

# Broward County Water Quality Analysis - Las Olas Finger Canals

Prepared by the Broward County  
Environmental Planning and Community Resilience Division

December 8, 2017

The Broward County Environmental Planning and Community Resilience Division (EPCRD), via the activities of the Environmental Monitoring Laboratory (EML), performs water quality analysis of freshwater, coastal, and marine waters as part of ambient water quality monitoring, enforcement support, and in assessment of potential water quality concerns.

In late August 2017, EPCRD staff observed the presence of a dense algal bloom present in several finger canals in the Las Olas areas during a routine aerial survey. As staff researched the overall conditions and spatial extent of the bloom we learned that the Florida Department of Environmental Protection (FDEP) had received resident complaints about the presence of the bloom and concerns about potential impacts on the health of local wildlife. The FDEP confirmed that analyses for microcystis and the microcystis toxin would be performed to determine the potential for wildlife impacts. Internally, Broward County staff were directed to collect water quality samples upstream and within the impacted area for analysis of chlorophyll *a*, nutrients, and fecal coliform in order to characterize water quality and potential contributors to the bloom condition, coupled with DNA analyses to quantify potential contributions of human sources to fecal contamination, if present. Fecal coliform was included in this assessment as it can serve as important parameter in determining whether fecal material is a potential nutrient source supporting bloom activity. The County EML is NELAC certified for each of these parameters with exception of DNA source tracking which is a newly implemented methodology by the Broward County EML to help inform Best Management Practices (BMPs) for water quality improvements targeting fecal coliform.

The EML staff collected surface water samples at a total of five (5) sites on four (4) dates: 9/5, 9/20, 9/27, and 10/2. Initial sampling included a site where the blooms was observed (Site 1) and a background site (Site 2) away from the affected area. Sites 3-5 were added in subsequent sampling events to get broader coverage of the area (see map). A period of two (2) weeks separated the first two sample collection dates due to disruptions associated with Hurricane Irma. Upon return of operations, staff confirmed that the bloom had persisted beyond the passage of Hurricane Irma and thus sampling was renewed on 9/20 and was concluded after an additional three (3) weeks of sampling. All sites were sampled for the above referenced

parameters with the results included in the attached documents, except for DNA analysis for human fecal sources which was only performed on samples collected on 9/5 and 9/20. Fecal coliform was further evaluated for E.Coli and Enterococci, with Enterococci noted to be the more appropriate parameter for identifying fecal coliform in conditions of saltwater and E. Coli the preferred index in freshwater systems.

A summary of the data is as follows:

Chlorophyll *a* concentration (a measure of algal biomass) varied over time and location, which is not surprising given the nature of blooms and that Hurricane Irma happened. Site 2 (background) had the lowest with concentrations (less than 5 µg/l). The other 4 sites had ranged from ca. 6 µg/l to 46 µg/l Chl *a* with the exception of one sample which showed 182 µg/l at Site 1. Note that the State's Impaired Waters Rules identifies 12 µg/l Chl *a* as the threshold for water quality in estuarine waters.

Per Florida Administrative Code, Table 62-302.530 Surface Water Quality Standards, water quality criteria are as follows. (Results are measured in colony forming units (cfu) per 100 mL).

- E. coli – not to exceed **410** cfu/100 mL in 10% of samples
- Enterococci - not to exceed **130** cfu/100 mL in 10% of samples
- Fecal Coliform – not to exceed **800** cfu/100 mL on any one day. **NOTE:** This criteria is for Class II waters only (shellfish harvesting), and does not apply to the Las Olas canals. Fecal coliform was analyzed for these samples as a comparative measure.

From the data collected:

- E. coli did not exceed criteria on any day
- Enterococci did exceed criteria on 9/27/17 at sites #1, #3, and #5 and on 10/2 at sites #3, #4, #5
- Fecal coliform did exceed criteria on 9/20/17 at all sites, excluding site #2. Exceedance of the threshold was measured at site #3 on 10/2.

