Indian River County
Department of Utility Services

PERFORMANCE REVIEW
FOR THE
INDIAN RIVER COUNTY
OSPREY MARSH ALGAL TURF SCRUBBER
WETLAND TREATMENT SYSTEM

January 1, 2016 – December 31, 2016

PREPARED BY:
INDIAN RIVER COUNTY
DEPARTMENT OF UTILITY SERVICES

March 2017

Indian River County
Department of Utility Services
1801 27th Street, Vero Beach, FL 32960

SECTION 1

INTRODUCTION

This Annual Performance Report for the Indian River County, Department of Utility Services' (IRCDUS) Osprey Marsh Algal Turf Scrubber System (ATS) Wetland Treatment System (OMWTS) serves as the second of such covering the facility from January 1, 2016 through to the end of December 2016. This report represents a comprehensive summary of the monitoring requirements found in the IRCDUS – South County Demineralization Concentrate Industrial Wastewater Facility Permit 31-FL0037940 for the OMWTS. The information contained within this report will demonstrate the operational compliance of the Osprey Marsh Algal Turf Scrubber Wetland Treatment System within the permit conditions during 2016.

At approximately 12 acres in size, the facility is located on the South side of 5th Street SW, ¼ mile East of 20th Avenue. (Figure 1.1). The longitude of the project site is 80° 23' 54.70 W and the latitude is 27° 35' 32.36" N. Throughout 2016, flows averaging 0.76 million gallons per day (MGD) Demineralization Concentrate (DC) from the South County Water Treatment Plant (WTP), and 7.24 MGD from the South Relief Canal (SRC) were introduced into the headworks of the Osprey Marsh where they were blended and allowed to gravity flow through the Wetland Treatment System. The treated discharge then left the site and flowed into the Sub-Lateral J-1 Canal. From the Sub-Lateral J-1 Canal, the water then flowed into the Lateral J Canal, and eventually rejoined back into the South Relief Canal downstream of the intake pumping station.

The Osprey Marsh is required to demonstrate compliance with the analytical requirements set forth in the Industrial Wastewater Permit issued to the South County Reverse Osmosis Water Treatment Plant (FL0037940). Permit Compliance samples are collected at seven (7) locations for various parameters: (1) Demineralization Concentrate from the sampling point at the South County RO WTP (INT02) (offsite location); (2) South Relief Canal Intake Water prior to Blending (INT01) (offsite location); (3) Osprey Marsh Headworks Mixer Box influent (EFF-02) (at the ATS™ headworks structure after blending just prior to introduction on the flow way); (4) Effluent structure just upstream of the Polishing Ponds (INT-03); (5) Discharge of the Marsh to the Sub-Lateral J-1 Canal (EFF-03); (6) Background location upstream of Marsh discharge to Sub-Lateral J-1 (SWB-01) (offsite location); and (7) background sampling location Canal (SWB-01). See Figure 1.2 for detail.

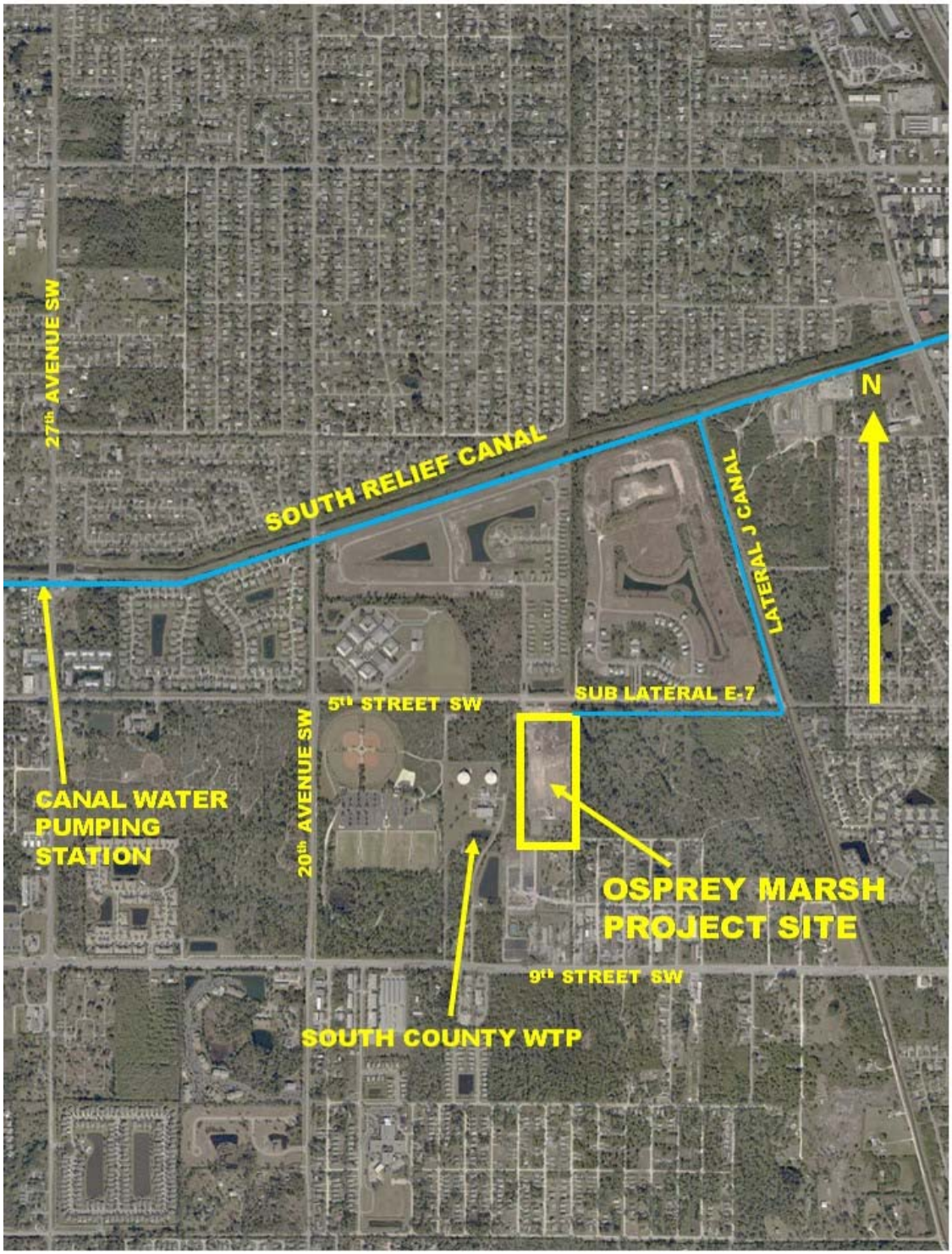


Figure 1 – Locational Map of the Osprey Marsh WTS, South County WTP and the South Relief Canal Pump Station.

