Assessment of the Impacts of On-Site Sewage Treatment and Disposal (OSTD) Systems on Water Quality in Taylor Creek and the Canals in the Treasure Island and Taylor Creek Isles Subdivisions.

Principal Investigator:
Dr. J. William Louda, Research Professor
Department of Chemistry and Biochemistry
and The Environmental Sciences Program
Florida Atlantic University
777 Glades Road
Boca Raton, Florida 33431
blouda@fau.edu
(561)297-3309 (office)   (561) 797-1852 (cell)

John F. Hayford, P.E.
Executive Director
Okeechobee Utility Authority (OUA)

Final Report Submitted to:
Okeechobee Utility Authority (OUA)
March 9, 2021
Update resubmitted February 25, 2021

TABLE of CONTENTS

FIGURES

EXECUTIVE SUMMARY

South Florida has been and still is experiencing nutrient (N, P) excesses in surface waters and sediments in Lake Okeechobee, coastal estuaries, and the Greater Everglades. Sources include sewerage, notably septic tank systems (Onsite Sewerage Treatment and Disposal Systems, OSTDS,), agricultural operations, and urban runoff.

This report covers a study contracted to Florida Atlantic University (Dr. J. Wm. Louda, P.I.) by the Okeechobee Utility Authority (Mr. John Hayford, Executive Director). This study utilized the artificial sweetener sucralose as a tracer of septic tank pollution of the canals in the lower stretches of Taylor Creek in Okeechobee County Florida. As Taylor Creek (TC) flows through the city of Okeechobee and nears Lake Okeechobee, it borders on the west by the subdivision of Taylor Creek Isles (TCI) and on the east by the subdivision of Treasure Island (TI). TCI homes are mainly on a municipal vacuum sewer system while all homes in the TI area use septic tanks and associated drainfields (aka OSTDS). As the anthropogenic substance sucralose is not metabolized by man and is quite stable for long periods of time in the environment, it makes an ideal tracer for human derived sewerage pollution.

Sampling included 3 TC, 6 TCI and 6 TI sites and included 16 sampling events over a 14 month (Nov. 2019- Dec. 2020) period for a total of 240 samples. Analyses included sucralose, soluble reactive phosphorus (SRP), total phosphorus (TP), ammonia, total nitrogen (TN), total chlorophyll-a (CHLa) and a variety of physical parameters (conductivity, pH, dissolved oxygen, total dissolved solids, turbidity).

Results confirmed the previous study in 2017-18 by Florida Gulf Coast University. In the present study, considering the sites away from Taylor Creek proper (i.e. TI-4/-5/-6 and TCI-4/-5/-6), it was found that that the Treasure Island canals had 5.7 times the mean concentration relative to the Taylor Creek Isles canals. This derives from the mean sucralose concentrations in TI (1,790 $\pm$ 372.7 ng/L) and TCI (315$\pm$ 106.6 ng/l). Sites in the TI and TCI areas close to Taylor Creek itself reflected drainage mixing with TC waters. Taylor Creek 'reference' sites (TC-1/-2), those before encountering TI or TCI drainage, had a mean sucralose concentration of 280 $\pm$ 57.8 ng/L). After traveling through the TI / TCI area, the TC site closest to Lake Okeechobee (TC-3) had a mean sucralose concentration of 426$\pm$ 113.2 ng/L, reflecting a 52% increase in sucralose.

During the heavy saturating rains of September-October 2020, increases in soluble reactive phosphorus (SRP) and ammonia were recorded for the inland Treasure Island sites (TI-4-/-5/-6. This is taken as an indication that drainfields from corresponding septic tanks were flushed through soils and into the canals more rapidly than during drier periods. The TI sites away from Taylor Creek had 2.25 times the total phosphorus and 1.20 times the total nitrogen compared to the TCI sites during that period.

Both the sucralose and nutrient data collected during this study confirms the fact that septic tank pollution of Taylor Creek and therefore Lake Okeechobee is occurring primarily from the Treasure Island subdivision.

INTRODUCTION / BACKGROUND

The pollution of surface waters with primary plant nutrients, notably nitrogen and phosphorus, is increasing worldwide (Carpenter et al., 1998; Dodds et al., 2009; Elser et al., 2007; Guignard et al., 2017; Smith et al., 1999). Nutrients can be and often are addressed within watershed management programs through processes termed best management practices or BMPs (FDACS, 2011; FDEP, 2013; Gunsalus et al., 1992; Sims et al., 2000), though lag-times between implementation and detection of impacts can range from years to decades (Meals et al., 2010).

In the October 2016 United States Environmental Protection Agency report entitled "National Nonpoint Source Program", it was stated; "Of all the waterbodies across the nation that have been assessed and a possible source of impairment identified, 85% of rivers and streams and 80% of lakes and reservoirs are polluted by nonpoint sources." (USEPA, 2016).

Under the United States Clean Water Act Section 502, General Definitions, it states: "The term 'point source' means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture." (USEPA, 2019).

It is the last sentence in the above definition that generates the idea of 'non-point' sources (NPS) from agricultural operations. That is, "Nonpoint source pollution, on the other hand, comes from disperse overland flow associated with rain events." (Pierce et al., 1998). Nonpoint nitrogen and phosphorus pollution is a well-known worldwide problem (Carpenter et al., 1998; Lankoski and Ollikainen, 2013; Xia et al., 2020).

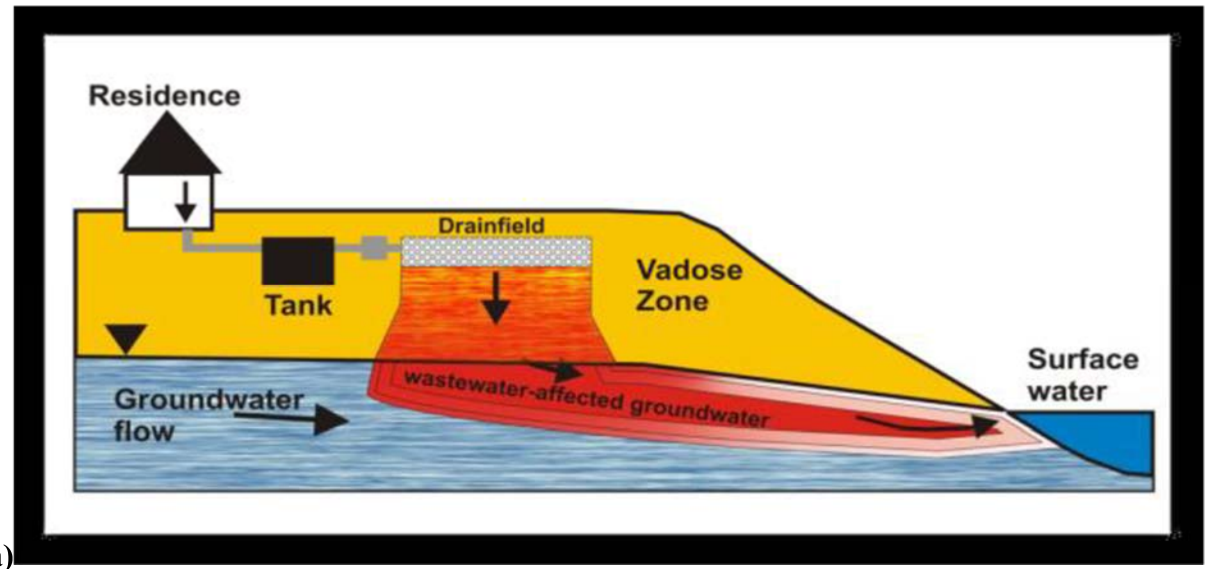
Many process-based mathematical models exist and utilize input data including nutrient concentrations, water flow, soil types, weather and numerous other parameters in order to develop and/or characterize BMP efficiencies. Such programs include SWAT (Soil and Water Assessment Tool) developed by the United States Department of Agriculture (Arnold et al., 1998, 2010; Neitsch et al., 2011; Shen et al., 2015). Several other models also exist (see e.g. Liu et al., 2019; Tuo et al., 2015) for the assessment of basin and catchment scale studies.

South Florida has been and still is experiencing nutrient (N, P) excesses in surface waters and sediments in Lake Okeechobee (Engstrom et al., 2006; Fisher et al., 2001; Havens, 1995; Havens and East, 1997; Havens et al., 2005; Pollman and James, 2011;), coastal estuaries (Duersch and Louda, 2017; Liu et al., 2009; Pant and Reddy, 2001; Phlips et al., 2002), and the Greater Everglades (Bruland et al., 2007; Childers et al., 2003; Louda et al.,2015; Reddy et al., 2011). Sources include sewerage, notably septic systems (aka OSTDS, Onsite Sewerage Treatment and Disposal Systems: Badruzzaman et al., 2012; FDOH, 2018; Lapointe et al., 2017; Meeroff et al., 2014), agricultural operations (Boggess et al., 1997; Duersch et al., 2020; Entry and Gottlieb, 2014; Stuck et al., 2001) and a growing equestrian industry (Cintron and Louda, 2007; Louda et al., 2019; Louda et al., 2021; Osetek and Louda, 2004).

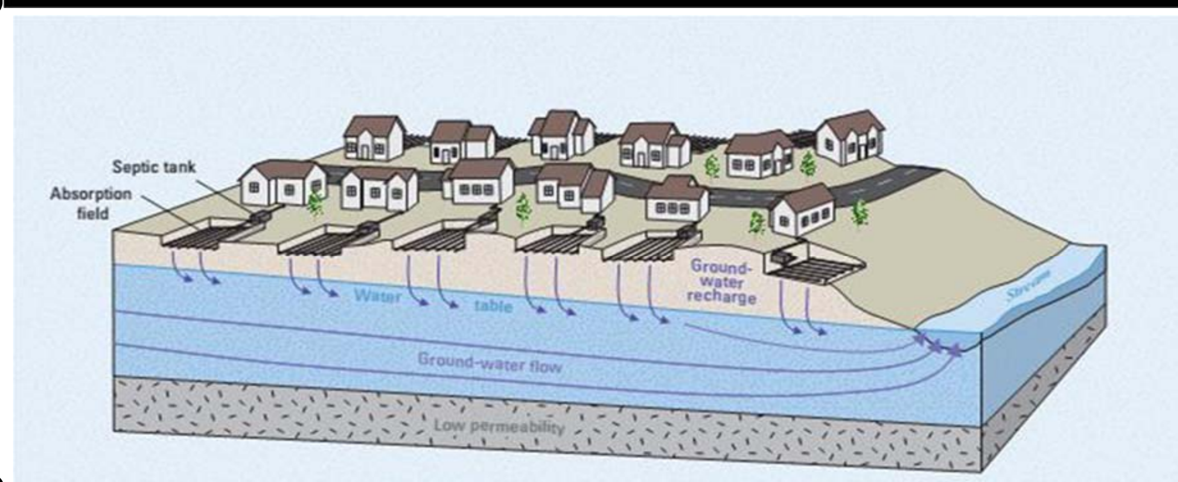
The current project was contracted to the PI at FAU by the Okeechobee Utility Authority in order to confirm and extend the previous study by Dr. J.-Y. Kim of the Florida Gulf Coast University (Final Report Aug. 10, 2019). The reader is directed to that report for additional background for the Taylor Creek area. The purpose of both the previous and current study was to examine for the presence and extent of OSTDS (see Figure 1) pollution of the waters in the lower Taylor Creek area north of Lake Okeechobee.

This study is to determine if onsite sewerage treatment & disposal (OSTD) systems, also known as septic tank systems, are responsible for elevated nutrient loadings in Taylor Creek, a surface water body flowing in to Lake Okeechobee.

This study will not attempt to address nutrient loadings from other actual sources, it will not address any actual effects higher nutrient loadings may have on water quality nor will this study address what Lake Okeechobee discharges have of water bodies receiving discharges from Lake Okeechobee.



(a)



(b)

<u>Figure 1</u>: (a) Diagram of septic tank drainfield leaching materials into ground water.
(b) Diagram showing the effect of septic tank density. (USGS, 2008).

The study area, circled in Figures 2 and 3, includes 15 sites; 3 within Taylor Creek and 6 each in the canals within the Treasure Island and Treasure Creek Isles subdivisions (See Figure

4). The report of Kim, 2019 has additional background information on the study of septic tank pollution in the Taylor Creek area.

"The Taylor Creek Sub-watershed (104 mi^2) and Nubbin Slough Sub-watershed (84 mi^2) are interconnected and drain into Lake Okeechobee from the north and northeast. The Nubbin Slough Sub-watershed includes three tributaries: Lettuce Creek, Henry Creek, and Mosquito Creek, which along with Nubbin Slough are intercepted by canals (L-63, L-64, and C-59) and enter Lake Okeechobee through flow-control structure S-191. The unmonitored boat locks at S-193 are used for gravity flows into and out of the lake. The lower reaches of Taylor Creek, downstream of S-192, flow into the lake through structure S-193. Additional flow into the lake is provided by the S-133 pump station, which is primarily operated for flood protection.**"** (SFWMD 2011). The control structures (S-133 and S103) mentioned above and elsewhere in the current report are indicated in Figures 2 & 3.

"The Kissimmee River (Fig. 2) was a subtropical, river/floodplain system connecting the Kissimmee Chain of Lakes to Lake Okeechobee. Channelization of the meandering, braided channel ended much of the river's functions and values as an ecosystem" (Redfield, 1999). Restoration or at least rejuvenation of the Kissimmee-Okeechobee-Everglades (KOE) system will take decades, especially since "Resource management decisions often are based on a combination of scientific and political factors."(Steinman et al., 2002). Certain steps are indeed being taken to study the quality, quantity and timing of waters entering the lake under the "Lake Okeechobee Watershed Project" (US-ACE, 2016). The South Florida Water Management District (SFWMD) has a widespread water quality monitoring system composed of permanent stations throughout the KOE (Kissimmee-Okeechobee-Everglades) system. The SFWMD data is available to all through their DBHYDRO (= Data Base Hydrologic) website (SFWMD-DBHYDRO, 2020)

The current project examined septic tank pollution of the waters that lead into Taylor Creek and then into Lake Okeechobee. Pollution from septic tank leachates contains not only the primary plant nutrients nitrogen (N) and phosphorus (P) (Lapointe et al., 2015; but also pharmaceuticals and human pathogens (Lapointe et al., 2012; Meeroff and Morin, 2005; Meeroff et al., 2014).

Figure 2: Florida with The City of Okeechobee and Taylor Creek area circled in red.

Figure 3: Expansion of the The City of Okeechobee, Lake Okeechobee with Taylor Creek (red) and Nubbin Slough (green) indicated. S192 is where Nubbin Slough branches off of Taylor Creek. S193 and S133 have Taylor Creek outflow into Lake Okeechobee. Map from South Florida Water Management website (www.sfwmd.gov).

The stable isotopes of carbon ($_6C^{13}$) and nitrogen ($_7N^{15}$) have been used to discriminate sewerage sources in a variety of ecosystems (Belanger et al., 2007; Bicki et al., 1984; Lapointe and Krupa, 1995a-b; Lapointe et al., 2015; Risk et al., 2008). Natural N-fixation source values are close to 0% (Heaton, 1986; France et al., 1998), atmospheric N typically ranges from -3‰ to +1‰ (Paerl and Fogel, 1994) and synthetic fertilizer N ranges from -2‰ to +2‰ (Bateman and Kelly, 2007). N sources are all depleted relative to enriched values of +3‰ to +19‰ for human sewage (Heaton, 1986; Costanzo et al., 2001). Additional tracers that have been used include sulfur hexafluoride, fluorescein, rhodamine-WT, and a bacteriophage (Virus) PRD-1 (Harden et al., 2008).

Tracer methods are used in areas of obvious inputs to the lake (canals, pipes, rivers) but also in an attempt to zero in on potential **non-point sources**. This includes the large concentrations of septic systems (onsite sewerage and treatment disposal systems: aka OSTDS) which communicate directly to adjacent canals. In the current and past (Kim, 2019) studies of the lower Taylor Creek area, the artificial sweetener **sucralose** was used as a tracer to show the impact of septic tank (OSTDS) effluents.

The compound sucralose (trade name Splenda) is almost ideal as a tracer. It is present in virtually every domestic wastewater discharge at detectable levels (10 to 40 parts per billion [ppb]), does not occur naturally, has low toxicity, is highly soluble in water, is not effectively metabolized or removed by wastewater treatment processes, and persists in the environment with a 1- to 2-year half-life. DEP's monitoring of sucralose has helped identify sites for more intensive study, track contaminant migration routes in surface water and groundwater, and distinguish between abatable and non-abatable sites based on the impacts of human activities."(FDEP, 2019)

SAMPLING SITES

Three areas in the Okeechobee Utility Authority (OUA) service area were chosen for the study. The study area chosen is near the mouth of Taylor Creek where it discharges in to Lake Okeechobee. The area to the east of Taylor Creek, is called Treasure Island (TI). This area is predominantly residential with wastewater service provided by the use of OSTD systems. The area to the west of Taylor Creek is the Taylor Creek Isles (TCI) area. This area is also predominantly residential with wastewater service provided by the use of centralized system where wastewater is collected and pumped to the treatment plant for ultimate treatment and disposal. Taylor Creek (TC) bisects these two areas and will provide a buffer between them

To the east of Taylor Creek, the Treasure Island subdivision is entirely (~1,500 lots) on septic tank (OSTDS) waste disposal. To the west of Taylor Creek, the Taylor Creek Isles subdivision is mainly on municipal sewerage. However, scattered holdouts (56) do remain on still on septic systems in TCI. The previous report by Kim (2019) detailed the sites within the TCI subdivisions that remain on septic systems. Most notably, as seen in Figure 4 of the report by Kim (2019: Fig. 3 of the 2017-2018 OUA study) there are a few septic tanks located near sites TCI-2, -3, and -4.

The sites of the current project (see Figure 3) lie within lower **Taylor Creek** (**TC**), and the subdivisions of **Treasure Island** (**TI**) and **Taylor Creek Isles** (**TCI**). Sampling sites are shown here within Figure 4 and their map grid locations (latitude and longitude) are given in Table 1.

Site selection was previously detailed in the report by Kim (2019). Two additional sites (TI-6, TCI-6) were selected following discussions between the PI and the project director, Mr. John Hayford. These sites (see Fig. 4) were selected for their distance away from Taylor Creek itself. The two added sites (TI-6 and TCI-6) were as far from Taylor Creek as possible in the canals containing Taylor Creek adjacent samples TI-2 and TCI-2 respectively. Therefore, the current study examined fifteen sites in total.

It is noted here that the PI moved site TC-2 a bit to the east of where it was during the previous study by FGCU. This was done in order to be closer to a drain pipe coming from the Cody sod farm.

S133 (LOCK) S-193

<u>Figure 4</u>: Sampling sites in Taylor Creek (TC), Taylor Creek Isles (TCI) & Treasure Island (TI). *Sampling order each event was*: TC-1, TC-2, TI-1, TI-2, TI-6, TI-3, TI-4, TI-5, TCI-1, TCI-2, TCI-6, TCI-5, TCI-4, TCI-3, TC-3. (see Table 1 for latitudes and longitudes).

Table 1: Site locations by Latitude and Longitude

Site	Latitude		Longitude
TC-1	27° 13' 20.12" N	x	80° 48' 36.49" W
TC-2	27° 13' 26.40" N	x	80° 48' 10.40" W
TC-3	27° 12' 32.83" N	x	80° 47' 53.19" W
TI-1	27° 13' 28.95" N	x	80° 47' 59.10" W
TI-2	27° 13' 11.39" N	x	80° 47' 52.39" W
TI-3	27° 13' 30.27" N	x	80° 47' 52.01" W
TI-4	27° 12' 55.48" N	x	80° 47' 39.77" W
TI-5	27° 12' 53.60" N	x	80° 47' 27.93" W
TI-6	27° 13' 11.48" N	x	80° 47' 08.69" W
TCI-1	27° 13'01.85" N	x	80° 48' 00.76" W
TCI-2	27° 12' 54.96" N	x	80° 48' 01.48" W
TCI-3	27° 12' 40.17" N	x	80° 48' 27.85" W
TCI-4	27° 12' 43.90" N	x	80° 48'17.27" W
TCI-5	27° 12' 44.02" N	x	80° 48' 04.43" W
TCI-6	27° 12' 54.80" N	x	80° 48' 29.38" W

Latitudes and longitudes from Google Maps

Figures 5 through 20 are pictures taken in opposite directions at each sampling site. These are provide so the reader may gauge the immediate surroundings at each site. Note the extra picture (Figure 7) which shows a pipe draining an older sod farm site near site TC-2.

Figure 5: Pictures looking west (left) and east (right) at Site TC-1.

Figure 6: Pictures looking east (left) and west (right) at Site TC-2.

Figure 7: Picture looking north taken immediately east (~ 50 yards) of Site TC-2.

The circled area in Figure 7 above highlights large amounts of brown water from a pipe draining an agricultural area.

Figure 8: Pictures south (left) and north (right) at Site TC-3.

Figure 9: Pictures looking east (left) and west (right) at Site TCI-1.

Figure 10: Pictures west (left) and east (right) at Site TCI-2.

Figure 11: Pictures looking west (left) and east (right) at Site TCI-3.

Figure 12: Pictures looking west (left) and east (right) at Site TCI-4.

Figure 13: Pictures looking west (left) and east (right) at Site TCI-5.

Figure 14: Pictures looking east (left) and west (right) at Site TCI-6.

Figure 15: Picture looking south at Site TI-1.

Figure 16: Pictures looking west (left) and east (right) at Site TI-2.

Figure 17: Pictures looking east (left) and west (right) at Site TI-3.

Figure 18: Pictures looking north (left) and south (right) at Site TI-4.

Figure 19: Pictures looking east (left) and west (right) at Site TI-5.

Figure 20: Pictures looking west (left) and east (right) at Site TI-6.

MATERIALS and METHODS

Sampling was performed using the PI's personal 15 foot outboard motor boat which was equipped with a depth finder, GPS and VHF radio. Water samples were collected at each site by hand by submerging inverted critically cleaned and HPLC grade water triple rinsed 500mL amber polypropylene rectangular bottles (Thermo-Scientific # 20090016) to a depth of 0.3 m and then rotating them in order to fill. The bottles were then placed in a cooler (Figure 21a) for transport to the lab for filtering within 3-4 hours.

Duplicate water samples for sucralose analyses at each site were collected in similar fashion using 60 mL amber polypropylene bottles (Thermo-Scientific #3120850002). The sucralose samples were placed in a separate (Styrofoam) cooler (Fig. 21b) and frozen with 4-6 hours of collection. Frozen samples for multi-matrix ultra-trace analysis by SPE HPLC high resolution mass spectrometry sucralose analysis were shipped overnight by FedEx to the Environmental Research Analytical Laboratory (EARL) of Florida International University (FIU).

Field measurements were taken as follows: pH and temperature with a Yellow Springs Instruments Pro-10 probe; Dissolved oxygen with an YSI ProODO chemiluminescence probe; Conductivity (µS), resistivity (kΩ), and total dissolved solids (TDS, ppm) with a Hanna Mdl. #HI98192 probe and USP meter; Turbidity (NTU, Nephelometric Turbidity Units) with a HACH #2100Q turbidity meter.

Back at the lab, ammonia was measured (HACH TNT830; 0.015 -2.00 mg/L NH_3-N) on unfiltered waters samples.

Water was then filtered through Whatman GF/F filters until just before clogging. The volume filtered was recorded and the filters were folded in half, blotted, reblotted, folded in quarters, reblotted, sealed in aluminum foil and frozen.

(a) 

(b) 

Figure 21: Sample collection bottles and coolers. (a-left) 500 mL bottles, water for all analyses except sucralose. (b-right) 60 mL bottles for sucralose analyses.

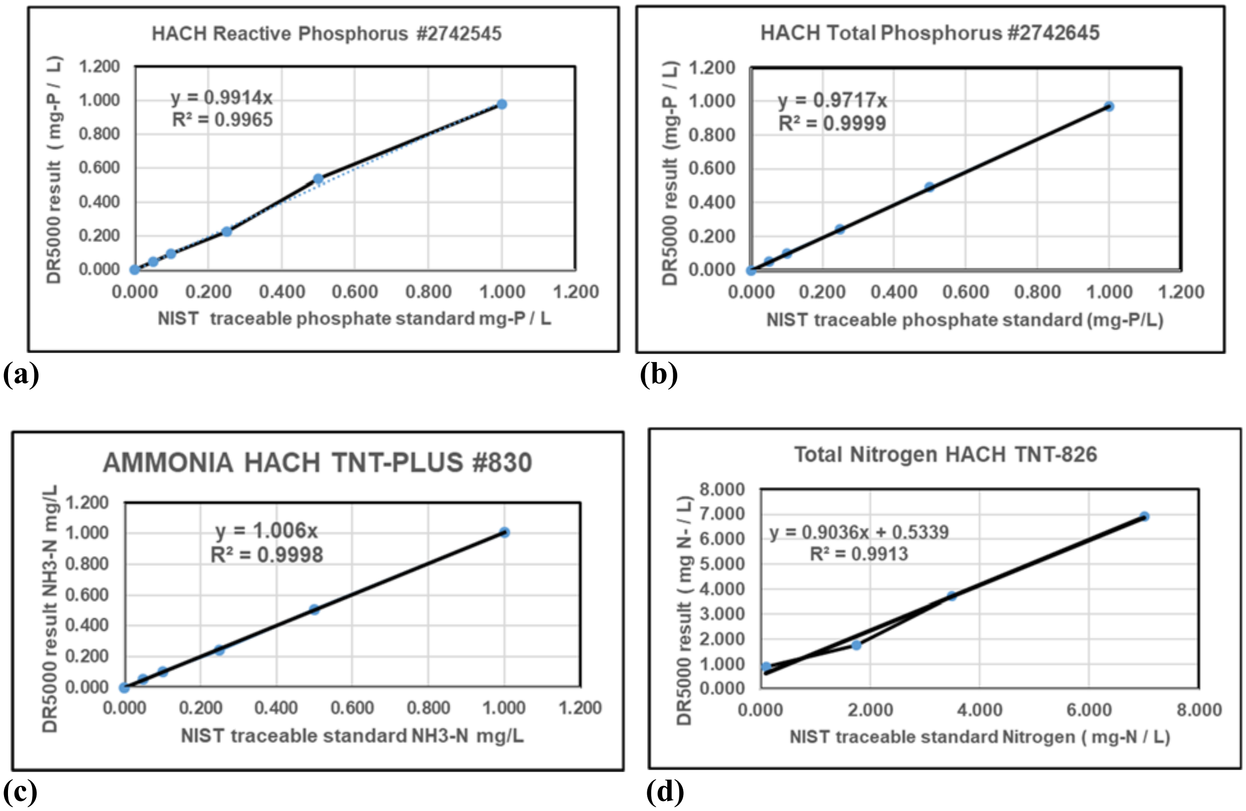
Pigments were extracted from the filters using 3 - 5 mL methanol : acetone : dimethylformamide : water (30:30:03:10, v/v/v/v) with grinding in a 10mL PYREX™ Potter-Elvehjem Tissue Grinder with a PTFE Pestle ice-bath, followed by steeping at refrigerator temperature (~ 4-5 ºC) according to Hagerthey, Louda and Mongkronsri (2006). Ultraviolet visible absorption spectra of pigments were recorded on a Perkin-Elmer Lambda-2 spectrophotometer with Scantraq software calibrated versus a homium oxide standard. Total chlorophyll-a was calculated using the SCOR-UNESCO equation (CHLa = 11.64 (A_{665}) – 2.16 (A_{645}) + 0.10 (A_{630}): See Louda and Monghkonsri, 2004). A few high performance liquid chromatographic (HPLC) full pigment analyses were performed in order to assess the phytoplankton community using pigment-based chemotaxonomy (see Grant and Louda. 2010; Louda, 2008; Louda et al., 2015; Millie et al., 1993). These analyses were not contracted for during the present study and were added at no expense to OUA by the PI (JWmL). HPLC analyses were performed using a Thermo-Separation P4000 quaternary solvent pump, and a Waters 996 photodiode array detector (PDA) with data collection by Waters Empower-2 software.

Primary plant nutrients, nitrogen and phosphorus, were analyzed in the filtrate as follows here. All tests were reagent kits from the HACH Chemical Company (www.hach.com) and performed using a HACH DR5000 spectrophotometer and a digital reactor block (DRB200) for the total nitrogen and total phosphorus tests requiring heated digestion procedures. All tests are EPA certified and were verified (QA/QC) against the following NIST-traceable standards: Phosphate (1 mg/L #256949), Mixed parameter (PO_4 = 10/mg/L; NH_3 = 10 mg/L; NO_3 = 6 mg/L; TN = 7 mg/L: # LCA721), nitrate (10m/L #30749). Dilution series of standards were made using HACH deionized water (#27248).

Total nitrogen was analyzed using the HACH TNT-826 reagent set which included a half-hour persulfate digestion at 120 ºC. Total phosphorus was analyzed using the HACH USEPA PhosVer 3 with acid persulfate digestion method kit (TNT-LR # 2742645) that included a half-hour digestion at 150 ºC. Soluble reactive phosphorus (SRP) was analyzed using the HACH phosphorus-reactive TNT-LR kit (#2742545).

Analyses of NIST-traceable standards served to verify each test. Sample standardization tests are given below in Figure 22. Analyses of HACH deionized water (#27248) provided the zero reading and adjustment for method background readings, if needed.

All tests performed well with R-squared values > 0.99 and y ~ 1.0x. It is noted here that the total nitrogen test is detailed by HACH Chemical Company to be valid only above 1.0 mg-N per liter.



