Appendix B: Preliminary Action Report
BACTERIA IMPLEMENTATION GROUP’S TOP FIVE MOST AND TOP FIVE LEAST IMPAIRED WATER BODIES

PRELIMINARY ACTION REPORT
August 4, 2016

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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.
Figure 7. Bacteria Implementation Group's (BIG’s) 2015 Top 10/Least 10 AU maps
**Phase I**

1. **AU Spreadsheet**
   - Top 10/Least 10 Lists
   - AU Spreadsheet Refinement
   - Top 5/Least 5 Lists

2. **GIS Aerial Image Review**
   - Review Analysis
   - GIS LU/LC Source Identification

3. **Prioritize**
   - Top 2/Least 2

4. **Testing?**
   - Conduct Analysis

5. **GIS Study**
   - Lists
   - GIS LU/LC Source Identification
   - Review Analysis

6. **Preliminary Action Report**
   - Assess
   - Further study.

7. **Monitoring Authority**
   - Local reported, elevated
   - Select top 2/Least 2 AU
   - GIS and stakeholder experience, to cut down Top 5/Least 5 lists to 2 AUs from each list for further study.

**Phase II**

1. **Conduct NELAP**
   - Yes
   - Sample Collection
   - Data Analysis and Source Identification

2. **Sample Collection Decision**
   - Do screening samples suggest a problem? If yes, then recommend AU for NELAP bacteria testing. If no, then conduct a second observation round with the next AU on the Top 5/Least 5 lists.

3. **Sample Collection**
   - Collect bacteria samples and field measures (D.O., Temperature, Secchi, pH, site parameters) at outfalls and sub tributary intersections at each Top 2/Least 2 AU. Phase II sample sites are selected based on Phase I reconnaissance. Samples will be analyzed at the NELAP lab. Location of sample will be reviewed, permits and the LU/LC studied to identify potential sources.

**Phase III**

1. **Elevated Bacteria Found?**
   - Yes
   - Authority Reports
   - Follow Up Monitoring
   - Final Data Analysis

2. **Final Report**
   - No

**Appendix B**

**Preliminary Action Report**

**Desk Review 1**
- **AU Spreadsheet**: Develop spreadsheet on each AU containing (description, monitoring station IDs), bacteria concentration/AU, WWTP outfalls, stormwater outfalls.
- **GIS**: Gather Aerial Images for AU review and analysis to determine accessibility.
- **Decision**: Using spreadsheet, aerial imagery and stakeholder experience, cut lists down from 10 to 5 for study.

**Desk Review 2**
- **AU Spreadsheet Refinement**: Size of AU catchment, bacteria trends, calculate LDC (if possible)
- **GIS**: Consider LU/LC and Aerial Images for AU review and analysis. Add GIS data layers.
- **Decision**: Using spreadsheet, GIS and stakeholder experience, to cut down Top 5/Least 5 lists to 2 AUs from each list for further study.

**AU Intensive Study**: Conduct vehicle and on the ground surveys of the selected AUs. Reconnaissance should GPS outfalls with flow, observe any releases during dry weather, assess bank and access points, note specific LU/LC, identify potential sources of bacteria, and note potential pollution sources. Map routes using GPS. Collect bacteria screening samples for analysis at H-GAC to direct future monitoring events.

**Sample Collection Decision**: Do screening samples suggest a problem? If yes, then recommend AU for NELAP bacteria testing. If no, then conduct a second observation round with the next AU on the Top 5/Least 5 lists.

**Sample Collection**: Collect bacteria samples and field measures (D.O., Temperature, Secchi, pH, site parameters) at outfalls and sub tributary intersections at each Top 2/Least 2 AU. Phase II sample sites are selected based on Phase I reconnaissance. Samples will be analyzed at the NELAP lab. Location of sample will be reviewed, permits and the LU/LC studied to identify potential sources.

