BACTERIA IMPLEMENTATION GROUP'S TOP FIVE MOST AND TOP FIVE LEAST IMPAIRED WATER BODIES

PRELIMINARY ACTION REPORT

August 4, 2016

Prepared by
Paniz Miesen
Houston-Galveston Area Council
P.O Box 22777
Houston, Texas 77227-2777
(832) 681-2523
paniz.miesen@h-gac.com

Project funded through grants from the U.S. Environmental Protection Agency through the Texas Commission on Environmental Quality's Galveston Bay Estuary Program

TABLE OF CONTENTS

1.0 Introduction

1.1 Background

The Bacteria Implementation Group (BIG), a partnership of government, business, and community leaders, was formed in 2008 following the completed Total Maximum Daily Load (TMDL) study. The BIG developed an implementation plan (I-Plan) that addresses elevated levels of bacteria in 72 bacteria-impaired segments in the Houston-Galveston region. The *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project was developed as a result of the BIG's tracking of bacteria levels and development of the Top 10 Most/ Top 10 Least Impaired Water Bodies lists. The Top 10 Most Impaired Water Bodies are impaired assessment units (AUs) with the highest geometric means relative to the state standards for bacteria; and the Top 10 Least Impaired Water Bodies are impaired AUs with the lowest geometric means relative to the state standards for bacteria. See Figure 1. The purpose of *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project is to investigate potential bacteria discharges in selected AUs from the Top 10/Least 10 lists to eliminate them by working with local jurisdictions in an effort to assist with Illicit Discharge Detection and Elimination (IDDE) in the BIG area. The ultimate goal of the project is to improve conditions enough to meet state water quality standards and remove listed stream segments from the state's list of bacteria-impaired waterways.

The BIG project area drains to Galveston Bay, where a sizeable area of the Bay's oyster producing waters are restricted to recreational harvest by the Texas Department of State Health Services due to elevated bacteria levels. However, contact recreation is the primary impairment or concern identified in the BIG region and will be the focus of this project. The contact recreation standard uses indicator bacteria (*E. coli* and Enterococcus) as surrogates for the potential presence of human pathogens. Bacteria is known to come from a variety of sources (anthropogenic and wildlife) and is associated with land cover/land uses which include but are not limited to agriculture and urban development run-off, wastewater conveyance and treatment, and illicit discharges.

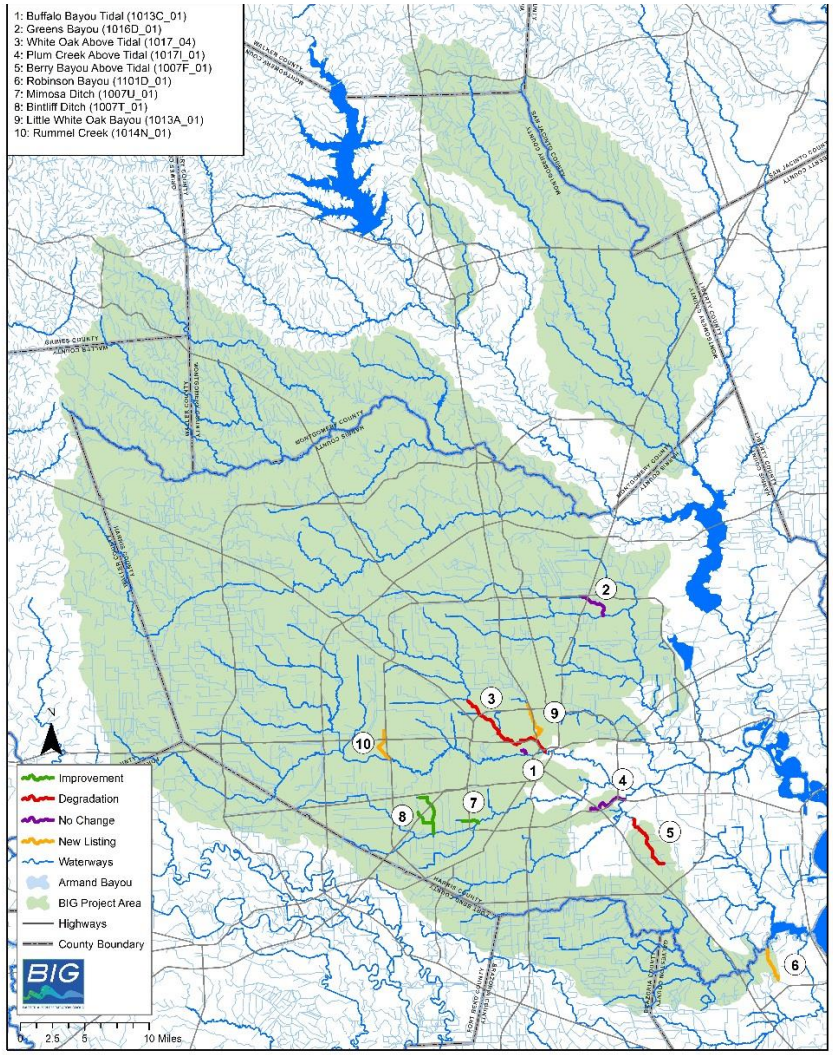
The Houston-Galveston Area Council (H-GAC) is the Regional Council of Governments for the Gulf Coast State Planning Region and has been actively involved in regional water quality planning and public outreach activities since the 1970s. H-GAC is designated as the lead agency responsible for administration of the *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project. The project is funded through grants from the U.S. Environmental Protection Agency through the Texas Commission on Environmental Quality's (TCEQ) Galveston Bay Estuary Program (GBEP).

1.2 Project Description

H-GAC staff will address 10 targeted watersheds (five each from the Top 10/Least 10 lists) by prioritizing the watersheds through desk reviews, ground truthing, identifying elevated sources of bacteria in the field through sample collection and analysis, and reporting those elevated bacteria sources to appropriate local jurisdictions. H-GAC will not correct the sources but will work with those jurisdictions to remove and/or eliminate the sources.

Local project partners are participating in a technical workgroup to share their extensive knowledge of subject AUs during regular progress meetings held throughout the project period. The project has been split into three phases for simplicity. Figure 2 delineates the three phases through a project flow chart and describes the tasks contained within. This Preliminary Action Report summarizes results for Phase I tasks completed between April and July 2016.

BIG'S TOP TEN MOST IMPAIRED ASSESSMENT UNITS



BIG'S TOP TEN LEAST IMPAIRED ASSESSMENT UNITS

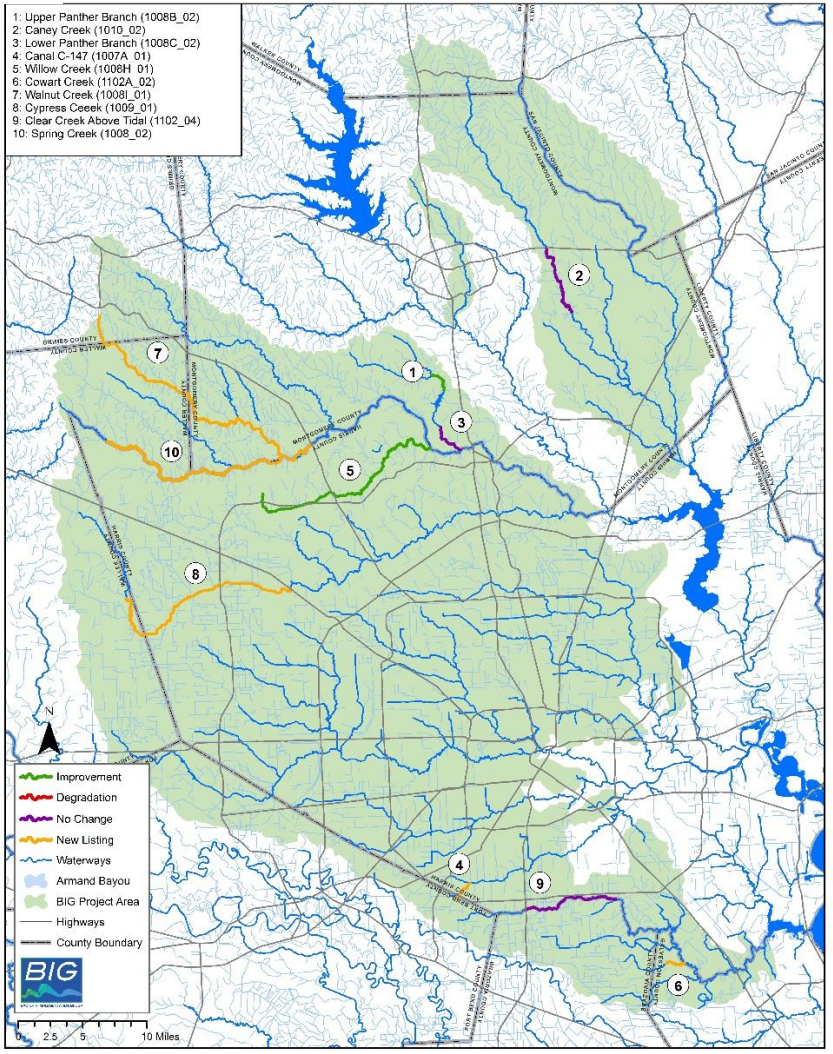


Figure 1. Bacteria Implementation Group's (BIG's) 2015 Top 10/Least 10 AU maps

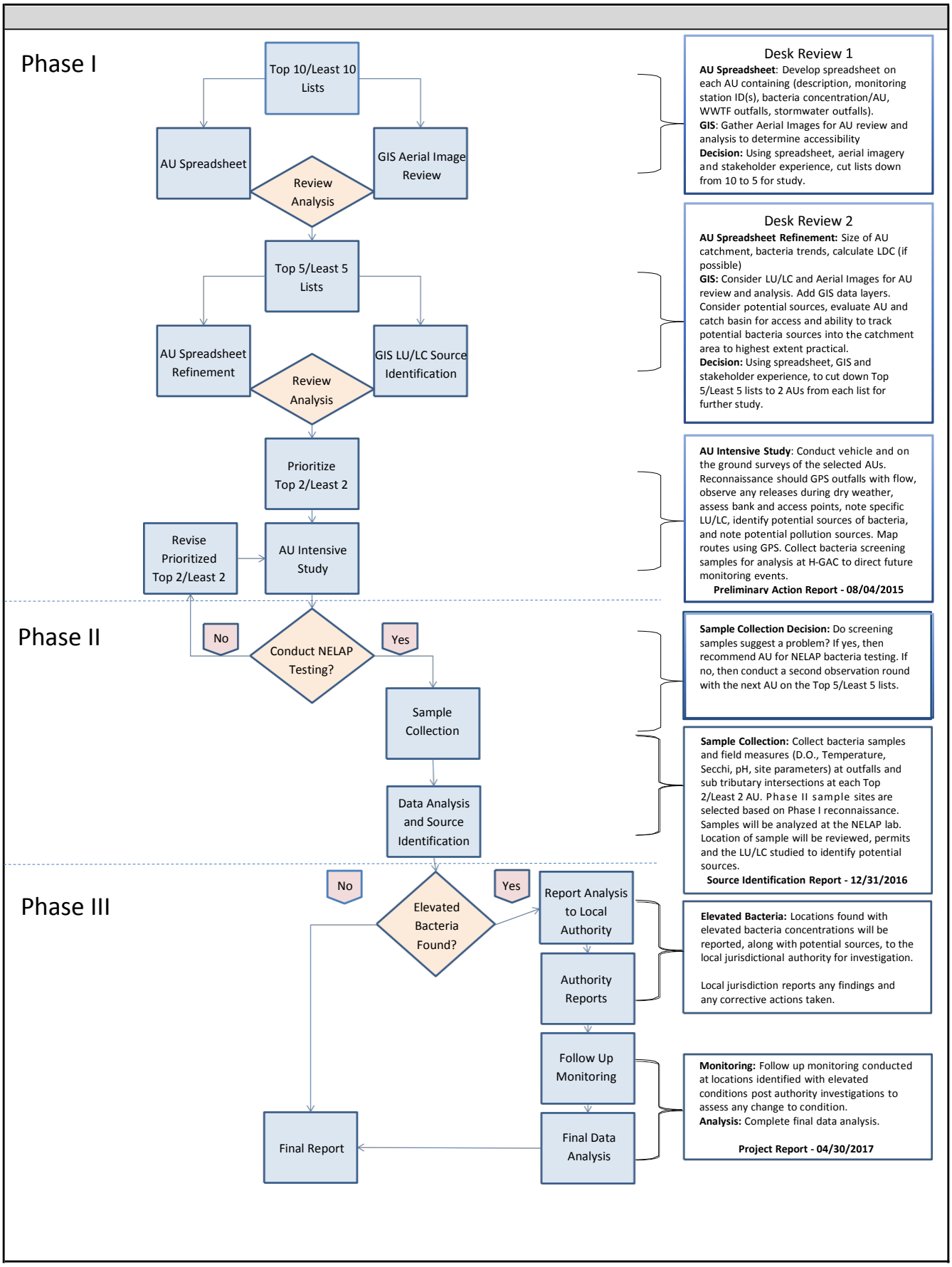


Figure 2. Project flow chart and timeline

2.0 Desk Review 1

During Desk Review 1, initial information about each AU on the BIG's Top 10/Least 10 lists were gathered through GIS map development and data analysis using SAS 9.3 statistical software. Desk Review 1 maps included information about the catchment area for each Top 10/Least 10 AU, as well as AU length, active monitoring stations, wastewater treatment facility (WWTF) outfalls, stormwater outfalls, and on-site sewage facilities (OSSFs). Desk Review 1 maps can be found in Appendix A.

An AU spreadsheet supplements the Top 10/Least 10 lists Desk Review 1 maps. The AU spreadsheet includes a description of each AU on the Top 10/Least 10 lists, along with designated uses, bacteria geometric mean concentrations, number of bacteria measurements used in analysis, as well as a description of active monitoring stations for each AU. Information from the Desk Review 1 AU spreadsheet can be found in the technical workgroup meeting presentation included in Appendix A.

Historical Clean Rivers Program (CRP) monitoring data ranging from January 2005 to present were used to develop moving seven-year bacteria geometric mean plots for each AU on the Top 10/Least 10 lists. The moving seven-year geometric mean plots for bacteria provide a visual interpretation of bacteria fluctuations over time for each AU being analyzed. Desk Review 1 moving-seven year bacteria geometric mean plots can be found in Appendix A.

All materials gathered during Desk Review 1 were presented at the technical workgroup meeting on April 20, 2016. Local partners and interested stakeholders participated and provided feedback about findings and shared additional knowledge and expertise about the Top 10AUs discussed. Based on Desk Review 1 results and discussions with the technical workgroup, the BIG's Top 10 AUs were cut down to the Top 5/Least 5 AUs with bacteria concentration, designated uses, accessibility, and level of interest being the primary criteria by which the lists were prioritized. Table 1 lists the final Top 5/Least 5 AUs that were selected. All materials presented at the meeting, as well as meeting summary notes, can be found in Appendix A.

Table 1. Top 5/Least 5 AU list after Phase I: Desk Review 1

Top Five Most Impaired AUs	Top Five Least Impaired AUs
Berry Bayou Above Tidal (Segment 1007F_01)	Upper Panther Branch (Segment 1008B_02)
Mimosa Ditch (Segment 1007U_01)	Lower Panther Branch (Segment 1008C_02)
Bintliff Ditch (Segment 1007T_01)	Canal C-147 (Segment 1007A_01)
Little White Oak Bayou (1013A_01)	Cowart Creek (Segment 1102A_02)
Rummel Creek (1014N_01)	Clear Creek Above Tidal (Segment 1102_04)

3.0 Desk Review 2

During Desk Review 2, the existing GIS maps from Desk Review 1 were further refined to include additional information about the prioritized Top 5/Least 5 AUs. In addition to the map layers included in Desk Review 1, a land use/land cover (LU/LC) layer was added to the Desk Review 2 maps to better identify potential bacteria sources within each AU on the Top 5/Least 5 lists. Potential bacteria sources were also identified on the Desk Review 2 maps with GPS coordinates included for each. Desk Review 2 maps can be found in Appendix B.

