Appendix 5C-6: Summary Report for Stormwater Treatment Area 2 Flow-ways 1, 2, and 3 Water and Total Phosphorus Budget Analyses

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INTRODUCTION

The *Stormwater Treatment Area Water and Phosphorus Budget Improvements Study* is part of the Restoration Strategies *Science Plan for the Everglades Stormwater Treatment Areas* (Science Plan; SFWMD 2013) implementation. The purpose of this study is to improve the accuracy of annual Everglades Stormwater Treatment Area (STA) water and total phosphorus (TP) budgets for selected STA treatment cells to meet the needs of the Science Plan. Water budget analysis is used to understand the treatment performance of STAs, and to develop accurate TP budgets. Water budgets are comprised of structure flows (inflows and outflows), seepage, rainfall, evapotranspiration (ET), and change in storage. The TP budgets are intrinsically tied to the water budgets and are comprised of structure flows and concentrations (inflow loads and outflow loads), rainfall load, and seepage load. Previously reported STA treatment cell annual water budgets contained high residuals, a term that is defined as total inflow minus the sum of total outflow and storage change (Pietro 2013). Similarly, TP budget residuals, defined as total inflow loads minus the sum of outflow loads and change of storage (TP mass) were also high. These high residuals limit the use of water and nutrient budgets to characterize and understand treatment performance. This appendix documents the water and TP budget improvements for STA-2 Flow-ways 1, 2, and 3 (**Figure 1**). Building upon the results of Polatel et al. (2014), flow data for STA-2 Flow-ways 1, 2, and 3 were reviewed and updated based on enhanced quality assurance/quality control improvements in flow rating curves, and stage data improvements.

SUMMARY FOR STA-2 FLOW-WAYS 1, 2, AND 3.

The vegetation is variable among the STA-2 flow-ways (**Figure 1**). Flow-way 1 is dominated by dense emergent aquatic vegetation (EAV) consisting mainly of cattail interspersed with sawgrass (*Cladium jamaicense*; Pietro and Ivanoff 2015). The vegetation in Flow-way 2 is also EAV-dominated except for a deep northwest corner that has submerged aquatic vegetation (SAV) comprised of mostly hydrilla (*Hydrilla* spp). The southernmost portion of this deep corner was converted from EAV to SAV in 2009 (Pietro and Ivanoff 2015). Flow-way 3 is SAV-dominated with a mixture of southern naiad (*Najas guadalupensis*), musk grass (*Chara* spp.), hydrilla, and coontail (*Ceratophyllum demersum*) with cattail (*Typha* spp.) growth on the higher areas along the eastern perimeter and on old farm roads that remain in the flow-way and are located perpendicular to flow (Pietro and Ivanoff 2015).