**Source Identification Report - 12/31/2016**

**Elevated Bacteria**: Locations found with elevated bacteria concentrations will be reported, along with potential sources, to the local jurisdictional authority for investigation.

**Local jurisdiction reports any findings and any corrective actions taken.**

**Monitoring**: Follow up monitoring conducted at locations identified with elevated conditions post authority investigations to assess any change to condition.

**Analysis**: Complete final data analysis.

**Project Report - 04/30/2017**

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

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
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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

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<th>Top Two Most Impaired AUs</th>
<th>Top Two Least Impaired AUs</th>
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<td>Upper Panther Branch (Segment 1008B_02)</td>
</tr>
<tr>
<td>Rummel Creek (1014N_01)</td>
<td>Canal C-147 (Segment 1007A_01)</td>
</tr>
</tbody>
</table>

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
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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
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.
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

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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.

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.

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.
4.2 Rummel Creek

Rummel Creek, Segment 1014N_01, is one of the most impaired water bodies within the BIG geographic area, with an \textit{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, \textit{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 \textit{E.coli} concentrations during dry weather conditions, an \textit{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.
1014N_01 Land Use Analysis

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 Beliway 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 30. Bacteria screening results for Rummel Creek survey
Table 4. Summary of bacteria results and significant findings for Rummel Creek

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<th>Sample Type</th>
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<th>Issue</th>
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<th>Further Investigation</th>
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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 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](image-url)
**Figure 37.** Moving seven-year E.coli geometric mean plot for Canal C-147

**Figure 38.** E.coli trend analysis for Canal C-147
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 39.** Bacteria versus days since last rain graph for Canal C-147. Red dotted line represents the water quality standard for E.coli.
5.1.2 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](image)

![Figure 44. Station map for Canal C-147 survey June 30, 2016](image)
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

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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 16632 on 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](image-url)
Appendix B
Preliminary Action Report

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

Figure 50. E.coli trend analysis for Upper Panther Branch
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.
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](image-url)
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.
Table 6 lists all significant findings that require further investigation and follow-up sampling. The average \textit{E.coli} count for Upper Panther Branch bacteria screening was approximately 496 cfu/100mL. Samples collected with \textit{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 \textit{E.coli} concentrations, 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.
Table 6. Summary of bacteria results and significant findings for Upper Panther Branch

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<th>Outfall Flow</th>
<th>Sample ID</th>
<th>Sample Type</th>
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<th>Issue</th>
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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.
Appendix A: Desk Review 1 Materials
TOP FIVE MOST AND
TOP FIVE LEAST
IMPAIRED WATER BODIES

Project Overview

- **Phase I**
  - Desk Review 1
  - Desk Review 2
  - AU Intensive Study

- **Phase II**
  - Sample Collection
  - Decision
  - Sample Collection

- **Phase III**
  - Elevated Bacteria
  - Agency Action Report
  - Follow-up Monitoring
  - Analysis
Phase I: Desk Review 1

- Review and analyze top 10 most wanted list
  - AU Spreadsheet
  - GIS Aerial Image Review

- Top 10 lists pared down to create preferential Top 5/Least 5 lists
  - BIG I-Plan Geographic Priority Framework:
    - Bacteria Level
    - Accessibility
    - Use Level
    - Implementation Opportunities
    - Future Land Use Changes

---

Top 10 Most Wanted

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<th>Use Level</th>
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<td>Bintliff Ditch (1007T_01)</td>
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<td>Little White Oak Bayou (1013A_01)</td>
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<td>Rummel Creek (1014N_01)</td>
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Top 10 Most Wanted

Bacteria Geomeans for Top 10 List

1. Buffalo Bayou Tidal

Segment 1013C  Unnamed Non-Tidal Tributary of Buffalo Bayo Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

Year

MPN/100 mL


Number of Results = 154.

