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Memo

To:	Charleston County; Town of James Island; City of Charleston
From:	Woolpert, Inc.
Date:	December 7, 2022
Subject:	James Island Creek Grab Sampling Results Memo Summer 2022 – data through September 2022

The James Island Creek TMDL for Enterococcus bacteria became effective in January 2020, and to maintain compliance with their NPDES General Permit, Charleston County, the Town of James Island, and the City of Charleston (the permittees) were required to submit a TMDL Monitoring Plan to SCDHEC within 12 months of the TMDL effective date (January 2021) and begin monitoring activities within 18 months of the TMDL effective date (July 2021). In accordance with the submitted TMDL Monitoring Plan, the permittees initiated monitoring activities in July 2021 and collected the first seasonal wet weather grab sample in August 2021. The sampling efforts have targeted both wet and dry conditions in order to assess bacteria concentrations in James Island Creek in response to storm events and during base flow conditions. This memo summarizes and discusses data collected through September 2022. It will be a cumulative document with new data added to the existing dataset as additional samples are collected. All sample results (August 2021 through September 2022) and notes about associated weather and tidal conditions are included in Appendix A.

Grab sampling efforts have included taking samples at four strategic locations in the watershed, shown in **Figure 1** below. The downstream-most site (Harbor View Bridge) is located at the bridge where Harbor View Road crosses James Island Creek. Continuing up the main stem of James Island Creek, the next site (Folly Road Bridge) is located at the bridge where Folly Road crosses James Island Creek. The upstream-most site (Riley Road) is located at the end of Riley Road, approximately 0.5 miles upstream of Folly Road Bridge. The upstream site on a tributary of James Island Creek (Jim Isle Drive) is located off the private dock at 715 Jim Isle Drive. The contributing drainage area to all locations includes human influence from suburban, urban, and developed areas. The Folly Road Bridge sampling location was added in December 2021 in response to input from the James Island Creek Task Force. Sampling at the Riley Road site was discontinued in March 2022, as it was determined that Folly Road Bridge adequately represented this portion of James Island Creek. The Jim Isle Drive location was added when site access was obtained in April 2022 to collect data from the Simpson Creek / Battery Point upstream reach of James Island Creek. It is anticipated that sampling locations may be added or modified in the future based on stakeholder input and as additional site access permissions are secured.

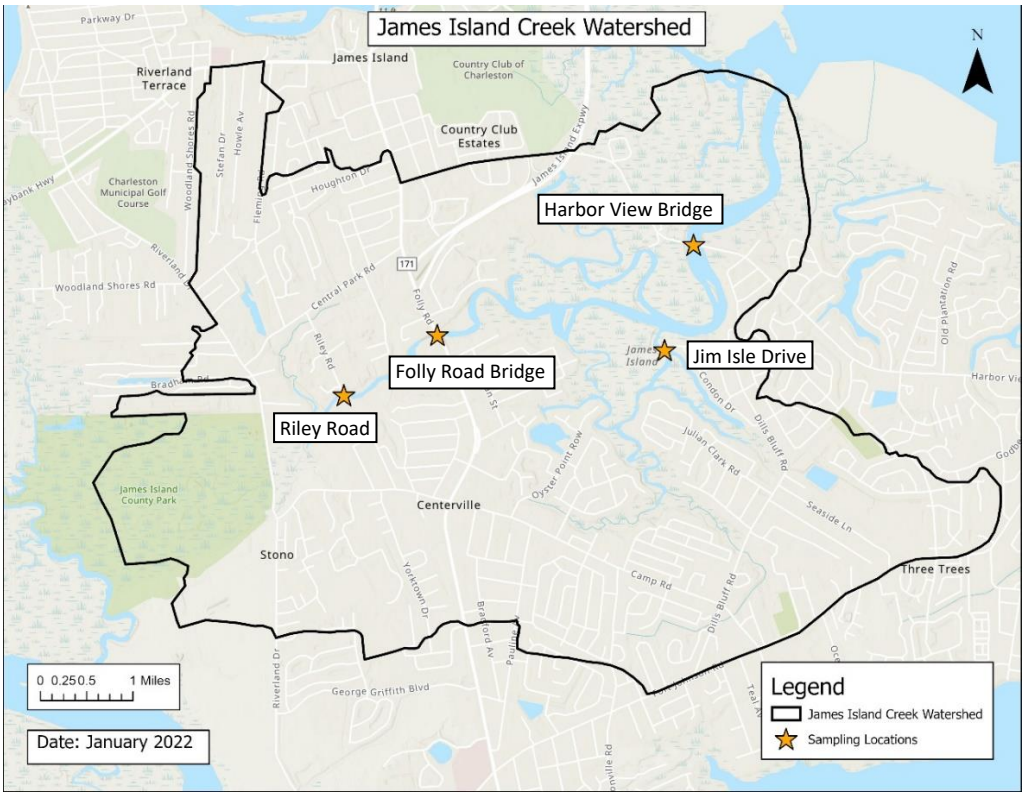

Figure 1: James Island Creek Sampling Locations

Samples were analyzed by Trident Laboratory in Ladson, SC, an EPA-approved laboratory, for Enterococcus bacteria using the SM-9230D method and results were reported as the Most Probable Number of bacteria per 100 milliliter sample (MPN/100ml). Summary statistics for Enterococcus grab sampling results to date (through September 2022) are shown in **Table 1** for each sampling location and weather condition. Sampling has been underway for different lengths of time at each location, as indicated by the narrative above and footnotes in the table. Therefore, the summary statistics should not be considered representative of the water quality throughout the year at every location and interpretation and discussion of the data will be limited until the sample size has increased.

Table 1: Summary Statistics for Grab Sample Enterococcus Results - By Location and Weather Condition

Sampling Location	Weather Condition	Summary Statistic (units of MPN/100ml)				# of Samples
		Mean	Median	Maximum	Minimum	
Harbor View Bridge	Dry	46	20	521	<10	40
Harbor View Bridge	Wet	271	60	2014	<10	21
Folly Road Bridge[1]	Dry	97	100	310	10	28
Folly Road Bridge	Wet	2272	230	12997	50	9
Jim Isle Drive[2]	Dry	60	30	150	<10	9
Jim Isle Drive	Wet	1753	992	4569	40	6
Riley Road[3]	Dry	192	120	1110	20	26
Riley Road	Wet	1363	530	8160	10	15

[1]Folly Road Bridge sampling location added in December 2021.
[2]Jim Isle Drive sampling location added in April 2022.
[3]Riley Rd sampling was discontinued in March of 2022. Also, an outlier result of 17,330 MPN/100ml on 11/24/21 was excluded from summary statistics; trash dumping occurred at the sampling location prior to collection and appeared to influence bacteria concentration of one sample.