<u>Figure 22</u>: Quality Assurance standardization tests of the nutrient analyses used herein. (a) Reactive Phosphorus (aka SRP), (b) Total phosphorus (TP), (c) Ammonia, (d) Total Nitrogen (TN)

RESULTS and DISCUSSION

A Previous investigation (pre-OUA contract) by the PI.

Prior to being awarded the current contract and the start of this study, the PI had performed an identical, yet very much smaller, investigation of sucralose in the waters of lower Taylor Creek (Figure 23). ***Of particular note here is the fact that at the northern end of the The City of Okeechobee portion of Taylor Creek, sucralose was below detectable levels***. That is, it was below the lower limit of detection for sucralose analysis at the Environmental Research Analytical Laboratory (EARL) of Florida International University (FIU), which is 48.4 ng/L.

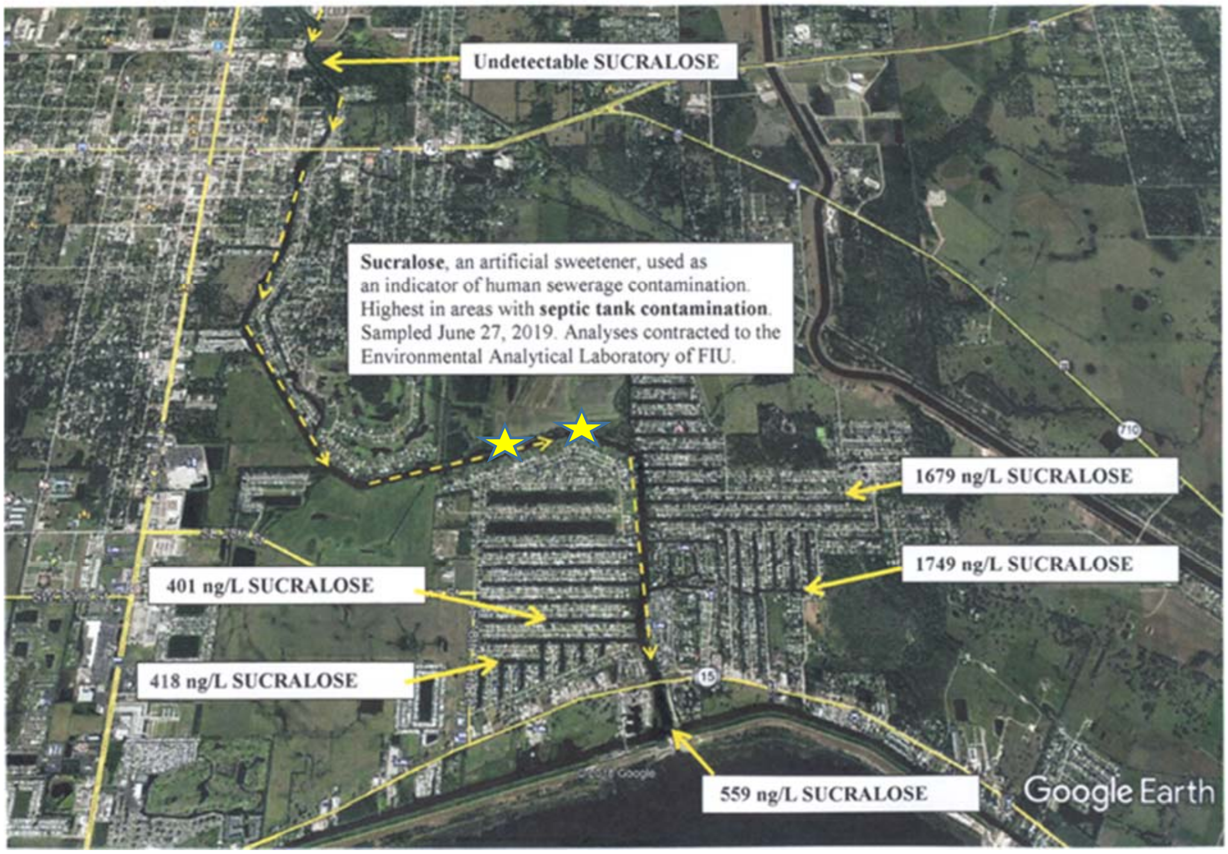


Figure 23: A study performed by the PI (J. Wm. Louda) prior to the current OUA contracted investigation.

The stars indicate the location of the current project sites TC-1(left) and TC-2 (right) which were meant (see Kim, 2019 p.12) as "upstream water quality" sites. TC-1 and TC-2 had mean sucralose concentrations of 380 and 422 ng/L, respectively. However, before passing through The City of Okeechobee Taylor Creek had sucralose below the lower limit of detection (LLD = 48.4 ng /L). Just from this little preliminary study one can note that the mean of the two Treasure Island sites (1,714 ng sucralose / Liter) is 4.2 times as high as the mean (410 ng sucralose / Liter) for sucralose in the canal waters of Taylor Creek Isles.

The data collected during the sixteen sampling events of the OUA contracted study covered many more samples (15) per sampling event, totally 240 samples, are described in the following sections.

Field and Laboratory analyses

Tables 2 through 17 contain all of the data collected at each of the 15 sites for the 16 sampling events of this study that ran from November 2019 through December 2020. These data are discussed following Table 17 in the context of trends. Any anomalously high data values are indicated by a tan highlight.

Table 2: Data, November 20, 2019

								as PO4	As P							
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	µg/L	ng/L
TC-1	20.0	7.60	503	1.98	255	5.77	0.024	0.16	0.052	0.110	3.552	1.40	87.50	24.6	54.00	362
TC-2	20.6	7.38	550	1.81	278	4.22	0.016	0.14	0.046	0.100	3.229	1.72	107.50	33.3	42.44	352
TC-3	20.9	8.09	522	1.91	262	6.62	0.014	0.10	0.033	0.100	3.229	1.39	86.88	26.9	59.66	677
TI-1	19.9	7.70	500	1.99	252	5.98	0.018	0.08	0.026	0.090	2.906	1.44	90.00	31.0	46.90	500
TI-2	20.4	7.74	511	1.95	256	6.45	0.016	0.10	0.033	0.090	2.906	1.38	86.25	29.7	43.96	626
TI-3	20.9	7.76	515	1.93	260	6.49	0.018	0.12	0.039	0.100	3.229	1.41	88.13	27.3	42.74	563
TI-4	20.0	8.17	568	1.75	286	8.86	0.014	0.11	0.036	0.110	3.552	1.56	97.50	27.5	52.99	1,692
TI-5	20.2	8.11	562	1.78	283	9.45	0.017	0.28	0.091	0.160	5.166	1.62	101.25	19.6	51.37	1,534
TI-6	19.7	7.83	484	2.06	243	10.90	0.018	0.08	0.026	0.090	2.906	1.34	83.75	28.8	72.71	975
TCI-1	21.4	8.12	500	1.99	252	6.80	0.019	0.08	0.026	0.090	2.906	1.33	83.13	28.6	56.80	399
TCI-2	21.4	8.20	520	1.91	262	8.91	0.017	0.04	0.013	0.080	2.583	1.31	81.88	31.7	61.50	434
TCI-3	20.8	8.67	512	1.95	254	14.60	0.019	0.14	0.046	0.060	1.937	1.34	83.75	43.2	67.39	336
TCI-4	20.7	8.73	532	1.88	266	13.30	0.018	0.05	0.016	0.060	1.937	1.42	88.75	45.8	56.97	319
TCI-5	20.2	8.45	506	1.96	256	8.48	0.019	0.10	0.033	0.150	4.843	1.36	85.00	17.6	50.60	515
TCI-6	21.5	8.42	490	2.03	246	7.77	0.018	0.06	0.020	0.050	1.614	1.22	76.25	47.2	47.66	443

Table 3: Data, December 16, 2019

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP*	SRP*	TP	P	TN	N	NH3	Atomic	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	mg/L	N:P	µg/L	ng/L
TC-1	23.9	7.98	515	1.92	262	5.23	0.033	0.18	0.059	0.12	3.9	1.18	73.8	0.033	19.0	26.6	257
TC-2	23.8	7.55	507	1.98	253	4.96	0.026	0.22	0.072	0.14	4.5	1.37	85.6	0.026	18.9	35.5	274
TC-3	24.4	8.10	574	1.74	288	7.83	0.024	0.15	0.049	0.11	3.6	1.35	84.4	0.024	23.8	35.6	433
TI-1	23.1	7.70	517	1.96	253	5.11	0.025	0.21	0.068	0.15	4.8	1.35	84.4	0.025	17.4	48.9	365
TI-2	23.0	7.83	519	1.91	262	8.12	0.026	0.25	0.082	0.14	4.5	1.44	90.0	0.026	19.9	47.9	394
TI-3	24.6	7.82	517	1.91	262	6.75	0.026	0.24	0.078	0.16	5.2	1.47	91.9	0.026	17.8	22.6	450
TI-4	23.9	7.91	549	1.79	281	7.47	0.026	0.36	0.117	0.17	5.5	1.54	96.3	0.026	17.5	67.5	828
TI-5	25.3	7.91	560	1.78	273	8.72	0.028	0.33	0.108	0.20	6.5	1.59	99.4	0.028	15.4	68.2	1508
TI-6	22.0	7.78	458	2.17	234	19.20	0.026	0.21	0.068	0.12	3.9	1.37	85.6	0.026	22.1	107.0	909
TCI-1	23.5	7.95	561	1.78	278	7.52	0.030	0.33	0.108	0.17	5.5	1.34	83.8	0.030	15.3	63.7	389
TCI-2	23.8	8.10	552	1.80	273	6.66	0.025	0.26	0.085	0.15	4.8	1.28	80.0	0.025	16.5	58.8	440
TCI-3	24.4	8.73	550	1.83	276	13.40	0.025	0.04	0.013	0.09	2.9	1.29	80.6	0.025	27.7	192.7	309
TCI-4	24.4	8.64	530	1.88	262	12.50	0.024	0.04	0.013	0.07	2.3	1.28	80.0	0.024	35.4	84.5	312
TCI-5	23.6	8.38	512	1.92	261	7.33	0.023	0.17	0.055	0.11	3.6	1.29	80.6	0.023	22.7	56.0	326
TCI-6	24.8	8.41	551	1.82	277	10.00	0.026	0.06	0.020	0.07	2.3	1.49	93.1	0.026	41.2	61.9	324

Table 4: Data January 14, 2020																
								as PO4	As P							
			Cond		TDS	Turb	NH3	SRP*	SRP*	TP	P	TN	N	Atomic	CHL-a	Sucralose
SITE	T^oC	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	µg/L	ng/L
TC-1	25.0	7.94	481	2.11	238	5.51	xx	0.19	0.062	0.13	4.2	1.11	69.4	16.5	54.7	302
TC-2	25.1	8.07	512	1.95	257	5.06	xx	0.30	0.098	0.23	7.4	1.25	78.1	10.5	55.6	308
TC-3	23.1	8.47	598	1.66	303	5.97	xx	0.39	0.127	0.21	6.8	1.37	85.6	12.6	40.0	367
TI-1	23.1	8.13	519	1.83	275	5.44	xx	0.33	0.108	0.23	7.4	1.27	79.4	10.7	82.4	325
TI-2	22.9	8.06	507	1.97	254	6.67	xx	0.41	0.134	0.19	6.1	1.37	85.6	14.0	60.2	543
TI-3	23.2	8.15	525	1.90	255	6.59	xx	0.62	0.202	0.28	9.0	1.46	91.3	10.1	64.9	842
TI-4	22.9	8.32	586	1.71	294	7.88	xx	0.51	0.166	0.22	7.1	1.43	89.4	12.6	60.0	1696
TI-5	22.1	8.37	578	1.72	292	7.84	xx	0.42	0.137	0.16	5.2	1.49	93.1	18.0	52.9	1807
TI-6	22.4	8.09	521	1.91	262	8.24	xx	0.50	0.163	0.22	7.1	1.21	75.6	10.6	82.5	951
TCI-1	23.1	8.27	503	2.05	247	3.92	xx	0.90	0.293	0.34	11.0	1.77	110.6	10.1	46.7	321
TCI-2	23.4	8.41	537	1.85	272	6.43	xx	0.62	0.202	0.25	8.1	1.43	89.4	11.1	66.2	337
TCI-3	24.5	9.25	587	1.74	292	13.20	xx	0.03	0.010	0.05	1.6	1.38	86.3	53.4	54.0	345
TCI-4	24.4	9.20	568	1.75	281	14.10	xx	0.04	0.013	0.06	1.9	1.28	80.0	41.3	48.6	334
TCI-5	23.7	8.90	569	1.75	286	11.80	xx	0.09	0.029	0.13	4.2	1.37	85.6	20.4	69.9	184
TCI-6	25.1	9.00	564	1.76	286	11.90	xx	0.21	0.068	0.13	4.2	1.41	88.1	21.0	93.3	341

Table 5: Data, February 4, 2020																	
								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T^oC	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	18.1	8.25	536	1.86	299	5.42	xx	0.32	0.104	0.170	5.5	1.08	67.5	12.3	109	108	295
TC-2	18.6	8.14	582	1.72	290	4.96	xx	0.22	0.072	0.100	3.2	5.05	315.6	97.8	123	112	314
TC-3	19.5	8.36	552	1.80	275	7.36	xx	0.55	0.179	0.260	8.4	1.34	83.8	10.0	94	65	372
TI-1	18.3	8.18	534	1.86	269	4.66	xx	0.37	0.121	0.180	5.8	1.19	74.4	12.8	97	116	337
TI-2	19.5	8.48	481	2.07	243	7.48	xx	0.41	0.134	0.250	8.1	1.15	71.9	8.9	115	168	452
TI-3	18.4	8.42	537	1.85	272	6.81	xx	0.38	0.124	0.260	8.4	1.46	91.3	10.9	109	171	563
TI-4	17.8	8.38	587	1.70	293	8.85	xx	0.37	0.121	0.170	5.5	1.28	80.0	14.6	84	79	1649
TI-5	18.1	8.66	623	1.61	311	8.66	xx	0.29	0.095	0.140	4.5	1.39	86.9	19.2	98	64	1767
TI-6	17.4	8.25	527	1.89	265	8.15	xx	0.48	0.156	0.210	6.8	1.11	69.4	10.2	89	58	1030
TCI-1	18.8	8.50	509	1.95	259	5.50	xx	0.53	0.173	0.250	8.1	0.62	38.8	4.8	109	146	317
TCI-2	19.1	8.70	538	1.85	267	6.18	xx	0.48	0.156	0.230	7.4	1.38	86.3	11.6	106	103	302
TCI-3	19.4	9.25	575	1.73	283	14.90	xx	0.08	0.026	0.060	1.9	1.16	72.5	37.4	132	67	320
TCI-4	19.8	9.19	577	1.75	288	12.51	xx	0.03	0.010	0.070	2.3	1.21	75.6	33.5	124	67	329
TCI-5	19.7	8.98	553	1.81	277	9.06	xx	0.43	0.140	0.200	6.5	1.67	104.4	16.2	124	85	336
TCI-6	19.1	8.85	533	1.87	266	8.10	xx	0.26	0.085	0.150	4.8	1.34	83.8	17.3	130	87	333

Table 6: Data, February 18, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP*	SRP*	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T^{o}C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	24.5	8.11	526	1.90	263	6.42	0.04	0.37	0.121	0.19	6.1	1.25	78.1	12.7	85.2	68	284
TC-2	24.8	8.09	535	1.86	269	7.96	0.03	0.36	0.117	0.20	6.5	0.72	45.0	7.0	86.7	92	280
TC-3	26.3	8.42	610	1.64	305	7.11	0.03	0.68	0.222	0.24	7.7	1.09	68.1	8.8	102.0	80	391
TI-1	24.1	8.09	560	1.78	280	5.35	0.04	0.45	0.147	0.23	7.4	1.17	73.1	9.8	76.9	60	330
TI-2	25.6	8.29	551	1.81	276	6.61	0.02	0.62	0.202	0.24	7.7	1.12	70.0	9.0	94.7	96	573
TI-3	24.7	8.18	563	1.77	279	9.10	0.02	0.76	0.248	0.27	8.7	1.45	90.6	10.4	81.7	84	805
TI-4	24.4	8.21	616	1.63	308	9.20	0.02	0.48	0.156	0.20	6.5	1.18	73.8	11.4	80.5	91	1904
TI-5	24.7	8.54	628	1.59	314	9.82	0.02	0.39	0.127	0.17	5.5	1.30	81.3	14.8	107.0	69	1950
TI-6	24.5	8.10	518	1.92	260	9.13	0.01	0.55	0.179	0.23	7.4	1.06	66.3	8.9	94.5	87	1066
TCI-1	25.0	8.48	558	1.79	280	5.30	0.01	0.72	0.235	0.30	9.7	1.15	71.9	7.4	101.0	96	322
TCI-2	25.1	8.33	559	1.79	279	7.55	0.01	0.75	0.245	0.28	9.0	1.14	71.3	7.9	103.0	109	344
TCI-3	27.3	9.24	578	1.73	289	15.60	0.02	0.07	0.023	0.07	2.3	1.21	75.6	33.5	138.0	57	334
TCI-4	25.2	9.17	583	1.72	291	18.90	0.02	0.06	0.020	0.06	1.9	1.02	63.8	32.9	156.0	95	324
TCI-5	26.1	9.06	554	1.79	280	16.50	0.02	0.05	0.016	0.07	2.3	1.12	70.0	31.0	139.0	76	176
TCI-6	25.9	8.71	547	1.82	275	8.00	0.01	0.39	0.127	0.18	5.8	1.13	70.6	12.2	131.0	109	333

Table 7: Data, March 23, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T^{o}C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	26.4	8.12	568	1.75	285	6.02	0.018	0.45	0.147	0.22	7.1	1.30	81.3	11.4	69	53	274
TC-2	26.5	7.98	592	1.69	296	7.49	0.028	0.50	0.163	0.18	5.8	1.43	89.4	15.4	76	32	310
TC-3	27.4	8.60	639	1.55	315	10.60	0.031	0.32	0.104	0.14	4.5	1.42	88.8	19.6	127	59	392
TI-1	26.6	8.36	590	1.69	295	7.46	0.260	0.45	0.147	0.20	6.5	1.22	76.3	11.8	86	45	362
TI-2	26.2	8.46	572	1.71	292	10.70	0.016	0.38	0.124	0.20	6.5	1.31	81.9	12.7	112	56	568
TI-3	26.3	8.80	625	1.61	311	15.30	0.025	0.50	0.163	0.18	5.8	1.55	96.9	16.7	112	72	751
TI-4	25.5	8.85	666	1.50	333	19.90	0.044	0.32	0.104	0.13	4.2	1.73	108.1	25.8	118	100	2307
TI-5	26.3	9.19	649	1.54	323	19.60	0.036	0.17	0.055	0.13	4.2	1.63	101.9	24.3	144	82	2053
TI-6	27.1	8.90	563	1.77	282	17.00	0.025	0.15	0.049	0.11	3.6	1.34	83.8	23.6	120	79	1188
TCI-1	27.5	9.60	608	1.66	302	10.20	0.032	0.29	0.095	0.24	7.7	1.62	101.3	13.1	118	72	391
TCI-2	27.0	8.92	601	1.66	301	13.30	bdl	0.45	0.147	0.21	6.8	1.21	75.6	11.2	140	78	378
TCI-3	26.9	8.90	581	1.76	287	16.60	0.068	0.16	0.052	0.07	2.3	1.54	96.3	42.6	140	81	319
TCI-4	27.2	9.15	579	1.73	288	41.60	0.074	0.13	0.042	0.07	2.3	1.44	90.0	39.8	181	95	340
TCI-5	27.4	9.18	581	1.72	291	37.90	0.039	0.32	0.104	0.11	3.6	1.37	85.6	24.1	162	90	433
TCI-6	27.5	9.24	612	1.63	304	14.20	0.027	0.16	0.052	0.12	3.9	1.45	90.6	23.4	176	96	354

Table 8: Data, April 14, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP*	SRP*	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	mM	mg/L	mM	N:P	%	mg/L	ng/L
TC-1	29.1	8.26	611	1.65	305	11.40	xx	0.29	0.095	0.18	5.8	1.45	90.6	15.6	82	46	298
TC-2	28.7	8.18	631	1.58	317	12.90	xx	0.35	0.114	0.16	5.2	1.44	90.0	17.4	87	82	400
TC-3	30.9	9.30	679	1.47	342	16.30	xx	0.14	0.046	0.10	3.2	0.87	54.4	16.8	189	93	513
TI-1	28.9	8.12	617	1.61	310	17.90	xx	0.12	0.039	0.13	4.2	1.30	81.3	19.4	125	88	531
TI-2	29.7	9.07	609	1.64	303	15.40	xx	0.20	0.065	0.13	4.2	1.30	81.3	19.4	150	80	742
TI-3	30.7	9.01	633	1.56	322	23.40	xx	0.08	0.026	0.12	3.9	1.38	86.3	22.3	164	86	1355
TI-4	29.4	9.03	639	1.57	320	25.90	xx	0.19	0.062	0.12	3.9	1.59	99.4	25.6	156	135	2307
TI-5	30.4	9.07	663	1.52	330	20.30	xx	0.17	0.055	0.13	4.2	1.65	103.1	24.6	215	107	2141
TI-6	29.0	9.13	584	1.73	290	22.40	xx	0.15	0.049	0.12	3.9	1.89	118.1	30.5	203	94	1217
TCI-1	29.7	8.97	607	1.64	307	17.90	xx	0.17	0.055	0.15	4.8	1.34	83.8	17.3	215	104	531
TCI-2	30.9	9.48	624	1.60	310	19.70	xx	0.10	0.033	0.10	3.2	1.56	97.5	30.2	231	115	511
TCI-3	33.2	9.46	578	1.73	290	43.20	xx	0.09	0.029	0.08	2.6	1.59	99.4	38.5	248	89	359
TCI-4	33.4	9.50	550	1.80	270	48.50	xx	0.09	0.029	0.07	2.3	1.77	110.6	48.9	233	99	401
TCI-5	31.2	9.63	600	1.67	297	43.40	xx	0.10	0.033	0.08	2.6	1.69	105.6	40.9	245	109	425
TCI-6	31.7	9.80	604	1.65	302	27.60	xx	0.08	0.026	0.10	3.2	6.47	404.4	125.2	283	102	449

Table 9: Data,May 11, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	26.5	8.40	546	1.82	272	12.6	0.024	0.17	0.055	0.14	4.5	1.26	78.8	17.4	86	68	227
TC-2	26.6	8.40	588	1.70	294	13.8	0.220	0.17	0.055	0.12	3.9	1.25	78.1	20.2	91	102	293
TC-3	27.4	9.20	627	1.59	315	19.0	0.035	0.06	0.020	0.09	2.9	1.42	88.8	30.5	117	93	579
TI-1	26.1	8.70	578	1.71	292	18.0	0.056	0.05	0.016	0.10	3.2	1.60	100.0	31.0	89	102	495
TI-2	25.5	8.70	589	1.68	294	20.5	0.043	0.16	0.052	0.12	3.9	1.58	98.8	25.5	120	77	445
TI-3	26.0	8.90	612	1.63	307	17.8	0.043	0.10	0.033	0.12	3.9	1.56	97.5	25.2	128	86	699
TI-4	26.2	8.90	602	1.66	300	23.7	0.052	0.11	0.036	0.12	3.9	1.97	123.1	31.8	91	104	2183
TI-5	26.6	9.00	626	1.62	312	28.5	0.046	0.09	0.029	0.11	3.6	1.80	112.5	31.7	122	116	1967
TI-6	25.0	8.70	499	2.02	248	49.0	0.059	0.09	0.029	0.10	3.2	1.58	98.8	30.6	143	183	1208
TCI-1	27.2	9.20	607	1.64	305	19.2	0.047	0.10	0.033	0.11	3.6	1.41	88.1	24.8	125	130	509
TCI-2	26.7	9.20	604	1.64	300	21.6	0.048	0.06	0.020	0.09	2.9	3.52	220.0	75.7	150	137	541
TCI-3	26.3	9.40	543	1.85	271	40.6	0.071	0.06	0.020	0.08	2.6	1.40	87.5	33.9	140	103	376
TCI-4	25.2	9.20	565	1.76	281	43.6	0.079	0.06	0.020	0.08	2.6	1.48	92.5	35.8	143	99	381
TCI-5	25.5	9.40	586	1.70	295	35.8	0.056	0.05	0.016	0.09	2.9	1.30	81.3	28.0	170	115	489
TCI-6	27.1	9.40	578	1.74	289	30.0	0.049	0.06	0.020	0.09	2.9	1.39	86.9	29.9	150	95	486

Table 10: Data, June 15, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP*	SRP*	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	30.3	7.2	422	2.37	210	4.50	0.090	2.45	0.799	0.86	27.8	1.93	120.6	4.3	85	59	209
TC-2	30.2	7.2	415	2.40	207	4.80	0.187	0.70	0.228	0.25	8.1	1.99	124.4	15.4	78	22	229
TC-3	30.2	7.1	452	2.21	226	5.40	0.303	0.71	0.231	0.28	9.0	2.25	140.6	15.6	58	36	267
TI-1	30.2	7.2	462	2.18	230	6.80	0.153	0.35	0.114	0.18	5.8	2.03	126.9	21.8	64	29	413
TI-2	29.8	7.3	461	2.16	232	6.00	0.222	0.42	0.137	0.19	6.1	2.04	127.5	20.8	82	27	450
TI-3	30.3	7.6	535	1.89	266	11.00	0.031	0.20	0.065	0.12	3.9	1.80	112.5	29.0	118	77	1554
TI-4	30.2	7.7	556	1.79	280	13.60	0.031	0.11	0.036	0.10	3.2	1.71	106.9	33.1	122	121	2280
TI-5	30.5	7.7	588	1.70	294	10.80	0.029	0.07	0.023	0.08	2.6	1.77	110.6	42.8	130	64	2056
TI-6	30.6	7.6	466	2.15	233	12.60	0.030	0.07	0.023	0.07	2.3	1.69	105.6	46.7	156	84	1354
TCI-1	31.1	7.4	494	2.03	246	6.00	0.144	0.40	0.130	0.19	6.1	1.97	123.1	20.1	113	59	292
TCI-2	30.7	7.8	486	2.06	242	11.10	0.029	0.19	0.062	0.11	3.6	1.50	93.8	26.4	157	63	324
TCI-3	31.0	8.2	551	1.81	275	16.30	0.034	0.13	0.042	0.06	1.9	1.65	103.1	53.2	181	52	229
TCI-4	30.7	8.4	542	1.84	272	19.90	0.042	0.05	0.016	0.06	1.9	1.48	92.5	47.7	179	66	247
TCI-5	31.3	7.2	509	1.97	254	16.60	0.040	0.05	0.016	0.06	1.9	1.57	98.1	50.7	207	117	310
TCI-6	31.7	8.3	519	1.93	259	13.20	0.026	0.05	0.016	0.07	2.3	1.48	92.5	40.9	132	116	308

Table 11: Data: July 6, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	31.4	8.0	511	1.97	255	5.7	0.097	0.82	0.260	0.27	8.72	1.77	110.63	12.7	75	41	328
TC-2	31.2	8.0	500	2.00	250	5.1	0.142	0.74	0.230	0.24	7.75	1.83	114.38	14.8	54	64	297
TC-3	32.1	8.7	667	1.48	333	6.2	0.023	0.09	0.029	0.12	3.87	1.57	98.13	25.3	126	108	408
TI-1	31.3	8.1	500	2.00	250	6.5	0.074	0.06	0.018	0.19	6.13	1.83	114.38	18.6	80	64	350
TI-2	31.2	8.2	493	2.03	247	7.8	0.031	0.25	0.082	0.16	5.17	1.77	110.63	21.4	87	89	564
TI-3	31.7	8.1	505	1.98	253	7.0	0.032	0.54	0.176	0.18	5.81	1.69	105.63	18.2	83	84	468
TI-4	30.3	8.3	613	1.64	307	10.7	0.031	0.09	0.029	0.06	1.94	1.69	105.63	54.5	79	85	2453
TI-5	31.0	8.6	607	1.65	305	7.7	0.026	0.08	0.026	0.05	1.61	1.81	113.13	70.1	105	82	2094
TI-6	30.6	8.4	485	2.06	243	11.9	0.032	0.19	0.062	0.06	1.94	1.37	85.63	44.2	111	88	1486
TCI-1	30.7	8.4	486	2.05	243	7.4	0.028	0.42	0.137	0.16	5.17	1.72	107.50	20.8	104	99	422
TCI-2	31.8	8.7	509	1.97	254	8.9	0.028	0.42	0.137	0.14	4.52	1.59	99.38	22.0	124	75	456
TCI-3	33.5	9.1	527	1.86	273	23.8	0.047	0.18	0.059	0.06	1.94	1.45	90.63	46.8	177	68	259
TCI-4	32.6	9.2	547	1.83	273	24.2	0.048	0.08	0.026	0.03	0.97	1.44	90.00	92.9	178	101	275
TCI-5	32.6	8.8	526	1.90	262	10.1	0.032	0.23	0.075	0.10	3.23	1.59	99.38	30.8	138	86	454
TCI-6	32.5	9.1	509	1.96	256	12.7	0.029	0.10	0.033	0.04	1.29	1.06	66.25	51.3	154	61	352