Further statistical analysis of historical CRP data was conducted for each AU on the Top 5/Least 5 lists during Desk Review 2. In addition to the moving seven-year bacteria geometric mean plots, a trend analysis was conducted for each AU to evaluate if bacteria conditions have been improving or getting worse over time. LDCs were also developed for AUs with available U.S. Geological Survey (USGS) flow data. A LDC is a graphical illustration that shows the corresponding relationship between contaminant loadings and stream flow conditions in a given area. Only two AUs on the Top 5/Least 5 lists had enough flow data available to generate LDCs, including Little White Oak Bayou and Cowart Creek. To better evaluate which stream segments tend to have high bacteria concentrations during dry weather conditions, bacteria versus days since last rain graphs were generated for the remaining AUs on the Top 5/Least 5 lists where LDCs were not feasible. Trend graphs, LDCs, and rain graphs generated during Desk Review 2 can be found in Appendix B.

All materials gathered during Desk Review 2 were presented at the technical workgroup meeting on May 26, 2016. The established workgroup participated and provided feedback on findings to assist in prioritizing the Top 5/Least 5 list down to a Top 2/Least 2 list for further assessment and ground truthing during the AU Intensive Study portion of Phase I. Based on Desk Review 2 results and discussions with the technical workgroup, the BIG's Top 5/Least 5 AUs were cut down to the Top 2/Least 2 AUs with bacteria conditions, designated uses, accessibility, and level of interest being the primary criteria by which the lists were prioritized. Table 2 lists the final Top 2/Least 2 AUs that were selected. All materials presented at the meeting, as well as meeting summary notes, can be found in Appendix B.

Table 2. Top 2/Least 2 AU list that was decided on after Phase I: Desk Review 2

Top Two Most Impaired AUs	Top Two Least Impaired AUs
Little White Oak Bayou (1013A_01)	Upper Panther Branch (Segment 1008B_02)
Rummel Creek (1014N_01)	Canal C-147 (Segment 1007A_01)

4.0 AU Intensive Study: Top 2 Most Impaired

4.1 Little White Oak Bayou

Little White Oak Bayou, Segment 1013A_01, is one of the most impaired water bodies within the BIG geographic area, with an *E.coli* geometric mean concentration of 1975 MPN/100mL compared to the state water quality standard of 126 MPN/100mL. Desk Review 1 and 2 findings show the primary LU/LC within the 7.9 square mile catchment area is residential. The total length of the waterway is approximately 3.9 miles with two active CRP monitoring stations: station 11148 at Little White Oak Bayou and Trimble Street; and station 16648 at Little White Oak Bayou and White Oak Drive. Designated uses for this segment include Aquatic Life Use, General Use, and Contact Recreation Use. Refer to Figure 3 for the watershed map of Little White Oak Bayou developed during Desk Review 2.

Statistical analysis of Little White Oak Bayou data revealed a gradual decrease in bacteria geometric mean concentrations since 2005 (Figure 4). However, *E.coli* concentrations remain significantly higher than the 126 MPN/100mL standard for the majority of samples collected during the assessment period (Figure 5). The LDC curve generated for station 11148 on Little White Oak Bayou revealed the majority of data points exceeding the state standard for *E.coli* during dry conditions, implying that dry weather discharges high in bacteria seem to be a common occurrence for this stream segment (Figure 6).

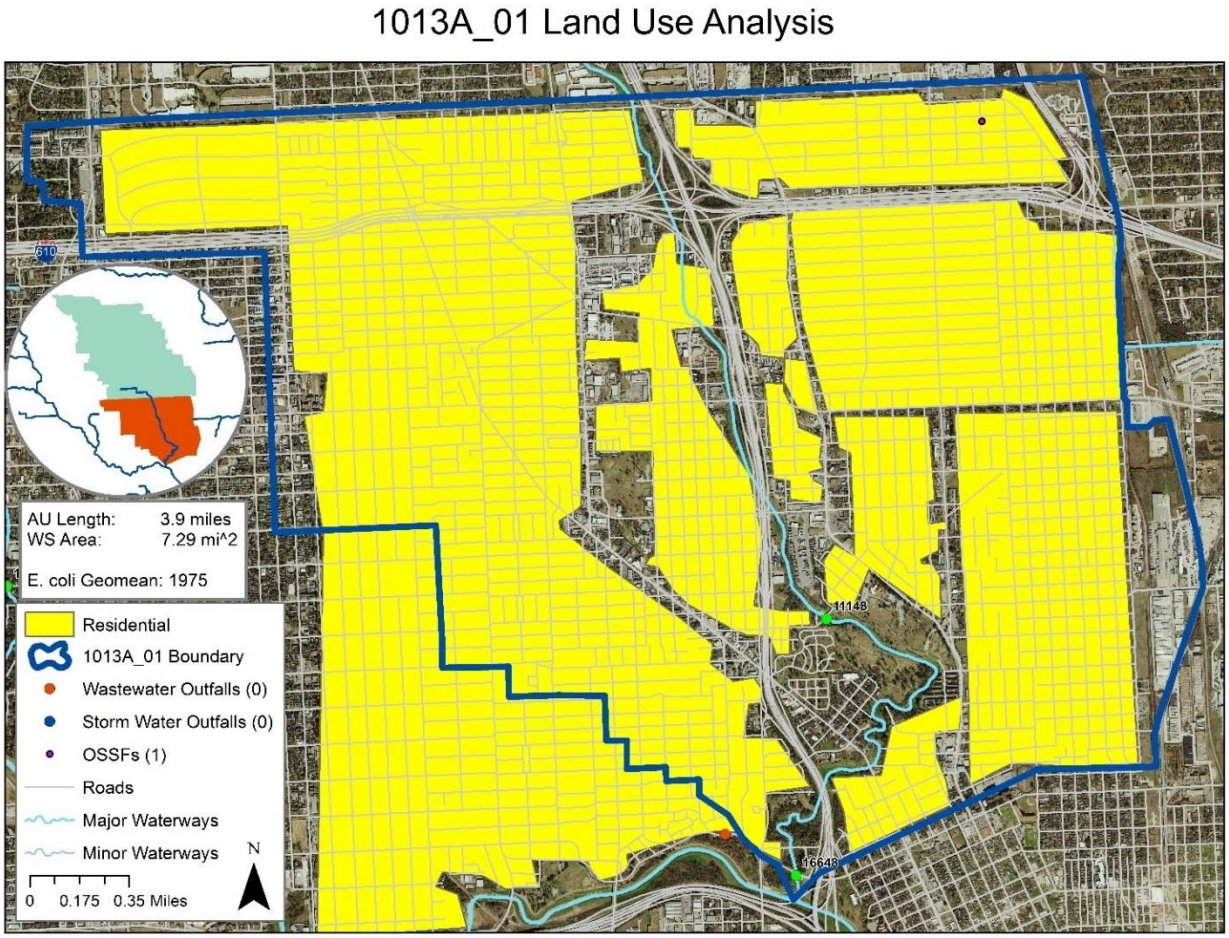


Figure 3. Desk Review 2 map for Little White Oak Bayou Segment 1013A_01

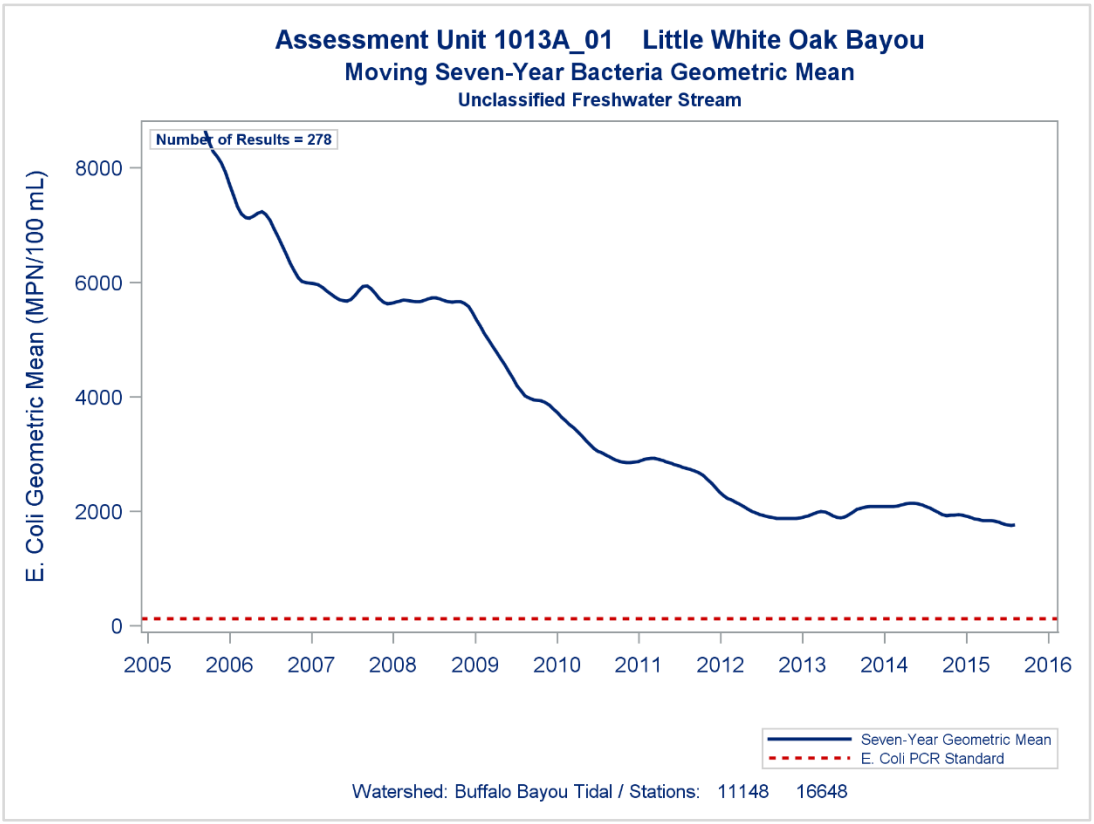


Figure 4. Moving seven-year E.coli geometric mean plot for Little White Oak Bayou

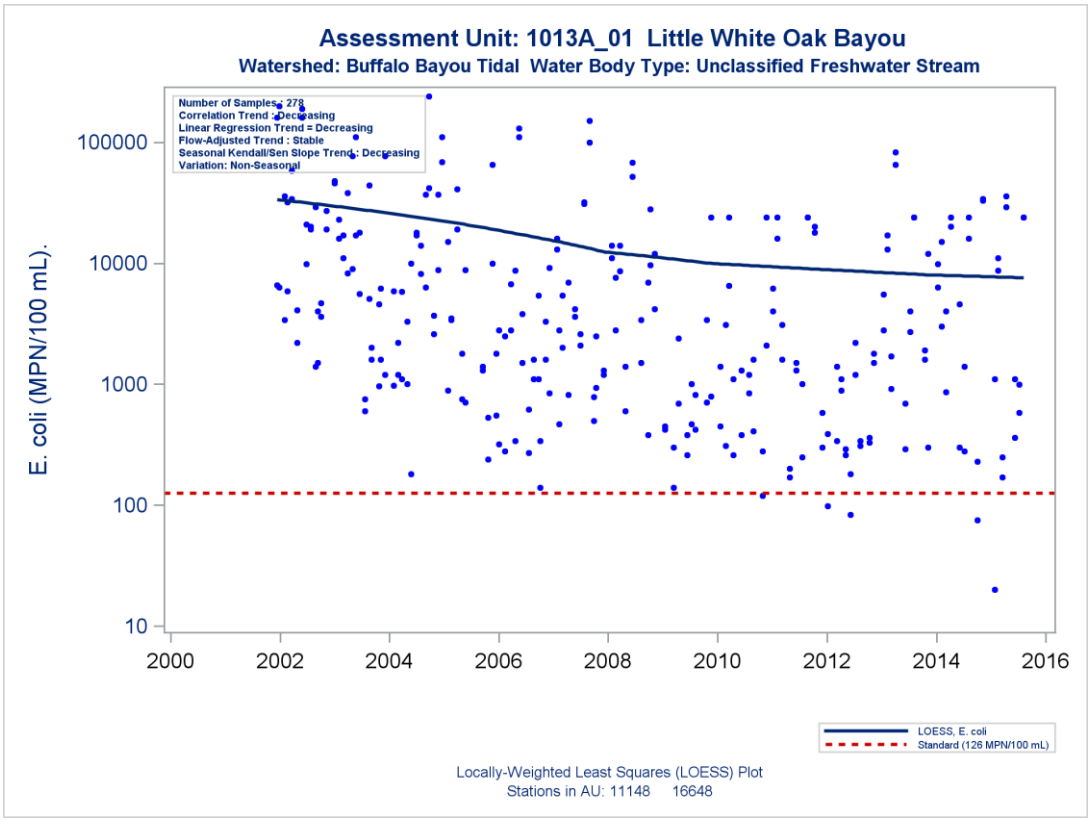


Figure 5. E.coli trend analysis for Little White Oak Bayou

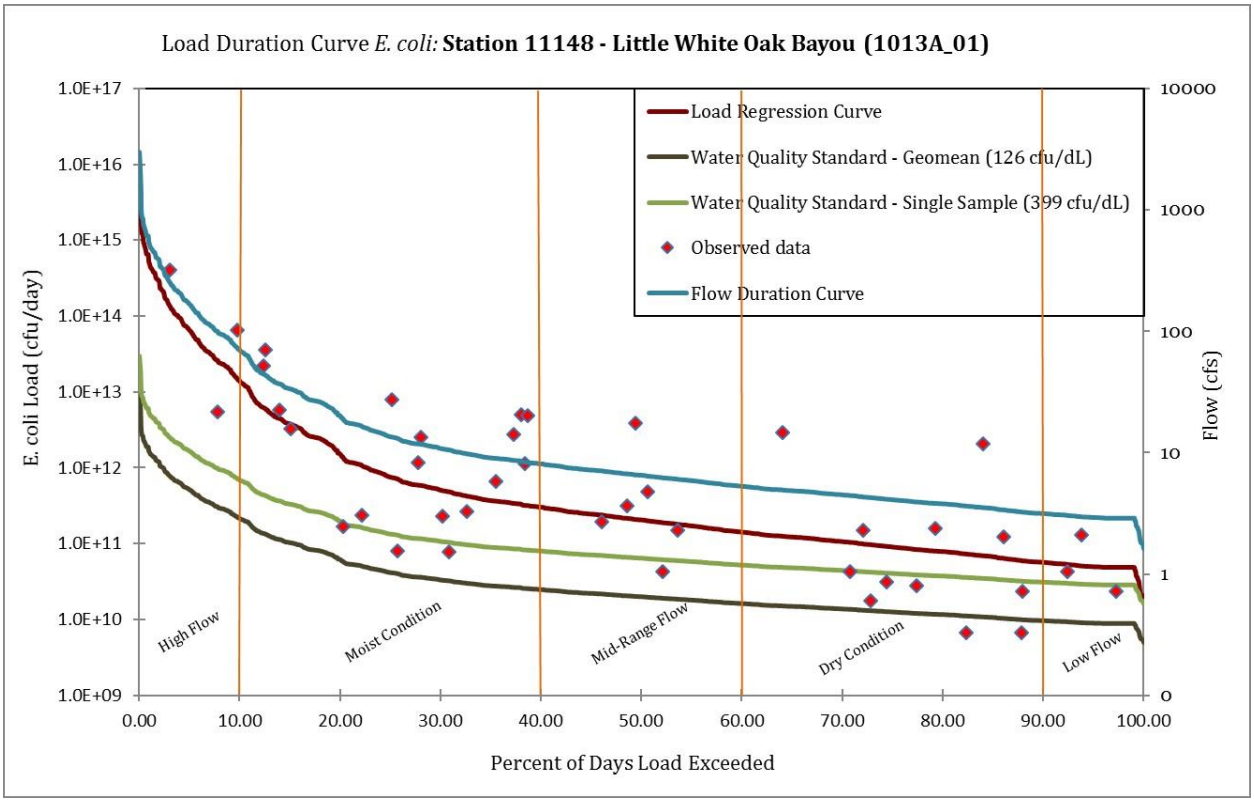


Figure 6. LDC for Little White Oak Bayou at station 11148

4.1.1 Windshield Survey

The windshield survey for Little White Oak Bayou was conducted on June 22, 2016. The waterway was investigated by vehicle, and points of access and potential bacteria sources were noted during the survey. Primary land use is residential throughout the catchment area with light commercial land uses present along the primary thoroughfares of Fulton Street, Main Street, and the I-45 and I-610 corridors. Although no potential bacteria sources were observed during the windshield survey, a significant amount of accumulated trash and litter was seen at bridge crossings and access points throughout the waterway. Refer to Figure C1 in Appendix C for a map of the windshield survey route.

