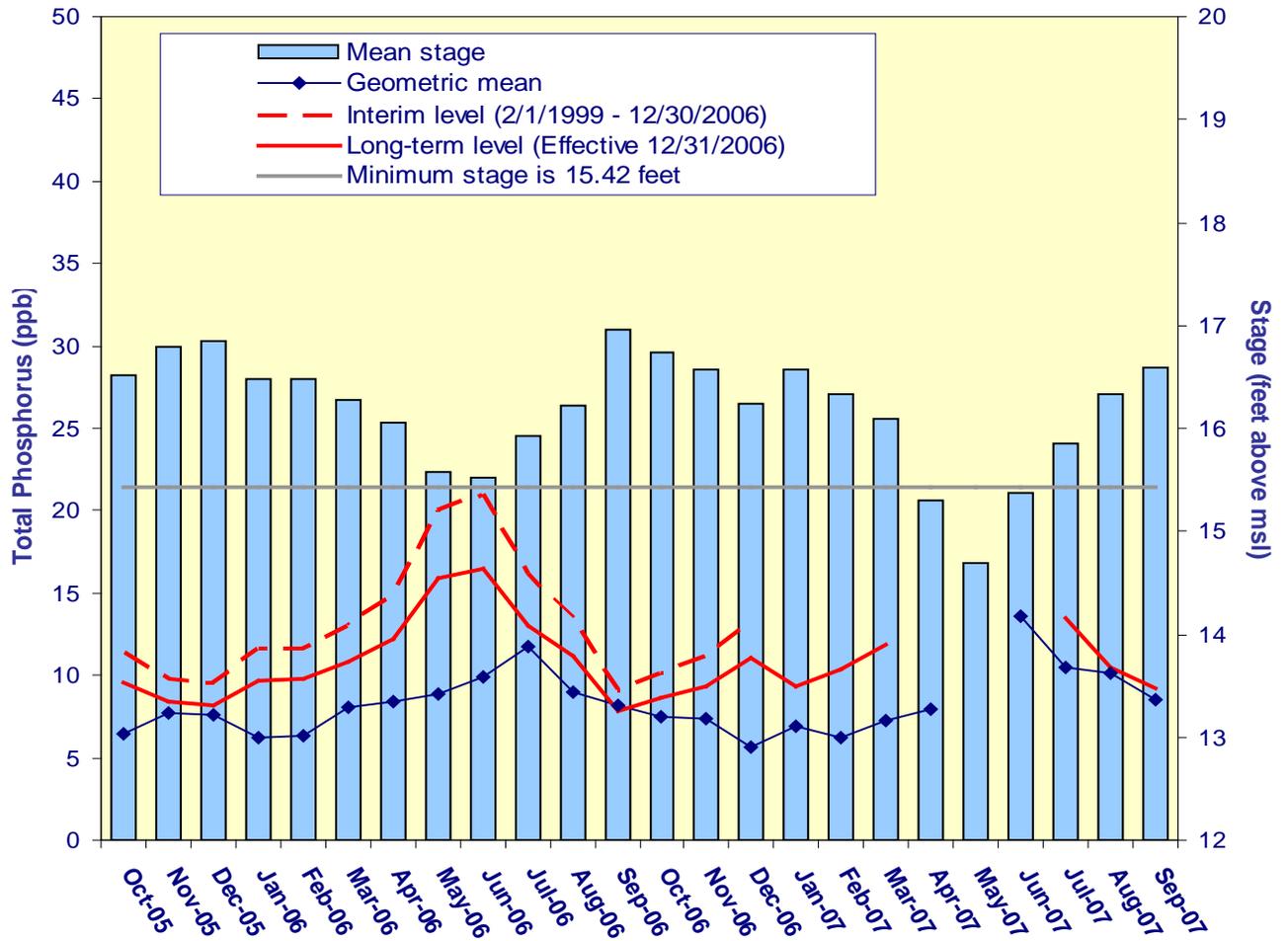
\* During the September 16<sup>th</sup> and 17<sup>th</sup> Refuge sampling trips, a pole with incorrect graduation markings was used to measure the water depth. The error was discovered on September 20, 2007, and the pole was replaced. According to the sampling protocol, no water samples are collected when the total water depth is less than 10 cm. Only total phosphorus (TP) samples are collected when the total water depth is greater than 10 cm but less than 20 cm. Water samples for the full suite of parameters are collected when the total water depth is greater than 20 cm.

On the September 16<sup>th</sup> sampling trip, LOX3 through LOX5 and LOX7 through LOX10 were visited but no samples were collected at LOX3 and LOX5 because the measurements at the sites indicated, incorrectly, the total water depths were less than 10 cm. On the September 17<sup>th</sup> sampling trip, LOX6 and LOX11 through LOX16 were visited. Water samples were collected only for TP at LOX11 because the total water depth was measured, incorrectly, as greater than 10 cm but less than 20 cm.

After communicating with USFWS staff, water samples were collected for TP only at LOX3 and LOX5, and for a full parameter suite at LOX11 on September 25, 2007, in order to remedy the error. This corrective action resulted in two TP samples being collected from LOX11 in September 2007 on the 17<sup>th</sup> and 25<sup>th</sup>.



**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 interim and long-term levels. The calculated concentration levels are adjusted for fluctuations in stage. The long-term levels were not applicable for April 2007 through June 2007 because the average stages were less than 15.42 feet.