Table 12: Data, July 20, 2020																	
								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP*	SRP*	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS[a]	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	30.3	7.8	372	2.79	185	4.27	0.083	0.65	0.212	0.250	8.07	1.58	98.8	12.2	30	38	278
TC-2	30.1	7.8	465	2.15	232	4.36	0.128	0.72	0.235	0.260	8.40	1.67	104.4	12.4	55	43	277
TC-3	31.0	8.5	477	2.11	238	6.33	0.027	0.39	0.127	0.160	5.17	1.54	96.3	18.6	112	166	414
TI-1	30.7	8.0	475	2.10	237	7.60	0.034	0.25	0.082	0.110	3.55	1.64	102.5	28.9	80	49	398
TI-2	30.7	8.0	475	2.10	238	6.56	0.029	0.29	0.095	0.140	4.52	1.53	95.6	21.2	98	59	625
TI-3	30.7	8.2	530	1.90	264	7.81	0.031	0.15	0.049	0.090	2.91	1.68	105.0	36.1	119	107	1433
TI-4	30.0	8.3	554	1.79	280	10.40	0.029	0.01	0.003	0.070	2.26	1.70	106.3	47.0	88	116	1742
TI-5	30.4	8.3	571	1.75	284	9.46	0.030	0.03	0.010	0.070	2.26	1.90	118.8	52.5	104	106	1546
TI-6	30.9	8.0	439	2.27	222	11.00	0.031	0.09	0.029	0.070	2.26	1.35	84.4	37.3	109	93	1250
TCI-1	31.1	8.2	477	2.12	237	5.89	0.024	0.34	0.111	0.150	4.84	1.52	95.0	19.6	114	67	366
TCI-2	30.2	8.3	474	2.13	236	6.19	0.028	0.41	0.134	0.150	4.84	1.44	90.0	18.6	121	88	405
TCI-3	30.8	9.1	497	2.01	249	20.30	0.045	0.05	0.016	0.040	1.29	1.32	82.5	63.9	148	121	243
TCI-4	30.8	8.9	507	1.97	255	21.20	0.044	0.09	0.029	0.040	1.29	1.34	83.8	64.8	138	103	262
TCI-5	30.7	9.0	500	2.00	250	18.00	0.037	0.02	0.007	0.050	1.61	1.35	84.4	52.3	148	103	274
TCI-6	31.7	8.9	482	2.07	241	10.80	0.026	0.09	0.029	0.050	1.61	1.51	94.4	58.5	149	94	481

Table 13: Data, August 17, 2020																	
								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	31.0	7.7	460	2.21	229	2.70	0.354	0.79	0.258	0.36	11.62	2.35	146.9	12.6	52	26	1468
TC-2	31.2	7.6	470	2.12	236	2.80	0.292	0.68	0.222	0.35	11.30	2.44	152.5	13.5	45	27	212
TC-3	33.0	8.0	428	2.35	213	6.60	0.076	0.53	0.173	0.27	8.72	1.77	110.6	12.7	114	62	328
TI-1	31.5	7.9	410	2.44	205	5.30	0.043	0.35	0.114	0.24	7.75	1.80	112.5	14.5	62	95	211
TI-2	31.6	7.8	408	2.45	204	7.60	0.061	0.54	0.176	0.27	8.72	1.73	108.1	12.4	82	55	623
TI-3	31.9	8.2	541	1.86	270	12.40	0.033	0.31	0.101	0.21	6.78	1.82	113.8	16.8	93	48	364
TI-4	31.3	8.1	578	1.73	290	10.30	0.032	0.22	0.072	0.19	6.13	1.89	118.1	19.3	83	120	1758
TI-5	31.3	8.1	569	1.76	284	7.50	0.086	0.32	0.104	0.21	6.78	2.16	135.0	19.9	83	128	1412
TI-6	31.7	8.1	468	2.14	234	8.40	0.024	0.20	0.065	0.17	5.49	1.37	85.6	15.6	113	99	1541
TCI-1	32.3	8.1	431	2.33	215	6.00	0.126	0.51	0.166	0.30	9.69	2.19	136.9	14.1	96	97	318
TCI-2	32.4	8.4	445	2.25	222	7.20	0.033	0.50	0.163	0.22	7.10	1.67	104.4	14.7	123	82	561
TCI-3	32.4	8.9	484	2.06	239	23.10	0.024	0.08	0.026	0.13	4.20	1.28	80.0	19.1	210	89	166
TCI-4	33.0	9.0	497	2.00	250	24.20	0.027	0.13	0.042	0.12	3.87	1.34	83.8	21.6	182	105	277
TCI-5	32.7	8.8	491	2.06	243	19.00	0.080	0.10	0.033	0.13	4.20	3.13	195.6	46.6	152	87	264
TCI-6	32.4	8.7	488	2.04	242	9.20	0.023	0.18	0.059	0.14	4.52	1.39	86.9	19.2	125	94	264

Table 14: Data, SEPT. 14, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	mM	mg/L	µM	N:P	%	mg/L	ng/L
TC-1	28.4	7.8	483	2.07	242	2.74	0.389	0.85	0.277	0.32	10.33	2.08	130.0	12.6	32	39	258
TC-2	28.2	7.6	423	2.36	212	3.56	0.391	0.65	0.212	0.27	8.72	1.97	123.1	14.1	37	14	217
TC-3	27.6	7.6	300	3.28	154	4.81	0.441	0.73	0.238	0.27	8.72	1.98	123.8	14.2	33	28	366
TI-1	28.4	7.7	414	2.40	205	4.90	0.400	0.91	0.297	0.32	10.33	2.13	133.1	12.9	65	34	705
TI-2	27.6	7.6	389	2.61	194	6.44	0.335	0.57	0.186	0.19	6.13	1.76	110.0	17.9	52	57	522
TI-3	28.3	7.5	467	2.18	231	4.70	0.630	0.64	0.209	0.25	8.07	2.34	146.3	18.1	32	50	924
TI-4	28.2	7.5	458	2.18	231	5.02	0.876	0.87	0.284	0.34	10.98	4.04	252.5	23.0	28	35	1201
TI-5	28.2	7.4	377	2.64	184	4.25	0.721	0.55	0.179	0.20	6.46	2.64	165.0	25.6	32	34	672
TI-6	28.8	7.9	770	2.33	218	5.06	0.237	0.68	0.222	0.25	8.07	1.68	105.0	13.0	73	66	1127
TCI-1	29.0	7.9	437	2.28	219	4.38	0.288	0.49	0.160	0.19	6.13	1.86	116.3	18.9	73	48	283
TCI-2	29.6	8.1	481	2.08	239	8.15	0.334	0.50	0.163	0.21	6.78	1.80	112.5	16.6	130	49	323
TCI-3	29.5	8.3	460	2.21	229	10.80	0.063	0.00	0.000	0.03	0.97	1.33	83.1	85.8	122	85	101
TCI-4	29.8	8.7	485	2.06	244	16.10	0.023	0.00	0.000	0.01	0.32	1.22	76.3	236.2	189	76	121
TCI-5	29.9	8.7	468	2.13	232	14.00	0.085	0.23	0.075	0.07	2.26	1.48	92.5	40.9	174	149	269
TCI-6	29.1	7.8	410	2.51	203	3.76	0.072	0.00	0.000	0.04	1.29	1.39	86.9	67.3	50	91	249

Table 15: Data, OCT.12, 2020

								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	mg/L	ng/L
TC-1	29.0	7.6	380	2.63	190	3.49	0.696	0.75	0.245	0.35	11.30	2.48	155.0	13.7	21	15	267
TC-2	28.8	7.8	372	2.69	186	2.93	0.628	0.74	0.241	0.32	10.33	2.36	147.5	14.3	21	11	240
TC-3	29.6	8.1	383	2.84	176	5.47	0.307	0.61	0.199	0.26	8.40	1.93	120.6	14.4	58	49	363
TI-1	28.6	7.7	300	3.32	150	2.92	0.317	1.07	0.349	0.37	11.95	2.00	125.0	10.5	25	43	965
TI-2	28.8	7.8	356	2.81	178	3.46	0.438	0.79	0.258	0.29	9.36	1.99	124.4	13.3	41	35	676
TI-3	29.0	7.9	423	2.36	213	4.13	0.420	0.82	0.267	0.29	9.36	2.39	149.4	16.0	33	57	621
TI-4	29.0	7.9	481	2.08	240	3.81	0.602	1.20	0.391	0.40	12.92	2.47	154.4	12.0	30	45	1470
TI-5	28.7	7.9	406	2.46	203	4.97	0.552	0.71	0.231	0.27	8.72	2.45	153.1	17.6	54	71	853
TI-6	28.5	7.7	423	2.35	213	3.35	0.204	0.85	0.277	0.30	9.69	1.68	105.0	10.8	15	46	2254
TCI-1	29.7	7.9	377	2.64	189	4.75	0.231	0.73	0.238	0.24	7.75	1.82	113.8	14.7	66	54	242
TCI-2	30.4	8.1	382	2.62	191	6.48	0.143	0.60	0.196	0.20	6.46	1.53	95.6	14.8	109	99	258
TCI-3	30.1	8.7	486	2.06	243	14.90	0.043	0.05	0.016	0.04	1.29	0.82	51.3	39.7	156	98	54
TCI-4	29.6	8.8	482	2.08	240	18.50	0.023	0.04	0.013	0.04	1.29	0.81	50.6	39.2	94	84	92
TCI-5	29.6	8.3	469	2.14	234	18.10	0.024	0.13	0.042	0.05	1.61	1.07	66.9	41.4	100	28	96
TCI-6	30.0	8.1	423	2.36	212	4.78	0.277	0.46	0.150	0.45	14.53	0.60	37.5	2.6	73	53	225

Table 16: Data, NOV. 13, 2020																	
								as PO4	As P								
			Cond		TDS	Turb	NH3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	µg/L	ng/L
TC-1	25.9	7.9	364	2.75	182	3.21	0.525	0.90	0.293	0.31	10.01	2.48	155.0	15.5	32	7.3	193
TC-2	25.9	7.7	377	2.65	156	2.99	0.539	0.97	0.316	0.35	11.30	2.42	151.3	13.4	32	5.4	202
TC-3	26.8	7.8	389	2.57	194	4.05	0.478	0.86	0.280	0.30	9.69	2.17	135.6	14.0	40	18.3	434
TI-1	25.9	7.7	320	3.09	160	3.55	0.311	1.27	0.414	0.45	14.53	2.21	138.1	9.5	23	3.3	960
TI-2	26.1	7.8	399	2.50	200	5.76	0.520	0.87	0.284	0.29	9.36	2.19	136.9	14.6	49	36.1	1089
TI-3	26.3	7.7	456	2.19	228	2.93	0.544	1.02	0.333	0.35	11.30	2.37	148.1	13.1	18	18.1	584
TI-4	26.2	7.7	521	1.91	261	3.23	0.704	1.29	0.421	0.43	13.88	2.63	164.4	11.8	18	18.4	1585
TI-5	26.8	7.8	462	2.16	231	2.45	0.364	1.09	0.355	0.37	11.79	2.50	156.3	13.3	23	1.9	1125
TI-6	26.1	7.8	438	2.29	219	8.28	0.252	0.77	0.251	0.26	8.40	1.64	102.5	12.2	62	78.5	1820
TCI-1	26.8	8.0	423	2.37	211	4.04	0.355	0.61	0.199	0.21	6.78	2.14	133.8	19.7	68	45.4	238
TCI-2	26.8	8.0	410	2.42	207	6.33	0.257	0.46	0.150	0.20	6.46	2.08	130.0	20.1	92	42.0	130
TCI-3	26.8	8.7	521	1.92	260	12.40	0.037	0.02	0.007	0.03	0.97	2.05	128.1	132.3	169	144.4	91
TCI-4	27.1	8.8	534	1.87	269	14.50	0.022	0.09	0.029	0.03	0.97	1.27	79.4	81.9	183	158.8	108
TCI-5	27.0	8.8	528	1.91	263	19.00	0.025	0.07	0.023	0.03	0.97	1.32	82.5	85.2	179	102.9	163
TCI-6	26.7	8.2	451	2.21	225	5.84	0.086	0.36	0.117	0.12	3.87	1.80	112.5	29.0	112	54.0	308

Table 17: Data, Dec. 5, 2020																	
								as PO_4	As P								
			Cond		TDS	Turb	NH_3	SRP	SRP	TP	P	TN	N	Atomic	D.O.	CHL-a	Sucralose
SITE	T°C	pH	µS	kΩ	ppm	NTU	mg/L	mg/L	mg/L	mg/L	µM	mg/L	µM	N:P	%	mg/L	ng/L
TC-1	20.2	7.7.	409	2.44	204	2.19	0.250	0.42	0.137	0.16	5.17	2.19	136.9	26.5	58	16	458
TC-2	20.0	7.8	405	2.45	199	2.35	0.213	0.43	0.140	0.16	5.17	2.35	146.9	28.4	59	12	409
TC-3	19.8	7.8	407	2.56	202	2.91	0.135	0.50	0.163	0.18	5.81	1.88	117.5	20.2	53	23	344
TI-1	20.0	7.9	396	2.49	203	2.80	0.164	0.46	0.150	0.17	5.49	2.10	131.3	23.9	62	28	454
TI-2	20.0	8.0	464	2.14	228	7.40	0.153	0.49	0.160	0.17	5.49	2.04	127.5	23.2	92	21	785
TI-3	20.7	8.0	429	2.36	213	2.79	0.109	0.47	0.153	0.17	5.49	1.87	116.9	21.3	69	30	437
TI-4	20.7	8.1	526	1.89	267	3.32	0.070	0.88	0.287	0.30	9.69	2.18	136.3	14.1	64	53	1512
TI-5	19.9	8.2	530	1.88	265	2.30	0.075	1.02	0.333	0.34	10.98	2.65	165.6	15.1	44	19	1348
TI-6	21.3	8.2	435	2.33	216	4.31	0.018	0.42	0.137	0.16	5.17	0.93	58.1	11.3	94	84	2249
TCI-1	21.3	8.3	430	2.32	216	4.86	0.025	0.33	0.108	0.14	4.52	2.10	131.3	29.0	94	70	428
TCI-2	20.9	8.5	489	2.04	244	7.06	0.071	0.34	0.111	0.13	4.20	1.89	118.1	28.1	104	54	343
TCI-3	21.3	8.6	496	2.02	248	7.05	0.019	0.05	0.016	0.03	0.97	1.25	78.1	80.7	121	63	83
TCI-4	22.0	9.0	561	1.77	281	11.70	0.021	0.07	0.023	0.04	1.29	1.21	75.6	58.6	178	81	171
TCI-5	21.9	9.1	583	1.72	291	8.75	0.037	0.29	0.095	0.11	3.55	1.54	96.3	27.1	158	47	328
TCI-6	20.6	8.5	416	2.43	207	9.00	0.033	0.14	0.046	0.08	2.58	1.56	97.5	37.7	73	55	343

The data compendia given above (Tables 2-17) provide the month-by-month full data sets but make trends difficult to visualize. Therefore, Tables 18-23 are provided for selected main parameters in order to reveal means, media, standard deviations and the minimal and maximal concentrations of each parameter found during the present study. These data and derived statistics are discussed following Table 24 below.

In order to provide a more graphic visual presentation, certain of data sets are presented as line graphs in Figures 24 – 31 below. The yellow in Table 24 highlights the sites away from Taylor Creek itself in both subdivisions. The light brown highlights call attention to unexplained anomalous data. Blue highlights indicate data that was below detectable levels (bdl) of the analytical method.

Table 18: Ammonia concentration (mg / L) data for the sixteen sampling events from Nov. 2019 through Dec. 2020.

	Taylor Creek Isles (TCI)						Taylor Creek (TC)			Treasure Island (TI)					
	TCI-1	TCI-2	TCI-3	TCI-4	TCI-5	TCI-6	TC-1	TC-2	TC-3	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
Nov. 20, 2019	0.019	0.017	0.190	0.018	0.019	0.018	0.024	0.016	0.014	0.018	0.016	0.018	0.014	0.017	0.018
Dec.16, 2019	0.030	0.025	0.025	0.024	0.023	0.026	0.033	0.026	0.024	0.025	0.026	0.026	0.026	0.028	0.026
Feb. 18, 2020	0.014	0.013	0.019	0.017	0.018	0.013	0.036	0.027	0.028	0.036	0.015	0.018	0.015	0.016	0.013
Mar. 23, 2020	0.032		0.068	0.074	0.039	0.027	0.018	0.028	0.031	0.260	0.016	0.025	0.044	0.036	0.025
May 11,2020	0.047	0.048	0.071	0.079	0.056	0.049	0.024	0.220	0.035	0.056	0.043	0.043	0.052	0.046	0.059
Jun. 15, 2020	0.144	0.029	0.034	0.042	0.040	0.026	0.090	0.187	0.303	0.153	0.222	0.031	0.031	0.029	0.030
Jul.6, 2020	0.028	0.028	0.047	0.048	0.032	0.029	0.097	0.142	0.023	0.074	0.031	0.032	0.031	0.026	0.032
Jul.20, 2020	0.024	0.028	0.045	0.044	0.037	0.026	0.083	0.128	0.027	0.034	0.029	0.031	0.029	0.030	0.031
Aug.17, 2020	0.126	0.033	0.024	0.027	0.080	0.023	0.354	0.292	0.076	0.043	0.061	0.033	0.032	0.086	0.024
Sep.14, 2020	0.288	0.334	0.063	0.023	0.085	0.072	0.389	0.391	0.441	0.400	0.335	0.630	0.876	0.721	0.237
Oct. 12, 2020	0.231	0.143	0.043	0.023	0.024	0.277	0.696	0.628	0.307	0.317	0.438	0.420	0.602	0.552	0.204
Nov. 13,2020	0.355	0.257	0.037	0.022	0.025	0.086	0.525	0.539	0.478	0.311	0.520	0.544	0.704	0.364	0.252
Dec.5, 2020	0.250	0.071	0.019	0.021	0.037	0.033	0.250	0.213	0.135	0.164	0.153	0.109	0.070	0.075	0.018
Jan.14, Feb. 4 and Apr.14 ammonia data not available (instrument malfunction).							bdl = below detectable levels								
MEAN	0.144	0.103	0.062	0.042	0.047	0.064	0.238	0.258	0.175	0.172	0.173	0.178	0.230	0.184	0.088
MEDIAN	0.047	0.031	0.043	0.024	0.037	0.027	0.090	0.187	0.035	0.074	0.043	0.032	0.032	0.036	0.030
STd.Dev.	0.120	0.105	0.045	0.021	0.022	0.070	0.224	0.198	0.172	0.134	0.177	0.222	0.309	0.235	0.090
Min	0.014	0.013	0.019	0.017	0.018	0.013	0.018	0.016	0.014	0.018	0.015	0.018	0.014	0.016	0.013
Max	0.355	0.334	0.190	0.079	0.085	0.277	0.696	0.628	0.478	0.400	0.520	0.630	0.876	0.721	0.252

Table 19: Soluble Reactive Phosphorus concentration (mg / L) data for the sixteen sampling events from Nov. 2019 through Dec. 2020.

	Taylor Creek Isles (TCI)						Taylor Creek (TC)			Treasure Island (TI)					
	TCI-1	TCI-2	TCI-3	TCI-4	TCI-5	TCI-6	TC-1	TC-2	TC-3	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
Nov. 20, 2019	0.026	0.013	0.046	0.016	0.033	0.020	0.052	0.046	0.033	0.026	0.033	0.039	0.036	0.091	0.026
Dec.16, 2019	0.108	0.085	0.013	0.013	0.055	0.020	0.059	0.072	0.046	0.068	0.082	0.078	0.117	0.108	0.068
Jan.4, 2020	0.293	0.202	0.010	0.013	0.029	0.068	0.062	0.098	0.127	0.108	0.134	0.202	0.166	0.137	0.163
Feb.4, 2020	0.173	0.156	0.026	0.010	0.140	0.085	0.104	0.072	0.179	0.121	0.134	0.124	0.121	0.095	0.156
Feb. 18, 2020	0.235	0.245	0.023	0.020	0.016	0.127	0.121	0.117	0.222	0.147	0.220	0.248	0.156	0.127	0.179
Mar. 23, 2020	0.095	0.147	0.052	0.042	0.104	0.052	0.147	0.163	0.104	0.147	0.124	0.163	0.104	0.055	0.049
Apr.14,2020	0.055	0.033	0.029	0.029	0.033	0.026	0.095	0.114	0.046	0.039	0.065	0.026	0.062	0.055	0.049
May 11,2020	0.033	0.020	0.020	0.020	0.016	0.020	0.055	0.055	0.020	0.016	0.052	0.033	0.036	0.029	0.029
Jun. 15, 2020	0.130	0.062	0.042	0.016	0.016	0.016	0.799	0.228	0.231	0.114	0.137	0.065	0.036	0.023	0.023
Jul.6, 2020	0.137	0.137	0.059	0.026	0.075	0.033	0.260	0.230	0.029	0.018	0.082	0.176	0.029	0.026	0.062
Jul.20, 2020	0.111	0.134	0.016	0.029	0.007	0.029	0.212	0.235	0.127	0.082	0.095	0.049	0.003	0.010	0.029
Aug.17, 2020	0.166	0.163	0.026	0.042	0.033	0.059	0.258	0.222	0.173	0.114	0.176	0.101	0.072	0.104	0.065
Sep.14, 2020	0.160	0.163	0.000	0.000	0.075	0.000	0.277	0.212	0.238	0.297	0.186	0.209	0.284	0.179	0.222
Oct. 12, 2020	0.238	0.196	0.016	0.013	0.042	0.150	0.245	0.241	0.199	0.349	0.258	0.267	0.391	0.231	0.277
Nov. 13, 2020	0.199	0.150	0.007	0.029	0.023	0.117	0.293	0.316	0.280	0.414	0.267	0.333	0.421	0.355	0.251
Dec. 5, 2020	0.108	0.111	0.016	0.023	0.095	0.046	0.137	0.140	0.163	0.150	0.160	0.153	0.287	0.333	0.137
MEAN	0.140	0.126	0.025	0.021	0.050	0.054	0.199	0.160	0.139	0.138	0.138	0.142	0.145	0.122	0.112
MEDIAN	0.134	0.142	0.022	0.020	0.033	0.040	0.142	0.152	0.145	0.114	0.134	0.139	0.111	0.100	0.067
STd.Dev.	0.075	0.067	0.017	0.011	0.038	0.044	0.182	0.082	0.085	0.118	0.070	0.093	0.132	0.105	0.086
Min	0.026	0.013	0.000	0.000	0.007	0.000	0.052	0.046	0.020	0.016	0.033	0.026	0.003	0.010	0.023
Max	0.293	0.245	0.059	0.042	0.140	0.150	0.799	0.316	0.280	0.414	0.267	0.333	0.421	0.355	0.277

Table 20: Total Phosphorus concentration (mg / L) data for the sixteen sampling events from Nov. 2019 through Dec. 2020.

	Taylor Creek Isles (TCI)						Taylor Creek (TC)			Treasure Island (TI)					
	TCI-1	TCI-2	TCI-3	TCI-4	TCI-5	TCI-6	TC-1	TC-2	TC-3	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
Nov. 20, 2019	0.09	0.08	0.06	0.06	0.15	0.05	0.11	0.10	0.10	0.09	0.09	0.10	0.01	0.16	0.09
Dec.16, 2019	0.17	0.15	0.09	0.07	0.11	0.07	0.12	0.14	0.11	0.15	0.14	0.16	0.17	0.20	0.12
Jan.4, 2020	0.34	0.25	0.05	0.06	0.13	0.13	0.13	0.23	0.21	0.23	0.19	0.28	0.22	0.16	0.22
Feb.4, 2020	0.25	0.23	0.06	0.07	0.20	0.15	0.17	0.10	0.26	0.18	0.25	0.26	0.17	0.14	0.21
Feb. 18, 2020	0.30	0.28	0.07	0.06	0.07	0.18	0.19	0.20	0.24	0.23	0.24	0.27	0.20	0.17	0.23
Mar. 23, 2020	0.24	0.21	0.07	0.07	0.11	0.12	0.22	0.18	0.14	0.20	0.20	0.18	0.13	0.13	0.11
Apr.14,2020	0.15	0.10	0.08	0.07	0.07	0.10	0.18	0.16	0.10	0.13	0.13	0.12	0.12	0.13	0.12
May 11,2020	0.11	0.09	0.08	0.08	0.09	0.09	0.14	0.12	0.09	0.10	0.12	0.12	0.01	0.11	0.10
Jun. 15, 2020	0.19	0.11	0.06	0.06	0.06	0.07	0.86	0.25	0.28	0.18	0.19	0.12	0.10	0.08	0.07
Jul.6, 2020	0.16	0.01	0.06	0.03	0.10	0.04	0.27	0.24	0.12	0.02	0.02	0.02	0.06	0.05	0.06
Jul.20, 2020	0.15	0.15	0.04	0.04	0.05	0.05	0.25	0.26	0.02	0.11	0.14	0.09	0.07	0.07	0.07
Aug.17, 2020	0.30	0.22	0.13	0.12	0.13	0.14	0.36	0.35	0.27	0.24	0.27	0.21	0.19	0.21	0.17
Sep.14, 2020	0.19	0.21	0.03	0.01	0.07	0.04	0.32	0.27	0.27	0.32	0.19	0.25	0.34	0.20	0.25
Oct. 12, 2020	0.23	0.19	0.04	0.04	0.05	0.45	0.35	0.32	0.26	0.37	0.29	0.29	0.40	0.27	0.30
Nov. 13, 2020	0.21	0.20	0.03	0.03	0.03	0.12	0.31	0.35	0.30	0.45	0.25	0.35	0.43	0.30	0.26
Dec. 7, 2020	0.14	0.13	0.03	0.04	0.11	0.08	0.16	0.16	0.18	0.17	0.17	0.17	0.30	0.34	0.16
Anomoly indicated by tan highlight															
MEAN	0.20	0.16	0.06	0.06	0.10	0.12	0.26	0.21	0.18	0.20	0.18	0.19	0.18	0.17	0.16
MEDIAN	0.19	0.17	0.06	0.06	0.10	0.10	0.21	0.22	0.20	0.18	0.19	0.18	0.17	0.16	0.14
STd.Dev.	0.07	0.07	0.03	0.03	0.04	0.10	0.18	0.08	0.09	0.11	0.07	0.09	0.13	0.08	0.08
Min	0.09	0.01	0.03	0.01	0.03	0.04	0.11	0.10	0.02	0.02	0.02	0.02	0.01	0.05	0.06
Max	0.34	0.28	0.13	0.12	0.20	0.45	0.86	0.35	0.30	0.45	0.29	0.35	0.43	0.34	0.30

Table 21: Total Nitrogen concentration (mg/ L) data for the sixteen sampling events from November 2019 through December 2020.

	Taylor Creek Isles (TCI)						Taylor Creek (TC)			Treasure Island (TI)					
	TCI-1	TCI-2	TCI-3	TCI-4	TCI-5	TCI-6	TC-1	TC-2	TC-3	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
Nov. 20, 2019	1.33	1.31	1.34	1.42	1.36	1.22	1.40	1.72	1.39	1.44	1.38	1.41	1.56	1.62	1.34
Dec.16, 2019	1.34	1.28	1.29	1.28	1.29	1.49	1.18	1.37	1.35	1.35	1.44	1.47	1.54	1.59	1.37
Jan. 14, 2020	1.77	1.43	1.38	1.28	1.37	1.41	1.11	1.25	1.37	1.27	1.37	1.46	1.43	1.49	1.21
Feb.4, 2020	0.62	1.38	1.16	1.21	1.67	1.34	1.08	5.05	1.34	1.19	1.15	1.46	1.28	1.39	1.11
Feb. 18, 2020	1.15	1.14	1.21	1.02	1.12	1.13	1.25	0.72	1.09	1.17	1.12	1.45	1.18	1.30	1.06
Mar. 23, 2020	1.62	1.21	1.54	1.44	1.37	1.45	1.30	1.43	1.42	1.22	1.31	1.55	1.73	1.63	1.34
Apr.14,2020	1.34	1.56	1.59	1.77	1.69	6.47	1.45	1.44	0.87	1.30	1.30	1.38	1.59	1.65	1.89
May 11,2020	1.41	3.52	1.40	1.48	1.30	1.39	1.26	1.25	1.42	1.60	1.58	1.56	1.97	1.80	1.58
Jun. 15, 2020	1.97	1.50	1.65	1.48	1.57	1.48	1.93	1.99	2.25	2.03	2.04	1.80	1.71	1.77	1.69
Jul.6, 2020	1.72	1.59	1.45	1.44	1.59	1.06	1.77	1.83	1.57	1.83	1.77	1.69	1.69	1.81	1.37
Jul.20, 2020	1.52	1.44	1.32	1.34	1.35	1.51	1.58	1.67	1.54	1.64	1.53	1.68	1.70	1.90	1.35
Aug.17, 2020	2.19	1.67	1.28	1.34	3.13	1.39	2.35	2.44	1.77	1.80	1.73	1.82	1.89	2.16	1.37
Sep.14, 2020	1.86	1.80	1.33	1.22	1.48	1.39	2.08	1.97	1.98	2.13	1.76	2.34	4.04	2.64	1.68
Oct. 12, 2020	1.82	1.53	0.82	0.81	1.07	0.60	2.48	2.36	1.93	2.00	1.99	2.39	2.47	2.45	1.68
Nov. 13, 2020	2.14	2.08	2.05	1.27	1.32	1.80	2.48	2.42	2.17	2.21	2.19	2.37	2.63	2.50	1.64
Dec. 7, 2020	2.10	1.89	1.25	1.21	1.54	1.56	2.19	2.35	1.88	2.10	2.04	1.87	2.18	2.65	0.93
Highlited = anomoly															
MEAN	1.64	1.67	1.38	1.32	1.53	1.68	1.71	1.99	1.60	1.66	1.62	1.75	1.94	1.92	1.42
MEDIAN	1.72	1.53	1.34	1.34	1.37	1.39	1.58	1.83	1.54	1.64	1.58	1.68	1.71	1.8	1.37
STd.Dev.	0.42	0.57	0.27	0.22	0.48	1.35	0.50	0.98	0.39	0.38	0.35	0.35	0.71	0.45	0.27
Min	0.62	1.14	0.82	0.81	1.07	0.6	1.08	0.72	0.87	1.17	1.12	1.38	1.18	1.3	0.93
Max	2.19	3.52	2.05	1.77	3.13	6.47	2.48	5.05	2.25	2.21	2.19	2.39	4.04	2.65	1.89

Table 22: Atomic N:P ratio data for the sixteen sampling events from Nov. 2019 through Dec. 2020.