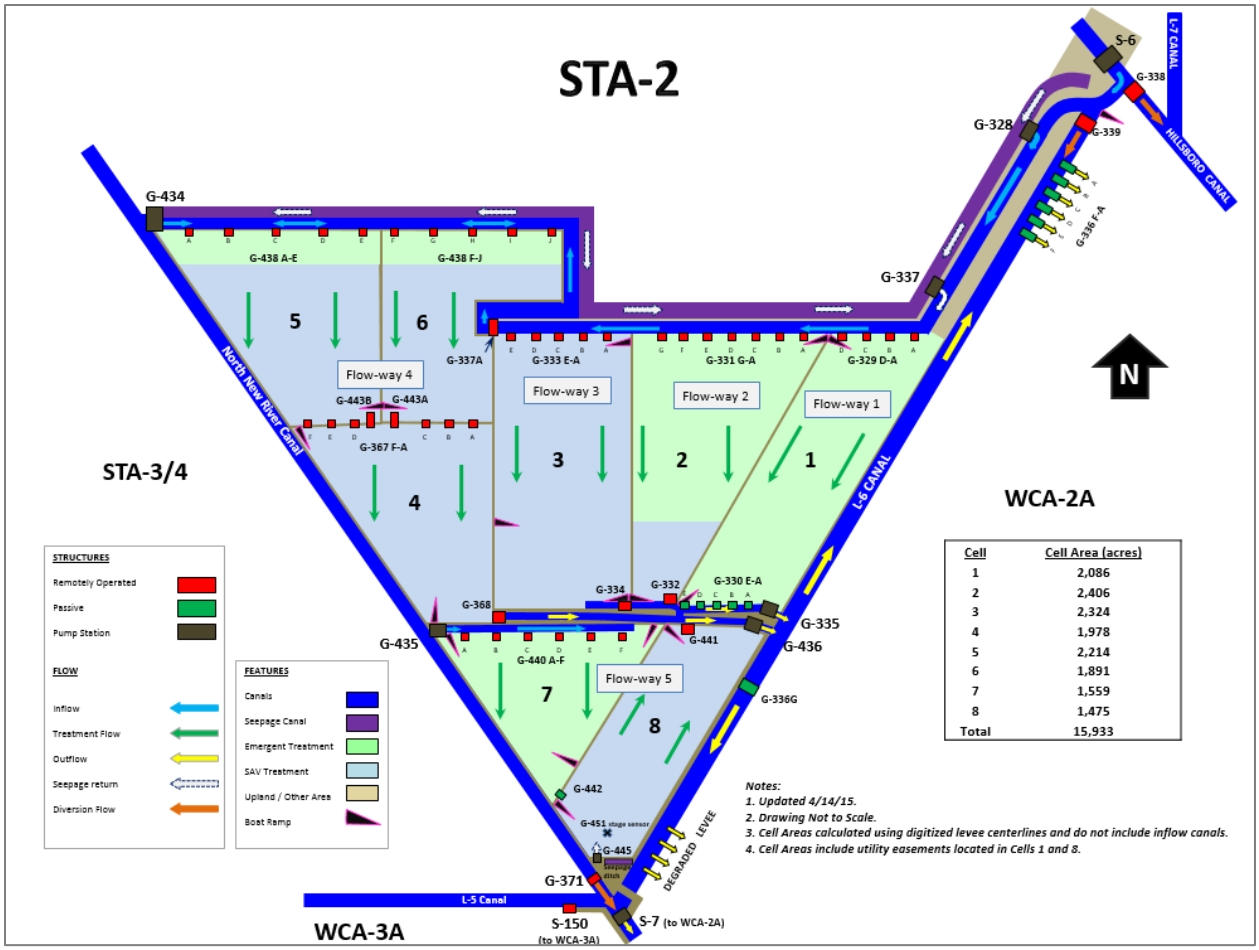

Figure 1 STA-2 schematic showing configurations of the treatment cells, flow direction, dominant vegetation type, and locations of flow structures.

Annual water and TP budgets were developed for STA-2 Flow-ways 1, 2, and 3 for the 15-year period of record (POR) from Water Year 2002 (WY2002; May 1, 2001–April 30, 2002) to WY2016 (Zhao and Piccone in review). Improved flow and stage data were used in the analyses resulting in improved overall water budget residuals (**Tables 1** through **3**) compared to previous budgets (Pietro 2013). A calibrated seepage coefficient of 0.0635 cubic meters per second per meter of head difference per kilometer of levee length ($m^3/s/m/km$) was used in this analysis. The TP budget results were used to estimate the annual and long-term average annual flow-way TP load and TP flow-weighted mean (FWM) reduction percentages, TP retention rate, hydraulic residence time (HRT), hydraulic loading rate (HLR), and phosphorus loading rate (PLR) for the three flow-ways (**Tables 4** through **10**).

Flow-way 1

Flow-way 1 is the smallest of the three cells in terms of effective treatment area (compare **Tables 7** through **9**). Over the 15-year POR (WY2002–WY2016), this cell received the smallest amount of inflow of the three flow-ways averaging 70 million cubic meters per year (m^3/yr) (**Table 1)** or 87.7% of the total inflow. Of the remaining total inflow, 11.2% (9 million m^3 per year) was from rainfall, and 1.1% (0.9 million m^3/yr) was from seepage in. The structure outflow averaged 65 million m^3/yr or 82.0% of the total outflow. ET and seepage out accounted for 12.3% (10 million m^3/yr) and 5.8% (5 million m^3/yr) of the total outflow, respectively. The annual average water budget residual was less than 1% of the average annual

total inflow and outflow, smaller than in the other two flow-ways, which indicated the flows and water volumes for this flow-way were reasonably accurate

The inflow TP FWM concentration for the POR to this flow-way was 86 micrograms per liter (µg/L) and outflow TP FWM concentration was the lowest of all three flow-ways at 14 µg/L (**Table 4**). The average annual TP load reduction and TP FWMC were both 83%, which was the highest percent load reduction of all three flow-ways. The average annual HLR, PLR, and water depth were all the lowest of the three flow-ways at 3.0 centimeters per day (cm/d, 0.92 grams per square meter per year [$g/m^2/yr$], and 0.3 meters (m), respectively (**Table 7**). Over the POR, Flow-way 1 retained 85.8 metric tons (t) of TP (**Table 10**).