4.1.2 Bacteria Screening

A total of 25 bacteria screening samples were collected along Little White Oak Bayou during the on-the -round surveys July 13, 18, and 20, 2016. Samples were collected at eight discharging outfalls (Figure 7) and one tributary, while the rest of the samples were surface water samples collected in an effort to better identify hot spots and trace bacteria sources back to their origin. It should be noted that a significant rain event occurred on July 19, 2016, making the samples collected on July 20, 2016, wet weather samples. Sample sites from July 20, 2016, will be re-visited during Phase II to collect dry weather samples for comparison.

Figure 7. Collecting sample from discharging outfall

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations. The prepared water samples were plated on a treated petri dish and incubated at a temperature of 33°C for 28 hours. Upon incubation, *E.coli* within the samples produce enzymes that react with color reagents in the media to create dark blue colonies. The number of colonies present on each petri dish reflect the *E.coli* concentration for that sample (Figure 8). Samples with greater than 200 blue colonies are labeled as Too Numerous To Count (TNTC). Two dilutions were measured for each sample and the average concentration is reported in Table 3. Refer to Figure 9 for a station map illustrating the location and sample type for each sample collected during the Little White Oak Bayou survey, and to Figure 10 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table C1 in Appendix C.

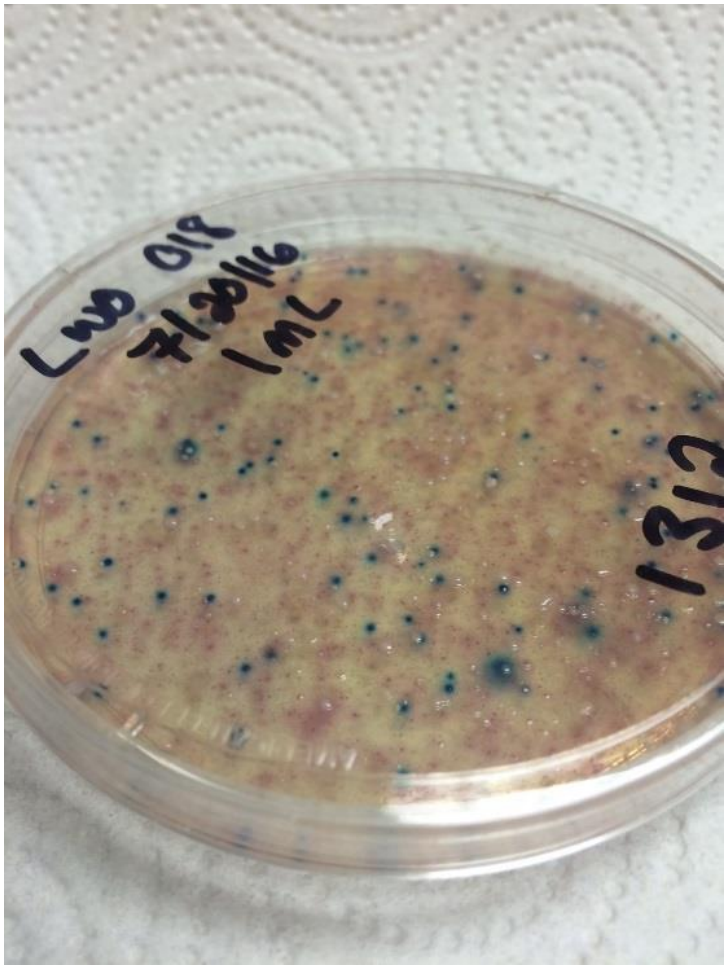


Figure 8. Coliscan Easygel E.coli colony count for Little White Oak Bayou sample 018

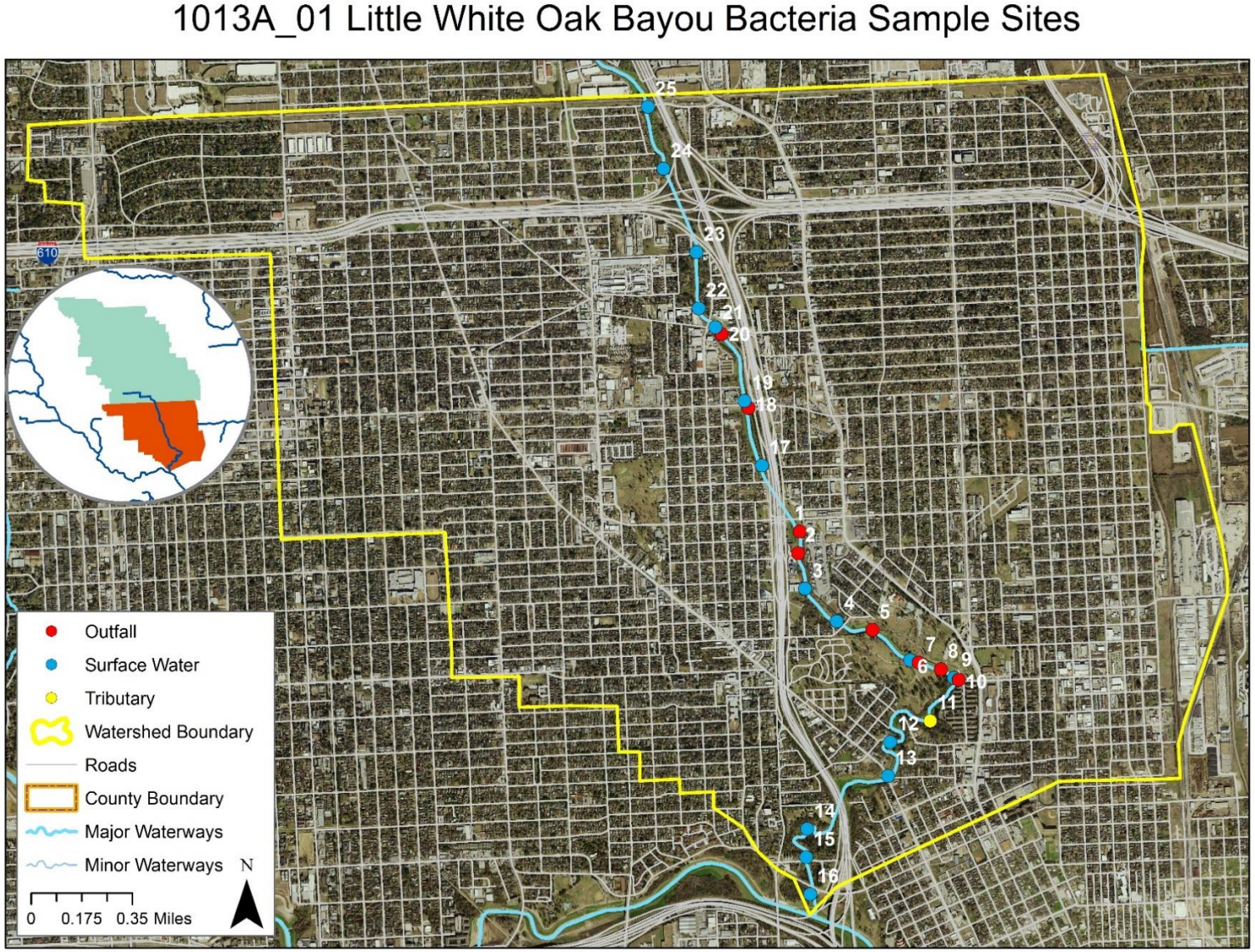


Figure 9. Station map for Little White Oak Bayou survey on July 13, 18, and 20, 2016

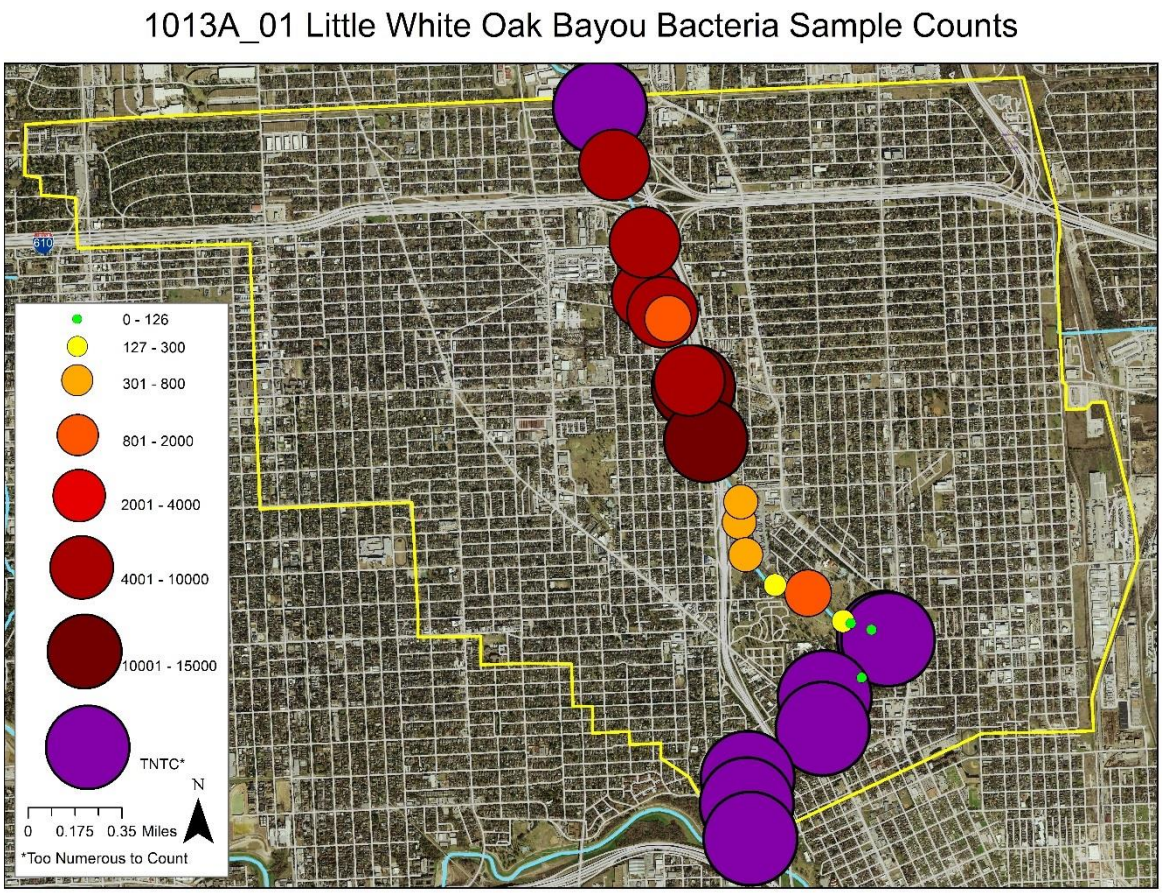


Figure 10. Bacteria screening results for Little White Oak Bayou surveys

4.1.3 Significant Findings

The most significant observation recorded during the Little White Oak Bayou survey was the litter and trash problem along the entire waterway. Portions of Little White Oak's banks were completely covered in trash and debris ranging from tires, shopping carts, plastics, Styrofoam, aluminum, and clothing. Trees along the lower portion of the waterway were covered in trash, likely from high flow conditions washing significant amounts of litter downstream that become trapped in branches and wrapped around tree trunks (Figures 11-14). However, even with the accumulated trash, there were abundant amounts of wildlife and aquatic organisms observed during the field surveys. Turtles and various bird species were common, many of which have made homes in the littered trees, shopping carts and tires. Alligator gar were also observed, primarily at the mouth of storm drains and outfall locations.

Table 3 lists all significant findings that require further investigation and follow-up sampling. The average *E.coli* count for the Little White Oak Bayou bacteria screening was approximately 3,974 cfu/100mL, which is likely a gross underestimation considering 32 percent of the samples were TNTC. Due to the extremely high concentrations found within this segment, samples collected with *E.coli* counts greater than 9,000 cfu/100mL were flagged as problem areas where further investigation is recommended. Three of the 25 samples collected had no bacteria colony forming units--two outfalls and one tributary. Further investigation is recommended for the non-detect sample locations to identify potential chlorine leaks or illicit discharges with high anti-bacterial agents.

Table 3. Summary of bacteria results and significant findings for Little White Oak Bayou

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	023	Outfall	Present	001	Outfall	575	N/A	7/13/2016	No	29.79758	-95.37048
2	025	Outfall	Present	002	Outfall	700	N/A	7/13/2016	No	29.79642	-95.37062
3	N/A	N/A	N/A	003	Surface Water	450	N/A	7/13/2016	No	29.79464	-95.37029
4	N/A	N/A	N/A	004	Surface Water	250	N/A	7/13/2016	No	29.79296	-95.36852
5	034	Outfall	Present	005	Outfall	1025	N/A	7/13/2016	No	29.79088	-95.36414
6	N/A	N/A	N/A	006	Surface Water	150	N/A	7/13/2016	No	29.79090	-95.36438
7	036	Outfall	Present	007	Outfall	0	No Bacteria	7/13/2016	Yes	29.79083	-95.36405
8	041	Outfall	Present	008	Outfall	0	No Bacteria	7/18/2016	Yes	29.79039	-95.36263
9	N/A	N/A	N/A	009	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78994	-95.36188
10	044	Outfall	Present	010	Outfall	TNTC	High Bacteria	7/18/2016	Yes	29.78984	-95.36163
11	048	Tributary	N/A	011	Surface Water	0	No Bacteria	7/18/2016	Yes	29.78782	-95.36334
12	N/A	N/A	N/A	012	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78683	-95.36567
13	N/A	N/A	N/A	013	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78513	-95.36585
14	N/A	N/A	N/A	014	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78260	-95.37060
15	050	Outfall	Present	015	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.78119	-95.37070
16	N/A	N/A	N/A	016	Surface Water	TNTC	High Bacteria	7/18/2016	Yes	29.77933	-95.37054
17	N/A	N/A	N/A	017	Surface Water	10900	High Bacteria	7/20/2016	Yes	29.80087	-95.37254
18	053	Outfall	Present	018	Outfall	13300	High Bacteria	7/20/2016	Yes	29.80372	-95.37321
19	N/A	N/A	N/A	019	Surface Water	7300	N/A	7/20/2016	No	29.80414	-95.37343
20	055	Outfall	Present	020	Outfall	1350	N/A	7/20/2016	No	29.80751	-95.37463
21	N/A	Outfall	Absent	021	Surface Water	6650	N/A	7/20/2016	No	29.80787	-95.37498
22	N/A	Outfall	Absent	021	Surface Water	6650	N/A	7/20/2016	No	29.80787	-95.37498
23	N/A	Outfall	Absent	021	Surface Water	6650	N/A	7/20/2016	No	29.80787	-95.37498
24	056	Outfall	Absent	022	Surface Water	9450	High Bacteria	7/20/2016	Yes	29.80884	-95.37589
25	N/A	N/A	N/A	023	Surface Water	4300	N/A	7/20/2016	No	29.81165	-95.37593
26	058	Outfall	Absent	024	Surface Water	5800	N/A	7/20/2016	No	29.81596	-95.37775
27	N/A	N/A	N/A	025	Surface Water	TNTC	High Bacteria	7/20/2016	Yes	29.81901	-95.37845
28	035	Outfall	Absent	N/A	N/A	N/A	Screen Cover	7/13/2016	Yes	29.79082	-95.36403
29	040	Outfall	Absent	N/A	N/A	N/A	Screen Cover	7/18/2016	Yes	29.79043	-95.36283
30	052	Sewer Manhole	Absent	N/A	N/A	N/A	Damaged	7/20/2016	Yes	29.80126	-95.37309
31	N/A	Outfall	Absent	N/A	N/A	N/A	Suspicious Pipe	7/20/2016	Yes	29.80425	-95.37350
32	033	Outfall	Present	N/A	N/A	N/A	Screen Cover	7/13/2016	Yes	29.79246	-95.36655
33	047	Sewer Manhole	N/A	N/A	N/A	N/A	Open	7/18/2016	Yes	29.78791	-95.36320

Figure 11. Shopping cart and litter on water bank

Figure 12. Trash wrapped around tree trunks in lower portion of Little White Oak

Figure 13. Trash accumulated on water banks near I-45 bridge

Figure 14. Washed up trash trapped by tree branches

Other than the in-stream and outfall samples collected, additional findings that require further investigation include the following:

1) Three suspicious outfall pipes adjacent to the Moody Park area had metal screened covers attached to the ends. One of the three pipes had a small amount of discharge dripping from the outfall, but not enough for sample collection and bacteria screening. Locations for the screened outfalls can be found in Table 3 (Tier II ID 033, 035, and 040). Refer to Figures 15-17 for images of the three suspicious outfall pipes.