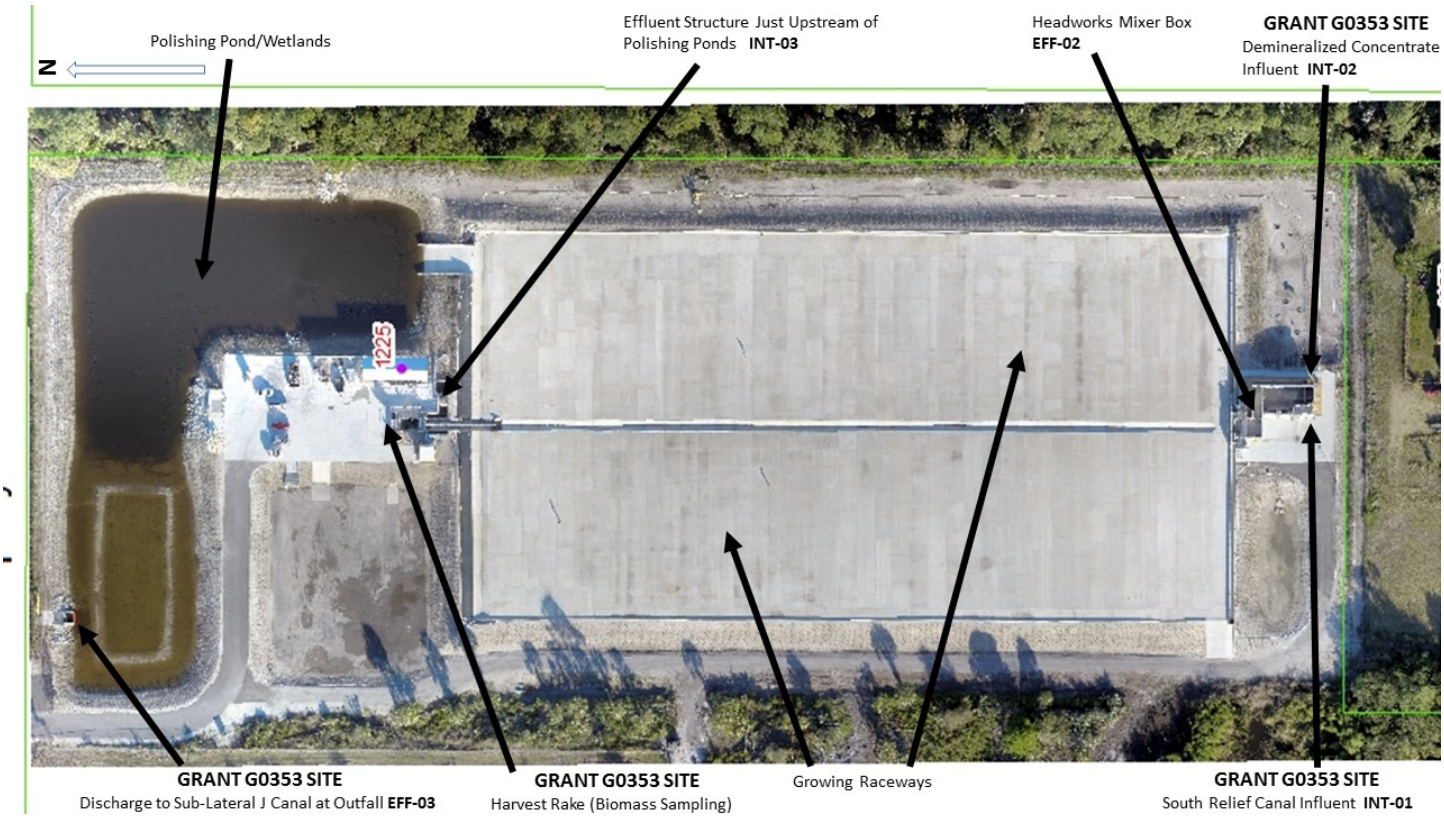


Figure 1.2 – Overview of Osprey Marsh WTS

In addition to demonstrating operational compliance within the Florida Department of Environmental Protection Operating Permit conditions for the Indian River County South Reverse Osmosis WTP (FL0037940), the Osprey Marsh must also meet any wasteload allocation (WLA) restrictions as defined by the United States Environmental Protection Agency (USEPA). The WLA defines the maximum amount of TN and TP that the WTP is permitted to discharge to the South Relief Canal after passing through the Osprey Marsh WTS. This allocation amounts to 4,636 lbs of Total Nitrogen (TN) and 291 lbs/ Total Phosphorus (TP) per calendar year. In addition, the Osprey Marsh is also charged with the removal of TN and TP from the stormwater run-off waters brought to the WTS from the South Relief Canal.

The parameters monitored, and frequency of the sampling events, are identified in the operating permit for the South County WTP. The permit also contains effluent concentration limits and loading limits. Compliance for the South County WTP is demonstrated by filing monthly Discharge Monitoring Reports (DMRs) and evaluating the results against the permit limits. Analytes monitored at Osprey Marsh ATS include:

pH	Dissolved Oxygen
Total Nitrogen	Fluoride
Total Phosphorus	Specific Conductance

Total Residual Chlorine
Unionized Hydrogen Sulfide
Low Level Mercury
Total Recoverable Copper

Total Recoverable Iron
Gross Alpha
Radium 226/228

Included in the permit requirements is the requirement that the Osprey Marsh WTS be subjected to testing that assesses the biological impact of the final effluent to the environment. This testing is accomplished by conducting Chronic Whole Effluent Toxicity (WET) tests in accordance with permit requirements. One important note to this type of test is that the water from the South Relief Canal makes up the majority of the final effluent (as designed from operating permit), so these quarterly toxicity tests are greatly influenced by any water chemistry changes seen in the South Relief Canal.

In summary, during the monitoring period in 2016, the Osprey Marsh WTS remained generally in compliance with the Industrial Wastewater Permit Conditions referenced in the South County WTP Permit, as well as met the EPA Wasteload Allocation restrictions for 2016. In addition, the OMWTS passed all of the Bioassay tests performed in 2016 (note: the April 2016 7 Day Whole Effluent Toxicity test produced failing results for the *Ceriodaphnia dubia* species. This test was considered suspect by the testing laboratory due to higher effluent concentrations not producing any mortality in the test species. Per permit requirements, follow-up tests were conducted with passing results. FDEP review of the data concluded that the original results were not representative of the water conditions of the OMWTS). As in 2015, there were no visible indications that the OMWTS was negatively impacting the environment.

SECTION 2

WATER QUALITY REVIEW

2.1 GENERAL

The water quality monitoring performed at the Osprey Marsh WTS during 2016, in accordance with the permitted operating conditions, demonstrated that the Osprey Marsh WTS was in compliance with the EPA's Wasteload Allocation limit, as well as generally in compliance with the permitted discharge limits contained in the FDEP Industrial Wastewater permit. Both of those items are directly related to the water quality of the WTPs DC and also to the quality of the waters in the South Relief Canal. This direct influence of the SRC can be seen in the Blended discharge to the headworks of the Osprey Marsh WTS (sample site EFF-02).

Extensive monitoring of the 7 permitted sample sites related to the Osprey Marsh WTS was performed in 2016. This monitoring was recorded on monthly Discharge Monitoring Reports that were submitted through the FDEP EzDMR electronic reporting database. The monthly data is compared against permit limits in order to demonstrate compliance within the operating permit issued. During the 2016 monitoring, Specific Conductance values were exceeded during the first 10 months of the year. This was as a result of the background sample site being a stagnant pool of water, not representative of the conditions of the stormwater brought on site. Discussions with the FDEP resulted in a permit revision being issued replacing the original background location with a more representative location for determining background specific conductance levels. The change to the new location resulted in the OMWTS meeting permit compliance for the remaining 2 months of monitoring in 2016. The remaining deviation from the permit requirements was due to a laboratory mishap that resulted in a sample that was submitted from the EFF-03 (Final Effluent) for a Low Level Mercury analysis in March of 2016 being broken, with insufficient notification to collect a replacement sample in time for the monitoring period.

Whole Effluent Toxicity (WET) tests following the procedures defined in the EPA's document "Short-term Methods for Estimating Chronic Toxicity of Effluents and Receiving Waters to Martine and Estuarine Organisms" were conducted on a quarterly basis in 2016. Results from the 3 of the 4 quarterly tests conducted in 2016 showed no toxic effects of the Osprey Marsh WTS final effluent. The 2nd quarter 2016 (April 2016) 7 Day Whole Effluent Toxicity test produced failing results for the *Ceriodaphnia dubia* species. This test was considered suspect by the testing laboratory due to higher effluent concentrations not producing any mortality in the test species. Per permit requirements, follow-up tests were conducted with passing results. FDEP review of the data concluded that the original results were not representative of the water conditions of the OMWTS. Permit conditions allowing for a reduced monitoring frequency after 4 successful Bioassay tests were discussed with the FDEP; this resulted in the FDEP reducing the frequency for future tests to a semi-annual basis.

As in 2015, water was continued to be pumped on-site from both the WTP and SRC sources during 2016. Fluctuations in the ratio of SRC water to DC water were observed in the 2016 flows, and was attributed available water levels in the SRC. The October 2016 reduction in SRC flow was attributed to the passing of Hurricane Matthew and the preparations taken by the Indian River Farms Water Control District in lowering the water levels in the canal system to levels below the minimum pumping levels for the SRC intake structure. During these times of reduced flow from the SRC, on-site recirculation of the water takes place in order to keep the algae hydrated over the flowways. There were no observed impacts to the Osprey Marsh WTS due to the varying flows of the SRC 2016. Water exited the Osprey Marsh WTS through the EFF-03 discharge point into the Sub-Lateral J-1 canal.