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Due to the many factors that influence bacteria concentrations (e.g., potential bacteria sources, season, weather, rainfall intensity, antecedent rainfall, tides, timing of watershed storm response), it is important to consider individual storm results in their own context in addition to summary statistics. To facilitate this kind of assessment, figures were created to illustrate the grab sampling results at each location along with approximate relative stage in James Island Creek, approximate rainfall data (for wet weather sampling), and observations about weather and tidal conditions. These figures were created for all sampling efforts and are located in Appendix B in chronological order. Available tide prediction and rainfall data were used to best approximate conditions in James Island Creek during sampling. Tide prediction data was obtained from NOAA station #8665530 "Charleston, Cooper River Entrance, SC" which is approximately 2.5 miles northeast from the Harbor View Bridge sampling location. For the wet weather sampling efforts, rainfall data was obtained from the Town of Mount Pleasant's Ravenel Bridge rain gauge, approximately 4.5 miles northeast of Harbor View Bridge. This gauge represents the closest source of incremental rainfall data that is available to approximate rainfall in the James Island Creek watershed. For the purposes of analysis and discussion, a "storm rainfall" was established which was a running sum of rainfall until 3 consecutive hours go by with zero additional precipitation that occurred closest to the time of sampling. In some cases, if there was additional rainfall outside the "storm rainfall" that was relevant to describing the watershed conditions, analysis may refer to a "total rainfall" or "largest storm rainfall" that is larger than the "storm rainfall" that occurred closest to the time of sampling.

Overall Trends

The summary statistics as well as individual storm results were reviewed and compared to observe trends and/or correlations between bacteria concentration sampling results and a variety of potential associated factors. It is important to note that with this limited data set, the following discussion is not asserting statistical significance, but rather seeking to explore possible relationships in an effort to start to understand the complex natural aquatic system of James Island Creek. The median summary statistics in **Table 1** indicate two overall trends with respect to Enterococcus concentrations: higher concentrations in the upper portion of the watershed (Folly Road Bridge, Riley Road, and Jim Isle Drive) than the lower portion (Harbor View Bridge) and higher concentrations in wet conditions than in dry conditions. Individual minimum or maximum results deviate from these general trends and also impact the mean summary statistics. It is noteworthy that Folly Road Bridge wet weather data was collected for the first time in the Winter season and Jim Isle Drive wet weather data was collected for the first time in Spring season, so additional sampling in other seasons is needed to generate representative summary statistics.

When comparing individual storm results in Appendix A (list form) and Appendix B (graphical form), it does appear that bacteria concentrations tend to be higher in wet weather conditions than dry weather conditions. However, a comparison of results for individual wet weather versus dry weather sampling efforts does not provide a clear trend; there is variation among both the wet weather events and dry weather events (e.g., some dry weather samples are slightly higher than some wet weather samples, contrary to the overall trend seen with summary statistics). This variation may be driven by some or all of the factors influencing bacteria concentrations mentioned previously. The limited dataset of grab sample results provides a glimpse of the water quality conditions that may also contribute to these variations. Though the dataset is limited, the following sections provide a discussion of specific sampling events and how they may or may not show potential trends for wet and dry weather conditions.

Wet Weather Sampling

The goal of wet weather sampling is to quantify the bacteria levels present in stormwater runoff by collecting grab samples during or soon after storm events. In tidal systems, such as James Island Creek, it can be difficult to differentiate between stormwater runoff and tidal flow using only nearby available stage and rainfall data. For purposes of discussion, bacteria concentrations will be approximated as order of magnitude: ones (0-9 MPN/1000ml); tens (10-99 MPN/100ml); hundreds (10^2); thousands (10^3); and tens of thousands (10^4). From the available grab sampling data, wet weather results at Harbor View Bridge have been observed to vary by three orders of magnitude, typically in the tens and hundreds, and once in the thousands. Wet weather results at Riley Road have been observed to vary by three orders of magnitude, sometimes as low as the tens and sometimes as high as the thousands. Wet weather results at Folly Road Bridge were usually in the hundreds, but sometimes in the tens, thousands, and ten thousands. Jim Isle Drive samples were in the hundreds and thousands but reflect data from only two days of sampling at this time.

A brief description of each wet weather sampling effort since August 2021 is provided below.

- The August 2021 event (8/3/2021) had a rainfall total of 0.20 inches (in) prior to sampling with samples collected from low to high tide, as the tide rose. The bacteria levels were relatively low, in the tens at Harbor View Bridge and varied between tens and hundreds at Riley Road. Additional rainfall was forecast to occur before and during the sampling window but did not actually occur until later in the day after the available sampling window (limited by laboratory hours).
- The September 2021 event (9/21/2021) had a rainfall total of 2.39 in prior to and during sampling with samples collected from high to low tide, as the tide fell. This larger storm event correlated with relatively high bacteria levels (results in the hundreds at Harbor View Bridge and results in the thousands at Riley Road).
- The December 2021 event (12/8/2021) had a rainfall total of 0.96 in that fell primarily in two waves, one a few hours before sampling began and one while sampling occurred. Results were in the hundreds and thousands at Riley Road. Results at Harbor View Bridge were one order of magnitude lower, varying between values in the tens and hundreds.
- The March 2022 event (3/10/2022) had a rainfall total of 0.82 in that fell before and during sampling. Samples were collected from low to high tide, as the tide rose. Results were in the hundreds at Riley Road and Folly Road Bridge, and in the tens at Harbor View Bridge.
- The May 2022 event (5/23/2022) had a rainfall total of 1.03 in that fell the day before sampling (two tidal cycles before). Samples were collected the following day due to limited lab hours, as the lab is not open on weekends. Samples were collected from low to high tide, as the tide rose. Results were in the hundreds and tens at Folly Road Bridge and Jim Isle Drive, and in the tens at Harbor View Bridge. Based on the below average bacteria concentrations and the delayed timing of sample collection, it is possible that these samples may have been collected later than the main period of stormwater influence in the watershed.
- The September event (9/14/2022) had a rainfall total of 2.73 in that fell across two storms, and samples were collected during the falling tide after the first storm and at low tide during the beginning of the second storm. Results were in the thousands at Jim Isle Dr. and Folly Road Bridge, and in the hundreds and thousands at Harbor View Bridge. The samples collected at low tide were the highest, with the Folly Road Bridge sample reporting in the ten thousands, a new maximum Enterococcus concentration at that location.

Comparing the wet weather sampling events thus far, the events with more rainfall associated with sampling had higher observed bacteria concentrations. The falling tide may also be associated with higher observed bacteria concentrations, when compared to samples taken during the rising or near a slack high tide. The summer season may also be associated with higher observed bacteria concentrations compared to the other seasons, though the summer storms sampled were also much larger than the storms in other seasons. It is unclear if the season or the size of the storm has a stronger association with bacteria concentrations. As additional data is collected, potential correlations between bacteria concentrations and tidal conditions, seasons, or other rainfall characteristics will be considered.

Dry Weather Sampling

Dry weather sampling intends to provide some background, baseline bacteria levels in James Island Creek to represent conditions not influenced by stormwater runoff. These levels could be attributed to wildlife in or near the water, historic deposits, non-stormwater human contributions, or aquatic life. For sampling to be considered “dry weather,” at least 72 hours must have passed since the last instance of greater than or equal to 0.1 inch of rainfall.

Dry weather results at Harbor View Bridge were typically low, with the majority of results being in the tens or less, but some results in the hundreds as well. Dry weather results at upstream sites (Folly Road Bridge, Riley Road, and Jim Isle Drive) were generally higher and more variable than at Harbor View Bridge, with most results varying from the tens to the hundreds and infrequent instances in the thousands. The bacteria concentrations at all sites may demonstrate correlation with tidal conditions, as most sampling events showed higher results during lower tidal conditions. Correlation between bacteria concentration and tide, as well as other environmental factors, will continue to be assessed as additional data is collected.