	Taylor Creek Isles (TCI)						Taylor Creek (TC)			Treasure Island (TI)					
	TCI-1	TCI-2	TCI-3	TCI-4	TCI-5	TCI-6	TC-1	TC-2	TC-3	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
Nov. 20, 2019	28.6	31.7	43.2	45.8	17.6	47.2	24.6	33.3	26.9	31.0	29.7	27.3	27.5	19.6	28.8
Dec.16, 2019	15.3	16.5	27.7	35.4	22.7	41.2	19.0	18.9	23.8	17.4	19.9	17.8	17.5	15.4	22.1
Jan.4, 2020	10.1	11.1	53.4	41.3	20.4	21.0	16.5	10.5	12.6	10.7	14.0	10.1	12.6	18.0	10.6
Feb.4, 2020	4.8	11.6	37.4	33.5	16.2	17.3	12.3	97.8	10.0	12.8	8.9	10.9	14.6	19.2	10.2
Feb. 18, 2020	7.4	7.9	33.5	32.9	31.0	12.2	12.7	7.0	8.8	9.8	9.0	10.4	11.4	14.8	8.9
Mar. 23, 2020	13.1	11.2	42.6	39.8	24.1	23.4	11.4	15.4	19.6	11.8	12.7	16.7	25.8	24.3	23.6
Apr.14,2020	17.3	30.2	38.5	48.9	40.9	125.2	15.6	17.4	16.8	19.4	19.4	22.3	25.6	24.6	30.5
May 11,2020	24.8	75.7	33.9	35.8	28.0	29.9	17.4	20.2	30.5	31.0	25.5	25.2	31.8	31.7	30.6
Jun. 15, 2020	20.1	26.4	53.2	47.7	50.7	40.9	4.3	15.4	15.6	21.8	20.8	29.0	33.1	42.8	46.7
Jul.6, 2020	20.8	22.0	46.8	92.9	30.8	51.3	12.7	14.8	25.3	18.6	21.4	18.2	54.5	70.1	44.2
Jul.20, 2020	19.6	18.6	63.9	64.8	52.3	58.5	12.2	12.4	18.6	28.9	21.2	36.1	47.0	52.5	37.3
Aug.17, 2020	14.1	14.7	19.1	21.6	46.6	19.2	12.6	13.5	12.7	14.5	12.4	16.8	19.3	19.9	15.6
Sep.14, 2020	18.9	16.6	85.8	236.2	40.9	67.3	12.6	14.1	14.2	12.9	17.9	18.1	23.0	25.6	13.0
Oct. 12, 2020	15.3	15.6	39.7	39.2	41.4	2.6	13.7	14.3	14.4	10.5	13.3	16.0	12.0	17.6	10.8
Nov. 13, 2020	19.7	20.1	132.3	81.9	85.2	29.0	15.5	13.4	14.0	9.5	17.0	13.1	11.8	16.1	12.2
Dec. 7, 2020	29.0	28.1	80.7	58.6	27.1	37.7	26.5	28.4	20.2	23.9	23.2	21.3	14.1	15.1	11.3
MEAN	17.4	22.4	52.0	59.8	36.0	39.0	15.0	21.7	17.8	17.8	17.9	19.3	23.9	26.7	22.3
MEDIAN	18.1	17.6	42.9	43.6	30.9	33.8	13.2	15.1	16.2	16.0	18.7	18.0	21.2	19.8	18.9
STd.Dev.	6.8	15.9	27.9	50.6	17.5	28.9	5.3	21.3	6.2	7.6	5.9	7.3	12.8	15.6	12.7
Min	4.8	7.9	19.1	21.6	16.2	2.6	4.3	7.0	8.8	9.5	8.9	10.1	11.4	14.8	8.9
Max	29.0	75.7	132.3	236.2	85.2	125.2	26.5	97.8	30.5	31.0	29.7	36.1	54.5	70.1	46.7

Table 23: Chlorophyll-a concentration (μg / L) data for the sixteen sampling events from Nov. 2019 through Dec. 2020.

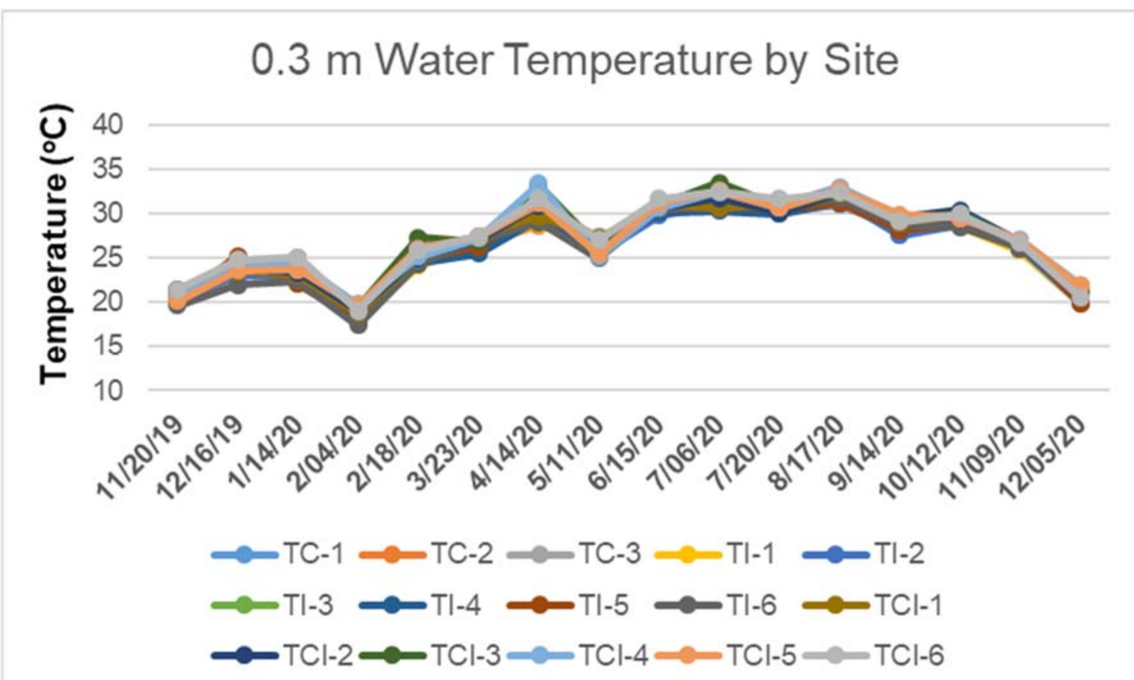
	Taylor Creek Isles (TCI)						Taylor Creek (TC)			Treasure Island (TI)					
	TCI-1	TCI-2	TCI-3	TCI-4	TCI-5	TCI-6	TC-1	TC-2	TC-3	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
Nov. 20, 2019	57	62	67	57	51	48	54	42	60	47	44	43	53	51	73
Dec.16, 2019	64	59	193	85	56	62	27	36	36	49	48	23	68	68	107
Jan.4, 2020	47	66	54	49	69	93	55	56	40	82	60	65	60	53	83
Feb.4, 2020	146	103	67	67	85	87	108	112	65	116	168	171	79	64	58
Feb. 18, 2020	96	109	57	95	76	108	68	92	80	60	96	84	91	69	87
Mar. 23, 2020	72	78	81	95	90	96	53	32	59	45	56	72	100	82	79
Apr.14,2020	104	115	88	99	109	102	46	82	93	88	80	83	135	107	94
May 11,2020	130	137	103	99	115	95	68	102	93	102	77	86	104	116	182
Jun. 15, 2020	59	63	52	66	117	116	59	22	36	29	27	77	121	54	84
Jul.6, 2020	99	75	68	101	86	60	41	64	108	64	89	84	85	82	88
Jul.20, 2020	67	88	121	103	102	94	38	43	166	49	58	107	116	106	92
Aug.17, 2020	97	82	89	104	87	94	26	27	62	95	55	48	120	128	98
Sep.14, 2020	48	49	85	76	149	91	39	14	28	34	57	50	35	34	66
Oct. 12, 2020	54	99	98	84	28	53	15	11	49	43	35	57	45	71	46
Nov. 13, 2020	45	42	144	159	103	54	7	5	18	3	36	18	18	2	79
Dec. 7, 2020	70	54	63	81	47	55	16	12	23	28	21	30	53	19	84
MEAN	78	80	89	89	86	82	45	47	63	58	63	69	80	69	87
MEDIAN	69	77	83	90	87	92	44	39	59	49	57	68	82	69	84
STd.Dev.	30	27	37	25	31	22	25	34	38	31	35	37	34	35	29
Min	45	42	52	49	28	48	7	5	18	3	21	18	18	2	46
Max	146	137	193	159	149	116	108	112	166	116	168	171	135	128	182

Table 24: Sucralose concentration (ng / L) data for the sixteen sampling events from November 2019 through December 2020.

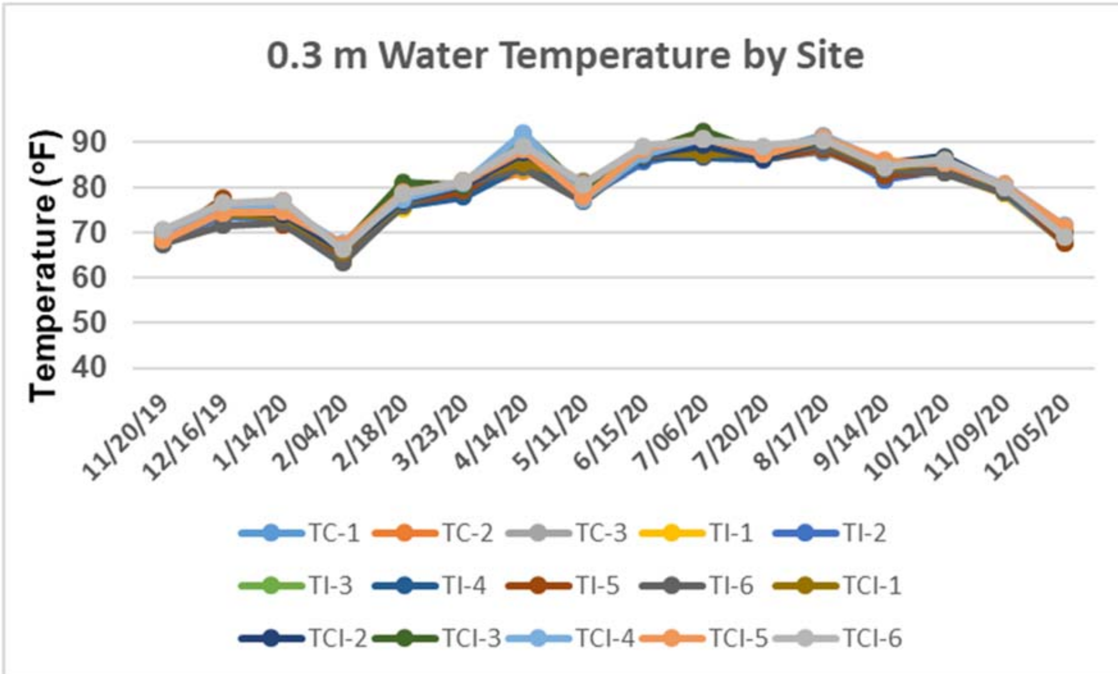
	Taylor Creek Isles (TCI)						Taylor Creek (TC)			Treasure Island (TI)					
	TCI-1	TCI-2	TCI-3	TCI-4	TCI-5	TCI-6	TC-1	TC-2	TC-3	TI-1	TI-2	TI-3	TI-4	TI-5	TI-6
Nov. 20, 2019	399	434	336	319	515	443	362	352	677	500	626	563	1659	1534	975
Dec.16, 2019	389	440	309	312	326	324	257	274	433	365	394	450	828	1508	909
Jan. 14, 2020	321	337	345	334	184	341	302	308	367	325	543	842	1696	1807	951
Feb.4, 2020	317	302	320	329	336	333	295	314	372	337	452	563	1649	1767	1030
Feb. 18, 2020	322	344	334	324	176	333	284	280	391	330	573	805	1904	1950	1066
Mar. 23, 2020	391	378	319	340	433	353	274	310	392	362	568	751	2307	2053	1188
Apr.14,2020	531	511	359	401	425	449	298	400	513	531	742	1355	2307	2141	1217
May 11,2020	509	541	376	381	489	486	227	293	579	495	445	699	2183	1967	1208
Jun. 15, 2020	292	324	229	247	310	308	209	229	267	413	450	1554	2280	2056	1354
Jul.6, 2020	422	456	259	275	454	352	328	297	408	350	564	468	2453	2094	1486
Jul.20, 2020	366	405	243	262	274	481	278	277	414	398	625	1433	1742	1546	1250
Aug.17, 2020	318	561	166	277	264	264	1468	212	328	211	623	364	1758	1412	1541
Sep.14, 2020	283	323	101	121	269	249	258	217	366	705	522	924	1201	672	1127
Oct. 12, 2020	242	258	54	92	96	225	267	240	363	965	676	621	1470	853	2254
Nov. 13, 2020	238	130	91	108	163	308	193	202	434	960	1089	584	1585	1125	1820
Dec. 7, 2020	428	343	83	171	328	343	458	409	344	454	785	437	1512	1348	2249
Anomoly indicated by highlight															
MEAN	362	380	246	271	309	359	382	293	420	482	630	791	1861	1662	1415
MEDIAN	322	344	259	277	310	341	295	293	391	413	623	621	1742	1767	1250
STd.Dev.	91.9	121.2	113.7	96.1	133.4	81.8	333.3	65.3	110.8	230.4	173.9	399.1	331.5	399.3	445.0
Min	238	130	54	92	96	225	193	202	267	211	445	364	1470	853	951
Max	531	561	376	401	515	486	1468	409	677	965	1089	1554	2453	2141	2254

Water temperature:

With the exception of a cooler May, the water temperatures (Figure 24) at 0.3 m reflect the warmer Spring-Summer and Cooler fall-Winter pattern as expected.



(24-a)



(24-b)

Figure 24: Temperature profiles recorded at 0.3 meters underwater for all sites from November 2019 –December 2020. (a) Centigrade, (b) Fahrenheit

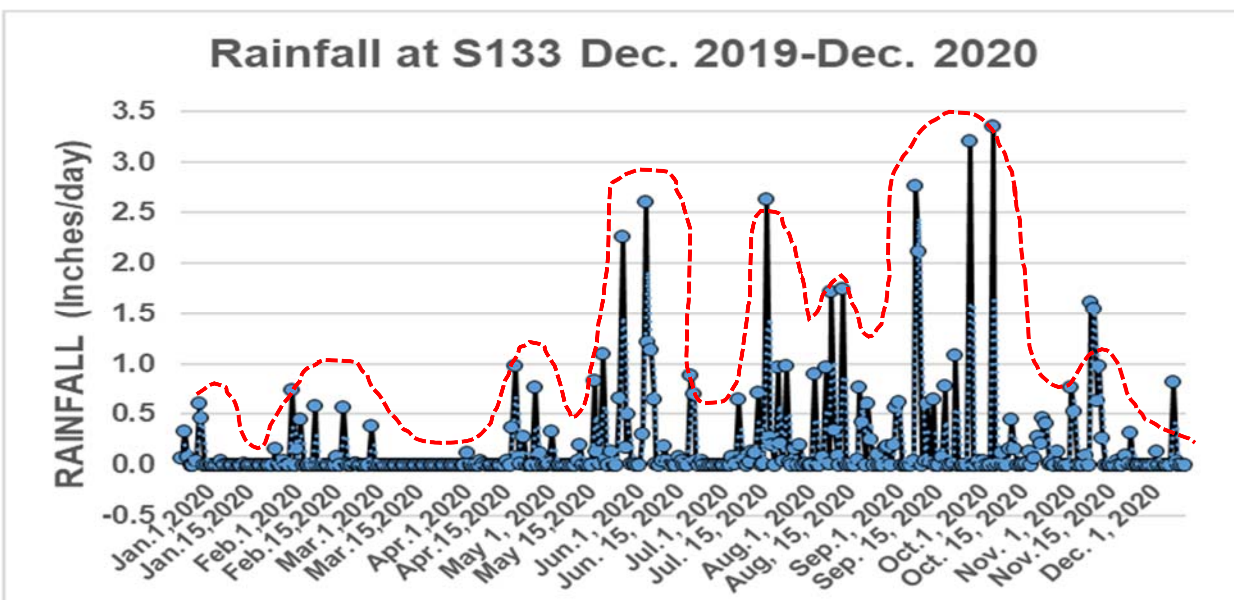


Figure 25: Rainfall data for the year 2020 collected at SFWMD structure S133.
(SFWMD-DBHYDRO, 2020).

pH: pH values ranged from about 7.2 to 9.4 (Tables 2-17). The only apparent trend noticed was that the interior TCI sites (TCI-3/-4/-5) tended to be more basic (pH 8.5-9.4) than all remaining sites. These same sites also routinely had the lowest SRP (Table 19) and TP (Table 20) amongst all sites throughout this study. A plot of percent SRP versus pH (figure 26) reveals that, with a noticeable spread, %SRP tended to decrease with increasing pH. The linear regression shown in Figure 26 gave the equation y = -0.709X + 8.73 with R^2 = 0.128. We return to this during discussion of SRP and TP.

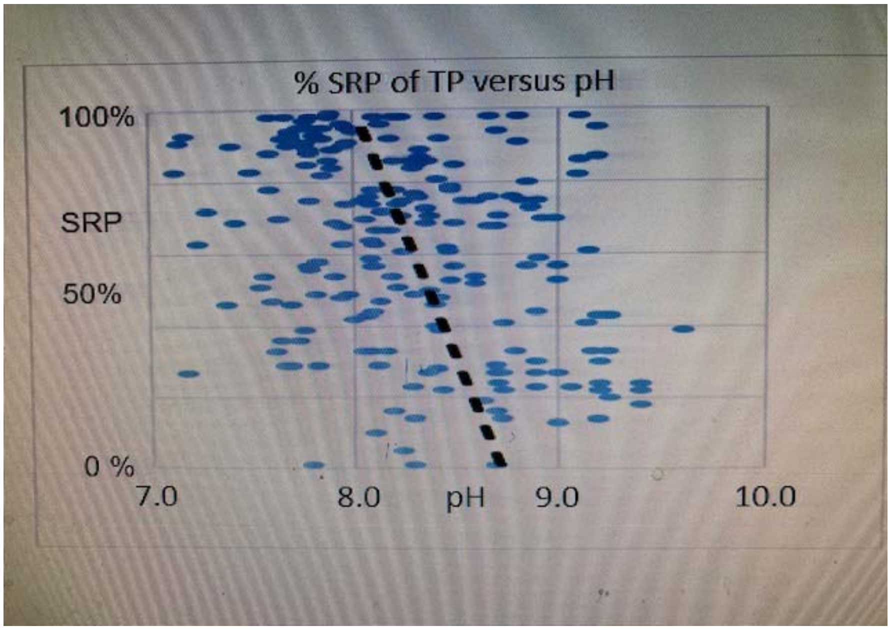
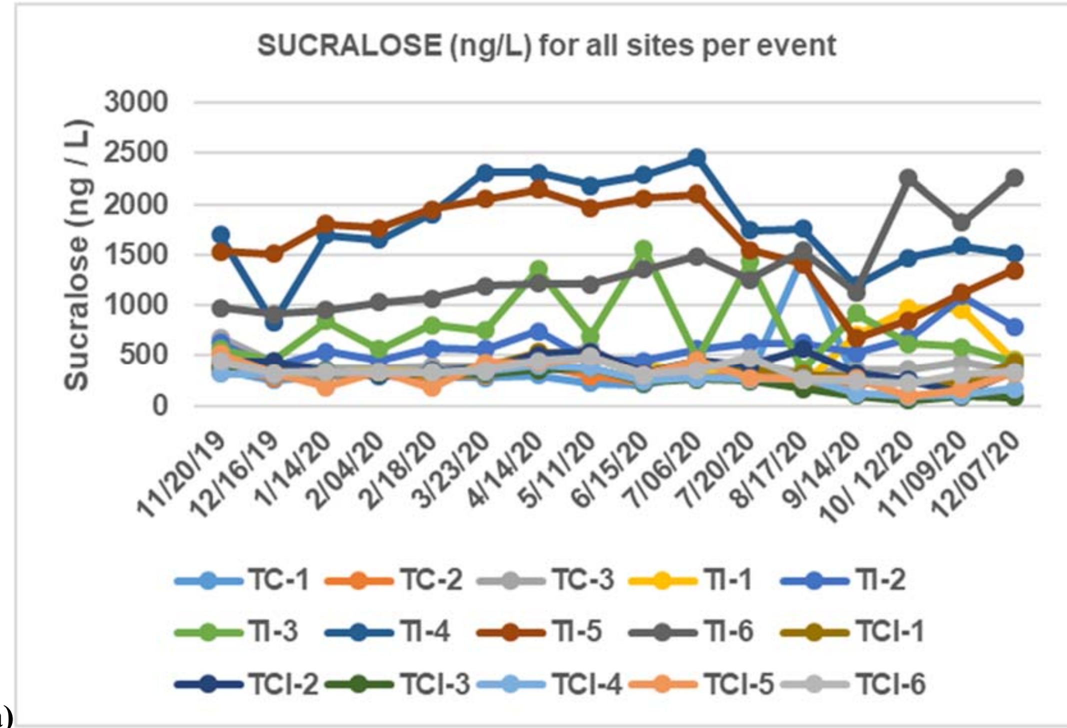


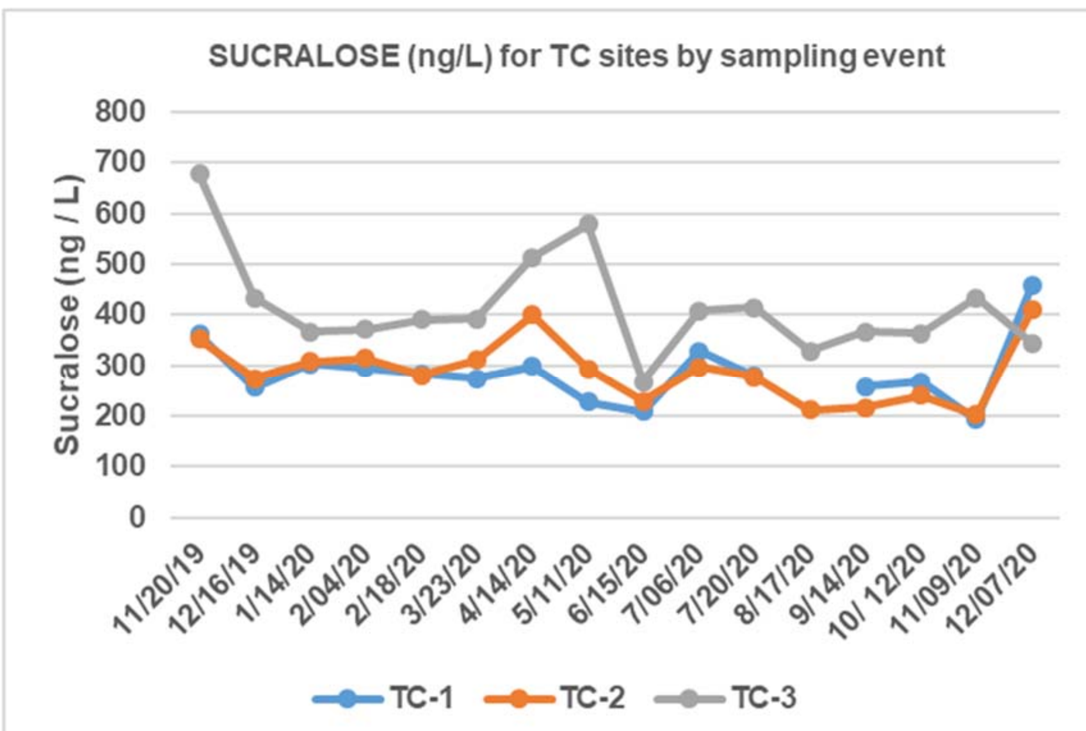
Figure 26: Percent soluble reactive phosphorus (SRP) of total phosphorus (TP) versus pH for all 240 samples in the current study.

Sucralose: As given in the Introduction, the artificial sweetener sucralose was used as a tracer for the current study. ***Immediately obvious is the fact that the inland Treasure Island canals are about five times (5x, 500%) as enriched in sucralose as are the Taylor Creek Isles canals.*** Dilution occurs as both the east (TI) and west (TCI) canals drain into Taylor Creek. An inexplicable large amount of sucralose was found at Taylor Creek site TC-1 in the August 2020 samples. Sucralose levels decreased a bit in the Treasure Island sites TI-4/-5/-6 in July to September 2020. This may be due to lower summer populations but exacting data is not available at this time. Increasing sucralose at those same sites through September to December likely reflects increasing rain (Figure 25) flushing of the, then water saturated, septic systems / drainfields plus increasing Fall-Winter populations and the excess rainwater appears to have diluted the septic derived sucralose at sites TI-4/-5/-6 in the Treasure Island canals.

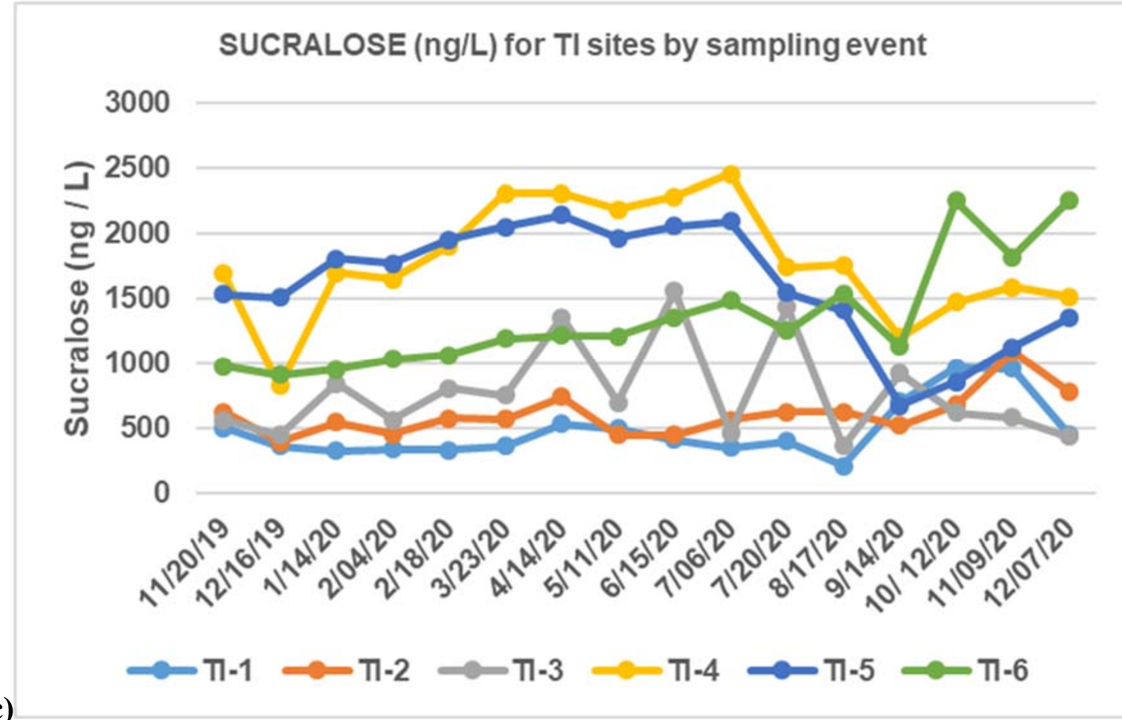
Sites TI-1/-2 and, in essence, all TCI sites are of similar sucralose concentrations with Taylor Creek itself. The most downstream Taylor Creek site (TC-3) is about 25-100% higher than the more upstream sites (TC-1/-2), reflecting the input of septic derived sucralose from the treasure Island drainages.


