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MARINE & ENVIRONMENTAL CONSULTING

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MEMORANDUM

TO: City of Marco Waterways Advisory Committee c/o Chadd Chustz

FROM: Tim Hall

DATE: March 10, 2017

RE: Marco Island Water Quality Numeric Nutrient Concentration Criteria

Executive Summary

Water quality data collected from Marco Island Waterways between January 2015 and November 2016 were analyzed to determine the degree to which the waters of Marco Island are in compliance with relevant criteria. For nutrients, it was found that levels of phosphorous, nitrogen, and chlorophyll-a were not out of compliance. Nitrogen levels were close to the allowed limits in 2016 but these levels are likely associated with record rainfall during the same time frame. The results suggest that monitoring of nitrogen concentrations should continue to ensure that conditions do not deteriorate. Should nitrogen levels begin to exceed established criteria; it would be useful to create a detailed loading model, in order to develop appropriate management responses.

Levels of fecal coliforms are not problematic based on the 2015 data collection efforts. Levels of enterococci bacteria are potentially problematic, though 3 of the 4 documented exceedances came during a single monitoring event and could have been exacerbated due to the same rainfall events that appear to have influenced the TN concentrations. Continued monitoring of the Enterococci bacteria levels is also recommended, especially given the anticipated action by FDEP to change the current fecal coliform standard to an enterococci standard.

Levels of dissolved oxygen are not problematic. All samples collected were well above the state standards outlined in FAC 62-302.533.

Based on the past two years data, the Marco Island waterways appear to be in relatively good shape. Nutrient and bacterial parameters are below the State thresholds, and Marco Island waterways are not expected to be impaired.

Background

Over the past several decades, it has become well-established that an over-abundance of the plant nutrients nitrogen and/or phosphorous can have adverse impacts on the water quality and ecology of lakes, rivers and estuaries. Excessive nutrient supply can stimulate the growth of nuisance plants, creating, on occasion, algal blooms. Algal blooms can reduce water clarity, which is essential for the continued persistence of seagrass meadows, which provide food and shelter for the majority of

recreationally and commercially important species of fish and invertebrates (such as crabs and shrimp). Once algal blooms die-off, their decomposition can reduce levels of dissolved oxygen, which is essential to most forms of aquatic life. Successful management of coastal waterbodies thus requires the collection, analysis and interpretation of results from water quality monitoring programs, including data related to nutrient supply.

The City of Marco has been monitoring the quality of waters around the island since approximately 2001. The City chose twelve (12) locations around the island to collect samples. A map of the sampling locations is included with this memo. The monitoring intensity has varied over time from monthly, to bi-monthly, to quarterly. From 2007 to 2014, the twelve sites were sampled every other month for a suite of parameters but since the samples were not collected under an approved field sampling quality manual, they are not considered reliable for use in the Florida Storage and Retrieval Database (STORET). In 2015 sampling was continued at the same twelve sites under an approved field sampling manual and was changed to quarterly collection instead of bi-monthly. The data collected is entered annually into STORET. This summary has been compiled with the assistance of City staff and Collier County Pollution Control staff to provide a general overview of the past two years of data collection. It is presented to the City of Marco Waterways Advisory Committee to assist them in upcoming decisions regarding the direction of future monitoring and stormwater planning efforts.

Likelihood of Impairment Status

The waters around Marco Island are located in Water Body Identification (WBID) number 32780. In 2015, the Florida Department of Environmental Protection (FDEP) also instituted numerical nutrient criteria (NNC) for estuarine waters. Marco Island is located with Estuarine Nutrient Region 3. The surface water quality criteria for Marco Island are listed in Florida Administrative Code (FAC) 62-302.500 and the nutrient specific criteria are listed in FAC 62-302.532. The nutrient criteria for Marco Island waters is based upon the annual geometric mean of values rather than on any single individual reading. Even in “pristine” estuaries with little to no human impacts, nutrient concentrations are lowest on high tides, in areas close to passes, and during dry periods with little rainfall-generated stormwater runoff. Even in pristine locations, nutrient concentrations generally increase away from passes, on lower tides, and during wet seasons, wet years, or even during shorter time periods of rainfall-generated runoff. Therefore, a single nutrient concentration criterion does not make much sense, if water quality data from even pristine locations could potentially pass or fail proposed criteria simply as a function of location, tidal stage or antecedent rainfall.

As outlined in FAC 62-302.532, the water quality status of waterbodies is to be determined on an annual basis, preferably within a calendar year. For this report, the data collection effort comprised 8 sampling efforts over 24 months. The data presented has been split into calendar years 2015 and 2016 to look at the geometric means for each year based on the quarterly sampling events.

