CITY OF BONITA SPRINGS

OCTOBER 2016 - SEPTEMBER 2017

SURFACE WATER QUALITY MONITORING REPORT

FEBRUARY 26, 2018

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EXEUCTIVE SUMMARY

This report summarizes the water quality results for samples collected from October 2016 - September 2017. A total of 15 active City of Bonita Springs (CBS) sample locations were monitored by Johnson Engineering during this period to characterize water quality within Spring Creek and Imperial River.

Monthly surface water quality grab samples were collected by Johnson Engineering personnel trained in proper surface water sampling techniques when flow was apparent. The water quality samples were laboratory analyzed for the following parameters: ammonia nitrogen, nitrate + nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus, chlorophyll-a, biochemical oxygen demand, copper, iron, and total hardness. In addition to the laboratory analyzed parameters, field measurements for specific conductivity, temperature, pH, turbidity, and dissolved oxygen were collected by Johnson Engineering personnel using Florida Department of Environmental Protection (FDEP) approved meters. Depth of water, channel geometry, and velocity measurements were also recorded to calculate flow rates during each sampling event.

Laboratory results were compared to FDEP Numeric Nutrient Criteria (NNC) for fresh and estuarine Florida streams. The mean nutrient levels at all of the Spring Creek and Imperial River CBS sample locations were below the fresh stream NNC limit of 1.54 milligrams/liter (mg/L) for total nitrogen except at CBS 10, CBS 12, and CBS 20. However, the mean total nitrogen levels in all of the CBS samples collected from the FDEP designated “fresh” section of the Imperial River were above the Total Maximum Daily Load (TMDL) concentration of 0.74 mg/L set for that waterbody. Also, although CBS 4A, CBS 7, CBS 12, CBS 16, CBS 20, and CBS 21 all represent fresh stormwater runoff, they are compared to the estuarine NNC limit of 0.63 mg/L because they flow to sections of Spring Creek or Imperial River that have been designated by FDEP as “estuarine.”

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1.0 INTRODUCTION

In 2006, the City of Bonita Springs requested a water quality monitoring program to characterize surface water entering the city as well as surface water runoff from commercial and industrial areas within the city. A program was developed to provide monthly surface water sampling at eight (8) sample locations (CBS 1 - CBS 8) along and within the city boundaries. The sample locations were selected after careful evaluation of stormwater runoff conveyances within the city and in consideration of existing sample locations being monitored by Lee County.

Johnson Engineering implemented the water quality monitoring program on June 28, 2006. Since that time, the monitoring program has continued to evolve and improve in response to the data collected and additional water quality regulations. In October 2007, a ninth sample location (CBS 9) was added to characterize inflow to Imperial River from Rosemary Canal, since it was a major tributary that was not being monitored as part of the Lee County plan.

In September 2009, two (2) of the original sample locations (CBS 2 and CBS 8) were removed from the monitoring program due to lack of flow. Two (2) new sample locations were added at that same time. CBS 10 was added to monitor surface water inflow to Imperial River from residential communities along the south side of Bonita Beach Road, east of Bonita Grande Drive. CBS 11 was added to provide an additional sampling location along Imperial River, near the west end of the section designated as fresh.

In October 2010, five (5) new sample locations (CBS 12, CBS 13, CBS 14, CBS 15, and CBS 16) were added to monitor additional tributaries and outfalls to Imperial River and Spring Creek. Additionally, one (1) of the original sample locations (CBS 1) was removed from the monitoring program after it was discovered that Lee County sample location SCEGR01 represented the same channel further downstream.

In October 2011, two (2) new sample locations were added to the program. CBS 17 was added as a replacement to CBS 15 to monitor water quality along the fresh section of Spring Creek between two (2) existing Lee County sample locations (48-25GR and 48-15GR). CBS 18 was added to monitor water quality along Imperial River at Old 41 Road, near the Imperial River freshwater/estuarine interface. New sample location CBS 19 was added in October 2012 to provide

an additional sampling location along the fresh section of Imperial River, in between I-75 and Imperial Parkway off the bridge on Bourbonniere Drive.

In October 2014, multiple changes were made to the program. CBS 3, CBS 4, and CBS 5 were removed and replaced with CBS 3A, CBS 4A, and CBS 5A. CBS 17 was removed. CBS 20, CBS 21, and CBS 22 were added. In October 2015, CBS 3A was removed due to the insufficient flow and number of samples collected. CBS 9 was also removed because samples taken at CBS 4A represent the same water body.

This report summarizes the water quality results for samples collected from October 2016 - September 2017. A total of 15 active City of Bonita Springs sample locations were monitored by Johnson Engineering during this period. One (1) of those sample locations (CBS 6) is located along the east city boundary, where surface water runoff enters the city. Two (2) other locations, CBS 4A and CBS 5A, represent runoff entering the city from the northeast. Nine (9) of the sample locations (CBS 4A, CBS 5A, CBS 7, CBS 10, CBS 12, CBS 13, CBS 14, CBS 16, CBS 20, CBS 21, and CBS 22) are at areas within the city that receive runoff from urban areas (commercial, industrial, and residential). However, no samples were collected from CBS 14 during this monitoring period because the outfall pipe did not show signs of discharge during the monthly sampling events. The remaining three (3) sample locations (CBS 11, CBS 18, and CBS 19) characterize water quality within the Imperial River. An aerial figure of the City of Bonita Springs surface water quality sample locations and nearby Lee County and FDEP sample locations is included in Appendix A. Lists describing each of the sample locations are also included in Appendix A.

Surface water runoff within the City of Bonita Springs generally flows from northeast to southwest towards Estero Bay. The primary conveyances for surface water runoff from the City of Bonita Springs are Spring Creek and Imperial River. FDEP has designated fresh versus marine (estuarine) sections for the Spring Creek and Imperial River watersheds. These designations are termed Water Body Identifications (WBIDs). In August 2008, FDEP issued a Total Maximum Daily Load (TMDL) to reduce total nitrogen loading to the fresh section of Imperial River east of Old 41 Road (WBID 3258EA). A Basin Management Action Plan (BMAP) has been developed to address this TMDL. The estuarine section of Imperial River west of Old 41 Road (WBID 3258EB) and the estuarine section of Spring Creek west of Tamiami Trail (a.k.a. US-41; WBID 3258H2) have both

been listed by FDEP as verified impaired. Therefore, there may be TMDLs issued for these WBIDs in the future. The fresh section of Spring Creek east of Tamiami Trail (WBID 3258H3) is not currently listed as verified impaired, but will continue to be re-evaluated every five (5) years, along with the other WBIDs. The next verified list of impaired water bodies for the Everglades West Coast WBIDs is expected to be issued in the fall of 2018.

2.0 METHODOLOGY

Monthly surface water quality grab samples were collected by Johnson Engineering personnel trained in proper surface water sampling techniques when flow was apparent. Samples were collected from each sample location where water was flowing at the time of sampling. Care was taken to ensure that samples were only collected from water flowing towards the gulf for tidally influenced locations. The water quality samples were collected in accordance with active FDEP Standard Operating Procedures. Benchmark EnviroAnalytical Laboratory (National Environmental Laboratory Accreditation Conference Number E84167) provided new containers for all sample collections and performed the laboratory analytical services.

The collected water quality samples were immediately placed in a cooler filled with wet ice and delivered to Benchmark EnviroAnalytical Laboratory (BEA) following chain-of-custody procedures. The water quality samples were laboratory analyzed for the following parameters: ammonia nitrogen, nitrate + nitrite, total Kjeldahl nitrogen, total nitrogen, ortho-phosphorus, total phosphorus, chlorophyll-a, biochemical oxygen demand, copper, iron, and total hardness. In addition to the laboratory analyzed parameters, field measurements for specific conductivity, temperature, pH, turbidity, and dissolved oxygen were collected by Johnson Engineering personnel using FDEP approved meters. Depth of water, channel geometry, and velocity measurements were also recorded to calculate flow rates during each sampling event. The laboratory data, field data, and flow calculations are included on the attached CD.

This report provides water quality data collected during the 2016 - 2017 dry season (October-May) on the following dates: October 20th, November 17th, December 19th, January 19th, February 16th, March 16th, April 20th, and May 11th. Wet season (June-September) surface water quality samples were collected throughout 2017 on June 20th, July 20th, August 17th, and September 21st. The sample event record is shown below in Table 1.

Table 1: Sample Event Record

Sample ID	10/20/2016	11/17/2016	12/19/2016	1/19/2017	2/16/2017	3/16/2017	4/20/2017	5/11/2017	6/20/2017	7/20/2017	8/17/2017	9/21/2017
SPRING CREEK (ESTUARINE) OCT 2016 - SEP 2017												
CBS 16	x								x	x	x	
CBS 21									x	x	x	
IMPERIAL RIVER (FRESH) OCT 2016 - SEP 2017												
CBS 5A	x	x							x	x	x	x
CBS 6									x	x	x	x
CBS 10	x	x								x	x	
CBS 11	x	x	x	x	x	x	x	x	x	x	x	x
CBS 14												
CBS 18	x	x	x	x	x	x	x	x	x	x	x	x
CBS 19	x	x	x	x	x	x	x	x	x	x	x	
CBS 22										x	x	x
IMPERIAL RIVER (ESTUARINE) OCT 2016 - SEP 2017												
CBS 4A	x	x	x	x	x				x	x	x	x
CBS 7									x	x	x	
CBS 12									x	x	x	
CBS 13	x								x	x		
CBS 20					x	x	x		x	x	x	
Total	**8**	**6**	**4**	**4**	**5**	**4**	**4**	**3**	**12**	**14**	**13**	**6**

3.0 RESULTS

Charts of monitored parameters for each City of Bonita Springs (CBS) sample location are included in Appendix B, along with charts of the same parameters from nearby sample locations that are monitored by Lee County and FDEP. Charts for each laboratory analyzed surface water quality parameter are grouped into four (4) separate plots: freshwater inflow locations (SCEGR01, CBS 6, and KEHLGR); freshwater interior runoff locations (CBS 4A, CBS 5A, CBS 10, CBS 22, and IMPRGR51); estuarine interior runoff locations (CBS 7, CBS 12, CBS 13, CBS 16, CBS 20, CBS 21, and IMPRGR41); and estuarine outflow locations (SPRIGR01 and IMPRGR01). Water quality for monitored parameters directly along Spring Creek (48-25GR, 48-15GR, 48-10GR, and SPRIGR01) and Imperial River (KEHLGR, IMPRGR80, CBS11, CBS 18, CBS 19, IMPRGR30, and IMPRGR01) are provided as separate plots, also in Appendix B.

Tables 2, 3, and 4 display minimum, arithmetic mean and maximum values of monitored parameters for each CBS sample location and are grouped into three (3) separate areas: Spring Creek estuarine (CBS 16 and CBS 21); Imperial River fresh (CBS 5A, CBS 6, CBS 10, CBS 11, CBS 18, CBS 19, and CBS 22); and Imperial River estuarine (CBS 4A, CBS 7, CBS 12, CBS 13, and CBS 20).

Table 2: Minimum, Mean & Maximum Values for Spring Creek Estuarine

SPRING CREEK (ESTUARINE) OCT 2016- SEPT 2017						
Parameters	**CBS 16**			**CBS 21**		
	Min	Mean	Max	Min	Mean	Max
Ammonia Nitrogen (mg/L)	0.008 *	0.063	0.096	0.008 *	0.032	0.081
Nitrate + Nitrite (mg/L)	0.042	0.160	0.322	0.090	0.112	0.149
Kjeldahl Nitrogen (mg/L)	0.488	0.719	1.020	0.729	0.820	0.889
Total Nitrogen (mg/L)	0.563	0.880	1.150	0.826	0.932	0.992
Biochemical Oxygen Demand (mg/L)	1.00 *	1.34	2.04	1.06	1.33	1.66
Total Phosphorus (mg/L)	0.015	0.053	0.107	0.011	0.015	0.022
Chlorophyll-a (µg/L)	1.06	6.94	18.80	7.87	14.59	22.60
Copper (µg/L)	1.00	3.21	5.87	4.07	10.52	15.70
Iron (µg/L)	190	418	602	70	119	192
Total Hardness (CaCO3)	139	242	337	272	325	391

* = Minimum Detectable Level (MDL)

Table 3: Minimum, Mean & Maximum Values for Imperial River Fresh

IMPERIAL RIVER (FRESH) OCT 2016- SEPT 2017																				
	CBS 5A			CBS 6			CBS 10			CBS 11			CBS 18			CBS 19			CBS 22		
PARAMETERS	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX
Ammonia Nitrogen (mg/L)	0.008 *	0.132	0.346	0.008 *	0.009	0.013	0.083	0.324	0.717	0.008 *	0.089	0.280	0.008 *	0.079	0.205	0.008 *	0.167	0.395	0.008 *	0.060	0.164
Nitrate + Nitrite (mg/L)	0.011	0.085	0.179	0.004 *	0.008	0.018	0.077	0.148	0.221	0.004 *	0.186	0.607	0.005	0.138	0.290	0.012	0.201	0.806	0.006	0.015	0.032
Kjeldahl Nitrogen (mg/L)	0.700	1.15	1.94	0.743	1.03	1.26	1.06	1.84	2.92	0.610	1.03	1.29	0.869	1.01	1.24	0.726	1.09	1.48	1.19	1.32	1.45
Total Nitrogen (mg/L)	0.876	1.24	1.99	0.761	1.04	1.26	1.25	1.99	3.14	0.844	1.21	1.53	0.896	1.15	1.32	0.878	1.29	1.80	1.20	1.34	1.48
Biochemical Oxygen Demand (mg/L)	1.00 *	1.69	3.69	1.00 *	3.53	11.10	1.25	1.91	2.63	1.00 *	1.74	6.91	1.00 *	1.65	6.83	1.00 *	1.001	1.01	1.77	2.49	3.85
Total Phosphorus (mg/L)	0.013	0.039	0.068	0.008 *	0.014	0.021	0.048	0.069	0.084	0.008 *	0.026	0.057	0.008 *	0.019	0.048	0.008 *	0.031	0.156	0.156	0.258	0.42
Chlorophyll-a (µg/L)	3.67	7.14	13.90	1.39	4.24	8.22	8.84	22.04	35.60	0.71	10.35	88.40	1.46	7.26	34.90	0.82	1.95	3.50	11.60	16.10	19.50
Copper (µg/L)	0.346 *	0.748	1.33	0.390	0.586	0.933	0.505	1.80	2.93	0.346 *	0.463	0.710	0.346 *	0.447	0.720	0.346 *	0.724	1.94	1.07	2.39	4.34
Iron (µg/L)	377	545	684	82	180	370	188	243	297	166	356	664	170	316	256	161	326	556	271	335	379
Total Hardness (CaCO3)	100	164	282	80	91	110	190	241	301	37	271	712	30	298	1076	91	226	369	158	175	184

* = Minimum Detectable Level (MDL)

Table 4: Minimum, Mean & Maximum Values for Imperial River Estuarine

IMPERIAL RIVER (ESTUARINE) OCT 2016- SEPT 2017															
	CBS 4A			CBS 7			CBS 12			CBS 13			CBS 20		
PARAMETERS	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX	MIN	MEAN	MAX
Ammonia Nitrogen (mg/L)	0.008 *	0.042	0.137	0.008 *	0.016	0.033	0.123	0.257	0.478	0.008 *	0.127	0.313	0.064	0.261	0.479
Nitrate + Nitrite (mg/L)	0.004 *	0.118	0.446	0.022	0.037	0.058	0.065	0.078	0.102	0.016	0.050	0.111	0.220	0.494	0.734
Kjeldahl Nitrogen (mg/L)	0.767	0.956	1.14	0.397	0.590	0.699	1.30	1.52	1.73	0.769	1.13	1.59	0.92	1.26	1.82
Total Nitrogen (mg/L)	0.854	1.075	1.35	0.419	0.627	0.76	1.37	1.60	1.80	0.791	1.18	1.70	1.65	1.75	2.04
Biochemical Oxygen Demand (mg/L)	1.00 *	1.36	3.10	1.00 *	1.12	1.37	1.00 *	1.38	1.80	1.00 *	1.32	1.86	1.00 *	1.08	1.28
Total Phosphorus (mg/L)	0.008 *	0.031	0.092	0.011	0.015	0.022	0.008 *	0.041	0.069	0.014	0.028	0.046	0.008 *	0.021	0.059
Chlorophyll-a (µg/L)	1.86	4.32	7.55	1.81	2.71	3.19	1.17	2.02	3.63	0.290	2.15	4.47	0.361	1.48	2.84
Copper (µg/L)	0.346 *	0.588	1.24	2.57	2.61	2.66	0.699	1.14	1.62	0.346 *	1.42	2.19	0.346 *	0.781	1.32
Iron (µg/L)	347	475	604	113	171	267	551	701	816	616	833	1050	910	1074	1180
Total Hardness (CaCO3)	75	154	302	121	133	140	224	260	323	155	270	410	322	361	416

* = Minimum Detectable Level (MDL)

4.0 DISCUSSION

Numeric Nutrient Criteria (NNC) have been developed for fresh and marine waters in various regions throughout Florida, including the Peninsula region where the fresh and marine sections of Spring Creek and Imperial River are located.

Chapter 62-302 Surface Water Quality Standards have been revised to include the NNC for nutrients including total nitrogen (TN), total phosphorus (TP), and chlorophyll-a for fresh and marine waters. The applicable criteria for Spring Creek and Imperial River fresh are 1.54 milligrams per liter (mg/L) for TN, 0.12 mg/L for TP, and 20 micrograms per liter (µg/L) for chlorophyll-a. Those criteria are expressed as annual geometric means not to be exceeded more than once in a three-year period. The applicable criteria for Spring Creek and Imperial River marine are 0.63 mg/L for TN, 0.07 mg/L for TP, and 5.9 µg/L for chlorophyll-a. Those criteria are expressed as annual arithmetic means not to be exceeded more than once in a three-year period.

A BMAP was developed to guide implementation of the TMDL adopted for the Imperial River fresh watershed (WBID 3258EA) east of Old 41 Road. The TMDL was issued because of WBID 3258EA being listed by FDEP as verified impaired for Dissolved Oxygen (DO). The impairment is based upon DO levels of less than 5.0 mg/L measured primarily at three (3) Lee County sample locations (KEHLGR, IMPRGR80, and IMPRGR51) from January 2000 - June 2007.

TN is the nutrient identified by FDEP as the causative pollutant for the DO impairment. Thus, FDEP set a maximum concentration level of 0.74 mg/L to reduce TN loading to the Imperial River fresh watershed. This represents a 25% reduction from the median concentration level of 0.96 mg/L for samples collected at WBID 3258EA sample locations from January 2000 - June 2007.

According to the DO standards for Class III fresh water bodies and predominately marine water bodies, no more than 10% of the daily average percent saturation values shall be below 38% for fresh water bodies and 42% for estuarine water bodies, respectively.

5.0 CONCLUSIONS

Two (2) City of Bonita Springs sample locations were monitored in the Spring Creek estuarine (CBS 16 and CBS 21) watershed during the October 2016 - September 2017 reporting period. For the purposes of this report, an annual arithmetic mean for DO was calculated for each sample location and compared to the average percent saturation values for the applicable water bodies. According to the criteria, no more than 10% of the values should be below the standard. The annual mean (arithmetic or geometric) concentrations for TN, TP, and chlorophyll-a were all calculated and compared to the applicable annual mean. The mean levels laid out in the criteria are not be to exceeded more than once in any consecutive three-year period.

More than 10% of the values measured at CBS 16 were below the DO state water quality standard of 42%. Also, the annual arithmetic mean for DO at CBS 16 was below the state water quality standard of 42%. The arithmetic mean concentration at CBS 16 for TN (0.88 mg/L) and CBS 21 (0.93 mg/L) was higher than the estuarine TN criteria limit of 0.63 mg/L. The arithmetic mean concentrations at CBS 16 (0.05 mg/L) and CBS 21 (0.02 mg/L) for TP were lower than the applicable estuarine criteria limit of 0.07 mg/L. The arithmetic mean at CBS 16 (6.9 µg/L) and CBS 21 (14.6 µg/L) for chlorophyll-a was higher than the applicable estuarine criteria limit (5.9 µg/L).

Table 5 displays the mean (arithmetic and geometric) values of DO, TN, TP and chlorophyll-a for Spring Creek estuarine (CBS 16 and CBS 21) compared to water quality criteria and typical values.

Table 5: Spring Creek Mean Values Compared to Water Quality Standards & Typical Values

Sample ID	Dissolved Oxygen (% Saturation)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (µg/L)
SPRING CREEK ESTUARINE [1]				
CBS 16	39	0.88	0.05	6.9
CBS 21	58	0.93	0.02	14.6
Marine Water Quality Criteria	≥42 [2]	≤0.63 [3]	≤0.07 [3]	≤5.9 [3]
More than 10% of the values below the standard	Yes @ CBS 16			
Typical Values For Florida Estuarine Waters [4]	81	0.7	0.02	4.6

[1] - Values for Spring Creek Estuarine are expressed as arithmetic mean for comparison to water quality standards

[2] - No more than 10% of the values shall be below the standard, 62-302.530, F.A.C.

[3] - Annual arithmetic mean not to be exceeded more than once in any consecutive calendar three year period, 62-302.530, F.A.C.

[4] - Median (50th percentile) value from Typical Water Quality Values for Florida's Lakes, Streams and Estuaries (Hand, 2008)

Thirteen (13) City of Bonita Springs sample locations were monitored in the Imperial River fresh (CBS 5A, CBS 6, CBS 10, CBS 11, CBS 14, CBS 18, CBS 19, and CBS 22) and estuarine (CBS 4A, CBS 7, CBS 12, CBS 13, and CBS 20) watershed during the October 2016 - September 2017 reporting period. For the purposes of this report, an annual arithmetic mean for DO was calculated for each sample location and compared to the daily average percent saturation values for the applicable water bodies. According to the criteria, no more than 10% of the values should be below the standard. The annual mean (arithmetic or geometric) concentrations for TN, TP, and chlorophyll-a were all calculated and compared to the applicable annual mean. The mean levels laid out in the criteria are not be to exceeded more than once in any consecutive three-year period.

More than 10% of the values fell below the DO standard of 38% at all the Imperial River fresh locations. Additionally, all the annual arithmetic mean concentrations for DO at the Imperial River fresh monitoring locations were below the standard of 38% except for CBS 10 (47%).

The geometric mean concentrations for the sample locations monitored in the Imperial River fresh watershed for TN were all lower than the criteria limit of 1.54 mg/L. However, the TMDL adopted for the Imperial River fresh watershed sets a maximum concentration value of 0.74 mg/L for TN. None of the Imperial River fresh sample locations met this TMDL criteria limit. The geometric mean concentrations of TP for all locations were below the criteria limit of 0.12 mg/L, except at

CBS 10 (0.14 mg/L). The geometric mean concentrations at these locations for chlorophyll-a were lower than the criteria limit of 20.0 µg/L.

More than 10% of the values fell below the DO standard of 42% at all the Imperial River estuarine locations except at CBS 7 and CBS 12. Additionally, annual arithmetic mean concentrations for DO at CBS 4A, CBS 13, and CBS 20 were below the standard of 42%. The arithmetic mean concentrations for the sample locations monitored at the Imperial River estuarine watershed for TN were all higher than the criteria limit of 0.63 mg/L. The only location that exceeded the criteria limit for TP (0.07 mg/L) was CBS 12 (0.12 mg/L) and CBS 20 (0.09 mg/L).

Table 6 displays the mean (arithmetic and geometric) values of DO, TN, TP, and chlorophyll-a for Imperial River fresh (CBS 5A, CBS 6, CBS 10, CBS 11, CBS 18, CBS 19, and CBS 22) and Imperial River estuarine (CBS 4A, CBS 7, CBS 12, CBS 13, and CBS 20) compared to water quality criteria and typical values.

Table 6: Imperial River Mean Values Compared to Water Quality Standards & Typical Values

Sample ID	Dissolved Oxygen (%)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-a (µg/L)
IMPERIAL RIVER FRESH (1)				
CBS 5A	25	1.07	0.02	4.4
CBS 6	11	1.05	0.02	2.6
CBS 10	43	1.05	0.14	5.3
CBS 11	33	1.13	0.02	1.3
CBS 18	22	1.04	0.02	1.8
CBS 19	20	1.12	0.02	1.3
CBS 22	28	0.91	0.02	3.8
Fresh Water Quality Criteria	≥38 (2)	≤1.54 (3)	≤0.12 (3)	≤20 (3)
More than 10% of the values below the standard	Yes at all Imperial River Fresh Locations			
Typical Values For Florida Streams (4)	68	1.00	0.07	1.9
Total Maximum Daily Load (TMDL)		0.74		
IMPERIAL RIVER ESTUARINE (5)				
CBS 4A	29	0.98	0.02	3.2
CBS 7	52	0.86	0.04	2.0
CBS 12	45	1.66	0.12	2.4
CBS 13	37	1.35	0.06	4.9
CBS 20	1	1.59	0.09	0.3
Marine Water Quality Criteria	≥42 (2)	≤0.63 (6)	≤0.07 (6)	≤5.9 (6)
More than 10% of the values below the standard	Yes at all Imperial River Fresh Locations			
Typical Values for Florida Coastal Waters (5)	85	0.35	0.01	1.1

(1) - Values for Spring Creek Fresh are expressed as geometric mean for comparison to water quality standards

(2) - No more than 10% of the values shall be below the standard, 62-302.530, F.A.C.

(3) - Annual geometric mean not to be exceeded more than once in any consecutive calendar three year period, 62-302.530, F.A.C.

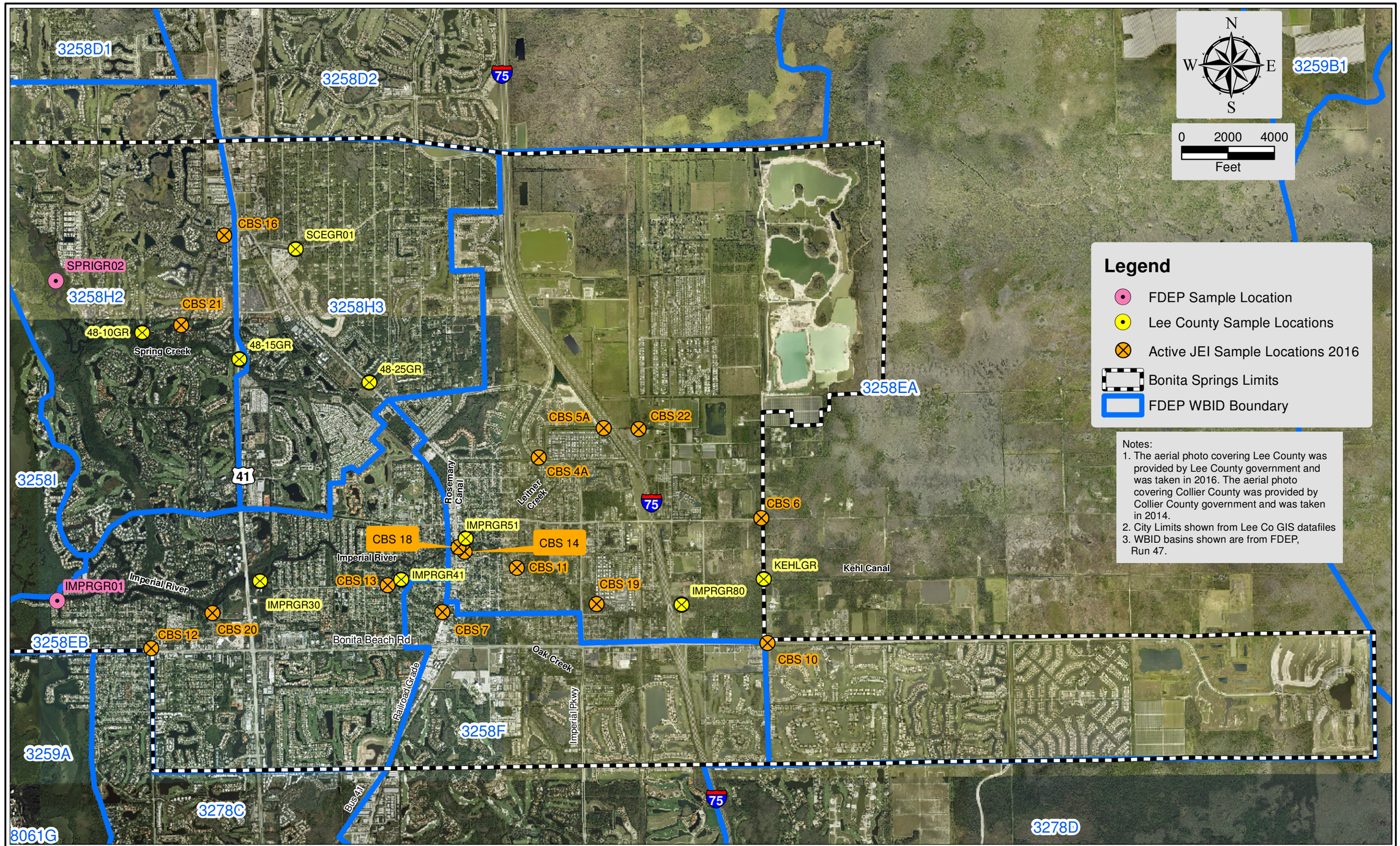
(4) - Median (50th percentile) value from Typical Water Quality Values for Florida's Lakes, Streams and Estuaries (Hand, 2008)

(5) - Values for Spring Creek Estuarine are expressed as arithmetic mean for comparison to water quality standards

(6) - Annual arithmetic mean not to be exceeded more than once in any consecutive calendar three year period, 62-302.530, F.A.C.