Figure 15. Outfall Tier II ID 035

Figure 16. Outfall Tier II ID 035

Figure 17. Outfall Tier II ID 040

2) Two sewer manholes require follow-up investigation. One manhole (Tier II ID 047) was found along the Bayou with an open lid likely from a recent sewer overflow. The smell of sewage inside the manhole could be detected from the bank. A second damaged manhole was found along the Bayou (Tier II ID 052). This manhole was about six feet tall with a large hole in the cement casing. Another hole was found in the ground by the sewer manhole. It was unclear if this was an active or abandoned manhole, but further investigation is recommended to ensure raw sewage does not discharge at the location. Refer to Table 3 for locations of each manhole, and to Figures 18-20 for images of each.

Figure 18. Outfall Tier II ID 047

Figure 19. Outfall Tier II ID 052

Figure 20. Outfall Tier II ID 052

3) A suspicious drain line from the Astro Inn's parking lot leads directly into Little White Oak Bayou on the right bank upstream of the West Cavalcade Street bridge. There was no discharge at the outfall at the time of sampling, but a surface water sample (019) was collected directly downstream of the pipe line resulting in an *E.coli* concentration of 7,300 cfu/100mL. Additional investigation is recommended to ensure this is not an illicit discharge. Refer to Table 3 (No. 31) for GPS coordinates and to Figure 21-23 for images of the drain line and parking lot.

Figure 21. Astro Inn Parking lot (No. 31)

Figure 22. Outfall No. 31

Figure 23. Outfall Tier No. 31

4.2 Rummel Creek

Rummel Creek, Segment 1014N_01, is one of the most impaired water bodies within the BIG geographic area, with an *E.coli* geometric mean concentration of 1960 MPN/100mL compared to the state water quality standard of 126 MPN/100mL. The stream length is approximately 3.04 miles with a catchment area of 4.62 square miles. There is one active CRP monitoring station located at Rummel Creek and Memorial Drive (station ID 11188). Primary LU/LC in the area is residential with some light commercial and industrial land uses present north of Beltway 8. Designated uses for this segment include Aquatic Life Use, General Use, and Contact Recreation Use. Potential bacteria sources identified during Desk Review 2 include dirt yards and a nursery located at the intersection of I-10 and Beltway 8(Figure 24).

Statistical analysis of Rummel Creek data revealed a gradual decrease in bacteria geometric mean concentrations since 2005 (Figure 25). However, *E.coli* concentrations remain significantly higher than the 126 MPN/100mL standard for the majority of samples collected during the assessment period (Figure 26). No LDC graphs were generated for Rummel Creek because flow data from USGS was unavailable for this segment. To assess the occurrence of high *E.coli* concentrations during dry weather conditions, an *E.coli* versus days since last rain graph was developed and showed data points exceeding the state water quality standard for bacteria more than 20 days after the last rain event (Figure 27).

4.2.1 Windshield Survey

The windshield survey for Rummel Creek was June 22, 2016. The waterway was investigated by vehicle, and points of access and potential pollution sources were noted. Primary land use is residential throughout the catchment area with commercial and industrial land uses present primarily north of Beltway 8 and at the intersection of I-10 and Beltway 8. Several industrial stormwater outfalls are adjacent to the I-10 corridor north of Beltway 8 before the stream goes underground. Nearby facilities include a hospital and various flooring distribution and furniture warehouses. A large plant nursery is on the southwest corner of the I-10 and Beltway 8 intersection adjacent to where Rummel Creek emerges from underground. A large discharging outfall appeared to be coming from the stormwater detention area adjacent to the nursery. A significant amount of vegetation was growing through the cement-lined channel adjacent to the nursery and stormwater detention outfall (Figure 28). Refer to Figure D1 in Appendix D for a map of the windshield survey route.

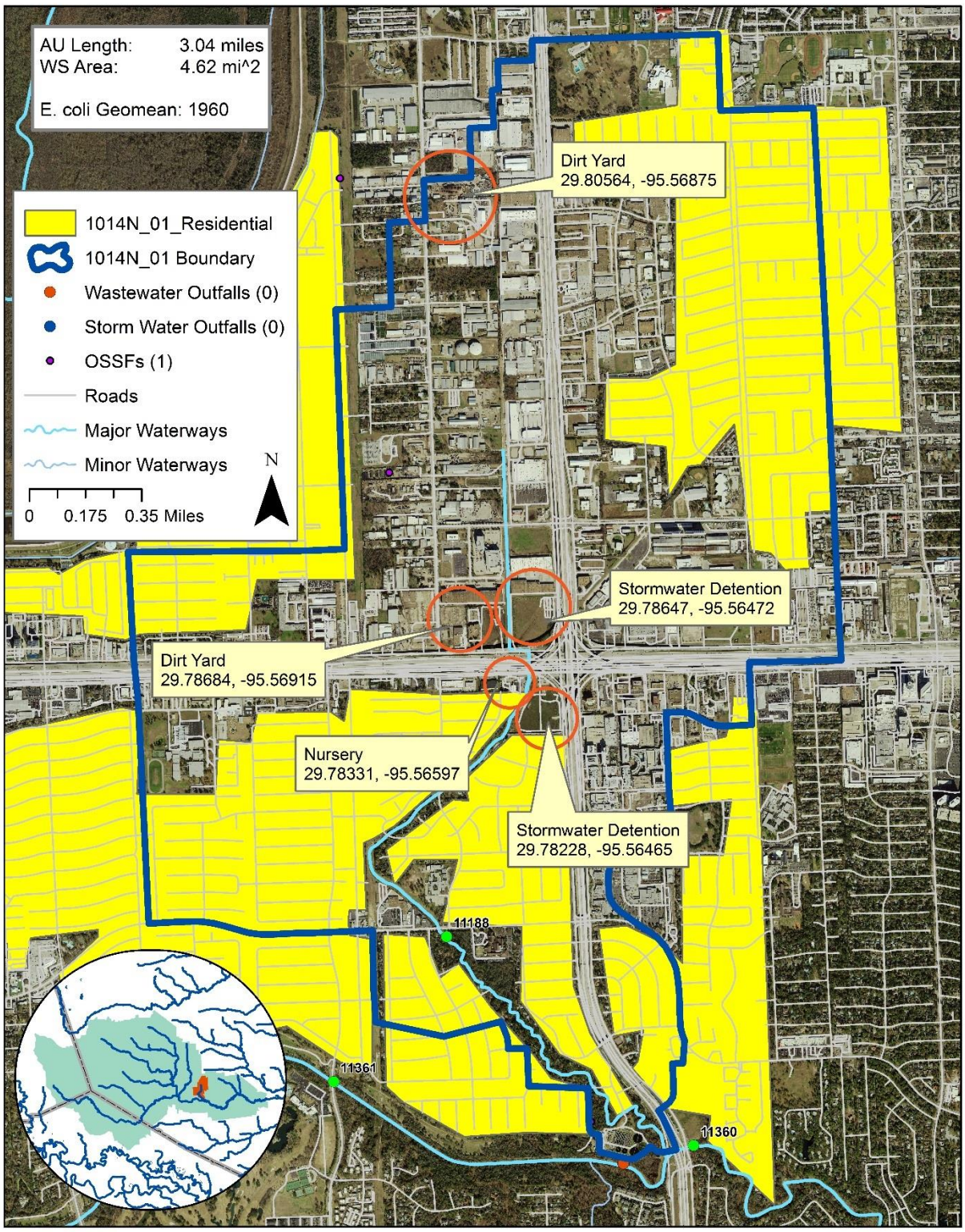


Figure 24. Desk Review 2 map for Rummel Creek, Segment 1014N_01

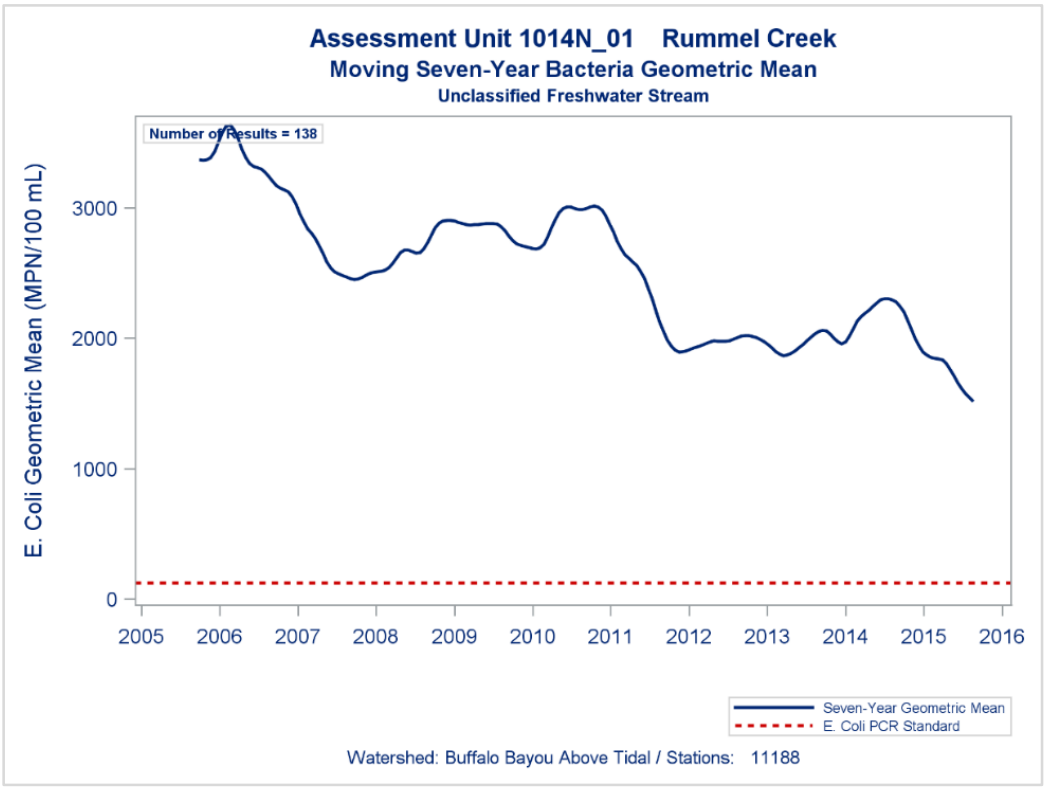


Figure 25. Moving seven-year E.coli geometric mean plot for Rummel Creek

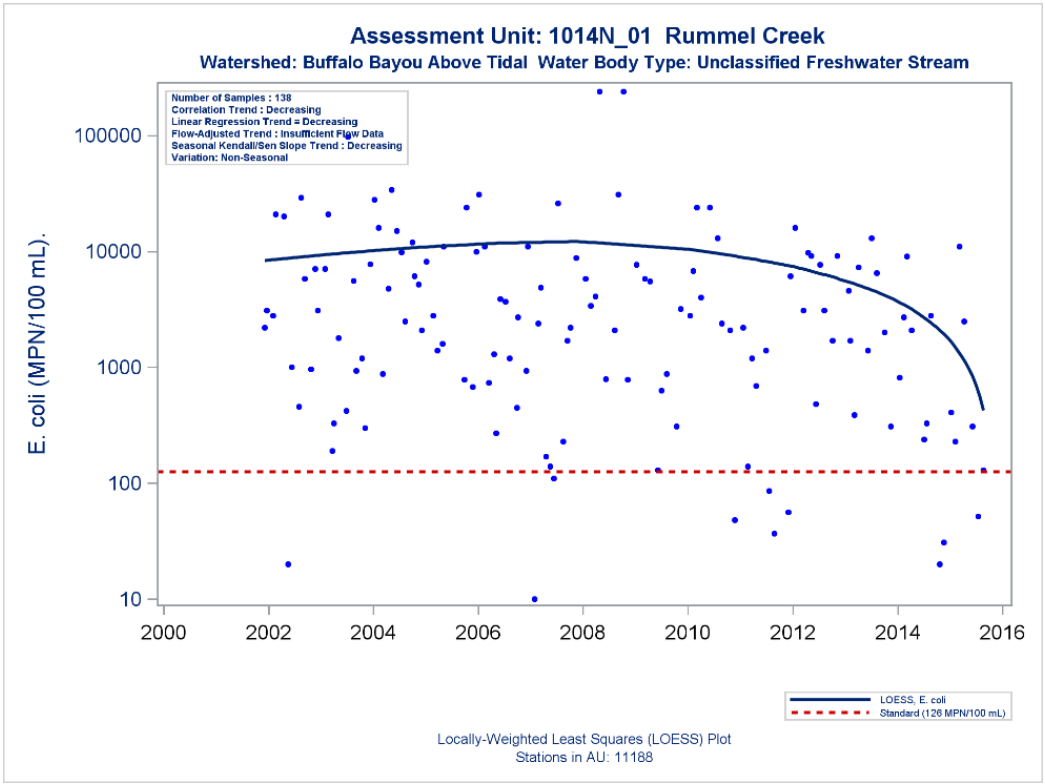


Figure 26. E.coli trend analysis for Rummel Creek

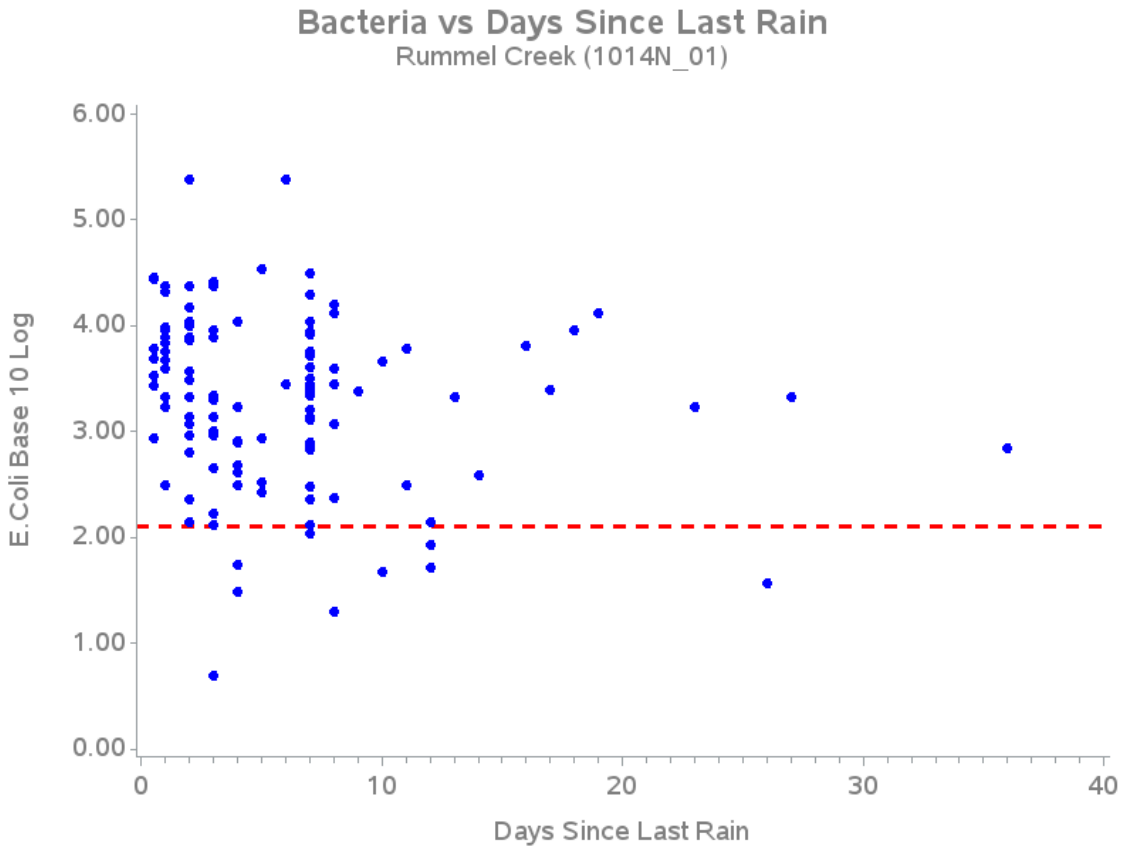


Figure 27. Bacteria versus days since last rain graph for Rummel Creek. Red dotted line represents the water quality standard for E.coli.