**Table 1. Loxahatchee National Wildlife Refuge TP Compliance Tracking.**

Month - Year	Geometric Mean Concentration	Interim Level <sup>a</sup> (ppb)	Long-Term Level <sup>a</sup> (ppb)	Average Stage <sup>b</sup>	Number of TP Samples	Number of Stage Measurements
	(ppb)	Effective 2/1/99-12/30/06	Effective 12/31/06	(ft NGVD)		
Oct-2005	6.5	11.4	9.6	16.52	13	3
Nov-2005	7.8	9.8	8.4	16.79	14	3
Dec-2005	7.6	9.6	8.2	16.85	14	3
Jan-2006	6.3	11.6	9.7	16.49	13	3
Feb-2006	6.4	11.7	9.8	16.48	13	3
Mar-2006	8.1	13.1	10.8	16.28	12	3
Apr-2006	8.4	14.9	12.2	16.05	12	3
May-2006	8.8	20.1	15.9	15.58	10	3
Jun-2006	9.9	21.0	16.5	15.51	5	3
Jul-2006	11.7	16.1	13.0	15.92	9	3
Aug-2006	9.0	13.5	11.1	16.22	11	3
Sep-2006	8.2	9.1	7.8	16.96	14	3
Oct-2006	7.5	10.1	8.6	16.74	14	3
Nov-2006	7.4	11.1	9.4	16.56	14	3
Dec-2006	5.6	13.4	11.0	16.23	11	3
Jan-2007	6.9	11.1	9.3	16.57	14	3
Feb-2007	6.2	12.6	10.4	16.34	13	3
Mar-2007	7.3	14.5	11.8	16.10	10	3
Apr-2007	8.0	N/A	N/A	15.30	3	3
May-2007	n/a	N/A	N/A	14.68	0	3
Jun-2007	13.6	N/A	N/A	15.37	4	3
Jul-2007	10.4	16.8	13.5	15.86	13	3
Aug-2007	10.1	12.7	10.5	16.33	13	3
Sep-2007	8.5	10.9	9.2	16.59	14	3

<sup>a</sup> N/A denotes that the level was not applicable because the average stage was less than 15.42 feet.

<sup>b</sup> Average stage is calculated using stage elevations at stations 1-7, 1-8C, and 1-9 on the sampling dates.

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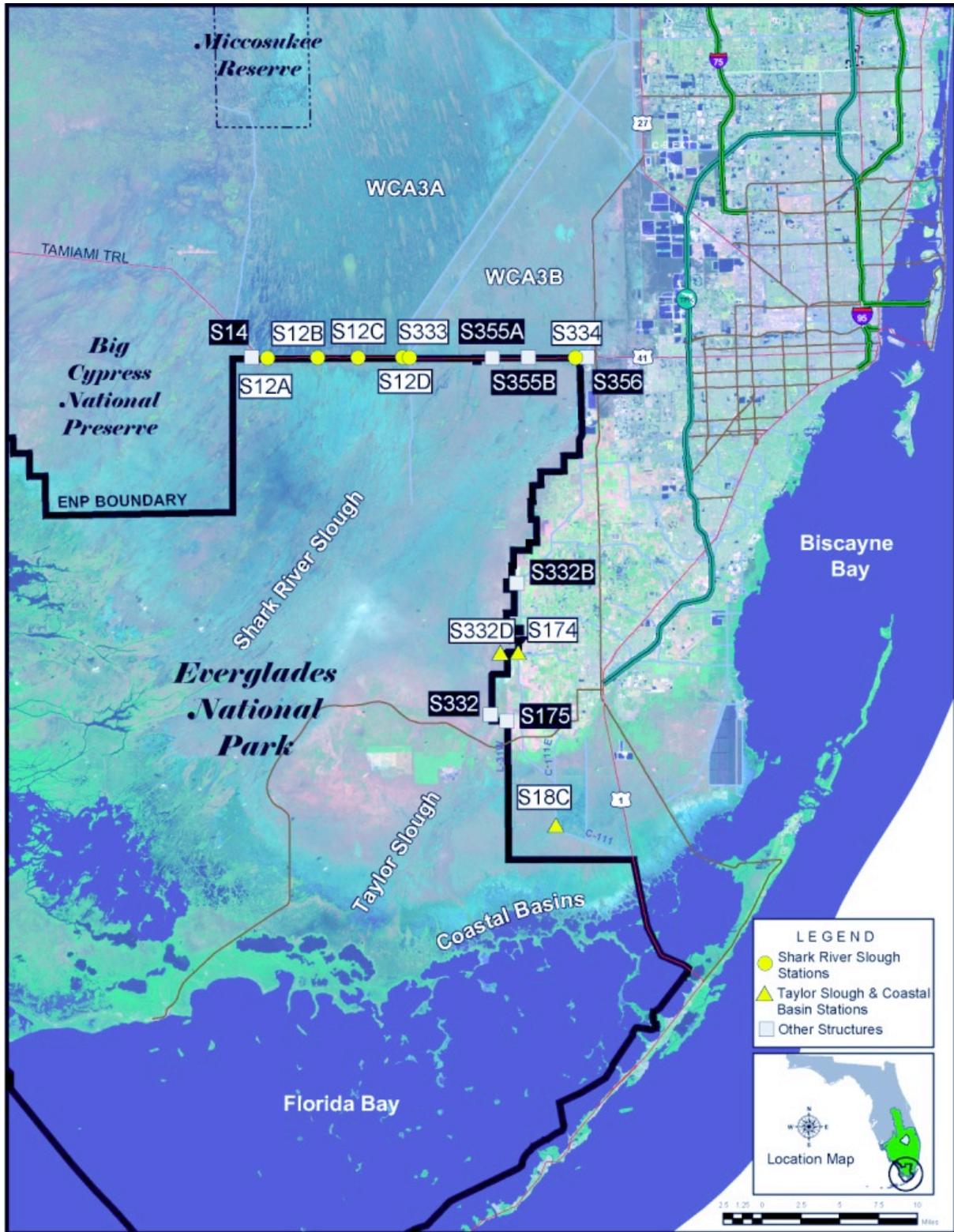
# EVERGLADES NATIONAL PARK