Microbial Source Tracking Results

While the presence of Enterococcus bacteria acts as an indicator to detect fecal contamination, it does not indicate the origins of fecal contamination. Understanding the sources of contamination is essential for identifying effective remediation measures (BMPs), complying with legal (permit) responsibility, and characterizing potential public health risks. The permittees included Microbial Source Tracking (MST) methods in their data collection efforts to target the source of the fecal bacteria through genetic markers in the bacteria. Host-associated genetic markers in gut bacteria have been identified based on the theory that the physiology in the gut of the host animal (e.g., diet, temperature, antibiotic treatment, etc.) is unique from one species of animal to another. These documented gut conditions and associated genetic markers of gut bacteria allow LuminUltra Technologies (formerly Source Molecular), an accredited MST laboratory, to use replicable methods to identify common hosts of gut bacteria and sources of fecal contamination.

The high cost (over 15 times the cost of a traditional bacteria sample) of MST reduces the feasibility of the permittees using this method for every bacteria sample. To capitalize on MST efforts, the permittees have conducted concurrent sampling for wet weather events where duplicate MST samples were collected along with standard Enterococcus bacteria samples. Enterococcus bacteria samples were analyzed first and then, based on those bacteria concentration results and collaborative discussion, MST analysis can be conducted on the duplicate MST sample for select samples of interest. This ensured that the more expensive MST analysis was only performed on select samples that appeared likely to provide insight about fecal bacteria sources in James Island Creek.

Approximate source contribution categories that correspond with numeric results were originally provided in reports from the MST laboratory and are summarized below in **Table 2**. The lab no longer provides this interpretation in their reports, but the scale and range of reported numeric values has not changed and the categories are helpful for data visualization, so their inclusion in discussion of MST results has continued. **Table 3** shows each individual MST analysis result, which includes the numeric result of DNA copies per 100ml sample shown at the bottom of each table cell, and the approximate source contribution category from **Table 2** shown at the top of each table cell (Absent, Low, Moderate, or High).

Table 2: Categories for Interpretation of MST Analysis Results

DNA Marker Quantified (# DNA Copies/100ml)	DNA Analytical Result	Approximate Source Contribution Category
ND	Not Detected	Not Detected
DNQ	Detected	Low
1-9,999	Detected	Low
10,000-99,999	Detected	Moderate
100,000 and up	Detected	High

The permittees budgeted to conduct MST analysis for up to four total samples over the course of one year of sampling, so samples were selected carefully. Samples were chosen for MST analysis from two storms that had relatively high wet weather Enterococcus results (compared to dry weather conditions) at Riley Road and Harbor View Bridge. In addition, the samples were collected during falling tides after the storm event, so the samples analyzed appeared likely to have captured samples influenced by stormwater runoff. All MST analysis results since August 2021 are shown in **Table 3**.

Table 3: Microbial Source Tracking (MST) Results for Selected Samples

Sample Date & Time	Location	Total Rainfall (inches)	Enterococcus Result (MPN/100ml)	MST Result Interpretation (# DNA Copies/100ml)			
				Dog	Bird	Human	Ruminant
9/21/2021 10:49	Riley Road	2.39	4110	Low DNQ*	Moderate 1.23E+05	Low DNQ*	Absent Not Detected
9/21/2021 11:15	Harbor View Bridge	2.39	290	Low DNQ*	Moderate 1.21E+05	Low 7.78E+03	Absent Not Detected
12/8/2021 14:05	Riley Road	0.96	1380	Low DNQ*	Low DNQ*	Absent Not Detected	Absent Not Detected
12/8/2021 13:52	Harbor View Bridge	0.96	150	Absent Not Detected	Low DNQ*	Low DNQ*	Absent Not Detected

*DNQ = "Did Not Quantify," presence of DNA markers was detected but below the minimum quantification level.

Total Rainfall is included in **Table 3** as a general indicator of size of the rainfall event. Other parameters such as rainfall distribution and intensity, tidal characteristics, and time of sampling relative to rainfall are also important to understand the sampling conditions associated with each MST analysis. Appendix C contains grab sampling figures showing these parameters for each event that included MST analysis, along with visual indication of which samples were analyzed.

The samples chosen from the September 2021 sampling effort were from the middle of the sampling period at Riley Road and Harbor View Bridge. Samples were collected during a high falling tide, the second falling tide that occurred during this extended period of rainfall. The Enterococcus concentrations were relatively high, being of the thousands order of magnitude at Riley Road and the hundreds order of magnitude at Harbor View Bridge. As indicated in **Table 3**, the MST analysis indicated a stronger presence of Bird than the other sources. Dog and Human were present in Low concentrations, though only the Harbor View Bridge sample had a quantifiable result. Ruminant (e.g., deer, goats, sheep) was not present in the samples.

The samples from the December 2021 sampling effort were collected at Riley Road and Harbor View Bridge during the immediate falling tide following the rainfall. Similar to the September 2021 samples, Enterococcus concentrations were relatively high, in the thousands at Riley Road and in the hundreds at Harbor View Bridge. Ruminant was not present in the samples. Bird was present in both samples but below the minimum quantification limit (DNQ). Dog was Low-DNQ at Riley Road and absent at Harbor View Bridge. Human was absent at Riley Road and Low-DNQ at Harbor View Bridge.

Bird appears to be one of the main sources of bacteria in James Island Creek, since it was the only source to have Moderate concentrations in the September 2021 samples, and it remained present in the December 2021 samples. Bird showed the most consistency between the sampling locations for both sampling events, besides Ruminant which was absent from all samples and appears to not be a likely source of bacteria in the watershed. Dog may be a frequent contributor of bacteria, since it was present in three of the four samples, although in Low concentrations for all three. Human was the only source that appeared to vary between the upstream and downstream sites. Although it was present in Low concentrations at both locations during the September 2021 storm event, it increased from a non-quantifiable result (Low-DNQ) at the upstream site (Riley Road), to a Low result at the downstream site (Harbor View Bridge). The December 2021 samples reported that Human was absent at the upstream site, and Low-DNQ at the downstream site.

MST analysis was also conducted by LuminUltra for two sampling efforts conducted by Charleston Water Systems (not associated with the permittees' efforts). In an effort to capitalize on all data collection efforts in James Island Creek and increase the understanding of the watershed, Woolpert reviewed the results of these sampling efforts for inclusion in this memo. Samples were collected by Charleston Water Systems at three locations in the watershed on 3/4/2021 and 5/18/2021 and submitted to LuminUltra for MST analysis of Human, Dog, and Bird DNA markers. The results are summarized as follows with reference to historic rainfall data from the Ravenel Bridge Rain Gauge provided for context.

- 3/4/2021 samples were collected the day after 1.41 in of rainfall occurred and indicated Low (but quantifiable) results for Human and Bird, and Low (DNQ) results for Dog at all three watershed locations.
- 5/18/2021 samples were collected under dry conditions (last rainfall was 1.06 in on 5/12/2021) and indicated Low (but quantifiable), Low (DNQ), and No Detect results for Human, and a mix of Low (DNQ) and No Detect results for both Bird and Dog among the different watershed locations.