It should be noted that data from the Las Olas water quality assessment are substantially limited given the relatively few samples collected and short timeframe, hence it is not possible to establish any statistical significance with the regards to the data set, to reveal findings of cause and effect, or to provide an accurate evaluation of data with consideration of the 10% exceedances, as per the FAC rule. Details on the rule can be found here <https://www.flrules.org/gateway/ChapterHome.asp?Chapter=62-302>. Instead, these data provide the basis for relative comparisons among and between sites under conditions of a

recent bloom that may be helpful in evaluating potential causal relationships and water quality exceptions for future events of a similar nature.

With respect to DNA source tracking, the target genetic marker HF 183 was used to identify human source fecal contamination (see DNA Source Tracking Update dated 11/29/17). Data collected at the referenced sites were compared to data collected within the broader regional surface water system in the months of June 2017 and August 2017 (the extent of Broward County record, see sample location map). Water quality in the regional system ranged from 25 – 494 target copies/ml in June 2017 and from 0 to 446 target copies/ml in August 2017. The exception was a June site which showed a count of 12,696 measuring a substantially higher amount of human source fecal contamination relative to other sites. Additionally, the counts were generally higher in August 2017. By comparison, counts measured in the referenced monitoring assessment ranged from 187-563 with one sample measuring 10,596 at site 4. These data do reveal the presence of human source fecal contamination, but the numbers appear to be relatively consistent with water quality measured in other parts of the regional water management system. Given the lack of regional data and limited sample size is not possible to draw any conclusive statements regarding the specific nutrient sources supporting bloom development in the Las Olas finger canals, as observed in Fall 2017.

### Conclusion

Water quality analyses performed by the Broward County EML in the area of an identified algal bloom within the Las Olas finger canals revealed Chl *a* concentrations above the water quality threshold established by the FDEP for estuarine waters. This is not surprising as Chl *a* provides a measure of algal biomass and an active bloom was observed during the time of sample collection. Nutrient concentrations appeared relative low, which might have been the result of active uptake by algae during bloom development and persistence. Fecal coliform was present, as most reliably determined based on Enterococci counts, with concentrations at several stations in exceedance of State water quality standards for estuarine waters, but the comparison against the standard requires the caveat that this as a small data set and given this few samples collected we are unable to calculate a 10% exceedance. Finally, while human source fecal contamination was present, overall the presence was not inconsistent with background water quality measured in of other parts of the county. One station did show a higher count of 10,596 target copies/100 ml but this represented a single data point. Continuation of water quality assessments as part of the regional system and for subsequent water quality events will provide additional information useful in establishing local background conditions, exceptions, and causal relationships relating to local and chronic water quality concerns.

November 29, 2017

## **Broward County Environmental Lab: DNA Source Tracking Update**

Results of DNA source tracking analyzed by quantitative polymerase chain reaction (qPCR) indicate the presence of human source fecal contamination in samples collected at all sites as presented in Table 1. In the industry, the genetic marker HF183, has gone through inter-laboratory comparison<sup>1,2</sup> and represents the best available science used to determine the presence of human fecal contamination<sup>3</sup>.

Currently, there exists no regulatory standard as to the number of target DNA copies which may in effect cause a risk to human health. As such, these results serve only to provide information so that best management practices of the area are taken into consideration.

During 2017, samples were collected at monitoring sites within the Intracoastal Waterway and at several canals primarily in east Broward County. Grab samples were collected in June, August and September, the September event was focused around an algae bloom in the Las Olas Isles.

Once collected, samples were transported to the Environmental Monitoring Lab and filtered that same day. They were then stored in a – 80 deg C freezer until extraction. All samples were extracted using a MP Bio DNA extraction kit and analyzed by qPCR. The actual qPCR analysis utilized a unique set of reagents purchased from Integrated DNA Technologies (IDT), Thermo Fisher Scientific/Applied Biosystems and Qiagen. The HF183 control, used to create a standard curve, was synthesized by IDT based on a specific 319 base pair sequence. All standard curves resulted in R squared values greater than 0.99.