Seven-Year Geometric Mean
Standard

Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater E. Coli 120 MPN/100 mL; Saltwater-E. coli 30 MPN/100 mL.
2. Greens Bayou

Segment 1018D Unnamed Tributary of Greens Bayou
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

Number of Results = 396

Year


MPN/100 mL

Seven-Year Geometric Mean

Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater E. Coli 120 MPN/100 mL, Saltwater Enterococci 35 MPN/100 mL

3. White Oak

Segment 1017 White Oak Bayou Above Tidal
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Classified Freshwater Stream

Number of Results = 498

Year


MPN/100 mL

Seven-Year Geometric Mean

Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater E. Coli 120 MPN/100 mL, Saltwater Enterococci 35 MPN/100 mL
4. Plum Creek Above Tidal

Segment 1007I  Plum Creek Above Tidal
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

5. Berry Bayou Above Tidal

Segment 1007F  Berry Bayou Above Tidal
Moving Seven-Year Bacteria Geometric Mean -All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
6. Robinson Bayou

Segment 1101D  Robinson Bayou
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Tidal Stream

Number of Results = 67

Year

MPN/100 mL

Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL, Saltwater Enterococcus 35 MPN/100 mL

7. Mimosa Ditch

Segment 1007U  Mimosa Ditch
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

Number of Results = 52

Year

MPN/100 mL

Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL, Saltwater Enterococcus 35 MPN/100 mL
8. Bintliff Ditch

9. Little White Oak Bayou
10. Rummel Creek

Top 10 Most Likely to Succeed

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Top 10 Most Likely to Succeed

Bacteria Geomeans for Least 10 List

1. Upper Panther Branch

Segment 1008B  Upper Panther Branch
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

Reference Line represents the Primary Contact Recreation (PCR) Standard
PCR Standard: Freshwater-E. Coli 126 MPN/100 mL, Saltwater-Enterococci 35 MPN/100 mL
2. Caney Creek

Segment 1010  Caney Creek
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Classified Freshwater Stream

3. Lower Panther Branch

Segment 1008C  Lower Panther Branch
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
4. Canal C-147

Segment 1007A Canal C-147
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

5. Willow Creek

Segment 1008H Willow Creek
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
6. Cowart Creek

Segment 1102A Cowart Creek
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream

7. Walnut Creek

Segment 1008I Walnut Creek
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Unclassified Freshwater Stream
8. Cypress Creek

Segment 1009   Cypress Creek
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Classified Freshwater Stream

9. Clear Creek Above Tidal

Segment 1102   Clear Creek Above Tidal
Moving Seven-Year Bacteria Geometric Mean - All Data in Segment
Waterbody Type: Classified Freshwater Stream
Next Steps

- **Phase I completion by June 30th, 2016**
  - Review 1 ~ April, 2016
  - Review 2 ~ May, 2016
  - AU Intensive Study ~ June, 2016

- **Phase II completion by October 31st, 2016**
  - Sample Collection & NELAP Testing ~ July - Aug, 2016
  - Data Analysis & Source ID ~ Sep - Oct, 2016

- **Phase III completion by April 30th, 2017**
  - Reporting to Local Authorities ~ Nov 2016 – Jan, 2017
  - Follow up monitoring ~ Feb – March, 2017
  - Final data analysis ~ April, 2017
Top 5 / Least 5 Workgroup Meeting Notes

Wednesday, April 20, 2016
1:00 PM to 3:00 PM
H-GAC Conference Room D
3555 Timmons Lane, 2nd Floor

1. Introductions

Paniz began the meeting at approximately 1:05 PM. Paniz welcomed and thanked everyone for coming and initiated self-introductions.

Persons in Attendance:
- Paniz Miesen – H-GAC
- William Merrell – H-GAC
- Becki Begley – H-GAC
- Rachel Fields – H-GAC
- Steven Johnston – H-GAC
- Lisa Marshall – GBEP
- Robert Snoza – HCFCG
- Steve Hupp – Bayou Preservation
- Lisa Groves – City of Houston

Persons on Conference Line:
- Denis Hall – Harris County Pollution Control

2. Project Overview

Paniz briefly reviewed the project flow chart with the group. Project is split into three phases.
- Phase I includes two desktop reviews and initial groundtruthing of chosen assessment units (AUs).
- Phase II includes sample collection, NELAP testing, and analysis of data.
- Phase III includes working with local jurisdictions to implement bacteria reduction measures and conduct follow-up sampling.