Regarding these two Charleston Water Systems sampling events, during wet weather sampling on 3/4/2021, the source results were generally consistent at different locations throughout the watershed. In comparison, the dry weather sample results on 5/18/2021 were more variable at different locations in the watershed.

As noted earlier, the trends and comparisons discussed in this memo are observations based on the limited dataset. This data is intended to provide the permittees with a preliminary understanding of the James Island Creek watershed and potential impacts of stormwater runoff on bacteria concentrations. The permittees intend to continue both wet weather and dry weather grab sampling, with MST analysis of select samples, to supplement these initial observations and continue to collect information about the dynamics of James Island Creek.

Appendix A: Grab Sampling Results and Associated Field Conditions

Date	Time	Sampling Location (Riley Rd/Harbor View Bridge)	Enterococcus Result (MPN/100 ML)	Tidal Conditions (High/Mid/Low, Rising/Falling)	Type of Sample (Wet/Dry)	Weather Conditions
8/3/2021	9:36	Riley Road	320	Low/Falling	Wet	Raining Total Rainfall = 0.20" Avg Temp = 78°F
8/3/2021	10:07	Harbor View Bridge	90	Low/Falling	Wet	
8/3/2021	10:33	Riley Road	10	Low/Rising	Wet	
8/3/2021	11:02	Harbor View Bridge	60	Low/Rising	Wet	
8/3/2021	12:15	Riley Road	380	Mid/Rising	Wet	
8/3/2021	12:30	Harbor View Bridge	50	Mid/Rising	Wet	
8/3/2021	13:56	Riley Road	90	High/Rising	Wet	
8/3/2021	14:20	Harbor View Bridge	20	High/Rising	Wet	
8/31/2021	9:29	Riley Road	1110	Low/Rising	Dry	Partly Cloudy 9 Days Since Rain Avg Temp = 85°F
8/31/2021	9:52	Harbor View Bridge	<10	Low/Rising	Dry	
8/31/2021	10:45	Riley Road	580	Mid/Rising	Dry	
8/31/2021	11:04	Harbor View Bridge	10	Mid/Rising	Dry	
8/31/2021	11:44	Riley Road	470	High/Rising	Dry	
8/31/2021	12:03	Harbor View Bridge	<10	High/Rising	Dry	
8/31/2021	13:30	Riley Road	250	High/Slack	Dry	
8/31/2021	13:53	Harbor View Bridge	<10	High/Slack	Dry	
9/21/2021	9:30	Riley Road	640	High/Rising	Wet	Rainy Total Rainfall = 2.39" Avg Temp = 76°F
9/21/2021	9:50	Harbor View Bridge	120	High/Rising	Wet	
9/21/2021	10:49	Riley Road	4110	High/Falling	Wet	
9/21/2021	11:15	Harbor View Bridge	290	High/Falling	Wet	
9/21/2021	12:13	Riley Road	2760	Mid-High/Falling	Wet	
9/21/2021	12:30	Harbor View Bridge	620	Mid-High/Falling	Wet	
9/21/2021	13:15	Riley Road	8160	Mid-Low/Fallng	Wet	
9/21/2021	13:35	Harbor View Bridge	810	Mid-Low/Fallng	Wet	

Date	Time	Sampling Location (Riley Rd/Harbor View Bridge)	Enterococcus Result (MPN/100 ML)	Tidal Conditions (High/Mid/Low, Rising/Falling)	Type of Sample (Wet/Dry)	Weather Conditions
10/14/2021	9:22	Riley Road	260	Low/Slack	Dry	Sunny 8 Days Since Rain Avg Temp = 82°F
10/14/2021	9:45	Harbor View Bridge	50	Low/Rising	Dry	
10/14/2021	10:40	Riley Road	100	Mid/Rising	Dry	
10/14/2021	11:00	Harbor View Bridge	30	Mid/Rising	Dry	
10/14/2021	12:07	Riley Road	60	Mid/Rising	Dry	
10/14/2021	12:22	Harbor View Bridge	30	Mid/Rising	Dry	
10/14/2021	13:48	Riley Road	50	High/Rising	Dry	
10/14/2021	14:08	Harbor View Bridge	20	High/Rising	Dry	
11/24/2021	9:48	Harbor View Bridge	20	High/Rising	Dry	Sunny 13 Days Since Rain Avg Temp = 52°F
11/24/2021	10:05	Riley Road	40	High/Rising	Dry	
11/24/2021	11:12	Harbor View Bridge	<10	High/Slack	Dry	
11/24/2021	11:35	Riley Road	75	High/Slack	Dry	
11/24/2021	12:35	Harbor View Bridge	10	High/Falling	Dry	
11/24/2021	12:46	Riley Road	197	High/Falling	Dry	
11/24/2021	13:50	Harbor View Bridge	10	Mid/Falling	Dry	
11/24/2021	14:02	Riley Road	17330	Mid/Falling	Dry	
12/8/2021	9:36	Harbor View Bridge	10	High/Rising	Wet	Rainy Total Rainfall = 0.96" Avg Temp = 63°F
12/8/2021	9:48	Riley Road	530	High/Rising	Wet	
12/8/2021	11:28	Harbor View Bridge	<10	High/Slack	Wet	
12/8/2021	11:40	Riley Road	170	High/Slack	Wet	
12/8/2021	12:45	Harbor View Bridge	10	High/Falling	Wet	
12/8/2021	12:57	Riley Road	860	High/Falling	Wet	
12/8/2021	13:52	Harbor View Bridge	150	Mid/Falling	Wet	
12/8/2021	14:05	Riley Road	1380	Mid/Falling	Wet	