The results presented in Table 1 indicate a presence of human source fecal contamination at all sites, and were not present in the field clean equipment blank (FCEB) collected on September 5, 2017, as expected.

<sup>1</sup>Shanks, Orin C., Mano Sivaganesan, Lindsay Peed, Catherine A. Kelty, A. Denene Blackwood, Monica R. Greene, Rachel T. Noble, Rebecca N. Bushon, Erin A. Stelzer, Julie Kinzelman, Tamara Anan'eva, Christopher Sinigalliono, David Wanless, John Griffith, Yiping Cao, Steve Weisber, Valarie J. Harwood, Christopher Staley, Kevin H. Oshima, Manju Varma, and Richard A. Haugland. 2012. "Inter-laboratory comparison of real-time PCR protocols for quantification of general fecal indicator bacteria." *Environmental Science and Technology* 46, no. 2: 945-953.

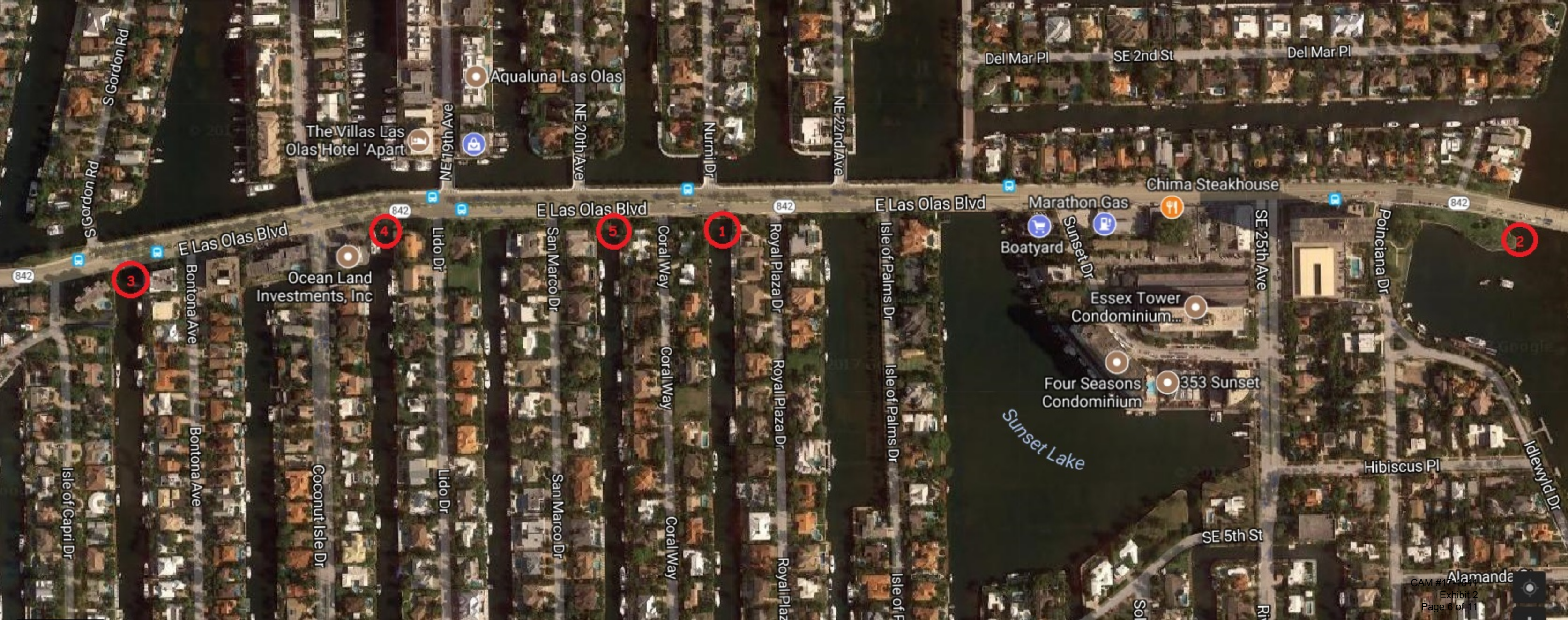
<sup>2</sup>Boehm, Alexandria B., Laurie C. Van De Werfhorst, John F. Griffith, Patricia A. Holden, Jenny A. Jay, Orin C. Shanks, Dan Wang and Stephen B. Weisberg. 2013. "Performance of forty-one microbial source tracking methods: A twenty-seven lab evaluation study." *Water Research* 47, no. 18: 6812-6828.