This meeting was held to satisfy Review 1 tasks associated with Phase I of the project: Reduce the Top 10 Most Wanted and Top 10 Most Likely to Succeed AU list to Top 5 Most Wanted and Top 5 Most Likely To Succeed.
3. **Review of Top 10 Most Wanted AUs**

The workgroup reviewed subwatershed maps and moving bacteria geometric mean plots for each AU on the Top 10 Most Wanted list and discussed important considerations and information pertinent to each AU.

1-Buffalo Bayou Tidal:
- Portions of this AU go underground creating some accessibility issues.
- This AU has been subject to assessment and special studies by the City of Houston and the Bayou Preservation Association.
- Area still seems to have many problems that are worth analyzing.
- Potential sources of pollution include leaking OSSFs.

2-Greens Bayou:
- Steve Hupp mentioned an unknown outfall location west of Hwy 59. Outfall permit exists, but actual outfall itself is hard to find.
- Apartment complexes in the area have been known to have wastewater problems.
- Lots of poison ivy.
- Possible OSSF issues north of the Beltway.
- Area known to have suspect dry weather flows.
- Slight sewage odor noticeable near sample locations.

3-White Oak:
- Noticeable sewage odor present in area around TC Jester and 11th.
- Larger homeless population in area.
- Something is going on in and around the underground portions of the AU, especially near the hospital, around Hwy 290, and near station 16596.
- City of Houston has assessed the area but hasn’t found any significant bacteria point sources.
- Ammonia levels have been high but were linked to leaking A/C unit.
- Lots of new infrastructure around station 16595 may have improved bacteria conditions in recent years.
- Safety and accessibility issues were mentioned.

4-Plum Creek:
- High bacteria hits have been found in the ditch near the stadium south of the 610 Loop.
- Lift station upstream of sampling location may be faulty and a potential source of bacteria.
- Areas upstream and downstream of the YMCA have had high bacteria levels. SSOs have been common in this area.
- Shallow concrete channels are common.
- May run into accessibility issues on private properties.
5-Berry Bayou:
- Station 16661 has had higher bacteria hits compared to the other sampling stations in this AU – assessment should focus upstream of this station.
- There is a network of open ditches in this AU which may make accessibility a potential issue.
- Not much work has been done in this AU, making it a good candidate for further assessment.
- Old and rusty infrastructure/collection systems are common in area.
- Based on samples collected, upstream portion seems to have higher bacteria levels. No hits in southern portions.
- Concrete lining is common in most areas upstream, many of which are newly constructed or are currently under construction.
- Steve Hupp suggested reviewing the most recent data to see if rehab in the area has made any impact on the water quality.
- Good option for further assessment.

6-Robinson Bayou:
- Enterococcus is the indicator bacteria for this AU. Top 5 / Least 5 project will be focusing only on AUs where E.coli is the indicator bacteria.

7-Mimosa Ditch:
- City of Bellaire mentioned dog shelter upstream of the sample location as possible bacteria source. Further discussion revealed that the shelter is too small and far from the waterway to be a significant source.
- High dry weather flows at Rice are suspect.
- A lot of construction and infrastructure rehab in the area.
- City of Bellaire jurisdiction.
- Good option for further assessment.