Flow-way 2

Flow-way 2 is the largest of the three flow-ways in terms of effective treatment area (**Table 8**). It received the highest annual average surface inflow averaging 142 million m^3/yr over the 15-year POR (**Table 2**) or 90.3% of the total inflow. Rainfall accounted for 7.4% (12 million m^3/yr), and seepage in was 2.2% (3.5 million m^3/yr). The structure outflow was 132 million m^3/yr or 90.9% of the total outflow. ET and seepage out made up the remaining 8.7 and 0.4% (13 and 0.6 million m^3/yr), respectively. The annual average water budget residual was -8% of the average annual total inflow and outflow, the largest (in terms of the absolute value) compared to the other two flow-ways. Of the three flow-ways, this was the only one where seepage in was greater than seepage out.

The inflow TP FWM concentration to this flow-way was 98 µg/L over the POR (**Table 5**). The outflow TP FWM concentration of 25 µg/L was the highest average of all three flow-ways. The average annual TP load reduction was 78% and the average annual TP FWM concentration reduction was 76%. The average annual HLR, PLR, and water depth were 4.5 cm/d, 1.62 $g/m^2/yr$, and 0.51 m, respectively (**Table 8**). The average HLR and PLR were the highest of the three flow-ways. The average annual HRT was 12 days (**Table 10)**. Over the POR, Flow-way 2 retained 178.0 t of TP.

Flow-way 3

Flow-way 3 has the second largest effective treatment area of the flow-ways. The surface inflow was the second largest at 136 million m^3/yr over the 15-year POR (**Table 3**) or 91.3% of the total inflow to this flow-way. Rainfall and seepage in accounted for 7.6% (11 million m^3/yr) and 1.1% (1.6 million m^3/yr), respectively, of the total inflow. The structure outflow from this flow-way was 137 million m^3/yr or 88.9% of the total outflow. ET and seepage out accounted for 7.9 (12.2. million m^3/yr) and 3.2% (4.9 million m^3/yr) of the total outflow, respectively. The total storage change over the POR was 0.05 million m^3/yr. The annual average water budget residual was 4% of the average annual total inflow and outflow.

The inflow TP FWM concentration to this flow-way was 90 µg/L over the POR and outflow TP FWM concentration was 17 µg/L (**Table 6**). The average annual TP load reduction and TP FWM concentration reduction were both 78%. The average annual HLR, PLR, and water depth were 4.4 cm/d, 1.38 $g/m^2/yr$, and 0.5 m, respectively (**Table 9)**. The average annual HRT was 13 days. Over the POR, Flow-way 3 retained 152.5 t of TP.

Comparison of Flow-ways

The three flow-ways together removed over 416 t of TP for the 15-year POR (**Table 10**). The amount of TP retained per unit area was greatest in Flow-way 2 and smallest in Flow-way 1. The Flow-way 1 annual discharge FWM concentration was 13 µg/L or less in nine of the fifteen water years (see **Table 4**).

Table 1. Summary of the annual water budget for STA-2 Flow-way 1.

Water Year	Inflow	Seepage In	Rain	Total Inflow	Outflow	Seepage Out	ET	Total Outflow	Change in Storage	Residual	Residual
	----------	----------	----------	----------	----------	----------	$m^3 \times 10^6$ ----------	----------	----------	----------	percent
2002	49.5	6.8	12.1	68.4	42.5	0.1	10.0	52.6	0.0	-15.8	-26
2003	54.2	3.1	9.6	67.0	37.9	3.4	9.7	51.0	4.0	-11.9	-20
2004	73.4	0.0	8.0	81.4	60.9	5.2	9.9	76.0	-2.0	-7.4	-9
2005	74.5	0.1	6.6	81.2	69.8	5.2	9.3	84.3	0.4	3.5	4
2006	73.9	0.2	8.6	82.6	68.0	4.9	10.1	82.9	-0.2	0.1	0
2007	68.8	0.1	7.8	76.6	51.3	6.5	9.6	67.4	-2.2	-11.5	-16
2008	73.9	0.5	10.3	84.8	56.2	6.2	9.7	72.1	2.1	-10.6	-14
2009	54.5	0.2	9.3	64.0	51.0	4.2	10.0	65.2	-2.0	-0.8	-1
2010	66.5	0.2	10.3	77.0	78.4	5.9	9.3	93.6	3.9	20.4	24
2011	30.2	0.3	7.2	37.7	34.0	5.4	10.3	49.7	-2.3	9.7	22
2012	65.5	0.0	9.9	75.4	59.9	5.9	10.1	75.9	1.8	2.3	3
2013	70.7	0.4	9.3	80.3	65.5	3.5	10.0	79.0	-0.8	-2.1	-3
2014	64.6	0.5	9.4	74.4	70.6	3.7	10.0	84.3	0.2	10.1	13
2015	187.1	0.0	6.0	193.1	177.9	5.5	9.6	193.0	1.2	1.1	1
2016	47.1	0.4	11.2	58.7	57.7	3.1	9.7	70.6	-1.9	10.0	16
Average	**70.3**	**0.9**	**9.0**	**80.2**	**65.4**	**4.6**	**9.8**	**79.8**	**0.1**	**-0.2**	**0**
Minimum	**30.2**	**0.0**	**6.0**	**37.7**	**34.0**	**0.1**	**9.3**	**49.7**	**-2.3**	**-15.8**	**-26**
Maximum	**187.1**	**6.8**	**12.1**	**193.1**	**177.9**	**6.5**	**10.3**	**193.0**	**4.0**	**20.4**	**24**
POR	**1,054.3**	**12.8**	**135.5**	**1,202.7**	**981.5**	**68.9**	**147.0**	**1,197.4**	**2.1**	**-3.2**	**-0.3**