2.2 FLOW

There were no apparent measurable negative effects associated with the discharge of waters from the WTP and/or the SRC to the Osprey Marsh WTS in 2016. The DC was pumped to the headworks of the Osprey Marsh WTS directly from the WTP, while the SRC water was pumped into the headworks of the Osprey Marsh WTS via a SRC intake pumping station located off site (identified in Figure 1.1). The DC and SRC waters were blended together in the headworks basin and allowed to gravity flow to the surger box assembly in advance of the distribution runnel. This surger box (identified as EFF-02 in Figure 1.2) is designed to allow the flow of the blended water to sheet over the ATS in a wave-like fashion which is designed to allow the algae to create a foothold on the ATS between waves. Flow from the WTP is directly related to potable water production output, while the flow from the SRC is controlled at the SRC intake structure. IRCDUS is permitted to withdraw up to 10 MGD from the SRC and also permitted to discharge up to 1.5 MGD maximum of DC from the WTP (1.2 MGD Annual Average). Values observed during the 2016 monitoring period were under those restrictions and presented below:

2016 Osprey Marsh Flows
Average Daily Flow (MGD)

	South Relief Canal INT-01	Demineralization Concentrate INT-02	End of ATS INT-03	Headworks Blend EFF-02	Final Discharge EFF-03
Jan 2016	7.58	0.78	7.16	8.36	5.65
Feb 2016	7.82	0.85	7.09	8.67	5.52
Mar 2016	7.86	0.90	7.53	8.77	5.79
Apr 2016	7.78	0.85	7.37	8.63	5.69
May 2016	7.69	0.77	7.41	8.46	5.52
Jun 2016	6.46	0.68	6.79	7.13	4.56
Jul 2016	7.91	0.83	7.42	8.75	5.57
Aug 2016	6.91	0.80	7.09	7.71	4.89
Sep 2016	7.86	0.67	7.28	8.54	5.55
Oct 2016	4.29	0.59	5.18	5.31	3.43
Nov 2016	7.26	0.74	6.67	7.99	5.42
Dec 2016	7.49	0.65	6.80	8.14	5.44

	South Relief Canal INT-01	Demineralization Concentrate INT-02	End of ATS INT-03	Headworks Blend EFF-02	Final Discharge EFF-03
Average Daily Flow	7.24	0.76	6.98	8.04	5.25
Permitted Average Daily Flow	10.0	1.2 Avg. (1.5 Max)			

The blended flow is evenly distributed via gravity flow across the ATS flow way through a series of dispersion nozzles. The speed of the blended water mixture flowing across the ATS was designed to be 0.75 feet/second. This flow rate is maintained by the gradual slope of the ATS away from the headworks surger box towards the harvesting rake, and was selected for optimal algal growth rate and nutrient uptake.

As identified above, there were some significant variability in the blending rate of the DC to the SRC waters during the 2016 monitoring period. These adjustments were made as a result of available canal water due to storm preparations taken by the Indian River Farms Water Control District's raising and lowering of water levels in the canals. Of significant note was the extended duration of unavailable canal water in October with the passing of Hurricane Matthew through the area. In preparation for the reduction in available flows from the SRC, the OMWTS installed stop-logs to effectively raise the level of water in the wetland portion of the system to allow for recirculating the water back to the headworks for blending with the DC. This approach continued until water levels returned to normal in the SRC, and the pump station was once again brought on line. During this timeframe, it is important to note that no adverse effects of the reduced blending rates were noted over the OMWTS, nor in the discharge J-1 canal or downstream.

As the potable water need of the customer base drives the production rates of the County's water plants, the DC input to the OMWTS from the South County Plant remained fairly steady over the monitoring period.

During times when the SRC pump station is off-line due to low flow levels in the SRC, or when herbicides are added to the SRC for maintenance activities, flow to blend with the DC from the Water Plant can be made up from on-site permitted wells, or from recirculating the waters from the polishing pond back to the headworks mixing tank. During the 2016 period, no make-up water was withdrawn from the on-site wells for the purposes of blending, rather water was recirculated from the polishing pond to blend with the DC and hydrate the algae.

The flow through the ATS is also influenced by rainfall patterns as well as evapotranspiration rates. Total rainfall recorded at the nearby South County Water Treatment Plant from January 2016 through December 2016 was determined to be 64.25". This amounts to nearly an additional 22.3 MG of water added due to rainfall. No evapotranspiration studies were conducted on the OMWTS in 2016, although an estimate can be made by taking the influent flow and effluent flows. Based on the numbers recorded in 2016, an estimated evapotranspiration rate of 35.2% can be assumed.

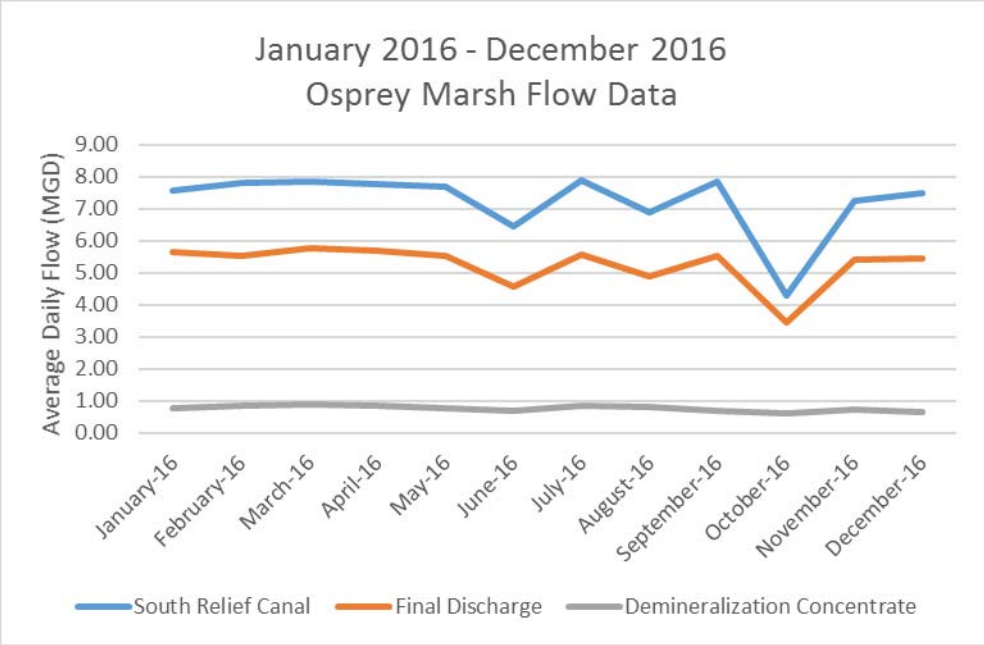


Figure 2.2.1 Flow rates observed at the Osprey Marsh during 2016

Varying flow rates from the SRC while fairly steady flow rates of the DC resulted in some significant swings in the blend ratio. IRCDUS continues to monitor the blend rates in order to determine if an optimal blending rate lends itself to enhanced algae growth and nutrient uptake, while maintaining permit compliance.

	South Relief Canal INT-01	Demineralization Concentrate INT-02	SRC:DC Ratio
Jan-16	7.58	0.78	9.71:1
Feb-16	7.82	0.85	9.2:1
Mar-16	7.86	0.90	8.73:1
Apr-16	7.78	0.85	9.15:1
May-16	7.69	0.77	9.991
Jun-16	6.46	0.68	9.5:1
Jul-16	7.91	0.83	9.53:1
Aug-16	6.91	0.80	8.63:1
Sep-16	7.86	0.67	11.46:1
Oct-16	4.29	0.59	7.27:1
Nov-16	7.26	0.74	9.81:1
Dec-16	7.49	0.65	11.52:1
2016 Average	7.24	0.76	9.52:1

2.3 TOTAL MAXIMUM DAILY MASS LOAD ASSESSMENT

The Total Maximum Daily Mass Load wasteload allocation was in compliance with the conditions identified in the FDEP Industrial Wastewater permit for the ATS in 2016. In accordance with Operating Permit Condition A.9, the calculated difference (cumulative total mass load in pounds at EFF-03 minus cumulative total of mass load in pounds at INT-01) must not exceed 4,636 pounds of Total Nitrogen and 291 pounds of Total Phosphorus in order to be determined to be in compliance. Based on the 2016 values, the Osprey Marsh WTS remained well under the WLA with a calculated difference of -7,259.71 pounds of TN (permitted not to exceed 4,636 pounds) and a calculated difference of -1,978.31 pounds of TP (permitted not to exceed 291 pounds).