8-Bintliff Ditch:
- City of Houston did a special study in this area a few years ago.
- Accessibility is an issue; chain link fences/gates and high vegetation on private property block access in many areas. Robert Snoza of HCFCD followed up with information regarding property rights and Fee ownerships. He does not believe HCFCD maintains this waterway and COH has had Fee ownership since 1960.
- Potential OSSF problems.
- Previous assessments by Bayou Preservation have found the area south of Hwy 59 and North of Bellaire are problem areas.
- Steve Hupp of Bayou Preservation has assessed the western branch and Carol LaBreche of COH has assessed the eastern branch – both are having bacteria problems.
- Good option for further assessment.
9-Little White Oak:
- City of Houston samples show station 11148 with highest bacteria levels compared to other stations in this AU.
- Fish kills have occurred upstream of station 11148.
- Lisa Groves mentioned the COH did a characterization 5-6 years ago and did not get significant bacteria hits.
- Steve Hupp has assessed the upstream portion and got no bacteria hits but did find high chlorine levels in surface water. Lisa Groves said they found leaking potable water in that area when they did their characterization which may have been the chlorine source.
- Lisa Groves also mentioned a lift station upstream of station 16648 with foul odor (Woodland Park area).
- Accessibility issues in some areas.
- Would be a very time intensive assessment due to the density of development and mixed use.
- Good option for further assessment.

10-Rummel Creek:
- Clean Rivers Program (CRP) partners mentioned wanting an additional monitoring station added on this AU during the CMM meeting on 4/12/16 due to concerns about potential pollution sources in areas where contact recreation is common.
- Area directly south of I-10 has seen issues including a fish kill last summer. Mulch yard and nursery nearby may be source of nutrients and bacteria to the waterway causing fish kills.
- Robert Snoza mentioned there are two pumped TXDOT detention basins in this area.
- Good option for further assessment.

4. Review of Top 10 Most Likely to Succeed AUs

The workgroup reviewed subwatershed maps and moving bacteria geometric mean plots for each AU on the Top 10 Most Likely to Succeed list and discussed important considerations and information pertinent to each AU.

1-Upper Panther Branch:
- San Jacinto River Authority does the monitoring for this AU.
- Wildlife is a likely contributor of bacteria in this AU.
- Steve Hupp mentioned this may be a good AU for source tracking.
- No one at the meeting has done much work in this area.
- Good option for further assessment.
2-Caney Creek:
- Rural watershed.
- Cattle grazing is common.
- Failing OSSFs may be a potential bacteria contributor.
- Drain field issues related to lot size present in the area.
- There is currently a WPP underway for this area. That may be a more fitting means of characterizing this AU.

3-Lower Panther Branch:
- San Jacinto River Authority does the monitoring for this AU.
- Increasing bacteria trends are likely related to increased development in the area.
- Feral hogs may be a potential source here.
- No one at the meeting has done much work in this area.
- Good option for further assessment.

4-Canal C-147:
- Flood control did work on detention basin improvements.
- Flea market and bull fighting in eastern portion of the watershed.
- Recently constructed wastewater treatment facility in the area. Would be interesting to compare before and after samples to see the impact.
- Not much work done in this AU by meeting attendees.
- Good option for further assessment.

5-Willow Creek:
- Lisa Groves of COH samples at station 11185.
- Wastewater treatment facility (WWTF) installed 10-11 years ago upstream of sample location.
- There are a lot of wastewater outfalls in this AU.
- May be a good area for regionalization of WWTFs.
- Good option for further assessment.

6-Cowart Creek:
- Environmental Institute of Houston (EIH) does the monitoring in this AU.
- May run into some accessibility issues (private properties).
- No one at meeting has done much work in this area.
- Good option for further assessment.

7-Walnut Creek:
- H-GAC staff has encountered an angry homeowner concerned about trespassing in the area when monitoring.
- There is currently a WPP underway for this area. That may be a more fitting means of characterizing this AU.
8-Cypress Creek:
- Upcoming development planned for the area.
- There has been some research done on overflow conditions in this AU.
- South of sample location is a large wetland mitigation area.
- Livestock is a likely bacteria contributor in this AU.
- Private properties may cause accessibility issues.
- Good option for further assessment.