For each year, total nitrogen (TN), total phosphorus (TP), and chlorophyll-a values collected within the waters around Marco were recorded and the annual geometric mean (AGM) was determined for each sampling site as well as for the entire sampling area as a whole. The AGM is defined as the nth root of the product of the values ($\sqrt[n]{x_1 x_2 x_3 \dots x_n}$) where n is the number of individual values.

The rule also requires that the AGM be based on at least four temporally-independent samples per year with at least one sample taken between May 1 and September 30 and at least one sample taken during other months of the calendar year (i.e. not all taken between May and September). To be treated as temporally-independent, samples must be taken at least one week apart. The sampling effort being conducted by the City is compliant with these requirements.

While the data is presented to show the AGM at each individual testing location, the determination of

impairment for the waterbody as a whole will be based on all of the sampling sites analyzed together, not on any single sampling site. The reason information for the individual sites was included is to assist the Committee in its planning efforts by identifying locations where there may be concern related to elevated nutrient levels. As is seen in the data set to date, phosphorus concentrations appear to be pretty good. Several of the sites did show TN exceedances individually but the entire data set together is still compliant with the NNC.

Data Analysis – Nutrient Status

The analysis conducted below was used to assess the water quality status of Marco Island during the 2015 and 2016 calendar years. Samples for 2015 were collected in January, May, August, and November. Sample for 2016 were collected in February, May, August, and November.

Water quality data from the City were provided by City of Marco staff and the Collier County Pollution Control Lab.

For comparison with the FDEP NNC for ENR3, as listed within FAC. 62-302-532(1)(e)(3), the water quality data sets provided were analyzed based on the following:

“Criteria expressed as annual geometric means (AGM) not to be exceeded more than once in a three year period.”

The AGM for TN, TP, and Chlorophyll-a concentrations as noted above are derived based on the following equation: $AGM = \sqrt[n]{X_1 X_2 X_3 \dots X_n}$

TN, TP, and Chlorophyll a concentration AGMs were compared to the FDEP limit thresholds to quantify the presence or absence of elevated concentrations of the three parameters, with graphical representations of the results provided in Appendix A.

2015 Nutrient Sampling Results (Sampling done in January, May, August, & November)

Over the period analyzed none of the AGMs for the individual sampling sites exceeded the state criteria for either TP or Chlorophyll-a. One of the sites (Barfield_Bridge) exceeded the state criteria for TN. However the overall AGM for the entire watershed was well below the state criteria for all three parameters and there would be no advancement towards an impairment determination based on the 2015 results.

2016 Nutrient Sampling Results (Sampling done in February, May, August, & November)

Over the period analyzed none of the individual sampling sites exceeded the state criteria for TP. One of the sites (Windmill) did exceed the state criteria for Chlorophyll-a, though the overall watershed was still well below. Five of the sites (Collier_Bridge, HC_Center, Hollyhock, Hummingbird, and Windmill) exceeded the state criteria for TN. The elevated TN levels are a result of higher levels in samples collected in February (8 of 12 samples above standard) and August (12 of 12 samples above standard). It appears as though these results could be associated with high rainfall amounts preceding the sampling. However the overall AGM for the entire watershed was still below the state criteria. Since all three parameters were again below their respective criteria limits, there would be no advancement towards an impairment determination based on the 2016 results.

Data Analysis – Fecal Coliform and Enterococci Status

The waters around Marco Island are classified as Class II waters. This designation is associated with shellfish propagation and harvesting areas. Though this does not occur in the Marco Island waters there

is a provisional area located just at the southernmost boundaries of the WBID. Our understanding is that FDEP intends to redraw the WBID boundary to remove the provisional shellfish harvesting area which would then classify the WDIB as a Class III water. The current bacteriological quality standard for Class II waters is based on Fecal Coliform bacteria counts.

“The MPN or MF counts shall not exceed a median value of 14 with not more than 10% of the samples exceeding 43 (for MPN) or 31 (for MF), nor exceed 800 on any one day.”

The Collier County Pollution Control Lab used the Membrane Filter (MF) methodology so the 31 count limit is applicable for the 2015 samples. Fecal coliform testing was not conducted in the last three quarters of 2016 so the summary provided is based on the four 2015 samplings events as well as the February 2016 data only (n=60). All of the median values for the 5 sampling events were below the 14 median value limit. Less than 6 samples could break the 10% threshold value of 31 and only five of the individual values were over that value. None of the samples were over the 800 cfu upper limit. Based on this data it does not appear as though the system would have been classified as impaired for fecal coliform bacteria.