APPENDIX A

SURFACE WATER SAMPLE LOCATIONS



Path: \\FTMS01\Proj-fmg\20076685-019\arcgis\11x17-SampleLocationMap2016.mxd Date: 11/28/2016 User: jwm

City of Bonita Springs
Lee County, Florida

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2122 JOHNSON STREET
P.O. BOX 1550
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PHONE (941) 334-0046
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E.B. #642 & L.B. #642

2016 Surface Water Sample Locations

DATE	PROJECT NO.	FILE NO.	SCALE	SHEET
Nov. 2016	20139568-002		As Shown	1

Lee County 2016 - 2017 Surface Water Sample Locations

Spring Creek Sample Locations

SCEGR01 – This inflow sample location captures surface water entering the City of Bonita Springs from a canal north of Strike Lane.

SPRIGR02 – This outflow sample location captures discharge from Spring Creek into Estero Bay.

48-10GR – This outflow sample location captures surface water exiting the City of Bonita Springs through Spring Creek, at Bay Creek Drive in Pelican Landing.

48-15GR – This Spring Creek sample location captures surface water from Spring Creek at the US41 bridge, along the marine/fresh boundary designated by FDEP.

48-25GR – This interior sample location captures surface water runoff from the canal south of The Villages of Bonita at Old US41 before it feeds into Spring Creek.

Imperial River Sample Locations

IMPRGR01 – This outflow sample location captures discharge from Imperial River into Estero Bay.

IMPRGR30 – This outflow sample location captures surface water east of US41 discharging from the City into the marine section of Imperial River.

IMPRGR41 – This tributary sample location captures surface water from Oak Creek at the Pennsylvania Avenue bridge.

IMPRGR51 – This tributary sample location captures surface water from Leitner Creek at the Goodwin Street bridge.

IMPRGR80 – This Imperial River sample location captures surface water from the Imperial River east of I-75 at the north end of Orr Road.

KEHLGR – This inflow sample location captures surface water entering the City of Bonita Springs from Kehl Canal at Bonita Grande Drive.

City of Bonita Springs 2016 - 2017 Surface Water Sample Locations

Spring Creek Sample Locations

CBS 16 – This interior sample location captures surface water runoff from a ditch at the southwest corner of Pelican Landing Parkway and Burnt Pine Drive that is fed by runoff from the surrounding commercial developments.

CBS 21 – This tributary sample location captures surface water from a large creek within Pelican Landing before it feeds into the marine section of Spring Creek.

Imperial River Sample Locations

CBS 4A – This interior sample location captures surface water runoff from a box culvert West of I-75 along a channel that becomes Leitner Creek.

CBS 5A – This interior sample location captures surface water runoff from a box culvert West of I-75 along a channel that becomes Rosemary Canal.

CBS 6 – This city boundary inflow sample location captures surface water runoff from converging ditches to the north of East Terry Street and east of Bonita Grande Drive.

CBS 7 - This interior sample location captures surface water runoff from a ditch south of Kentucky Street that is fed by runoff from industrial areas along Industrial Street to the north and south of Bonita Beach Road.

CBS 10 – This interior sample location captures residential surface water runoff from a ditch southeast of Bonita Beach Road and Bonita Grande Drive

CBS 11 – This Imperial River sample location captures surface water from the fresh section of Imperial River (east of Old US41 Rd) below the west side of the Matheson Avenue bridge.

CBS 12 – This interior sample location captures surface water discharge from a pipe north of Bonita Beach Road along the west side of Luke Street which is fed by runoff from residential developments south of Bonita Beach Road. The pipe discharges into a canal that feeds to the marine section of Imperial River.

CBS 13 – This interior sample location captures surface water runoff from a ditch at southeast corner of Pennsylvania Avenue and Michigan Street that is fed by runoff from the residential developments to the south. The ditch dumps into a large canal that flows into the marine section of Imperial River

CBS 14 - This interior sample location captures surface water discharge from the ditch along the west side of Felts Avenue that is fed by runoff from the old residential area to the south.

CBS 18 – This Imperial River sample location captures surface water from Imperial River at the junction of the fresh and marine sections. The sample is collected from the footbridge due east of Old US41 Rd.

CBS 19 – This Imperial River sample location captures surface water from the fresh section of Imperial River (between I-75 and Imperial Parkway). The sample is collected from a bridge within the Imperial Bonita Estates community off Bourbonniere Drive.

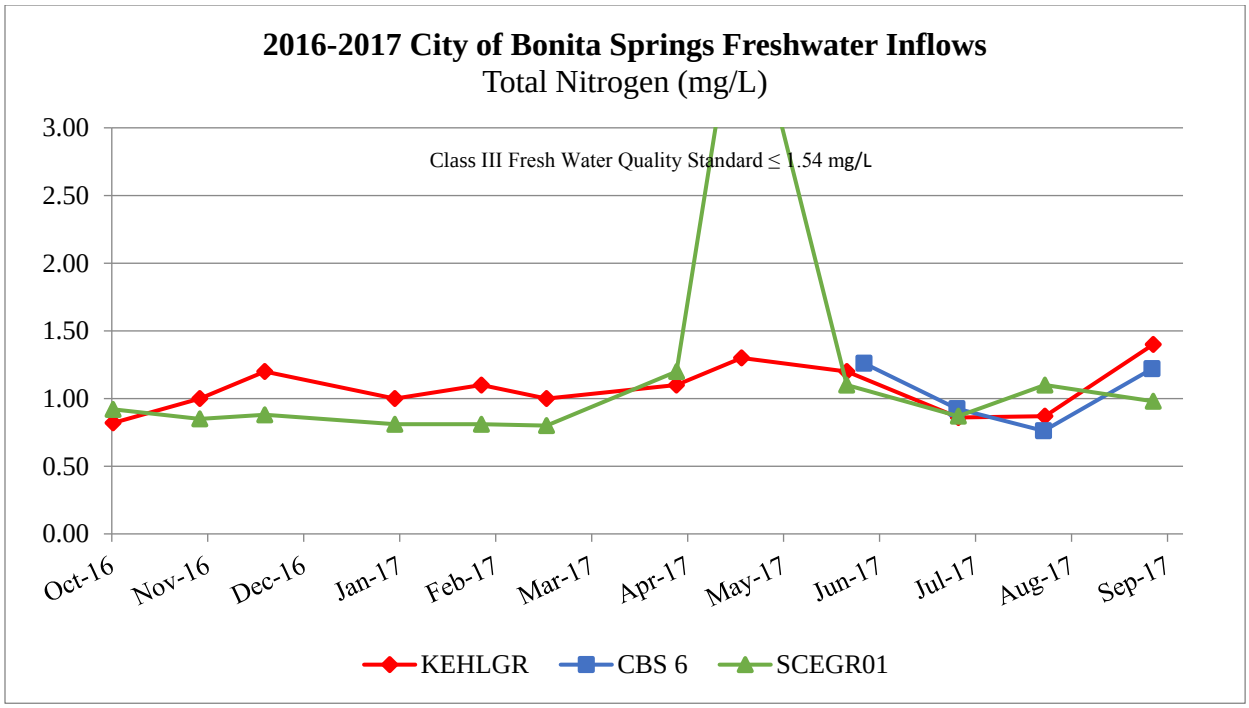
CBS 20 – This interior sample location captures surface water discharge from a ditch along Windsor Road. The sample is collected from the culvert structure at the end of Windsor Road before the water discharges into the marine section of Imperial River.

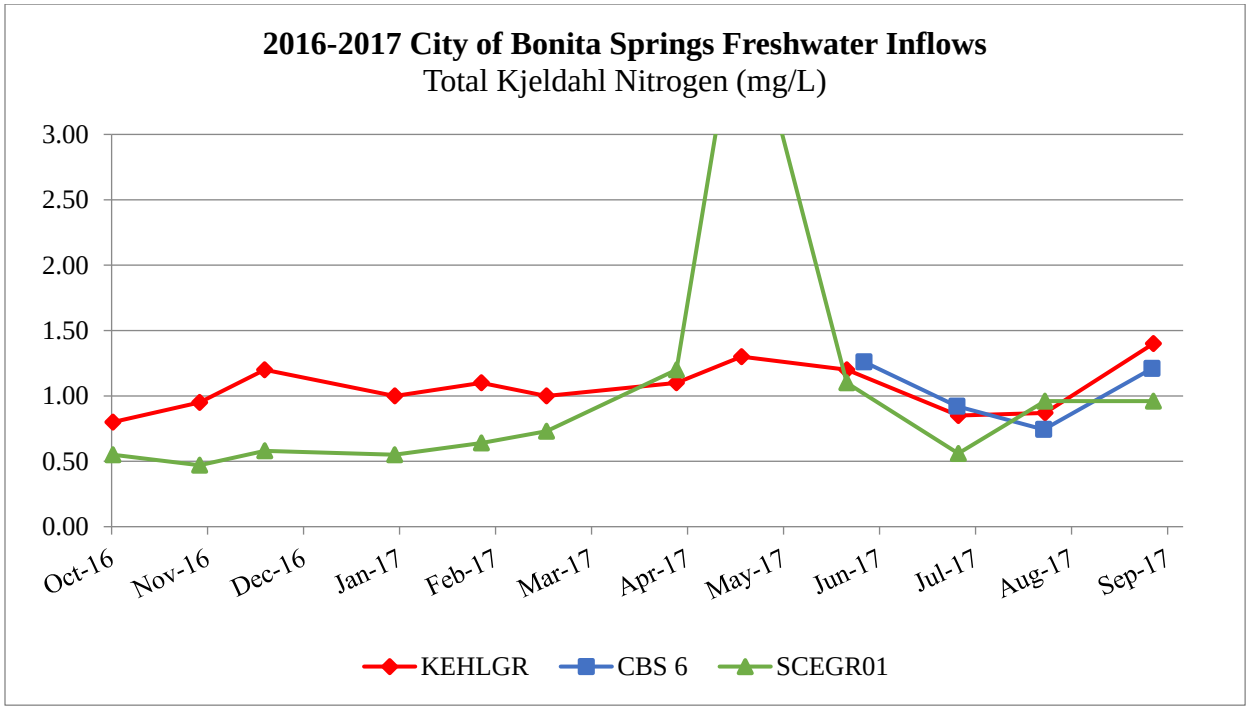
CBS 22 - This interior sample location captures surface water discharge from a ditch at the end of Cutting Horse Lane at a culvert pipe structure leading to the channelized section of Leitner Creek.

APPENDIX B

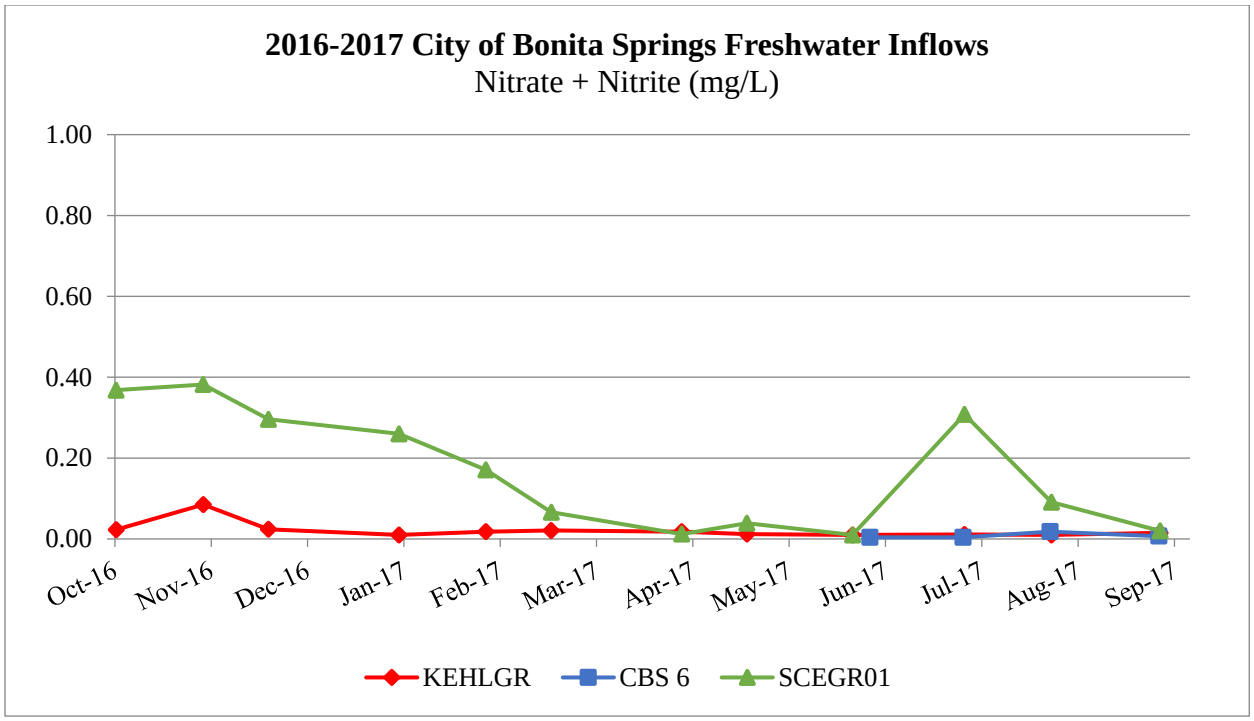
CHARTS OF MONITORED PARAMETERS

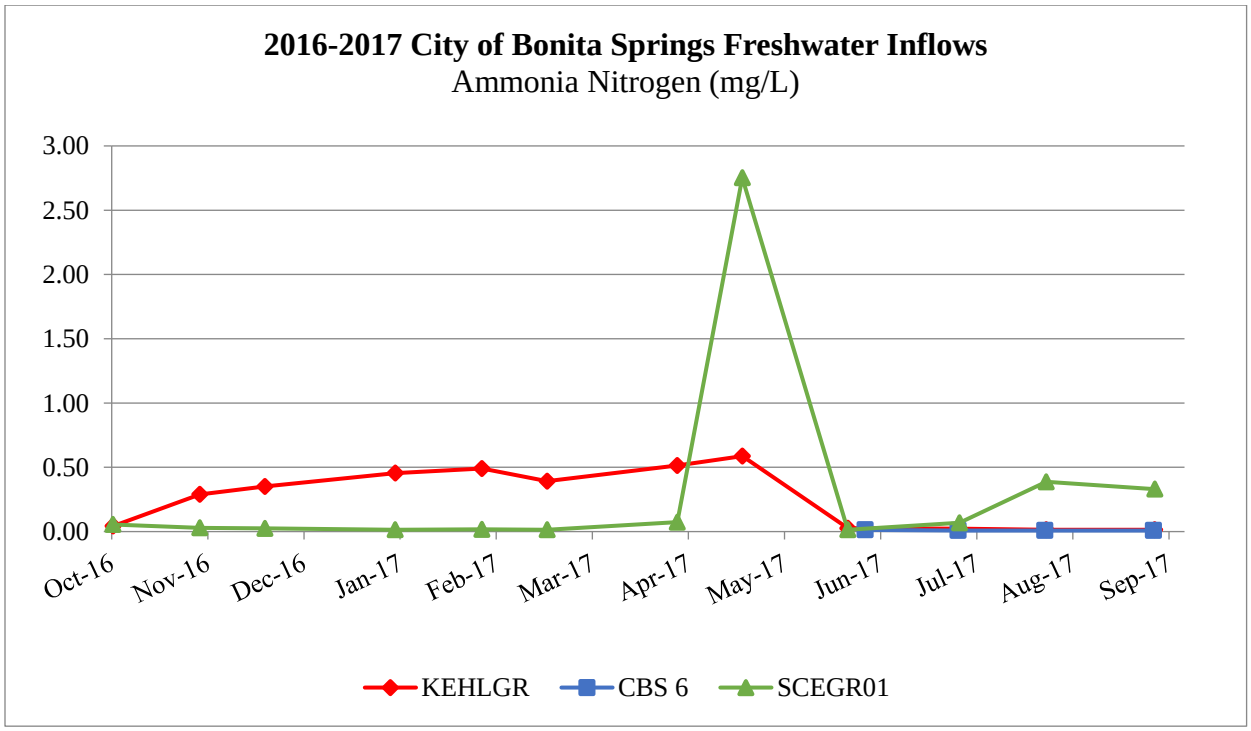
Appendix B: 2016-2017 City of Bonita Springs Freshwater Inflows Charts



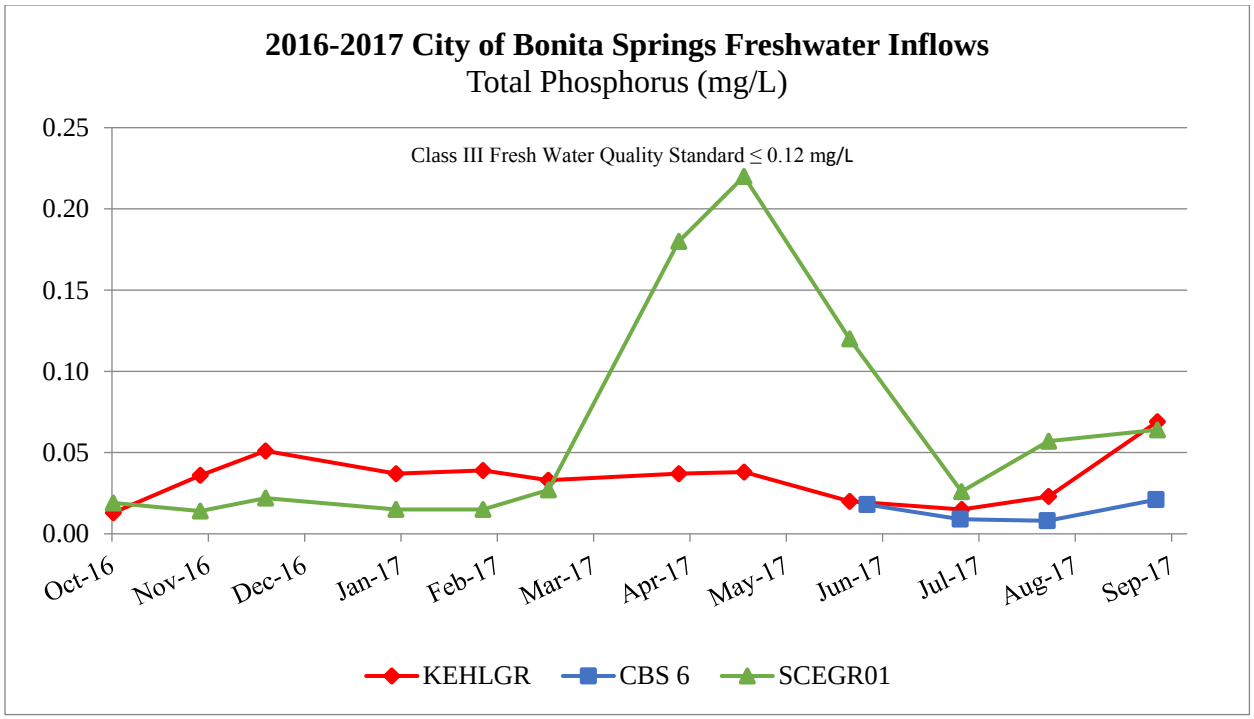


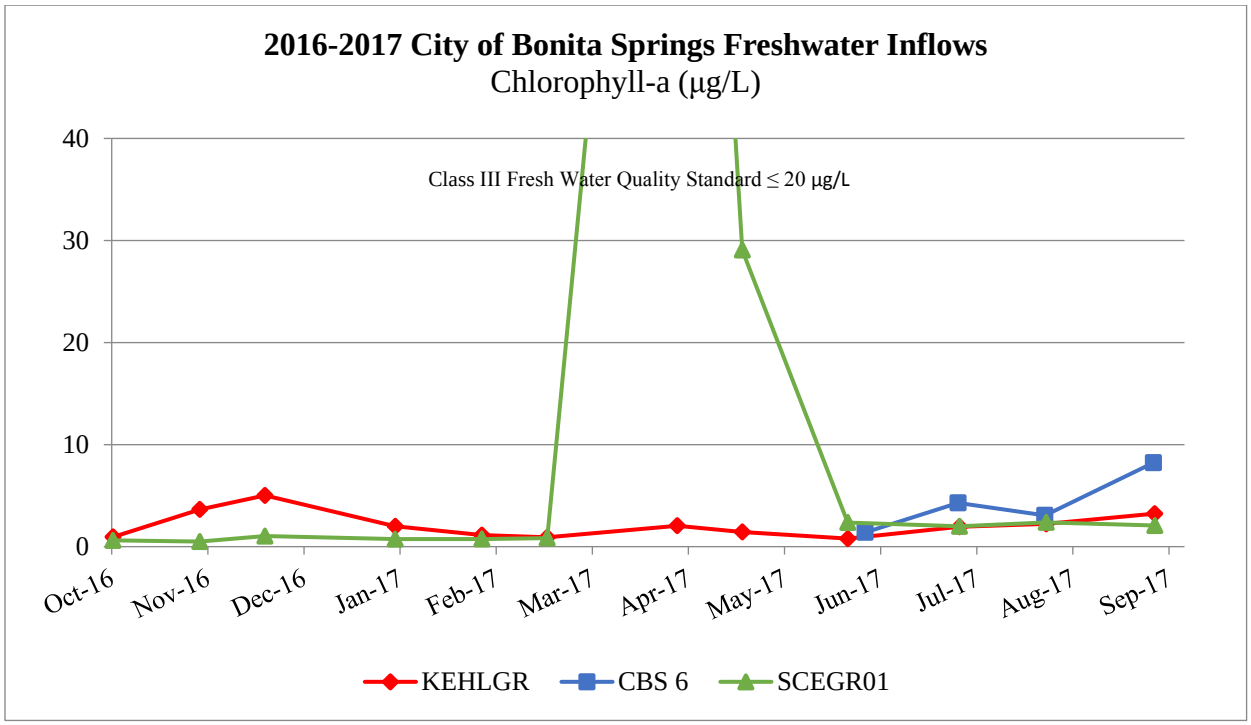
Appendix B: 2016-2017 City of Bonita Springs Freshwater Inflows Charts



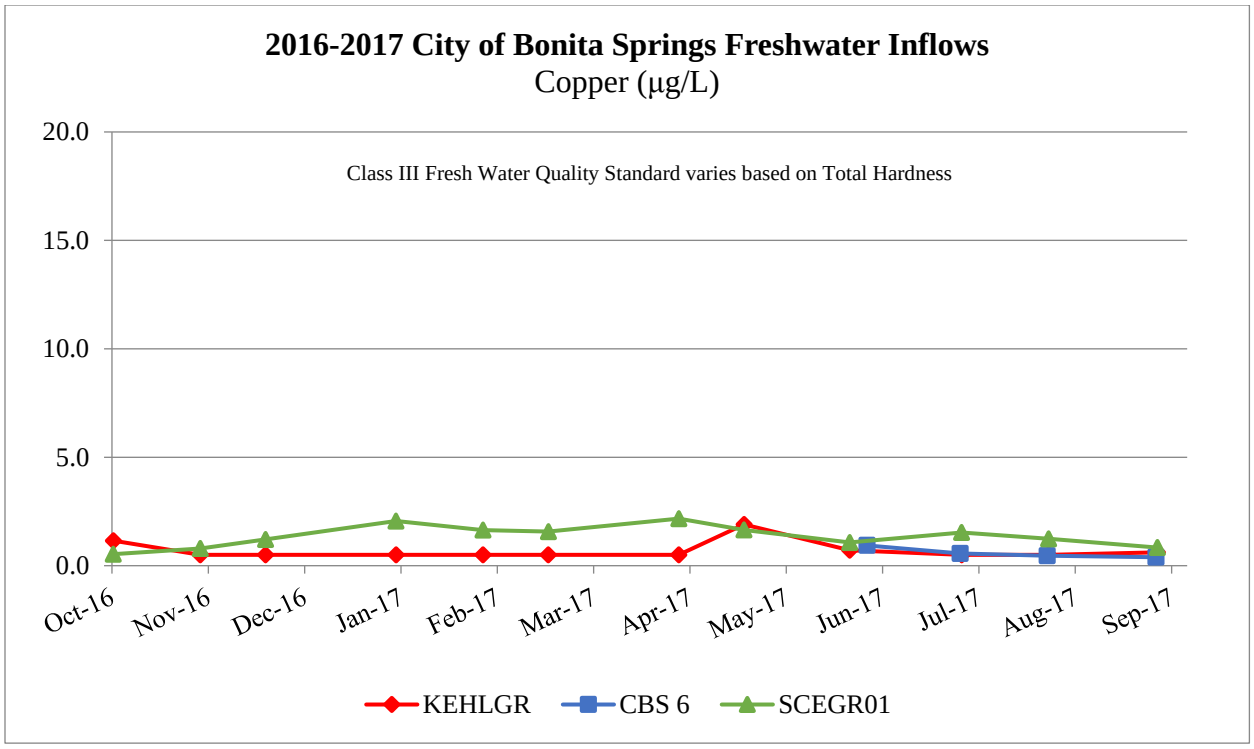


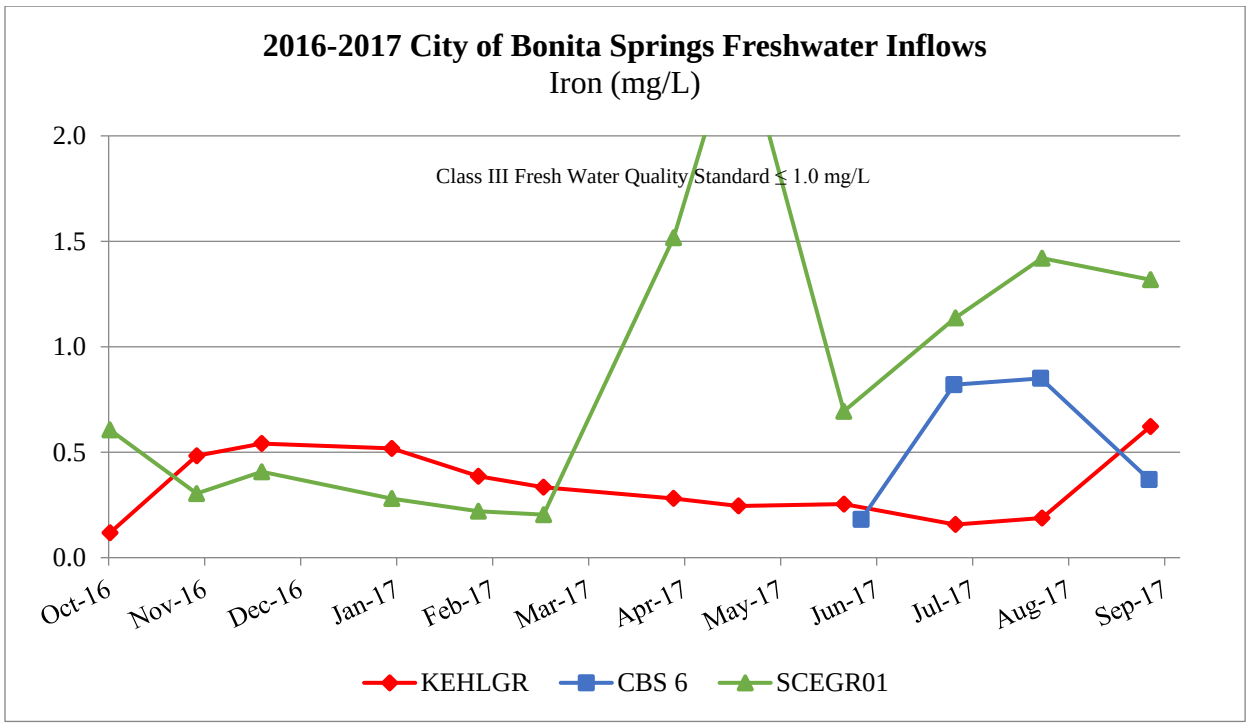
Appendix B: 2016-2017 City of Bonita Springs Freshwater Inflows Charts