## Shark River Slough

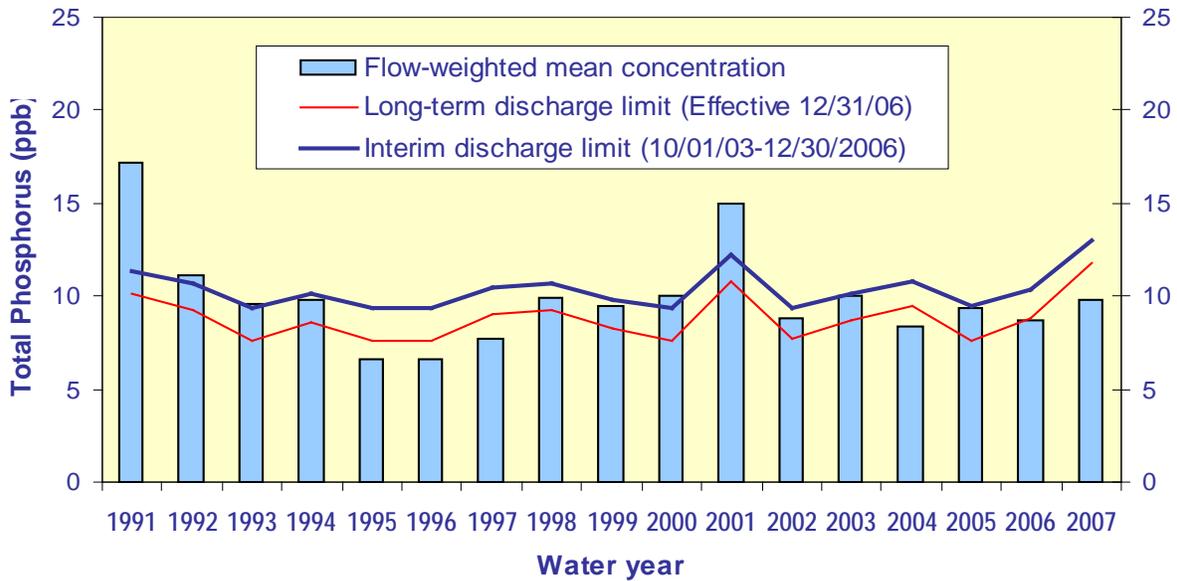
The Consent Decree of 1995 specified that interim and long-term total phosphorus (TP) concentration limits for discharges into the Everglades National Park (ENP) (**Figure 3**) through Shark River Slough be met by October 1, 2003, and December 31, 2006, respectively. It was specified that the TP concentrations be presented as 12-month flow-weighted means. Only the TP concentrations for the water year ending September 30<sup>th</sup> 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 1<sup>st</sup> through September 30<sup>th</sup>) from 1991 to 2006 (**Figure 4**). The 12-month flow-weighted mean TP concentration for October 2006 through September 2007 was 9.8 ppb. The corresponding long-term limit, which became effective on December 31, 2006, was 11.8 ppb (**Table 2**).

**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. Only the bi-weekly compliance monitoring grab concentration data were used for the calculations. For the 12-month periods ending in July, August and September 2007, the 12-month flow-weighted mean TP concentrations were 10.6, 10.3, and 9.8 ppb, respectively. The long-term limits were 10.9, 11.1 and 11.8 ppb, respectively. The 12-month flow-weighted mean concentrations were lower than the long-term limits for the months of July, August and September 2007.

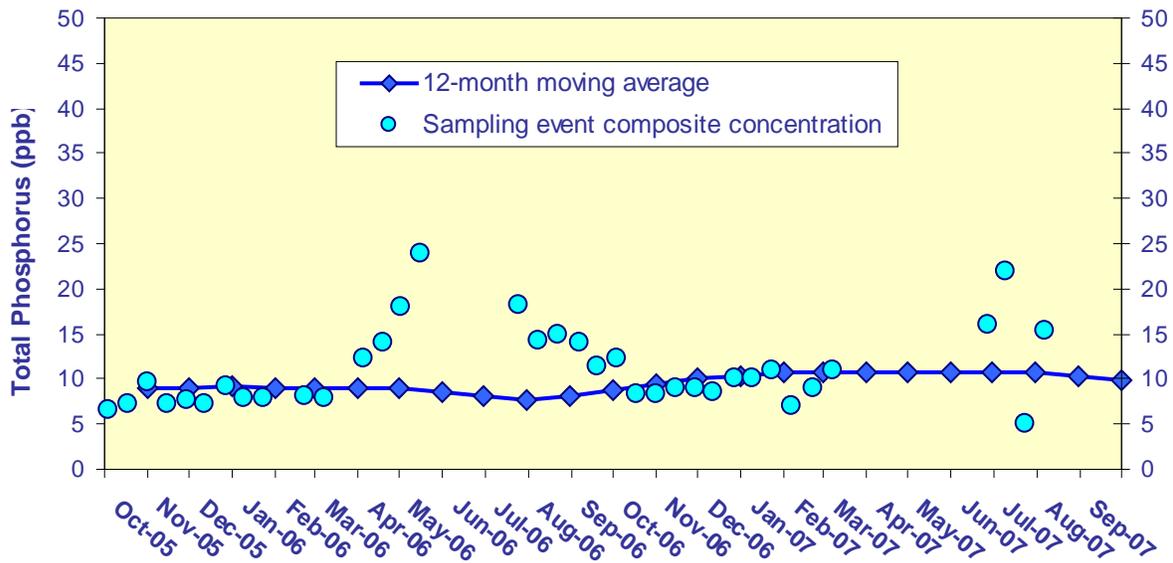
The Consent Decree stipulates that the percentage of flow-weighted mean TP concentrations greater than 10 ppb from each sampling event in any 12-month period must not exceed a guideline value based on flow into Shark River Slough for the same 12-month period. For the 12-month periods ending July, August and September TP concentrations greater than 10 ppb were 47.4, 44.4 and 37.5 percent, respectively. The observed percentages of the sampling event flow-weighted mean TP concentrations greater than 10 ppb were lower than the guidelines for July, August and September 2007 (**Table 2**). The 12-month flow-weighted mean concentrations and the flow-weighted mean concentrations for individual sampling events are presented in **Figure 5**.