Fecal Coliform Exceedances Table

	BARFIELD_BRIDGE	COLLIER_BRIDGE	E_WINTERBERRY_BRIDGE	HC_CENTER	HOLLYHOCK	HUMMINGBIRD	JH_PARK	KENDALL	MCILVAINE	PERRINE	W_WINTERBERRY_BRIDGE	WINDMILL
1/27/15	1.0	1.0	1.0	12.0	1.0	6.0	5.0	10.0	3.0	7.0	10.0	6.0
5/12/15	70.0	13.0	1.0	8.0	1.0	1.0	20.0	17.0	1.0	140.0	1.0	15.0
8/25/15	210.0	340.0	7.0	6.0	31.0	5.0	110.0	9.0	8.0	6.0	3.0	10.0
11/19/15	1.0	10.0	19.0	1.0	1.0	13.0	1.0	1.0	3.0	1.0	1.0	2.0
2/1/16	5.00	6.0	24.0	1.0	5.0	13.0	4.0	14.0	1.0	5.0	3.0	5.0

The Marco Island waters are more consistent with the Class III designation which is identified as “fish consumption, recreation, propagation and maintenance of a healthy, well-balanced population of fish and wildlife”. It is anticipated that the Surface Water designation will change from Class II to Class III when FDEP modifies the WBID boundary to exclude the shellfish harvesting areas. The bacteriological quality standard for Class III waters is based on Enterococci bacteria counts.

“MPN or MF counts shall not exceed a monthly geometric mean of 35 nor exceed the Ten Percent Threshold Value (TPTV) of 130 in 10% or more of the samples during any 30-day period. Monthly geometric means shall be based on a minimum of 10 samples taken over a 30-day period.”

Enterococci data was collected during both the 2015 and 2016 sampling efforts so an analysis was done on the Enterococci as compared to the Class III water standards. The monthly geometric mean was determined by calculating the nth root of the product of the values for each sampling period ($\sqrt[n]{x_1 x_2 x_3 \dots x_n}$) where n = the number of samples collected (12). The City does not collect 10 samples from any one sampling location during a 30 day period so for this review, the 12 sampling stations have been combined to account for a minimum of 12 samples during the 1 to 2 days of sampling effort. It is not

clear whether this would be the approach taken by FDEP in reviewing the data because the intent of the 10 samples in 30 days is that the samples are spread out temporally throughout the 30 day time frame and not all collected on the same day.

All of the monthly geometric mean values for the 8 sampling events were below the 35 monthly geometric mean value limit. Because the data collection involves 12 sample sites, the 10% threshold value for allowed exceedances would be less than 2 samples over the 130 cfu value for each sampling event. The analysis of the August 2015 sampling resulted in 3 samples higher than the allowed exceedance.

It is important to remember that the Enterococci testing is not currently the standard outlined in FAC 62-302-530(11) for these Class II waters but it could be in the future if the designation is altered from Class II to Class III or if the current Fecal Coliform standards are replaced with Enterococci standards in the future. It is anticipated that one of both of these events will occur in the future. Still, the Enterococci samples should not result in an impaired designation for the waterbody at this time.

Enterococci Exceedances Table

	BARFIELD_BRIDGE	COLLIER_BRIDGE	E_WINTERBERRY_BRIDGE	HC_CENTER	HOLLYHOCK	HUMMINGBIRD	JH_PARK	KENDALL	MCILVAINE	PERRINE	W_WINTERBERRY_BRIDGE	WINDMILL
1/27/15	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
5/12/15	20.00	10.00	10.00	10.00	20.00	10.00	10.00	10.00	10.00	10.00	10.00	20.00
8/25/15	245.00	213.00	10.00	10.00	20.00	10.00	146.00	10.00	10.00	10.00	10.00	10.00
11/19/15	10.00	10.00	51.00	10.00	10.00	41.00	10.00	10.00	10.00	10.00	10.00	10.00
2/1/16	10.00	10.00	20.00	10.00	10.00	52.00	10.00	10.00	10.00	10.00	41.00	10.00
5/10/16	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00		10.00	10.00
8/11/16	311.00	41.00	10.00	40.00	10.00	10.00	62.00	10.00	10.00	10.00	10.00	10.00
11/9/16	10.00	10.00	10.00	10.00	63.00	10.00	10.00	10.00	10.00	10.00	10.00	30.00

Data Analysis – Dissolved Oxygen

For levels of dissolved oxygen (DO) the applicable regulatory criterion, as outlined in FAC 62-302.533, is that minimum DO levels (for Class II waters like Marco) shall not be lower than 42 percent saturation more than 10 percent of the time (for average daily values) or that 7-day average values shall not be below 51 percent saturation more than once in any 12-week period, or that the 30-day average DO percent saturation shall not be below 56 percent more than once per year.