Table 2. Summary of the annual water budget for STA-2 Flow-way 2.

Water Year	Inflow	Seepage In	Rain	Total Inflow	Outflow	Seepage Out	ET	Total Outflow	Change in Storage	Residual	Residual
	----------	----------	----------	----------	----------	----------	m^3 X 10^6 ----------	----------	----------	----------	percent
2002	144.2	1.3	15.5	161.1	106.4	1.7	12.9	121.0	2.2	-37.8	-27
2003	149.6	3.7	12.3	165.6	126.6	1.1	12.5	140.1	5.2	-20.3	-13
2004	118.7	3.8	10.4	132.9	102.2	0.2	12.5	114.8	-3.1	-21.1	-17
2005	187.1	5.4	8.5	201.0	166.6	0.3	12.4	179.3	-1.9	-23.6	-12
2006	158.1	5.0	11.1	174.2	134.0	0.2	12.6	146.8	0.2	-27.2	-17
2007	154.2	4.3	10.0	168.6	130.5	0.2	12.6	143.4	-2.2	-27.3	-18
2008	74.4	6.9	13.3	94.6	75.1	0.0	12.7	87.7	2.6	-4.3	-5
2009	129.1	5.4	12.0	146.5	129.5	0.2	12.5	142.2	-2.9	-7.2	-5
2010	157.7	4.6	13.3	175.5	158.6	0.1	11.9	170.6	5.7	0.8	1
2011	82.9	1.3	9.3	93.5	75.9	1.1	13.3	90.3	-1.6	-4.9	-5
2012	98.1	2.2	12.7	113.1	94.7	0.3	13.0	108.0	1.6	-3.4	-3
2013	189.4	0.8	11.9	202.2	187.8	1.4	12.8	202.0	-0.1	-0.3	0
2014	165.6	1.8	12.1	179.5	169.4	1.2	12.8	183.4	-1.6	2.4	1
2015	188.8	3.5	7.7	200.0	190.6	0.3	12.4	203.3	1.8	5.1	3
2016	134.0	2.2	14.5	150.7	130.4	0.8	12.5	143.7	-1.5	-8.5	-6
Average	**142.1**	**3.5**	**11.6**	**157.3**	**131.9**	**0.6**	**12.6**	**145.1**	**0.3**	**-11.8**	**-8**
Minimum	**74.4**	**0.8**	**7.7**	**93.5**	**75.1**	**0.0**	**11.9**	**87.7**	**-3.1**	**-37.8**	**-27**
Maximum	**189.4**	**6.9**	**15.5**	**202.2**	**190.6**	**1.7**	**13.3**	**203.3**	**5.7**	**5.1**	**3**
POR	**2,131.9**	**52.3**	**174.7**	**2,359.0**	**1,978.3**	**9.2**	**189.3**	**2,176.8**	**4.5**	**-177.7**	**-8**

Table 3. Summary of the annual water budget for STA-2 Flow-way 3.