**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 have met the interim limits since they became effective on October 1, 2003. In addition, the 12-month flow-weighted mean TP concentration for the compliance year through September 2007 was below the long-term limit, effective December 31, 2006.



**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)	Interim Limit (ppb)	Long-Term Limit (ppb)	Percent of Sampling Events Greater than 10 ppb	
			Effective 10/1/03-12/30/06	Effective 12/31/06	( <b>%</b> )	
					Guideline	Observed
11/1/04 - 10/31/2005	1338.1	9.0	9.4	7.6	40.1	<b>40.9</b>
12/1/04 - 11/30/2005	1381.7	9.1	9.4	7.6	40.1	<b>42.9</b>
1/1/05 - 12/31/2005	1447.6	9.1	9.4	7.6	40.1	<b>42.9</b>
2/1/05 - 1/31/2006	1507.7	9.1	9.4	7.6	40.1	39.1
3/1/05 - 2/28/2006	1497.6 <sup>a</sup>	9.0	9.4	7.6	40.1	39.1
4/1/05 - 3/31/2006	1481.0 <sup>a</sup>	9.0	9.4	7.6	40.1	34.8
5/1/05 - 4/30/2006	1436.1 <sup>a</sup>	9.0	9.4	7.6	40.1	34.8
6/1/05 - 5/31/2006	1395.5 <sup>a</sup>	8.5	9.4	7.6	40.1	31.8
7/1/05 - 6/30/2006	1326.6 <sup>a</sup>	8.2	9.4	7.6	40.1	25.0
8/1/05 - 7/31/2006	1113.3 <sup>a</sup>	7.7	9.4	7.6	40.1	26.3
9/1/05 - 8/31/2006	914.7 <sup>b</sup>	8.1	9.9	8.3	43.5	36.8
10/1/05 - 9/30/2006	<b>814.1<sup>b</sup></b>	<b>8.7</b>	<b>10.3</b>	<b>8.8</b>	<b>46.0</b>	<b>45.0</b>
11/1/05 - 10/31/2006	779.6 <sup>b</sup>	9.5	10.5	9.0	46.9	<b>50.0</b>
12/1/05 - 11/30/2006	642.8 <sup>b</sup>	10.0	11.1	9.7	50.8	50.0
1/1/06 - 12/31/2006	507.9 <sup>b</sup>	10.3	11.8	10.5	55.0	50.0
2/1/06 - 1/31/2007	446.1 <sup>b</sup>	10.7	12.1	10.9	57.0	55.0
3/1/06 - 2/28/2007	442.4 <sup>c</sup>	10.8	12.1	10.9	57.2	52.4
4/1/06 - 3/31/2007	456.0 <sup>c</sup>	10.8	12.0	10.8	56.7	<b>57.1</b>
5/1/06 - 4/30/2007	449.5 <sup>c</sup>	10.8	12.1	10.8	56.9	52.6
6/1/06 - 5/31/2007	445.5 <sup>c</sup>	10.7	12.1	10.9	57.1	47.1
7/1/06 - 6/30/2007	447.6 <sup>c</sup>	10.8	12.1	10.8	57.0	50.0
8/1/06 - 7/31/2007	444.6 <sup>c</sup>	10.6	12.1	10.9	57.1	47.4
9/1/06 - 8/31/2007	401.0	10.3	12.3	11.1	58.6	44.4
10/1/06 - 9/30/2007	<b>289.7</b>	<b>9.8</b>	<b>13.0</b>	<b>11.8</b>	<b>62.6</b>	<b>37.5</b>

<sup>a</sup> Flow of 1.82 kac-ft in February 2006 at S355A and S355B was included for the 12-month total flows.

<sup>b</sup> Flow of 3.33 kac-ft in August 2006 at S356 structure was included for the 12-month total flows in addition to the flow of 1.82 kac-ft in February 2006 at S355A and S355B structures.

<sup>c</sup> 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 (October 1- September 30), which are the compliance points.

2) Bold italicized values exceeded the guideline percentages.