The less-restrictive 7-day and 30-day criteria require DO measurements to be made over a 24 hour period, which is not applicable for comparison with water quality data collected at a single time of day, once a quarter. As such, the more restrictive criterion was used for this summary, and DO values (in units of percent saturation) were compared against the 42 percent saturation value. Results are shown in Appendix A.

Since DO values were collected at 12 stations, 4 times each over a twelve month period (n = 48) it would take 5 values below 42 percent saturation for the Marco Island waters to be considered out of compliance with the DO criteria listed in FAC 62-302.533. None of the values over the two years show DO values lower than 42 percent saturation, the waters of Marco would not be considered to be out of compliance with existing DO criteria.

Recommendations

Should the City of Marco decide to continue its water quality testing program, the parameter suite currently being tested is appropriate to determine compliance with State nutrient and bacterial parameters except for the lack of fecal coliform testing. If the City is testing to determine for human health and safety concerns, enterococci is a better indicator of human contamination than fecal coliforms. If the intent of the testing is to determine if the waters will be called impaired under current FDEP standards then fecal coliform testing should be added until the rule is changed or the FDEP reclassifies the WBID as a Class III water, fecal coliform testing should probably be re-instated so that comparison to the current State standard can continue. As stated above, FDEP has indicated its intention to move towards an enterococci based scale in the future due to a plethora of scientific information indicated that enterococci is a better indicator for human pathogens. There appears to be a high correlation between heavy rains and higher TN and bacterial concentrations. The three months of August 2015, February 2016, and August 2016 were responsible for 26 of the 31 (84%) highest TN values and all three of these months were preceded by periods of heavy rainfall. In addition all of the enterococci exceedances occurred in the month of August (3 in 2015 and 1 in 2016).

Spatially, TN levels appear to be slightly elevated throughout the island but the highest concentrations appear to be occurring in the central portion of the island. The Collier Bridge, Windmill, Hummingbird, Health Center, and Hollyhock sampling sites are all located in the central belt across the island and these are the five sites that showed elevated TN concentrations in 2016.

Further investigations into the sources of the elevated concentrations could be undertaken if these higher levels continue to be observed in future sampling efforts.