Water Year	Inflow	Seepage In	Rain	Total Inflow	Outflow	Seepage Out	ET	Total Outflow	Change in Storage	Residual	Residual
	---------- m^3 X 10^6----------										percent
2002	161.1	0.0	15.0	176.2	122.0	13.4	12.5	147.8	2.6	-25.7	-16
2003	196.5	0.0	11.9	208.4	152.4	18.5	12.2	183.1	2.1	-23.2	-12
2004	155.6	0.0	10.0	165.7	135.4	14.8	12.3	162.5	-3.8	-6.9	-4
2005	183.0	0.0	8.2	191.2	197.0	9.8	11.6	218.5	-0.5	26.8	13
2006	169.3	0.5	10.7	180.5	173.2	5.7	12.5	191.5	-0.8	10.3	6
2007	85.4	1.5	9.7	96.6	76.5	0.8	12.0	89.2	-0.1	-7.5	-8
2008	111.4	0.1	12.9	124.4	120.2	4.7	12.1	136.9	1.8	14.4	11
2009	83.9	1.8	11.6	97.3	75.6	0.6	12.4	88.6	-1.0	-9.7	-10
2010	153.2	1.2	12.9	167.3	164.5	0.6	11.5	176.6	3.5	12.8	8
2011	90.5	0.1	9.0	99.5	89.5	3.0	12.8	105.3	-2.2	3.6	4
2012	97.9	0.7	12.3	110.9	113.7	1.2	12.6	127.4	0.9	17.5	15
2013	134.9	3.1	11.6	149.6	155.1	0.1	12.4	167.6	-1.2	16.8	11
2014	137.0	4.2	11.7	152.9	160.1	0.1	12.4	172.6	-0.4	19.4	12
2015	112.1	6.6	7.5	126.1	132.8	0.0	12.0	144.8	1.0	19.8	15
2016	165.6	4.8	14.0	184.5	185.6	0.0	12.1	197.7	-1.5	11.8	6
Average	**135.8**	**1.6**	**11.3**	**148.7**	**136.9**	**4.9**	**12.2**	**154.0**	**0.0**	**5.3**	**3**
Minimum	**83.9**	**0.0**	**7.5**	**96.6**	**75.6**	**0.0**	**11.5**	**88.6**	**-3.8**	**-25.7**	**-16**
Maximum	**196.5**	**6.6**	**15.0**	**208.4**	**197.0**	**18.5**	**12.8**	**218.5**	**3.5**	**26.8**	**15**
POR	**2,037.4**	**24.5**	**169.1**	**2,230.9**	**2,053.8**	**73.1**	**183.4**	**2,310.3**	**0.7**	**80.1**	**4**

Table 4. Summary of the annual TP budget for STA-2 Flow-way 1.

Water Year	TP Load from Structure Inflow (t)	TP FWM from Structure Inflow (µg/L)	TP Load from Structure Outflow (t)	TP FWM from Structure Outflow (µg/L)	TP Load from Rain (t)	TP Load from Dry Deposition (t)	TP FWM from Seepage In (µg/L)	TP Load Seepage In (t)	TP FWM from Seepage Out (µg/L)	TP Load Seepage Out (t)	Total TP Load In (t)	Total TP Load Out (t)	Total TP Load Retained (t)	Total Inflow FWM (µg/L)	Total TP Outflow FWM (µg/L)	Total TP Load Retained (%)	Total TP FWM Reduction (%)
2002	4.65	94	0.79	18	0.12	0.24	20	0.14	59	<0.01	5.03	0.79	4.24	74	15	84	80
2003	2.72	50	0.55	14	0.10	0.24	23	0.07	35	0.12	3.07	0.67	2.41	46	13	78	71
2004	5.33	73	0.83	14	0.08	0.24	25	0.00	46	0.24	5.67	1.07	4.60	70	14	81	80
2005	7.41	99	0.70	10	0.07	0.24	20	0.00	56	0.29	7.73	0.99	6.74	95	12	87	88
2006	6.55	89	1.15	17	0.09	0.24	19	0.00	54	0.26	6.89	1.42	5.48	83	17	79	80
2007	10.45	152	0.45	9	0.08	0.24	15	0.00	91	0.59	10.79	1.04	9.74	141	15	90	89
2008	6.59	89	0.64	11	0.10	0.24	20	0.01	56	0.35	6.95	0.98	5.97	82	14	86	83
2009	6.50	119	0.49	10	0.09	0.24	25	0.00	66	0.28	6.86	0.77	6.09	107	12	89	89
2010	7.86	118	3.78	48	0.10	0.24	26	0.01	80	0.48	8.23	4.26	3.97	107	46	48	57
2011	2.62	87	0.41	12	0.07	0.24	17	0.01	47	0.25	2.95	0.66	2.29	78	13	78	83
2012	5.19	79	0.54	9	0.10	0.24	15	0.00	46	0.27	5.55	0.80	4.74	74	11	86	86
2013	7.97	113	0.54	8	0.09	0.24	16	0.01	63	0.22	8.32	0.76	7.56	104	10	91	91
2014	5.80	90	0.57	8	0.09	0.24	18	0.01	47	0.18	6.15	0.74	5.41	83	9	88	89
2015	14.64	78	1.47	8	0.06	0.24	15	0.00	44	0.24	14.95	1.71	13.24	77	9	89	89
2016	3.57	76	0.49	9	0.11	0.24	13	0.01	39	0.12	3.94	0.62	3.32	67	9	84	87
Average	**6.52**	**94**	**0.89**	**14**	**0.09**	**0.24**	**19**	**0.02**	**55**	**0.26**	**6.87**	**1.15**	**5.72**	**86**	**14**	**83**	**83**
Minimum	**2.62**	**50**	**0.41**	**8**	**0.06**	**0.24**	**13**	**0.00**	**35**	**0.00**	**2.95**	**0.62**	**2.29**	**46**	**9**	**48**	**57**
Maximum	**14.64**	**152**	**3.78**	**48**	**0.12**	**0.24**	**26**	**0.14**	**91**	**0.59**	**14.95**	**4.26**	**13.24**	**141**	**46**	**91**	**91**
POR	**97.86**	**93**	**13.38**	**13.6**	**1.35**	**3.60**	**20**	**0.26**	**57**	**3.90**	**103.08**	**17.28**	**85.80**	**86**	**14**	**83**	**83**