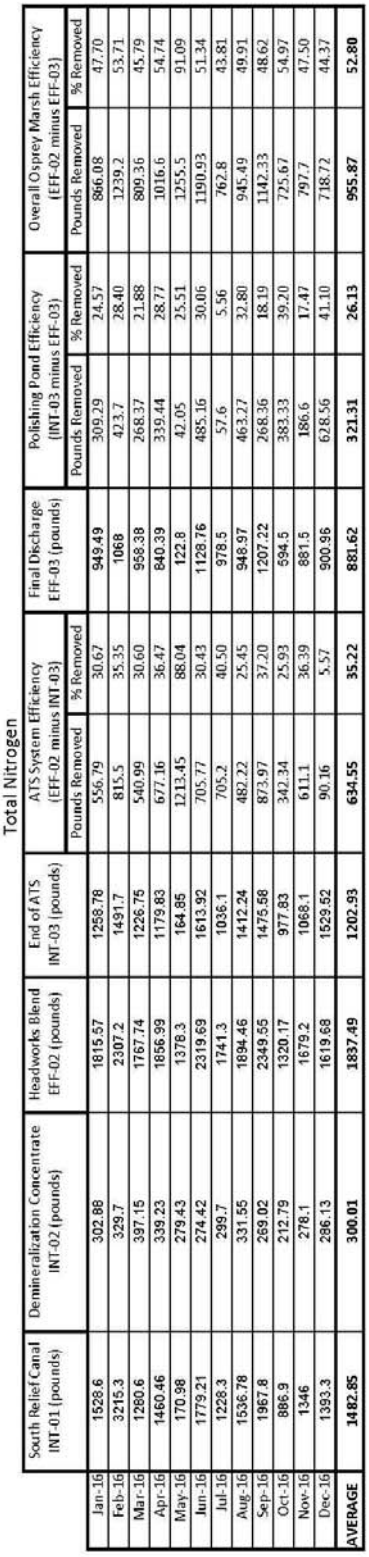
TOTAL NITROGEN

	South Relief Canal INT-01 (pounds)	Final Discharge EFF-03 (pounds)	Difference EFF-03 minus INT-01	Compliance WLA (pounds)
Jan-16	1528.6	949.5	-579.1	
Feb-16	3215.3	1068.0	-2147.3	
Mar-16	1280.6	958.4	-322.2	
Apr-16	1460.5	840.4	-620.1	
May-16	171.0	122.8	-48.13	
Jun-16	1779.2	1128.8	-650.5	
Jul-16	1228.3	978.5	-249.8	
Aug-16	1536.8	949.0	-587.8	
Sep-16	1967.8	1207.2	-760.6	
Oct-16	886.9	549.5	-337.4	
Nov-16	1346.0	881.5	-464.5	
Dec-16	1393.3	901.0	-492.3	
			-7259.7	<= 4636

TOTAL PHOSPHORUS

	South Relief Canal INT-01 (pounds)	Final Discharge EFF-03 (pounds)	Difference EFF-03 minus INT-01	Compliance WLA (pounds)
Jan-16	98.0	73.0	-25.0	
Feb-16	605.2	33.4	-571.8	
Mar-16	50.8	37.4	-13.4	
Apr-16	235.2	71.2	-181.9	
May-16	218.7	35.7	-183.0	
Jun-16	226.5	57.0	-169.4	
Jul-16	22.52	72.0	-153.2	
Aug-16	321.7	63.3	-258.4	
Sep-16	314.9	69.4	-245.5	
Oct-16	55.4	44.4	-11.1	
Nov-16	91.0	67.8	-23.2	
Dec-16	212.9	70.4	-142.5	
			-1978.3	<= 291

Permit Condition A.9.b. requires that the performance of the ATS and overall Osprey Marsh performance be summarized in this Annual Compliance Report. This is done in accordance with the calculation formulas identified in the Operating Permit and summarized in the table below. In general, the Algal Turf Scrubber portion of the Osprey Marsh system had an operational efficiency of 52.8% removal on the Total Nitrogen flowed into the headworks, while maintaining an average operational efficiency of 62.6% removal on the Total Phosphorus that was introduced at the headworks. The formula used to calculate these removal efficiencies utilized the blended headworks flow water chemistry values at sample site EFF-02.



Total Nitrogen

	South Relief Canal INT-01 (pounds)	Demineralization Concentrate INT-02 (pounds)	Headworks Blend EFF-02 (pounds)	End of ATS INT-03 (pounds)	ATS System Efficiency (EFF-02 minus INT-03)		Final Discharge EFF-03 (pounds)	Polishing Pond Efficiency (INT-03 minus EFF-03)		Overall Osprey Marsh Efficiency (EFF-02 minus EFF-03)	
					Pounds Removed	% Removed		Pounds Removed	% Removed	Pounds Removed	% Removed
Jan-16	1528.6	302.86	1815.57	1258.78	556.79	30.67	949.49	309.29	24.57	866.08	47.70
Feb-16	3215.3	329.7	2307.2	1491.7	815.5	35.35	1068	423.7	28.40	1239.2	53.71
Mar-16	1280.6	397.15	1767.74	1226.75	540.99	30.60	958.38	268.37	21.88	809.36	45.79
Apr-16	1460.46	339.23	1856.99	1179.83	677.16	36.47	840.39	339.44	28.77	1016.6	54.74
May-16	170.98	279.43	1378.3	164.86	1213.45	88.04	122.8	42.05	25.51	1255.5	91.09
Jun-16	1779.21	274.42	2319.69	1613.92	705.77	30.43	1128.76	485.16	30.06	1190.93	51.34
Jul-16	1228.3	299.7	1741.3	1036.1	705.2	40.50	978.5	57.6	5.56	762.8	43.81
Aug-16	1536.78	331.55	1894.46	1412.24	482.22	25.45	948.97	463.27	32.80	945.49	49.91
Sep-16	1967.8	269.02	2349.55	1475.58	873.97	37.20	1207.22	268.36	18.19	1142.33	48.62
Oct-16	886.9	212.79	1320.17	977.83	342.34	25.93	694.5	383.33	39.20	725.67	54.97
Nov-16	1346	278.1	1679.2	1068.1	611.1	36.39	881.5	186.6	17.47	797.7	47.50
Dec-16	1393.3	286.13	1619.68	1529.52	90.16	5.57	900.96	628.56	41.10	718.72	44.37
AVERAGE	1482.85	300.01	1837.49	1202.93	634.55	35.22	881.62	321.31	26.13	955.87	52.80

Total Phosphorus

	South Relief Canal INT-01 (pounds)	Demineralization Concentrate INT-02 (pounds)	Headworks Blend EFF-02 (pounds)	End of ATS INT-03 (pounds)	ATS System Efficiency (EFF-02 minus INT-03)		Final Discharge EFF-03 (pounds)	Polishing Pond Efficiency (INT-03 minus EFF-03)		Overall Osprey Marsh Efficiency (EFF-02 minus EFF-03)	
					Pounds Removed	% Removed		Pounds Removed	% Removed	Pounds Removed	% Removed
Jan-16	97.99	5.05	108.07	92.56	15.51	14.35	73.04	19.52	21.09	35.03	32.41
Feb-16	605.2	5.15	104.87	42.86	62.01	59.13	33.4	9.46	22.07	71.47	68.15
Mar-16	50.86	5.84	56.66	48.68	7.98	14.08	37.44	11.24	23.09	19.22	33.92
Apr-16	253.15	5.3	259.12	92.17	166.95	64.43	71.22	20.95	22.73	187.9	72.51
May-16	218.7	4.99	109.4	47.92	61.48	56.20	35.7	12.22	25.50	73.7	67.37
Jun-16	226.46	4.29	214.25	84.94	129.31	60.35	57.01	27.93	32.88	157.24	73.39
Jul-16	225.18	5.35	113.07	47.97	65.1	57.57	71.95	-23.98	-49.99	41.12	36.37
Aug-16	321.65	5.18	239.3	183.41	55.89	23.36	63.26	120.15	65.51	176.04	73.56
Sep-16	314.85	4.2	320.39	91.08	229.31	71.57	69.38	21.7	23.83	251.01	78.35
Oct-16	55.43	54.72	192.52	133.95	58.57	30.42	44.37	89.58	66.88	148.15	76.95
Nov-16	90.95	76.01	199.91	83.44	116.47	58.26	67.8	15.64	18.74	132.11	66.08
Dec-16	212.9	79.11	252.4	246.13	6.27	2.48	70.39	175.74	71.40	182.01	72.11
AVERAGE	222.78	21.27	180.83	99.59	81.24	42.68	57.91	41.68	28.64	122.92	62.60