SUCRALOSE (ng/L) for all sites per event
Sucralose (ng / L)
3000
2500
2000
1500
1000
500
0
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/07/20
TC-1
TC-2
TC-3
TI-1
TI-2
TI-3
TI-4
TI-5
TI-6
TCI-1
TCI-2
TCI-3
TCI-4
TCI-5
TCI-6

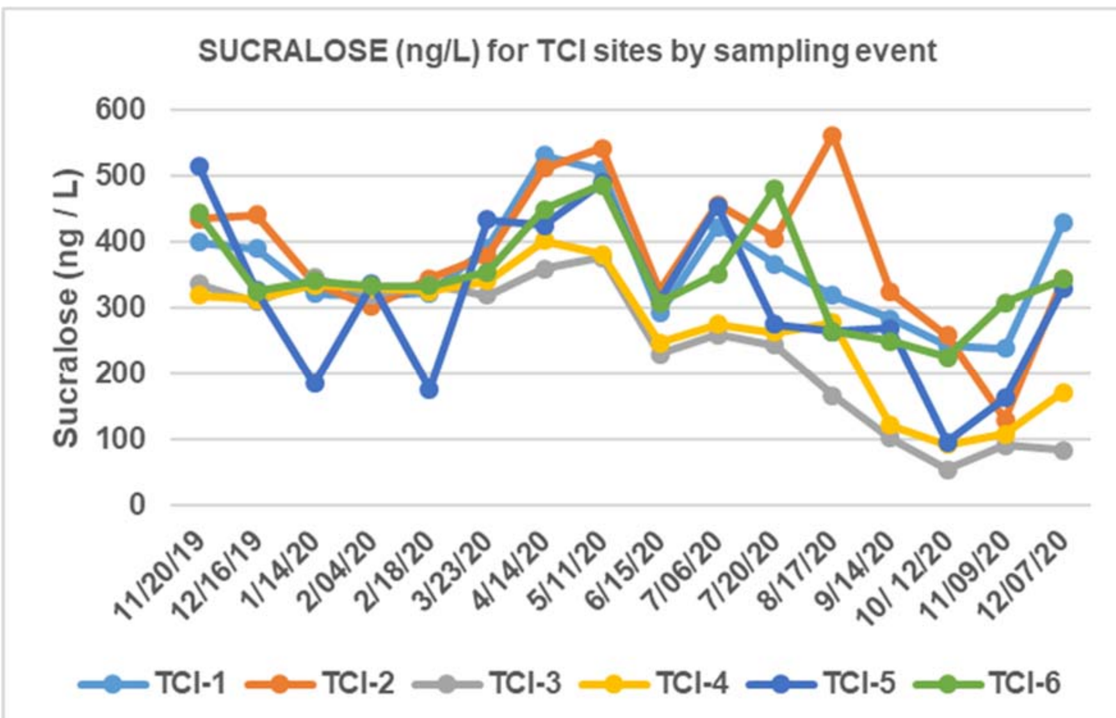
(27-a)


SUCRALOSE (ng/L) for TC sites by sampling event
Sucralose (ng / L)
800
700
600
500
400
300
200
100
0
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/07/20
TC-1
TC-2
TC-3

(27-b)



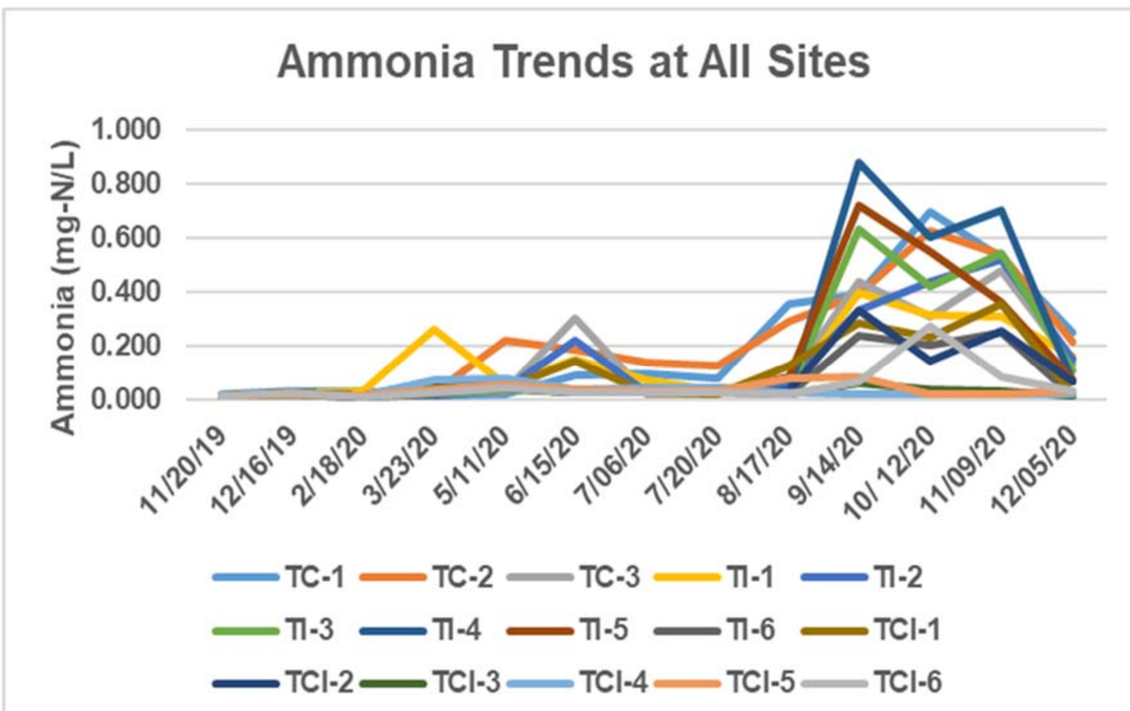
(27-c)



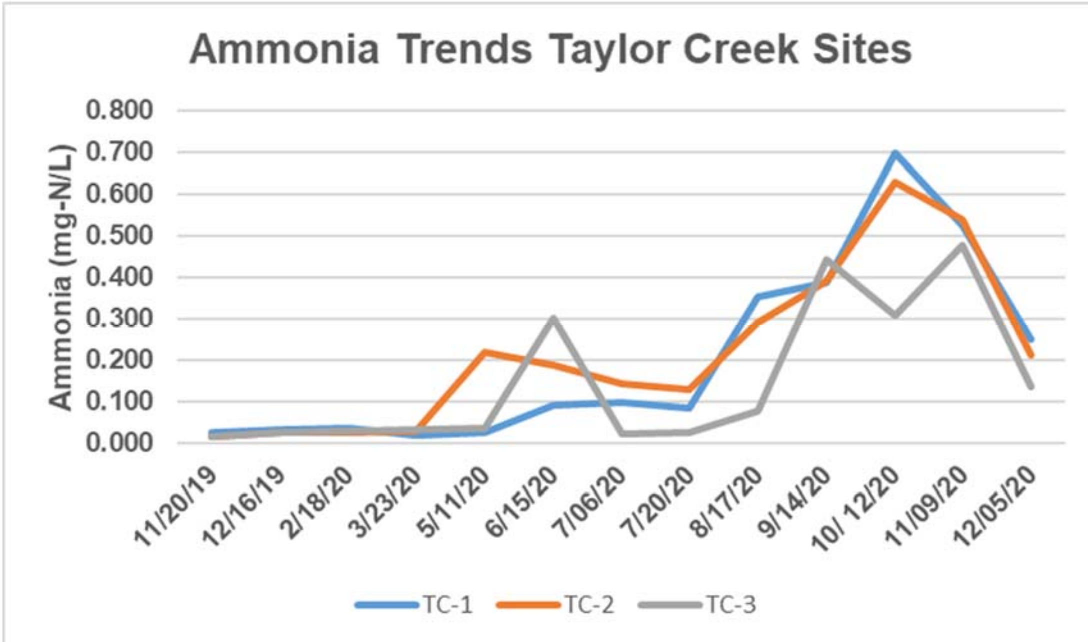
(27-d)

<u>**Figure 27**</u>**:** Plots of monthly sucralose values (ng-sucralose/L) for; (a) all sites combined, (b) Taylor Creek sites, (c) Treasure Island sites, and (d) Taylor Creek Isles sites. Note: The anomalously high sucralose value for TC-1 in August 2020 (see Table 24) was not plotted in Fig. 27-b above.

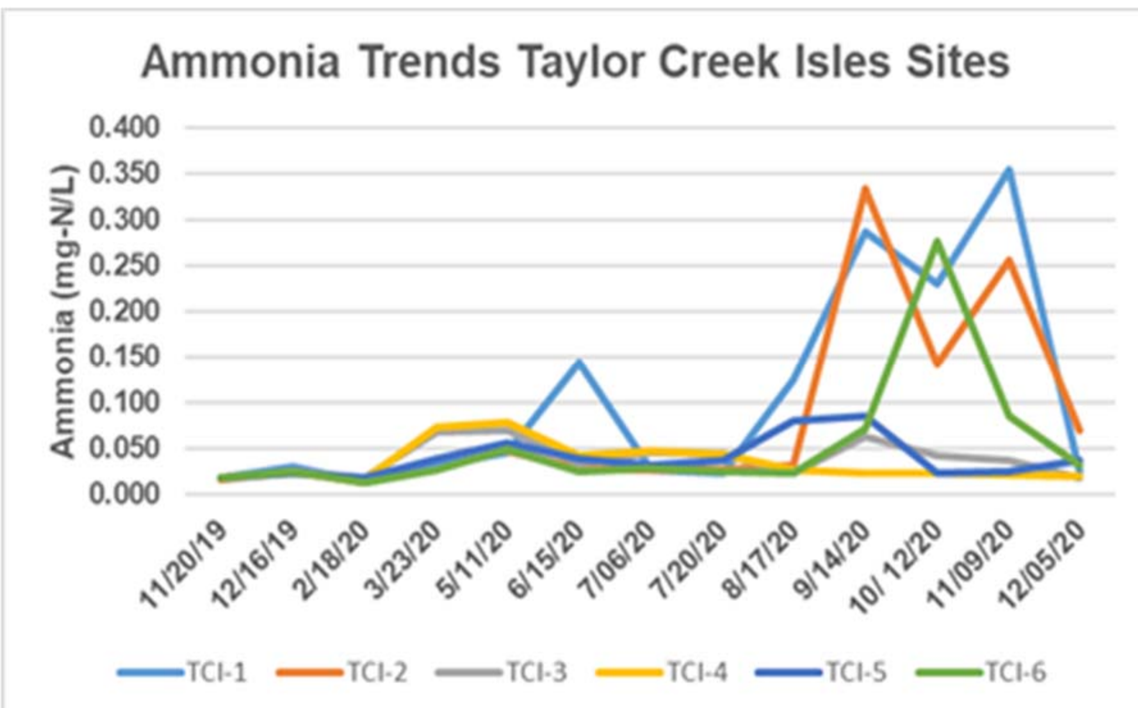
Ammonia: Taylor Creek and Treasure Island sites revealed the highest ammonia concentrations. However, the most apparent differences are the contrasts between the interior sites TI-3/-4/-5 (Figure 27d) when compared to interior sites TCI-3/-4/-5 (Figure 28c). The TI interior sites had 3-4 times (0.18-0.24 mg-NH_3-N/L) the mean ammonia in comparison to the all the TCI (0.04-0.06 mg-NH_3-N/L) interior sites. Further, the highest values were observed from September through November 2020, corresponding to a period of very high rainfall (2-3 inches/day), as seen in Table 25 and incrasing Fall-Winter populations. This we conclude is from the rain driven flushing of septic tanks and their drain fields. The interior TCI sites (TCI-3/-4/-5: grey, yellow and dark blue traces in Fig. 28c) did show this rain impact. TCI sites TCI-1 and TCI-2 are very close to Taylor Creek itself and reflect the overall September through November increase in ammonia. The anomalous increase at TCI-6, a site well away from Taylor Creek is unexplainable at present but is still about 3 times lower than the interior Treasure Island sites. The increased ammonia from September through November at Taylor Creek sites TC-1 and TC-2 (Figure 28b) is likely due to the input of rain increased drainage waters from the Cody sod farm (see Figure 7).



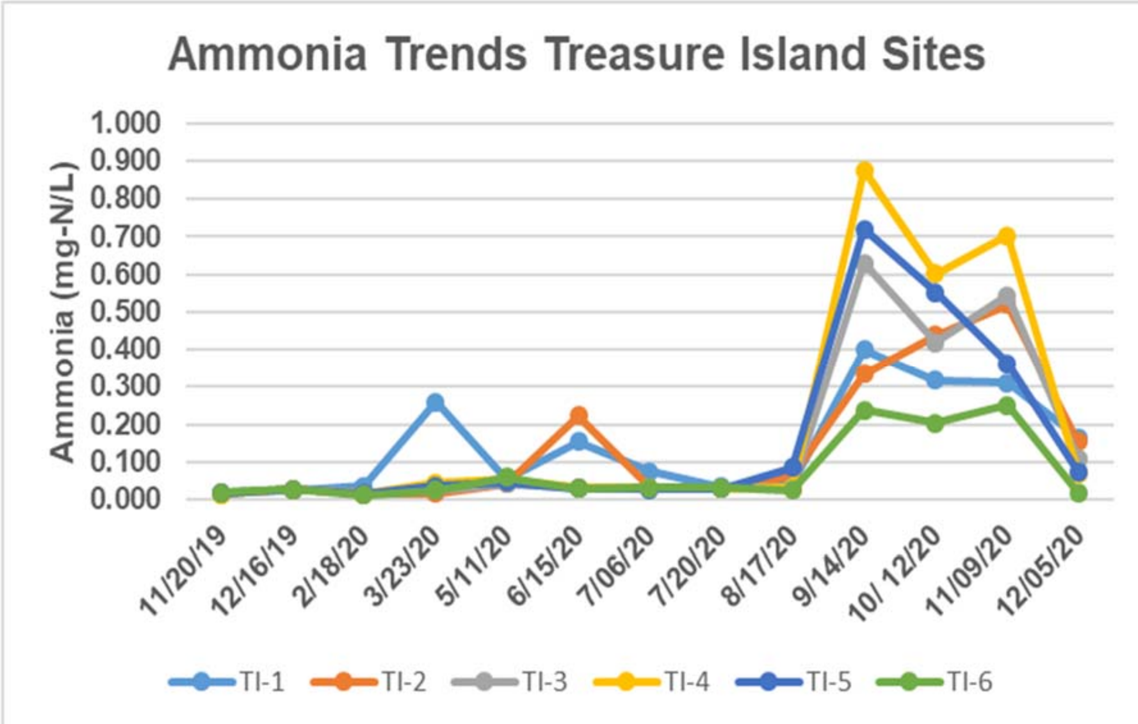
(28-a)


Ammonia Trends Taylor Creek Sites
Ammonia (mg-N/L)
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
11/20/19
12/16/19
2/18/20
3/23/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TC-1
TC-2
TC-3

(28-b)


Ammonia Trends Taylor Creek Isles Sites
Ammonia (mg-N/L)
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
11/20/19
12/16/19
2/18/20
3/23/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TCI-1
TCI-2
TCI-3
TCI-4
TCI-5
TCI-6

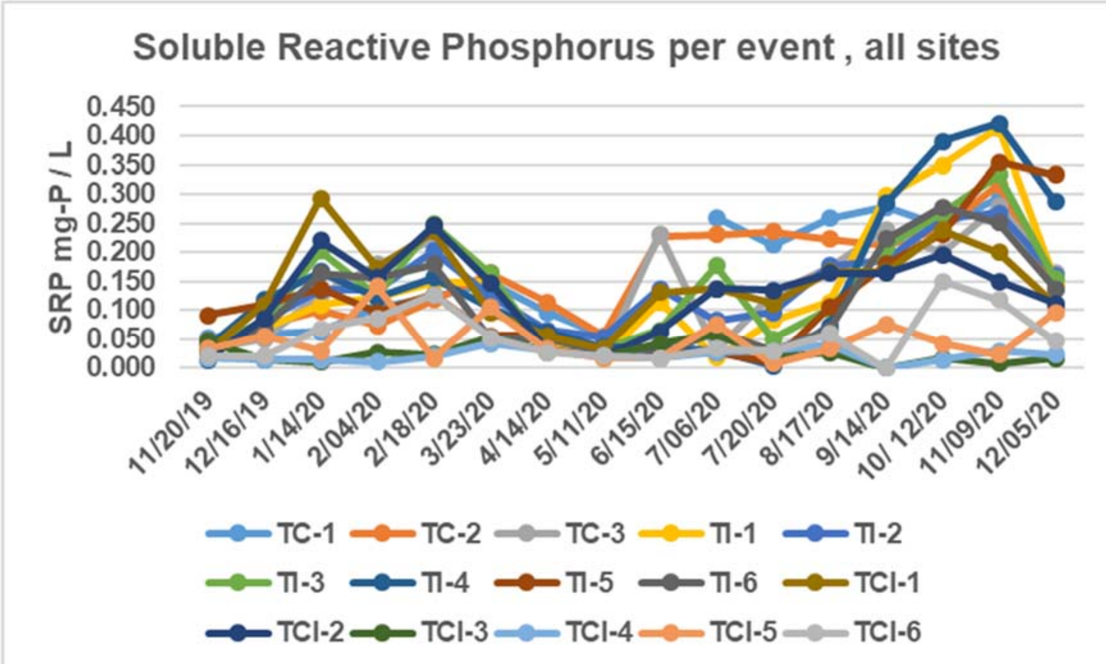
(28-c)



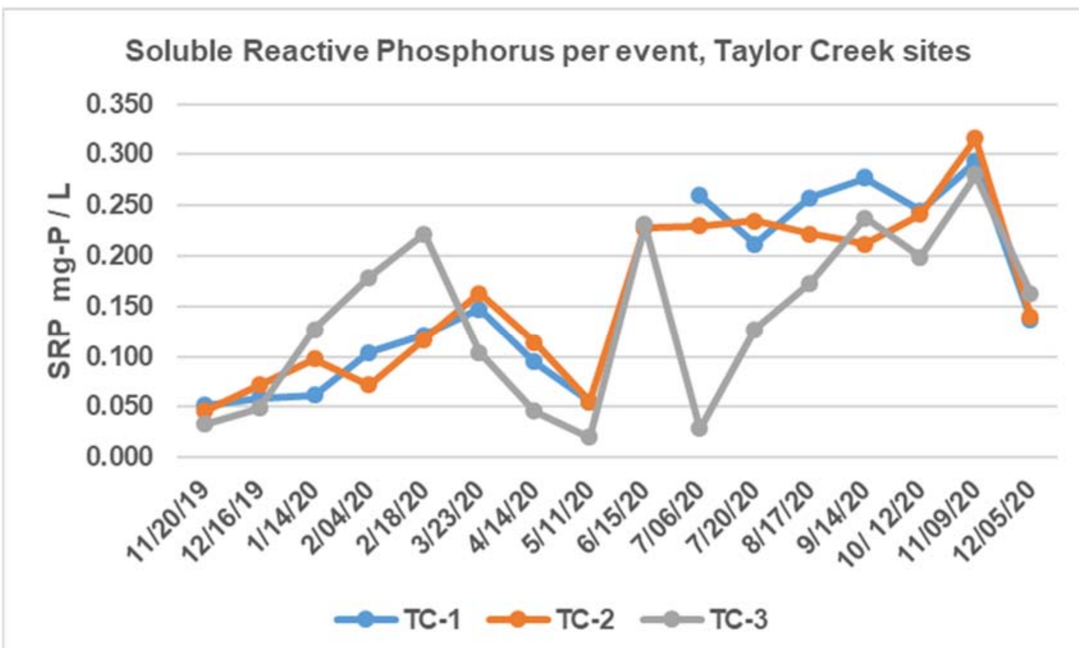
(28-d)

<u>Figure 28:</u> Trends in ammonia concentrations for (a) all sites, (b) Taylor Creek sites, (c) Taylor Creek Isles sites, and (d) Treasure Island sites.

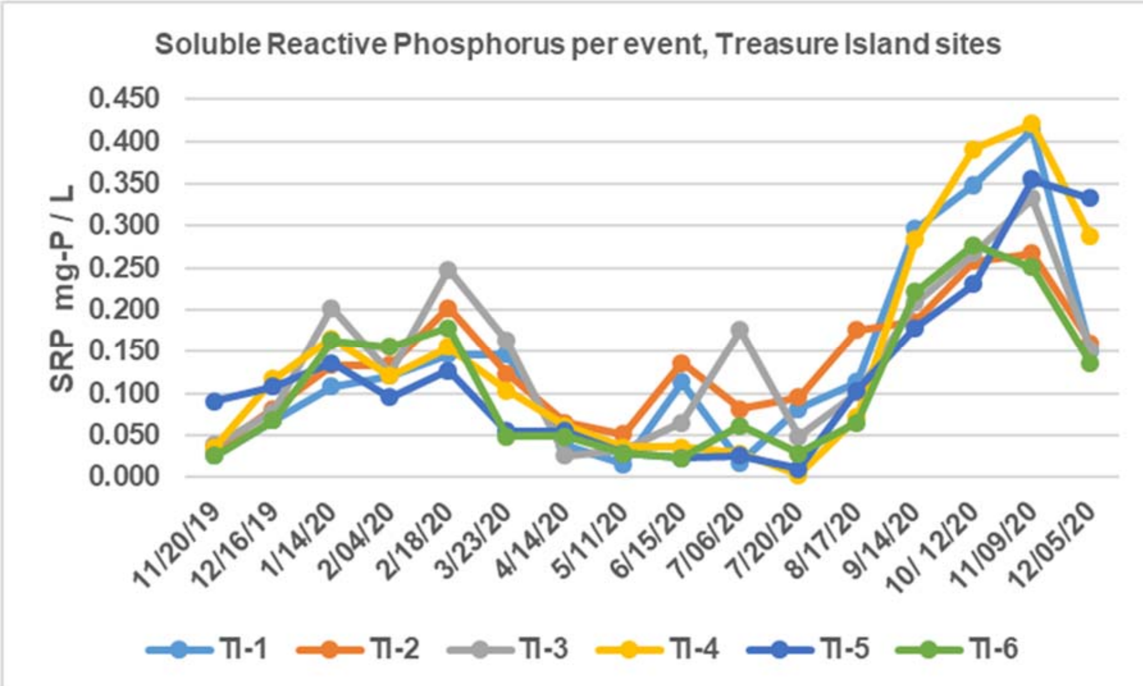
<u>Soluble Reactive Phosphorus</u>:. During the period of November 2019 through July 2020 SRP values within TI and TCI canals where relatively comparable. As with ammonia, the intense rains of September-November correspond to large increases in the amounts of SRP in the canal waters of the inland Treasure Island sites (TI-3.-4/-5: Figure29c). These increases were also found in the sites close to Taylor Creek itself and that indicates movement from Treasure Island canals towards Taylor Creek (Figure 29b). During the rain events TI sites had about twice the SRP (~ 0.4 mg-SRP/L) relative to the TCI sites (~ 0.2 mg-SRP/L) (see Table 19, Figures 29c-d). This is in-line with increases in ammonia (figure 28d). Anomalous high SRP values were observed for TC-1 in June 2020 (Fig.29b) and for TCI-5 in October 2020 (Fig.29d). No reasons for these spikes can be forwarded at this time. The spike at TC-1 ‘may’ be related to agricultural activities but that is speculative at best.

(29-a) 

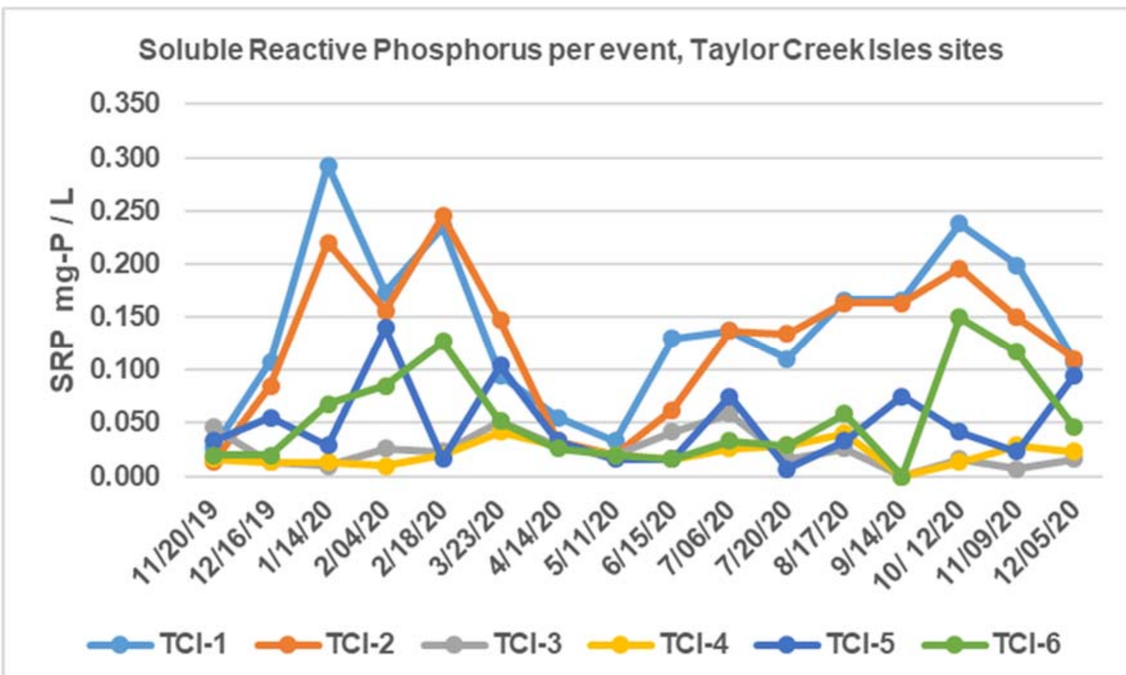
Soluble Reactive Phosphorus per event , all sites
SRP mg-P / L
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TC-1
TC-2
TC-3
TI-1
TI-2
TI-3
TI-4
TI-5
TI-6
TCI-1
TCI-2
TCI-3
TCI-4
TCI-5
TCI-6

(29-b) 

Soluble Reactive Phosphorus per event, Taylor Creek sites
SRP mg-P / L
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TC-1
TC-2
TC-3



(29-c)

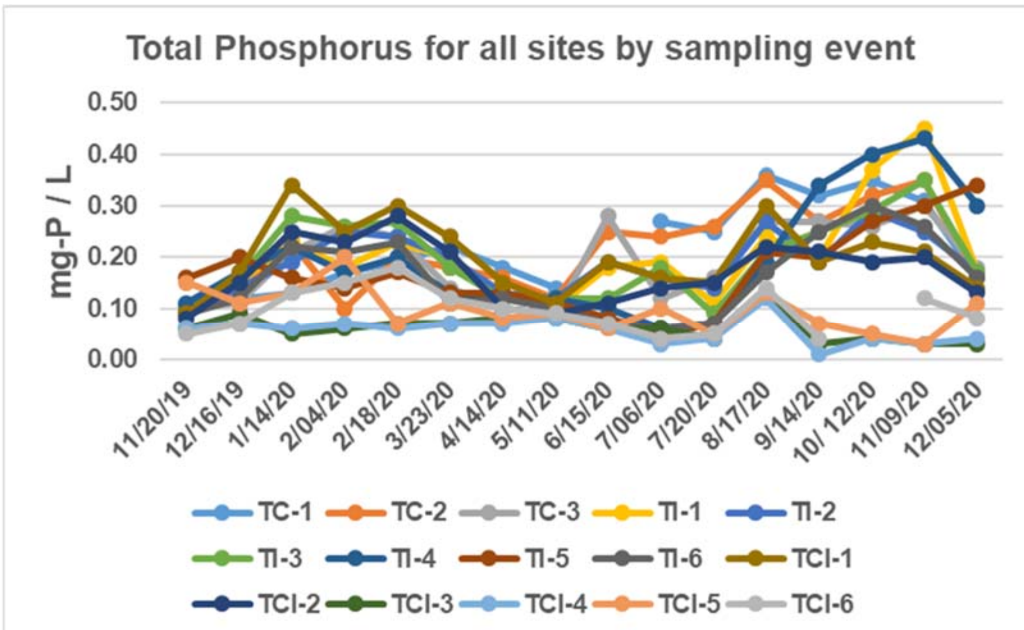


(29-d)

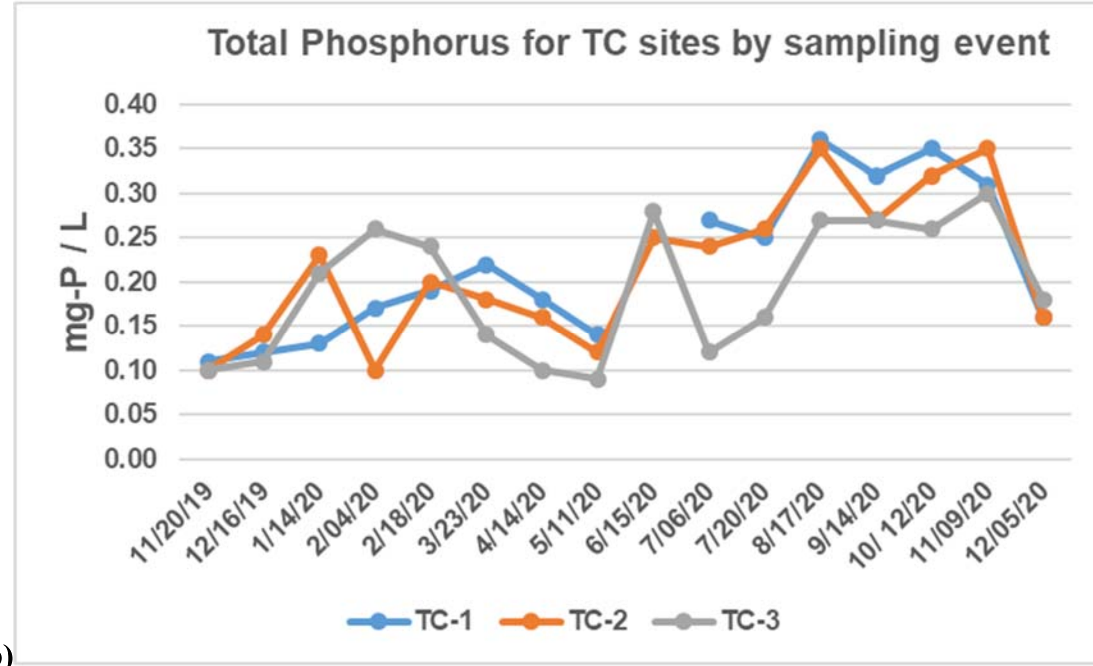
Figure 29: Plots of monthly soluble reactive phosphorus (SRP as mg-P/L) for (a) all sites combined, (b) Taylor Creek sites, (c) Treasure Island sites, and (d) Taylor Creek Isles sites. Note; an anomalously high reading for TC-1 in June 2020(see Table 19) was not plotted in Figs. 29-a & -b above.