<sup>3</sup>Griffith, John F., Blythe A. Layton, Alexandria B. Boehm, Patricia A. Holden, Jennifer Jay, Charles Hagedorn, Charles D. McGee, and Stephen B. Weisberg. 2013. "The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches." Accessed June 24, 2015. [http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/804\\_SIPP\\_MST\\_ManualPag.pdf](http://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/804_SIPP_MST_ManualPag.pdf)

**Table 1. DNA Source Tracking HF183 Results**

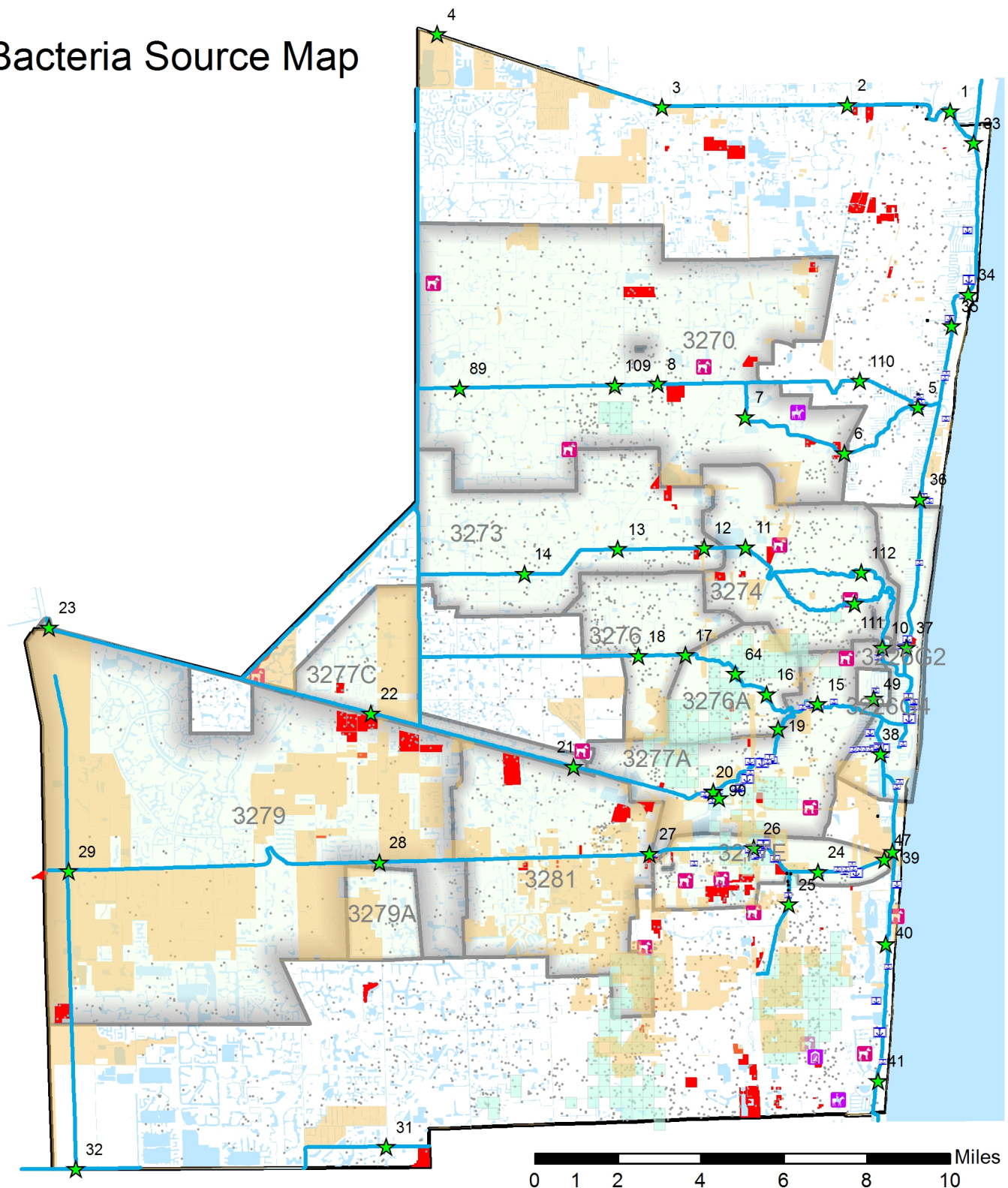
<b>Site #</b>	<b>Date Collected</b>	<b>HF 183 target copies per 100 ml</b>
<b>37</b>	6/12/2017	165
<b>19</b>	6/14/2017	184
<b>16</b>	6/14/2017	12,696
<b>64</b>	6/14/2017	494
<b>121</b>	6/14/2017	48
<b>123</b>	6/14/2017	32
<b>20</b>	6/14/2017	63
<b>10</b>	6/19/2017	46
<b>129</b>	6/19/2017	25
<b>37</b>	8/21/2017	91
<b>19</b>	8/23/2017	446
<b>16</b>	8/23/2017	Unable to obtain sample due to construction
<b>64</b>	8/23/2017	69
<b>120</b>	8/21/2017	105
<b>121</b>	8/23/2017	0
<b>123</b>	8/23/2017	128
<b>20</b>	8/23/2017	180
<b>10</b>	8/30/2017	406
<b>129</b>	8/28/2017	51
<b>Las Olas FCEB</b>	9/5/2017	0
<b>Las Olas Site 1-Algae</b>	9/5/2017	408
<b>Las Olas Site 2-Background</b>	9/5/2017	187
<b>Las Olas Site 1-Algae</b>	9/20/2017	433
<b>Las Olas Site 2-Background</b>	9/20/2017	250
<b>Las Olas Site 3-Algae</b>	9/20/2017	266
<b>Las Olas Site 3 DUP-Algae</b>	9/20/2017	563
<b>Las Olas Site 4-Algae</b>	9/20/2017	10,596
<b>Las Olas Site 5-Algae</b>	9/20/2017	301