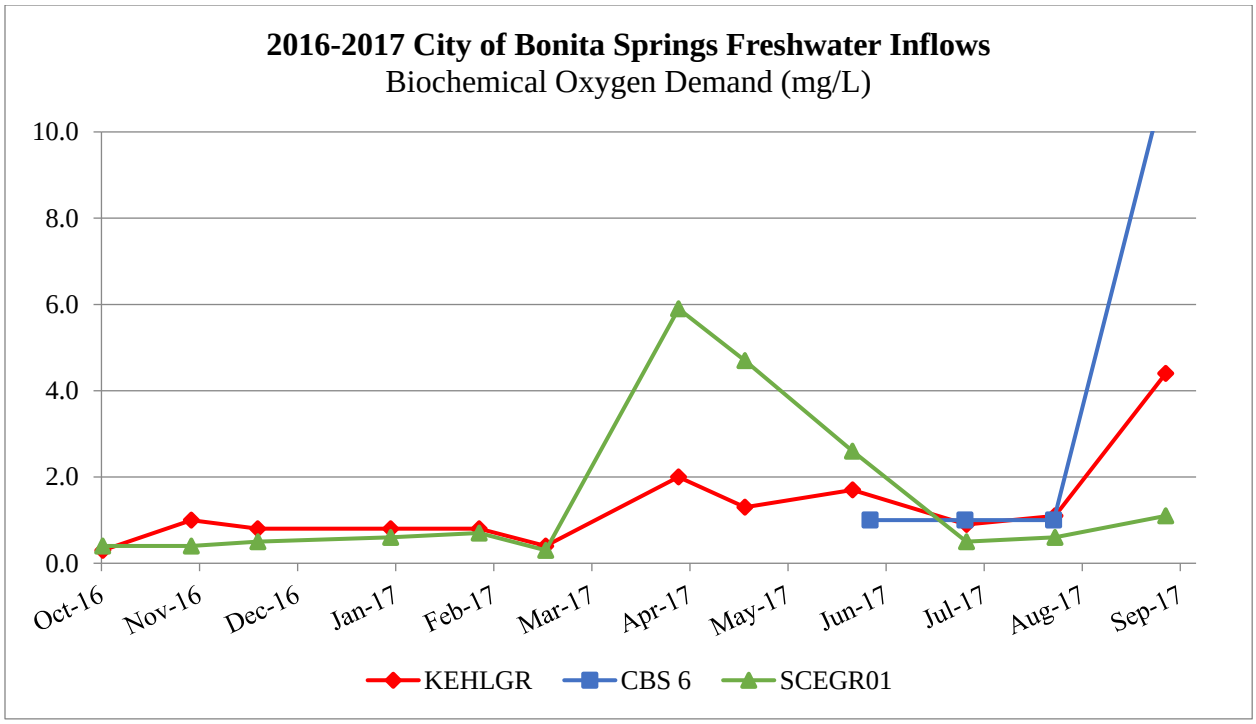


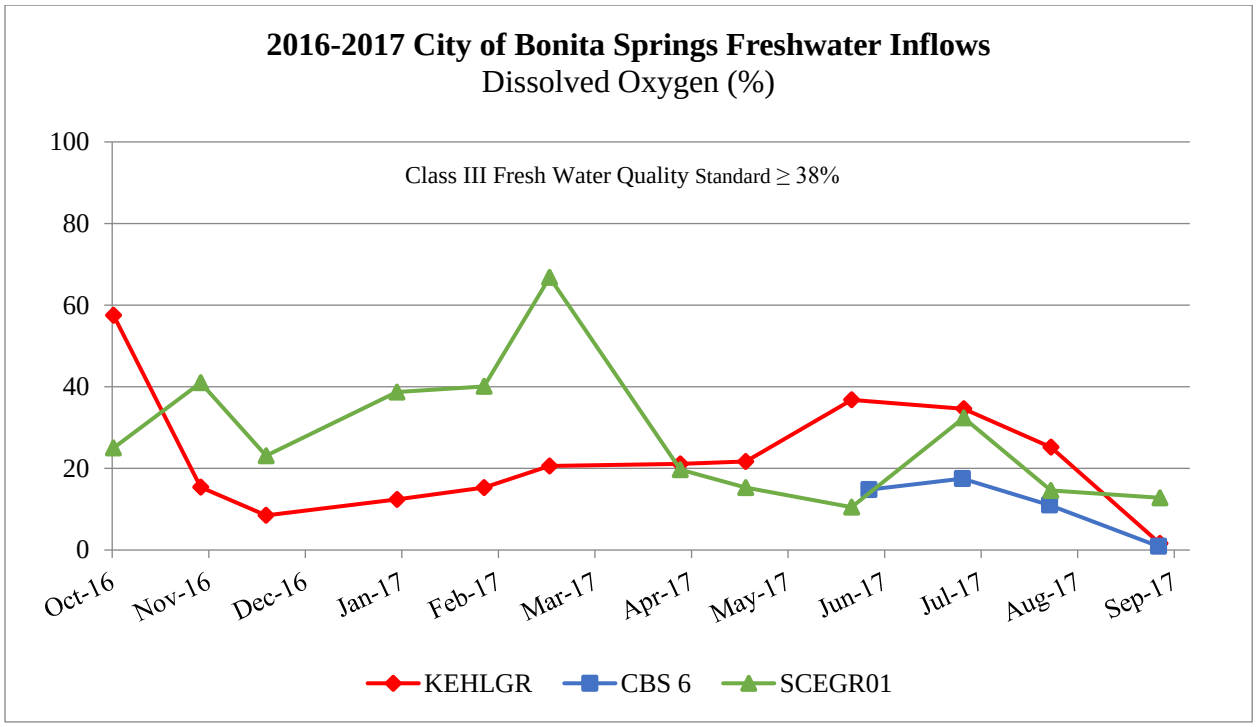
Appendix B: 2016-2017 City of Bonita Springs Freshwater Inflows Charts



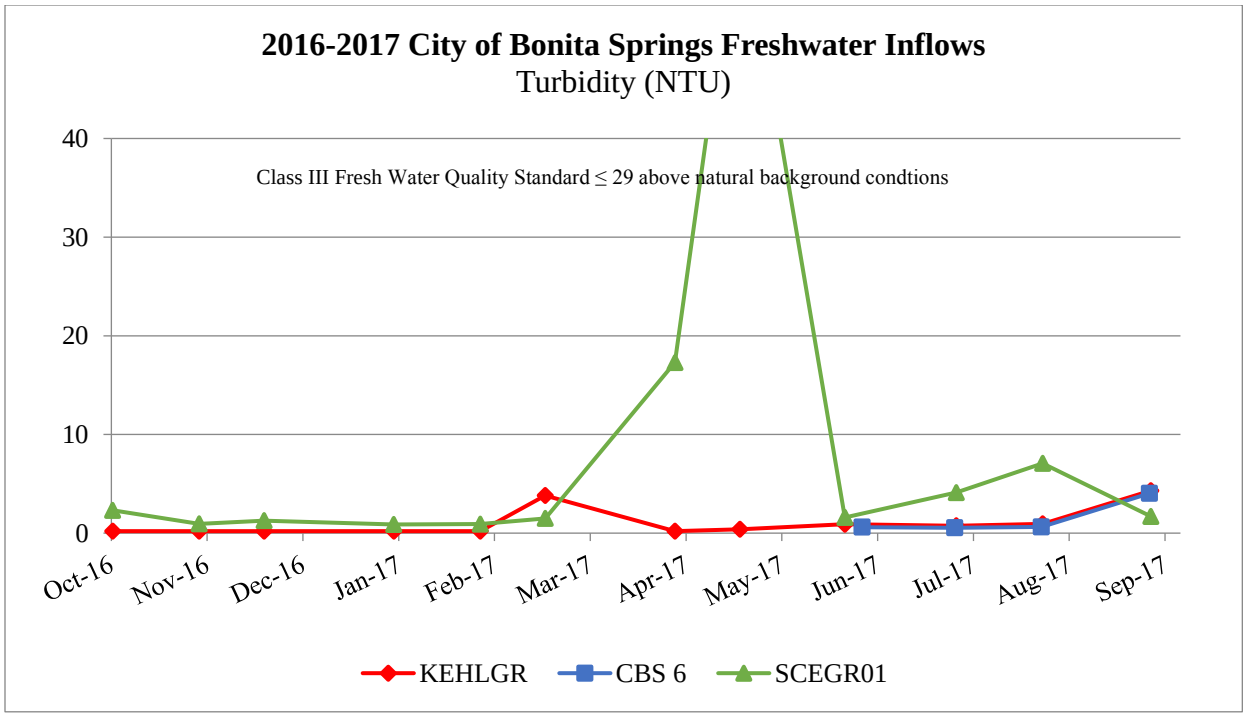


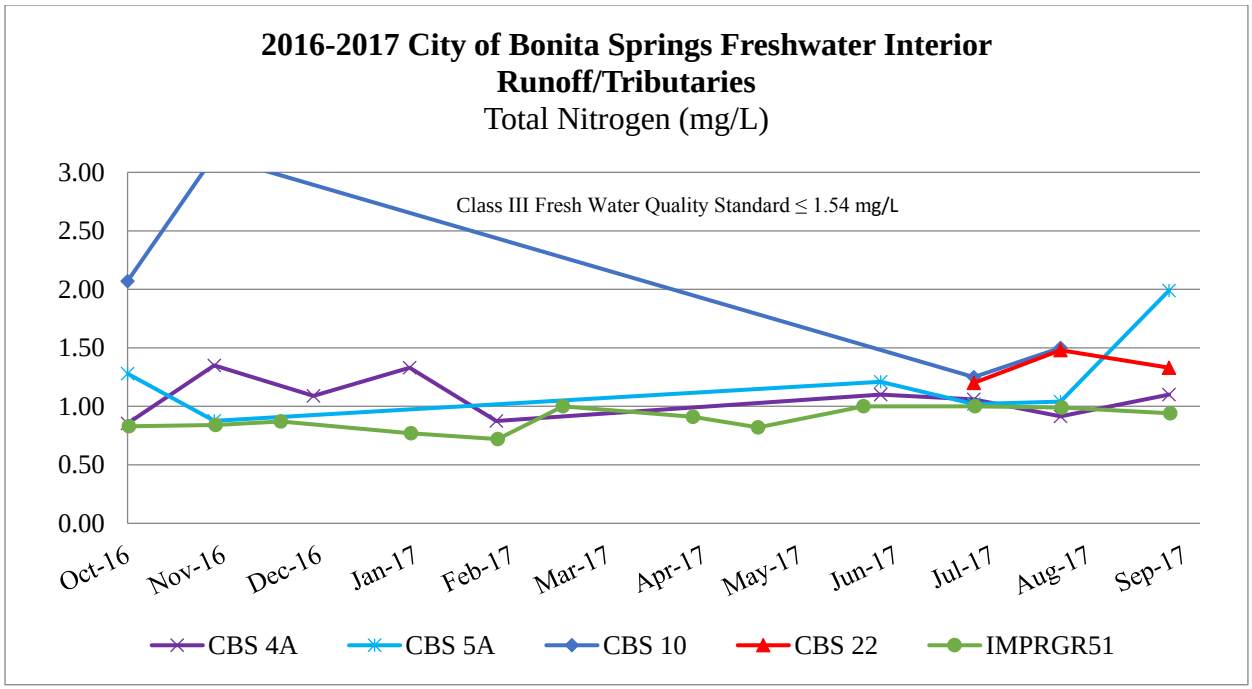
Appendix B: 2016-2017 City of Bonita Springs Freshwater Inflows Charts

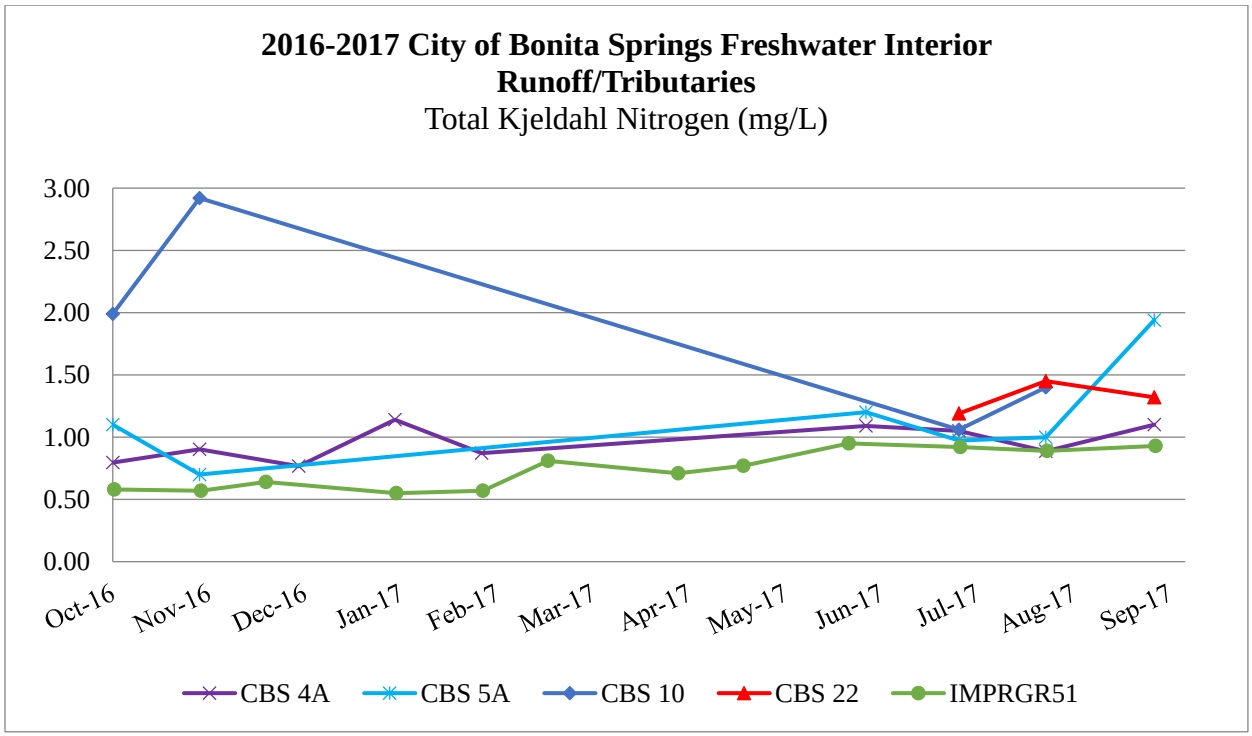


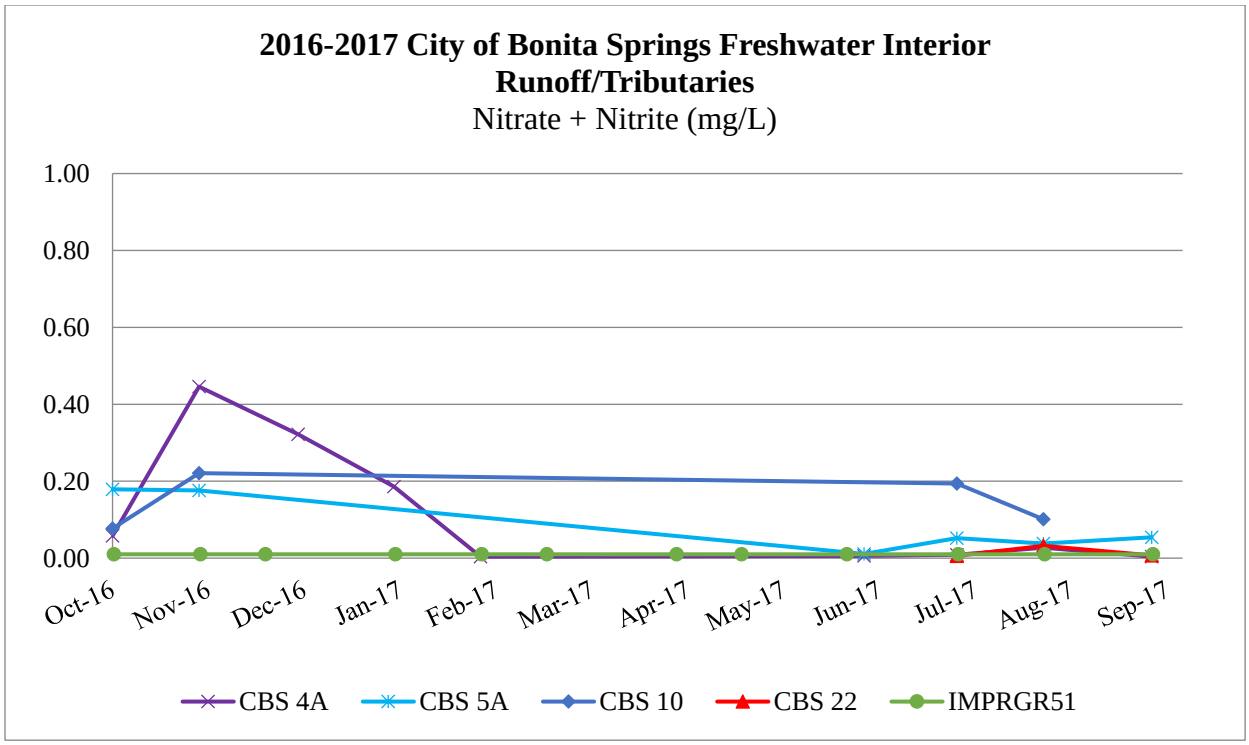


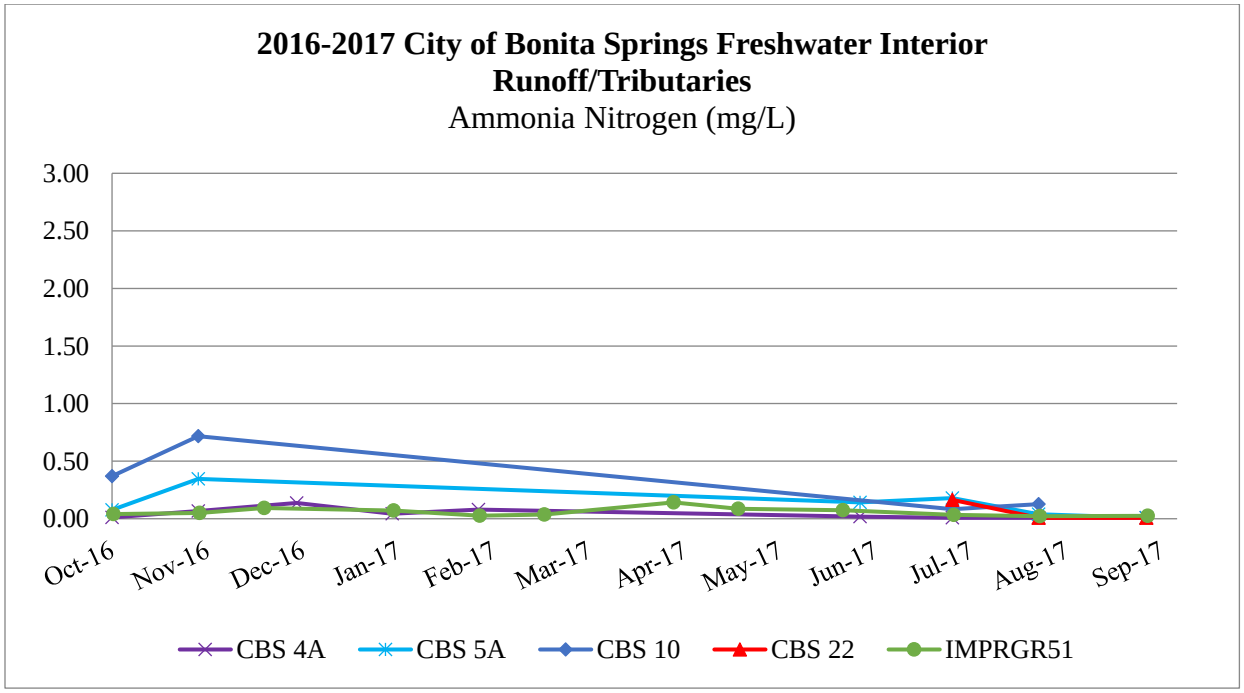
Appendix B: 2016-2017 City of Bonita Springs Freshwater Inflows Charts

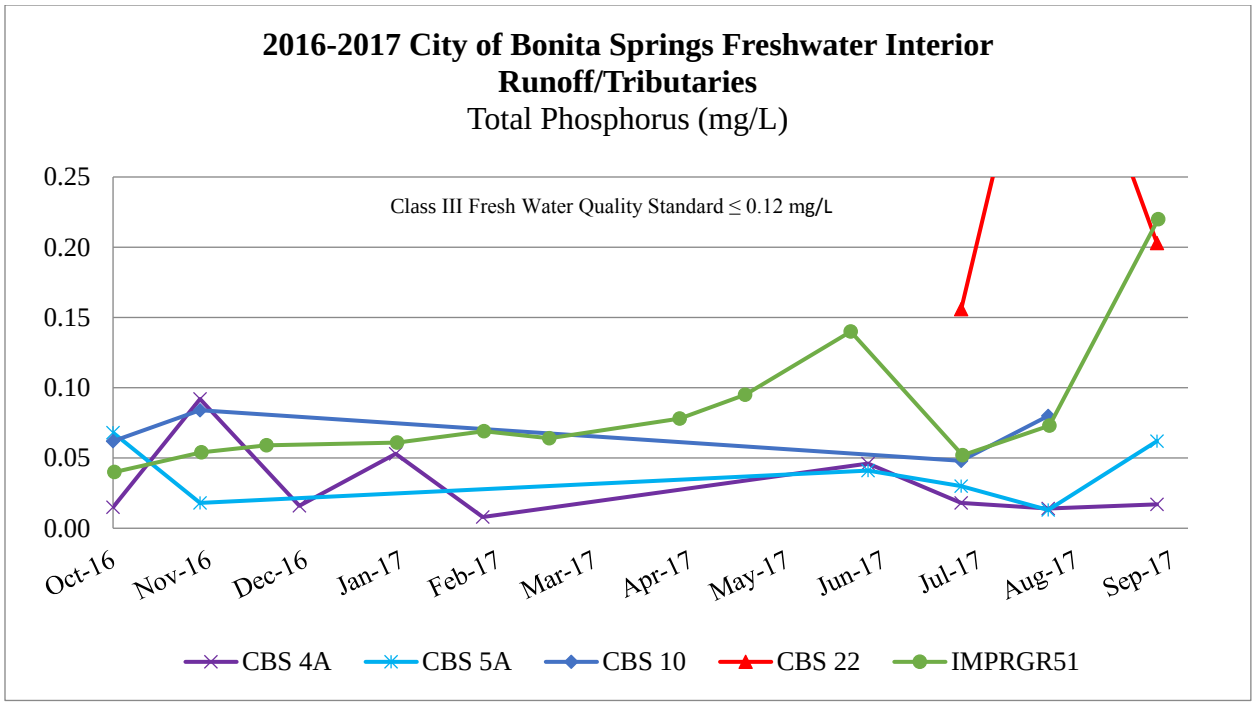


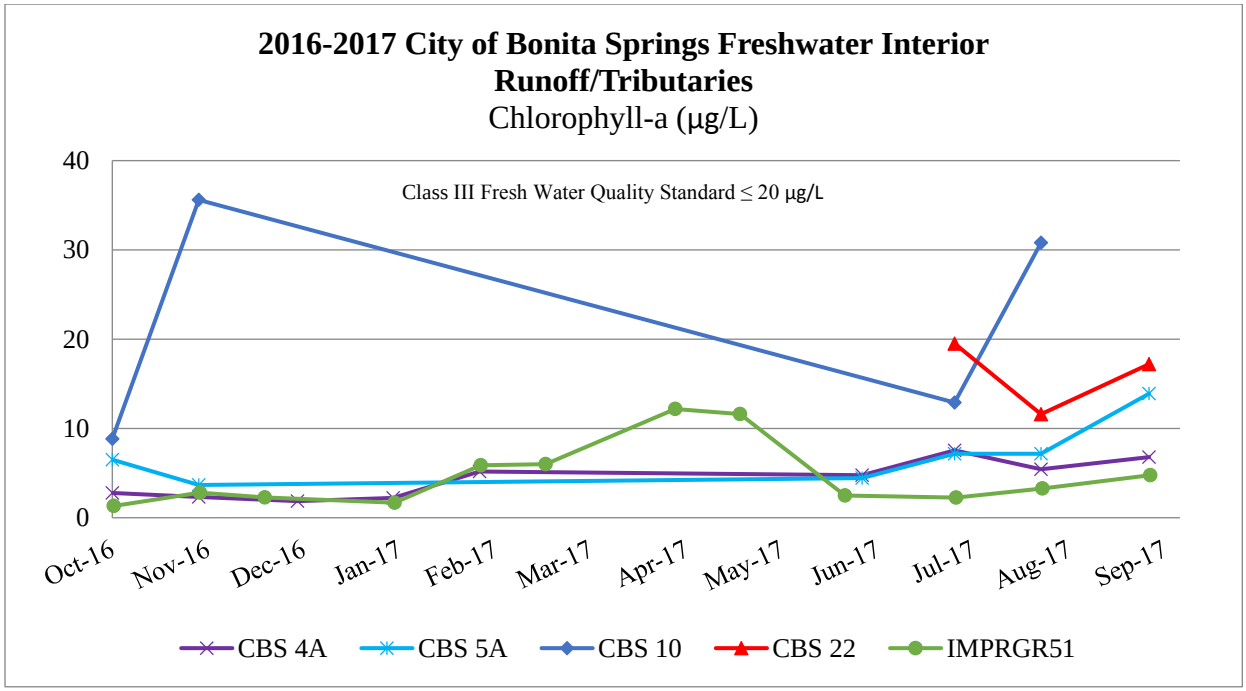

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Total Nitrogen (mg/L)
Class III Fresh Water Quality Standard ≤ 1.54 mg/L
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