Figure 28. Stormwater detention outfall adjacent to plant nursery at southwest corner of I-10 and Beltway 8 intersection

4.2.2 Bacteria Screening

A total of 13 bacteria screening samples were collected along Rummel Creek during the on-the-ground survey July 11, 2016. Samples were collected at four discharging outfalls and two tributaries, while the rest of the samples were surface water samples collected in an effort to better identify hot spots and trace bacteria sources back to their origin.

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations. Two dilutions were measured for each sample and the average concentration is reported in Table 4. Refer to Figure 29 for a station map illustrating the location and sample type for each sample collected during the Rummel Creek survey, and to Figure 30 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table D1 in Appendix D.

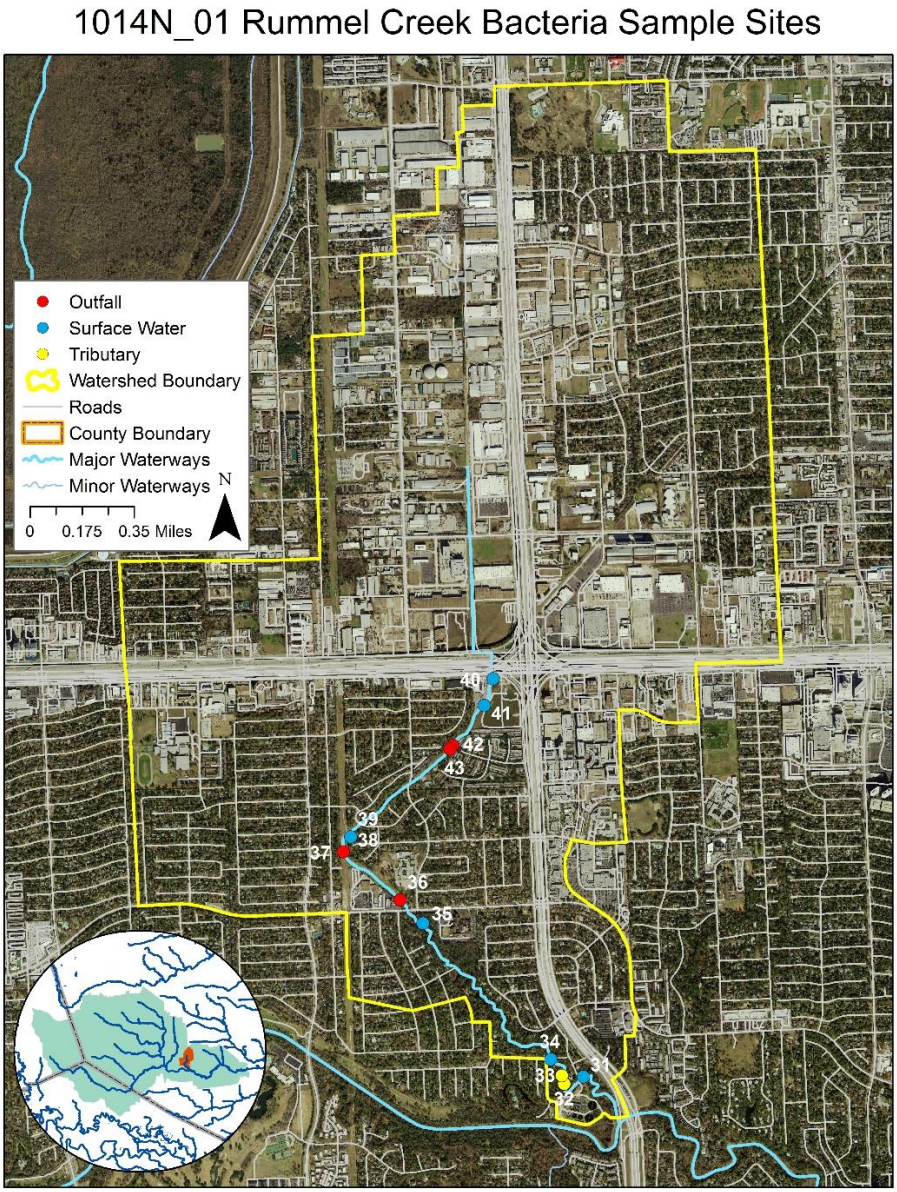


Figure 29. Station map for Rummel Creek survey July 11, 2016

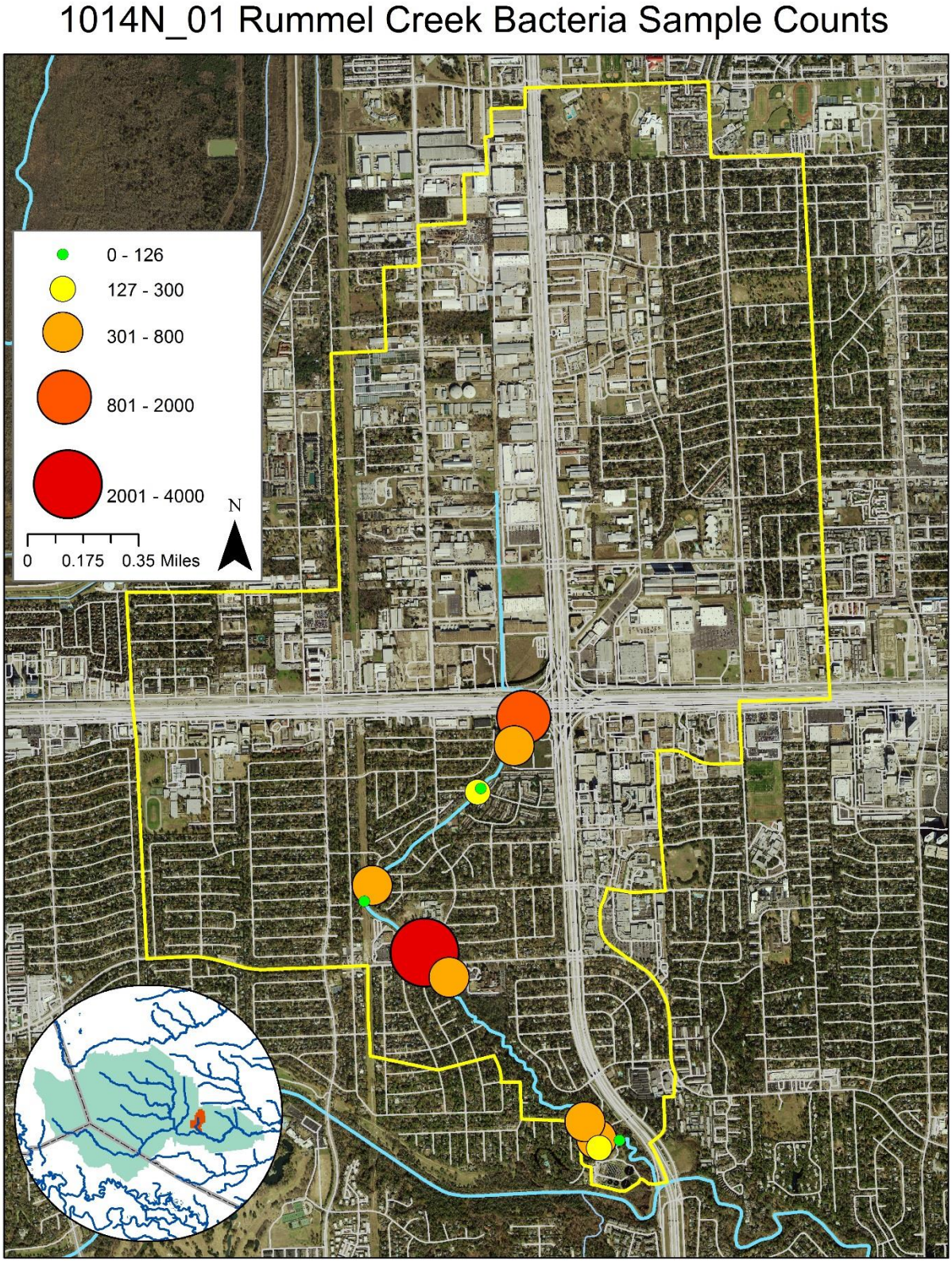


Figure 30. Bacteria screening results for Rummel Creek survey

Table 4. Summary of bacteria results and significant findings for Rummel Creek

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	N/A	N/A	N/A	031	Surface Water	125	N/A	7/11/2016	No	29.76429	-95.56070
2	002	Tributary	Absent	032	Surface Water	225	N/A	7/11/2016	No	29.76397	-95.56178
3	003	Tributary	Absent	033	Surface Water	775	High Bacteria	7/11/2016	Yes	29.76438	-95.56191
4	N/A	N/A	N/A	034	Surface Water	525	High Bacteria	7/11/2016	Yes	29.76519	-95.56248
5	N/A	N/A	N/A	035	Surface Water	425	N/A	7/11/2016	No	29.77200	-95.56940
6	006	Outfall	Present	036	Outfall	2275	High Bacteria	7/11/2016	Yes	29.77316	-95.57065
7	010	Outfall	Present	037	Outfall	100	N/A	7/11/2016	No	29.77559	-95.57374
8	N/A	N/A	N/A	038	Surface Water	400	N/A	7/11/2016	No	29.77630	-95.57330
9	N/A	N/A	N/A	039	Surface Water	700	High Bacteria	7/11/2016	Yes	29.77630	-95.57330
10	N/A	N/A	N/A	040	Surface Water	925	High Bacteria	7/11/2016	Yes	29.78381	-95.56509
11	N/A	N/A	N/A	041	Surface Water	350	N/A	7/11/2016	No	29.78252	-95.56563
12	021	Outfall	Present	042	Outfall	125	N/A	7/11/2016	No	29.78060	-95.56744
13	023	Outfall	Present	043	Outfall	225	N/A	7/11/2016	No	29.78044	-95.56762

4.2.3 Significant Findings

Table 4 lists all significant findings that require further investigation and follow-up sampling. The average *E.coli* count for the Rummel Creek bacteria screening was approximately 552 cfu/100mL. Samples collected with *E.coli* counts greater than 500 cfu/100mL were flagged as problem areas where further investigation is recommended.

Noteworthy findings include sample 033 collected at a bend in the stream segment where trash accumulation was observed and apparent groundwater discharge was present. A slight sheen was visible on the water surface at the same location disturbed by the groundwater movement in the otherwise stagnant water (Figure 31). Two dilapidated pipes were observed at sample location 034 where high bacteria levels were detected. One pipe was bored under the waterway (Figure 32) while the other crossed above the water at street level. A concrete slab was found on the floor of Rummel Creek just downstream of the Rummel Creek Road bridge (Figure 33). The concrete was impeding water flow and creating high algae accumulation on the upstream side of the slab. Samples were taken upstream and downstream of the concrete slab, and bacteria levels were higher upstream where water flow was slower (sample 039). Algae was common throughout the waterway but appeared particularly dense north of Memorial Drive near Rummel Creek Elementary School (Figures 34-35). The sample collected at this location (sample 036) had the highest bacteria concentration collected during the Rummel Creek survey.

Figure 31. Groundwater discharge and surface sheen at sample 033

Figure 32. Pipe and outfall near sample 034

Figure 33. Concrete slab downstream of Rummel Creek Road

Figure 34. Dense algal blooms near Rummel Creek Elementary School (sample 036)

Figure 35. Dense algal blooms near Rummel Creek Elementary School (sample 036)

5.0 AU Intensive Study: Top 2 Least Impaired

5.1 Canal C-147

Canal C-147, Segment 1007A_01, is one of the least impaired water bodies within the BIG geographic area. It is close to meeting state water quality standards for bacteria, with an *E.coli* geometric mean concentration of 157 MPN/100mL compared to the 126 MPN/100mL standard. The segment length is approximately 2.08 miles with a catchment area of 2.63 square miles. There is one active CRP monitoring station at the downstream end of Canal C-147 at Tiffany Drive (station ID 16656). Primary LU/LC identified during Desk Review 2 is residential. Designated uses for this segment include Aquatic Life Use, General Use, and Recreation Use. Potential bacteria sources identified during Desk Review 2 include the WWTF located south of Beltway 8, and Pine Island Sand and Gravel northwest of the WWTF (Figure 36).

Statistical analysis of Canal C-147 data revealed a gradual decrease in bacteria geometric mean concentrations since 2005 (Figure 37). However, *E.coli* concentrations remain higher than the 126 MPN/100mL standard for nearly half of the samples collected during the assessment period (Figure 38). No LDC graphs were generated for Canal C-147 because flow data from USGS was unavailable for this segment. Bacteria versus days since last rain graphs for Canal C-147 show few instances where data points exceed the state water quality standard for bacteria after 10 or more days of no rain, with the majority of high bacteria concentrations following significant rain events (Figure 39).