9-Clear Creek Above Tidal:
- Environmental Institute of Houston (EIH) does the monitoring for this AU.
- There is a high variety of pollution sources in this area.
- Good option for further assessment.

10-Spring Creek:
- Covers a very large geographic area.
- Rural residential watershed.
- Bacteria geomeans have been gradually improving since 2012.

5. Next Steps:

Paniz reviewed the project timeline with the workgroup.
- Phase I completion by June 30th, 2016
- Phase II completion by October 31st, 2016
- Phase III completion by April 30th, 2017

There will be another workgroup meeting scheduled in May to discuss Phase I, Review 2 tasks: Reducing the Top 5 / Least 5 list to the final Top 2 / Least 2 AUs.

6. Adjourn

Paniz thanked the group again for attending. Meeting adjourned at 3:15 PM.
Appendix B: Desk Review 2 Materials
Project Overview

- **Phase I completion by June 30th, 2016**
  - Pare down Top 10 / Least 10 to Top 2 / Least 2
  - AU intensive study of Top 2 / Least 2

- **Phase II completion by October 31st, 2016**
  - Sample collection & NELAP testing
  - Data analysis and source identification

- **Phase III completion by April 30th, 2017**
  - Report to local authorities and work with local jurisdictions to implement bacteria reduction measures
  - Follow up monitoring and data analysis
Phase I: Review 2

- Review Top 5 Most Wanted AUs
  - Moving seven-year bacteria geomeans
  - Trend analysis
  - LDCs or bacteria vs days since last rain
  - GIS maps

- Review Top 5 Most Likely to Succeed AUs
  - Moving seven-year bacteria geomeans
  - Trend analysis
  - LDCs or bacteria vs days since last rain
  - GIS maps

- Rank Top 5 / Least 5 in order of priority

Top 5 Most Wanted

<table>
<thead>
<tr>
<th>Top 5 Most Wanted</th>
<th>E. Coli Geometric Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Rummel Creek (1014N_01)</td>
<td></td>
</tr>
<tr>
<td>2/3) Berry Bayou Above Tidal (1007F_01)</td>
<td></td>
</tr>
<tr>
<td>2/3) Little White Oak Bayou (1013A_01)</td>
<td></td>
</tr>
<tr>
<td>4) Mimosa Ditch (1007U_01)</td>
<td></td>
</tr>
<tr>
<td>5) Bintliff Ditch (1007T_01)</td>
<td></td>
</tr>
</tbody>
</table>
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Rummel Creek (1014N_01)

Berry Bayou (1007F_01)
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Little White Oak (1013A_01)

Mimosa Ditch (1007U_01)
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Bintliff Ditch (1007T_01)

Assessment Unit 1007T_01 Bintliff Ditch
Moving Seven-Year Bacteria Geometric Mean
Unclassified Freshwater Stream

Watershed: Houston Ship Channel/Buffalo Bayou Tidal / Stations: 18950

E. Coli Geometric Mean (MPN/100 mL)

[Graph showing E. Coli levels from 2005 to 2016]

Bintliff Ditch (1007T_01)

Assessment Unit: 1007T_01 Bintliff Ditch
Watershed: Houston Ship Channel/Buffalo Bayou Tidal Water Body Type: Unclassified Freshwater Stream

[Graph showing E. Coli levels with trend line and data points from 2005 to 2016]

Locally Weighted Linear Regression, L (DESS) Plot
Stations in AU: 18950

206
Bintliff Ditch (1007T_01)

Top 5 Most Likely to Succeed

1) Canal C-147 (1007A_01)
2/3) Upper Panther Branch (1008B_02)
2/3) Lower Panther Branch (1008C_02)
4) Clear Creek Above Tidal (1102_04)
5) Cowart Creek (1102A_02)
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Canal C-147 (1007A_01)

Assessment Unit 1007A_01 Canal C-147
Moving Seven-Year Bacteria Geometric Mean
Unclassified Freshwater Stream

Watershed: Houston Ship Channel/Buffalo Bayou Tidal / Stations: 15875 16955

Canal C-147 (1007A_01)