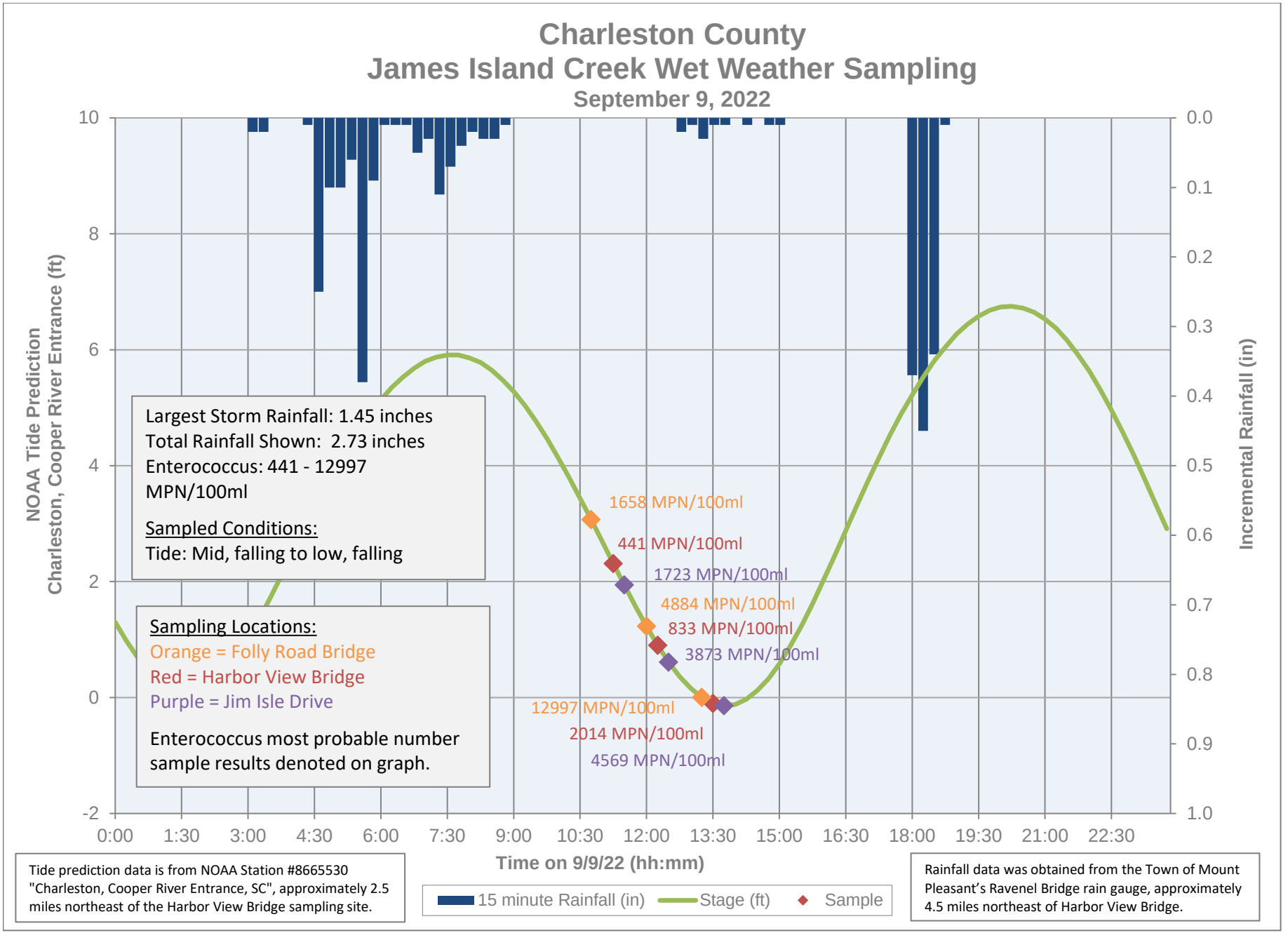
Date	Time	Sampling Location (Riley Rd/Harbor View Bridge/Folly Road Bridge)	Enterococcus Result (MPN/100 ML)	Tidal Conditions (High/Mid/Low, Rising/Falling)	Type of Sample (Wet/Dry)	Weather Conditions
12/29/2021	9:03	Riley Road	300	Low/Falling	Dry	Partly Cloudy 8 Days Since Rain Avg Temp = 74°F
12/29/2021	9:20	Folly Road Bridge	310	Low/Falling	Dry	
12/29/2021	9:37	Harbor View Bridge	140	Low/Falling	Dry	
12/29/2021	11:04	Riley Road	220	Low/Rising	Dry	
12/29/2021	11:21	Folly Road Bridge	140	Low/Rising	Dry	
12/29/2021	11:38	Harbor View Bridge	90	Low/Rising	Dry	
12/29/2021	12:57	Riley Road	150	Mid/Rising	Dry	
12/29/2021	13:08	Folly Road Bridge	220	Mid/Rising	Dry	
12/29/2021	13:26	Harbor View Bridge	10	Mid/Rising	Dry	
1/20/2022	10:28	Riley Road	160	High/Falling	Dry	Partly Cloudy 4 Days Since Rain Avg Temp = 70°F
1/20/2022	10:40	Folly Road Bridge	20	High/Falling	Dry	
1/20/2022	10:57	Harbor View Bridge	<10	High/Falling	Dry	
1/20/2022	11:45	Riley Road	30	Mid/Falling	Dry	
1/20/2022	11:58	Folly Road Bridge	30	Mid/Falling	Dry	
1/20/2022	12:12	Harbor View Bridge	<10	Mid/Falling	Dry	
1/20/2022	13:15	Riley Road	100	Low/Falling	Dry	
1/20/2022	13:28	Folly Road Bridge	200	Low/Falling	Dry	
1/20/2022	13:48	Harbor View Bridge	10	Low/Falling	Dry	
2/11/2022	9:41	Riley Road	75	Low/Falling	Dry	Partly Cloudy 4 Days Since Rain Avg Temp = 65°F
2/11/2022	9:55	Folly Road Bridge	122	Low/Falling	Dry	
2/11/2022	10:10	Harbor View Bridge	521	Low/Falling	Dry	
2/11/2022	11:33	Riley Road	52	Low/Rising	Dry	
2/11/2022	11:45	Folly Road Bridge	63	Low/Rising	Dry	
2/11/2022	12:03	Harbor View Bridge	109	Low/Rising	Dry	
2/11/2022	13:18	Riley Road	20	Mid/Rising	Dry	
2/11/2022	13:30	Folly Road Bridge	63	Mid/Rising	Dry	
2/11/2022	13:50	Harbor View Bridge	10	Mid/Rising	Dry	

Date	Time	Sampling Location (Riley Rd/Harbor View Bridge/Folly Road Bridge)	Enterococcus Result (MPN/100 ML)	Tidal Conditions (High/Mid/Low, Rising/Falling)	Type of Sample (Wet/Dry)	Weather Conditions
3/10/2022	9:33	Riley Road	590	Low/Rising	Wet	Rainy Total Rainfall = 0.82" Avg Temp = 61°F
3/10/2022	9:55	Folly Road Bridge	230	Low/Rising	Wet	
3/10/2022	10:16	Harbor View Bridge	40	Low/Rising	Wet	
3/10/2022	10:55	Riley Road	380	Mid/Rising	Wet	
3/10/2022	11:12	Folly Road Bridge	100	Mid/Rising	Wet	
3/10/2022	11:29	Harbor View Bridge	20	Mid/Rising	Wet	
3/10/2022	13:08	Riley Road	60	High/Slack	Wet	
3/10/2022	13:24	Folly Road Bridge	120	High/Slack	Wet	
3/10/2022	13:44	Harbor View Bridge	30	High/Slack	Wet	
3/29/2022	10:22	Riley Road	60	Mid/Falling	Dry	Sunny 4 Days Since Rain Avg Temp = 60°F
3/29/2022	10:42	Folly Road Bridge	110	Mid/Falling	Dry	
3/29/2022	10:56	Harbor View Bridge	40	Mid/Falling	Dry	
3/29/2022	11:33	Riley Road	170	Low/Falling	Dry	
3/29/2022	11:47	Folly Road Bridge	100	Low/Falling	Dry	
3/29/2022	12:02	Harbor View Bridge	60	Low/Falling	Dry	
3/29/2022	13:13	Riley Road	120	Low/Rising	Dry	
3/29/2022	13:30	Folly Road Bridge	160	Low/Rising	Dry	
3/29/2022	13:48	Harbor View Bridge	60	Low/Rising	Dry	
4/12/2022	10:34	Folly Road Bridge	140	Low/Falling	Dry	Sunny 5 Days Since Rain Avg Temp = 76°F
4/12/2022	10:49	Harbor View Bridge	90	Low/Falling	Dry	
4/12/2022	11:43	Folly Road Bridge	160	Low/Slack	Dry	
4/12/2022	11:57	Harbor View Bridge	40	Low/Slack	Dry	
4/12/2022	12:34	Folly Road Bridge	60	Low/Rising	Dry	
4/12/2022	12:48	Harbor View Bridge	60	Low/Rising	Dry	
4/12/2022	13:33	Folly Road Bridge	40	Mid/Rising	Dry	
4/12/2022	14:00	Harbor View Bridge	10	Mid/Rising	Dry	