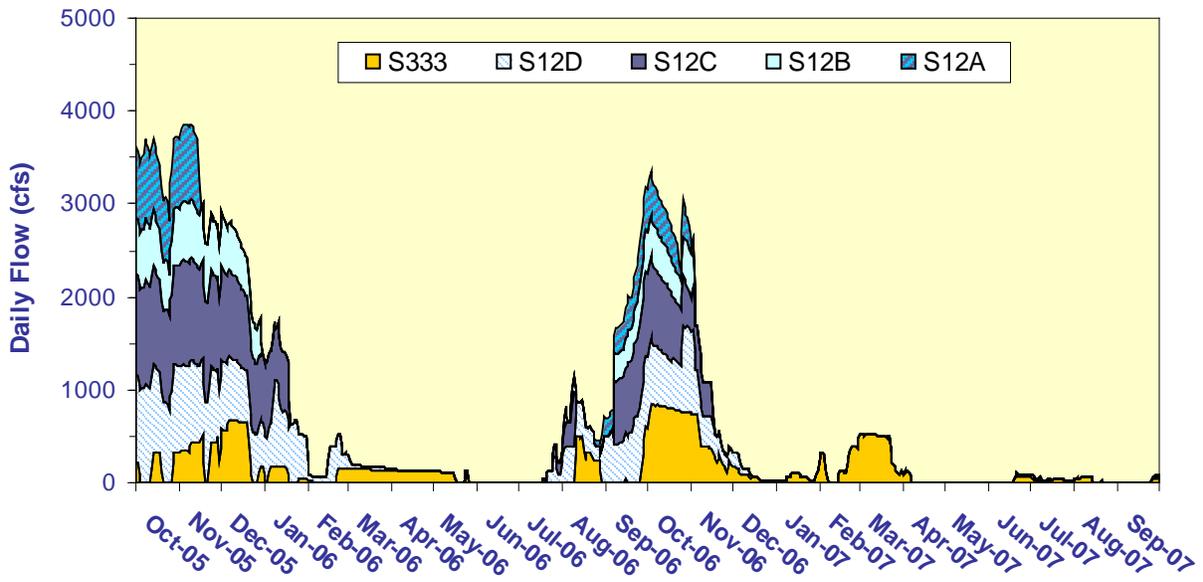
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The daily flows through the individual Shark River Slough structures from October 2005 through September 2007 are presented in **Figure 6**. S12A, S12B and S12C were closed until mid-July in accordance with the Interim Operational Plan (IOP) for protection of the Cape Sable Seaside Sparrow. S12D had been closed for the structure maintenance dredging, which was substantially completed on June 5, 2007; S12D was reopened on June 20, 2007.

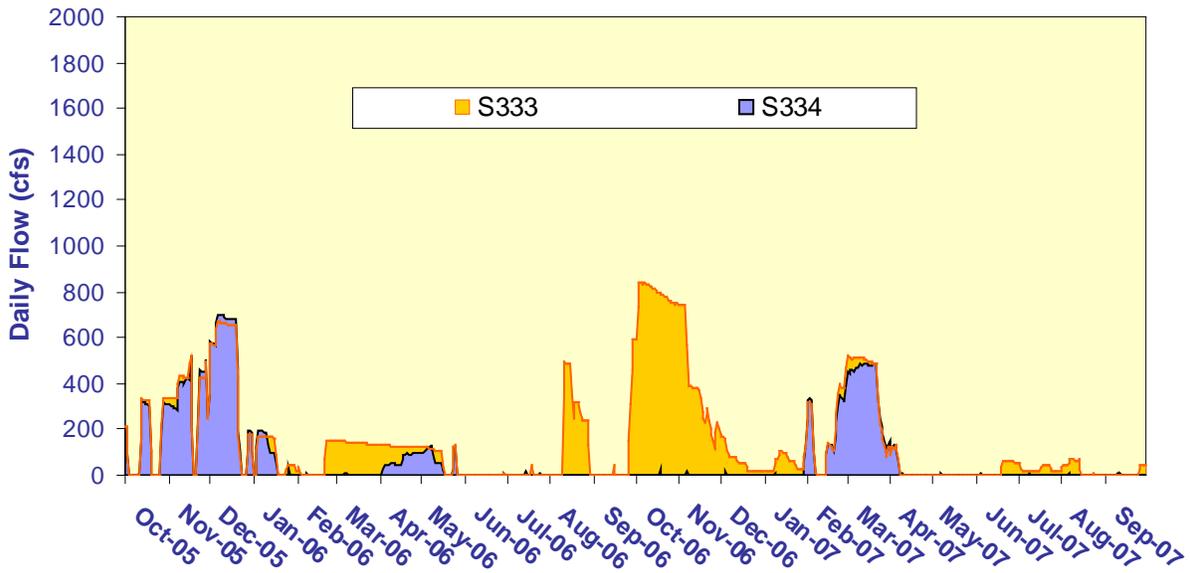
There was little flow in the system during the reporting period because the stage levels at Water Conservation Area (WCA) 3A remained below the regulation schedule through the quarter. S12s and S333 were utilized only to meet the target discharges described in the Shark River Slough "Rain Driven Water Deliveries to Everglades National Park". Very little flow entered the L29 Canal through S333 and almost no water in the L29 Canal was diverted to S334 during the third quarter of 2007 (**Figure 7**).

The flow through S355A and S355B during the February 2006 flow test and the flow through S356 during the August 2006 pump test are included in the 12-month total flows in **Table 2**. Including the flows and associated TP loads from the tests in the 12-month flow-weighted mean concentration calculations did not change the values. However, including this flow for the limit calculations lowered the long-term limits for the 12-month period ending April 2007 and June 2007 from 10.9 ppb to 10.8 ppb.

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**. Values had been following the strong inverse relationship between flow and TP concentration for waters entering the ENP through Shark River Slough. However, these high sampling event flow-weighted mean concentrations taken during the reporting quarter did not impact the 12-month flow-weighted mean concentrations because of the low flow on the sampling days.



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



**Figure 7.** Daily flows comparison between S333 and S334



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## 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.

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).