<u>Total Phosphorus (TP)</u>: As the values of TP (Figure 30) were very similar to SRP and the trends in TP mimicked SRP changes, it is quite apparent that the vast majority of phosphorous in these canals is in the form of SRP, also known as ortho-phosphate. The amount of SRP relative to TP was detailed earlier (Figure 26) and generally revealed higher SRP/TP ratios at lower water pH values.

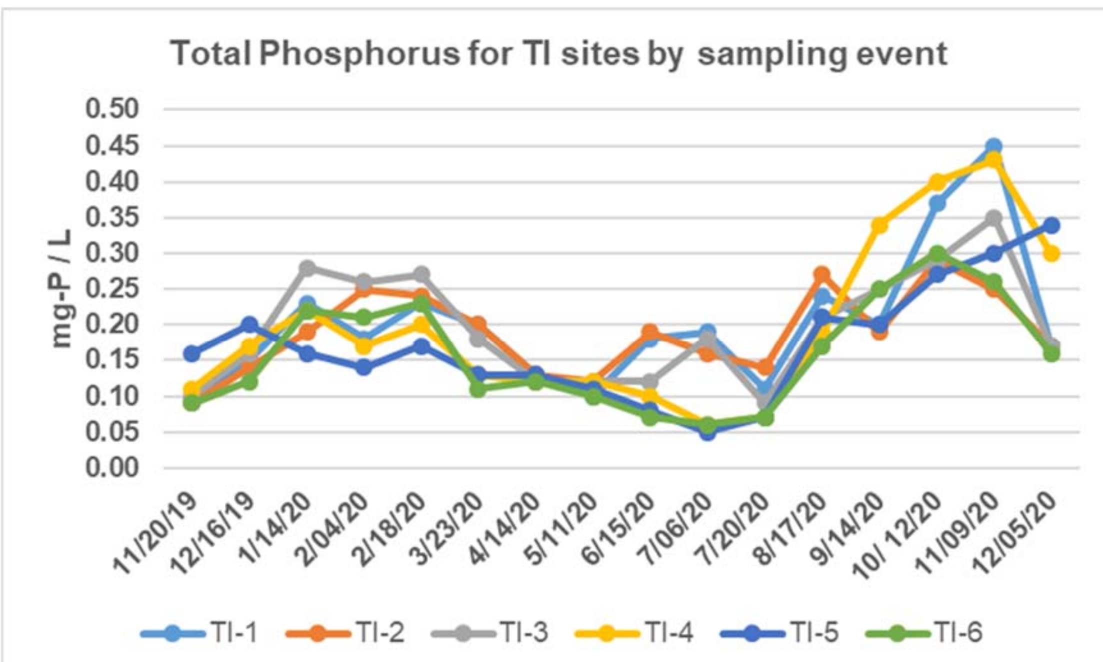
In Table 20 the means and standard deviations for the sites in TI and TCI that are farther away from Taylor Creek are highlighted in yellow. The average of these for TI (TI-3/-4/-5/-6) is 0.18±0.09 mg-P/L and the average for TCI (TCI-3/-4/-5/-6) is 0.08±0.05 mg-P/L. **This shows that the total phosphorus in the Treasure Island canals is 2.25 times as high as in the Taylor Creek Isle canals.**



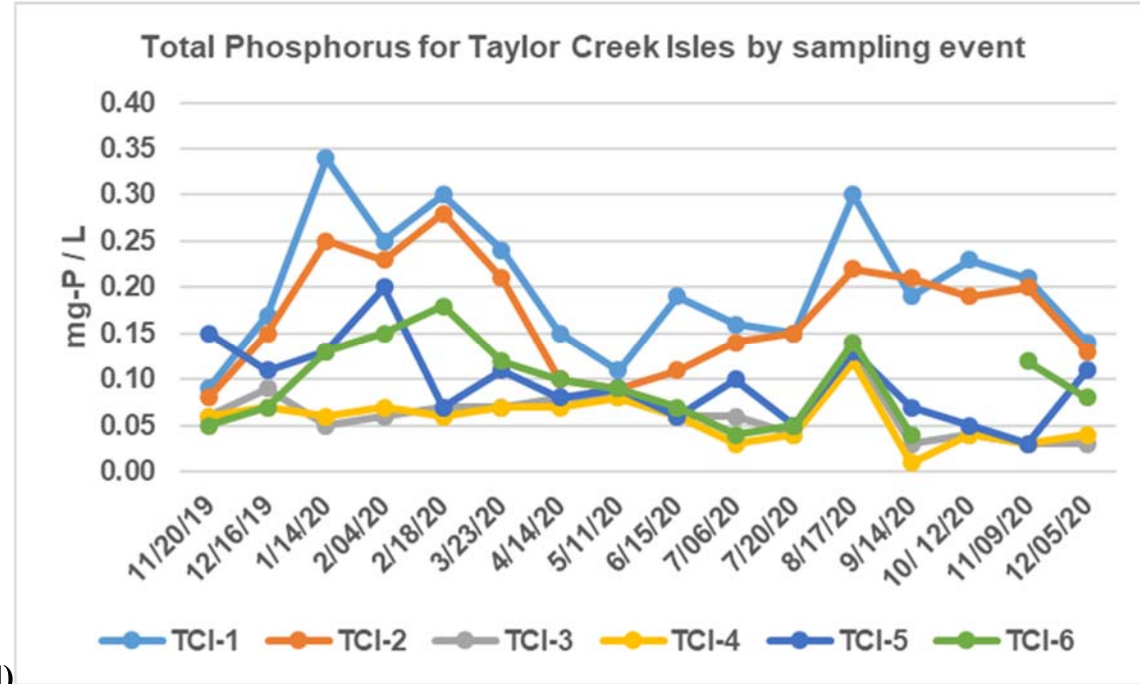
(30-a)


Total Phosphorus for TC sites by sampling event
mg-P / L
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TC-1
TC-2
TC-3

(30-b)


Total Phosphorus for TI sites by sampling event
mg-P / L
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TI-1
TI-2
TI-3
TI-4
TI-5
TI-6

(30-c)



(30-d)

Figure 30: Plots of monthly total phosphorus (TP as mg-P/L) for (a) all sites combined, (b) Taylor Creek sites, (c) Treasure Island sites, and (d) Taylor Creek Isles sites.
NOTE: Anonomously high data points for TC- in May 2020 and TCI-6 in October 2020 were not plotted (see Table 20.

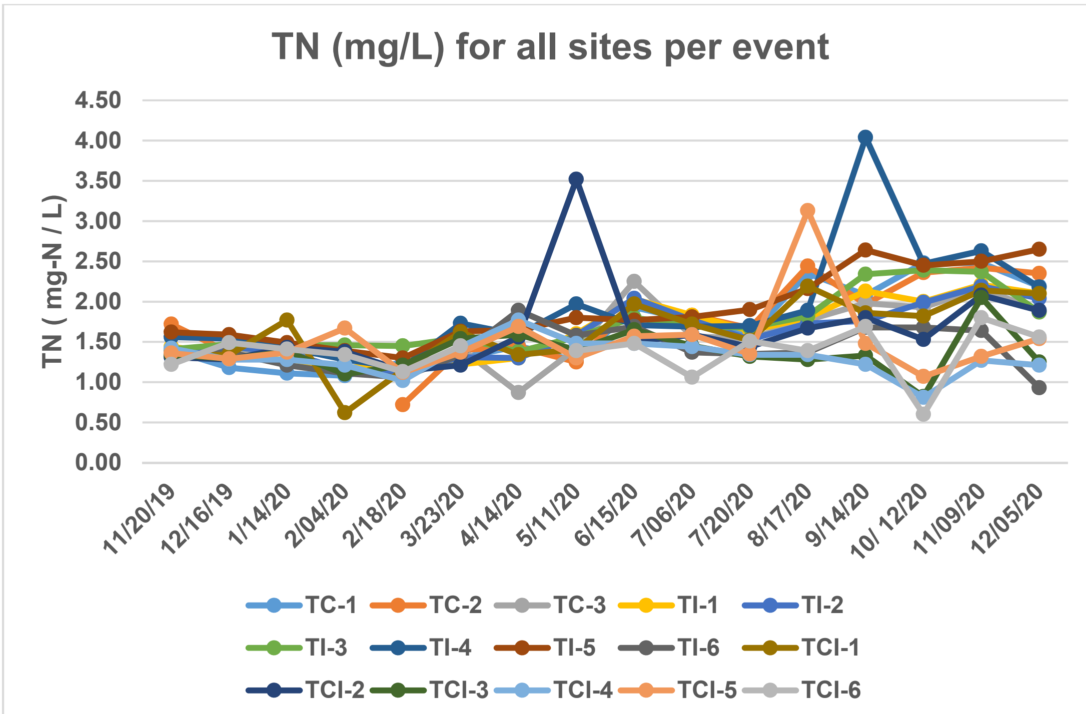
Total Nitrogen (TN): Though not as dramatic as the rain induced increases in SRP (Figure 29) and TP (Figure 30), there was an increase of about 50-100% in the TN in the inland waters (TI-3-/-4/-5: Figure 31c) of the Treasure Island canals. That is, from the means of about 1.0-1.5 mg-N/L in pre-September samples through November rains, increases to 2.0 – 2.5 mg-N/L were observed. Smaller increases were noticed for the TCI sites. The trends in TN in Taylor Creek waters did reflect inputs at TC-3 from the TI sites and in the waters at TC-1 & TC-2 from presumed agricultural inputs (see Figure 7). Large, presently inexplicable, increases in TN were found at TCI-6 (6.47 mg-N/L: Tables 8 & 21; Figure 31b) and TI-4 (4.0 mg-N/L: Tables 5 & 21; Figure 31c). The large spike in TN at TC-2 (5.0 mg-N/L: Tables 14 &21; Figure 31b) appears to be related to the input of agricultural drainage from the Cody sod farm (see Figure 7).

Using the means (Table 21) of TN the inland sites for TI (TI-3 +TI-4 +TI-5) and TCI (TCI-3 + TCI-4 + TCI-5) sites, we find TI to have 1.87 mg-N/L and TCI have 1.41 mg-N/L as their overall averages. **Therefore, we find that the inland waters of the Treasure Island canals have 33% more total nitrogen compared to the inland canals of Taylor Creek Isles**.

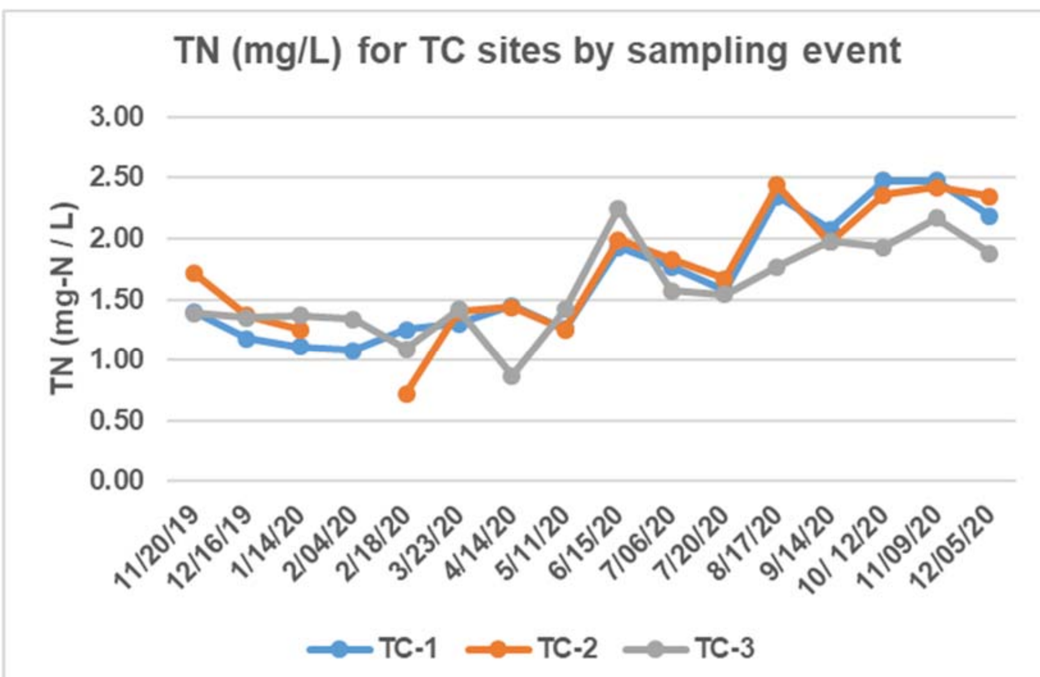
Several anomalous spikes in TN where noticed (e.g. TC-2 Feb. 2020 {Fig.31b]; TCI-6, Apr. 2020{Fig.31d}) and no explanation is offered at this time. Potential reasons could include lawn fertilization, agriculture activities, land clearing, septic tank flushing and others.

In Table 21 the means and standard deviations for the sites in TI and TCI that are farther away from Taylor Creek are highlighted in yellow. The average of these for TI (TI-3/-4/-5/-6) is 1.78±0.44 mg-N/L and the average for TCI (TCI-3/-4/-5/-6) is 1.48±0.58 mg-N/L. This shows that the ***total nitrogen in the Treasure Island canals is 1.20 times as high as in the Taylor***

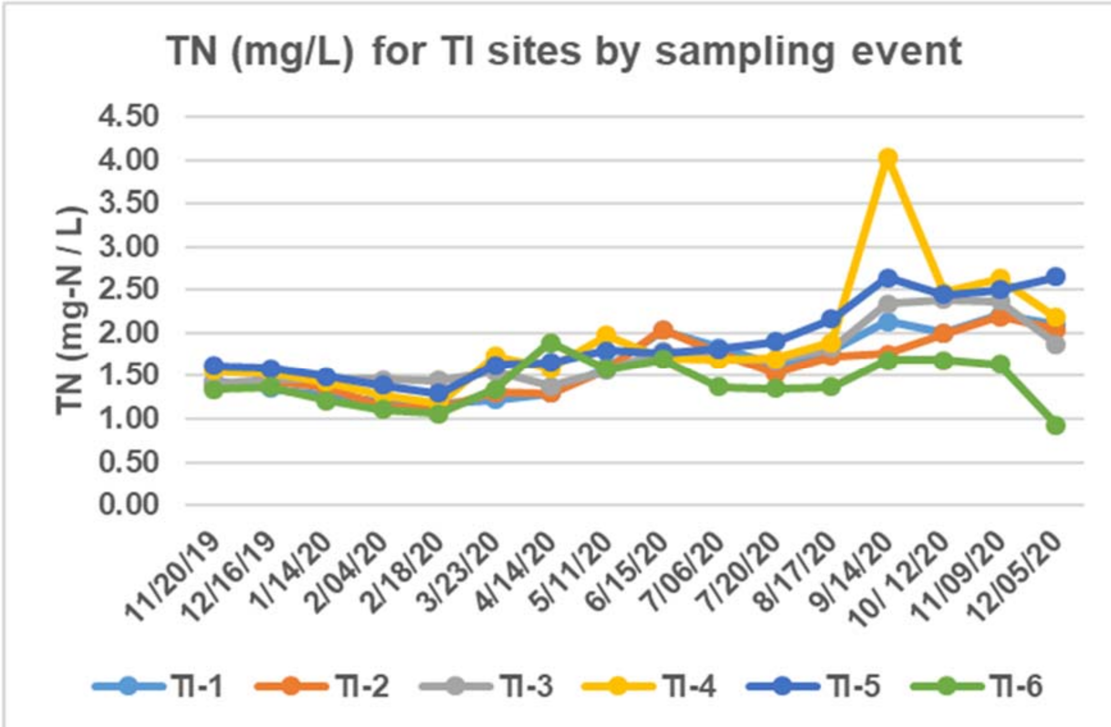
Creek Isle canals. If the anomalous spike in TN at TCI-6 for April 2020 was discounted, then the TCI mean would be lower and the TI to TCI comparison would be higher.



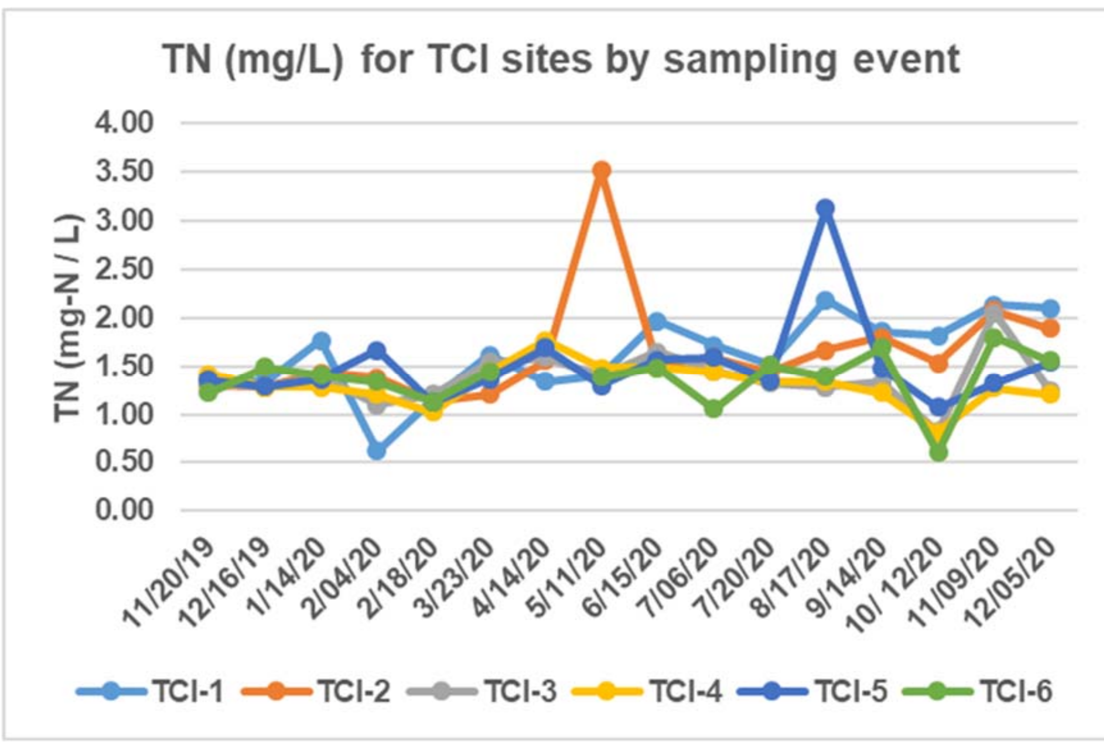
(31-a)



(31-b)



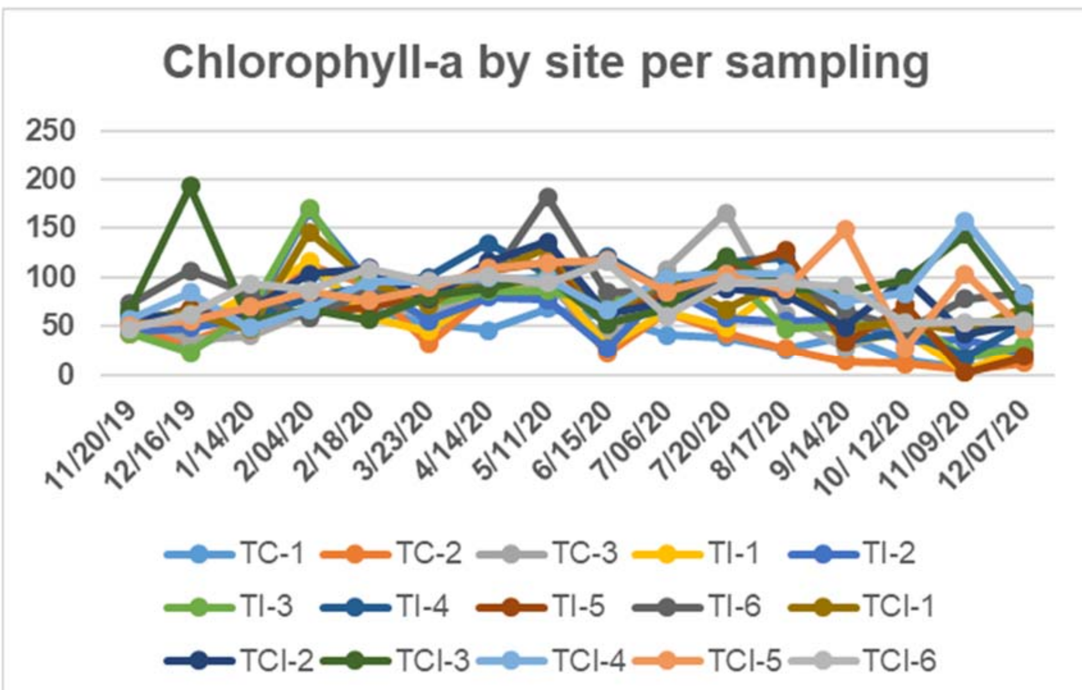
(31-c)



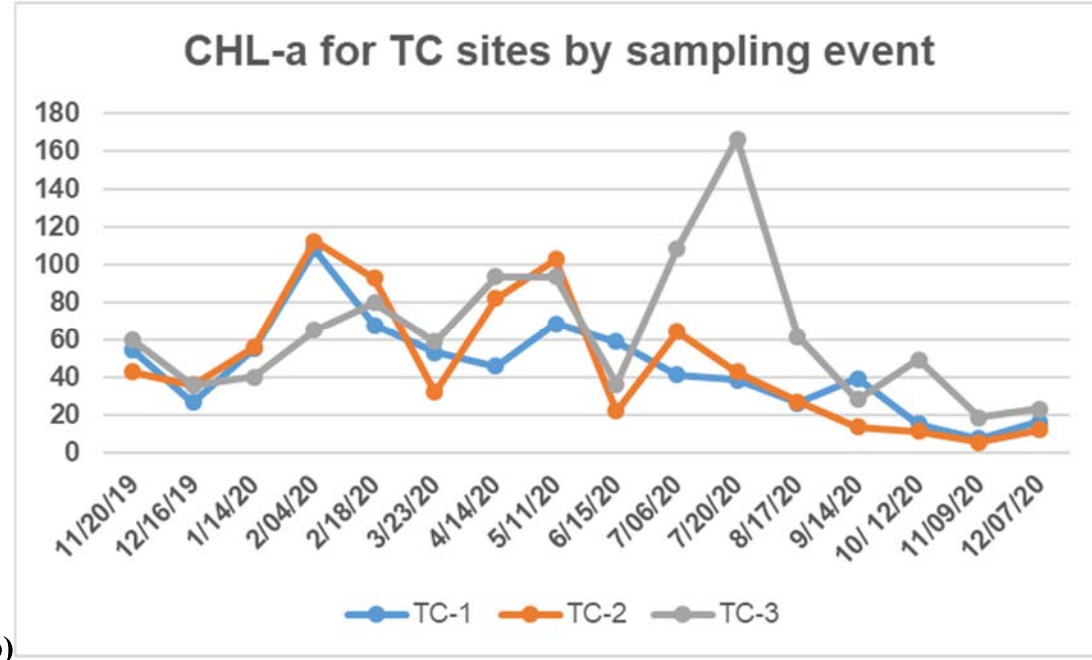
(31-d)

Figure 31: Plots of monthly total nitrogen (TN as mg-P/L) for (a) all sites combined, (b) Taylor Creek sites, (c) Treasure Island sites, and (d) Taylor Creek Isles sites.
NOTE: Anonymously high TN values for TC2 in February 2020 and for tCI-6 in April 2020 were not plotted above (see Table 21).

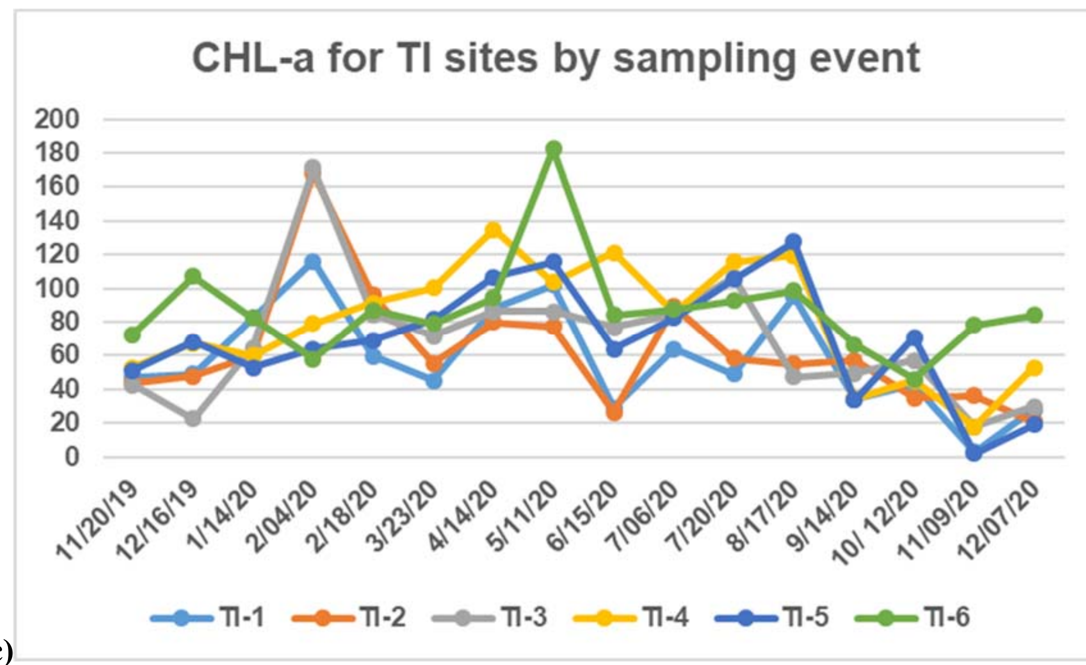
Chlorophyll-a (CHLa): Total CHLa is used as a proxy for microalgal (i.e. phytoplankton) biomass. Values of CHLa of 40+ µg-CHLa / L are considered to indicate an algal bloom (Havens, 1994; Walker and Havens, 1995). Figure 32 contains the monthly data plots of total CHLa using the data from Tables 2-17. Examining the means and deviations of these data (Table 23) the following overall ranges were found: Taylor Creek (45-65 µg-CHLa/L), Treasure Island (70-80 µg-CHLa/L) and Taylor Creek Isles (86-90 µg-CHLa/L). The ranges for TI and TCI given here were selected from their interior sites (3-6) as sites 1 & 2 in each case are very near TC itself. In all cases, the level of CHLa in these waters are considered to be in the range of algal blooms (see Havens, 1994; Walker and Havens, 1995). Sites TCI-3/-4/-5 had the highest overall turbidity (See Tables 2-17) and the highest mean chlorophyll-a values. Following the high prolonged rains of August through November (Figure 25), the level of chlorophyll-a was mostly below 40 µg/L in Taylor Creek and many sites within Treasure Island. The somewhat higher CHLa values in the TCI interior sites may related to higher amounts of cyanobacteria versus chlorophytes plus diatoms in the TI sites. However, this is very speculative as pigment-based chemotaxonomy was performed only a very few samples and without any spatial / temporal monitoring.