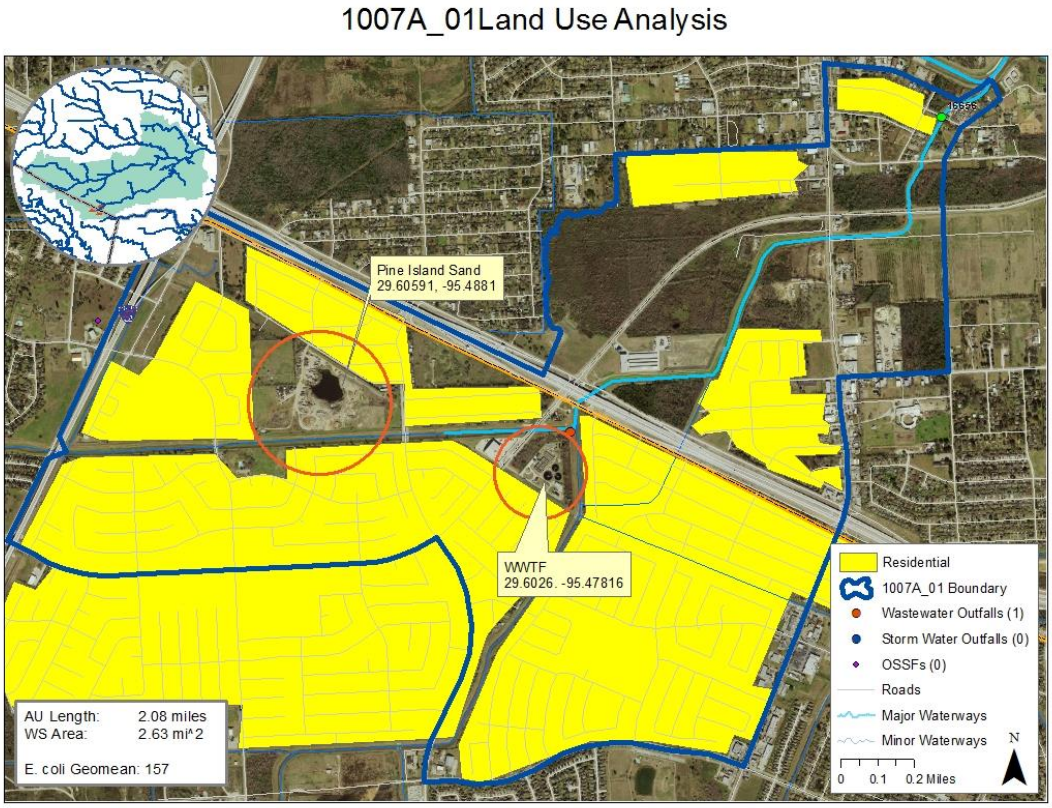


Figure 36. Desk Review 2 map for Canal C-147, Segment 1007A_01

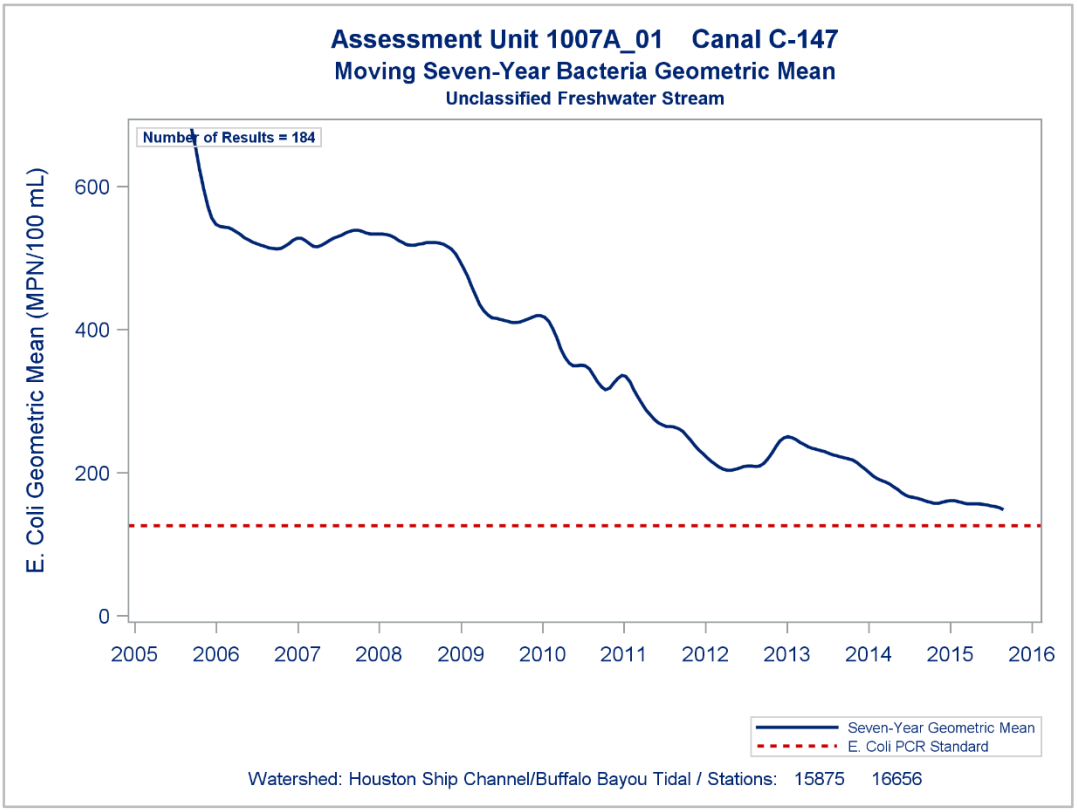


Figure 37. Moving seven-year E.coli geometric mean plot for Canal C-147

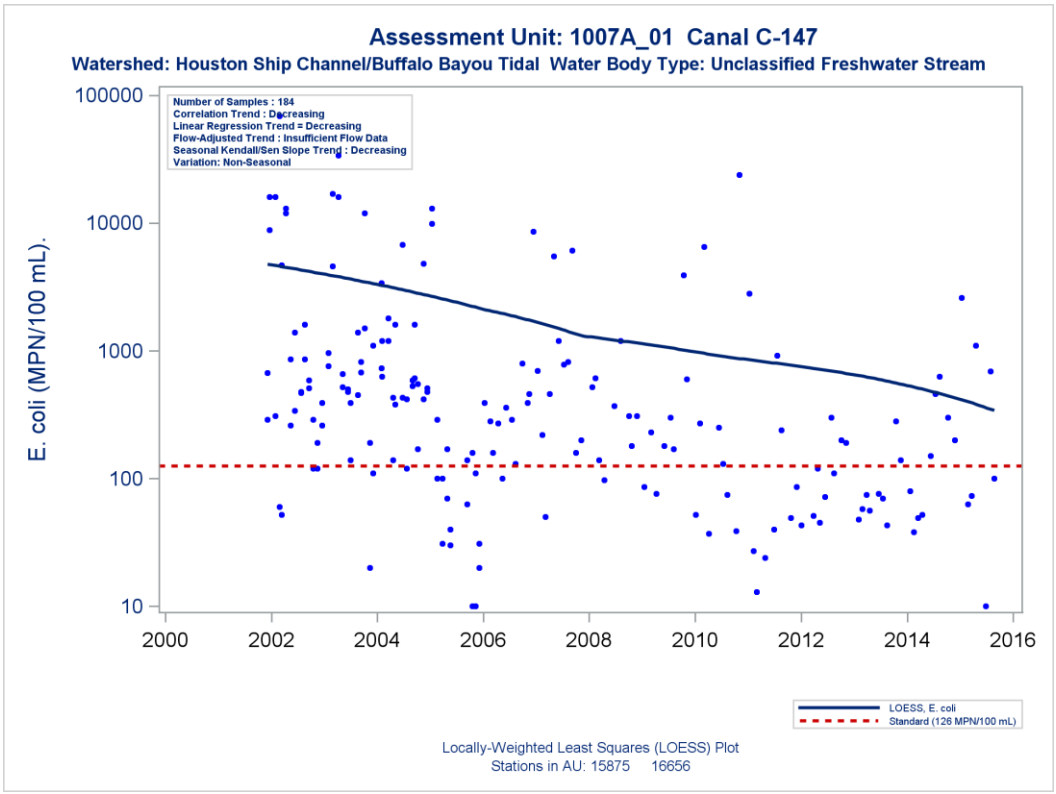


Figure 38. E.coli trend analysis for Canal C-147

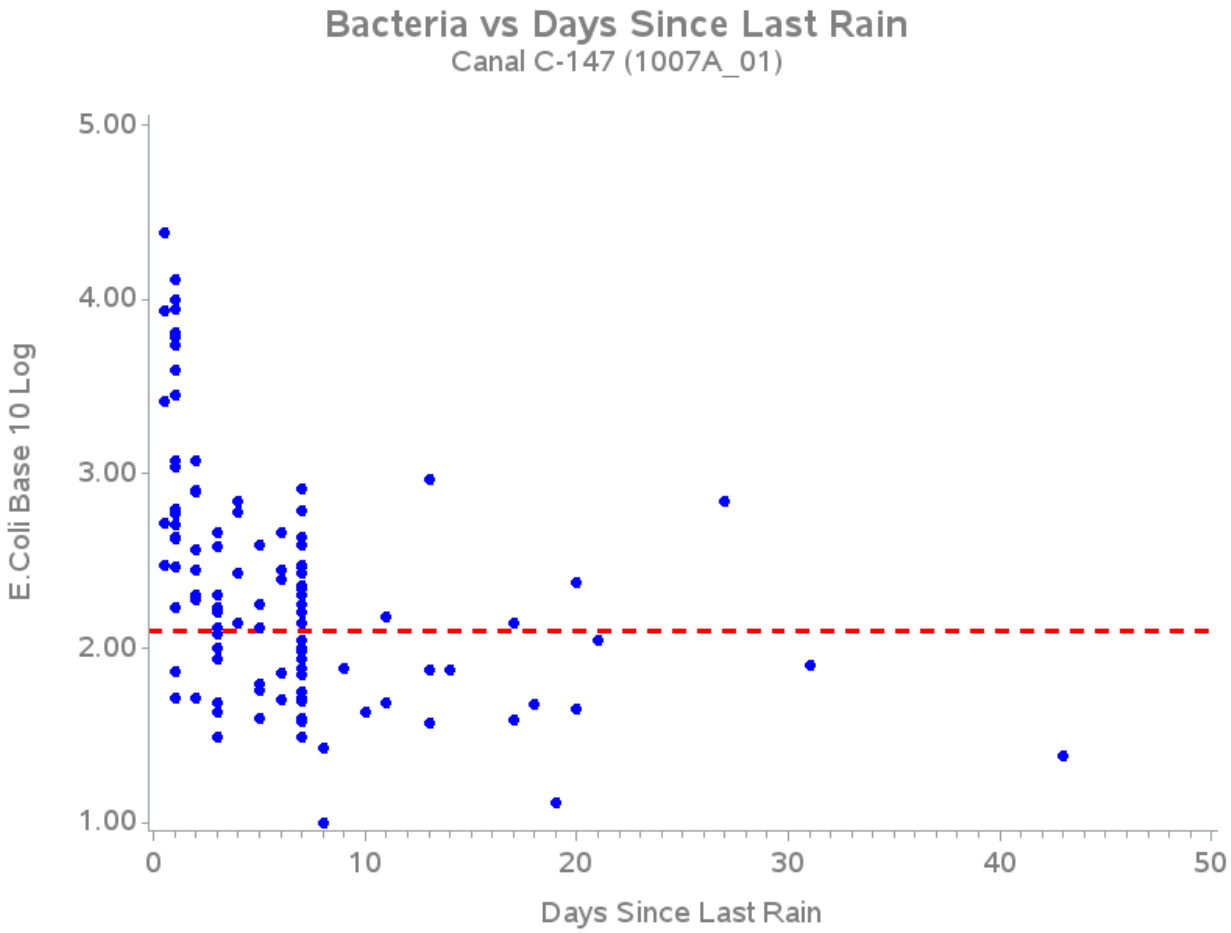


Figure 39. Bacteria versus days since last rain graph for Canal C-147. Red dotted line represents the water quality standard for E.coli.

5.1.1 Windshield Survey

The windshield survey for Canal C-147 was conducted on June 22, 2016. The waterway was investigated by vehicle, and points of access and potential pollution sources were noted. Primary land use is residential throughout the catchment area, with light commercial land uses present along the primary thoroughfares of West Fuqua Street and the Beltway 8 corridor. Illegal dumping of trash was common in the neighborhood at the downstream end of the canal adjacent to the CRP monitoring station. A significant amount of household trash, including mattresses, fencing, and furniture, was found in alleyways and ditches near the stream (Figures 40-42). Refer to Figure E1 in Appendix E for a map of the windshield survey route.

Figure 40. Illegal dumping

Figure 41. Illegal dumping

Figure 42. Illegal dumping

5.1.2 Bacteria Screening

A total of 21 bacteria screening samples were collected along Canal C-147 during the on the ground survey June 30, 2016. Samples were collected at eight discharging outfalls and three tributaries while the rest of the samples were surface water samples collected in an effort to track bacteria sources back to their origin.

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations (Figure 43). Two dilutions were measured for each sample and the average concentration is reported in Table 5. Refer to Figure 44 for a station map illustrating the location and sample type for each sample collected during the Canal C-147 survey, and to Figure 45 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table E1 in Appendix E.

Figure 43. Plating Canal C-147 samples using Coliscan Easygel methodology

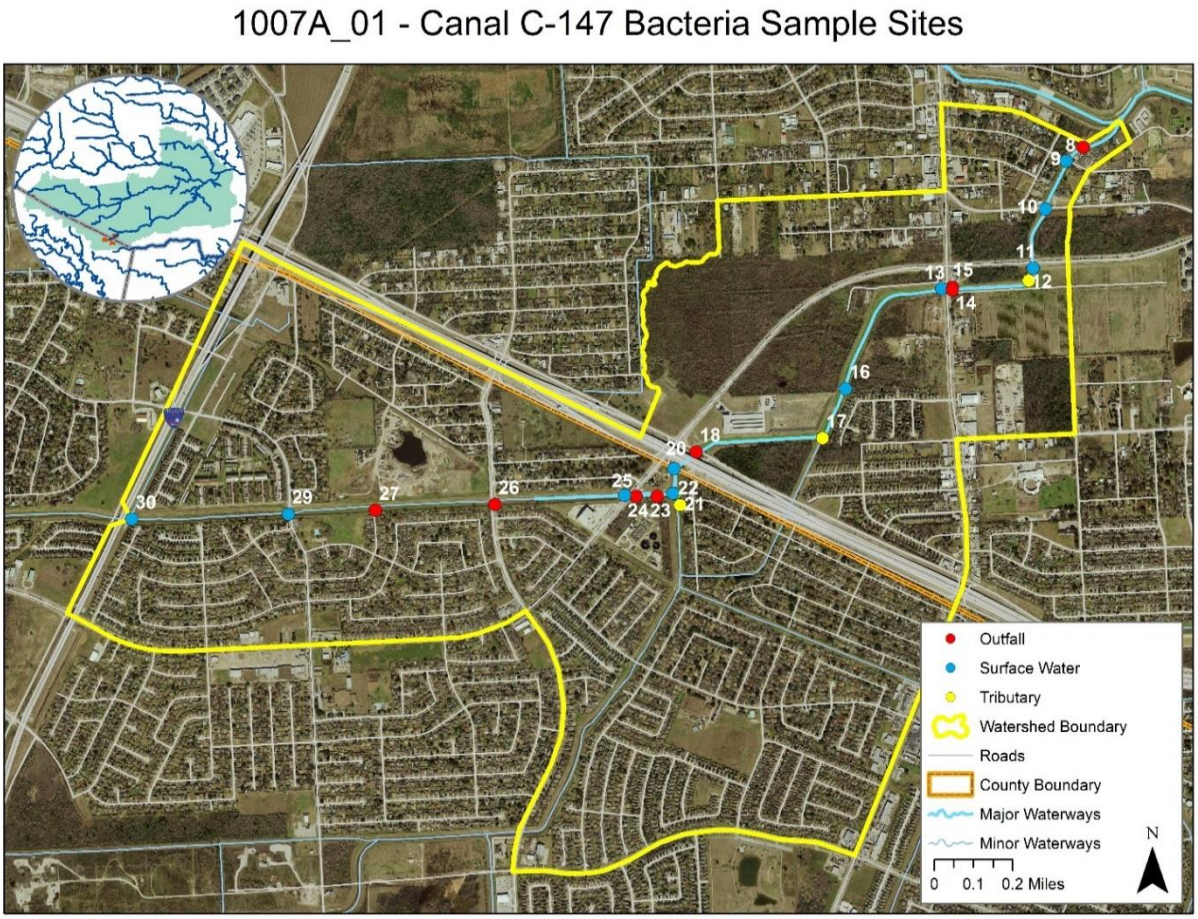


Figure 44. Station map for Canal C-147 survey June 30, 2016

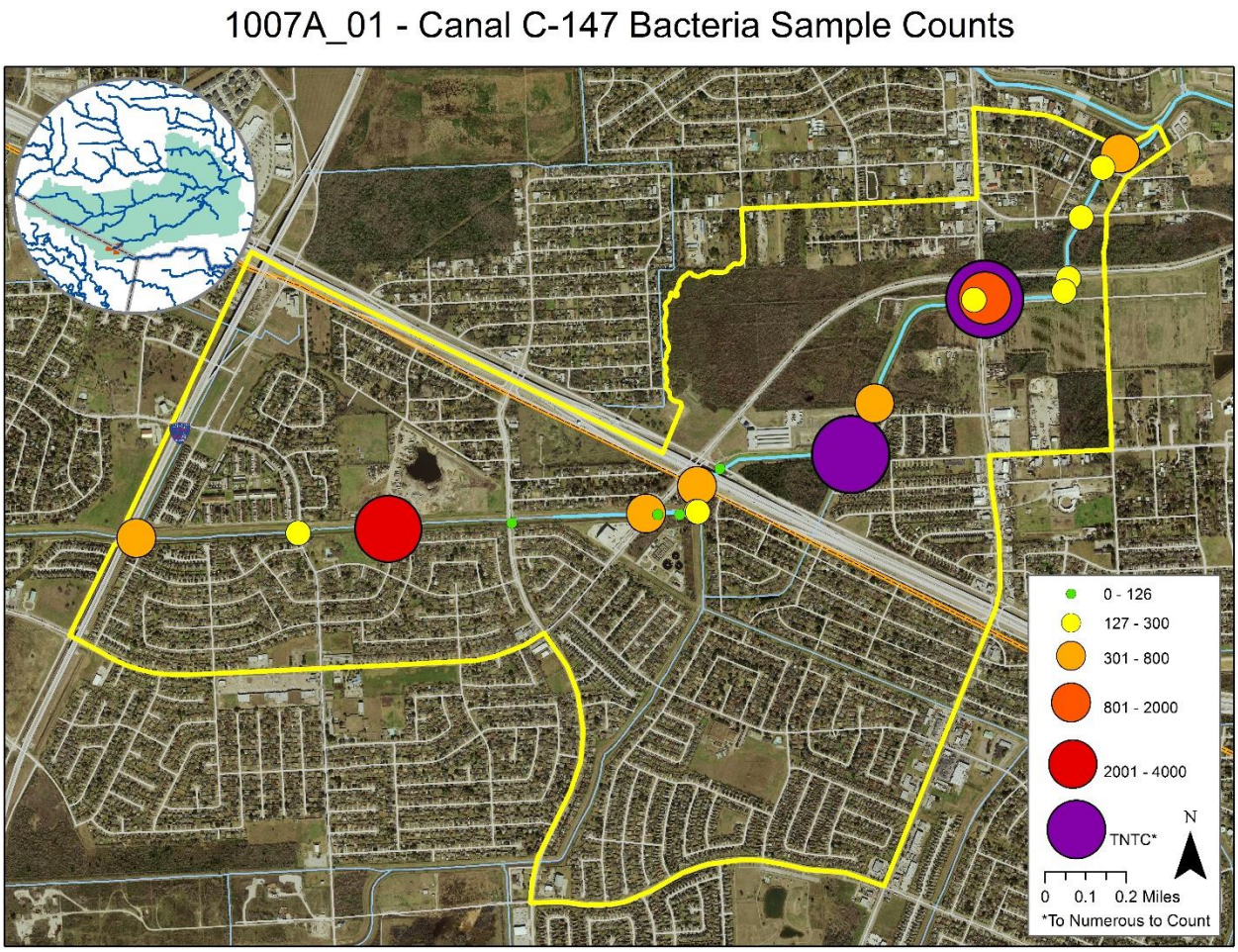


Figure 45. Bacteria screening results for Canal C-147 survey

5.1.3 Significant Finding

Table 5 lists all significant findings that require further investigation and follow up sampling. The average *E.coli* count for Canal C-147 bacteria screening was approximately 443 cfu/100mL which is likely a slight underestimation because about 10 percent of the samples were TNTC and were not incorporated into the overall average for the waterway. Samples collected with *E.coli* counts greater than 500 cfu/100mL were flagged as problem areas where further investigation is recommended. One outfall sample collected had no bacteria colony forming units detected during analysis. Further investigation is recommended for the non-detect sample to identify potential chlorine leaks or illicit discharges with high anti-bacterial agents.