Table 5. Summary of the annual TP budget for STA-2 Flow-way 2.

Water Year	TP Load from Structure Inflow (t)	TP FWM from Structure Inflow (µg/L)	TP Load from Structure Outflow (t)	TP FWM from Structure Outflow (µg/L)	TP Load from Rain (t)	TP Load from Dry Deposition (t)	TP FWM from Seepage In (µg/L)	TP Load Seepage In (t)	TP FWM from Seepage Out (µg/L)	TP load Seepage Out (t)	Total TP Load In (t)	Total TP Load Out (t)	Total TP Load Retained (t)	Total Inflow FWM (µg/L)	Total TP Outflow FWM (µg/L)	Total TP Load Retained (%)	Total TP FWM Reduction (%)
2002	12.83	89	1.68	16	0.16	0.31	20.3	0.03	58	0.10	13.32	1.79	11.53	83	15	87	82
2003	9.73	65	2.52	20	0.12	0.31	22.6	0.08	44	0.05	10.24	2.57	7.67	62	18	75	70
2004	10.41	88	1.63	16	0.10	0.31	24.9	0.10	55	0.01	10.92	1.63	9.29	82	14	85	83
2005	20.57	110	6.27	38	0.09	0.31	19.9	0.11	76	0.03	21.07	6.30	14.77	105	35	70	66
2006	16.46	104	3.57	27	0.11	0.31	19.4	0.10	69	0.01	16.98	3.58	13.40	98	24	79	75
2007	27.55	179	7.23	55	0.10	0.31	15.0	0.07	122	0.03	28.02	7.26	20.76	166	51	74	70
2008	9.30	125	2.71	36	0.13	0.31	19.9	0.14	80	0.00	9.88	2.71	7.17	104	31	73	70
2009	16.10	125	2.56	20	0.12	0.31	25.4	0.14	72	0.02	16.66	2.58	14.09	114	18	85	84
2010	21.00	133	10.00	63	0.13	0.31	26.1	0.12	98	0.01	21.56	10.00	11.56	123	59	54	52
2011	8.37	101	1.41	19	0.09	0.31	16.8	0.02	62	0.07	8.79	1.48	7.31	94	16	83	83
2012	9.85	100	1.38	15	0.13	0.31	15.0	0.03	58	0.02	10.32	1.40	8.92	91	13	86	86
2013	23.35	123	4.33	23	0.12	0.31	15.5	0.01	73	0.10	23.79	4.43	19.36	118	22	81	81
2014	14.81	89	3.64	21	0.12	0.31	17.5	0.03	55	0.06	15.27	3.70	11.57	85	20	76	76
2015	15.21	81	3.07	16	0.08	0.31	14.9	0.05	48	0.02	15.65	3.09	12.56	78	15	80	81
2016	10.04	75	2.40	18	0.14	0.31	13.1	0.03	47	0.04	10.52	2.44	8.08	70	17	77	76
Average	**15.04**	**106**	**3.63**	**27**	**0.12**	**0.31**	**19**	**0.07**	**68**	**0.04**	**15.53**	**3.66**	**11.87**	**98**	**25**	**78**	**76**
Minimum	**8.37**	**65**	**1.38**	**15**	**0.08**	**0.31**	**13**	**0.01**	**44**	**0.00**	**8.79**	**1.40**	**7.17**	**62**	**13**	**54**	**52**
Maximum	**27.55**	**179**	**10.00**	**63**	**0.16**	**0.31**	**26**	**0.14**	**122**	**0.10**	**28.02**	**10.00**	**20.76**	**166**	**59**	**87**	**86**
POR	**225.58**	**106**	**54.41**	**28**	**1.75**	**4.61**	**20.1**	**1.05**	**61**	**0.56**	**232.98**	**54.97**	**178.01**	**99**	**25**	**76**	**74**

Table 6. Summary of the annual TP budget for STA-2 Flow-way 3.