Figure 2.3.1 Osprey Marsh 2016 Performance Summary

2.4 TOTAL NITROGEN

The Osprey Marsh Wetland Treatment System effectively removed all of the TN pumped on-site from the WTP as well as a significant portion of the TN pumped on-site from the SRC over the 2016 calendar year. The annual average TN concentration pumped on-site from the SRC in 2016 was 0.81mg/L, a reduction of 35% from the concentrations seen in the previous monitoring period which was 1.15 mg/L. The annual average concentration going back to the Sub-Lateral J-1 through EFF-03 discharge point (which discharges back in to the SRC) was 0.67mg/L (18% lower than the concentrations discharged during the 2015 monitoring period). The average reduction in concentration of TN from the combined SRC and DC waters passing through the Osprey Marsh WTS for the 12 months of flow in 2016 was approximately 25%. The annual average TN concentration pumped on site from the WTP was 1.55mg/L (in line with the 2015 average concentration of 1.54 mg/L).

Water flowed back to the receiving Sub-Lateral J-1 canal through the D-002 discharge point (EFF-03). Approximately 10,579 lbs of TN was discharged to this canal in 2016. This annual load was equivalent to a discharge of approximately 28.98 lbs TN/day back to the River, or about 47.2% of the TN load pumped onto the site (realized 52.8% reduction of TN throughout the Osprey Marsh).

These TN reductions reflect the Osprey Marsh system mathematically removing all of the TN from the WTP and approximately 59.5% of the TN pumped onto the site from the SRC.

Table 2.4.1 Comparison of the TN loading rates to the Osprey Marsh WTS from the SRC, the TN loading rates discharged from the Osprey Marsh to the Sub-Lateral J-1, and the percent of the TN loadings pumped into the Osprey Marsh WTS from the SRC that were removed by the Osprey Marsh WTS

	TN Load IN			Load OUT		Removal
Year	INT-01 (lb/day)	INT-02 (lb/day)	INT01+INT02 (lb/day)	EFF-03 (lb/day)	TN Uptake (lb/day)	Rate %
2015	65.0	8.60	73.6	36.8	35.9	51.8
2016	48.8	9.86	58.7	28.9	29.8	52.8

The 2016 monthly average TN concentrations flowing in and out of the Osprey Marsh WTS are shown in Figure 2.4.2. The data in this figure show the average monthly concentrations of TN leaving the Osprey Marsh WTS are lower than the values of TN pumped in from the SRC.

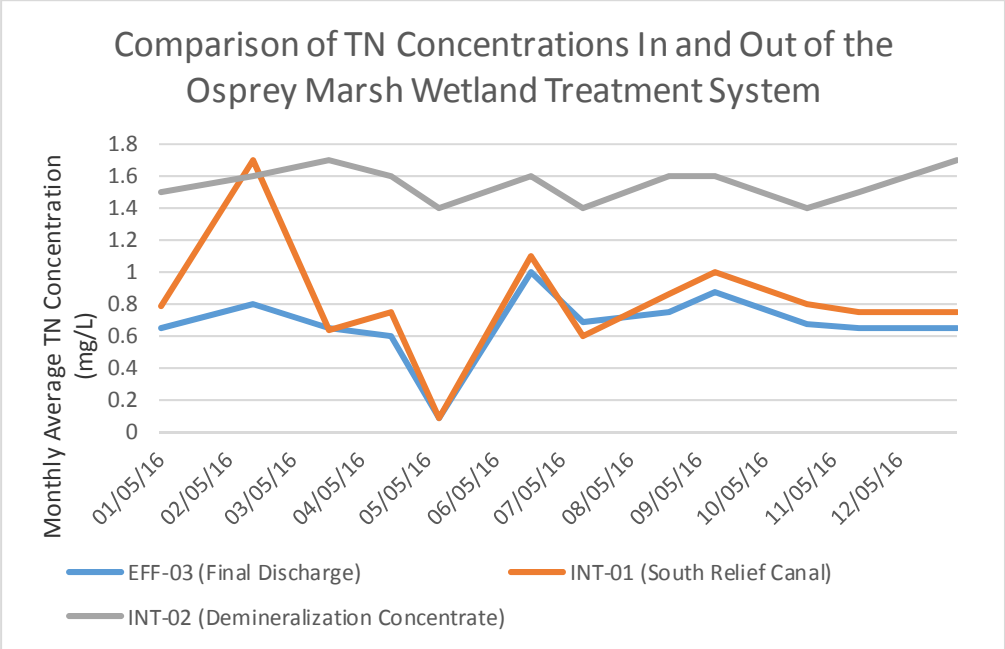


Figure 2.4.2 Comparison of the 2016 TN Concentrations discharged to and from the Osprey Marsh

Figure 2.4.3 below relates the monthly average TN concentrations and the monthly average flows in order to calculate the average daily loading rates in and out of the OMWTS. In general, the data presented in this table follows the same pattern as the concentration data, with variations seen based on the flow rates from each input.

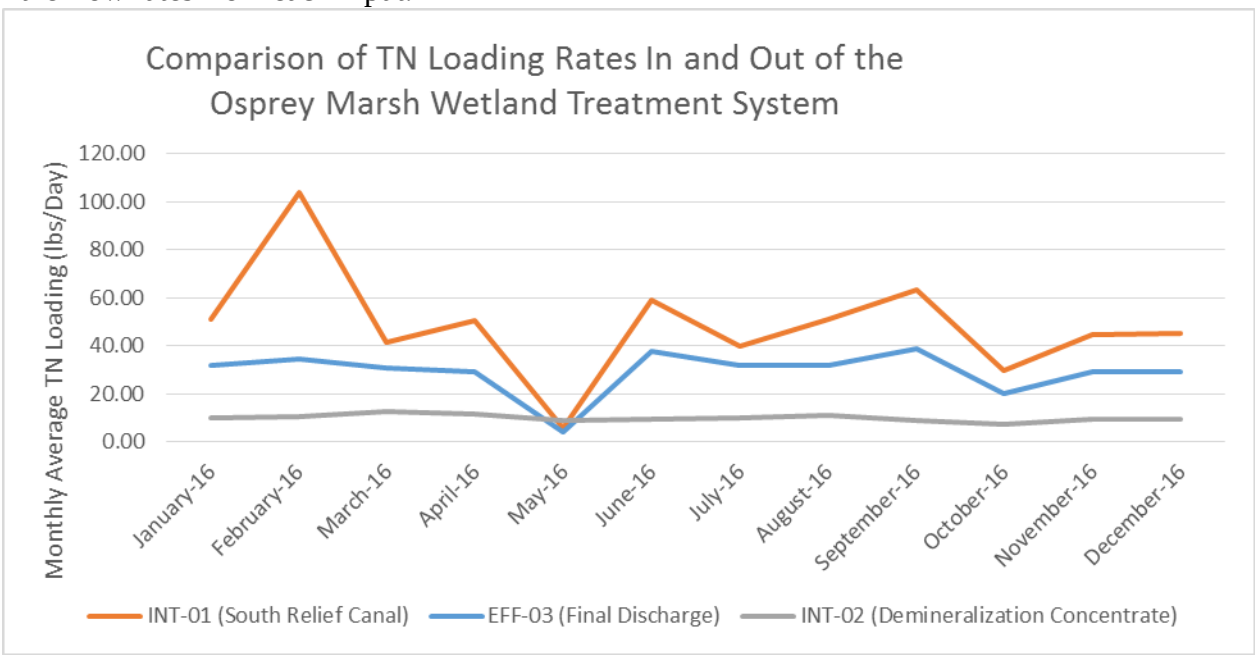


Figure 2.4.3 Comparison of the 2016 Monthly Average loading rates in and out of the Osprey Marsh

In summary, the 2016 year TN data shows the TN uptake rates of the Osprey Marsh Wetland Treatment System are directly related to the loading rates from the SRC and DC. The Osprey Marsh WTS effectively lowers the TN concentrations of water pumped onto the site. The 2016 data clearly shows that the Osprey Marsh Wetland Treatment System had a positive effect on the TN conditions of the SRC and ultimately the Indian River Lagoon, by removing all of the TN pounds associated with the WTP DC, as well as a significant amount of the TN pounds associated with the SRC water pumped on site.