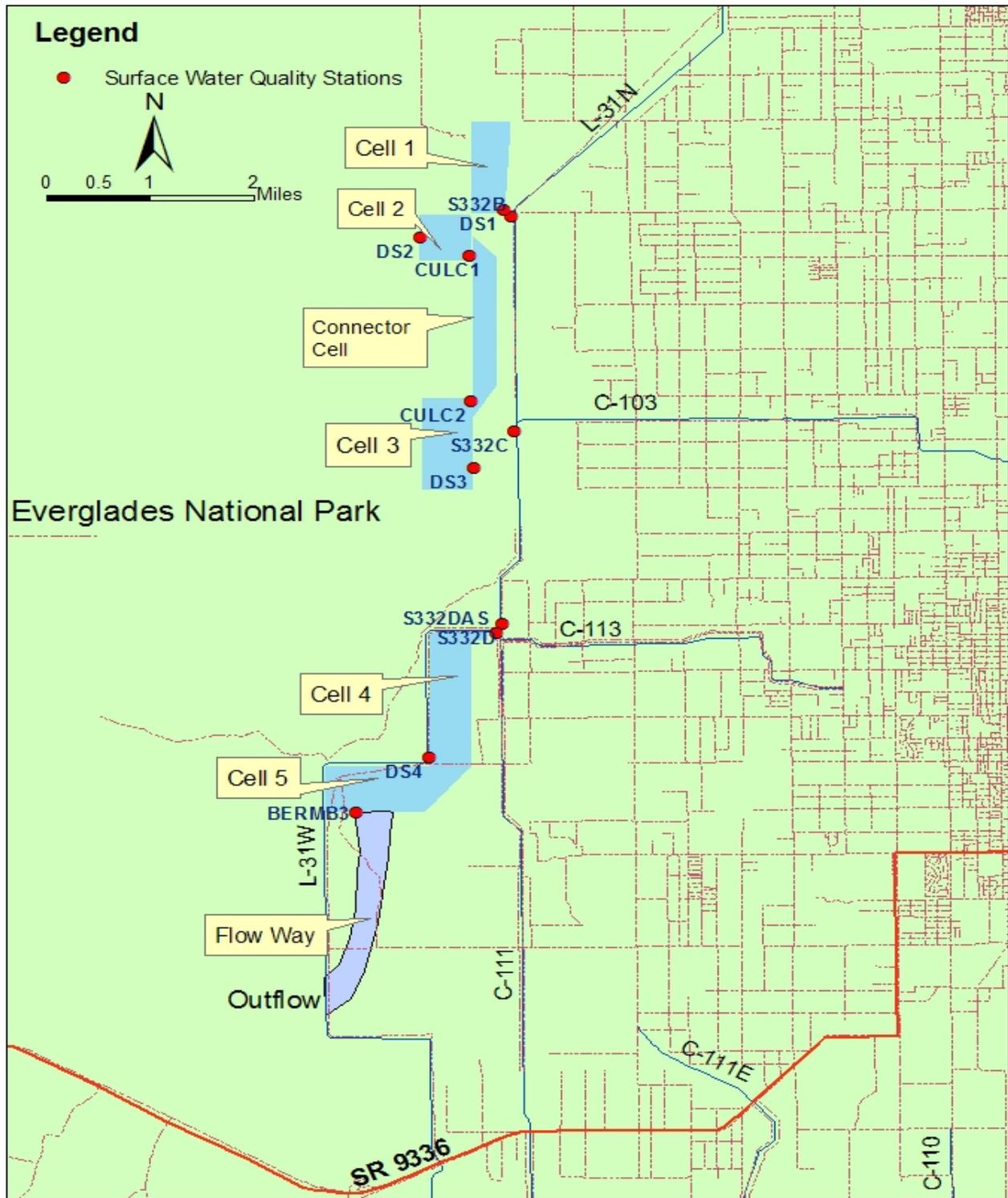
The USACE and the South Florida Water Management District (District) will monitor the implementation of the IOP under the terms and conditions of the C-111 Project Cooperation Agreement executed in 1995. The District, on behalf of the USACE, is implementing a monitoring plan approved by FDEP that assesses 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 monitoring plan treats the detention areas as a single project with five cells, three inflows and a single outflow to ENP. The diversion structures DS1 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.

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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 ground water seepage in an easterly direction from ENP.

S332B pumped 7.0 kac-ft to Cell 1 (North Pond) and 5.2 kac-ft to Cell 2 (West Pond) during the reporting quarter but there were no overflows.



**Figure 9.** C-111 Project facilities.

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## Compliance with Consent Decree

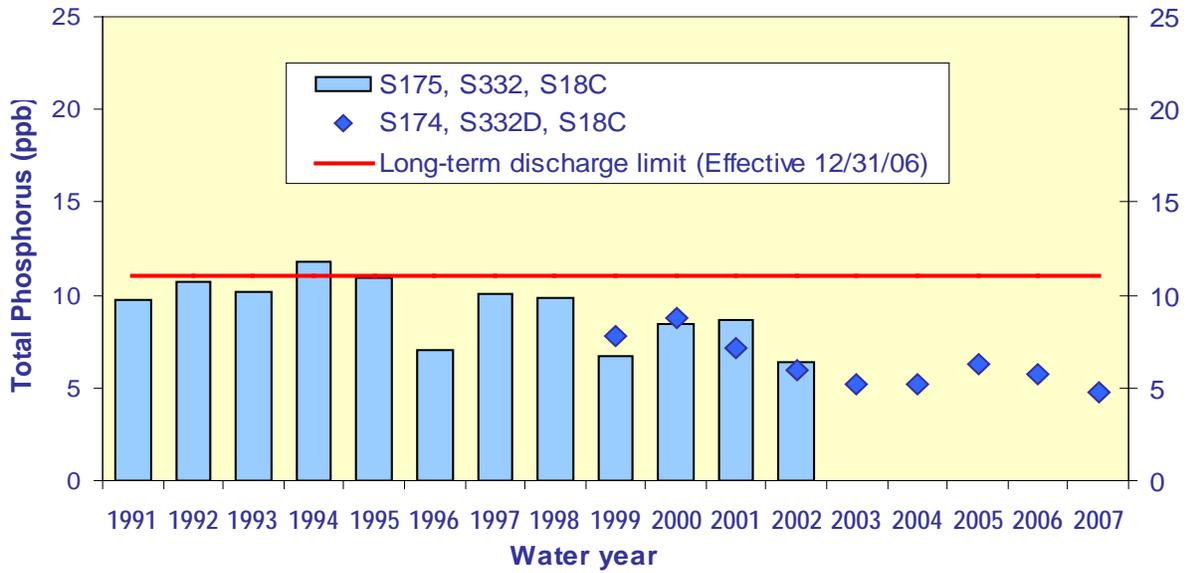
Inflow TP concentrations to the ENP through Taylor Slough and the Coastal Basins are compared to the 11 ppb limit at the end of each water year using data from both the old (S175, S332, S18C) and new (S174, S332D, S18C) combinations of structures (**Figure 10**). The bars in **Figure 10** represent the 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 2007 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**.