Water Year	TP load from Structure Inflow (t)	TP FWM from Structure Inflow (µg/L)	TP load from Structure Outflow (t)	TP FWM from Structure Outflow (µg/L)	TP Load from Rain (t)	TP Load from Dry Deposition (t)	TP FWM from Seepage In (µg/L)	TP Load Seepage In (t)	TP FWM from Seepage Out (µg/L)	TP Load Seepage Out (t)	Total TP Load In (t)	Total TP Load Out (t)	Total TP Load Retained (t)	Total Inflow FWM (µg/L)	Total TP Outflow FWM (µg/L)	Total TP Load Retained (%)	Total TP FWM Reduction (%)
2002	4.40	27	1.95	16	0.15	0.30	20.3	0.00	22	0.30	4.85	2.25	2.60	28	15	54	45
2003	10.53	54	2.36	15	0.12	0.30	22.6	0.00	37	0.68	10.94	3.05	7.90	53	17	72	68
2004	12.17	78	1.79	13	0.10	0.30	24.9	0.00	48	0.71	12.57	2.50	10.07	76	15	80	80
2005	21.43	117	3.29	17	0.08	0.30	19.9	0.00	65	0.64	21.81	3.93	17.88	114	18	82	84
2006	15.74	93	2.95	17	0.11	0.30	19.4	0.01	55	0.31	16.16	3.26	12.89	90	17	80	81
2007	10.97	128	1.96	26	0.10	0.30	15.0	0.02	80	0.06	11.38	2.02	9.37	118	23	82	81
2008	12.59	113	2.06	17	0.13	0.30	19.9	0.00	63	0.29	13.02	2.36	10.66	105	17	82	84
2009	14.81	177	2.23	30	0.12	0.30	25.4	0.05	107	0.06	15.27	2.29	12.98	157	26	85	84
2010	16.91	110	2.86	17	0.13	0.30	26.1	0.03	62	0.04	17.37	2.89	14.48	104	16	83	84
2011	7.37	81	1.35	15	0.09	0.30	16.8	0.00	48	0.14	7.76	1.49	6.27	78	14	81	82
2012	7.96	81	1.65	15	0.12	0.30	15.0	0.01	45	0.05	8.39	1.70	6.69	76	13	80	82
2013	14.81	110	4.07	26	0.12	0.30	15.5	0.05	65	0.00	15.27	4.07	11.20	102	24	73	76
2014	13.17	96	2.67	17	0.12	0.30	17.5	0.07	53	0.00	13.66	2.68	10.99	89	16	80	83
2015	10.03	90	2.08	16	0.07	0.30	14.9	0.10	49	0.00	10.50	2.08	8.43	83	14	80	83
2016	12.69	77	3.11	17	0.14	0.30	13.1	0.06	45	0.00	13.19	3.11	10.08	72	16	76	78
Average	**12.37**	**96**	**2.43**	**18**	**0.11**	**0.30**	**19**	**0.03**	**56**	**0.22**	**12.81**	**2.65**	**10.16**	**90**	**17**	**78**	**78**
Minimum	**4.40**	**27**	**1.35**	**13**	**0.07**	**0.30**	**13**	**0.00**	**22**	**0.00**	**4.85**	**1.49**	**2.60**	**28**	**13**	**54**	**45**
Maximum	**21.43**	**177**	**4.07**	**30**	**0.15**	**0.30**	**26**	**0.10**	**107**	**0.71**	**21.81**	**4.07**	**17.88**	**157**	**26**	**85**	**84**
POR	**185.59**	**91**	**36.38**	**18**	**1.69**	**4.46**	**16.5**	**0.40**	**45**	**3.30**	**192.14**	**39.68**	**152.46**	**86**	**17**	**79**	**80**

Table 7. Effective treatment area, operational period, depth, HLR, PLR, and HRT for STA-2 Flow-way 1.