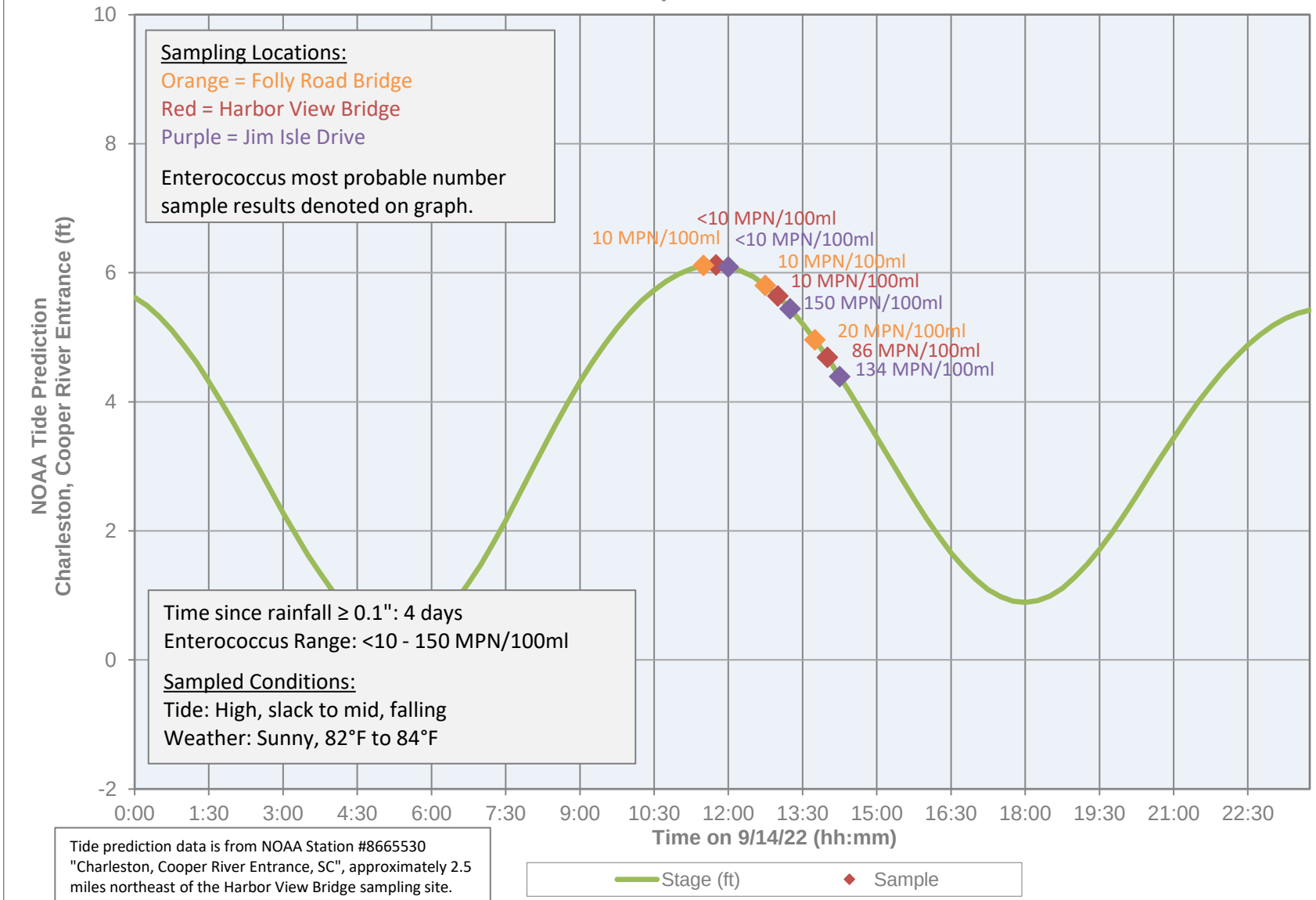
Date	Time	Sampling Location (Riley Rd/Harbor View Bridge/Folly Road Bridge)	Enterococcus Result (MPN/100 ML)	Tidal Conditions (High/Mid/Low, Rising/Falling)	Type of Sample (Wet/Dry)	Weather Conditions
5/10/2022	10:29	Folly Road Bridge	50	Low/Rising	Dry	Sunny 6 Days Since Rain Avg Temp = 72°F
5/10/2022	10:46	Harbor View Bridge	20	Low/Rising	Dry	
5/10/2022	11:09	Jim Isle Drive	110	Low/Rising	Dry	
5/10/2022	11:51	Folly Road Bridge	30	Mid/Rising	Dry	
5/10/2022	12:12	Harbor View Bridge	<10	Mid/Rising	Dry	
5/10/2022	12:21	Jim Isle Drive	30	Mid/Rising	Dry	
5/10/2022	13:14	Folly Road Bridge	30	High/Rising	Dry	
5/10/2022	13:30	Harbor View Bridge	10	High/Rising	Dry	
5/10/2022	13:40	Jim Isle Drive	<10	High/Rising	Dry	
5/23/2022	10:55	Folly Road Bridge	260	Low/Rising	Wet	Cloudy Total Rainfall = 1.03" Avg Temp = 82°F
5/23/2022	11:20	Harbor View Bridge	60	Low/Rising	Wet	
5/23/2022	11:32	Jim Isle Drive	260	Low/Rising	Wet	
5/23/2022	12:21	Folly Road Bridge	150	Mid/Rising	Wet	
5/23/2022	12:41	Harbor View Bridge	10	Mid/Rising	Wet	
5/23/2022	12:52	Jim Isle Drive	50	Mid/Rising	Wet	
5/23/2022	13:19	Folly Road Bridge	50	High/Rising	Wet	
5/23/2022	13:31	Harbor View Bridge	<10	High/Rising	Wet	
5/23/2022	13:40	Jim Isle Drive	40	High/Rising	Wet	
6/23/2022	8:29	Folly Road Bridge	100	Low/Falling	Dry	Sunny 4 Days Since Rain Avg Temp = 87°F
6/23/2022	8:52	Harbor View Bridge	30	Low/Falling	Dry	
6/23/2022	9:02	Jim Isle Drive	50	Low/Falling	Dry	
6/23/2022	10:13	Folly Road Bridge	100	Low/Slack	Dry	
6/23/2022	10:28	Harbor View Bridge	10	Low/Slack	Dry	
6/23/2022	10:39	Jim Isle Drive	30	Low/Slack	Dry	
6/23/2022	11:59	Folly Road Bridge	60	Low/Rising	Dry	
6/23/2022	12:18	Harbor View Bridge	20	Low/Rising	Dry	
6/23/2022	12:27	Jim Isle Drive	20	Low/Rising	Dry	