(32-a)

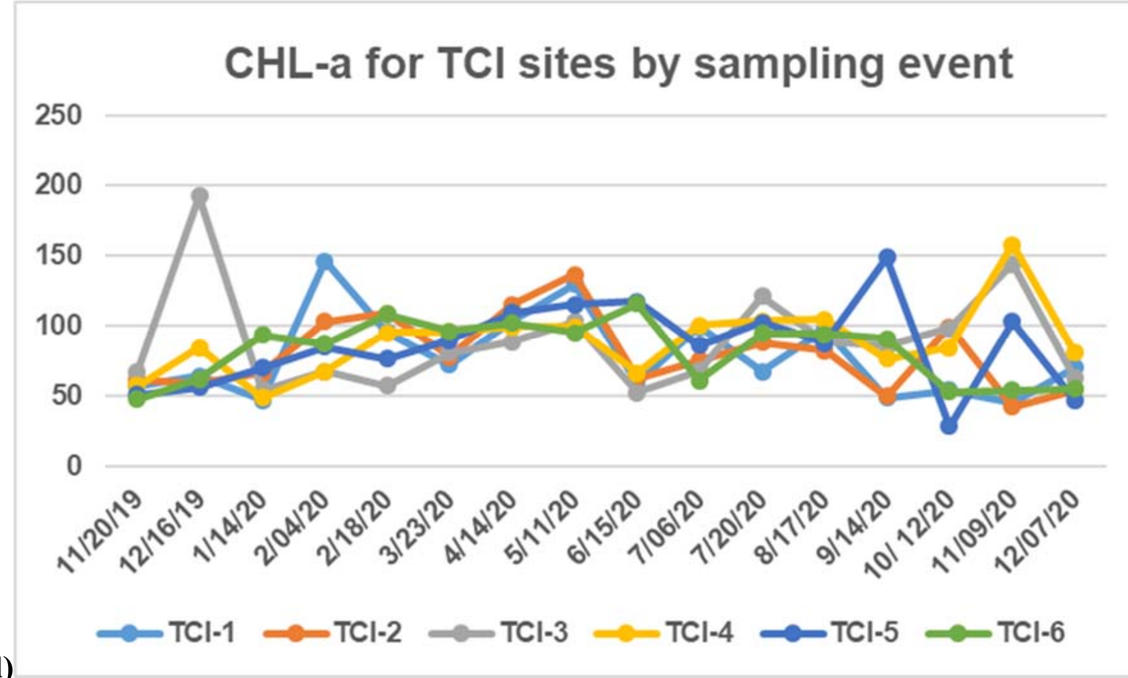

CHL-a for TC sites by sampling event
180
160
140
120
100
80
60
40
20
0
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/07/20
TC-1
TC-2
TC-3

(32-b)


CHL-a for TI sites by sampling event
200
180
160
140
120
100
80
60
40
20
0
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/07/20
TI-1
TI-2
TI-3
TI-4
TI-5
TI-6

(32-c)

(32-d)



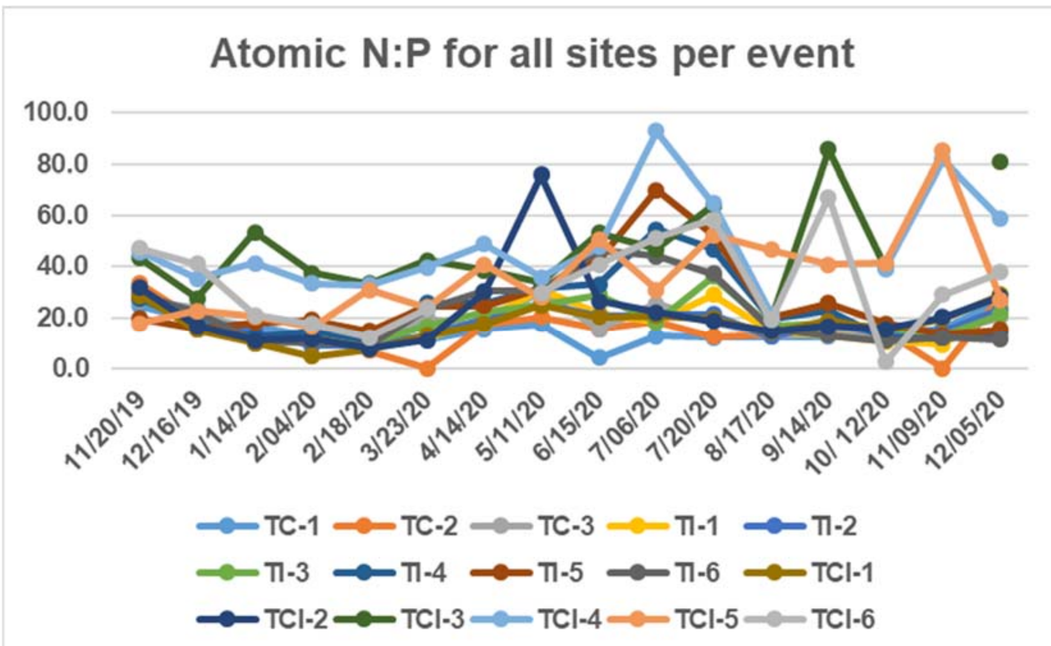
<u>Figure 32</u>: Plots of monthly Chlorophyll-a (μg/L) for (a) all sites combined, (b) Taylor Creek sites, (c) Treasure Island sites, and (d) Taylor Creek Isles sites.

<u>N:P Ratios / Redfield Ratio</u>: The atomic ratio of nitrogen (N) to phosphorus (P)

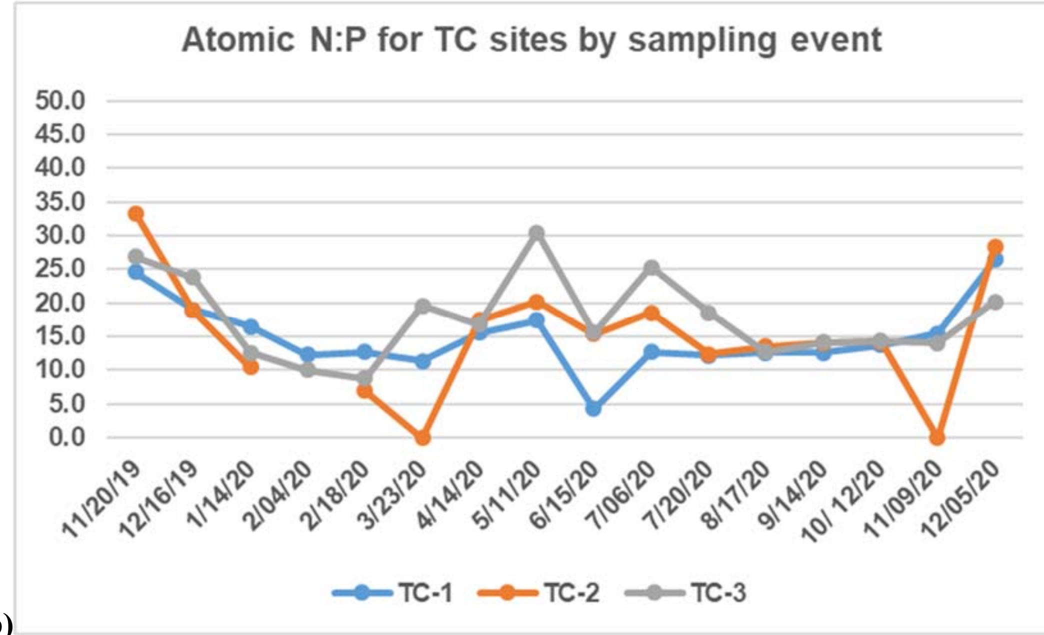
The atomic molar canonical ratio of carbon (C) to nitrogen (N) to phosphorus (P) first described by Alfred Redfield (1934, 1958) is C:N:P ~ 106:16:1 was derived for oceanic phytoplankton. However, the C:N:P ratio for freshwaters is most often higher to much higher than that for the oceans (Hecky et al., 1993; Ptacnik et al., 2010; Sterner, 2011; They et al., 2017). They and others (2017) stated this as "The canonical Redfield C:N:P ratio for algal biomass is often not achieved in inland waters due to higher C and N content and more variability when compared to the oceans."

The mean N:P values for all sites ranged from 15.0 to 59.8 (Table 22). Two sites in Taylor Creek Isles (TCI-3 and TCI-4) had the highest N:P mean values (52.0 and 59.8, respectively). This reflects the extremely low TP values for these sites (TP mean = 0.06 mg/L) relative to all other sites (Table 20). While the N:P mean values for Taylor Creek and Treasure Island sites were a bit above (17.8 to 26.7) the oceanic Redfield ratio, it is the high variability form month to month that indicates fluctuations in N and P sourcing throughout the year. For example, site TC-2 exhibited a minimum of 2.6 and a maximum of 125.2 N:P (Table 22).

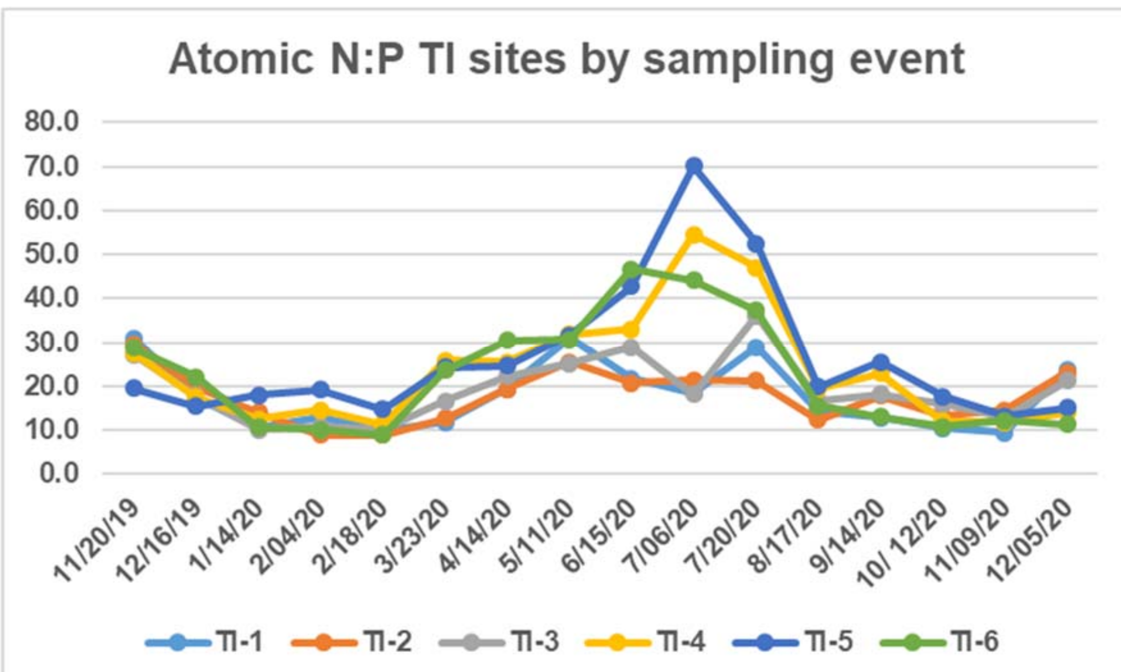
The increase in N:P for the Treasure Island inland sites (TI-4/-5/-6: Fig.33c, Table 22) during May-June-July appears to be linked to lower saturating rains. That is, our sampling dates occurred during lower rainfall periods. Strongly saturating rainfall, such as the September through November period (Figure 25) correspond to large influxes of TP (Figure 30) which is mainly SRP (Figure 29). Except for a spike in TN during February 2020 at site TC-2, likely linked to the Cody Sod farm effluent, and a spike during September at TCI-4 of unknown causation, TN profiles were relatively constant at most other sites. Septic tank flushing or lack thereof can drastically alter N:P ratios as well as SRP and TP values. N:P ratios can rise or fall given increases or decreases in TN as well as decreases or increases in TP.



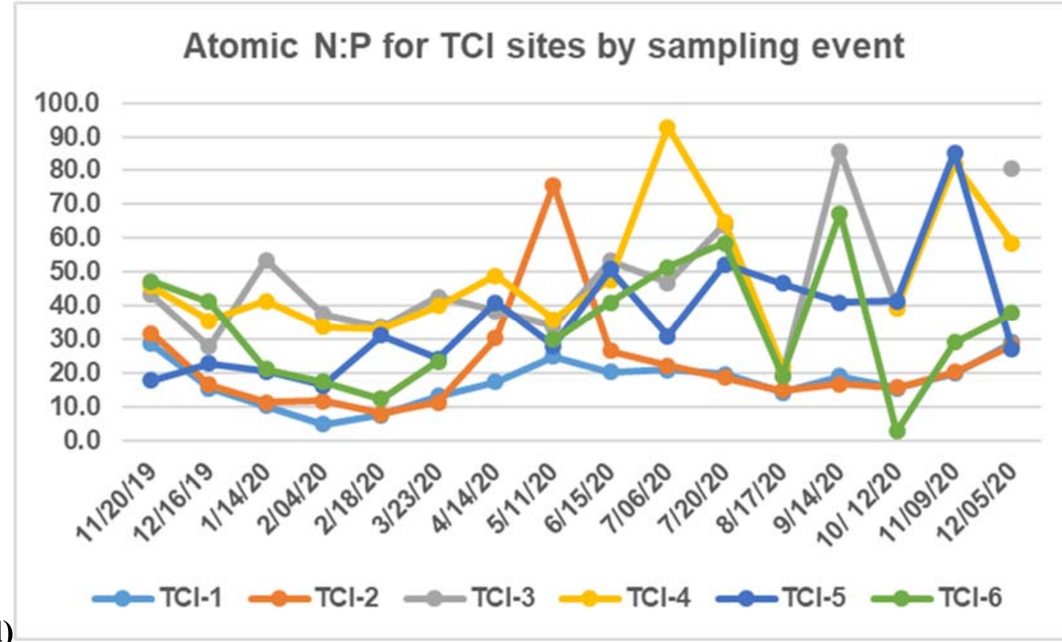
32-(a)


Atomic N:P for TC sites by sampling event
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TC-1
TC-2
TC-3

(32-b)


Atomic N:P TI sites by sampling event
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
11/20/19
12/16/19
1/14/20
2/04/20
2/18/20
3/23/20
4/14/20
5/11/20
6/15/20
7/06/20
7/20/20
8/17/20
9/14/20
10/ 12/20
11/09/20
12/05/20
TI-1
TI-2
TI-3
TI-4
TI-5
TI-6

(32-c)



(33-d)

Figure 33: Plots of monthly micromolar N:P ratios (Redfield Richards considerations): (a) all sites combined, (b) Taylor Creek sites, (c) Treasure Island sites, and (d) Taylor Creek Isles sites. **NOTE:** Anomalous high data points for TC-2 (Feb.2020)., TCI-3 (Sept.2020), TCI-4 (Nov.2020) and TCI-6(Apr. 2020) were not plotted

Pigment-Based Chemotaxonomy: Though not part of the current contract, we undertook the HPLC analyses of a few samples in order to ascertain which major groups of phytoplankton were in the TI and TCI canals. Table 25 has the phytoplankton Division estimates for the six samples determined by HPLC analyses. Except for TC-3, these samples were interior sites. The cyanobacteria detected here were non-nitrogen fixing forms as the pigment aphanizophyll was absent. These could be *Microcystis aeruginosa* but that cannot be confirmed. Surface aggregations were not observed. Chlorophyll-a values ranged from 60-120 mg / L (Figure 23, Table 23) indicating "bloom" conditions. As routine pigment-based chemotaxonomic analyses were not performed, neither spatial nor temporal trends can be forwarded here.

Table 25: Pigment based chemotaxonomic assessment of various samples collected during 2020.					
Sample	**Cyano**	**Chloro**	**Diats**	**Dinos**	**Cryptos**
TI-6 February	17	44	26	0	13
TC-3 February	11	33	38	6	12
TI-4 July	68	22	10	0	0
TCI-4 February	56	29	13	0	2
TCI-4 May	66	22	10	0	2
TCI-4 July	46	33	17	0	4

Total Phosphorus (TP) – Total Nitrogen (TN) relationship:

Overall, and as expected, TP and TN mainly increased in concert with each other. In Figure 33, the black trend line and the regression formula shown are for all 240 samplings. The red trend line is a relationship suggested to ignore the several TN values falling along the TP ~ 0.1 mg/L value.

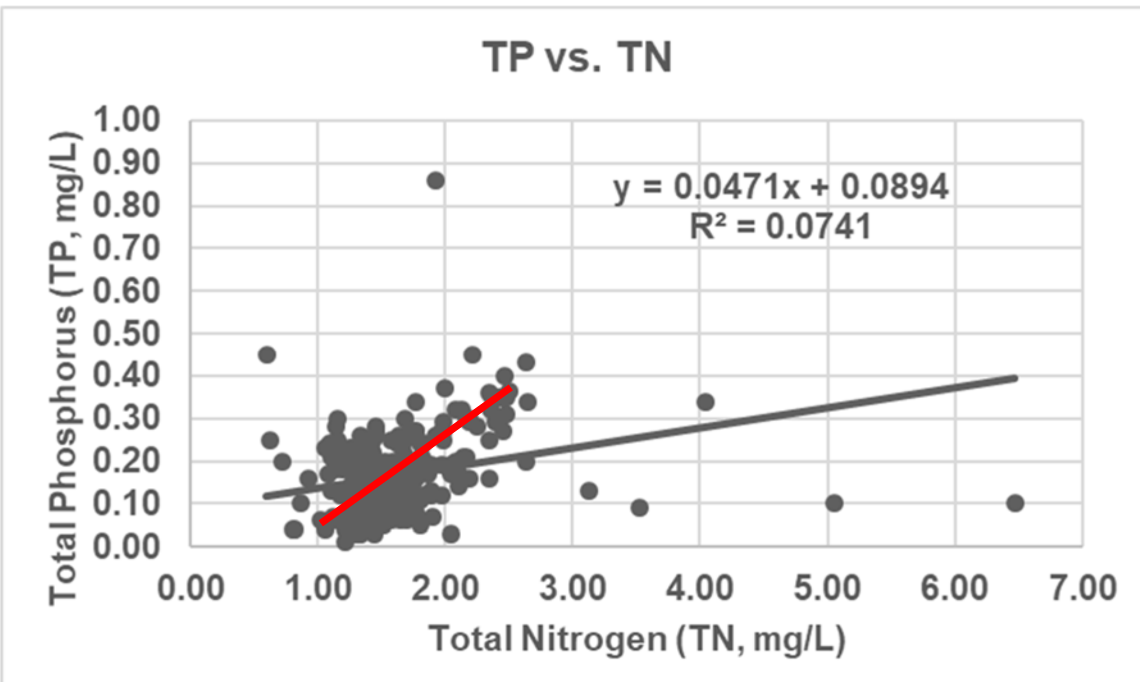


Figure 34: Plot of total phosphorus versus total nitrogen for all sites Nov. 2019 through Dec. 2020. Red line is a suggested trend if one eliminates 6-10 of the low TP high TN data points.

Total Nitrogen (TN) and Total Phosphorus (TP) versus sucralose:

TN (Figure 34) and TP (Figure 35) both exhibit slight upward trends with sucralose values. The most noticeable increases, as given earlier in text, occurred at the interior Treasure Island sites (TI-3/-4/-5/-6) in relation to the prolonged saturating rains (see figure 25) of Fall and early Winter 2020. That is TN (Figure 31c), ammonia (Figure 28d), and TP (Figure 30c) all showed notable increases following prolonged rain periods. This reflects the flushing of septic tanks and notably decreasing residence time of septic tank effluents in their respective drain fields.

Phosphorus (P) trends to increase a bit more than nitrogen (N) with increasing sucralose. This likely reflects a higher uptake of N, relative to P, by plants and bacteria affected by the drainfield.

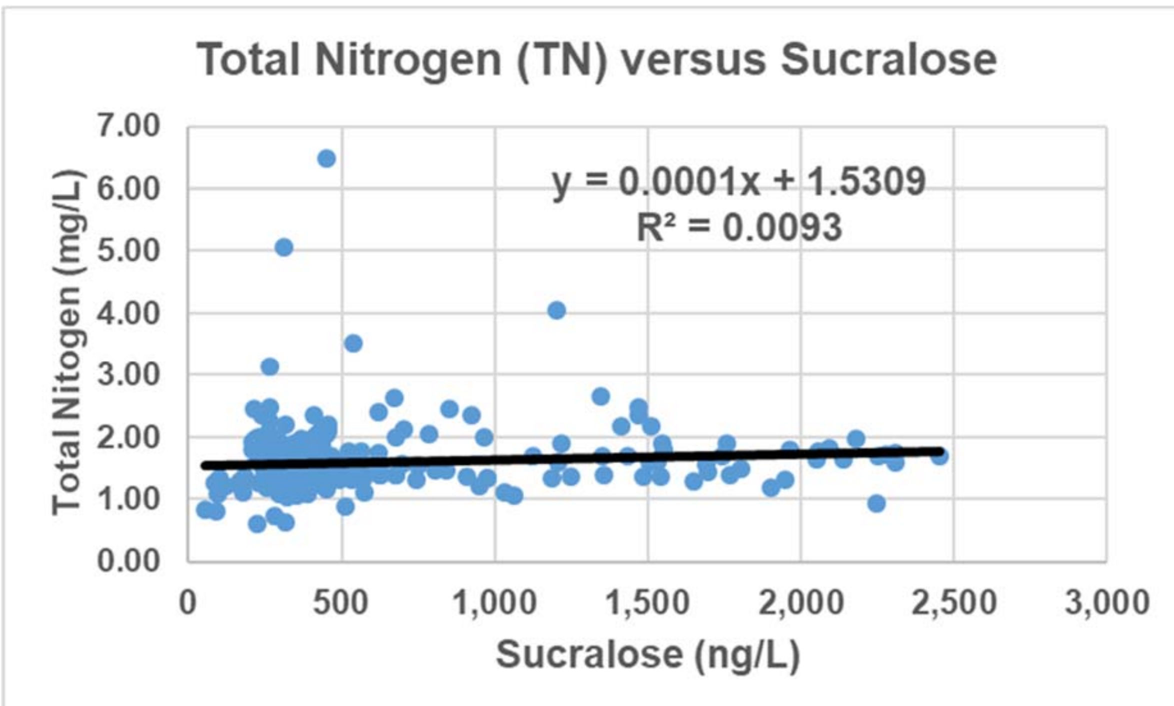
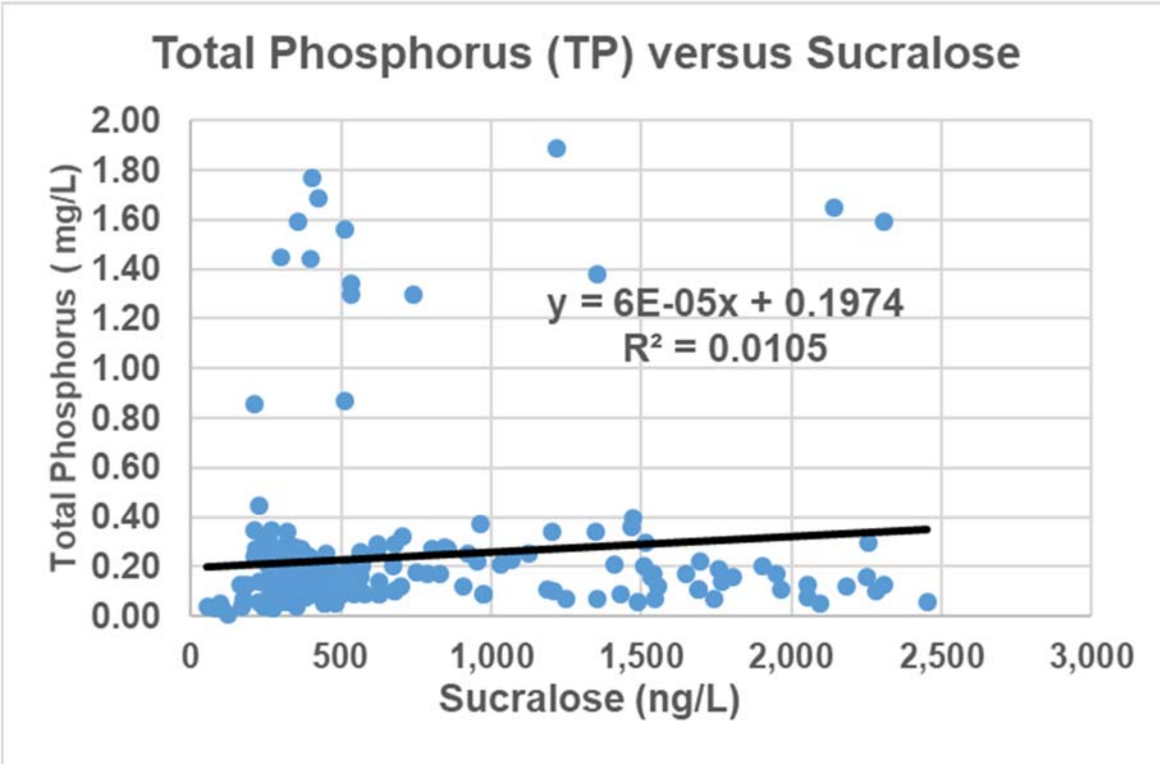


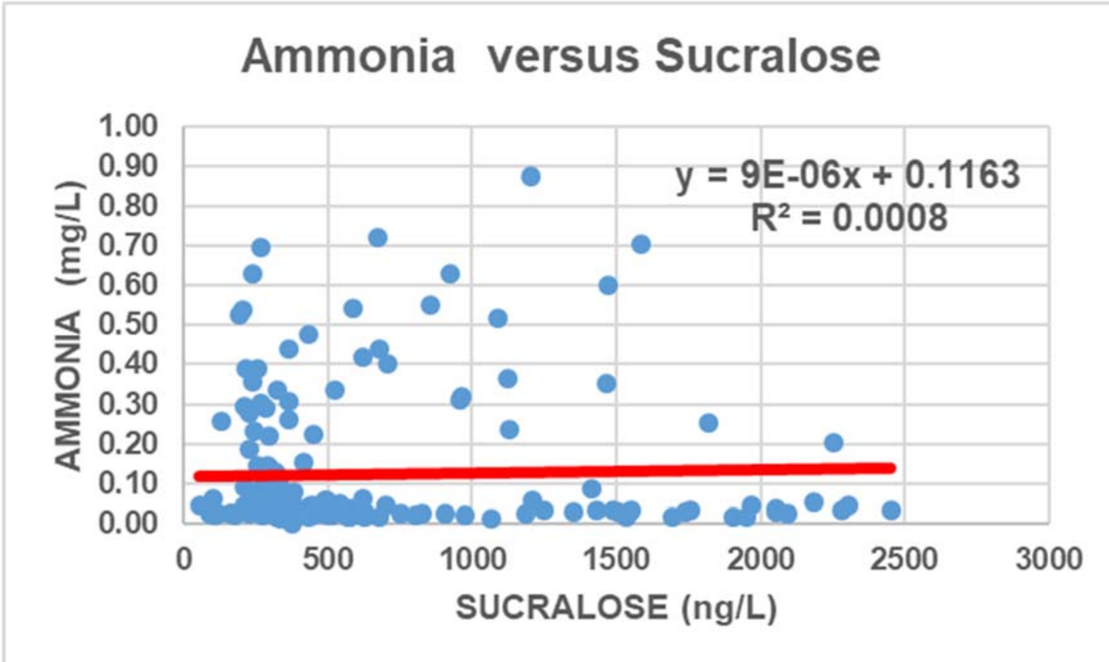
Figure 35: Plot of total nitrogen (TN) versus sucralose concentration for all sites.



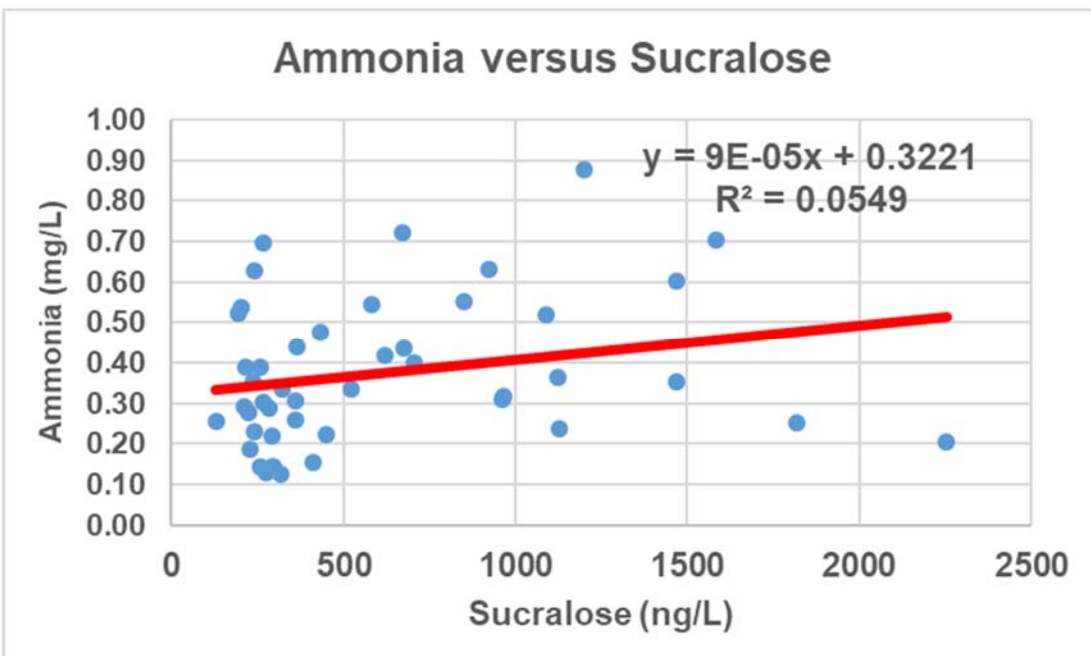
<u>Figure 36</u>: Plot of total phosphorus (TP) versus sucralose concentration for all sites.

<u>Ammonia versus sucralose</u>:

Considering all data points (Figure 37a), there is high scatter and no apparent relationship between sucralose and ammonia concentrations. However, if one considers only those data with ammonia values above 0.1 mg-NH_3/L (Figure 37b) then a slightly positive increasing correlation between higher sucralose concentrations and ammonia appears. If the values at about 1700 and 2250 ng-sucralose/L are removed the regression increases to y = 0.0002 + 0.2884 with R^2 = 0.144.



(a)



(b)

<u>Figure 37</u>: Plots of ammonia versus sucralose concentration for all sites.
(a) All data; (b) Only data with ammonia > 0.10 mg-NH_3/L.

CONCLUSIONS

Regarding ‘septic tanks’ (aka Onsite Sewerage Treatment and Disposal Systems: OSTDS), the following remarks derive from a Charlotte Harbor Environmental Center study (Chenvir. Cntr., 2003). “OSTDS contribute pollution through two pathways. In a properly working OSTDS, the effluent remains below land surface and infiltrates to the surficial groundwater where it mixes with existing groundwater. Effluent plumes then move downgradient with the surficial aquifer. If the surficial aquifer intersects a stream, lake or other depression in the land the effluent and surficial water will exit as base flow. Nutrients and pathogens are attenuated by movement vertically and horizontally through the soil.”

Going on the above quotation and having observed the very small height differences between land and canal surface levels, it is not surprising that septic tank effluent travels into and through the drainfield communicates easily with the surficial aquifer and the canals in the Treasure Island subdivision.

Results of the present study confirmed and extended the previous study in 2017-18 by Florida Gulf Coast University. In the present study, considering the sites away from Taylor Creek proper (i.e. TI-4/-5/-6 and TCI-4/-5/-6), it was found that that the ***Treasure Island canals had 5.3 times the mean concentration of sucralose relative to the Taylor Creek Isles canals***. This is based on the mean concentrations in TI (1,646 ± 223.4 ng/L) and TCI (313± 44.1 ng/l). Sites in the TI (TI-1/-2/-3) and TCI (TCI-1/-2/-3) areas close to Taylor Creek itself reflected their respective drainages mixing with TC waters. Taylor Creek ‘reference’ sites (TC-1/-2), those before encountering TI or TCI drainage, had a mean sucralose concentration of 280 ± 57.8 ng/L). After traveling through the TI / TCI area, the TC site closest to Lake Okeechobee (TC-3) had a mean sucralose concentration of 426± 113.2 ng/L, reflecting a 52% increase in sucralose.