2.5 TOTAL PHOSPHORUS

During the 2016 calendar year of operations, the Osprey Marsh Wetland Treatment System removed the equivalent of all the TP discharged to the site from the WTP and a significant amount of the TP brought onto the site from the SRC. The Osprey Marsh WTS effectively reduced the TP concentrations discharged onto the site from the River, in 2016 this reduction was noted to be 76%.

TP concentrations pumped into the Osprey Marsh Wetland Treatment System and the TP concentrations flowing out of the OMWTS for 2016 are shown in Figure 2.5.1. The data presented by this figure shows the TP concentrations pumped on-site from the SRC remain higher than the concentration being flowed off the site into the Sub-Lateral J-1 receiving Canal.

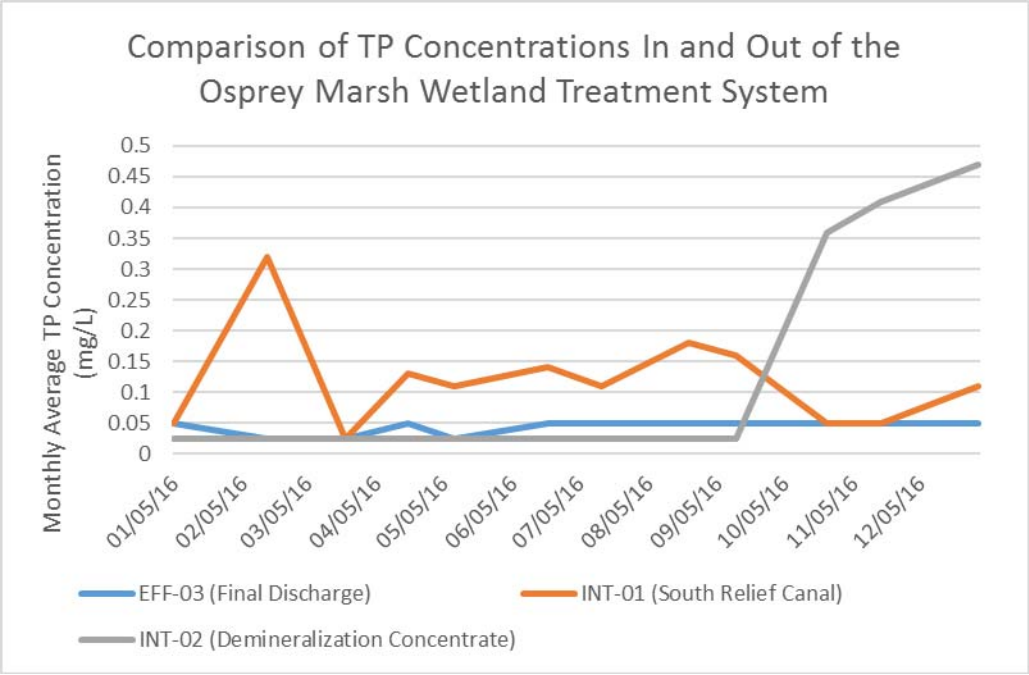


Figure 2.5.1 Comparison of 2016 TP Concentrations (In and Out of the Osprey Marsh WTS)

The 2016 annual average TP concentration pumped onto the site from the SRC was 0.12 mg/L, and the 2016 annual average TP concentration pumped onto the site from the DC was 0.12mg/L. The TP discharged from the WTP in the DC remained fairly constant through September 2016. Due to an antiscalant change-out that occurred in late September, the concentration of Phosphorus was shown to increase in the DC stream beginning in October. The increase in TP from the antiscalant did not appear to have any negative impacts on the OMWTS, to the contrary, the increase in Phosphorus loading appeared to spawn heavier algae growth, this increase in growth continued the OMWTS high Phosphorus removal efficiencies. As in 2015, the 2016 monitoring period continued to demonstrate that the OMWTS TP concentrations are influenced greater by the TP concentrations in the SRC.

2016 annual average TP concentrations discharged from the OMWTS into the Sub-Lateral J-1 Canal and eventually back into the South Relief Canal was 0.04 mg/L.

Figure 2.5.2 below relates the monthly average TP concentrations and the monthly average flows in order to calculate the average daily loading rates in and out of the OMWTS. In general, the data presented in this table follows the same pattern as the concentration data, with variations seen based on the flow rates from each input.

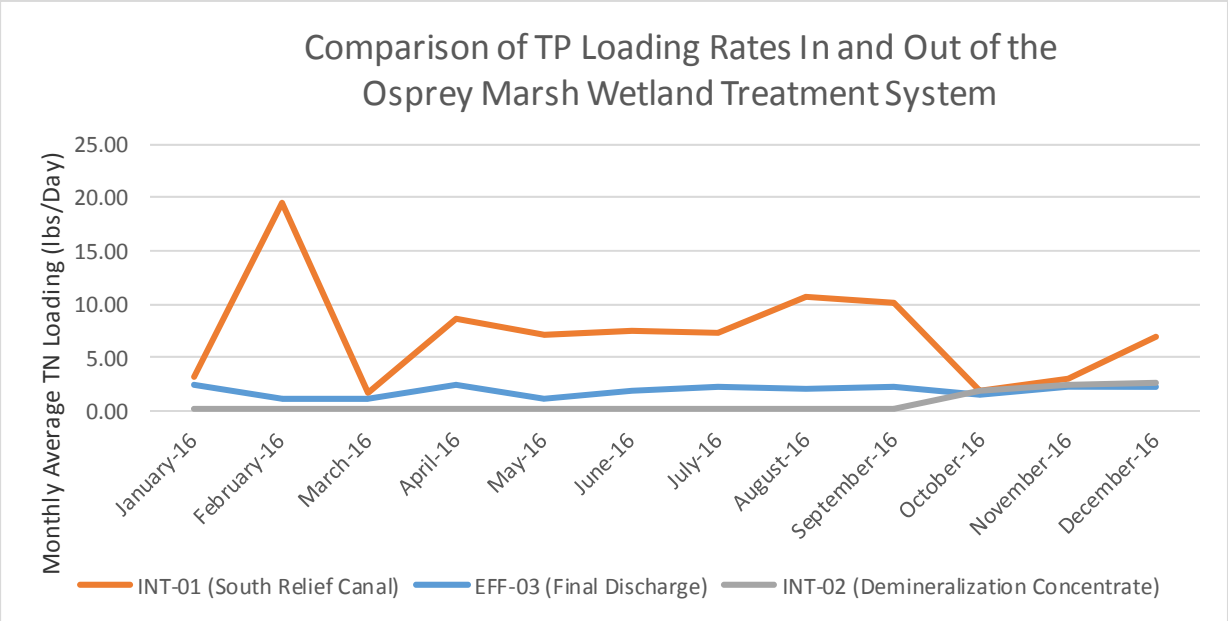


Figure 2.5.2 Comparison of the 2016 TP Loading Rates In and Out of the OMWTS

The 2016 annual average TP load pumped onto the OMWTS from the SRC was 7.32 lbs/day. The annual average TP load contained in the WTP DC amounted to 0.70 lbs/day in 2016. Discharge from the OMWTS back to the Sub-lateral J1 through the EFF-03 discharge point averaged averaged 1.90 lbs/day. The net uptake of TP observed in the OMWTS during 2016 was 5.42 lbs/day. Data

collected in 2016 indicates that the TP uptake/storage rate was a function of the TP loading rate as is expected.