# Bacteria Source Map



- Dog Park
- Stray Cat (Oct 2015 to Mar 2017)
- Stray Cat Hot Spot (Oct 2015 to Mar 2017)
- Dog Race Track
- Horse Race Track
- PSD Mobile Home/RV Parks
- Marina (up to 50 wet slips)
- Marina (51 - 100 wet slips)
- Marina (>100 wet slips)
- Sampling Location
- Unsewered Area
- Elevated Fecal Bacteria



CAM #17-1511

Exhibit 2

Page 7 of 11

Sample Num	Sample Point	Param. Name	Reported Value	Units	Sample Collection Date
170906-001B	Las Olas Algae Site #1	Ammonia	0.072	mg/L	9/5/2017 10:50
170922-004B	Las Olas Algae Site #1	Ammonia	0.126	mg/L	9/20/2017 10:05
170906-001E	Las Olas Algae Site #1	Chlorophyll-a	46	mg/m3	9/5/2017 10:50
170922-004E	Las Olas Algae Site #1	Chlorophyll-a	10.6	mg/m3	9/20/2017 10:05
170925-001E	Las Olas Algae Site #1	Chlorophyll-a	182	mg/m3	9/27/2017 10:30
170929-005E	Las Olas Algae Site #1	Chlorophyll-a	7.01	mg/m3	10/2/2017 10:50
170906-001A	Las Olas Algae Site #1	E Coli	112	cfu/100mL	9/5/2017 10:50
170922-004A	Las Olas Algae Site #1	E Coli	108	cfu/100mL	9/20/2017 10:05
170925-001A	Las Olas Algae Site #1	E Coli	248	cfu/100mL	9/27/2017 10:30
170929-005A	Las Olas Algae Site #1	E Coli	70	cfu/100mL	10/2/2017 10:50
170906-001A	Las Olas Algae Site #1	Enterococci	96	cfu/100mL	9/5/2017 10:50
170922-004A	Las Olas Algae Site #1	Enterococci	80	cfu/100mL	9/20/2017 10:05
170925-001A	Las Olas Algae Site #1	Enterococci	560	cfu/100mL	9/27/2017 10:30
170929-005A	Las Olas Algae Site #1	Enterococci	67	cfu/100mL	10/2/2017 10:50
170906-001A	Las Olas Algae Site #1	Fecal Coliform	367	cfu/100mL	9/5/2017 10:50
170922-004A	Las Olas Algae Site #1	Fecal Coliform	2120	cfu/100mL	9/20/2017 10:05
170925-001A	Las Olas Algae Site #1	Fecal Coliform	820	cfu/100mL	9/27/2017 10:30
170929-005A	Las Olas Algae Site #1	Fecal Coliform	80	cfu/100mL	10/2/2017 10:50
170906-001C	Las Olas Algae Site #1	Nitrite	0.019	mg/L	9/5/2017 10:50
170922-004C	Las Olas Algae Site #1	Nitrite	0.014	mg/L	9/20/2017 10:05
170906-001B	Las Olas Algae Site #1	NO2 + NO3	0.136	mg/L	9/5/2017 10:50
170906-001D	Las Olas Algae Site #1	OPO4	0.006	mg/L	9/5/2017 10:50
170922-004D	Las Olas Algae Site #1	OPO4	0.022	mg/L	9/20/2017 10:05
170925-001D	Las Olas Algae Site #1	OPO4	0.026	mg/L	9/27/2017 10:30
170929-005D	Las Olas Algae Site #1	OPO4	0.03	mg/L	10/2/2017 10:50
170906-001B	Las Olas Algae Site #1	TKN	0.783	mg/L	9/5/2017 10:50
170922-004B	Las Olas Algae Site #1	TKN	0.566	mg/L	9/20/2017 10:05
170906-001B	Las Olas Algae Site #1	TPO4	0.153	mg/L	9/5/2017 10:50
170922-004B	Las Olas Algae Site #1	TPO4	0.072	mg/L	9/20/2017 10:05