Noteworthy findings include the high bacteria loading from an outfall (sample 008) directly downstream of the CRP monitoring station off Tiffany Drive (Figure 46). Discharges from this outfall would not be captured in routine CRP monitoring due to its location. Two large concrete storm drains directly downstream of the South Post Oak Road bridge (Figure 47-48) had high *E.coli* concentrations (samples 013 and 014). Another high bacteria source discharging into the canal was a small tributary north of Beltway 8, sample 021 (Figure 49).

Table 5. Summary of bacteria results and significant findings for Canal C-147

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	N/A	Outfall	Present	008	Outfall	800	High Bacteria	6/30/2016	Yes	29.61648	-95.45901
2	N/A	N/A	N/A	009	Surface Water	230	N/A	6/30/2016	No	29.61599	-95.45975
3	N/A	N/A	N/A	010	Surface Water	290	N/A	6/30/2016	No	29.61424	-95.46069
4	N/A	N/A	N/A	011	Surface Water	200	N/A	6/30/2016	No	29.61206	-95.46129
5	N/A	Tributary	Present	012	Surface Water	180	N/A	6/30/2016	No	29.61161	-95.46149
6	N/A	Outfall	Present	013	Outfall	TNTC	High Bacteria	6/30/2016	Yes	29.61142	-95.46475
7	N/A	Outfall	Present	014	Outfall	1770	High Bacteria	6/30/2016	Yes	29.61145	-95.46475
8	N/A	N/A	N/A	015	Surface Water	190	N/A	6/30/2016	No	29.61140	-95.46519
9	N/A	N/A	N/A	016	Surface Water	510	High Bacteria	6/30/2016	Yes	29.60781	-95.46939
10	N/A	Tributary	Present	017	Surface Water	TNTC	High Bacteria	6/30/2016	Yes	29.60601	-95.47043
11	N/A	Outfall	Present	018	Outfall	40	N/A	6/30/2016	No	29.60564	-95.47581
12	N/A	N/A	N/A	020	Surface Water	320	N/A	6/30/2016	No	29.60504	-95.47677
13	N/A	Tributary	Present	021	Surface Water	190	N/A	6/30/2016	No	29.60412	-95.47678
14	N/A	N/A	N/A	022	Surface Water	230	N/A	6/30/2016	No	29.60413	-95.47684
15	N/A	Outfall	Present	023	Outfall	50	N/A	6/30/2016	No	29.60404	-95.47752
16	N/A	Outfall	Present	024	Outfall	10	N/A	6/30/2016	No	29.60406	-95.47842
17	N/A	N/A	N/A	025	Surface Water	530	High Bacteria	6/30/2016	Yes	29.60412	-95.47890
18	N/A	Outfall	Present	026	Outfall	0	No Bacteria	6/30/2016	Yes	29.60392	-95.48441
19	N/A	Outfall	Present	027	Outfall	2130	High Bacteria	6/30/2016	Yes	29.60384	-95.48948
20	N/A	N/A	N/A	029	Surface Water	230	N/A	6/30/2016	No	29.60379	-95.49318
21	N/A	N/A	N/A	030	Surface Water	520	High Bacteria	6/30/2016	Yes	29.60378	-95.49982

Figure 46. Outfall with dry weather discharge downstream of CRP monitoring station (sample 008)

Figures 45 and 46. Storm drains downstream of the S. Post Oak Road bridge (samples 013 and 014)

Figure 47. Tributary north of Beltway 8 with high bacteria concentration (sample 021)

5.2 Upper Panther Branch

Upper Panther Branch, Segment 1008B_02, is one of the least impaired water bodies within the BIG geographic area. It is close to meeting state water quality standards for bacteria, with an *E.coli* geometric mean concentration of 133 MPN/100mL compared to the 126 MPN/100mL standard. The segment length is approximately 2.21 miles with a catchment area of 2.01 square miles. There are two active CRP monitoring stations: station 16632on Upper Panther Branch at Gosling Road; and station 16630 directly downstream of the WWTF. Primary LU/LC identified during Desk Review 2 is residential. Designated uses for this segment include Aquatic Life Use, Fish Consumption Use, General Use, and Recreation Use. Potential bacteria sources identified during Desk Review 2 include the WWTF off Research Forest Drive north of Gosling Road and a residential neighborhood east of Gosling with a concentration of OSSFs (Figure 48).

Statistical analysis of Upper Panther Branch data revealed a significant decrease in bacteria geometric mean concentrations in recent years (Figure 49). However, *E.coli* concentrations exceeding the 126 MPN/100mL standard are still frequent (Figure 50). No LDC graphs were generated for Upper Panther Branch because flow data from USGS was unavailable for this segment. Bacteria versus days since last rain graphs for this segment show few instances where data points exceed the state water quality standard for bacteria after 10 or more days of no rain, with the majority of high bacteria concentrations occurring immediately after significant rain events (Figure 51).