2.6 OTHER PARAMETERS

The operating permit also defines limits for nine other water quality parameters that are monitored at the final discharge point of the OMWTS (EFF-03): Total Recoverable Copper, Total Recoverable Mercury, Gross Alpha Particle Activity, Radium 226 + Radium 228 (Total), Specific Conductance, pH and Total Residual Chlorine. Total Recoverable Copper and Total Recoverable Mercury were also collected from the SRC sample point in order to establish background values, with Total Recoverable Copper being collected from the DC.

The monthly samples collected from sample point EFF-03 for Gross Alpha Particle Activity were all below the permit limit of 15 pCi/L. The monthly samples collected from sample station EFF-03 for the combined Radium 226 and Radium 228 were all below the permit limit of 5.0 pCi/L. Individual samples were not collected at the WTP DC nor the SRC to account for the contribution from each source to that number.

The monthly samples collected from EFF-03 that were analyzed for Total Recoverable Copper were all well below their calculated permit limit. The levels of and Total Recoverable Mercury in both the DC (INT-02) and Final Discharge (EFF-03) were reported as being below the permit limit of 0.012 ug/L.

During the months monitored in 2016, there were 10 occasions in which the Specific Conductance Limit was exceeded at sample point EFF-03 (final discharge). Permit conditions allow for a discharge to not increase the background Specific Conductance level in the receiving canal (sub-lateral J-1) by more than 50%, or not to exceed the permit level of 1275 umhos/cm (whatever is higher). During the months of January through October 2016, both of those criteria were exceeded. It is important to note however, that during these months the Osprey Marsh Final effluent Specific Conductance was lower than 1 and ½ times the Specific Conductance of the SRC, which makes up a large percentage of the effluent. Therefore, although the effluent did exceed the conductivity requirements of the background point, a majority of the effluent came directly out of the SRC which had specific conductivity values elevated near the OMWTS permitted effluent limit. IRCDUS entered into discussions with the FDEP regarding switching the sampling point for background conductivity determinations to a more representative location (such as the South Relief Canal intake pump structure). Based on data sent to the FDEP on this topic, the FDEP issued a permit revision that changes the background sampling point to the SRC intake pump station, which has proven to be a more representative location.

In addition to the routine chemical parameters that were monitored in 2016, the Osprey Marsh Wetland Treatment System was also subjected to quarterly Chronic Toxicity tests following the guidelines established in the EPA's Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms (4th edition, EPA -821-R-02-013). Results from 3 of the 4 quarterly Toxicity tests that were performed during 2016 demonstrated that the OMWTS did not produce any toxic effects to the organisms tested. Testing performed during the 2nd

QTR of 2016 did yield a result for the *Ceriodaphnia dubia* species that was considered a failure. Review of the data surrounding this test did point to an anomaly in the failing concentration dilution. Discussions with the testing laboratory, along with the FDEP resulted in the test being considered suspect, and not representative of the actual water conditions of the effluent leaving the OMWTS. Repeat tests, as required in the operating permit, were performed on the *C. dubia* species, with results from both of those tests further confirming the conclusion that the results from the initial test were not representative of the OMWTS water quality. FDEP review of the Bioassay tests that were conducted during 2015 and 2016 resulted in the Department lowering the frequency of the tests from a quarterly basis to a semi-annual basis. It is important to note here though, that the majority of the water subjected to testing is made up of the SRC, with the smaller percentage coming from the DC, therefore if any toxicological effects were observed, it would be impossible to determine whether they came from the SEC or the DC directly.

3.0 HARVESTING

Unique to the Osprey Marsh Wetland Treatment System is the Algal Turf Scrubber (ATS). The ATS is the portion of the OMWTS on which the targeted algae is grown on. The growing algae acts as the nutrient sink for the removal of the TN and TP. Complete removal from the water system is accomplished through routine 'harvesting' of the algae. Harvesting is the process by which the algae is scraped off the growing raceways of the ATS and sent down the pad towards the harvesting rake, where the filamentous algae is strained from the water, allowed to dewater and then is hauled off site for further processing. This harvested biomass is weighed and samples have been sent to the laboratory for analysis in order to determine its nutrient content. During the 2016 monitored harvesting events, more than 1,029,420 pounds of algae were removed by the OMWTS facility.

4.0 SUMMARY

In summary, over the 2016 calendar year with water flowing through the Osprey Marsh Wetland Treatment System, the OMWTS demonstrated acceptable performance at reducing the levels of TP and TN from not only the demineralization concentrate fed to the headworks of the marsh, but also from the SRC water pumped in from the off-site pump station on the SRC. In addition, and or primary importance, the OMWTS operated within the permit conditions it is subjected to with the exceedances being based on Specific Conductivity levels leaving the marsh that were higher than the receiving water body (but in line with the blend water coming from the SRC). As stated previously, exceedances of the Specific Conductivity analyte was due to an improper background sampling location which has since been changed by FDEP permit revision.

The Specific Conductivity exceedances noted in the monthly reports and in this report appeared to have no negative influence on the operation of the OMWTS. Additionally, it appears that the varying flow and blending ratios observed in 2016 did not have a negative effect on the functionality of the OSMTS, but appears to be tied to performance of the Marsh at removing TN and TP which is tied directly on the water inputs.

The natural processes involved in the OMWTS at treating the Demineralization Concentrate by-product of the Indian River County South Reverse Osmosis Water Treatment Facility continue to

remove thousands of pounds of Nitrogen and Phosphorus from not only the DC by-product, but also from the waters of the South relief Canal introduced at the headworks. Waters discharged into the Sub-Lateral J1 Canal River after being processed through the OMWTS go back with significantly lower levels of nutrients then when they had entered the headworks of the Osprey Marsh.

APPENDIX A

WATER QUALITY DATA

INT-01
SOUTH RELIEF CANAL

INT-01 South Relief Canal

	Total Recoverable Copper (ug/L)	Total Recoverable Mercury (ug/L)	Ammonia (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate/ Nitrite (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	pH (S.U.)
1/5/2016	1.8	0.000732	0.071	0.58	0.2	0.78	*0.084 I*	7.52
2/16/2016	6.7	0.0029	0.1	1.5	0.2	1.70	0.32	7.47
3/22/2016	1.8	0.00238	<0.020	0.62	<0.025	0.63	<0.050	7.57
4/19/2016	3.1	0.00156	<0.020	0.7	0.057	0.75	0.13	7.3
5/10/2016	2	0.00156	<0.020	*0.45 I*	<0.025	*0.47 I*	0.11	7.56
6/21/2016	*5*	0.00196	0.074	1	0.1	1.10	0.14	7.45
7/15/2016	1.5	0.00271	<0.020	0.58	*0.029 I*	0.60	0.11	7.43
8/23/2016	2.6	0.0019	0.1	0.75	0.1	0.86	0.18	7.42
9/13/2016	2.7	0.00142	0.18	0.82	0.22	1.00	0.16	7.28
10/24/2016	1.9	0.00158	*0.077*	0.64	0.16	0.80	*0.096 I*	7.37
11/17/2016	1.4	0.000732	*0.022 I*	0.61	0.12	0.74	*0.073 I*	7.44
12/13/2016	1.7	0.000847	<0.020	0.6	0.13	0.72	0.11	7.4

Italicized results reflect results less than Laboratory's Practical Quantitation Limit, but above the Laboratory's Method Detection Limit