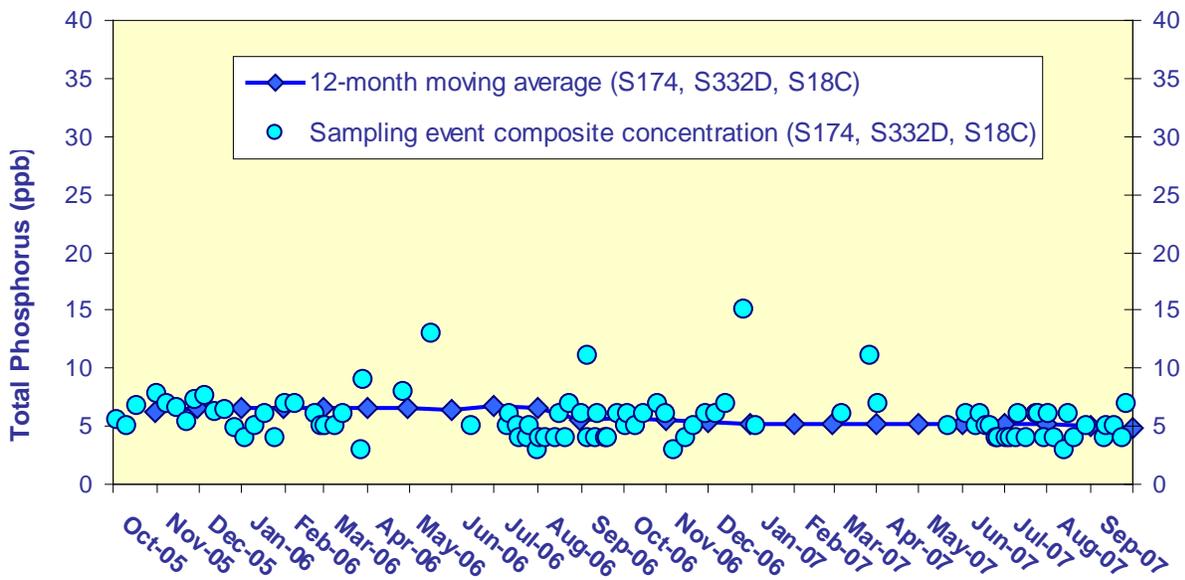
**Figure 11** presents the 12-month and individual sampling event flow-weighted mean TP concentrations at the S174, S332D and S18C structures. All TP grab sample concentrations taken on positive flow days reported for surface water monitoring at the 3 sites were used for the compliance calculations.

For the 12-month periods ending in July, August, and September 2007, the 12-month flow-weighted mean TP concentrations were 5.1, 5.0, and 4.8 ppb, respectively, for the combined flow through S174, S332D and S18C (**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 observed percentages of the sampling event flow-weighted mean TP concentrations greater than 10 ppb for the combined flow through S174, S332D and S18C were 6.4, 6.4, and 4.6 percent for the periods ending July, August, and September 2007, respectively.

The daily flows into the ENP through S332D, S174 and S18C are presented in **Figure 12**. **Figure 13** shows the relationship between the daily inflows and the corresponding flow-weighted mean TP concentrations for each sampling event. From 1984 to 1990, there was no observable relationship between daily mean flow and flow-weighted mean TP concentrations at S332 and S18C structures. A few high concentration values for the area, such as 15 ppb on December 26, 2006, and 11 ppb on March 6, 2007, were observed during low flow periods in recent years. However, the flow-weighted mean concentrations remained very low, 3 to 7 ppb, since April 2007.