Sincerely,

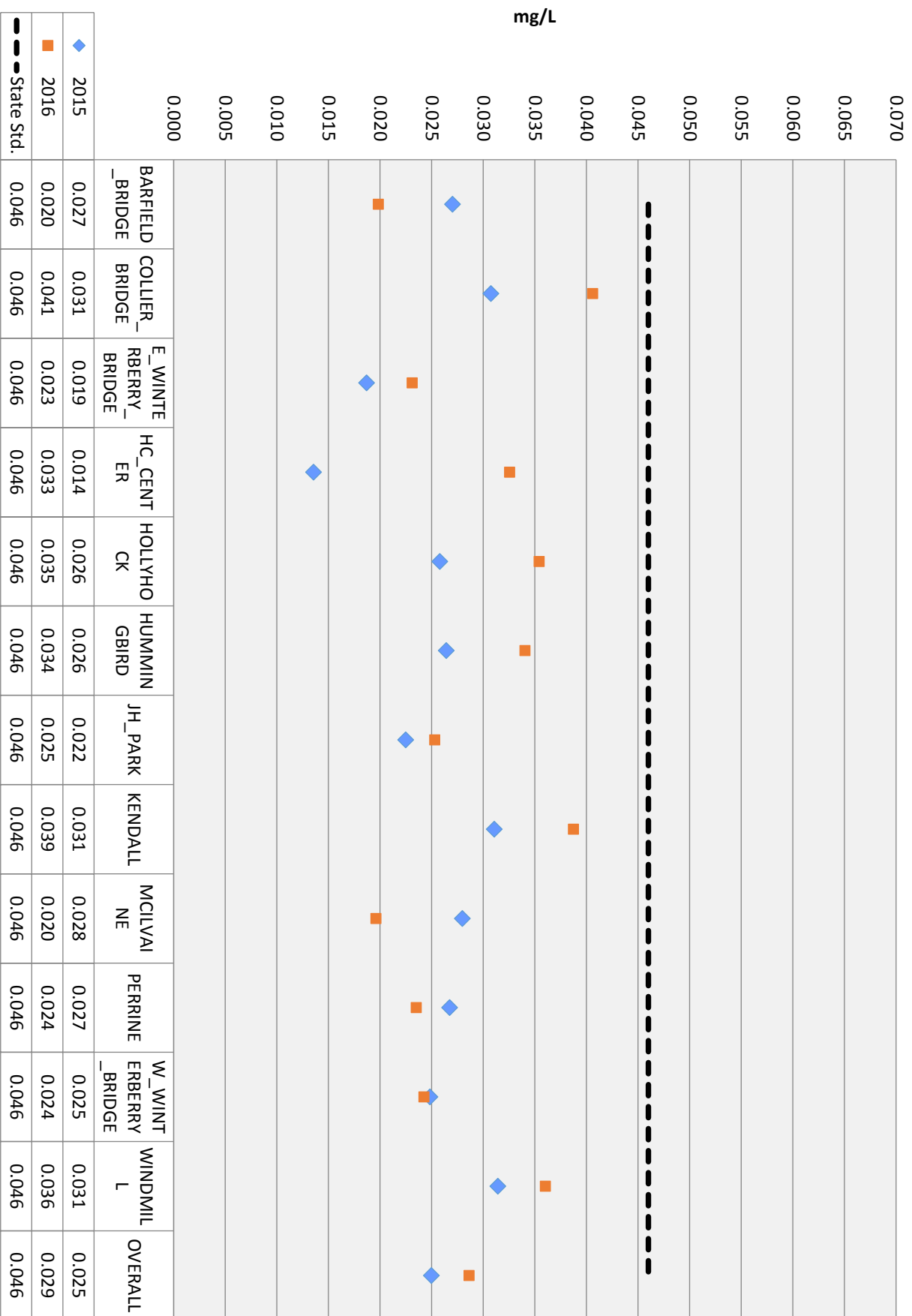
A handwritten signature in blue ink, appearing to read 'TH Hall', is positioned above the printed name.