APPENDIX B

WATER QUALITY DATA

INT-02
DEMINERALIZATION CONCENTRATE

INT-02 Demineralized Concentrate

	Total Recoverable Copper (ug/L)	Total Recoverable Mercury (ug/L)	Ammonia (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate/ Nitrite (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	pH (S.U.)
1/5/2016	<0.50	<0.00020	1.5	1.5	<0.025	1.50	<0.050	7.9
2/16/2016	<0.50	*0.000463 I*	1.5	1.6	<0.025	1.60	<0.050	7.93
3/22/2016	<0.50	0.00117	1.5	1.7	<0.025	1.70	<0.050	7.97
4/19/2016	<0.50	0.000624	1.5	1.6	<0.025	1.60	<0.050	7.93
5/10/2016	<0.50	*0.000426 I*	1.4	1.4	<0.025	1.40	<0.050	7.81
6/21/2016	<0.50	0.000507	1.4	1.6	<0.025	1.60	<0.050	8
7/15/2016	<0.50	*0.000328 I*	1.5	1.4	<0.025	1.40	<0.050	7.95
8/23/2016	<0.50	<0.000250	1.6	1.6	<0.025	1.60	<0.050	7.87
9/13/2016	<0.50	*0.000262 I*	1.4	1.6	<0.025	1.60	<0.050	7.8
10/24/2016	<0.50	*0.000372 I*	1.6	1.4	<0.025	1.40	0.36	7.84
11/17/2016	<0.50	<0.00025	1.5	1.5	<0.010	1.50	0.41	7.83
12/13/2016	<0.050	*0.000278 I*	1.4	1.7	*0.010 I*	1.70	0.47	7.91
Permitted Limit		**0.012**						

Italicized results reflect results less than Laboratory's Practical Quantitation Limit, but above the Laboratory's Method Detection Limit

APPENDIX C

WATER QUALITY DATA

EFF-02
BLENDED INFLUENT TO OSPREY MARSH HEADWORKS

EFF-02 Headworks Blend

	Ammonia (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate/ Nitrite (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
1/5/2016	0.18	0.62	0.22	0.84	0.076 I
2/16/2016	0.26	0.89	0.21	1.10	0.074 I
3/22/2016	0.21	0.75	0.029 I	0.78	<0.050
4/19/2016	0.22	0.79	0.074	0.86	0.12
5/10/2016	0.2	0.6	0.031 I	0.63	0.092 I
6/21/2016	0.18	1.1	0.12	1.30	0.12
7/15/2016	0.22	0.71	0.064	0.77	0.086 I
8/23/2016	0.27	0.83	0.13	0.95	0.12
9/13/2016	0.22	0.86	0.28	1.10	0.15
10/24/2016	0.26	0.77	0.2	0.96	0.14
11/17/2016	0.17	0.7	0.14	0.84	0.1
12/13/2016	0.17	0.63	0.14	0.77	0.12

Italicized results reflect results less than Laboratory's Practical Quantitation Limit, but above the Laboratory's Method Detection Limit

APPENDIX D

WATER QUALITY DATA

INT-03
END OF ATS
PRIOR TO POLISHING POND

INT-03 End of ATS

	Ammonia (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate/ Nitrite (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
1/5/2016	*0.040 I*	0.61	0.074	0.68	*0.057 I*
2/16/2016	*0.031 I*	0.9	0..081	0.87	<0.050
3/22/2016	*0.022 I*	0.62	<0.025	0.63	<0.050
4/19/2016	<0.020	0.63	<0.025	0.64	*0.068 I*
5/10/2016	<0.020	*0.48 I*	<0.025	*0.049 I*	<0.050
6/21/2016	<0.020	0.93	<0.025	0.95	*0.071 I*
7/15/2016	<0.020	0.53	<0.025	0.54	<0.050
8/23/2016	*0.023 I*	0.73	*0.037 I*	0.77	0.1
9/13/2016	*0.033 I*	0.72	0.091	0.81	*0.081 I*
10/24/2016	*0.022 I*	0.65	0.078	0.73	0.1
11/17/2016	<0.020	0.62	*0.025 I*	0.64	*0.080 I*
12/13/2016	*0.028 I*	0.82	0.05	0.87	0.14

Italicized results reflect results less than Laboratory's Practical Quantitation Limit, but above the Laboratory's Method Detection Limit

APPENDIX E

WATER QUALITY DATA

EFF-03
DISCHARGE FROM OSPREY MARSH TO SUB-LATERAL J-1 CANAL

EFF-03 Final Discharge (Outfall-D002)

	Total Recoverable Copper (ug/L)	Total Recoverable Mercury (ug/L)	Ammonia (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Nitrate/ Nitrite (mg/L)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	pH (S.U.)
1/5/2016	1.3	0.000573	0.058	0.57	0.086	0.65	*0.051 I*	8.34
2/16/2016	2.2	0.000159	*0.043 I*	0.7	0.1	0.80	<0.050	7.94
3/22/2016	1.2	LS	<0.020	0.062	<0.025	0.64	<0.050	8.71
4/19/2016	2.2	0.00184	<0.020	0.57	<0.025	0.59	*0.057 I*	8.06
5/10/2016	2	0.00108	<0.020	*0.44 I*	<0.025	*0.45 I*	<0.050	7.96
6/21/2016	3.7	0.0017	<0.020	0.97	<0.025	0.99	<0.050	8.21
7/15/2016	1.1	0.000856	<0.020	0.7	<0.025	0.68	*0.052 I*	7.96
8/23/2016	1.8	0.00133	0.06	0.71	*0.040 I*	0.75	<0.050	7.92
9/13/2016	1.6	0.00104	0.059	0.77	0.11	0.87	*0.069 I*	7.79
10/24/2016	1.9	0.00153	<0.020	0.64	*0.031 I*	0.67	<0.050	7.99
11/17/2016	1.3	0.000833	*0.023 I*	0.62	*0.034 I*	0.65	*0.059 I*	8.12
12/13/2016	1.8	0.000856	*0.047 I*	0.58	0.067	0.64	*0.093 I*	7.94
Permit Limits	**Calculated Limit**	**Calculated Limit**						**6.0 - 8.5**

Italicized results reflect results less than Laboratory's Practical Quantitation Limit, but above the Laboratory's Method Detection Limit

LS - Laboratory mishap. Sample lost prior to analysis.

EFF-03 Final Discharge (Outfall-D002)

	Specific Conductance (umhos/cm)	Temperature (Deg C)	Fluoride (mg/L)	Dissolved Oxygen	Alpha, Gross Particle Activity (pCi/L)	Radium 226/228	Total Residual Chlorine (mg/L)	Unionized Hydrogen Sulfide
1/5/2016	1609	19.9	0.98	8.62	5.09	1.75	<0.01	<0.10
2/16/2016	1875	21.7	0.88	8.6	3.03	2.15	<0.01	<0.10
3/22/2016	2496	23	1	8.72	4.34	0.667	<0.01	<0.10
4/19/2016	1991	23.4	0.92	7.58	6.47	2.93	<0.01	<0.10
5/10/2016	2353	24.9	1	7.86	5.18	1.87	<0.01	<0.10
6/21/2016	1852	28	0.92	8.48	4.18	1.18	<0.01	<0.10
7/15/2016	1775	29.5	0.64	6.95	<2.92	1.59	<0.01	<0.10
8/23/2016	2006	30.2	0.94	6.15	<3.02	1.43	<0.01	<0.10
9/13/2016	2069	27.9	0.92	6.5	3.86	2.41	<0.01	<0.10
10/24/2016	1742	23.8	0.65	7.03	5.02	1.41	<0.01	<0.10
11/17/2016	2230	22.5	0.89	7.66	<3.75	2.53	<0.01	<0.10
12/13/2016	2477	23.5	0.86	7.94	<2.97	1.71	<0.01	<0.10
Permit Limits Calculated Limit			**5**	**>5.0**	**15**	**5**	**0.01**	

Italicized results reflect results less than Laboratory's Practical Quantitation Limit, but above the Laboratory's Method Detection Limit

APPENDIX F

2016 WATER FLOW DATA

AVERAGE DAILY FLOW (MGD)

	INT-01 South Relief Canal	INT-02 Demineralization Concentrate	EFF-03 Osprey Marsh Final Discharge
JAN-16	7.58	0.78	5.65
FEB-16	7.82	0.85	5.52
MAR-16	7.86	0.90	5.79
APR-16	7.78	0.85	5.69
MAY-16	7.69	0.77	5.52
JUN-16	6.46	0.68	4.56
JUL-16	7.91	0.83	5.57
AUG-16	6.91	0.80	4.89
SEP-16	7.86	0.67	5.55
OCT-16	4.29	0.59	3.43
NOV-16	7.26	0.74	5.42
DEC-16	7.49	0.65	5.44
AVERAGE	7.24	0.76	5.25