Water Year	Effective Treatment Area (hectares)	Days of Operation (days)	Average Depth (m)	HLR (cm/d)	PLR ($g/m^2/yr$)	HRT (days)
2002	557	273	0.18	N/A [a]	0.68	N/A
2003	745	365	0.18	2.5	0.41	8
2004	745	366	0.40	3.0	0.76	14
2005	745	365	0.41	3.0	1.04	14
2006	745	365	0.41	3.0	0.93	13
2007	745	365	0.35	2.8	1.45	13
2008	745	366	0.31	3.1	0.93	11
2009	745	365	0.22	2.4	0.92	9
2010	745	365	0.38	2.8	1.11	12
2011	745	365	0.26	1.4	0.40	16
2012	745	366	0.39	2.8	0.74	14
2013	745	365	0.45	3.0	1.12	15
2014	745	365	0.48	2.7	0.83	17
2015	745	365	0.64	7.1	2.01	9
2016	745	366	0.49	2.2	0.53	21
Average	**745**	**359**	0.37	**3.0**	**0.92**	**13**
Minimum	**745**	**273**	0.18	**1.4**	**0.40**	**8**
Maximum	**745**	**366**	0.64	**7.1**	**2.01**	**21**
POR	**745**	**5,114**	0.37	**3.0**	**0.92**	**13**

a. N/A – Not applicable.

Table 8. Effective treatment area, operational period, depth, HLR, PLR, and HRT for STA-2 Flow-way 2.

Water Year	Effective Treatment Area (hectares)	Days of Operation (days)	Average Depth (m)	HLR (cm/d)	PLR ($g/m^2/yr$)	HRT (days)
2002	960	365	0.43	4.6	1.39	11
2003	960	365	0.51	4.7	1.07	12
2004	960	366	0.55	3.8	1.14	16
2005	960	365	0.46	5.7	2.19	8
2006	960	365	0.35	5.0	1.77	8
2007	960	365	0.44	4.8	2.92	10
2008	960	366	0.36	2.7	1.03	14
2009	960	365	0.36	4.2	1.74	9
2010	960	365	0.46	5.0	2.25	9
2011	960	365	0.50	2.7	0.92	19
2012	960	366	0.54	3.2	1.07	17
2013	960	365	0.67	5.8	2.48	12
2014	960	365	0.67	5.1	1.59	13
2015	960	365	0.70	5.7	1.63	12
2016	960	366	0.68	4.3	1.10	16
Average	**960**	**365**	**0.51**	**4.5**	**1.62**	**12**
Minimum	**960**	**365**	**0.35**	**2.7**	**0.92**	**8**
Maximum	**960**	**366**	**0.70**	**5.8**	**2.92**	**19**
POR	**960**	**5,479**	**0.51**	**4.5**	**1.62**	**12**

Table 9. Effective treatment area, operational period, depth, HLR, PLR, and HRT for STA-2 Flow-way 3.

Water Year	Effective Treatment Area (hectares)	Days of Operation (days)	Average Depth (m)	HLR (cm/d)	PLR ($g/m^2/yr$)	HRT (days)
2002	929	365	0.66	5.2	0.52	14
2003	929	365	0.74	6.1	1.18	13
2004	929	366	0.66	4.9	1.35	14
2005	929	365	0.50	5.6	2.35	8
2006	929	365	0.47	5.3	1.74	9
2007	929	365	0.40	2.8	1.23	15
2008	929	366	0.52	3.7	1.4	13
2009	929	365	0.52	2.9	1.64	19
2010	929	365	0.55	4.9	1.87	11
2011	929	365	0.55	2.9	0.84	18
2012	929	366	0.55	3.3	0.9	16
2013	929	365	0.53	4.4	1.64	11
2014	929	365	0.54	4.5	1.47	11
2015	929	365	0.51	3.7	1.13	13
2016	929	366	0.55	5.4	1.42	10
Average	**929**	**365**	**0.55**	**4.4**	**1.38**	**13**
Minimum	**929**	**365**	**0.40**	**2.8**	**0.52**	**8**
Maximum	**929**	**366**	**0.74**	**6.1**	**2.35**	**19**
POR	**929**	**5,479**	**0.55**	**4.4**	**1.38**	**13**

Table 10. POR Flow-way performance comparison.

Flow-way	TP Load Reduction (%)	TP Concentration Reduction (%)	HRT (days)	HLR (cm/d)	PLR ($g/m^2/yr$)	POR TP Load Retained (t)	TP Load Retained per Unit Area ($g/m^2/yr$)	POR TP Load Retention (g/m^2)
1	83	83	13	3.0	0.92	85.8	0.77	11.55
2	78	76	12	4.5	1.62	178.01	1.24	18.60
3	78	78	13	4.4	1.38	152.46	1.09	16.35

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