Tim Hall
Senior Ecologist

APPENDIX A

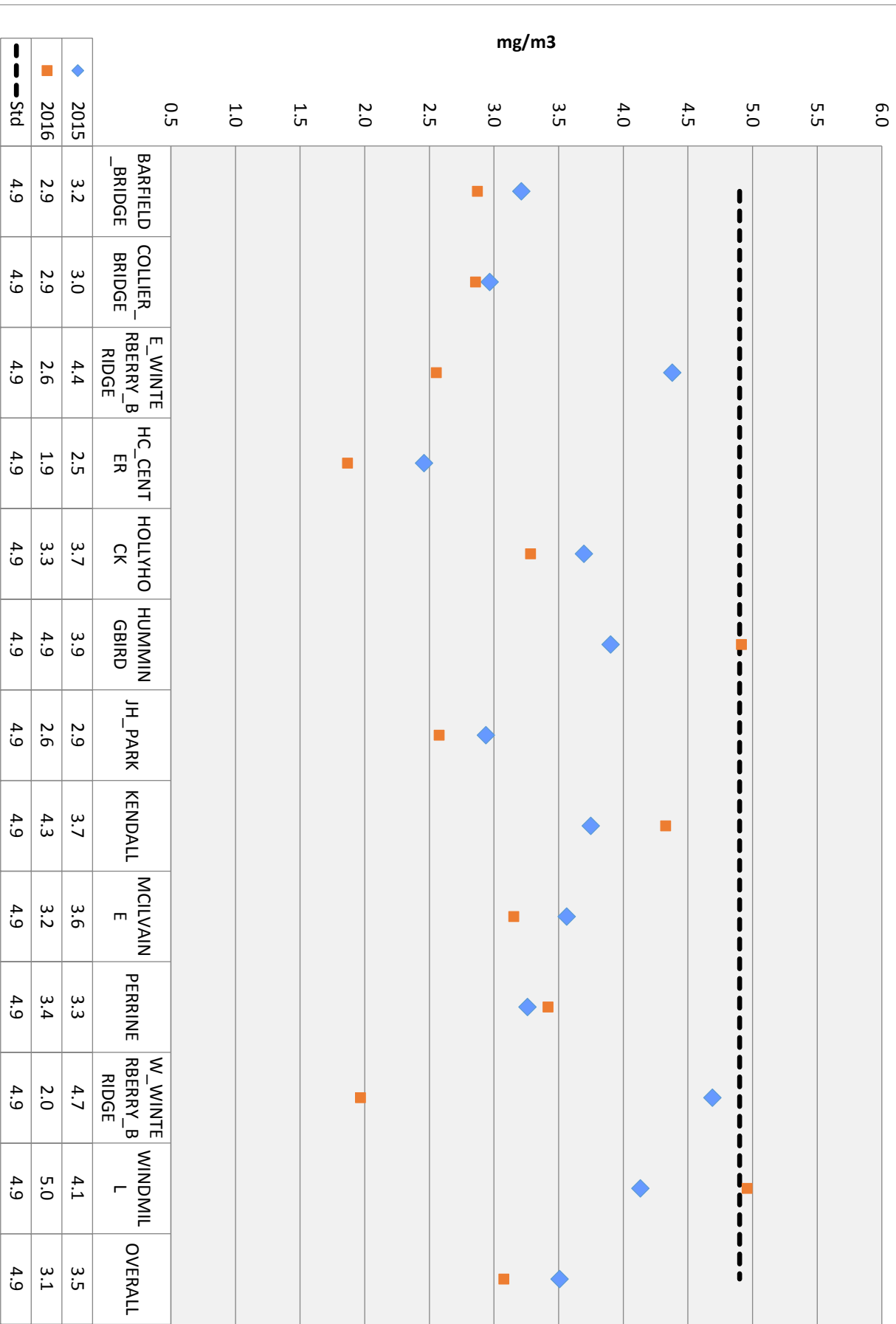
Graphs of Parameter Concentrations

TOTAL PHOSPHORUS

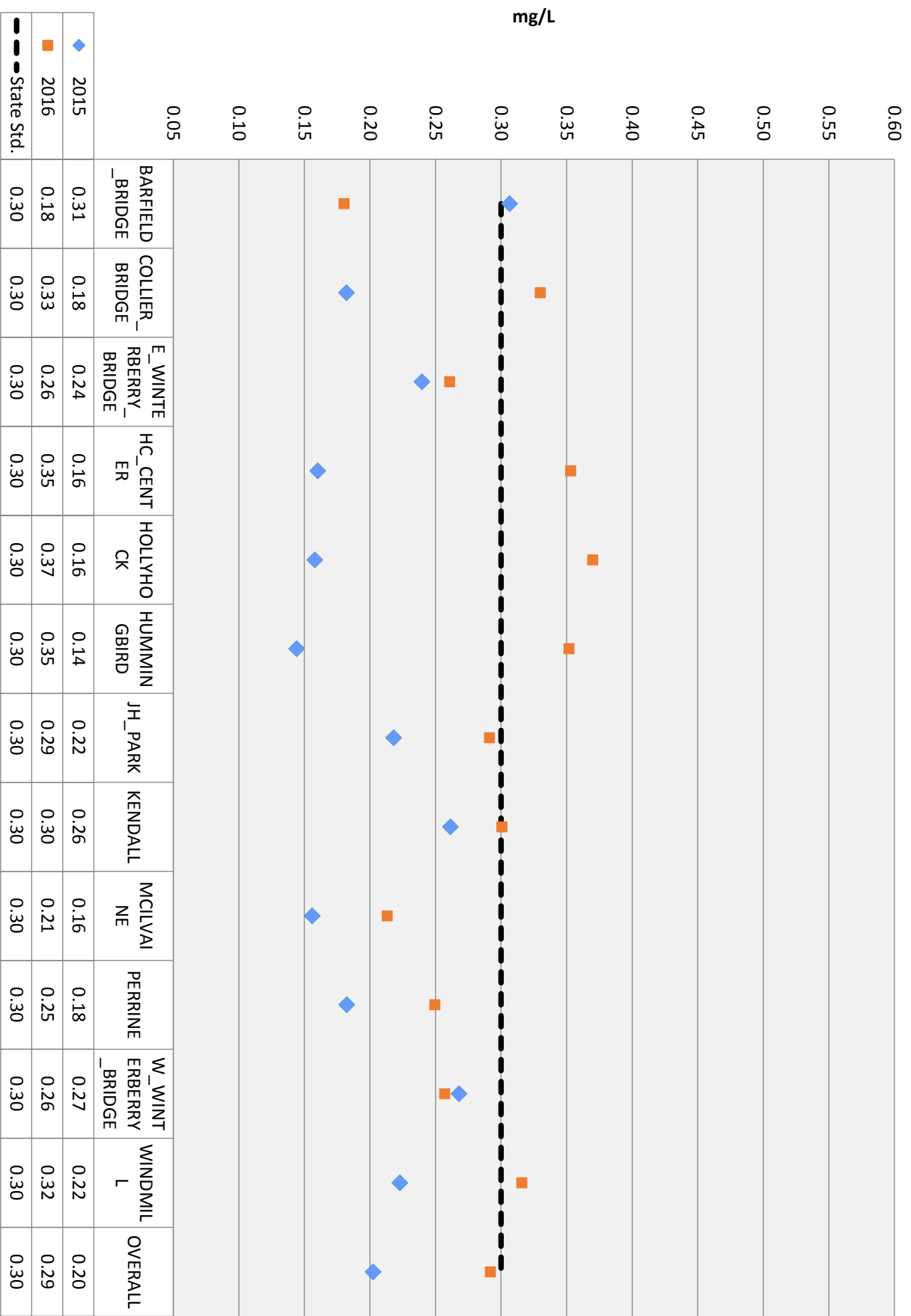


State Std. 0.046

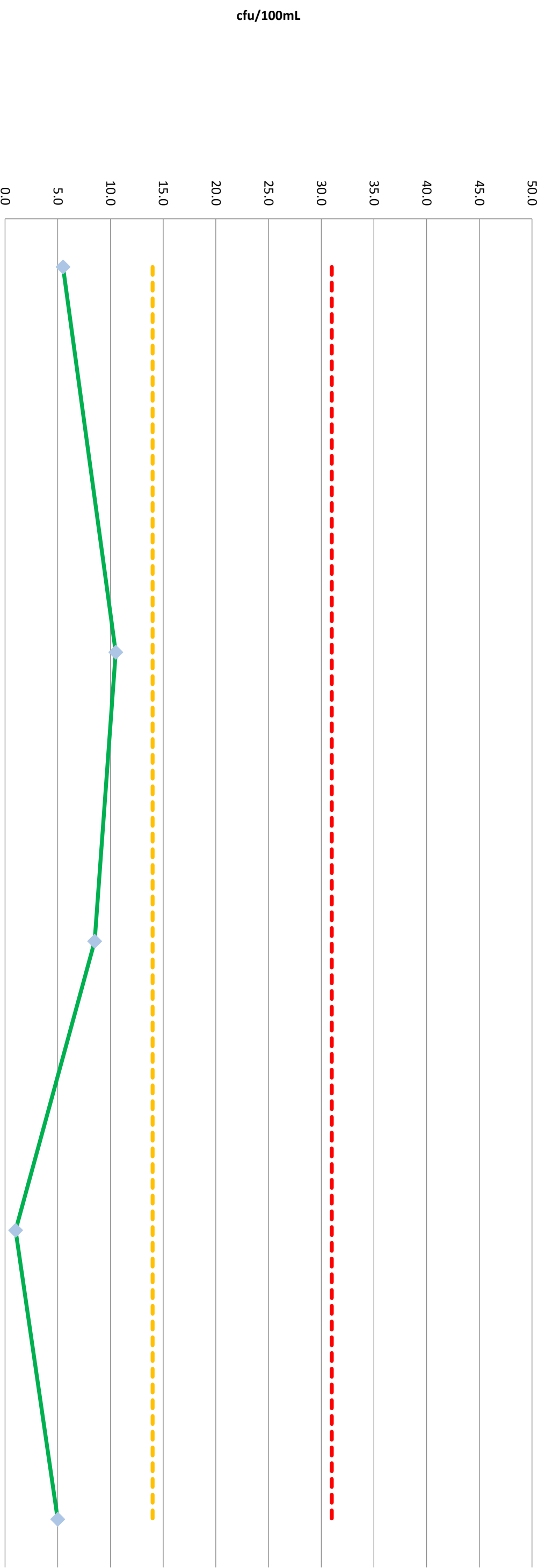
CHLOROPHYLL-a



TOTAL NITROGEN

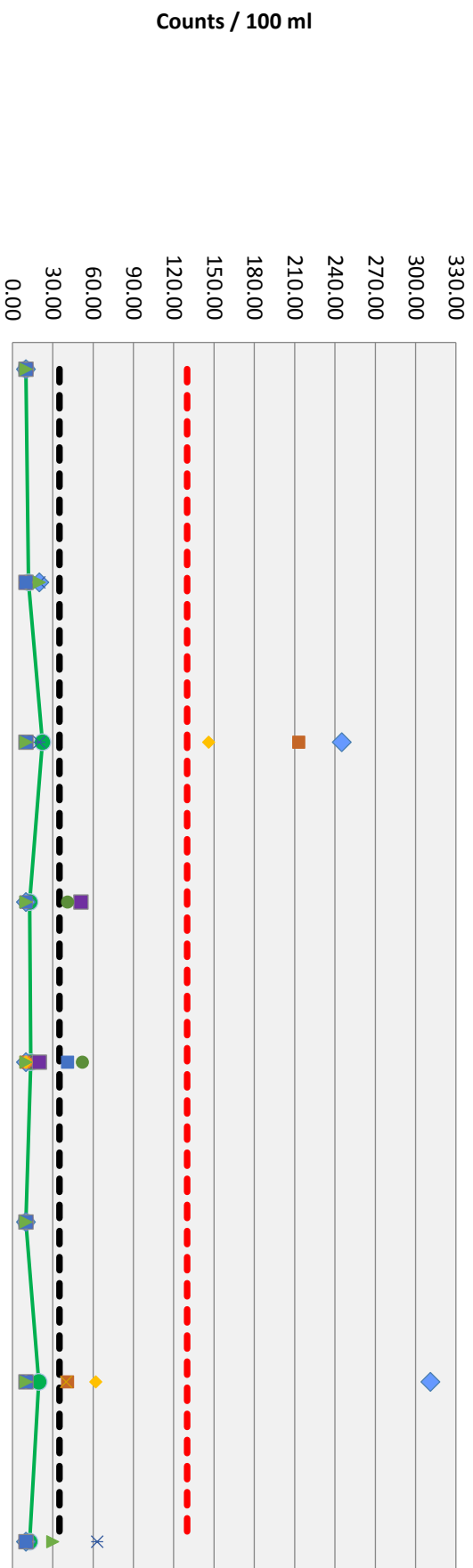


FECAL COLIFORM BACTERIA



	1/27/15	5/12/15	8/25/15	11/19/15	2/1/16
BARFIELD_BRIDGE	1.0	70.0	210.0	1.0	5.0
COLLIER_BRIDGE	1.0	13.0	340.0	10.0	6.0
E_WINTERBERRY_BRIDGE	1.0	1.0	7.0	19.0	24.0
HC_CENTER	12.0	8.0	6.0	1.0	1.0
HOLLYHOCK	1.0	1.0	31.0	1.0	5.0
HUMMINGBIRD	6.0	1.0	5.0	13.0	13.0
JH_PARK	5.0	20.0	110.0	1.0	4.0