During and following the heavy saturating rains of September-October 2020, increases in soluble reactive phosphorus (SRP) and ammonia were recorded for the inland Treasure Island sites (TI-4-/5-/-6). This is taken as an indication that drainfields from corresponding septic tanks were flushed through soils and into the canals more rapidly than during drier periods. Additional N and P could also derive from lawn fertilization. However, personal observations reveal that the lawns are much more luxuriant in the TCI subdivision. Additionally Fall-Winter are the times when fertilizers are least likely to be used. The ***TI sites away from Taylor Creek had 2.25 times the total phosphorus and 1.20 times the total nitrogen compared to the TCI sites.***

Conversion of the Treasure Island subdivision to the vacuum municipal sewer system currently proposed by OUA would certainly aid in decreasing nutrient pollution of the lower Taylor Creek system and its receiving waters directly downstream, namely Lake Okeechobee and indirectly all water bodies receiving discharges from the lake..

This report does not attempt to identify all of the sources contributing to nutrient laden water entering the South Florida waters. What this report will acknowledge is that nutrient rich waters are entering the tributaries of Taylor Creek, which flows in to the “Big Water”, Lake Okeechobee.

Sucralose data confirms and nutrient data suggests that effluent from septic tank systems in the Treasure Island area do in fact make it in to Taylor Creek and will degrade surface water quality within Lake Okeechobee and all surface waters downstream.

LITERATURE CITED

Arnold, J.G., Srinivasan, R., Muttiah, R.S., and Williams, J.R.. 1998. Large area hydrologic modeling and assessment part I: Model development. J. Am. Water Resour. Assoc. 34 (1): 73– 89. doi: https://doi.org/10.1111/j.1752-1688.1998.tb05961.x

Arnold, J.G., Allen, P.M., Volk, M., Williams, J.R., and Bosch, D.D.. 2010. Assessment of different representations of spatial variability on SWAT model performance. Trans. ASABE 53 (5): 1433– 1443. doi: https://doi.org/10.13031/2013.34913

Badruzzaman, M., Pinzon, J., Oppenheimer, J., and Jacangelo, J.G. (2012) Source of nutrients Impacting surface waters in Florida: a review. J Environ. Manag. 109:80–92

Bateman, A.S. and Kelly, S.D. (2007) Fertilizer nitrogen isotope signatures. Isotopes Environ. Health Stud. **43** (3): 237–247.

Belanger, T.V., Price, T.L., Heck, and Howell, H.(2007) Submarine groundwater Discharge in the Indian River Lagoon Florida. How important is it? Fla. Sci. **70** (4): 344–362.

Bicki, T.J., Brown, R.B., Collins, M.E., Mansell, R.S. and Rothwell, D.F. (1984) Impact of on-site sewage disposal systems on surface and ground water quality. Report to Florida Department of Health and Rehabilitative Services under contract number LC170.

Boggess, W.G., Johns,G., and Meline, C. (1997) Economic impacts of water quality programs in the Lake Okeechobee watershed of Florida. J. Dairy Sci., 80:2682-2691

Bruland, G.L, Osborne, T.Z., Reddy, K.R., Grunwald, S., Newman, S. and DeBusk, W.F. (2007) Recent changes in soil total phosphorus in the Everglades: Water Conservation Area 3. Environ. Monitor. Assess. 129:379-95. doi: 10.1007/s10661-006-9371-x.

Carpenter, S. R., N. F. Caraco, D. L. Correll, R. W. Howarth, A. N. Sharpley, and V. H. Smith (1998) Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecological Applications 8:559-568.

CHEnvir.Cntr., (2003)

Childers, D.L., Iwaniec, D.M., Leonard, L., Madden, C.J., Mitchell-Bruker, S., Rondeau, D., Solo-Gabriele, H., and Wood,A. (2003) Relating Water Flow to Wetland Processes and Everglades Restoration: Getting the Water REALLY Right in the River of Grass. Joint Conference on the Science and Restoration of the Greater Everglades and Florida Bay Ecosystem, Palm Harbor, Florida, April 16, 2003.

Cintron, C. and Louda, J.W. (2007) Extractability of phosphorous from horse manure and implications for the pollution of the surficial waters and aquifers of southern Florida. 71st. Annual Meeting of the Florida Academy of Science. St. Petersburg, Florida. March 16-17. Abstr. ENV.

Costanzo, S.D., O'Donohue, M.J., Dennison, W.C., Loneragan, N.R. and Thomas, M. (2001) A new approach for detecting and mapping sewage impacts. Mar. Pollut. Bull. **42** (2), 149–156.

DBHYDRO of South Florida Water Management District (https://www.sfwmd.gov/science-data/dbhydro).

Dodds, W.E., Bouska, W.W., Fitzman, J.L., Riley, A.J., Schloesser J.T., and Thornbrugh D.J. (2009) Eutrophication of U.S. freshwaters: Analysis of potential economic damages. Environ. Sci. Technol. 43: 12-19.

Duersch B.G., Bhadha J.H., Root T. and Louda J.W. (2020) The role of rice (*Oryza sativa* L.) in sequestering phosphorus compounds and trace elements: Speciation and dynamics. Sci. Total Environ.725 (138366) https://doi.org/10.1016/j.scitotenv.2020.138366

Duersch, B.G. and Louda, J.W. (2017) Phosphorus speciation using P31 nuclear magnetic resonance spectroscopy in order to trace phosphorus sources and movement in the C51 basin and northern Everglades. Greater Everglades Ecosystem Restoration Conference. Coral Springs, Fl, April 17-21. (Poster)

Elser, J. J., Bracken, M. E. S., Cleland, E. E., Gruner, D. S., Harpole, W. S., Hillebrand, H., et al. (2007). Global analysis of nitrogen and phosphorus limitation of primary producers in freshwater, marine and terrestrial ecosystems. *Ecol. Lett.* 10, 1135–1142.

Engstrom, D.R., Schottler, S.P., Leavitt, P.R., and Havens, K.E. (2006) A reevaluation of the cultural eutrophication of Lake Okeechobee using multiproxy sediment records. Ecol. Appl. 16:1194-1206.

Entry, J.A., and Gottlieb, A. (2014) The impact of stormwater treatment areas and agricultural best management practices on water quality in the Everglades protection area. Environ. Monit.Assess. 186:1023–1037.

FDACS (2011) 2011 Annual Report of the Florida Department of Agriculture and Consumer Services, Tallahassee, Fl. Published March 20, 2012. https://www.fdacs.gov/content/download/81841/file/2011-FDACS-Annual-Report.pdf

FDEP (2013) Basin Management Action Plans. Florida Department of Environmental Protection. Tallahassee, Fl. https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps

FDEP (2019) Final Integrated Water Quality Assessment for Florida: 2018 Sections 303(d), 305(b), and 314 Report and Listing Update. Florida Department of Environmental Protection, Tallahassee, Fl. (floridadep.gov) 157pp.

FDOH (2018) Chapter 64e-6, Florida administrative **code** standards for onsite sewage treatment and disposal systems effective July 31, 2018.

Fisher, M.M., Reddy, K.R. and James R.T. (2001) Long-Term Changes in the Sediment Chemistry of a Large Shallow Subtropical Lake. Lake Reserv. Manag. 17: 217-232.

France, R., Holmquist, J., Chandler, M., Cattaneo, A., 1998. δ15N evidence for nitrogen fixation associated with macroalgae from a seagrass-mangrove-coral reef system. Mar. Ecol. Prog. Ser. **167**: 297–299.

Grant, C.S. and Louda, J.W. (2010) Microalgal pigment ratios in relation to light intensity– Implications for chemotaxonomy. *Aquatic Biology.* **11**: 127-138.

Guignard, M.S., Leitch, A.R., Acquisti. C., Eizaguirre. C., Elser. J.J., Hessen, D.O., Jeyasingh, P.D., Neiman, M., Richardson, A.E., Soltis, P.S., Soltis, D.E., Stevens, C.J., Trimmer, M., Weider, L.J., Woodward, G. and Leitch, I.J. (2017) Impacts of Nitrogen and Phosphorus: From Genomes to Natural Ecosystems and Agriculture. Front. Ecol. Evol. 5:70. doi: 10.3389/fevo.2017.00070

Gunsalus, B., E. G. Flaig, and G. Ritter. 1992. Effectiveness of agricultural best management practices implemented in the Taylor Creek/Nubbin Slough watershed and the Lower Kissimmee River basin. Pages 161–171*in* The National Rural Clean Water Program Symposium. Enivironmental Protection Agency, Washington, DC.

Hagerthey, S. E., Louda, J. W. and Mongkronsri, P. (2006) Evaluation of pigment extraction methods and a recommended protocol for periphyton chlorophyll *a* determination and chemotaxonomic assessment. *J. Phycology* **42*:*** 1125 – 1136.

Harden, H.S., Roeder, E., Hooks, M., and Chanton, J.P. (2008) Evaluation of on-site sewerage treatment and disposal systems in shallow karst terrain. Water Research 42: 2585-2597.

Havens, K. E. (1994) Relationships of annual chlorophyll a means, maxima and algal bloom frequencies in a shallow eutrophic lake (Lake Okeechobee, Florida). Lake and Reserv. Manage. 10: 133-138.

Havens, K.E. (1995). Secondary Nitrogen Limitation in a Subtropical Lake Impacted by Non-Point Source Agricultural Pollution. Environ. Pollut. 89: 241-246.

Havens, K.E. and T.L. East. 1997. Carbon Dynamics in the Grazing Food Chain of a Subtropical Lake. J. Plankton Res. 19: 1687-1711.

Havens, K.E. and Walker, Jr., W.W. (2002) Development of a Total Phosphorus Concentration Goal in the TMDL Process for Lake Okeechobee, Florida (USA). Lake Reserv. Manage. 18: 227-238.

Heaton, T.H.E. (1986). Isotopic studies of nitrogen pollution in the hydrosphere and atmosphere: a review. Chem. Geol. **5**: 87–102.

Hecky, R.E., Campbell, P., and Hendzel, L.L. (1993) The stoichiometry of carbon, nitrogen, and phosphorus in particulate matter of lakes and oceans. *Limnol. Oceaongr*. 38: 709-724.

Kim, J.-Y. (2019) *Evaluation of Impacts of On-Site Sewerage Treatment and Disposal (OSTD) Systems on Water Quality in Taylor Creek.* Final Report from Florida Gulf Coast University to Okeechobee Utility Authority. August 10, 2019. 47pp.

Lankoski, J., and M. Ollikainen. 2013. "Innovations in Nonpoint Source Pollution Policy-European Perspectives". Choices. Quarter 3. Agricultural & Applied Economics Association.28(3): 5 pp.

Lapointe, B.E. and Krupa, S. (1995a) Jupiter Creek septic tank/water quality investigation. Final Report. Loxahatchee River Environmental Control District, Jupiter, FL 96 pp.

Lapointe, B.E. and Krupa, S. (1995b) Tequesta Peninsula septic tank/water quality investigation. Final Report. Loxahatchee River Environmental Control District, Jupiter, FL 87 pp.

Lapointe, B. E., Herren, L.W., Debortoli, D., and Vogel, M.A.. (2015) Evidence of sewage-Driven eutrophication and harmful algal blooms in Florida's Indian River Lagoon. Harmful Algae **43**:82-102.

Lapointe, B. E., Herren, L.W., and Bedford, B.J. (2012) Effects of hurricanes, land-use, and water management on nutrient and microbial pollution of the St. Lucie Estuary, Southeast Florida. J. Coastal Research 28 ;1345-1361.

Lapointe, B. E., Herren, L.W., and Paule, A.L. (2017) Septic systems contribute to nutrient pollution and harmful algal blooms in the St. Lucie Estuary, Southeast Florida, USA. Harmful Algae 70: 1-22.

Liu, F., Li, X.-Q., Dong, G.-C., and Qin, Y.-G. (2011) Water pollution of Yellow River coastal wetland. China Environ. Sci. 31: 1705-1710.

Liu, Y., Guo, T., Wang, R., Engel, B.A., Flanagan, D.C., Li, S., Pijanowski, B.C., Collingsworth, P.D., Lee, J.G., and Wallace, C,W. (2019) A SWAT-based optimization tool for obtaining cost-effective strategies for agricultural conservation practice implementation at watershed scales. Sci Total Environ. 2019 Nov 15;691:685-696. doi: 10.1016/j.scitotenv.2019.07.175.

Loftin, K.A., Clark, J.M., Journey, C.A., Koplin, D.A., VanMetre, P.C., Carlisle, D. and Bradley, P.M. (2016) Spatial and temporal variation in microcystin occurrence in wadeable streams in the southeastern United States. Environ. Toxicolgy Chem. **35**(9): 2281-2287.

Louda, J. W. (2008) Pigment-Based Chemotaxonomy of Florida Bay Phytoplankton; Development and Difficulties. J. Liquid Chromatogr. & Rel. Tech. **31**: 295-323

Louda, J. W. and Monghkonsri, P. (2004) Comparison of spectrophotometric estimates of chlorophylls-*a*, -*b*, -*c* and 'pheopigments' in Florida Bay seston with that obtained by high performance liquid chromatography-photodiode array analyses. *Fla. Sci.* **67**(4): 281 – 292.

Louda J.W., Grant C., Browne J. and Hagerthey S.E. (2015) Pigment-based chemotaxonomy and its application to Everglades periphyton. In: J. A. Entry, K. Jayachandrahan, A.D. Gottlieb and A. Ogram (Eds.) MICROBIOLOGY OF THE EVERGLADES ECOSYSTEM. Science Publishers. Chapter 13; pp. 287-347 plus appendices (pp.455-468) and color plate (p485). (ISBN 9781498711838)

Louda, J.W., Duersch, B.G., Cintron, C., Quierrez, V., Cahljub, L., and Osetek, J. (2021-in preparation). Phosphorus non-point pollution from equestrian wastes and the need for recycling. To be submitted to J. Environ. Qual.

Louda, J.W., Duersch, B., Querioz, V. and Cintron, C. (2019) Equestrian waste streams as a source of surface-water phosphorus pollution. American Chemical Society 257th Annual Meeting. Orlando, Florida. March 31-April 4. Environmental Division. (Talk # ENVR-207)

McCarthy, M.J., Gardner, W.S., Lehmann, M.F., Guindon, A. and Bird, D.F. (2016) Benthic nitrogen regeneration, fixation, and denitrification in a temperate, eutrophic lake: Effects on the nitrogen budget and cyanobacterial blooms. Limnol. Oceanogr. **61**: 1406-1421.

Meals, Donald & Dressing, Steven & Davenport, Thomas. (2010). Lag Time in Water Quality Response to Best Management Practices: A Review. Journal of environmental quality. 39: 85-96. 10.2134/jeq2009.0108.

Meeroff, D.E., and Morin, F.J. (2005) Contribution of on-site treatment and disposal systems on coastal pollutant loading. WEFTEC.05. Conference proceedings. 2005. 8391-8407.

Meeroff, D.E., Bloetscher F., Long, S.C., and Bocca, T. (2014) The use of multiple tracers to evaluate the impact of sewered and non-sewered development on coastal water quality in a rural area of Florida. Water Environment Research 86: 445-456.

Millie, D.F., Paerl, H.W. and Hurley, J.P. (1993) Microalgal pigment assessments using high-performance liquid chromatography: A Synopsis of organismal and ecological applications. Can. J. Fish. Aquat. Sci. **50**: 2513 - 2527.

Neitsch, S.L., Arnold, J.G., Kiniry, J.R., and Williams, J.R.. 2011. Soil and Water Assessment Tool theoretical documentation: Version 2009. USDA–ARS, Grassland, Soil and Water Research Laboratory, Temple, TX; and Blackland Research and Extension Center, Texas AgriLife Research, Temple, TX. Texas Water Resources Institute Technical Rep. 406, Texas A&M University System, College Station, TX. http://swatmodel.tamu.edu/documentation/

Osetek, J. and Louda, J. W. (2004) Water quality analyses of canals in the agricultural / residential community of Loxahatchee Groves, Florida. 68th. Annual Meeting of the Florida Academy of Sciences. Orlando, Fl., March 12-13, 2004. Abstract ENV-10.

Paerl, H.W. (2009) Controlling Eutrophication along the Freshwater-Marine Continuum: Dual Nutrient (N and P) Reductions are Essential. Estuaries Coasts **32**: 593-601.

Paerl, H.W. and Fogel, M.L. (1994) Isotopic characterization of atmospheric nitrogen inputs as sources of enhanced primary production in coastal Atlantic Ocean waters. Mar. Biol. **119** (4), 635–645.

Paerl, H. W., Xu, H., McCarthy, M. J., Zhu, G., Qin, B., Li, Y., and Gardner, W. S. (2011). Controlling harmful cyanobacterial blooms in a hyper-eutrophic lake (Lake Taihu, China): the need for a dual nutrient (N & P) management strategy. Water Research **45**(5): 1973-1983.

Paerl, H. W., Xu, H., Hall, N.S., Zhu, G., Qin, B., Wu, Y., Rossingnol, K.l., Dong, L., McCarthy, M.J.,and Joyner, A.R. (2014) Controlling Cyanobacterial Blooms in Hyperutrophic Lake Taihu, China: Will Nitrogen Reductions Cause Replacement of Non-N_2 Fixing by N_2 Fixing Taxa? PLOS ONE **9**(11): e113123; 13 pp.

Phlips, E.J., Badylak, S., and Grosskopf, T. (2002) Factors affecting the abundance of phytoplankton in a restricted subtropical lagoon, the Indian River Lagoon, Florida, USA Estuar. Coast. Shelf Sci., 55 (2002), pp. 385-402

Pierce, J.J., Weiner, R.F., and Vesilind, P.A. (1998) Environmental Pollution and Control. Butterworth-Heinemann (Elsevier) pp. 137-145.

Pollman, C.D., and James, R.T. (2011) A simple model of internal loading of phosphorus in Lake Okeechobee. Lake Reserv. Manage. 27: 15-27, DOI:10.1080/07438141.2010.542877

Ptacnik, R., Anderson, T., and Tamminen, T. (2010) Performance of the Redfield ratio and a family of nutrient limitation indicators as thresholds fr phytoplankton N vs. P limitation. *Ecosystems* 13: 1201-1214.

Recheigl, J.E. (1997) Phosphorus-Natural versus Pollution Levels: Lake Okeechobee Case Study. 1997 Florida Beef Cattle Short Course. University of Florida - Institute of Food and Agricultural Sciences

Recheigl, J.E. and Bottcher, A.B. (1995) Fate of phosphorus on bahiagrass (*Paspalum notatum*) pastures. Ecol. Engineer. **5**: 247-259.

Redfield, A.C.(1934) On the proportions of organic derivations in sea water and their relation to the composition of plankton. In: R.J. Daniel (Ed.) James Johnstone Memorial Volume. (ed. R.J. Daniel). University Press of Liverpool, pp. 176–192.

Redfield, A.C. (1958) The biological control of chemical factors in the environment. Amer. Scientist. Autumn: 205-221

Redfield, G. (1999) Science – Management Linkages in Ecosystem Management. S. Fla. Restoration Science Forum. May 1999.

Risk, M.J., Lapointe, B.E., Sherwood, O.A., Bedford, B.J., 2008. The use of d15N in assessing sewage stress on coral reefs. Mar. Pollut. Bull. **58** (6), 793–802.

SFWMD (2011) Lake Okeechobee Protection Plan-Update March 2011. South Florida Water Management District, March 201. Florida Department of Agriculture and Consumer Services

Shen, Z., Xie, H., Chen, L., Qiu, J., and Zhong, Y. (2015) Uncertainty analysis for nonpoint source pollution modeling: implications for watershed models. Int. J. Envir. Sci. Technol.12, pages739–746

Sims, J.T. (2000) The role of soil testing in environmental risk assessment for phosphorus. p.57-81.In: A.N. Sharpley (ed.),Agriculture and Phosphorus Management: The Chesapeake Bay, Lewis Publishers, Washington, DC.

Smith, V. H., Tilman, G. D., and Nekola, J. C. (1999). Eutrophication: impacts of excess nutrient inputs on freshwater, marine, and terrestrial ecosystems. Environ. Pollut. 100: 179–196

Steinman, A., Havens, K. E. and Hornung, L. (2002) The Managed Recession of Lake Okeechobee, Florida: Integrating Science and Natural Resource Management. Ecol. Society **6**(2): Art. 17, 10pp.

Sterner, R.W. (2011) C:N:P stoichiometry in Lake Superior: freshwater sea as end member. Inland Waters 1: 29-46.

Stone, R. (2011) China aims to turn tide against toxic lake pollution. Science **333**: 1201-1211.

Stuck, J.D., Izuno, F.T., Campbell, K.l., Bottcher, A.B. , and Rice, R.W. (2001) Farm-level studies of particulate phosphorus transport in the Everglades Agricultural Area. Trans.ASAE. 44: 1105–1116. (doi: 10.13031/2013.6438)

They, N.H., Amando, A.M., and Cotner, J.B. (2917) Redfield ratios in inland waters: Higher biological control of C:N:P ratios in tropical semi-arid high water residence time lakes. *Frontiers Microbiol*. 8: Article 1505

Tuo, Y., Chiogna, G., Disse, M. (2015). Model selection for nutrient transport at the catchment scale. International Conference Integrated Hydrosystem Modellig 2015, Tübingen, Germany.

US-ACE (2016) Lake Okeechobee Watershed Project. US Army Corps of Engineers, Jacksonville District. ahttp://www.saj.usace.army.mil/Missions/Environmental/Ecosystem-Restoration/Lake-Okeechobee).

USEPA (2016) National Nonpoint Source Program- a catalyst for water quality improvements. United States Environmental Protection Agency Publication EPA-841-R-16-009.

USEPA (2019) Clean WaterACt Analytical Methods. Methods Rule Update-2019. https://www.epa.gov/cwa-methods/methods-update-rule-2019

Walker Jr., W.W. and Havens, K.E. (1995) Relating algal bloom frequencies to phosphorus concentrations in Lake Okeechobee. Lake and Reserv. Manage. 11: 77-83.

Weiskel, P.K. and Howes, B.L. (1992) Differential transport of sewage-driven nitrogen and phosphorus through a coastal watershed. Environ. Sci. Technol. **26** (2): 352–360

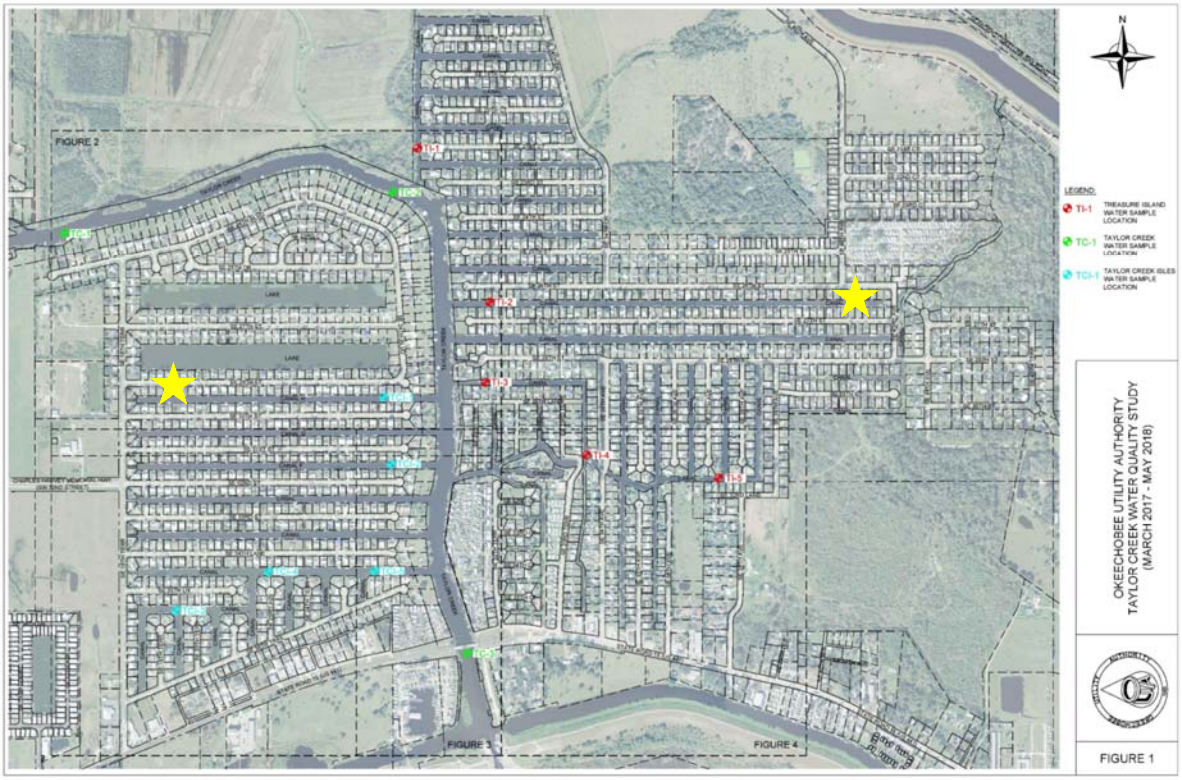
Xia, Y., Zhang, M., Tsang, D.C.W., Geng, N., Lu1, D., Zhu, L., Igalavithana, A.D.,Dissanayake, P.D., Rinklebe, J., Yang,X.,and Ok, Y.S. (2020) Recent advances in control technologies for non-point source pollution with nitrogen and phosphorous from agricultural runoff: current practices and future prospects. Appl. Biol. Chem. 63:8.

Xu, H., Paerl, H.W., Qin, Q., Zhu, G.W. and Gao (2010) Nitrogen and phosphorus inputs control phytoplankton growth in euthrophic Lake Taihu, China. Limnol. Oceanogr. **55**: 420-432.

Yokoyama, A. and Park, H.-D. (2003) Depuration kinetics and persistence of the cyanobacterial toxin microcystin-LR in the freshwater bivalve *Unio douglasiae*. Environ. Toxicol. **18**:61–67.

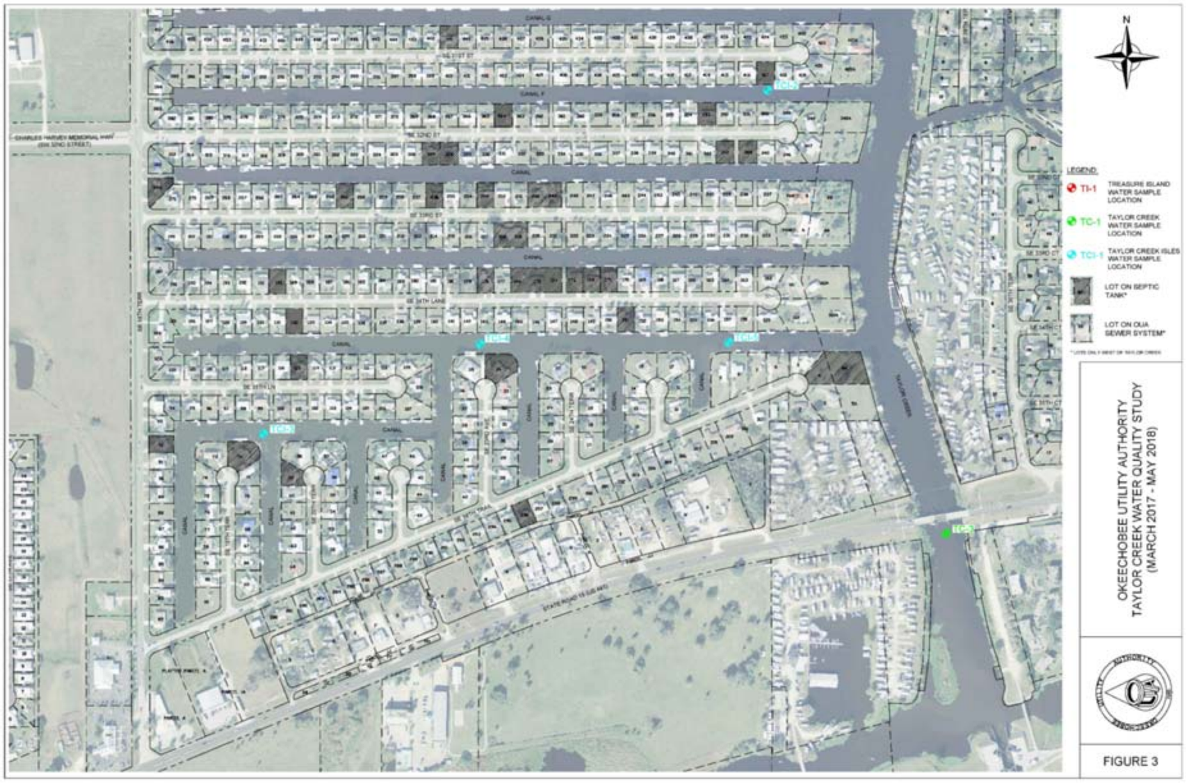
Zhou, M. and Struve, D. (2016) Remote P Analysis Contributes to Water Quality Studies. South Florida Water Management District, West Palm Beach, Florida. Poster. Aug. 4, 2016.

SUPPLEMENTARY FIGURES



<u>Figure S1</u>: Sites of previous and current study. Current study added TI-6 and TCI-6 (Stars)

<u>Figure S2</u>: Northern part of Taylor Creek Isles showing lots that remain on septic tanks (dark grey shaded)



<u>Figure S3</u>: Southern part of Taylor Creek Isles showing lots that remain on septic tanks (dark grey shaded).