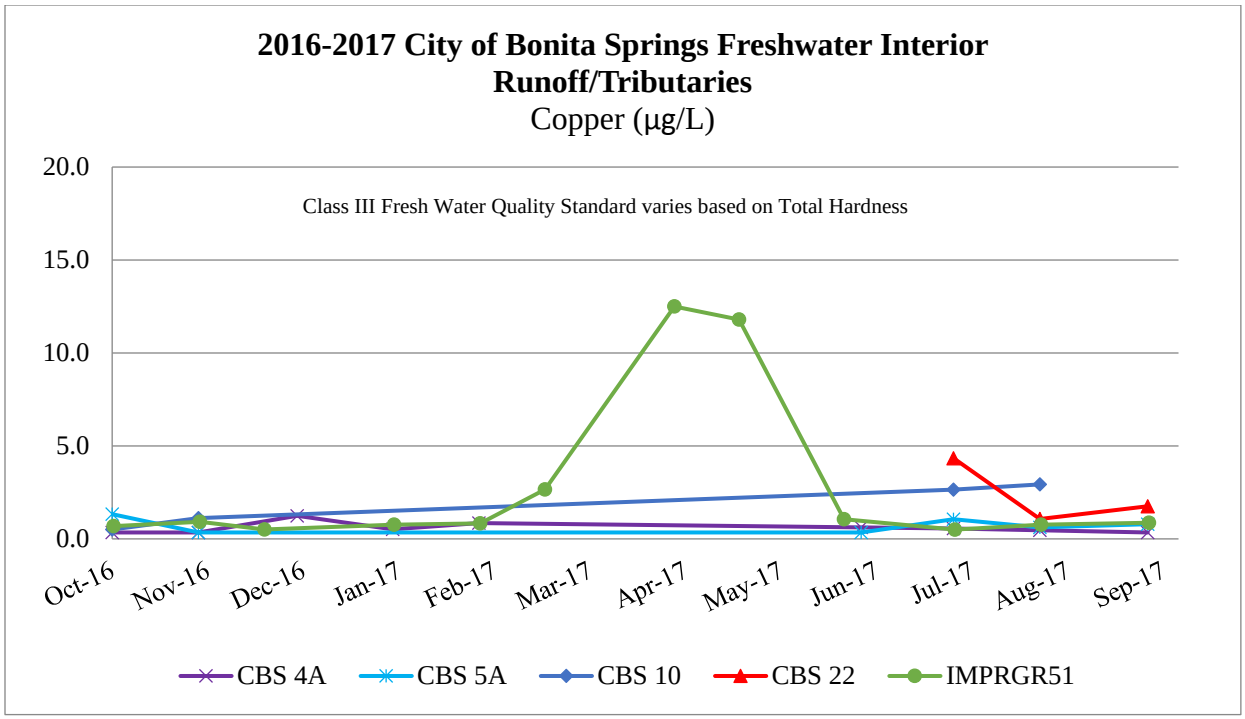

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Total Kjeldahl Nitrogen (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

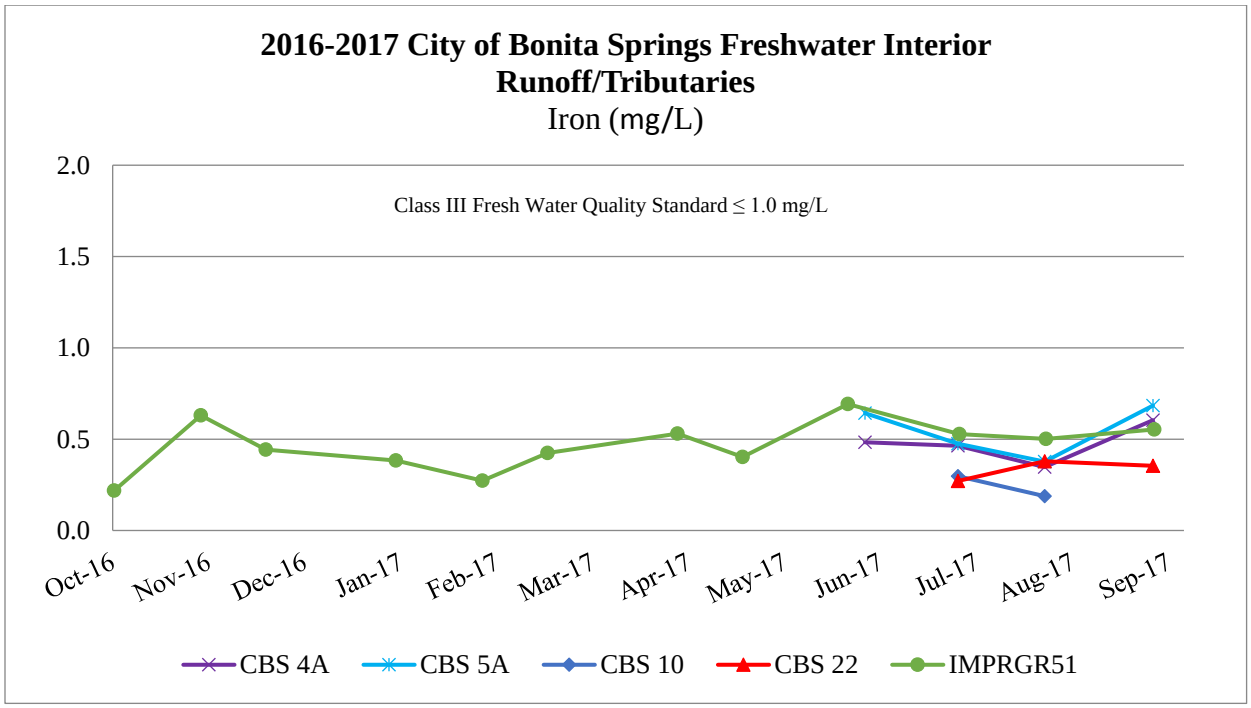

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Nitrate + Nitrite (mg/L)
1.00
0.80
0.60
0.40
0.20
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

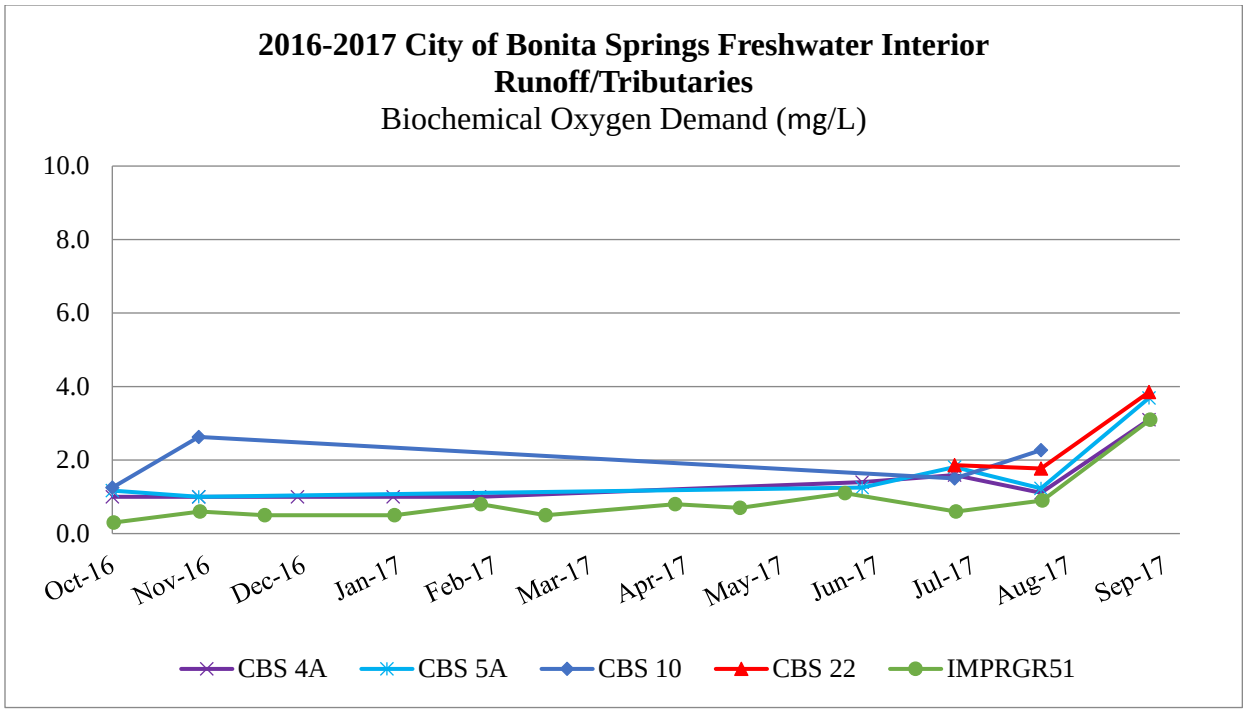

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Ammonia Nitrogen (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

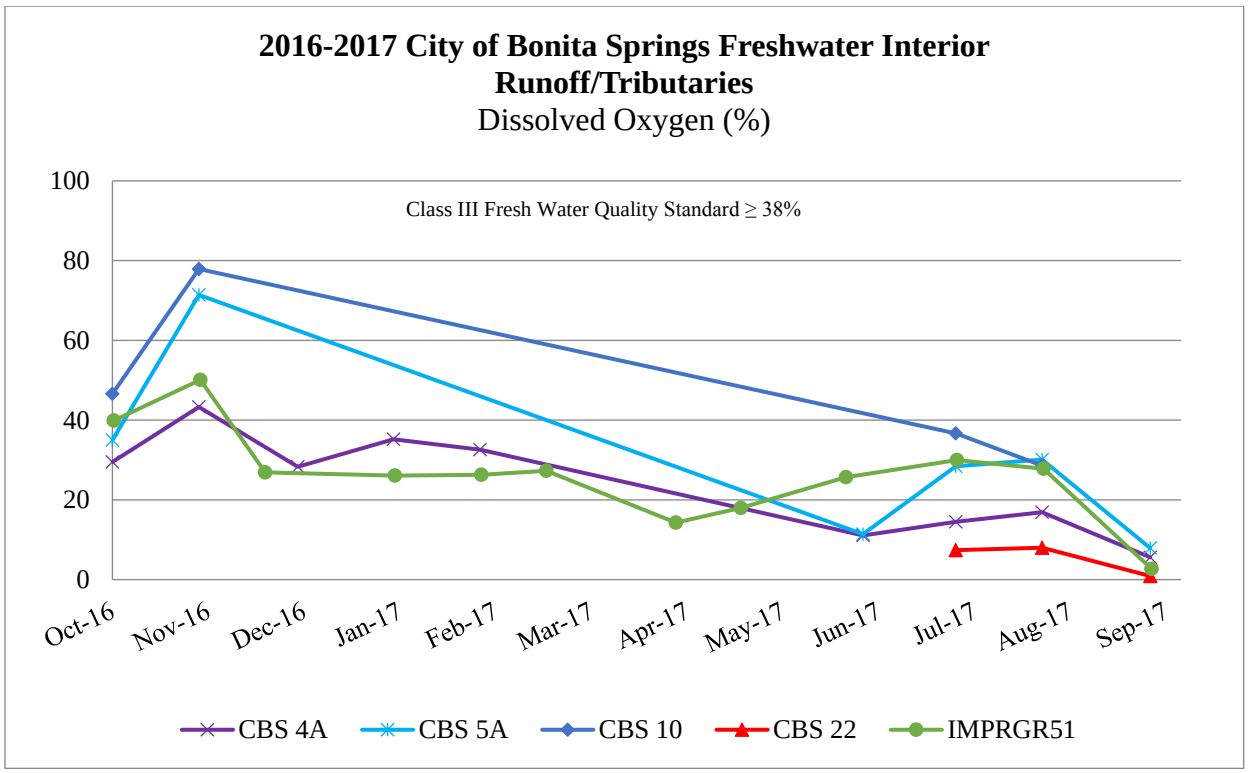

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Total Phosphorus (mg/L)
Class III Fresh Water Quality Standard ≤ 0.12 mg/L
0.25
0.20
0.15
0.10
0.05
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51


2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Chlorophyll-a (µg/L)
Class III Fresh Water Quality Standard ≤ 20 µg/L
40
30
20
10
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

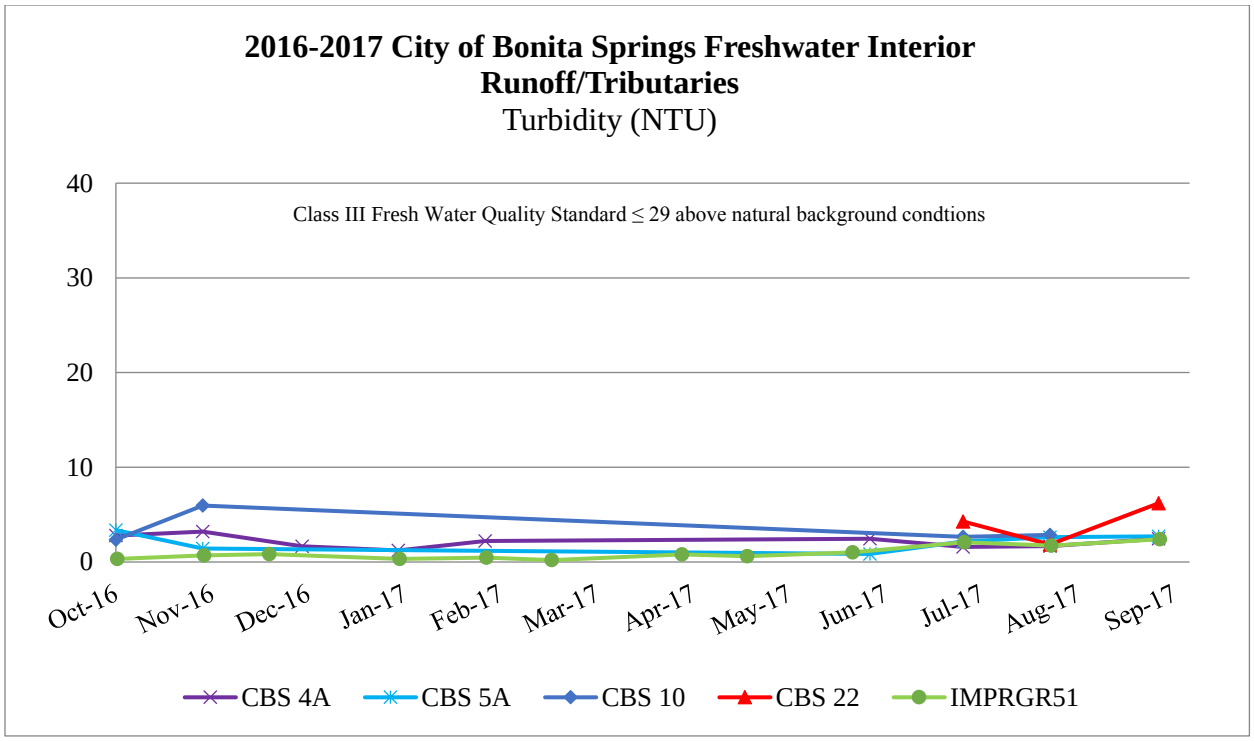

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Copper (µg/L)
Class III Fresh Water Quality Standard varies based on Total Hardness
20.0
15.0
10.0
5.0
0.0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

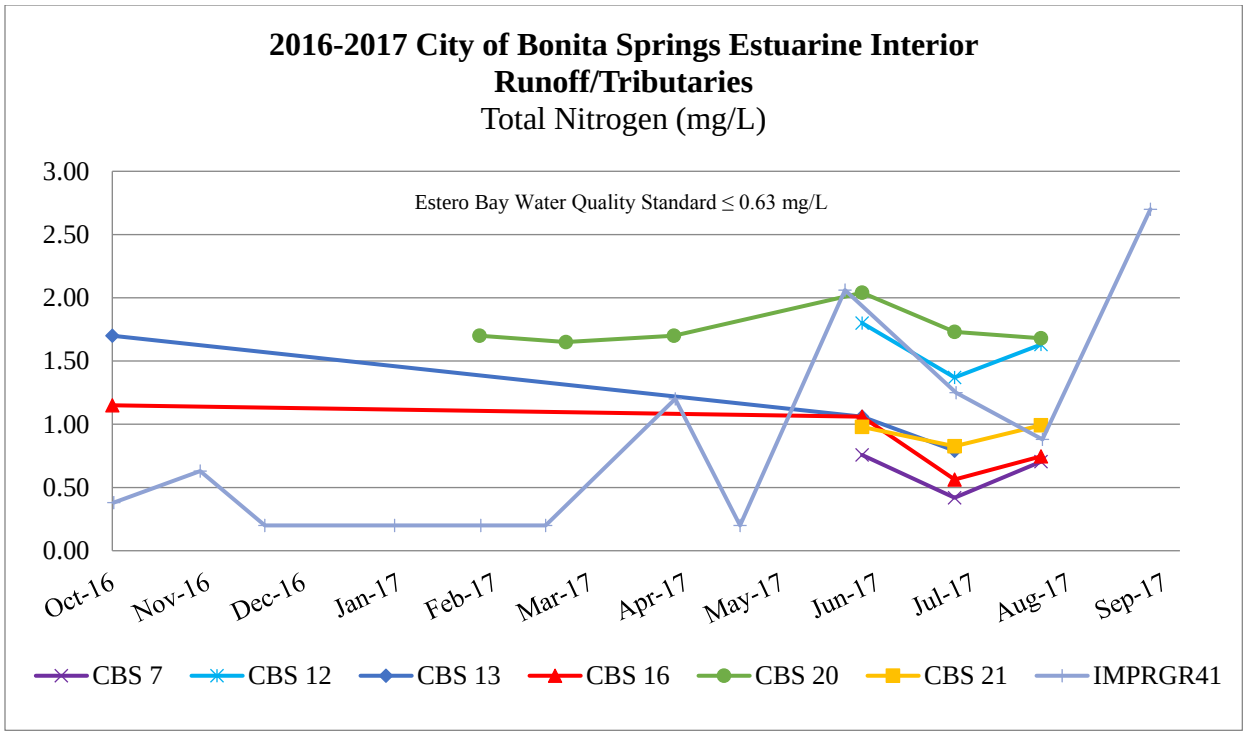

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Iron (mg/L)
Class III Fresh Water Quality Standard ≤ 1.0 mg/L
2.0
1.5
1.0
0.5
0.0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

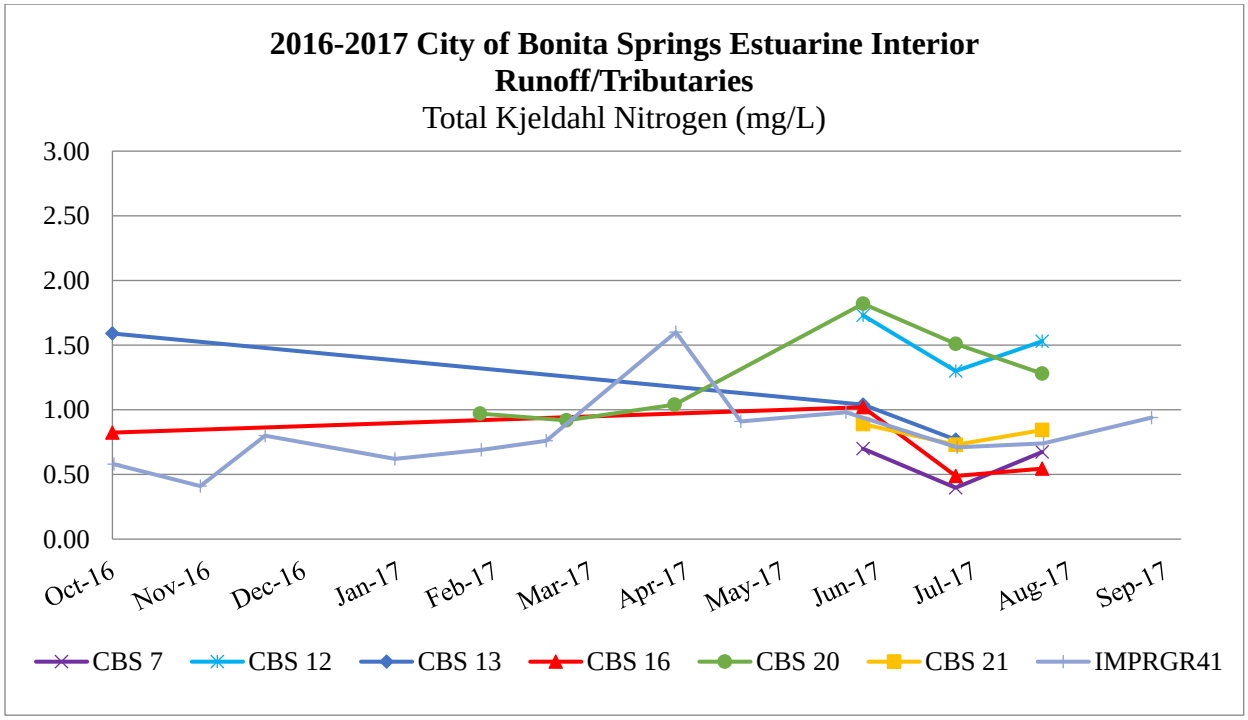

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Biochemical Oxygen Demand (mg/L)
10.0
8.0
6.0
4.0
2.0
0.0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

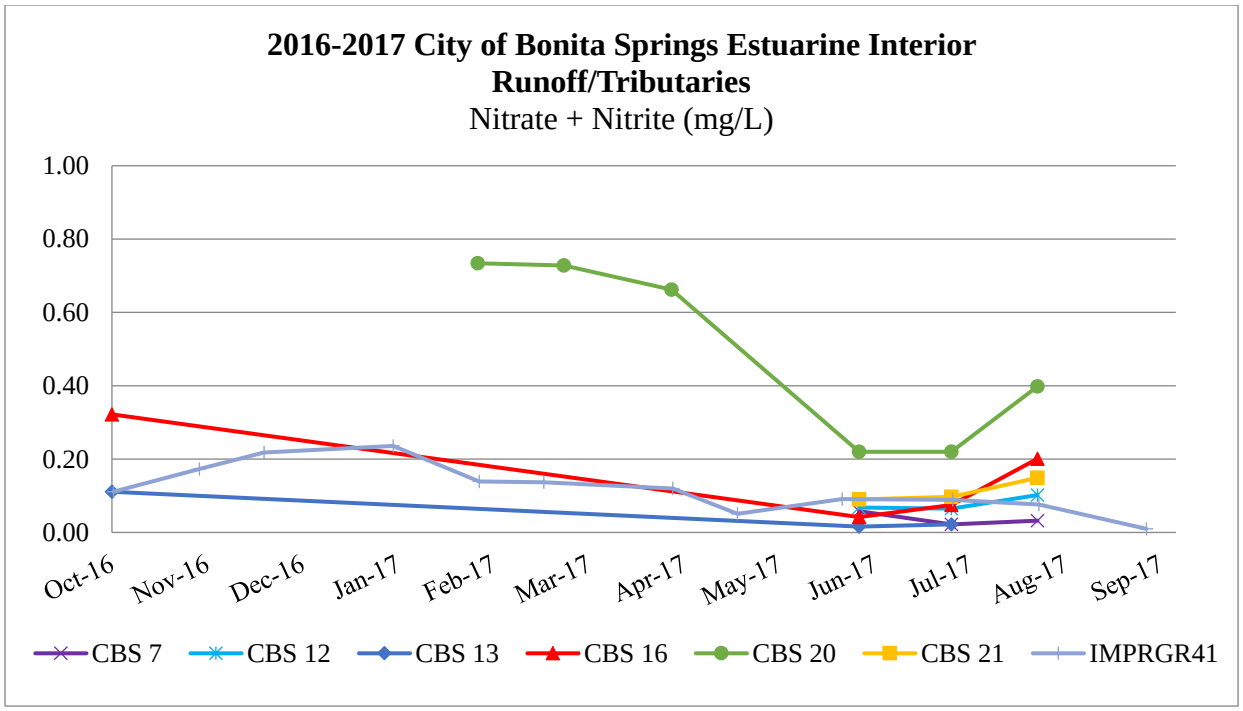

2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries
Dissolved Oxygen (%)
100
80
60
40
20
0
Class III Fresh Water Quality Standard ≥ 38%
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 4A
CBS 5A
CBS 10
CBS 22
IMPRGR51

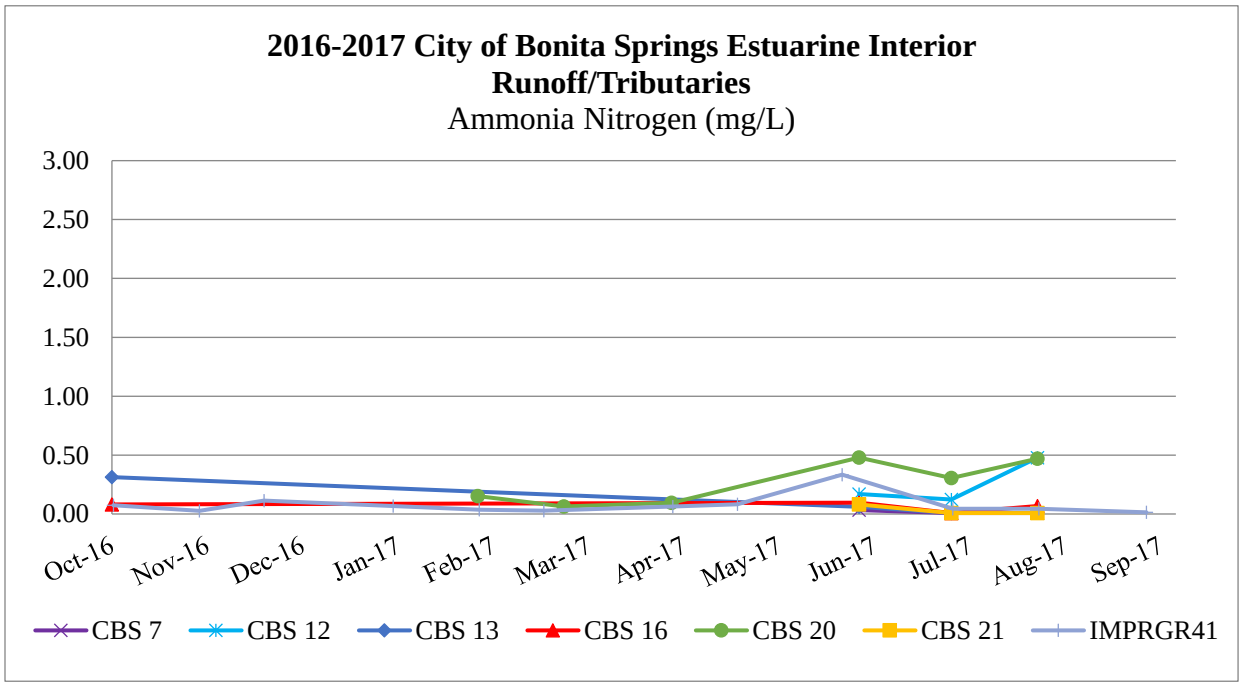
Appendix B: 2016-2017 City of Bonita Springs Freshwater Interior Runoff/Tributaries