KENDALL	10.0	17.0	9.0	1.0	14.0
MCILVAINE	3.0	1.0	8.0	3.0	1.0
PERRINE	7.0	140.0	6.0	1.0	5.0
W_WINTERBERRY_BRIDGE	10.0	1.0	3.0	1.0	3.0
WINDMILL	6.0	15.0	10.0	2.0	5.0
MEDIAN VALUE	5.5	10.5	8.5	1.0	5.0
Not to Exceed Median Value	14	14	14	14	14
10% Threshold Value	31	31	31	31	31

Enterococci (Analysis based on Class III water standards)



Date	BARFIELD_BRIDGE	COLLIER_BRIDGE	E_WINTERBERRY_BRIDGE	HC_CENTER	HOLLYHOCK	HUMMINGBIRD	JH_PARK	KENDALL	MCILVAINE	PERRINE	W_WINTERBERRY_BRIDGE	WINDMILL	OVERALL	MGMLimit	10% Threshold Limit
1/27/15	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	11.89	35.00	130
5/12/15	20.00	10.00	10.00	10.00	20.00	10.00	10.00	10.00	10.00	10.00	10.00	20.00	11.89	35.00	130
8/25/15	245.00	213.00	10.00	10.00	20.00	10.00	146.00	10.00	10.00	10.00	10.00	10.00	22.31	35.00	130
11/19/15	10.00	10.00	51.00	10.00	10.00	41.00	10.00	10.00	10.00	10.00	10.00	10.00	12.88	35.00	130
2/1/16	10.00	10.00	20.00	10.00	10.00	52.00	10.00	10.00	10.00	10.00	41.00	10.00	13.67	35.00	130
5/10/16	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	35.00	130
8/11/16	311.00	41.00	10.00	40.00	10.00	10.00	62.00	10.00	10.00	10.00	10.00	10.00	19.57	35.00	130
11/9/16	10.00	10.00	10.00	10.00	63.00	10.00	10.00	10.00	10.00	10.00	10.00	30.00	12.78	35.00	130