170906-002B	Las Olas Algae Site #2	Ammonia		0.028 mg/L	9/5/2017 11:35
170922-005B	Las Olas Algae Site #2	Ammonia		0.111 mg/L	9/20/2017 13:05
170906-002E	Las Olas Algae Site #2	Chlorophyll-a		2.61 mg/m3	9/5/2017 11:35
170922-005E	Las Olas Algae Site #2	Chlorophyll-a		2.59 mg/m3	9/20/2017 13:05
170925-002E	Las Olas Algae Site #2	Chlorophyll-a		4.45 mg/m3	9/27/2017 10:50
170929-006E	Las Olas Algae Site #2	Chlorophyll-a		1.98 mg/m3	10/2/2017 11:05
170906-002A	Las Olas Algae Site #2	E Coli	NR	cfu/100mL	9/5/2017 11:35
170922-005A	Las Olas Algae Site #2	E Coli		40 cfu/100mL	9/20/2017 13:05
170925-002A	Las Olas Algae Site #2	E Coli		74 cfu/100mL	9/27/2017 10:50
170929-006A	Las Olas Algae Site #2	E Coli		4 cfu/100mL	10/2/2017 11:05
170906-002A	Las Olas Algae Site #2	Enterococci		15 cfu/100mL	9/5/2017 11:35
170922-005A	Las Olas Algae Site #2	Enterococci		38 cfu/100mL	9/20/2017 13:05
170925-002A	Las Olas Algae Site #2	Enterococci		88 cfu/100mL	9/27/2017 10:50
170929-006A	Las Olas Algae Site #2	Enterococci		23 cfu/100mL	10/2/2017 11:05
170906-002A	Las Olas Algae Site #2	Fecal Coliform		21 cfu/100mL	9/5/2017 11:35
170922-005A	Las Olas Algae Site #2	Fecal Coliform		360 cfu/100mL	9/20/2017 13:05
170925-002A	Las Olas Algae Site #2	Fecal Coliform		124 cfu/100mL	9/27/2017 10:50
170929-006A	Las Olas Algae Site #2	Fecal Coliform		20 cfu/100mL	10/2/2017 11:05
170906-002C	Las Olas Algae Site #2	Nitrite		0.015 mg/L	9/5/2017 11:35
170922-005C	Las Olas Algae Site #2	Nitrite		0.015 mg/L	9/20/2017 13:05
170906-002B	Las Olas Algae Site #2	NO2 + NO3		0.06 mg/L	9/5/2017 11:35
170906-002D	Las Olas Algae Site #2	OPO4		0.01 mg/L	9/5/2017 11:35
170922-005D	Las Olas Algae Site #2	OPO4		0.023 mg/L	9/20/2017 13:05
170925-002D	Las Olas Algae Site #2	OPO4		0.034 mg/L	9/27/2017 10:50
170929-006D	Las Olas Algae Site #2	OPO4		0.035 mg/L	10/2/2017 11:05
170906-002B	Las Olas Algae Site #2	TKN		0.476 mg/L	9/5/2017 11:35
170922-005B	Las Olas Algae Site #2	TKN		0.489 mg/L	9/20/2017 13:05
170906-002B	Las Olas Algae Site #2	TPO4		0.232 mg/L	9/5/2017 11:35
170922-005B	Las Olas Algae Site #2	TPO4		0.051 mg/L	9/20/2017 13:05

170922-006B	Las Olas Algae Site #3	Ammonia	0.13 mg/L	9/20/2017 11:10
170922-006E	Las Olas Algae Site #3	Chlorophyll-a	13.4 mg/m3	9/20/2017 11:10
170925-003E	Las Olas Algae Site #3	Chlorophyll-a	8.43 mg/m3	9/27/2017 9:10
170929-007E	Las Olas Algae Site #3	Chlorophyll-a	18 mg/m3	10/2/2017 9:15
170922-006A	Las Olas Algae Site #3	E Coli	176 cfu/100mL	9/20/2017 11:10
170925-003A	Las Olas Algae Site #3	E Coli	168 cfu/100mL	9/27/2017 9:10
170929-007A	Las Olas Algae Site #3	E Coli	144 cfu/100mL	10/2/2017 9:15
170922-006A	Las Olas Algae Site #3	Enterococci	124 cfu/100mL	9/20/2017 11:10
170925-003A	Las Olas Algae Site #3	Enterococci	200 cfu/100mL	9/27/2017 9:10
170929-007A	Las Olas Algae Site #3	Enterococci	430 cfu/100mL	10/2/2017 9:15
170922-006A	Las Olas Algae Site #3	Fecal Coliform	1360 cfu/100mL	9/20/2017 11:10
170925-003A	Las Olas Algae Site #3	Fecal Coliform	460 cfu/100mL	9/27/2017 9:10
170929-007A	Las Olas Algae Site #3	Fecal Coliform	3600 cfu/100mL	10/2/2017 9:15
170922-006C	Las Olas Algae Site #3	Nitrite	0.02 mg/L	9/20/2017 11:10
170922-006D	Las Olas Algae Site #3	OPO4	0.022 mg/L	9/20/2017 11:10
170925-003D	Las Olas Algae Site #3	OPO4	0.03 mg/L	9/27/2017 9:10
170929-007D	Las Olas Algae Site #3	OPO4	0.033 mg/L	10/2/2017 9:15
170922-006B	Las Olas Algae Site #3	TKN	1.04 mg/L	9/20/2017 11:10
170922-006B	Las Olas Algae Site #3	TPO4	0.06 mg/L	9/20/2017 11:10