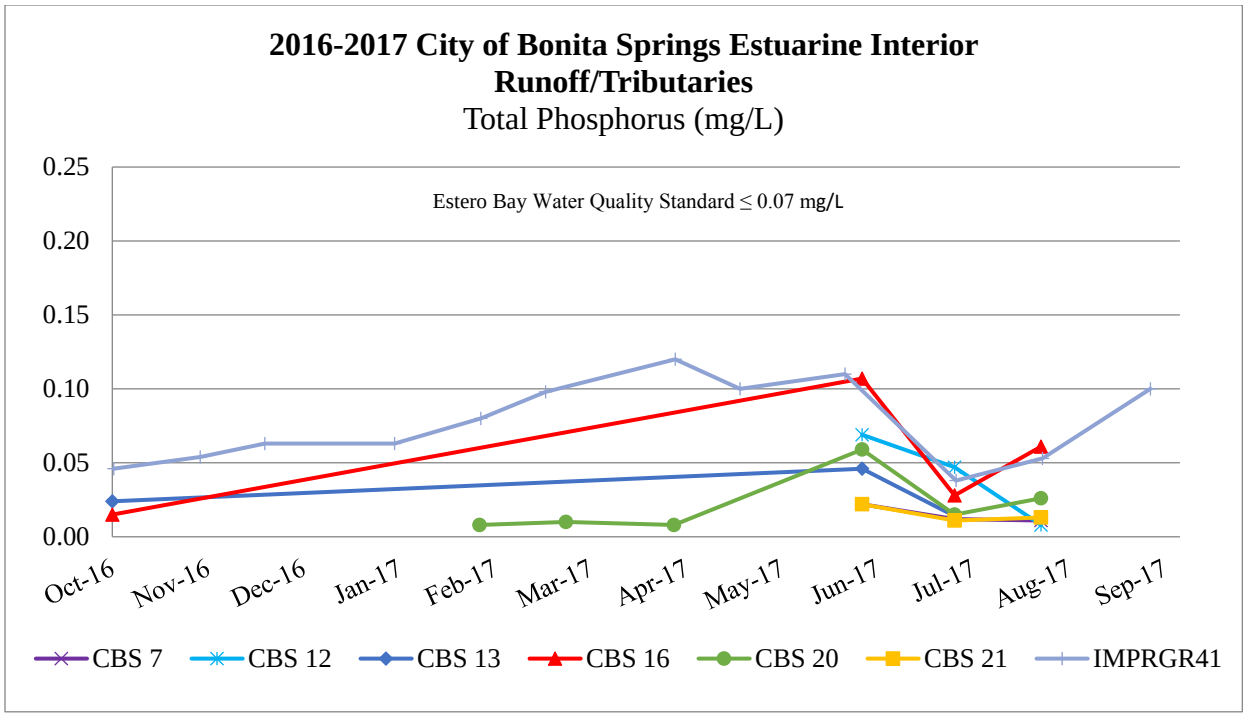


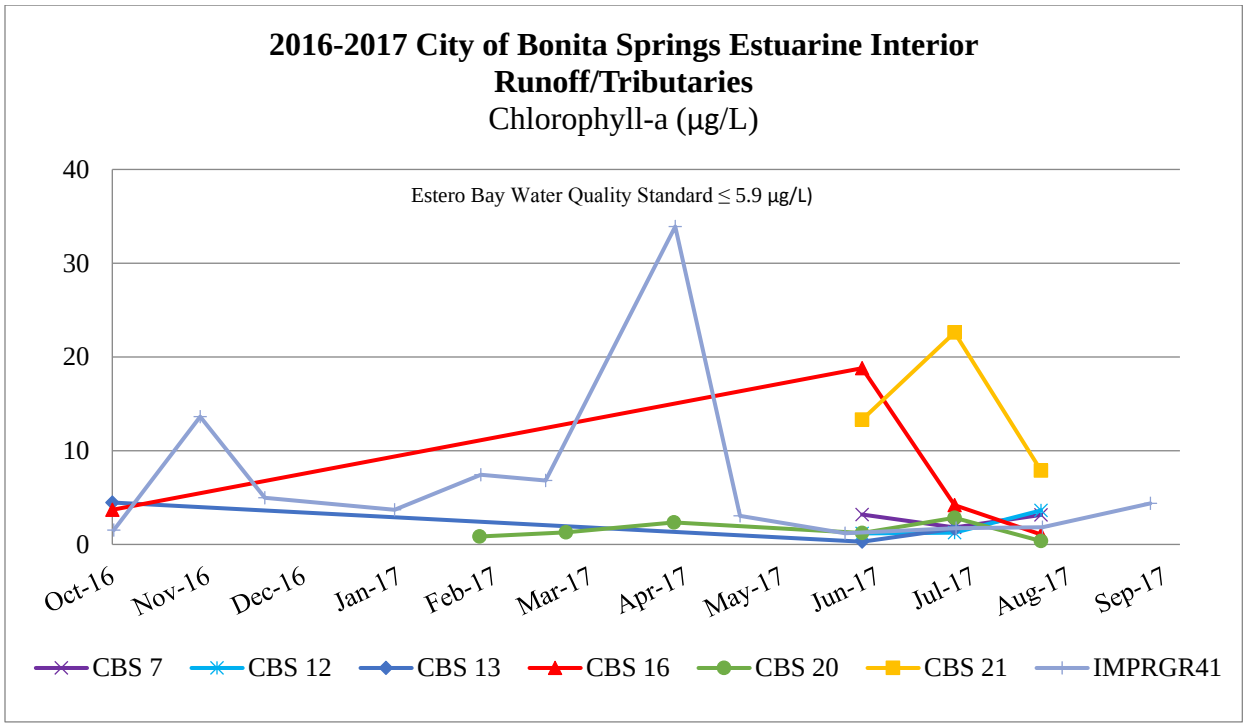

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Total Nitrogen (mg/L)
Estero Bay Water Quality Standard ≤ 0.63 mg/L
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

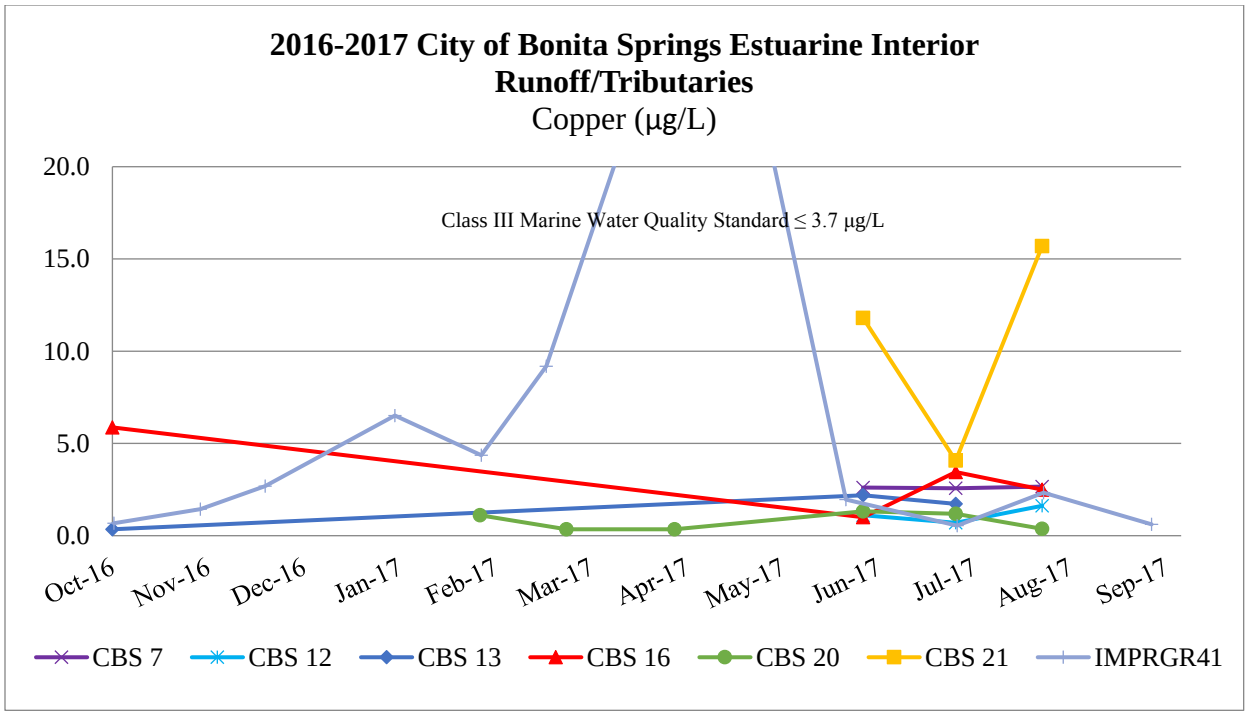

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Total Kjeldahl Nitrogen (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

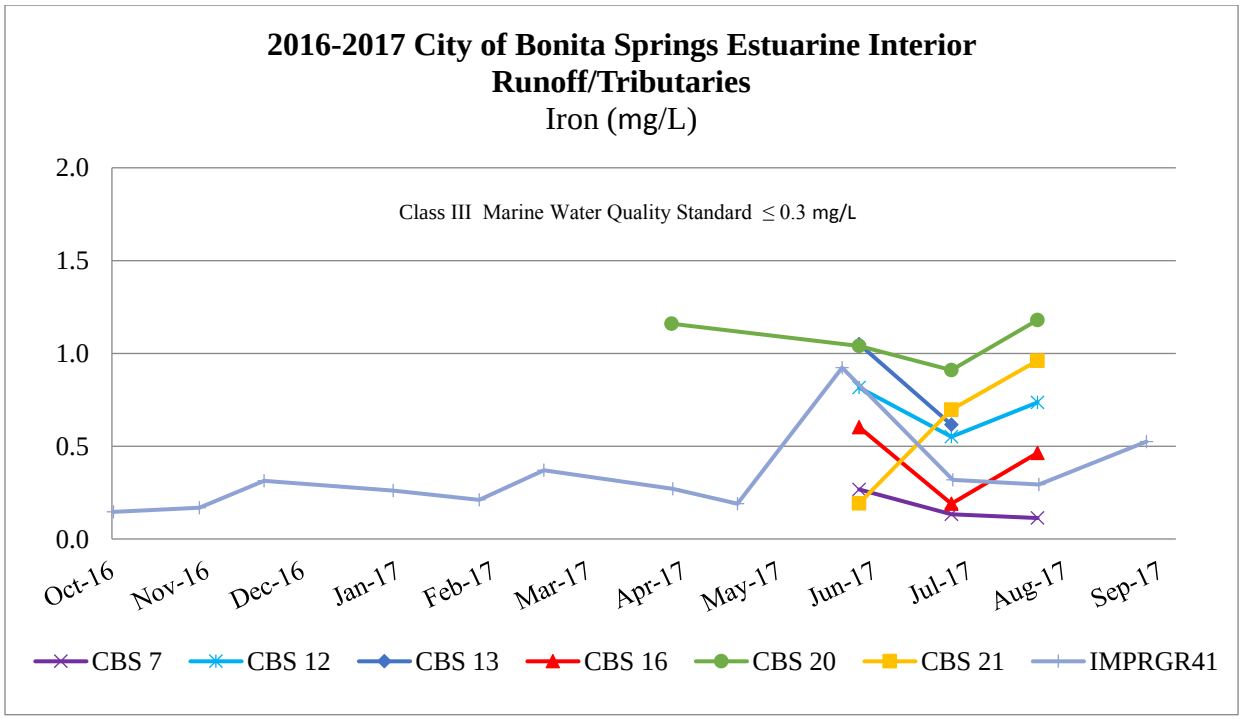

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Nitrate + Nitrite (mg/L)
1.00
0.80
0.60
0.40
0.20
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

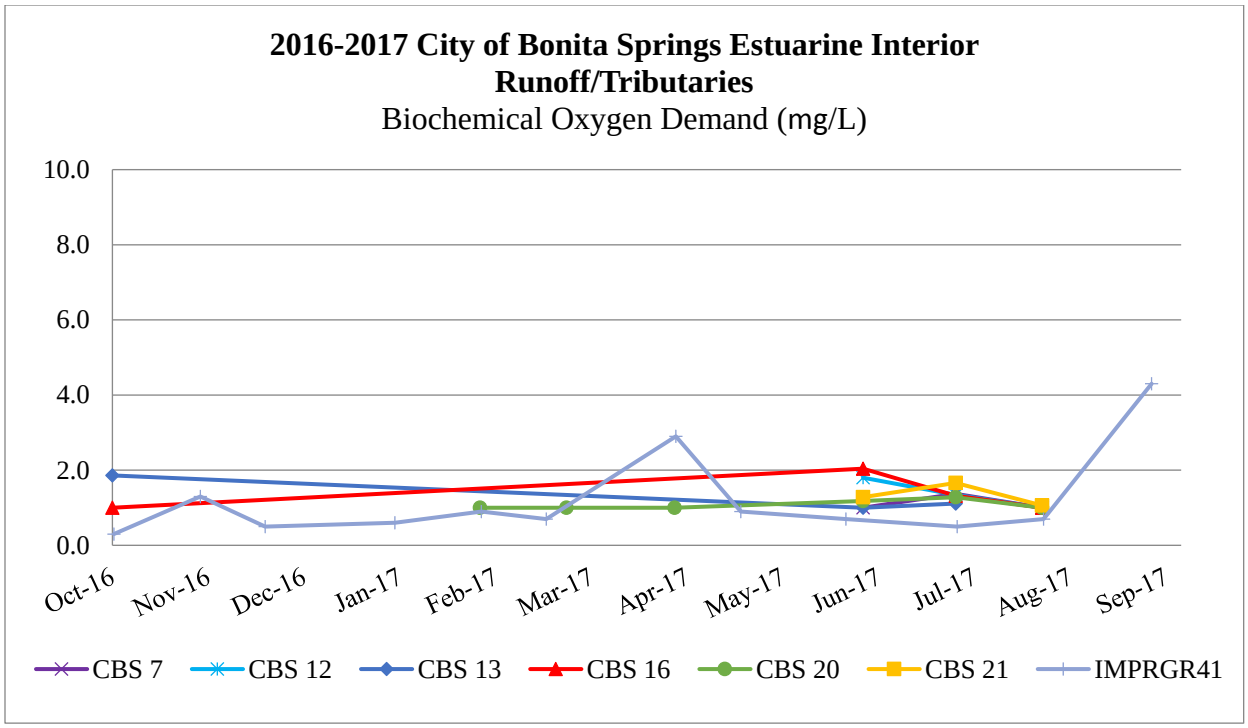

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Ammonia Nitrogen (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

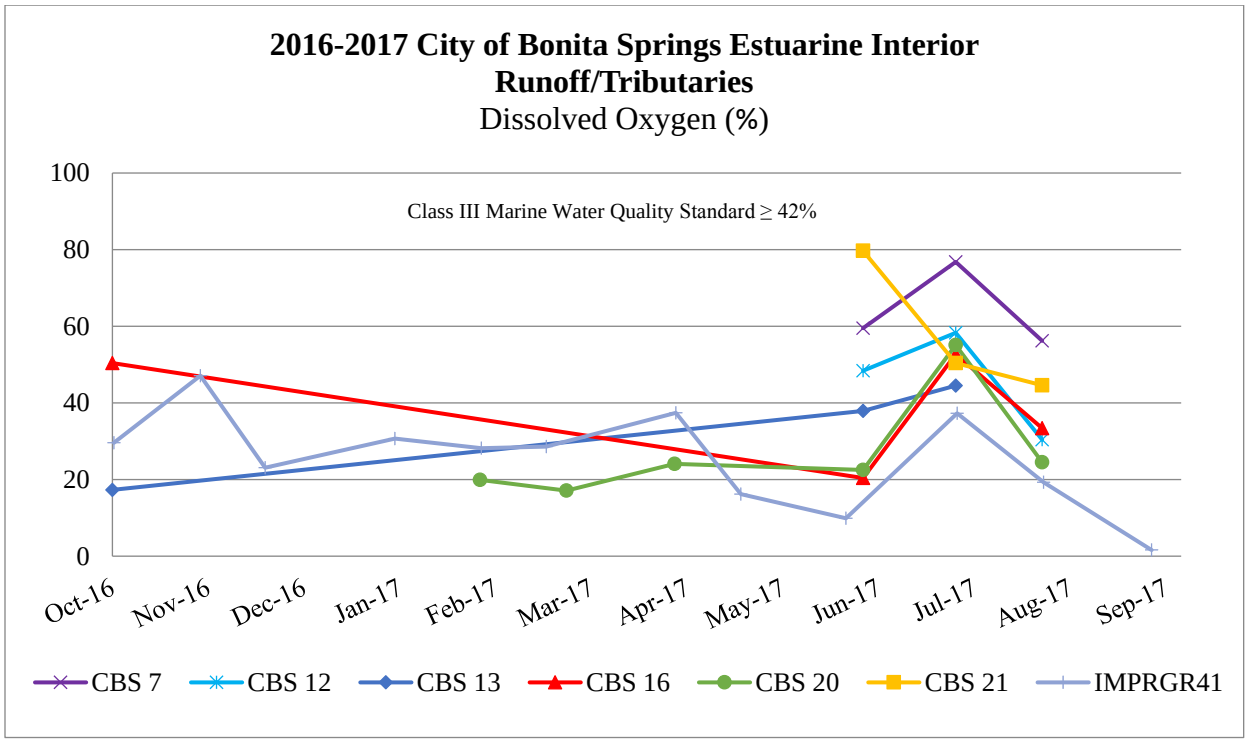

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Total Phosphorus (mg/L)
Estero Bay Water Quality Standard ≤ 0.07 mg/L
0.25
0.20
0.15
0.10
0.05
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41


2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Chlorophyll-a (µg/L)
Estero Bay Water Quality Standard ≤ 5.9 µg/L)
40
30
20
10
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

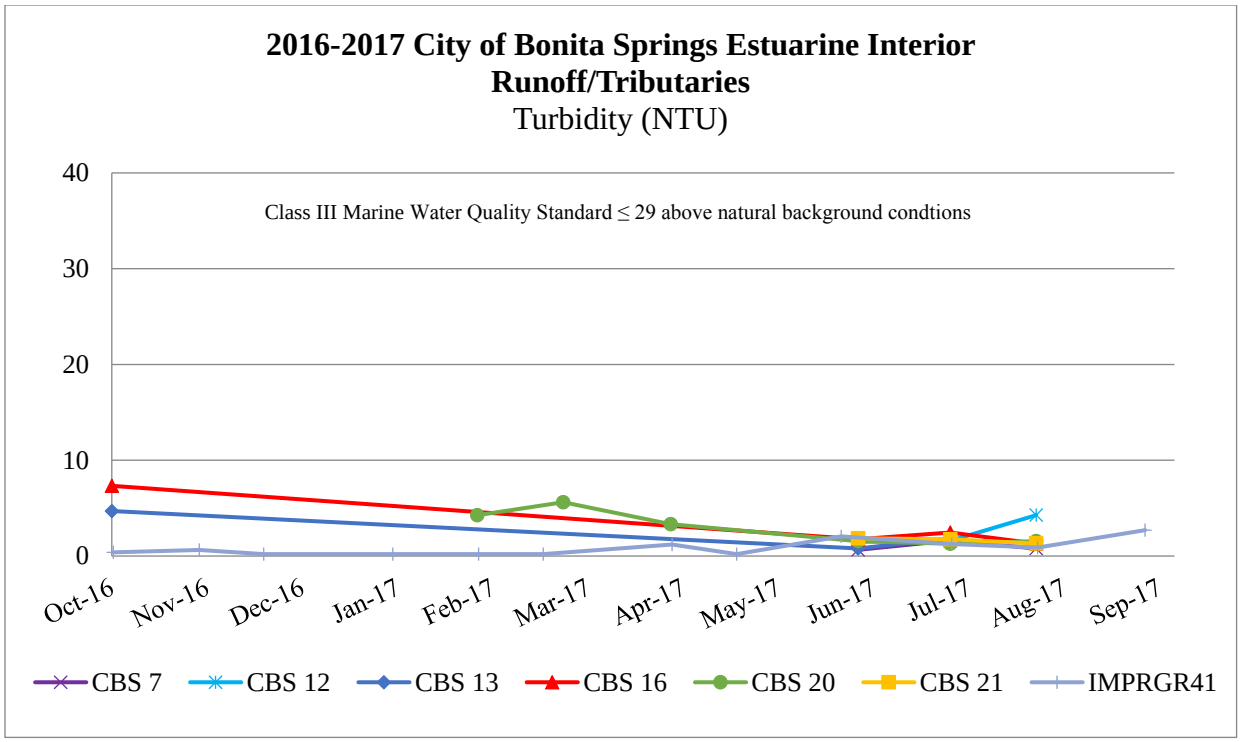

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Copper (µg/L)
Class III Marine Water Quality Standard ≤ 3.7 µg/L
20.0
15.0
10.0
5.0
0.0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41


2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Iron (mg/L)
Class III Marine Water Quality Standard ≤ 0.3 mg/L
2.0
1.5
1.0
0.5
0.0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

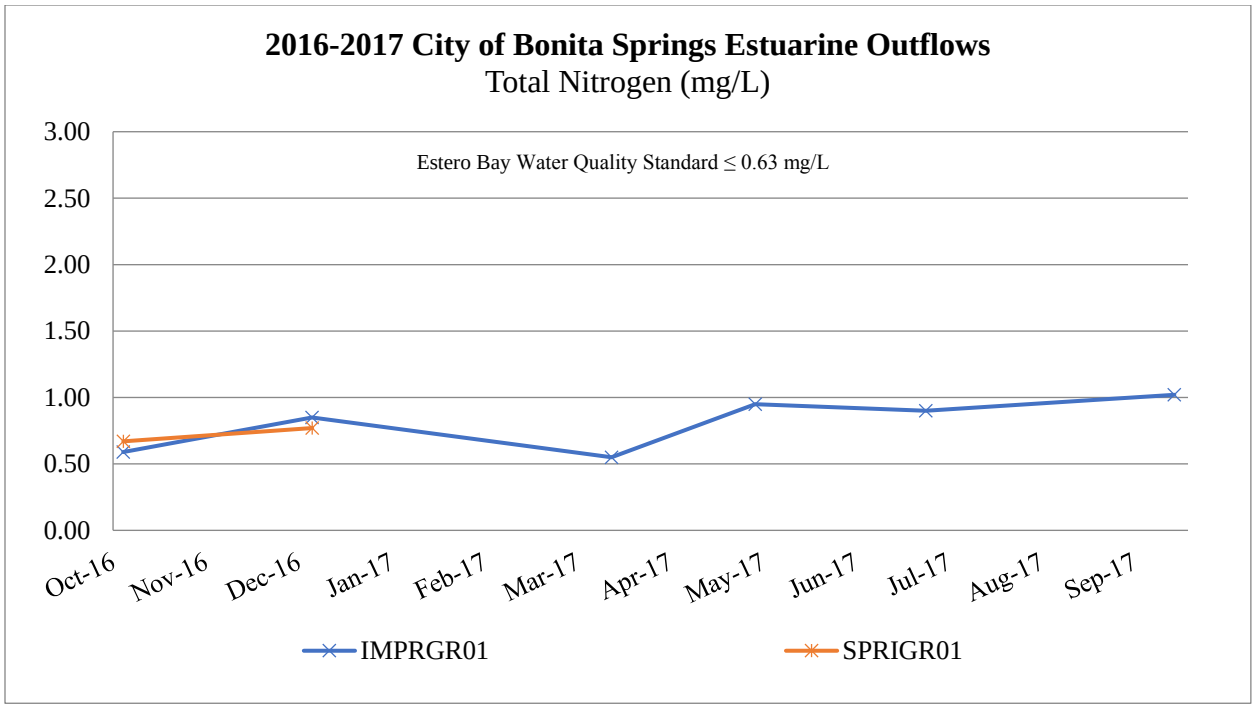

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Biochemical Oxygen Demand (mg/L)
10.0
8.0
6.0
4.0
2.0
0.0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

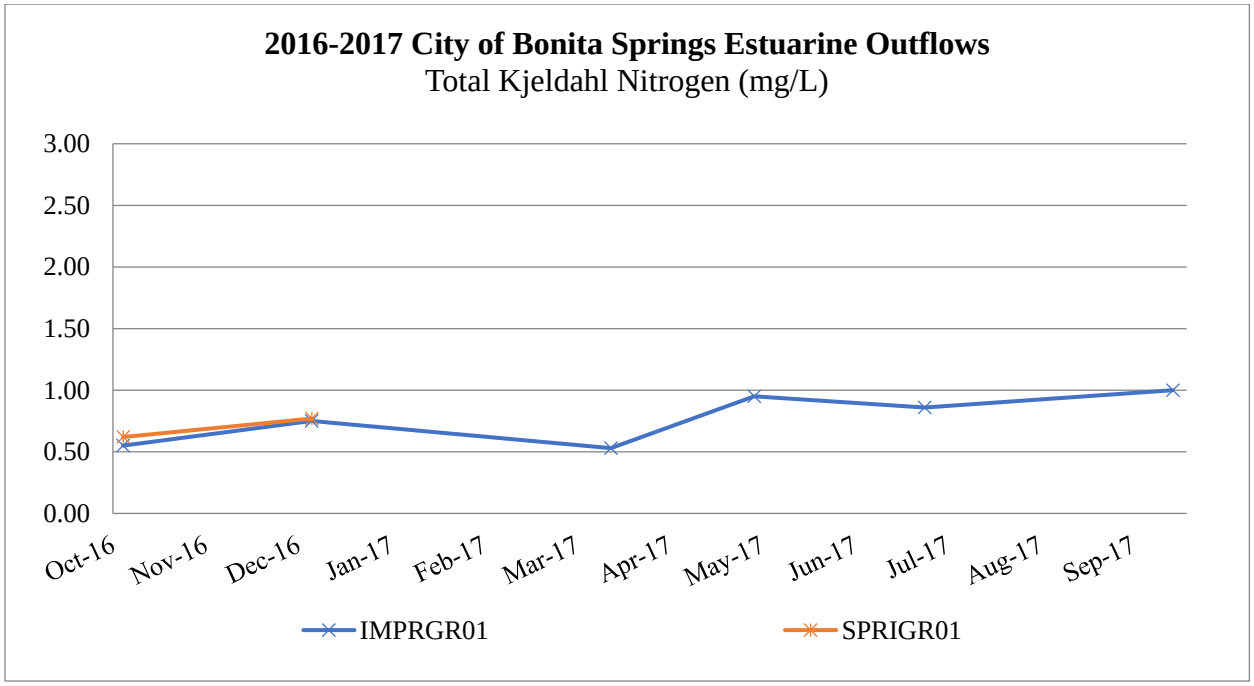

2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries
Dissolved Oxygen (%)
Class III Marine Water Quality Standard ≥ 42%
100
80
60
40
20
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
CBS 7
CBS 12
CBS 13
CBS 16
CBS 20
CBS 21
IMPRGR41

Appendix B: 2016-2017 City of Bonita Springs Estuarine Interior Runoff/Tributaries