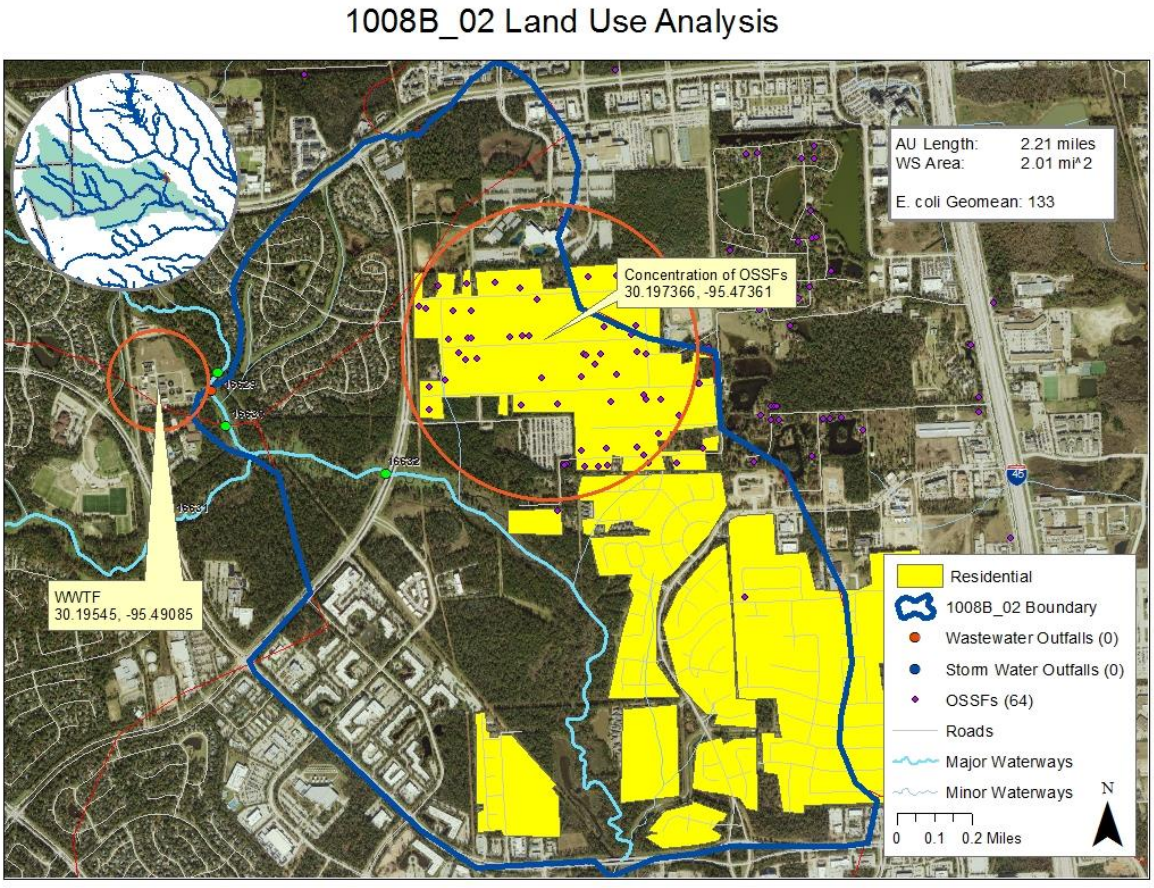


Figure 48. Desk Review 2 map for Upper Panther Branch, Segment 1008B_02

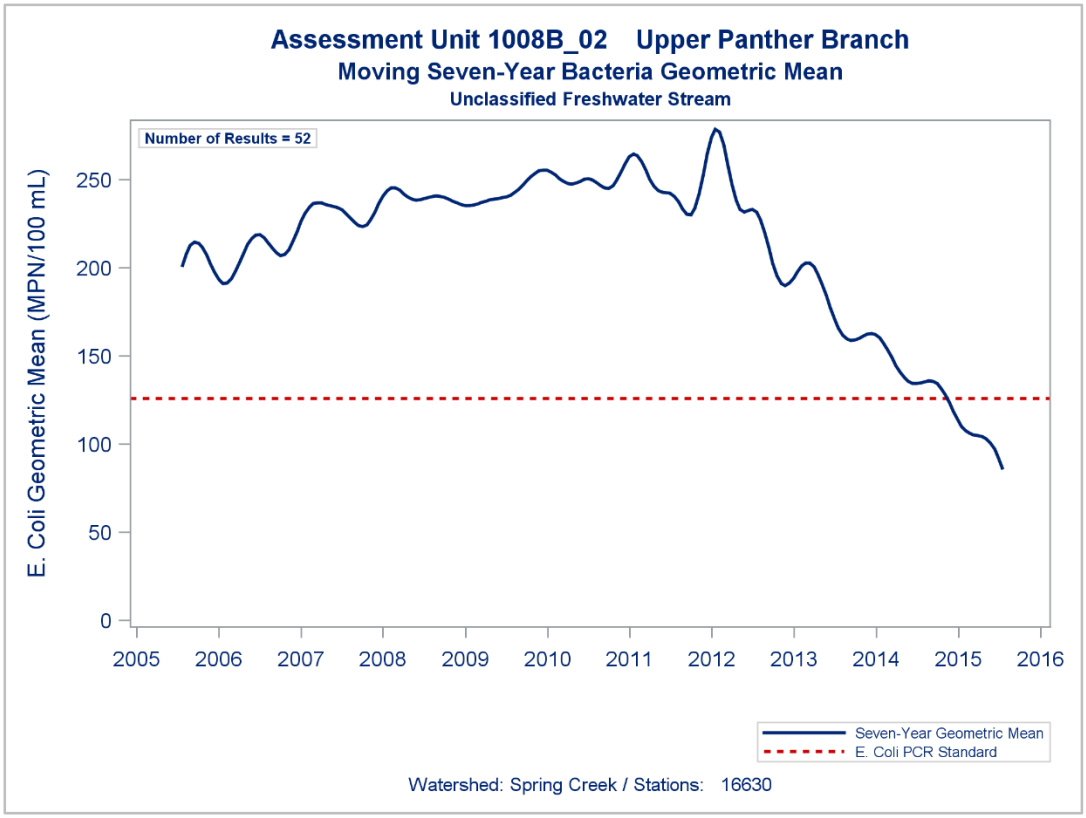


Figure 49. Moving seven-year E.coli geometric mean plot for Upper Panther Branch

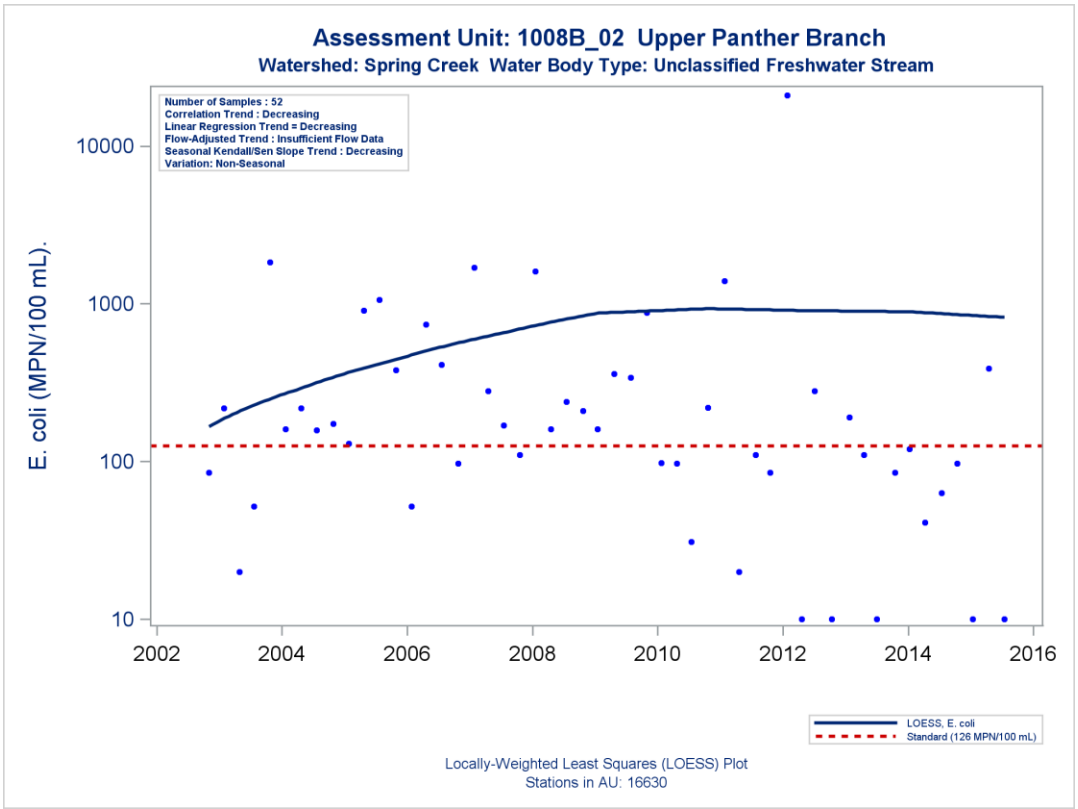


Figure 50. E.coli trend analysis for Upper Panther Branch

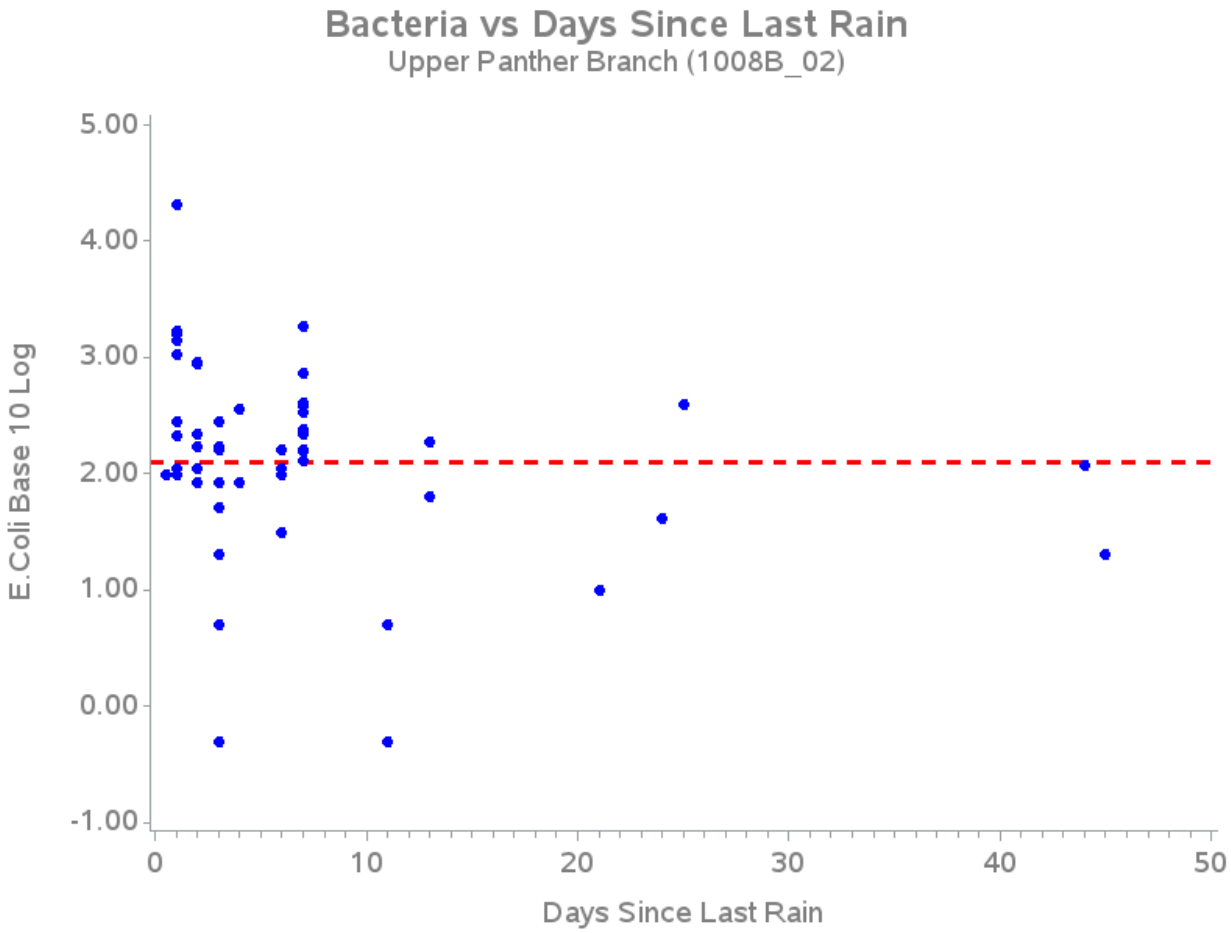


Figure 51. Bacteria versus days since last rain graph for Canal C-147. Red dotted line represents the water quality standard for E.coli

5.2.1 Windshield Survey

The windshield survey for Upper Panther Branch was on June 21, 2016. The waterway was investigated by vehicle, and points of access and potential pollution sources were noted. Primary land use is residential throughout the catchment area, with light commercial land uses present mainly along Research Forest Drive. Access points were difficult to locate by vehicle and would require a short trek through neighborhoods or hiking trails to reach the waterway (Figure 52). There were no potential bacteria sources observed during the windshield survey. Refer to Figure F1 in Appendix F for a map of the windshield survey route.

Figure 52. Hiking trail leading to Upper Panther Branch

5.2.2 Bacteria Screening

A total of 15 bacteria screening samples were collected along Upper Panther Branch during the on-the-ground survey on July 26 and 27, 2016. Samples were collected at nine discharging stormwater drainage tributaries and one discharging outfall, while the rest of the samples were surface water samples collected in an effort to track bacteria sources back to their origin.

Samples were analyzed using the Coliscan Easygel method to test for *E.coli* concentrations. Two dilutions were measured for each sample, and the average concentration is reported in Table 6. Refer to Figure 53 for a station map illustrating the location and sample type for each sample collected during the Upper Panther Branch survey, and to Figure 54 for a map illustrating the bacteria results for each sample collected. Additional information about sample locations and descriptions can be found in Table F1 in Appendix F.

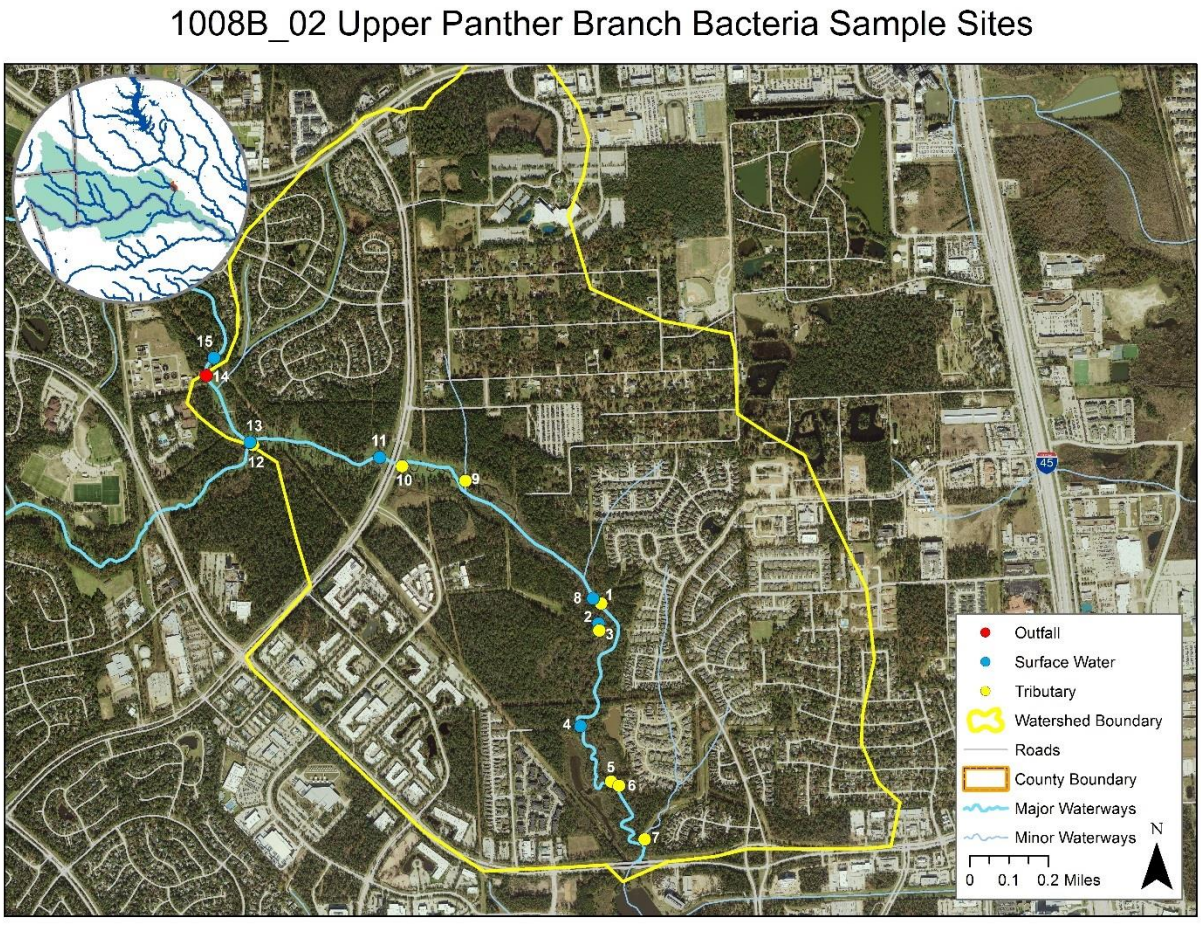


Figure 53. Station map for Upper Panther Branch survey July 26 and 27, 2016

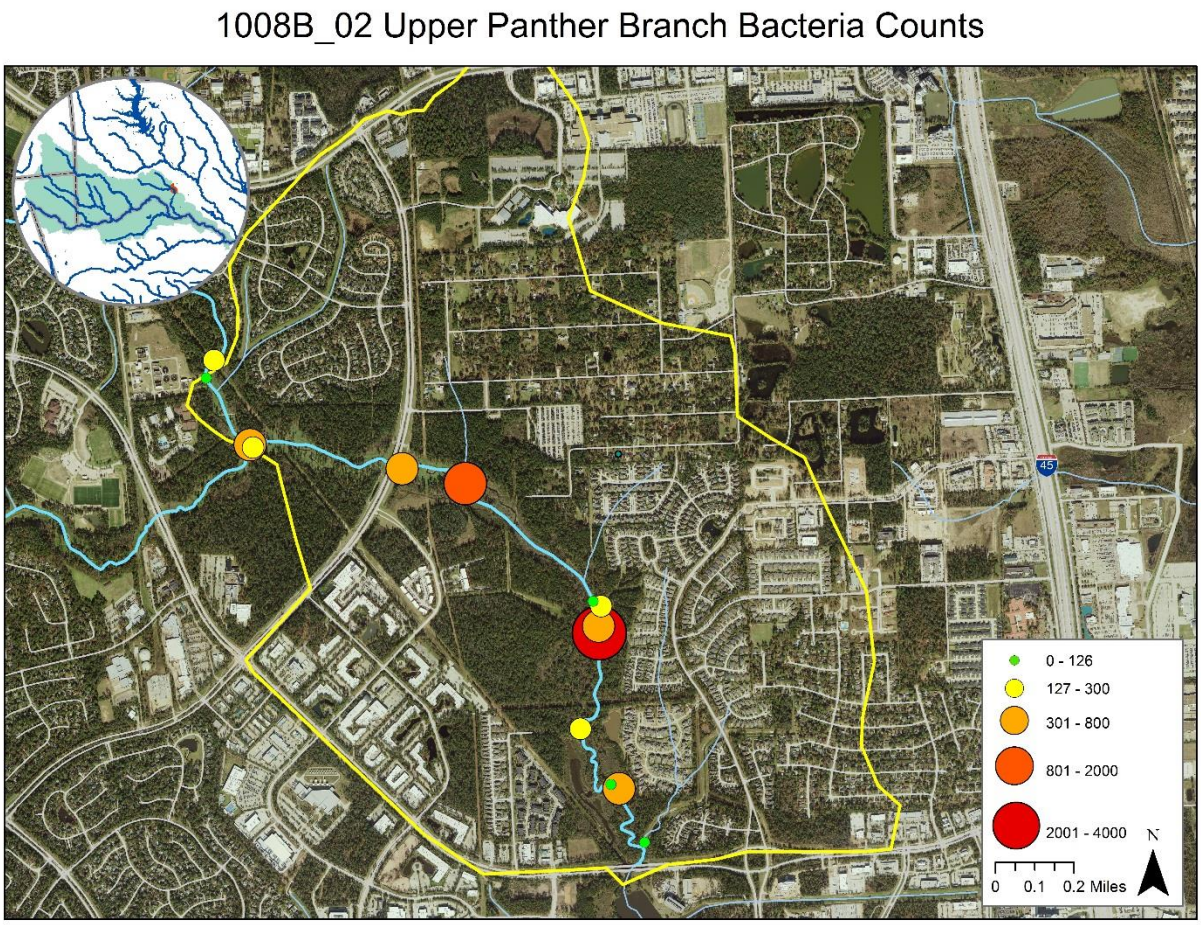


Figure 54. Bacteria screening results for Upper Panther Branch surveys

5.1.3 Significant Findings

The most significant observation recorded during the Upper Panther Branch surveys was the strong odor and presence of chlorine throughout the waterway. Chlorine test strips were used at the majority of sample locations to detect estimated chlorine levels. All chlorine test strips tested positive for chlorine with *at least* 1.0 mg/L present for every sample tested (Figure 55). Many of the stormwater drainage tributaries had lower levels of chlorine and higher bacteria concentrations compared to the main stem of Upper Panther Branch. Further investigation is recommended in order to identify where the chlorine was originating.

Figure 55. Chlorine test strip result for Upper Panther Branch sample 004

Table 6 lists all significant findings that require further investigation and follow-up sampling. The average *E.coli* count for Upper Panther Branch bacteria screening was approximately 496 cfu/100mL. Samples collected with *E.coli* counts greater than 500 cfu/100mL were flagged as problem areas where further investigation is recommended.

Noteworthy findings include the high bacteria loading from a stormwater drainage tributary (Tier II ID 065) originating from the subdivision off Grogans Mill Road (Figure 56). Homeowners were seen walking their dogs along the drainage tributaries in this area, making pet waste a potential contributor of bacteria at this location. Another stormwater drainage tributary (Tier II ID 072, sample 009) coming from the sporting facility on Marisco Place had high *E.coli* concentrations, l with the water sample having a strong petrochemical smell likely from surface runoff from the adjacent parking lot (Figure 57). Several of the tributaries feeding into Upper Panther Branch had a very distinct reddish tint (Figures 58-60). It was unclear if this was a result of impacts from different soil types or if there were other factors. However, there did not seem to be a correlation between bacteria concentration and red water at these sample locations.

Figure 56. Stormwater drainage tributary with high bacteria concentration (Tier II ID 065, sample 003)

Figure 57. Stormwater drainage tributary with high bacteria concentration (Tier II ID 072, sample 009)

Figures 58-60. Red tinted waters in the tributaries of Upper Panther Branch

Table 6. Summary of bacteria results and significant findings for Upper Panther Branch

No.	Tier II ID	Tier II Type	Outfall Flow	Sample ID	Sample Type	*E. coli (cfu/100ml)*	Issue	Date Identified	Further Investigation	Latitude	Longitude
1	062	Tributary	Present	001	Surface Water	170	N/A	7/26/2016	No	30.18642	-95.47234
2	063	Tributary	Present	002	Surface Water	310	N/A	7/26/2016	No	30.18568	-95.47247
3	065	Tributary	Present	003	Surface Water	3420	High Bacteria	7/26/2016	Yes	30.18542	-95.47245
4	067	N/A	N/A	004	Surface Water	140	N/A	7/26/2016	No	30.18191	-95.47338
5	068	Tributary	Present	005	Surface Water	100	N/A	7/26/2016	No	30.17983	-95.47214
6	069	Tributary	Present	006	Surface Water	580	High Bacteria	7/26/2016	Yes	30.17966	-95.47181
7	070	Tributary	Present	007	Surface Water	60	N/A	7/26/2016	No	30.17765	-95.47079
8	071	N/A	N/A	008	Surface Water	50	N/A	7/26/2016	No	30.18661	-95.47267
9	072	Tributary	Present	009	Surface Water	1040	High Bacteria	7/27/2016	Yes	30.19110	-95.47796
10	073	Tributary	Present	010	Surface Water	390	N/A	7/27/2016	No	30.19172	-95.48064
11	N/A	N/A	N/A	011	Surface Water	230	N/A	7/27/2016	No	30.19200	-95.48200
12	074	Tributary	Present	012	Surface Water	270	N/A	7/27/2016	No	30.19266	-95.48696
13	N/A	N/A	N/A	013	Surface Water	400	N/A	7/27/2016	No	30.19277	-95.48708
14	075	Outfall	Present	014	Outfall	20	N/A	7/27/2016	No	30.19528	-95.48886
15	N/A	N/A	N/A	015	Surface Water	260	N/A	7/27/2016	No	30.19593	-95.48851

6.0 Conclusion

The *BIG's Top Five Most and Top Five Least Impaired Water Bodies* project was developed in an effort to demonstrate the value of a prioritized watershed approach for correcting bacteria sources in impaired water bodies within the BIG geographic area. The project began with a Top 10/Least 10 list of bacteria impaired water bodies developed by the BIG that was then prioritized and pared down to the Top 2/Least 2 lists through desk reviews and input from a technical workgroup. The resulting list of four AUs were then subject to further assessment and field investigation in order to identify potential bacteria sources. This Preliminary Action Report summarizes tasks completed during the first phase of the project, including Desk Review 1, Desk Review 2, windshield surveys, and field investigations for bacteria screening.

6.1. Next Steps

Phase II of the project will include professional water quality monitoring at the locations found to have high bacteria concentrations during the screening in Phase I. This report will help prioritize problem areas so Phase II investigations can be more focused to areas that present significant concerns. H-GAC staff will meet with the technical workgroup and local jurisdictions to discuss Phase I findings and plan where to focus efforts for the next phase of the project. Phase II sample results will then be reported to the appropriate jurisdictions for further investigation and implementation of corrective actions to reduce bacteria loadings into the surveyed AUs. Phase III of the project will include follow-up monitoring at locations where corrective actions were implemented to investigate the effectiveness of bacteria reduction practices.