170922-008B	Las Olas Algae Site #4	Ammonia	0.185 mg/L	9/20/2017 12:05
170922-008E	Las Olas Algae Site #4	Chlorophyll-a	40 mg/m3	9/20/2017 12:05
170925-005E	Las Olas Algae Site #4	Chlorophyll-a	48.3 mg/m3	9/27/2017 9:45
170929-009E	Las Olas Algae Site #4	Chlorophyll-a	6.41 mg/m3	10/2/2017 10:30
170922-008A	Las Olas Algae Site #4	E Coli	164 cfu/100mL	9/20/2017 12:05
170925-005A	Las Olas Algae Site #4	E Coli	128 cfu/100mL	9/27/2017 9:45
170929-009A	Las Olas Algae Site #4	E Coli	120 cfu/100mL	10/2/2017 10:30
170922-008A	Las Olas Algae Site #4	Enterococci	77 cfu/100mL	9/20/2017 12:05
170925-005A	Las Olas Algae Site #4	Enterococci	104 cfu/100mL	9/27/2017 9:45
170929-009A	Las Olas Algae Site #4	Enterococci	140 cfu/100mL	10/2/2017 10:30
170922-008A	Las Olas Algae Site #4	Fecal Coliform	2560 cfu/100mL	9/20/2017 12:05
170925-005A	Las Olas Algae Site #4	Fecal Coliform	480 cfu/100mL	9/27/2017 9:45
170929-009A	Las Olas Algae Site #4	Fecal Coliform	280 cfu/100mL	10/2/2017 10:30
170922-008C	Las Olas Algae Site #4	Nitrite	0.018 mg/L	9/20/2017 12:05
170922-008D	Las Olas Algae Site #4	OPO4	0.031 mg/L	9/20/2017 12:05
170925-005D	Las Olas Algae Site #4	OPO4	0.031 mg/L	9/27/2017 9:45
170929-009D	Las Olas Algae Site #4	OPO4	0.031 mg/L	10/2/2017 10:30
170922-008B	Las Olas Algae Site #4	TKN	0.793 mg/L	9/20/2017 12:05
170922-008B	Las Olas Algae Site #4	TPO4	0.062 mg/L	9/20/2017 12:05
170922-009B	Las Olas Algae Site #5	Ammonia	0.119 mg/L	9/20/2017 12:35
170922-009E	Las Olas Algae Site #5	Chlorophyll-a	19.9 mg/m3	9/20/2017 12:35
170925-006E	Las Olas Algae Site #5	Chlorophyll-a	35.6 mg/m3	9/27/2017 10:10
170922-009A	Las Olas Algae Site #5	E Coli	144 cfu/100mL	9/20/2017 12:35
170925-006A	Las Olas Algae Site #5	E Coli	228 cfu/100mL	9/27/2017 10:10
170922-009A	Las Olas Algae Site #5	Enterococci	112 cfu/100mL	9/20/2017 12:35
170925-006A	Las Olas Algae Site #5	Enterococci	156 cfu/100mL	9/27/2017 10:10
170922-009A	Las Olas Algae Site #5	Fecal Coliform	1560 cfu/100mL	9/20/2017 12:35
170925-006A	Las Olas Algae Site #5	Fecal Coliform	640 cfu/100mL	9/27/2017 10:10
170922-009C	Las Olas Algae Site #5	Nitrite	0.016 mg/L	9/20/2017 12:35
170922-009D	Las Olas Algae Site #5	OPO4	0.026 mg/L	9/20/2017 12:35
170925-006D	Las Olas Algae Site #5	OPO4	0.027 mg/L	9/27/2017 10:10
170922-009B	Las Olas Algae Site #5	TKN	0.758 mg/L	9/20/2017 12:35
170922-009B	Las Olas Algae Site #5	TPO4	0.067 mg/L	9/20/2017 12:35