Date	Time	Sampling Location (Riley Rd/Harbor View Bridge/Folly Road Bridge)	Enterococcus Result (MPN/100 ML)	Tidal Conditions (High/Mid/Low, Rising/Falling)	Type of Sample (Wet/Dry)	Weather Conditions
9/9/2022	10:49	Folly Road Bridge	1658	Mid/Falling	Wet	Rainy Total Rainfall = 2.73" Avg Temp = 74°F
9/9/2022	11:17	Harbor View Bridge	441	Mid/Falling	Wet	
9/9/2022	11:33	Jim Isle Drive	1723	Mid/Falling	Wet	
9/9/2022	12:07	Folly Road Bridge	4884	Low/Falling	Wet	
9/9/2022	12:22	Harbor View Bridge	833	Low/Falling	Wet	
9/9/2022	12:34	Jim Isle Drive	3873	Low/Falling	Wet	
9/9/2022	13:15	Folly Road Bridge	12997	Low/Falling	Wet	
9/9/2022	13:32	Harbor View Bridge	2014	Low/Falling	Wet	
9/9/2022	13:41	Jim Isle Drive	4569	Low/Falling	Wet	
9/14/2022	11:29	Folly Road Bridge	10	High/Slack	Dry	Sunny 4 Days Since Rain Avg Temp = 83°F
9/14/2022	11:48	Harbor View Bridge	<10	High/Slack	Dry	
9/14/2022	12:00	Jim Isle Drive	<10	High/Slack	Dry	
9/14/2022	12:46	Folly Road Bridge	10	High/Falling	Dry	
9/14/2022	13:01	Harbor View Bridge	10	High/Falling	Dry	
9/14/2022	13:15	Jim Isle Drive	150	High/Falling	Dry	
9/14/2022	13:47	Folly Road Bridge	20	High/Falling	Dry	
9/14/2022	14:07	Harbor View Bridge	86	High/Falling	Dry	
9/14/2022	14:22	Jim Isle Drive	134	High/Falling	Dry	

Appendix B: Figures of Individual Storm Grab Sampling Results


Charleston County
James Island Creek Wet Weather Sampling
September 9, 2022
NOAA Tide Prediction
Charleston, Cooper River Entrance (ft)
Incremental Rainfall (in)
Time on 9/9/22 (hh:mm)
Largest Storm Rainfall: 1.45 inches
Total Rainfall Shown: 2.73 inches
Enterococcus: 441 - 12997 MPN/100ml
Sampled Conditions:
Tide: Mid, falling to low, falling
Sampling Locations:
Orange = Folly Road Bridge
Red = Harbor View Bridge
Purple = Jim Isle Drive
Enterococcus most probable number sample results denoted on graph.
1658 MPN/100ml
441 MPN/100ml
1723 MPN/100ml
4884 MPN/100ml
833 MPN/100ml
3873 MPN/100ml
12997 MPN/100ml
2014 MPN/100ml
4569 MPN/100ml
15 minute Rainfall (in)
Stage (ft)
Sample
Tide prediction data is from NOAA Station #8665530 "Charleston, Cooper River Entrance, SC", approximately 2.5 miles northeast of the Harbor View Bridge sampling site.
Rainfall data was obtained from the Town of Mount Pleasant's Ravenel Bridge rain gauge, approximately 4.5 miles northeast of Harbor View Bridge.

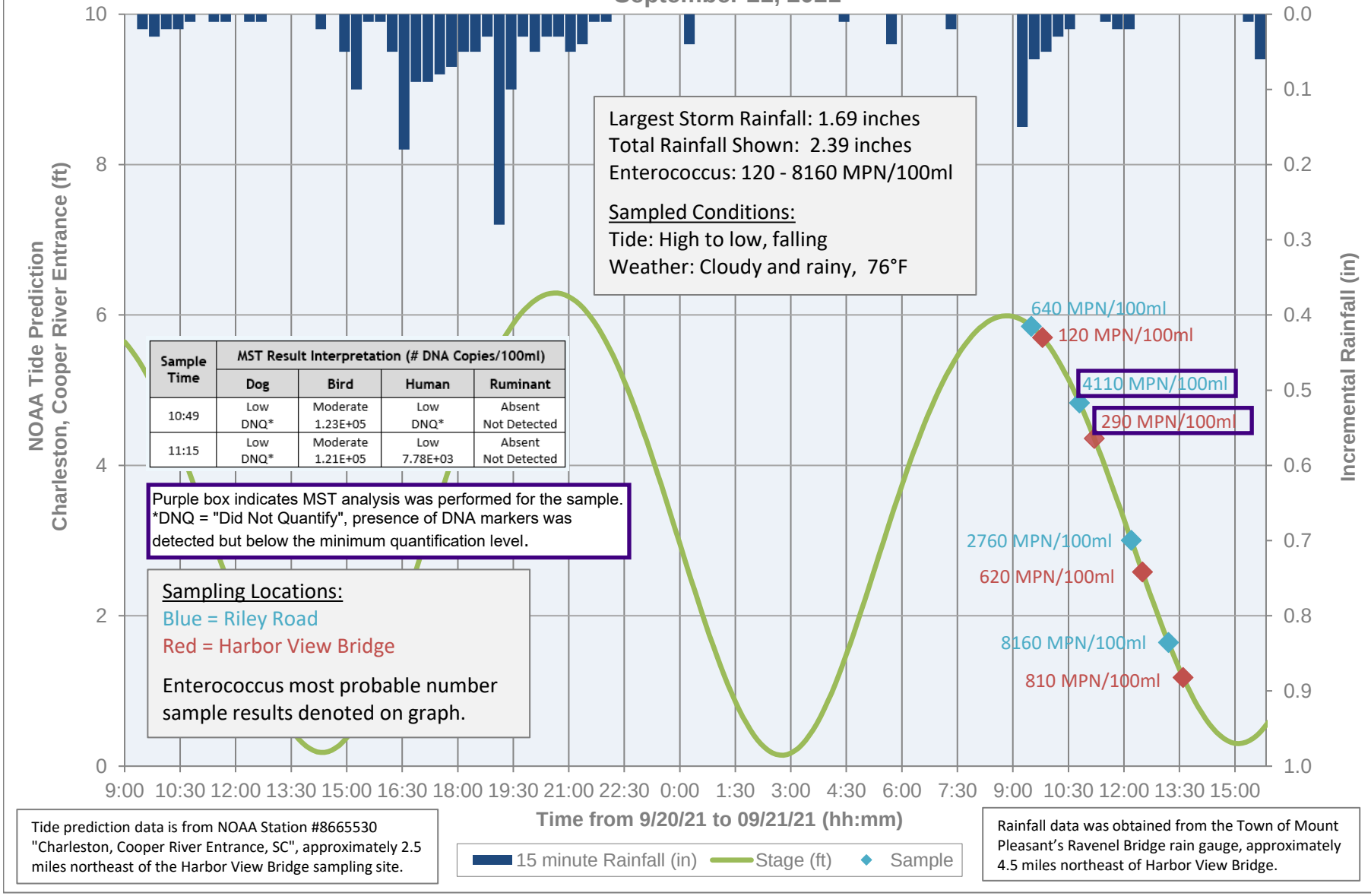
Charleston County
James Island Creek Dry Weather Sampling
September 14, 2022



Tide prediction data is from NOAA Station #8665530 "Charleston, Cooper River Entrance, SC", approximately 2.5 miles northeast of the Harbor View Bridge sampling site.