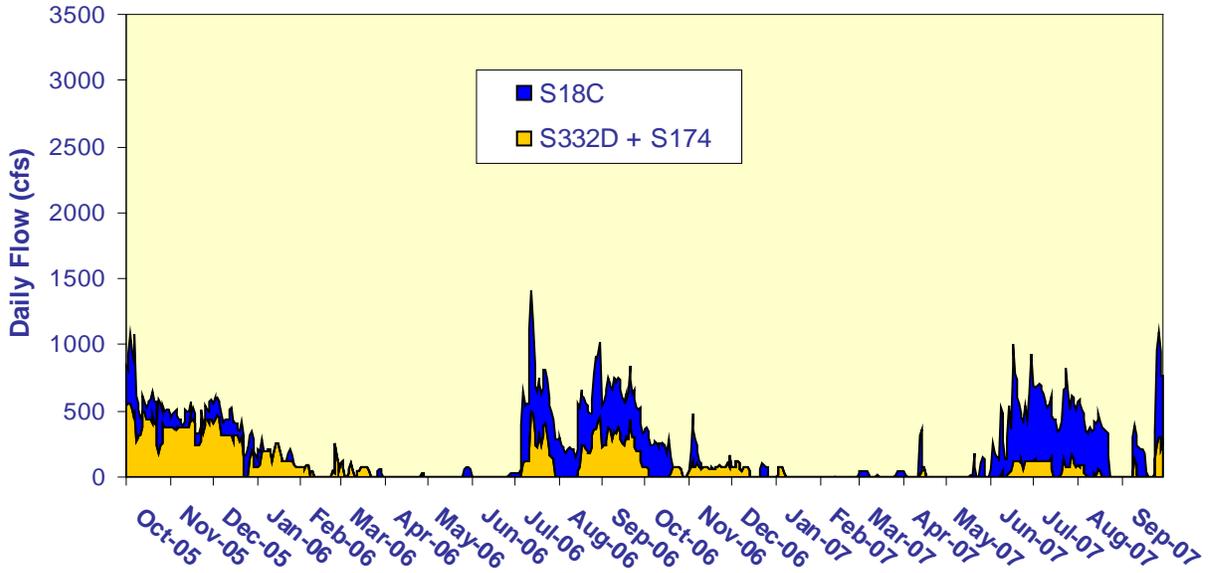
**Figure 10.** The 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each water year compared to the 11 ppb long-term TP limit.



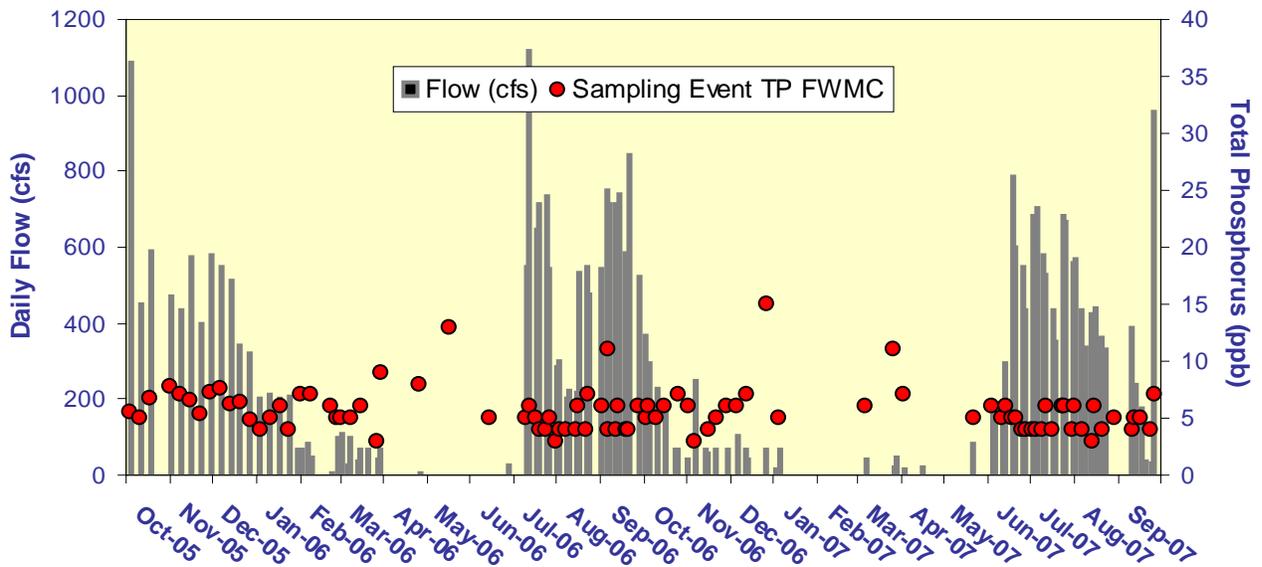
**Figure 11.** 12-month flow-weighted mean TP concentrations in inflows to Everglades National Park through Taylor Slough and the Coastal Basins at the end of each month and the flow-weighted mean TP concentration for each sampling event.

**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
11/1/2004 - 10/31/2005	373.4	6.3	11.0	53.1	12.2
12/1/2004 - 11/30/2005	358.6	6.6	11.0	53.1	12.0
1/1/2005 - 12/31/2005	366.9	6.6	11.0	53.1	11.8
2/1/2005 - 1/31/2006	369.5	6.6	11.0	53.1	11.8
3/1/2005 - 2/28/2006	364.6	6.6	11.0	53.1	11.8
4/1/2005 - 3/31/2006	359.7	6.6	11.0	53.1	11.8
5/1/2005 - 4/30/2006	351.5	6.5	11.0	53.1	10.4
6/1/2005 - 5/31/2006	343.7	6.4	11.0	53.1	4.5
7/1/2005 - 6/30/2006	295.5	6.7	11.0	53.1	4.9
8/1/2005 - 7/31/2006	280.0	6.6	11.0	53.1	4.5
9/1/2005 - 8/31/2006	227.0	5.5	11.0	53.1	2.2
<b>10/1/2005 - 9/30/2006</b>	<b>207.4</b>	<b>5.7</b>	<b>11.0</b>	<b>53.1</b>	<b>4.1</b>
11/1/2005 - 10/31/2006	179.5	5.6	11.0	53.1	3.9
12/1/2005 - 11/30/2006	158.8	5.3	11.0	53.1	3.9
1/1/2006 - 12/31/2006	137.4	5.2	11.0	53.1	6.0
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
<b>10/1/2006 - 9/30/2007</b>	<b>120.8</b>	<b>4.8</b>	<b>11.0</b>	<b>53.1</b>	<b>4.6</b>



**Figure 12.** Daily flows into Everglades National Park through Taylor Slough (S332D+S174) and S18C.



**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.