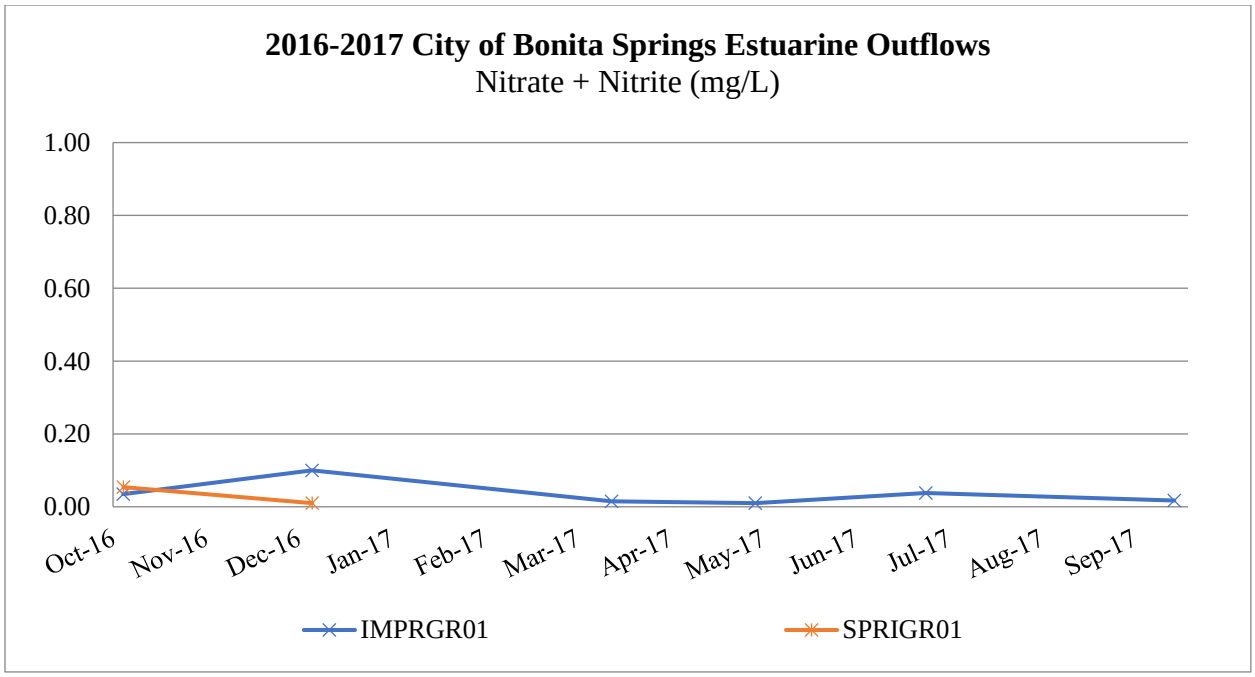


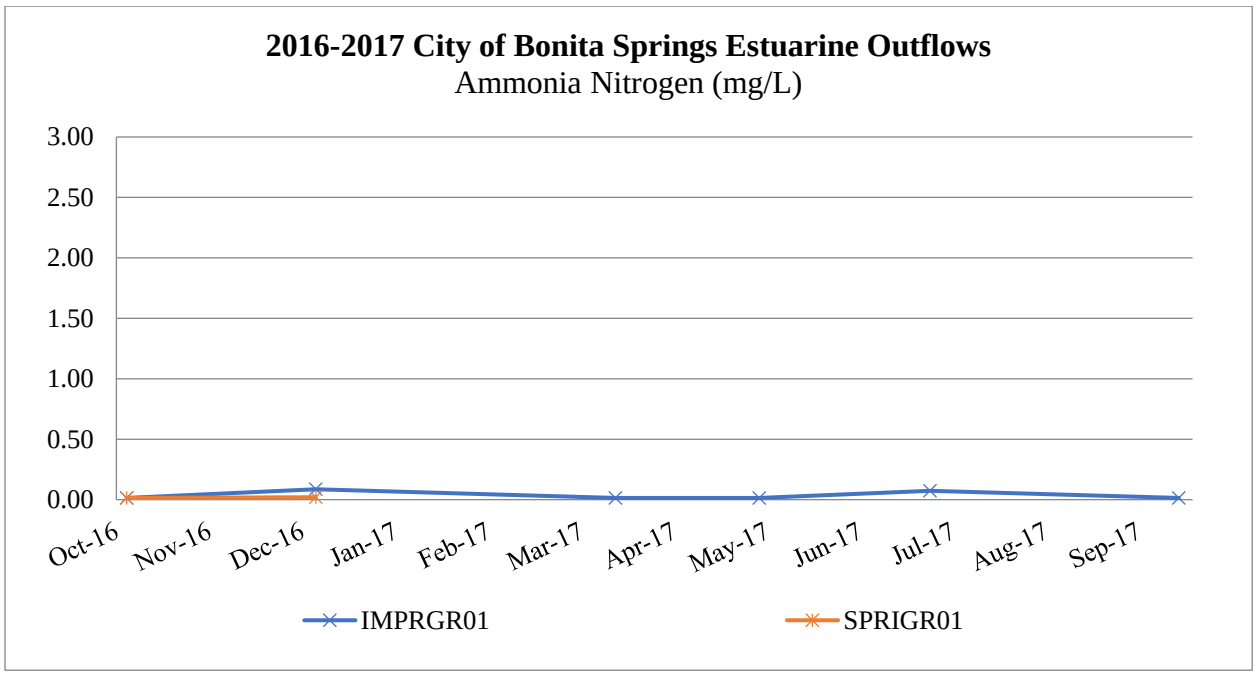
Appendix B: 2016-2017 City of Bonita Springs Estuarine Outflows



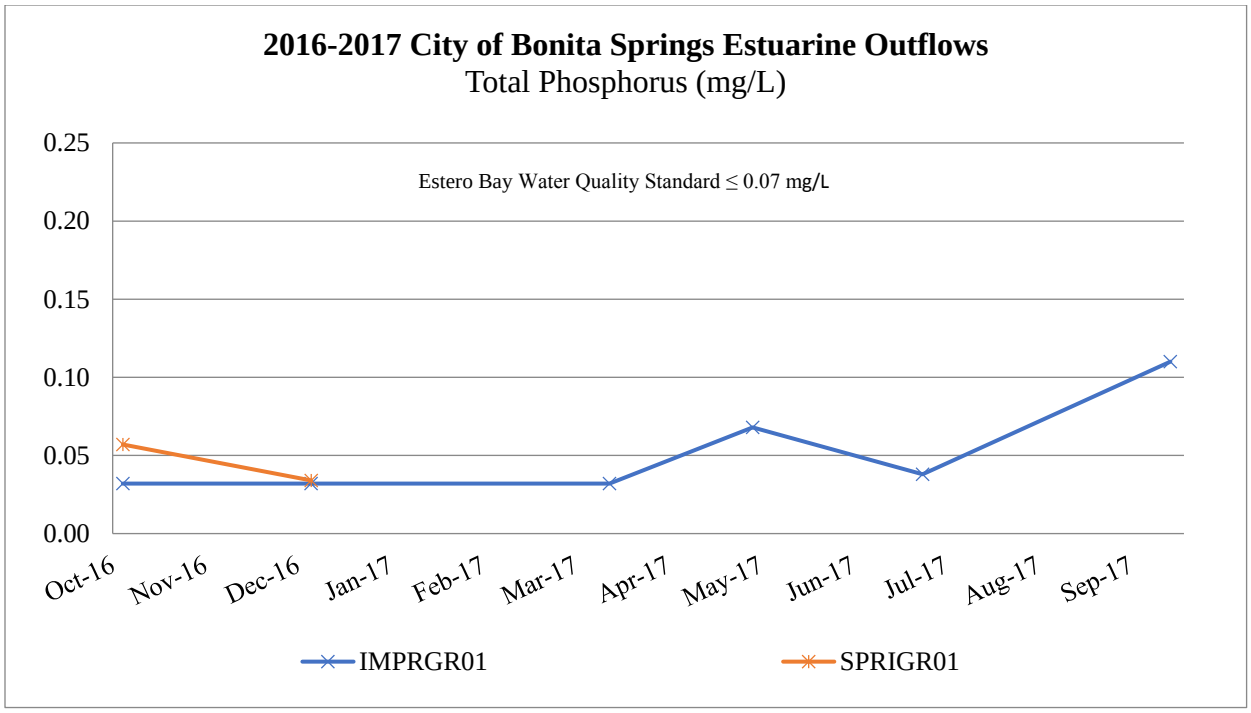


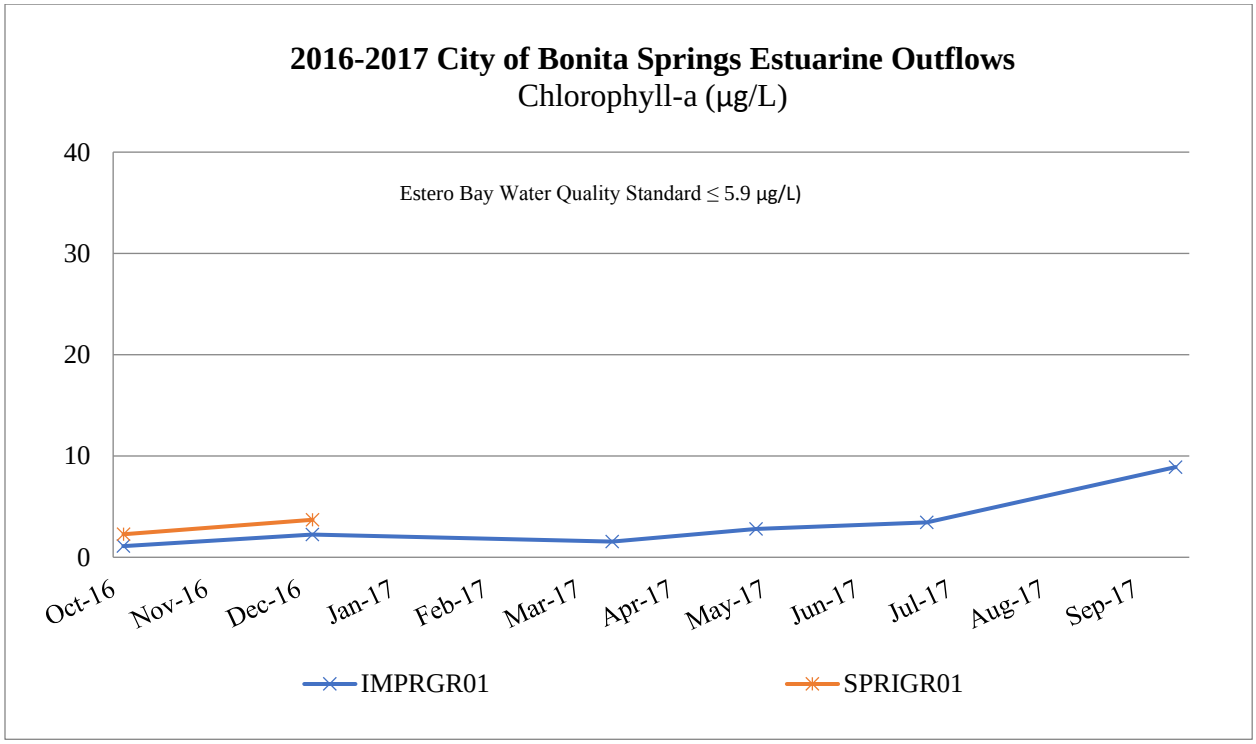
Appendix B: 2016-2017 City of Bonita Springs Estuarine Outflows



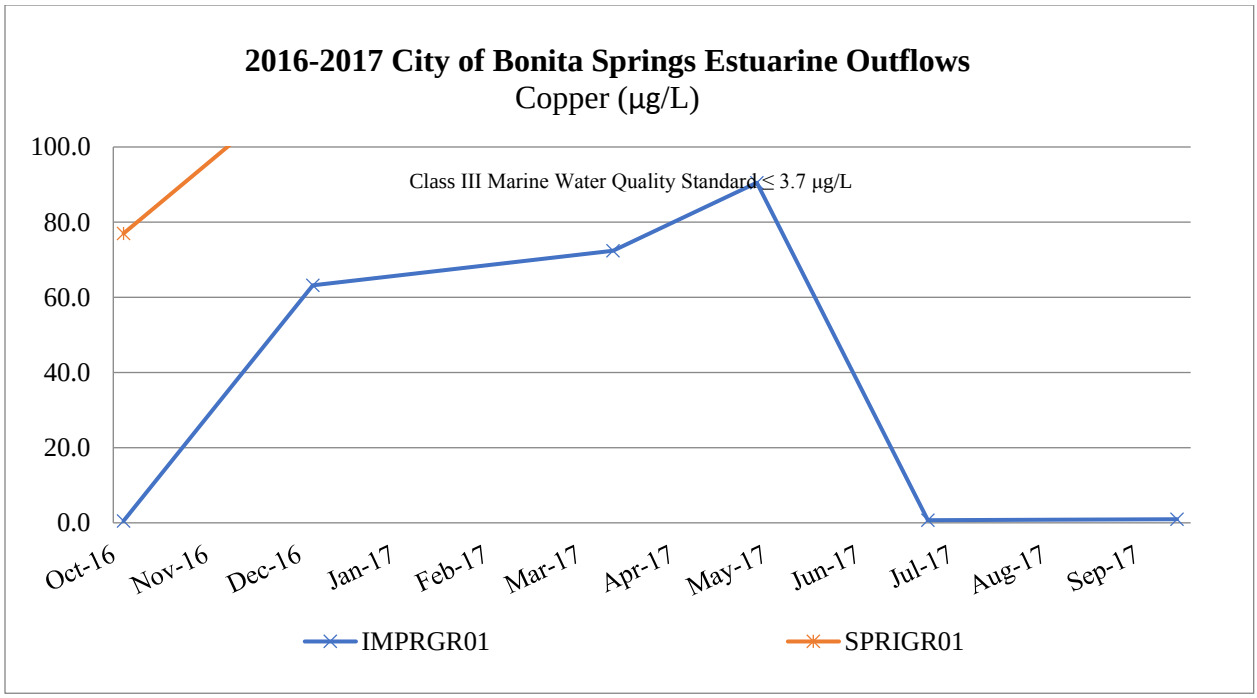


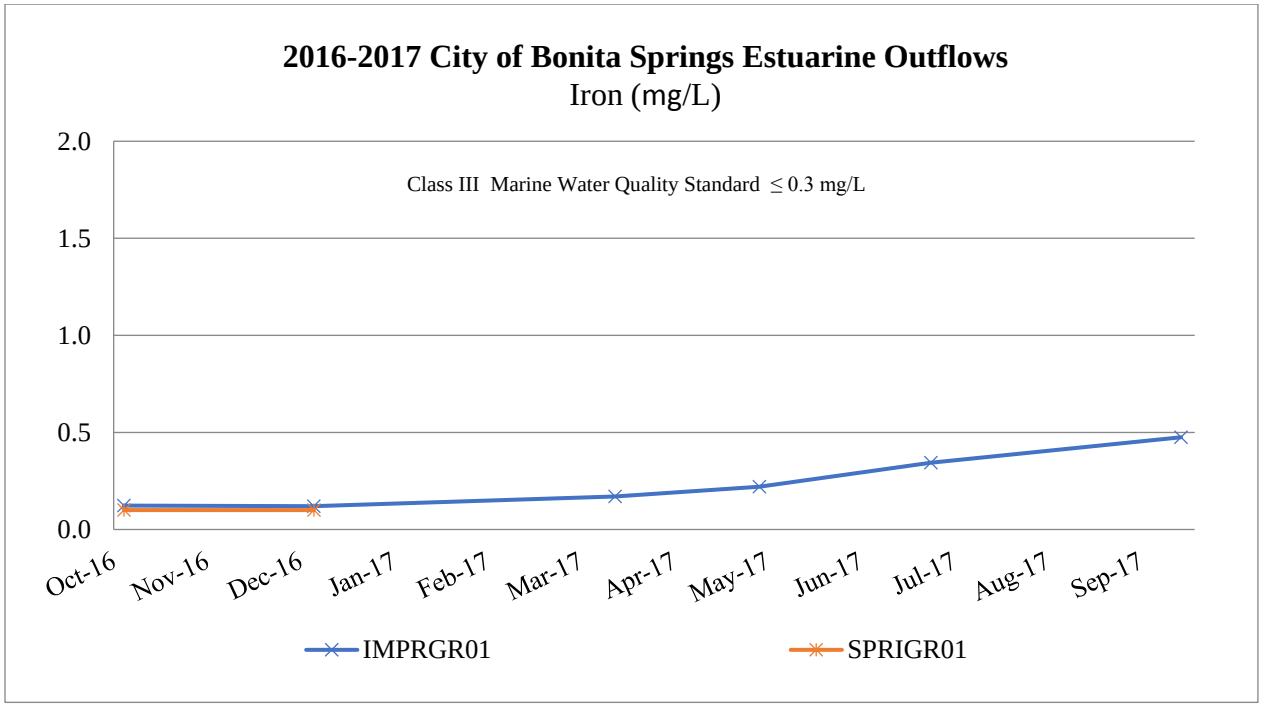
Appendix B: 2016-2017 City of Bonita Springs Estuarine Outflows



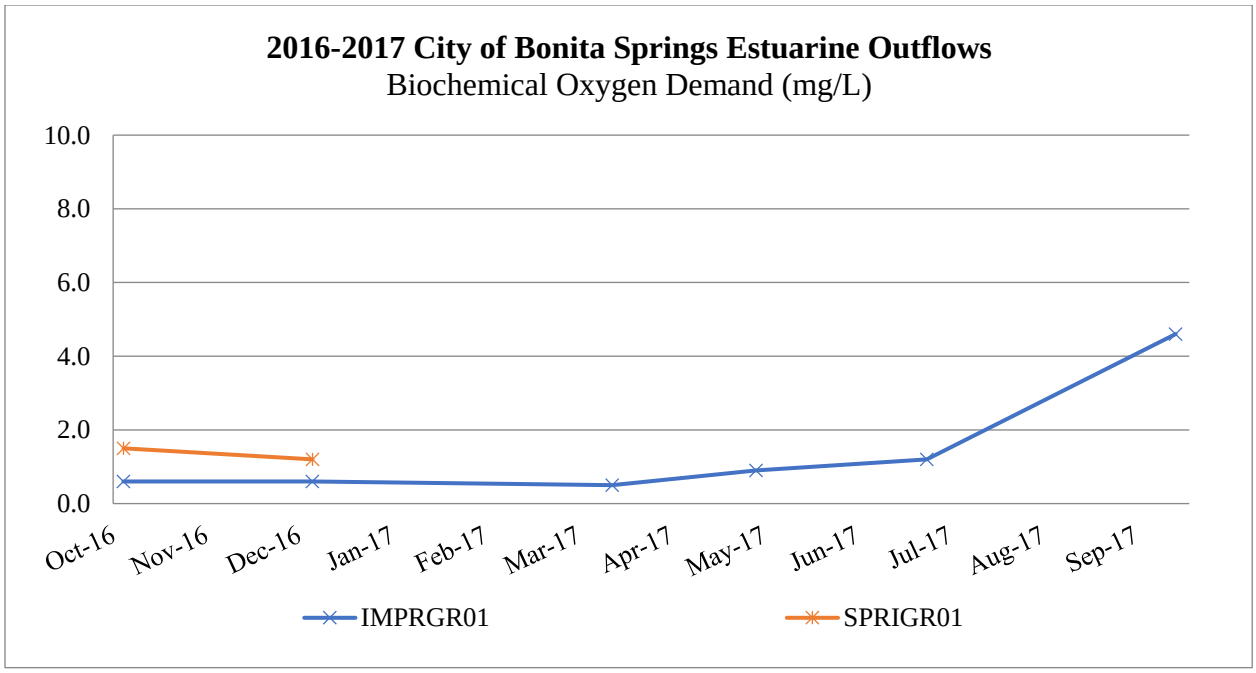


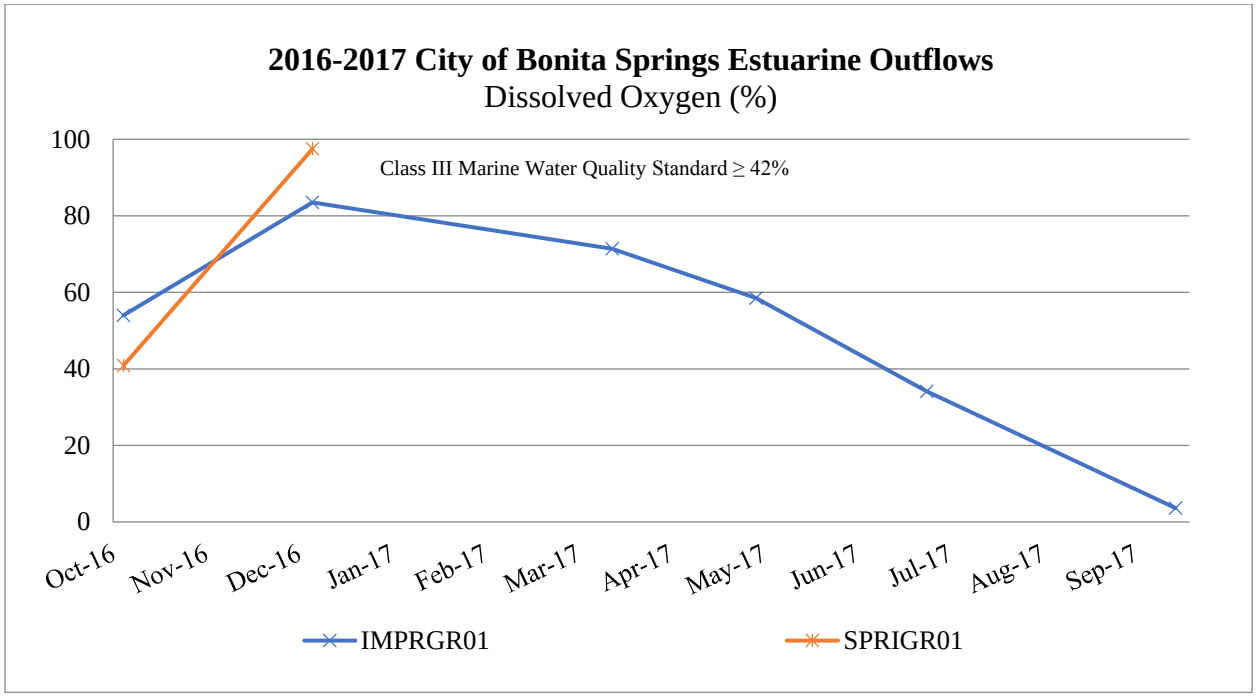
Appendix B: 2016-2017 City of Bonita Springs Estuarine Outflows