Appendix C: Microbial Source Tracking Results Graphs

Charleston County
James Island Creek Wet Weather Sampling
September 21, 2021



Largest Storm Rainfall: 1.69 inches
Total Rainfall Shown: 2.39 inches
Enterococcus: 120 - 8160 MPN/100ml

Sampled Conditions:
Tide: High to low, falling
Weather: Cloudy and rainy, 76°F

640 MPN/100ml
120 MPN/100ml
4110 MPN/100ml
290 MPN/100ml
2760 MPN/100ml
620 MPN/100ml
8160 MPN/100ml
810 MPN/100ml

Sample Time	MST Result Interpretation (# DNA Copies/100ml)			
	Dog	Bird	Human	Ruminant
10:49	Low DNQ*	Moderate 1.23E+05	Low DNQ*	Absent Not Detected
11:15	Low DNQ*	Moderate 1.21E+05	Low 7.78E+03	Absent Not Detected

Purple box indicates MST analysis was performed for the sample.
*DNQ = "Did Not Quantify", presence of DNA markers was detected but below the minimum quantification level.

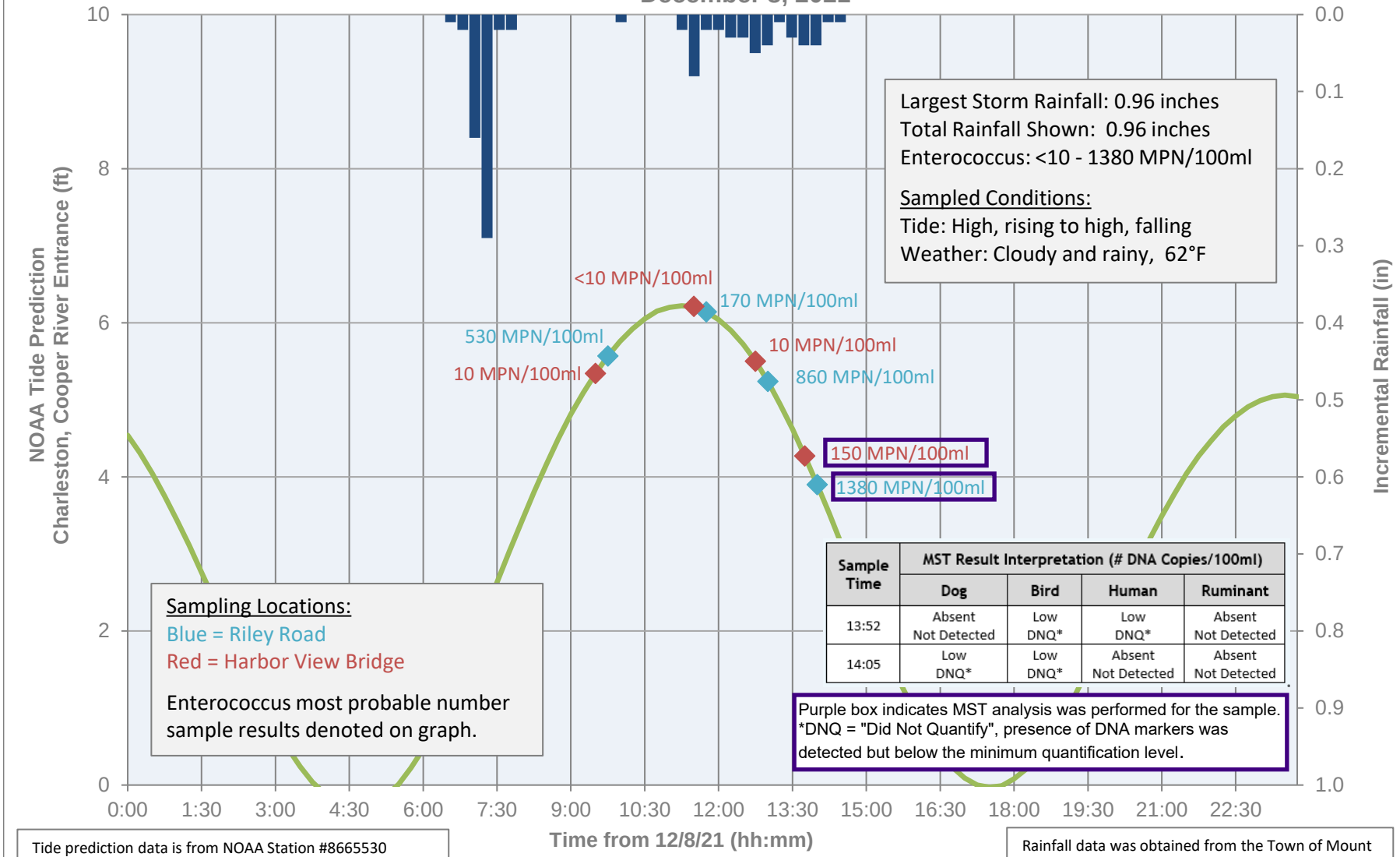
Sampling Locations:
Blue = Riley Road
Red = Harbor View Bridge

Enterococcus most probable number sample results denoted on graph.

Tide prediction data is from NOAA Station #8665530 "Charleston, Cooper River Entrance, SC", approximately 2.5 miles northeast of the Harbor View Bridge sampling site.

Rainfall data was obtained from the Town of Mount Pleasant's Ravenel Bridge rain gauge, approximately 4.5 miles northeast of Harbor View Bridge.

Charleston County
James Island Creek Wet Weather Sampling
December 8, 2021



Largest Storm Rainfall: 0.96 inches
Total Rainfall Shown: 0.96 inches
Enterococcus: <10 - 1380 MPN/100ml

Sampled Conditions:
Tide: High, rising to high, falling
Weather: Cloudy and rainy, 62°F

Sampling Locations:
Blue = Riley Road
Red = Harbor View Bridge

Enterococcus most probable number sample results denoted on graph.

Sample Time	MST Result Interpretation (# DNA Copies/100ml)			
	Dog	Bird	Human	Ruminant
13:52	Absent Not Detected	Low DNQ*	Low DNQ*	Absent Not Detected
14:05	Low DNQ*	Low DNQ*	Absent Not Detected	Absent Not Detected

Purple box indicates MST analysis was performed for the sample.
*DNQ = "Did Not Quantify", presence of DNA markers was detected but below the minimum quantification level.

Tide prediction data is from NOAA Station #8665530 "Charleston, Cooper River Entrance, SC", approximately 2.5 miles northeast of the Harbor View Bridge sampling site.

Rainfall data was obtained from the Town of Mount Pleasant's Ravenel Bridge rain gauge, approximately 4.5 miles northeast of Harbor View Bridge.