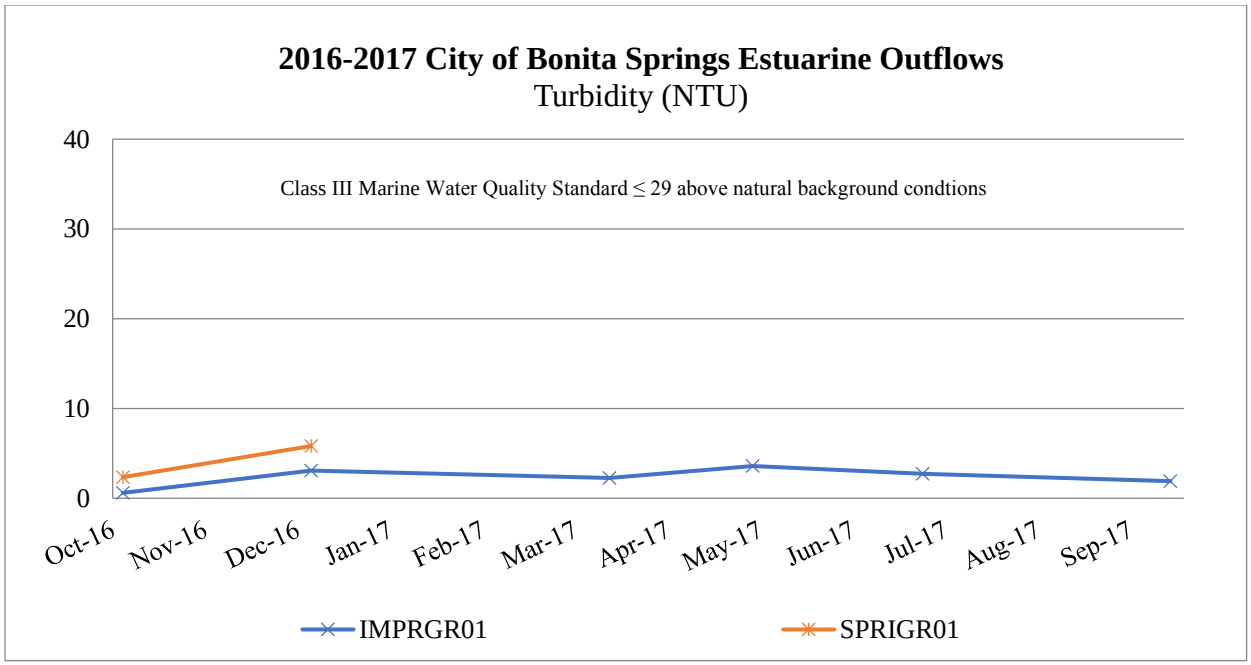


Appendix B: 2016-2017 City of Bonita Springs Estuarine Outflows

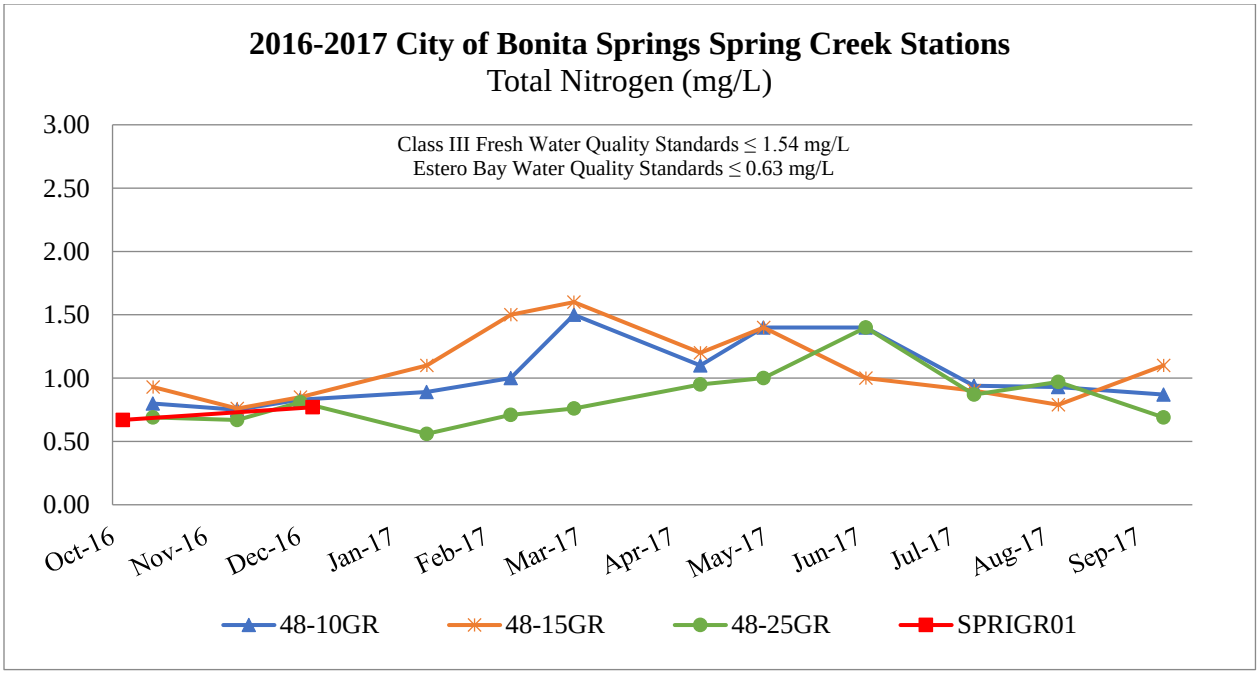


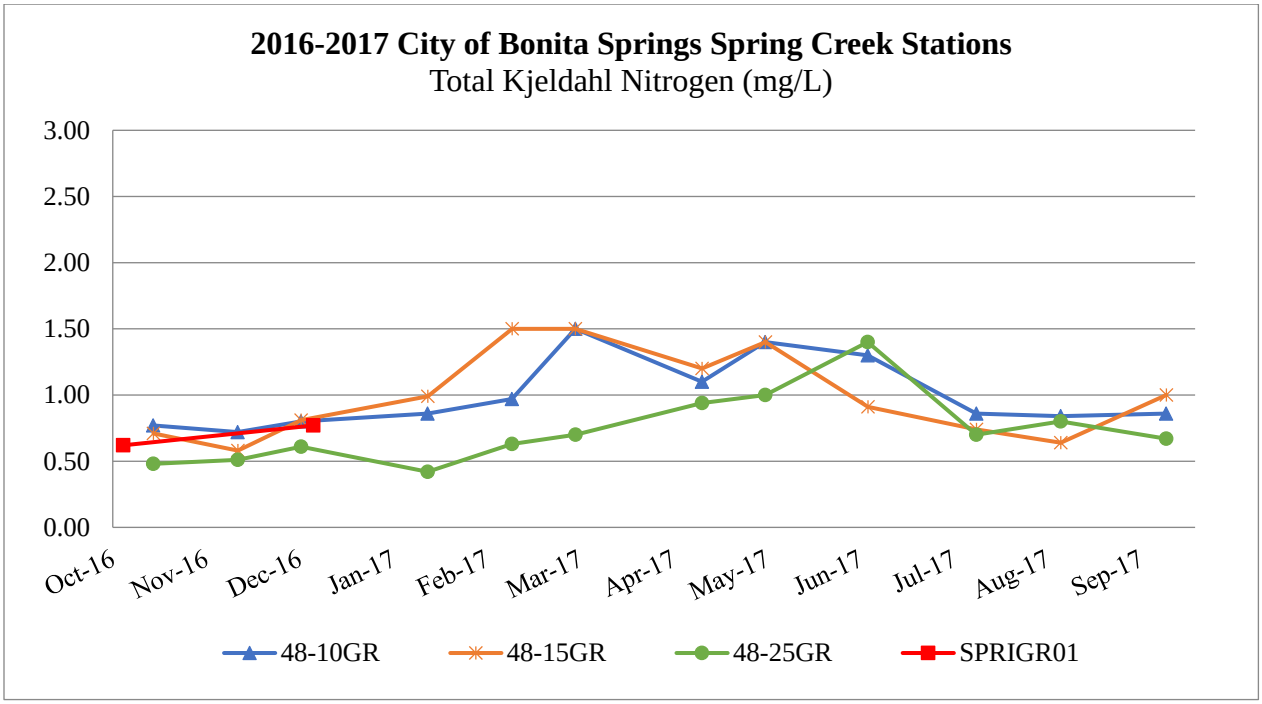


Appendix B: 2016-2017 City of Bonita Springs Estuarine Outflows

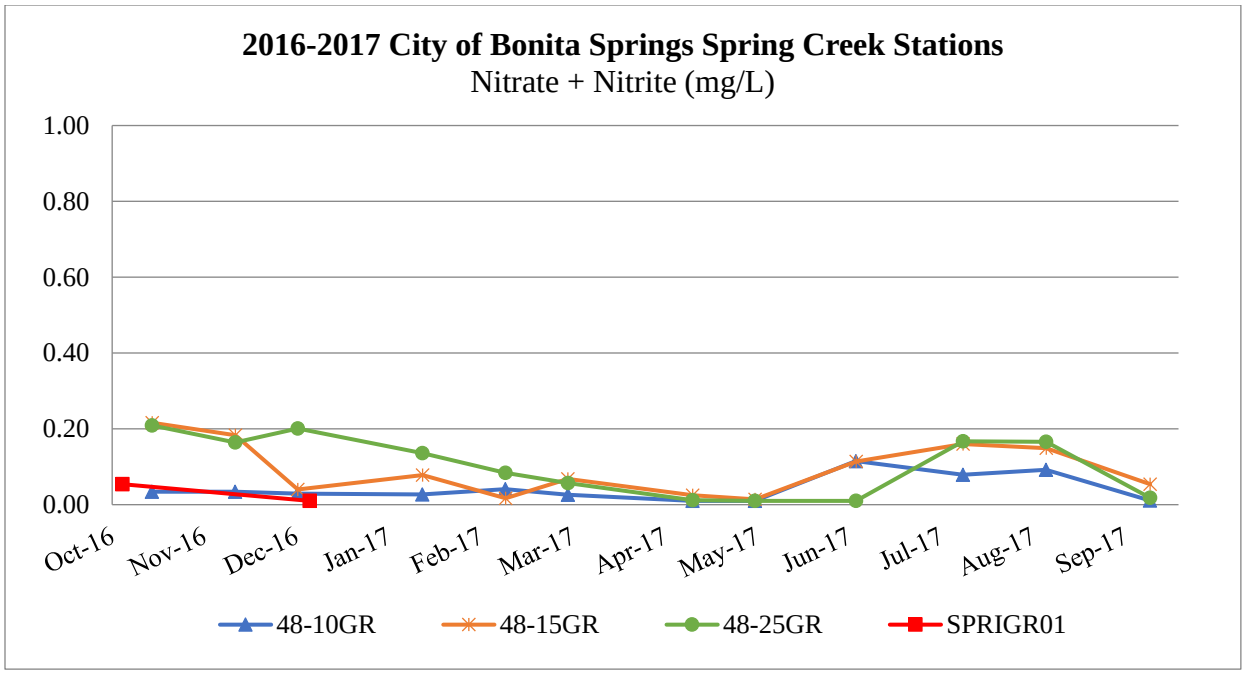


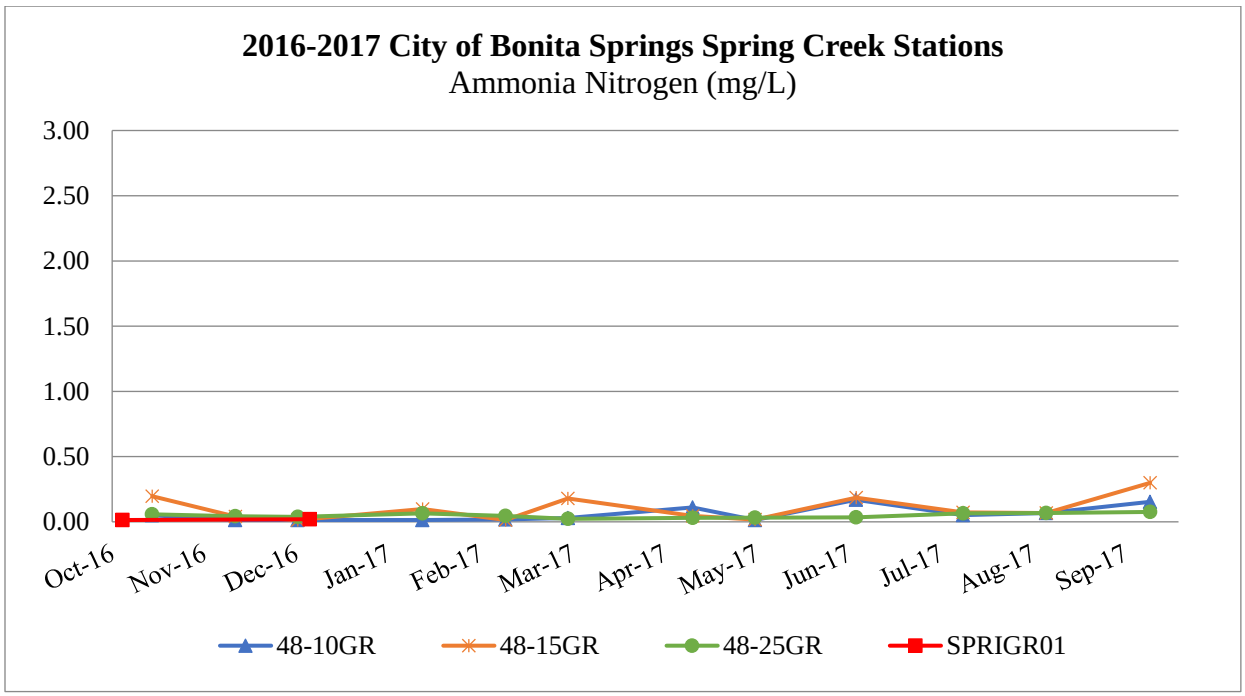
Appendix B: 2016-2017 City of Bonita Springs Spring Creek Stations



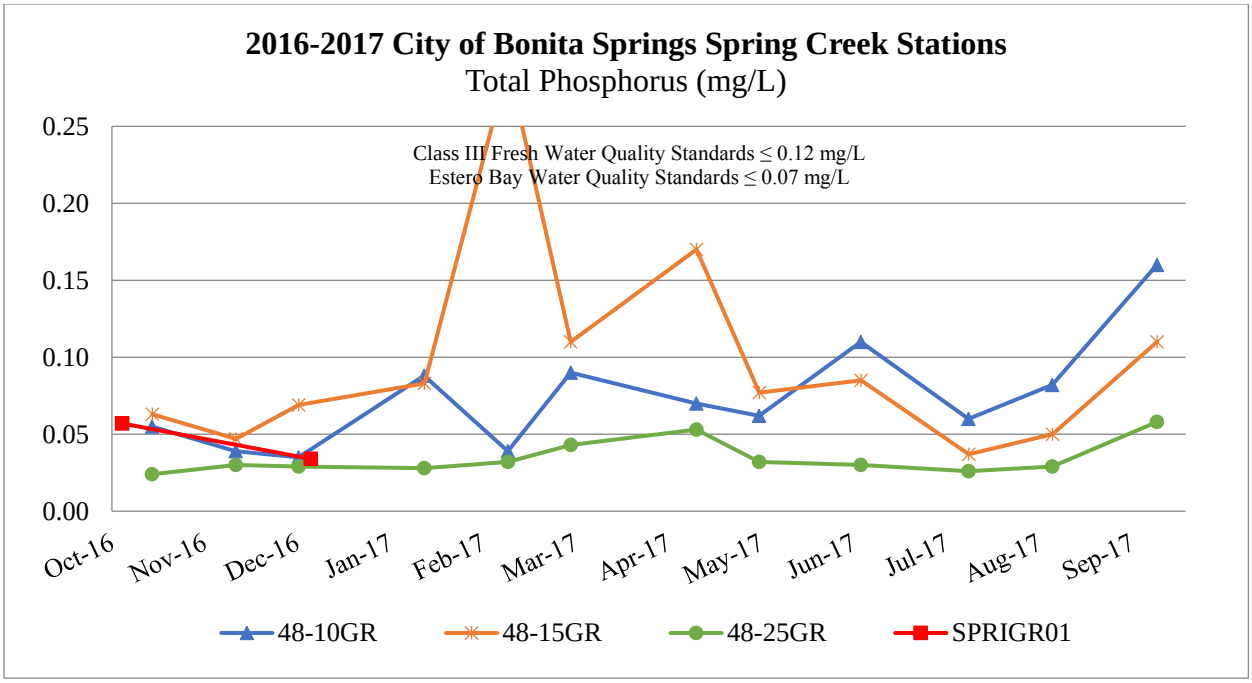


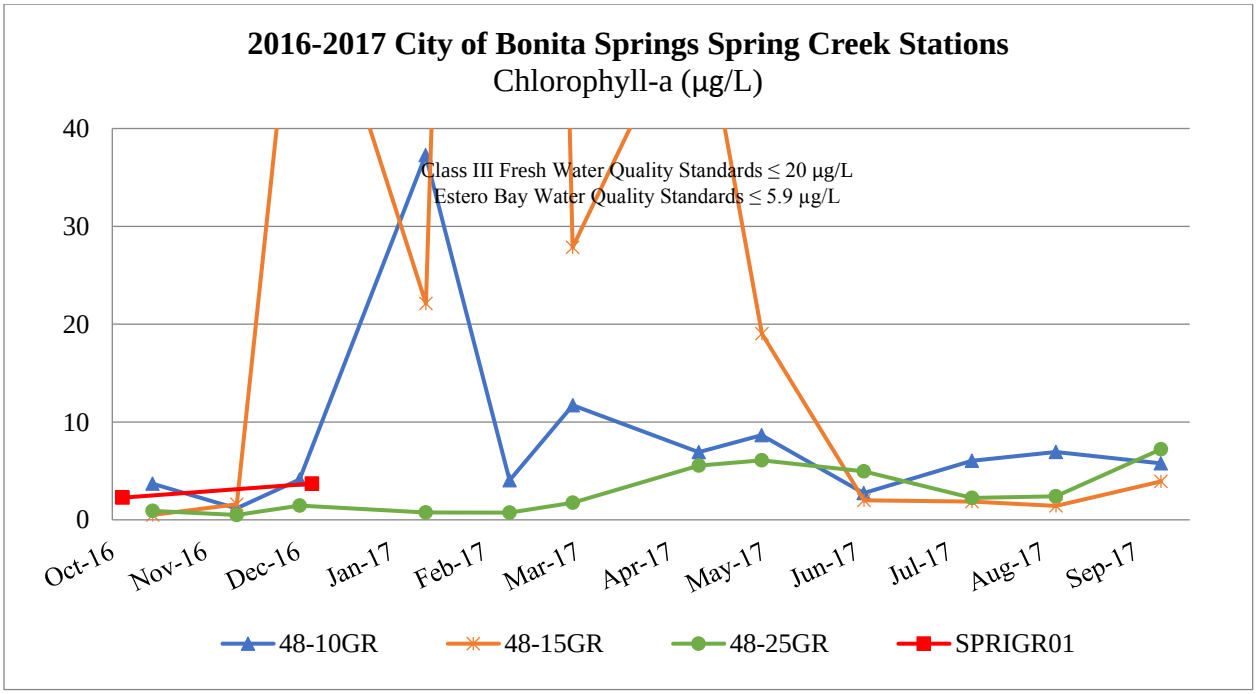
Appendix B: 2016-2017 City of Bonita Springs Spring Creek Stations



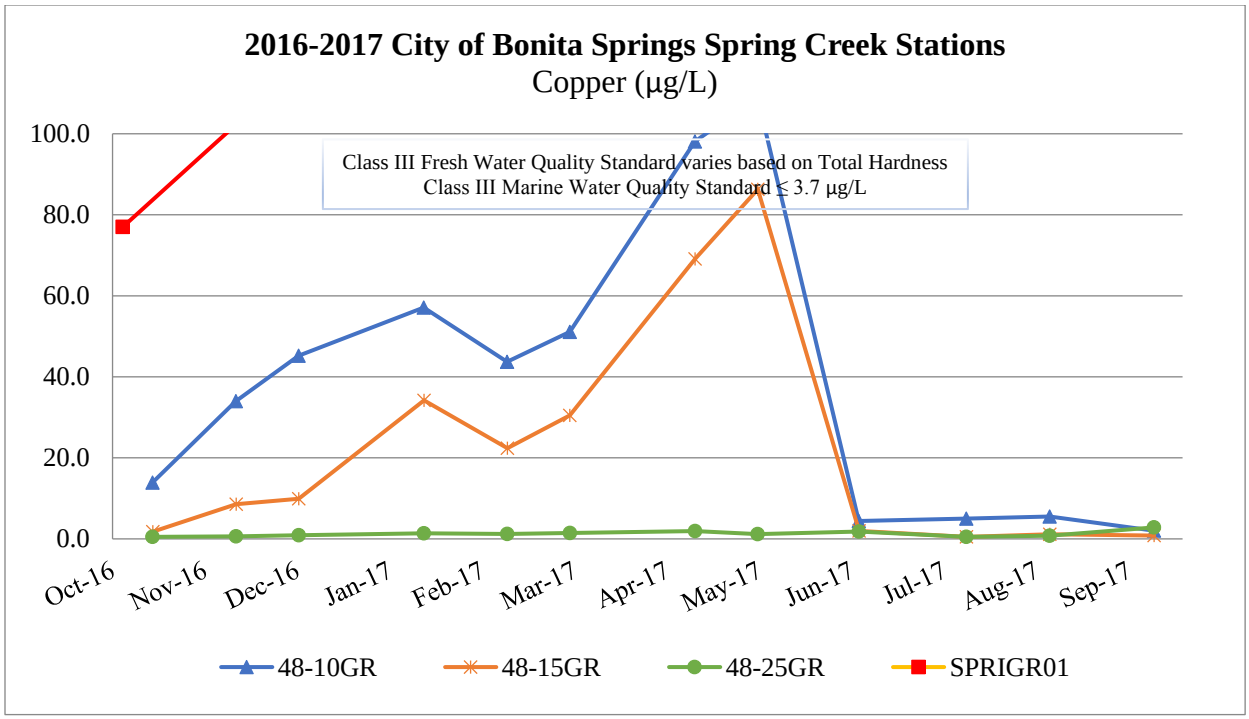


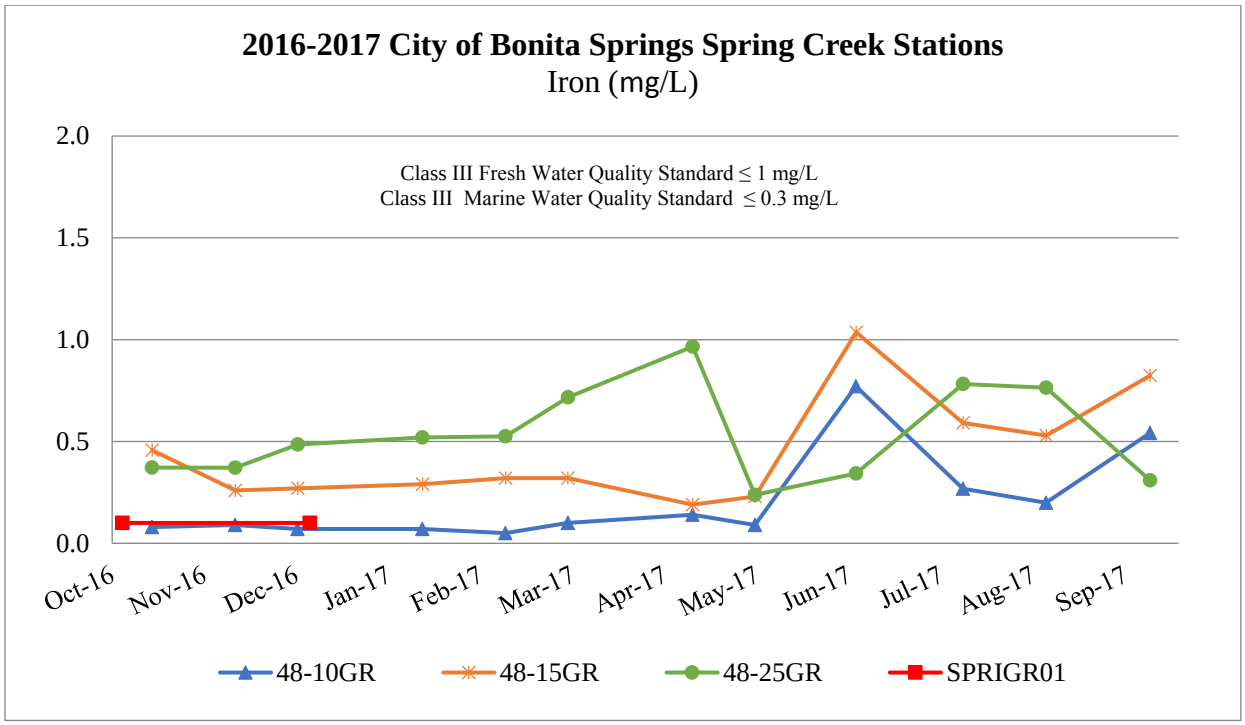
Appendix B: 2016-2017 City of Bonita Springs Spring Creek Stations



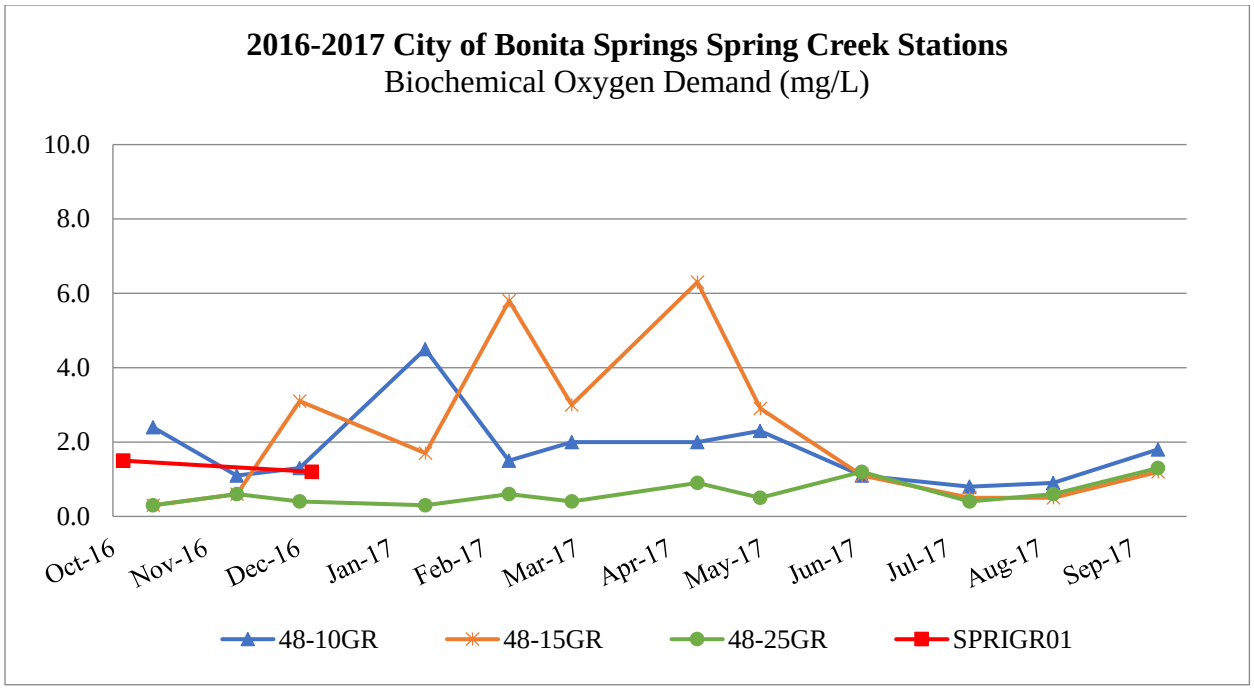


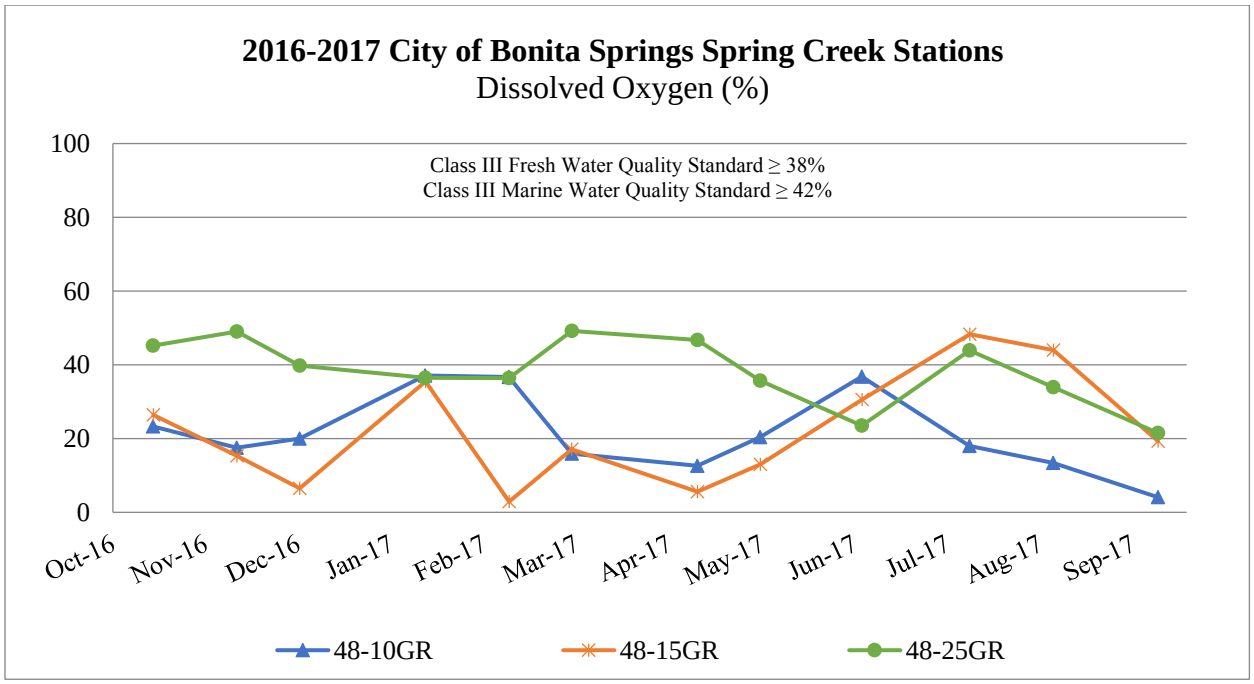
Appendix B: 2016-2017 City of Bonita Springs Spring Creek Stations



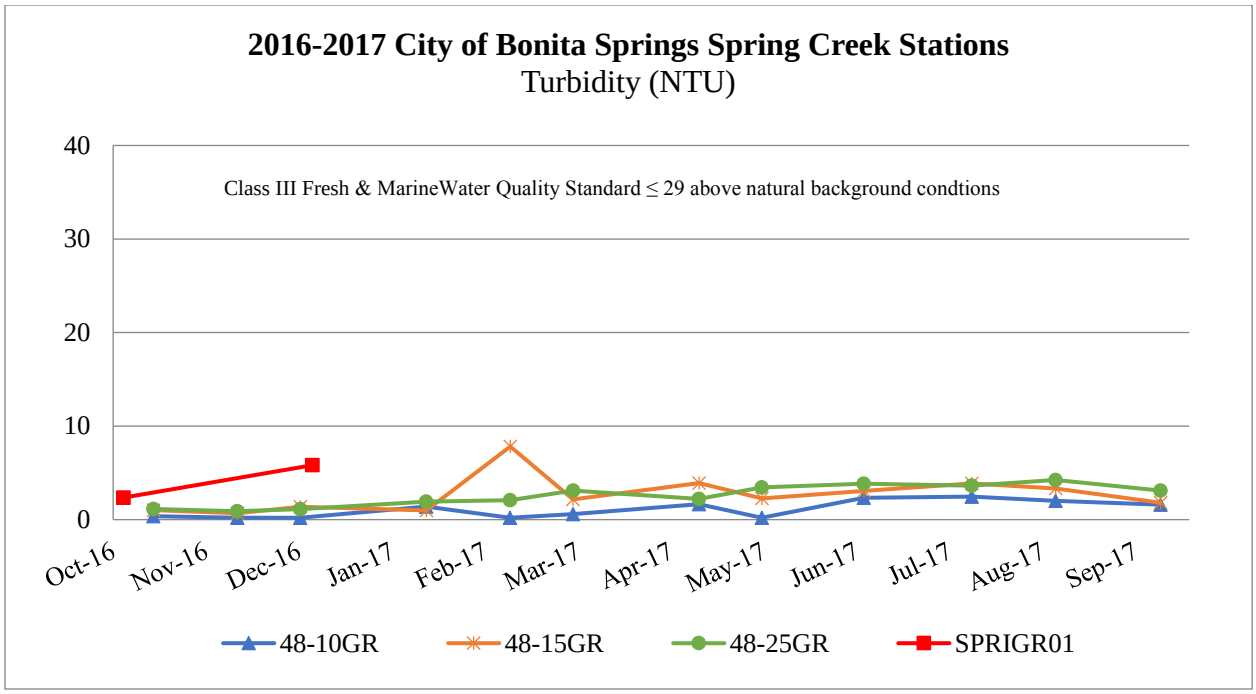


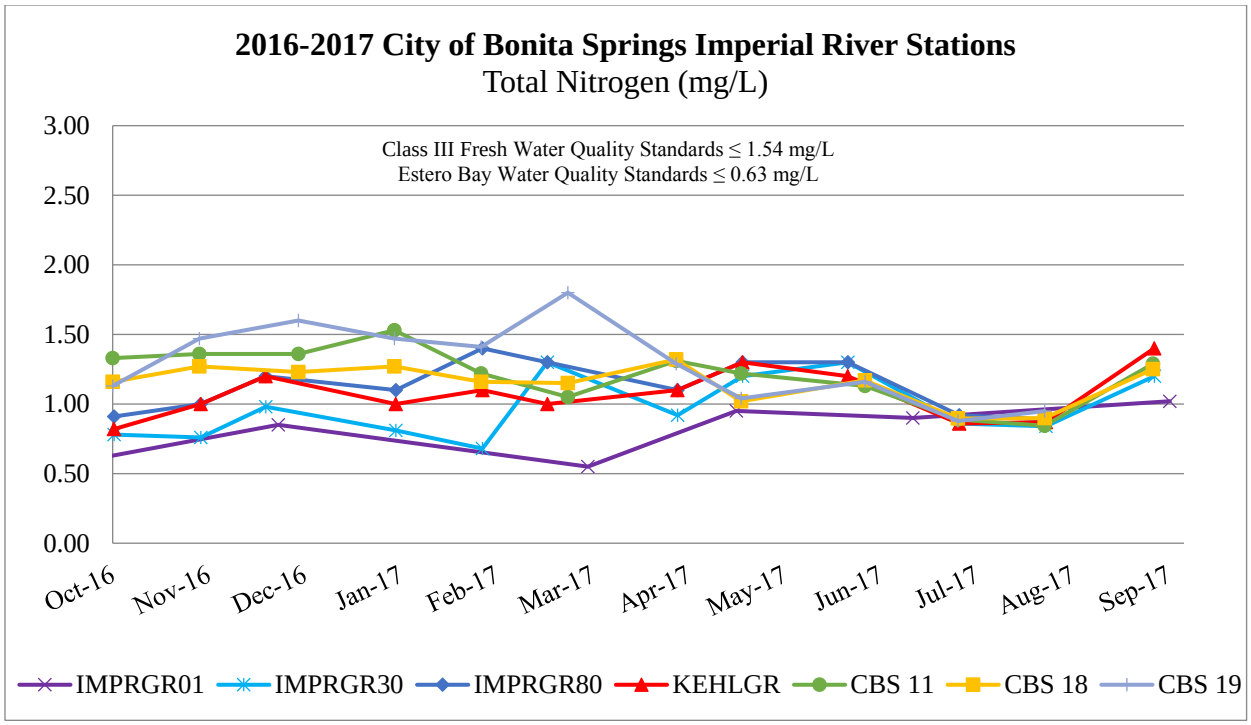
Appendix B: 2016-2017 City of Bonita Springs Spring Creek Stations

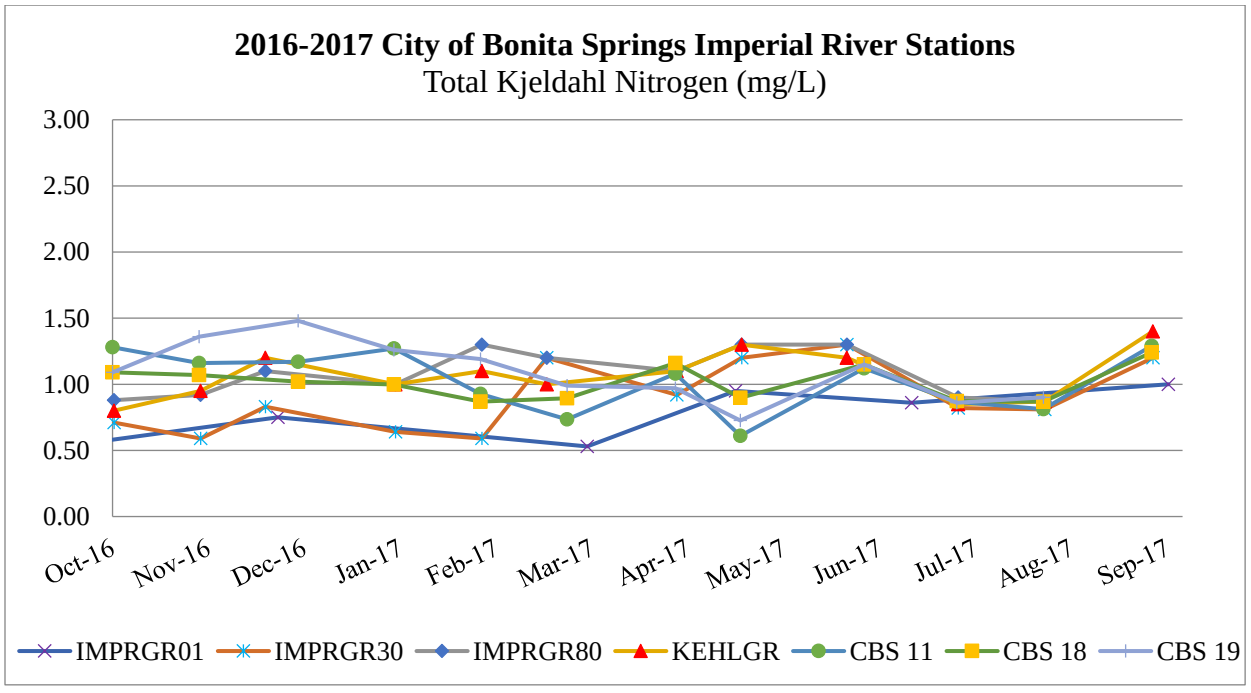


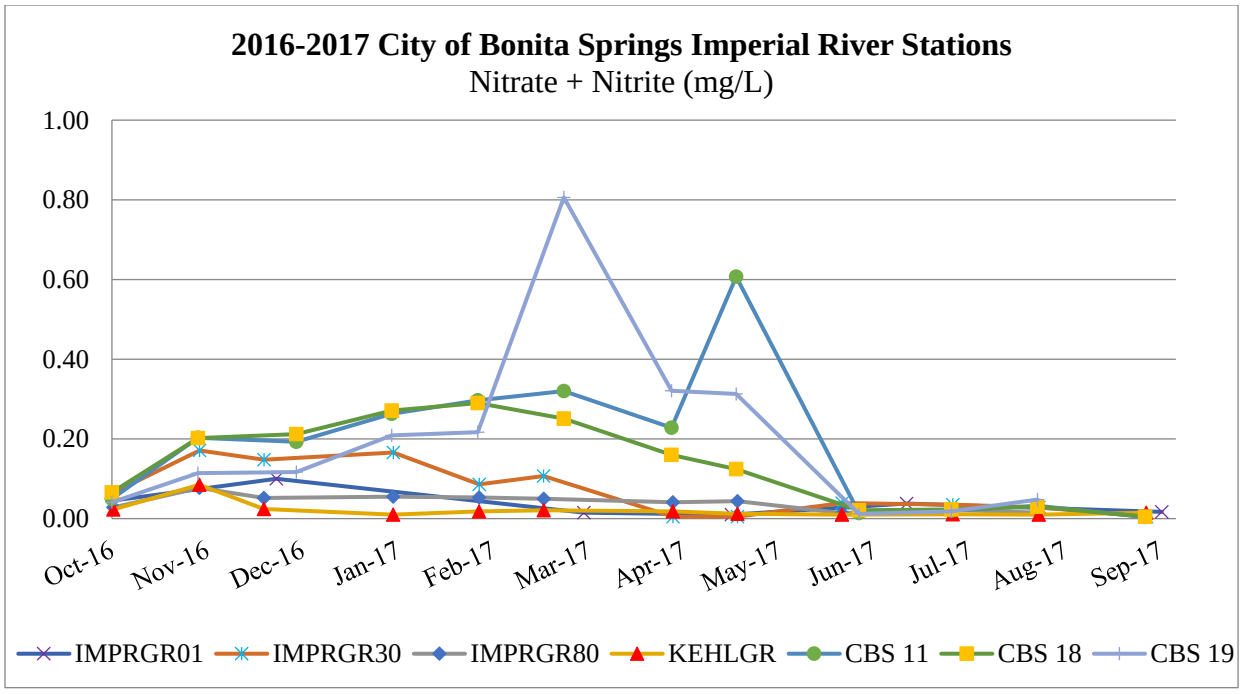


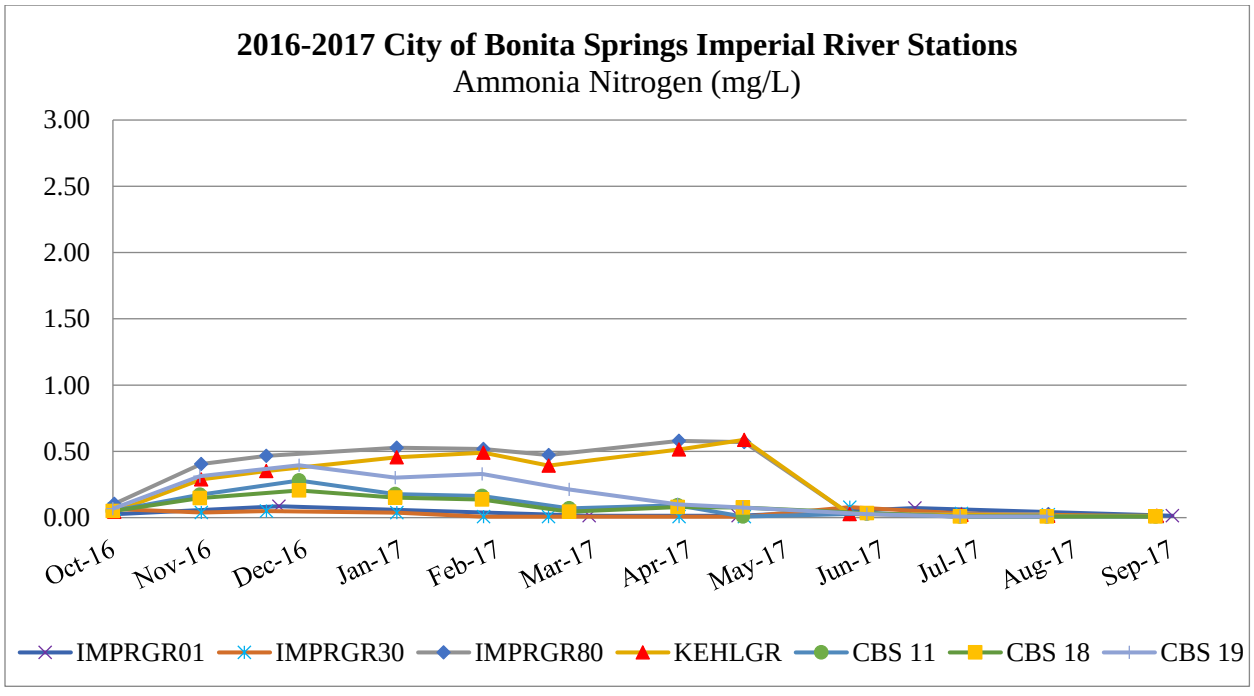
Appendix B: 2016-2017 City of Bonita Springs Spring Creek Stations



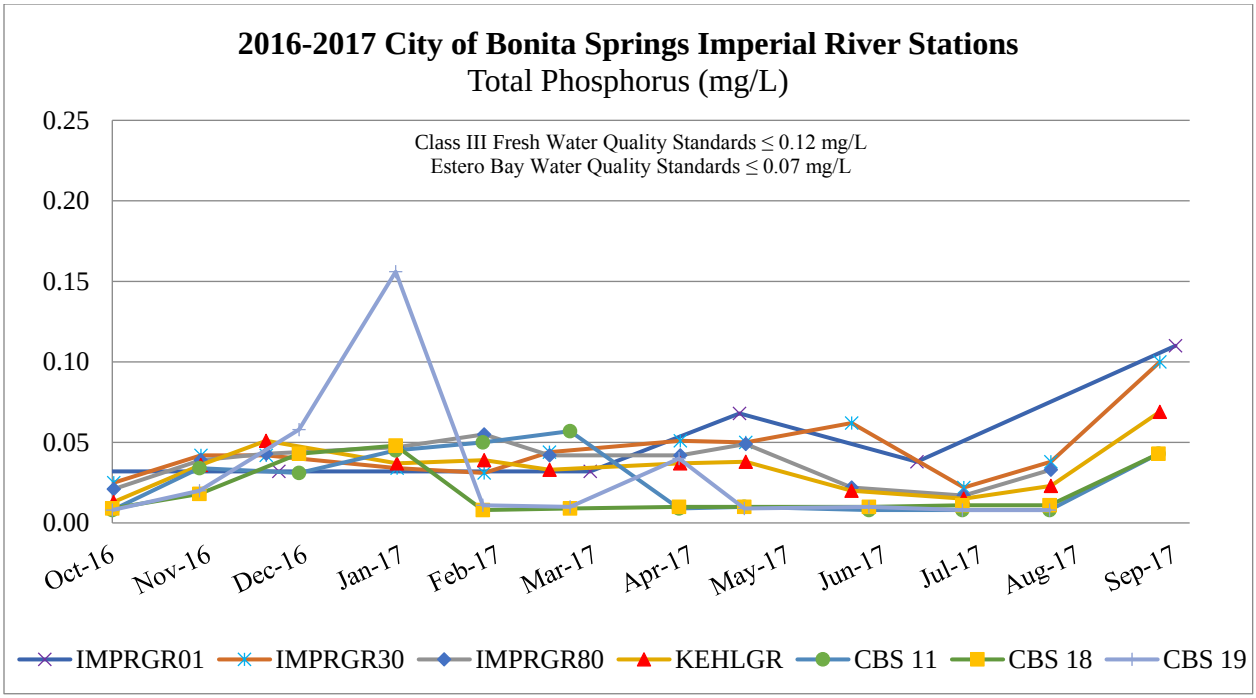

2016-2017 City of Bonita Springs Imperial River Stations
Total Nitrogen (mg/L)
Class III Fresh Water Quality Standards ≤ 1.54 mg/L
Estero Bay Water Quality Standards ≤ 0.63 mg/L
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
IMPRGR01
IMPRGR30
IMPRGR80
KEHLGR
CBS 11
CBS 18
CBS 19

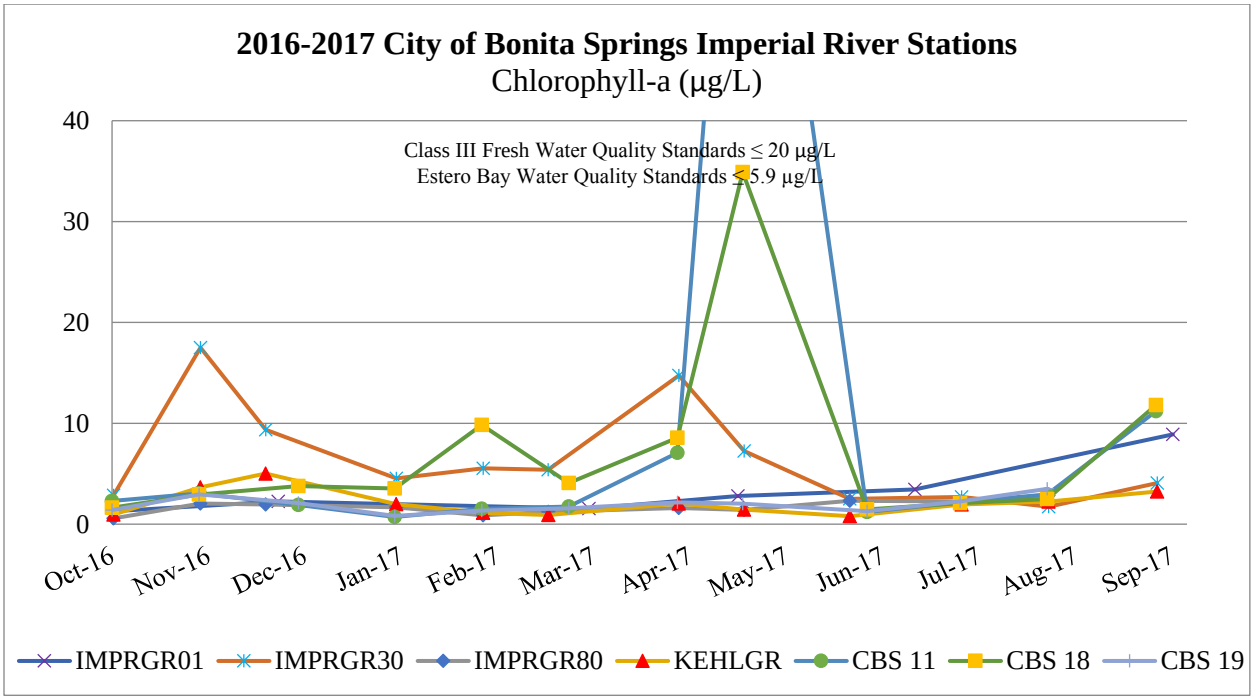

2016-2017 City of Bonita Springs Imperial River Stations
Total Kjeldahl Nitrogen (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
IMPRGR01
IMPRGR30
IMPRGR80
KEHLGR
CBS 11
CBS 18
CBS 19


2016-2017 City of Bonita Springs Imperial River Stations
Nitrate + Nitrite (mg/L)
1.00
0.80
0.60
0.40
0.20
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
IMPRGR01
IMPRGR30
IMPRGR80
KEHLGR
CBS 11
CBS 18
CBS 19

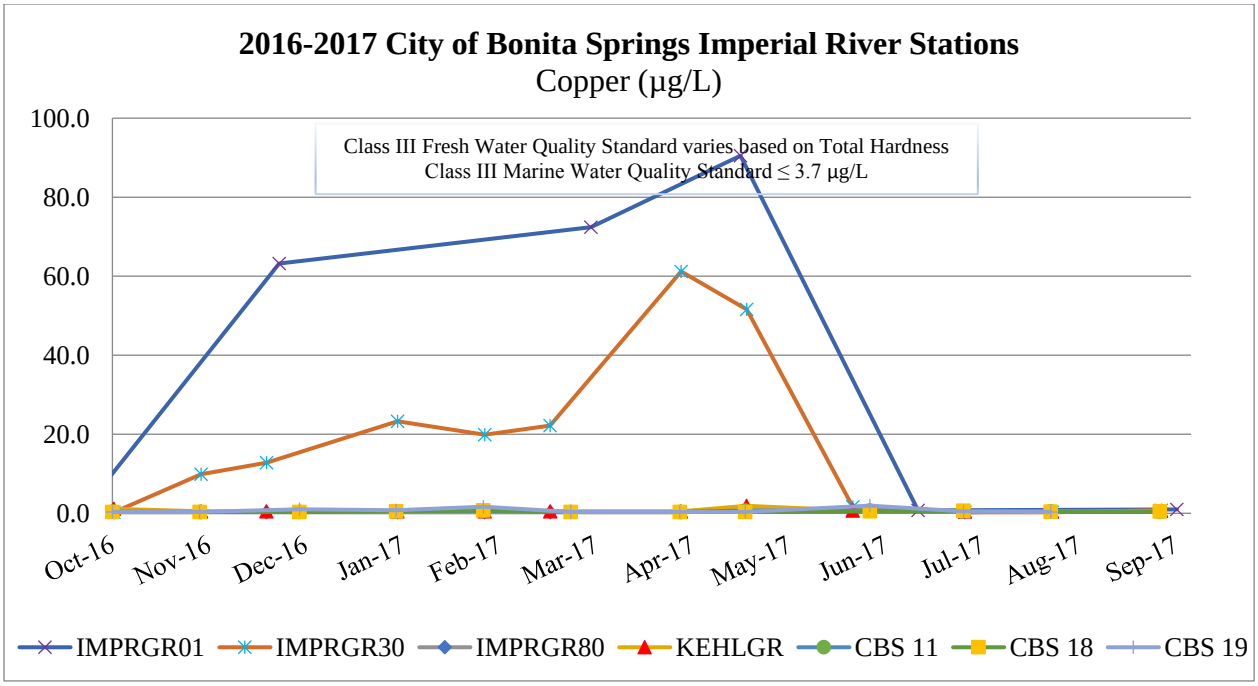

2016-2017 City of Bonita Springs Imperial River Stations
Ammonia Nitrogen (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
IMPRGR01
IMPRGR30
IMPRGR80
KEHLGR
CBS 11
CBS 18
CBS 19

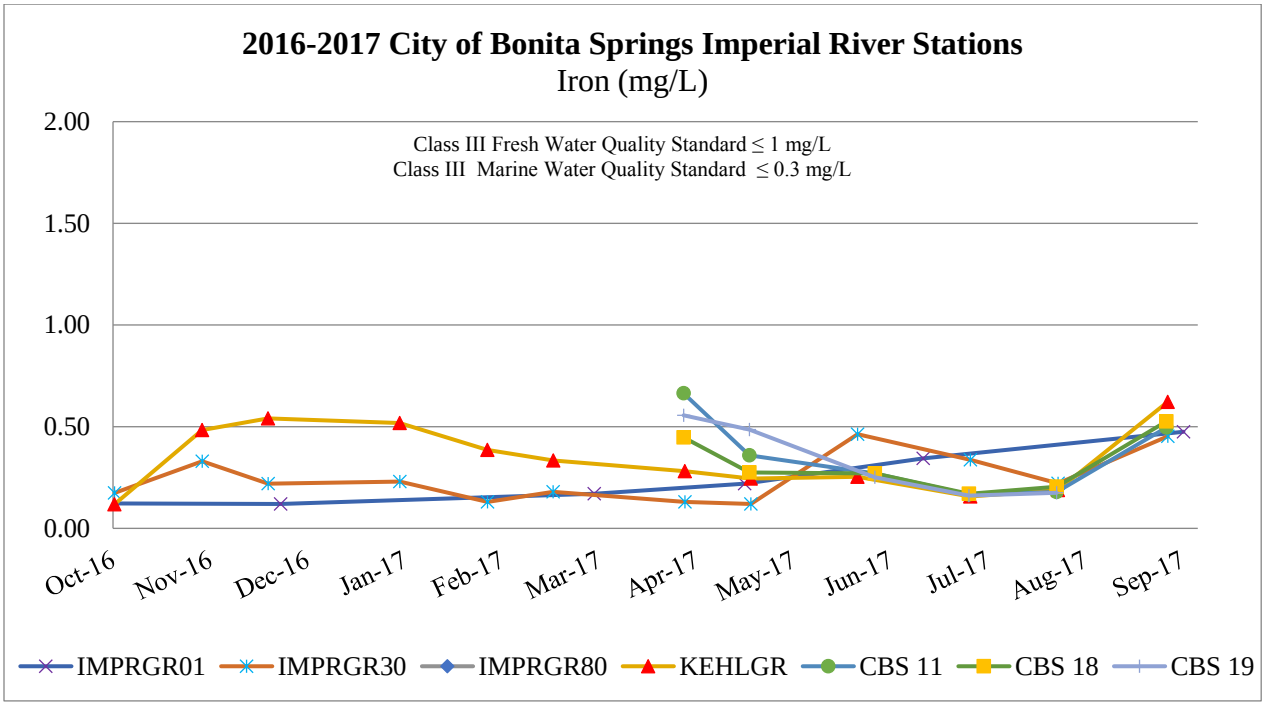
Appendix B: 2016-2017 City of Bonita Springs Imperial River Stations

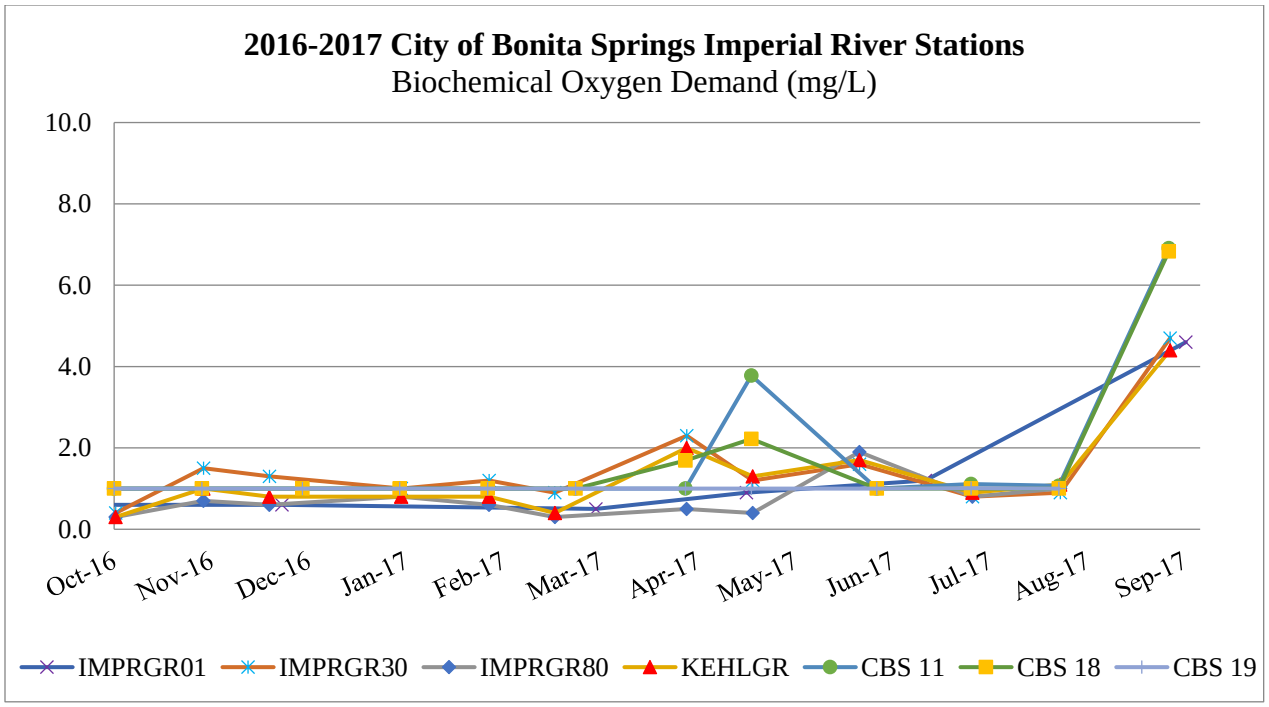


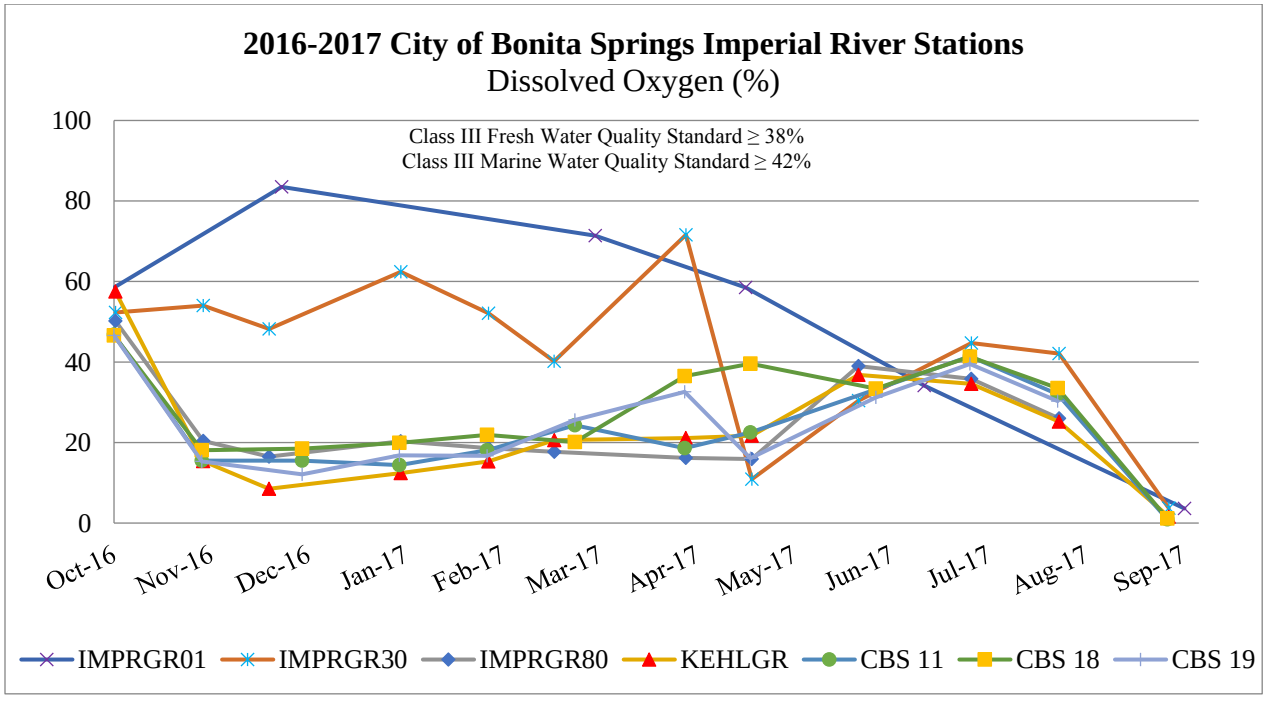


Appendix B: 2016-2017 City of Bonita Springs Imperial River Stations






2016-2017 City of Bonita Springs Imperial River Stations
Biochemical Oxygen Demand (mg/L)
10.0
8.0
6.0
4.0
2.0
0.0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
IMPRGR01
IMPRGR30
IMPRGR80
KEHLGR
CBS 11
CBS 18
CBS 19


2016-2017 City of Bonita Springs Imperial River Stations
Dissolved Oxygen (%)
Class III Fresh Water Quality Standard ≥ 38%
Class III Marine Water Quality Standard ≥ 42%
100
80
60
40
20
0
Oct-16
Nov-16
Dec-16
Jan-17
Feb-17
Mar-17
Apr-17
May-17
Jun-17
Jul-17
Aug-17
Sep-17
IMPRGR01
IMPRGR30
IMPRGR80
KEHLGR
CBS 11
CBS 18
CBS 19

Appendix B: 2016-2017 City of Bonita Springs Imperial River Stations