Assessment Unit: 1007A_01 Canal C-147
Watershed: Houston Ship Channel/Buffalo Bayou Tidal Water Body Type: Unclassified Freshwater Stream

Locally-Weighted Least Squares (LOESS) Plot
Stations in AU: 15875 16955
Canal C-147 (1007A_01)

Upper Panther Branch (1008B_02)
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Preliminary Action Report

**Upper Panther Branch (1008B_02)**

![Graph of Upper Panther Branch E.Coli Comparisons]

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**Lower Panther Branch (1008C_02)**

![Graph of Lower Panther Branch Assessment Unit 1008C_02]

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Watershed: Spring Creek  
Stations: 16627
Cowart Creek (1102A_02)

Top 5 / Least 5 in Order of Priority

**Top 5 Most Wanted**
1) Rummel Creek (1014N_01)
2) Little White Oak Bayou (1013A_01)
3) Mimosa Ditch (1007U_01)
4) Berry Bayou Above Tidal (1007F_01)
5) Bintliff Ditch (1007T_01)

**Top 5 Most Likely to Succeed**
1) Canal C-147 (1007A_01)
2) Upper Panther Branch (1008B_02)
3) Lower Panther Branch (1008C_02)
4) Cowart Creek (1102A_02)
5) Clear Creek Above Tidal (1102_04)
Top 5 / Least 5 Workgroup Meeting Notes  
Thursday, May 26, 2016  
1:00 PM to 3:00 PM  
H-GAC Conference Room D  
3555 Timmons Lane, 2nd Floor

7. **Introductions**

**Persons in Attendance:**  
Paniz Miesen – H-GAC  
Steven Johnston – H-GAC  
Denise Hall – Harris County Pollution Control  
Steve Hupp – Bayou Preservation  
Danielle Cioce – Harris County Watershed Protection  
Robert Snoza – Harris County Flood Control  
Carol LaBreche – City of Houston  
Lisa Leja – City of Houston  
Ambrose Okpokpo – City of Houston

**Persons on Conference Line:**  
Lisa Groves – City of Houston

8. **Project Overview**

- This meeting was held to satisfy Review 2 tasks associated with Phase I of the project: *Prioritize the Top 2 Most Wanted and Top 2 Most Likely to Succeed AUs that will be subject to characterization and identification of bacteria sources.*

9. **Review of Top 5 Most Wanted AUs**

The workgroup reviewed statistical graphs and subwatershed maps for each AU on the Top 5 Most Wanted list. Graphical analysis included moving seven-year bacteria geomeans, *E. coli* trend analysis, LDCs, and *E. coli* vs days since last rain plots. Maps included outfall locations, OSSFs, land use information, and potential bacteria sources. The following are important notes and considerations pertinent to each AU based on the analysis provided.

1-Rummel Creek:  
- Analysis of *E. coli* data revealed a slight decreasing trend in bacteria concentrations, but the geometric mean of 1960 MPN/100 mL is still well above the 126 MPN/100 mL standard.  
- High *E. coli* concentrations during dry periods are common.
- Potential bacteria sources include dirt yards using manure based products and the plant nursery adjacent to I-10 at the Beltway.
- There are two stormwater detention basins adjacent to I-10 and the Beltway.
- Clean Rivers Program (CRP) partners have expressed concern about Rummel Creek and the need for additional monitoring/characterization to find and eliminate bacteria sources due to known contact recreation.
- Accessibility is favorable.
- City of Houston offered access to GIS layer with lift station locations.
- City of Houston’s Gims would also be a useful tool for finding information about current or planned rehab projects in the greater Houston area.

2-Berry Bayou:
- *E. coli* concentrations have remained well above the 126 MPN/100 mL standard with more than 90% of the data exceeding the state water quality standard.
- Current *E. coli* geometric mean is 2469 MPN/100 mL.
- Heavy residential and industrial land uses in the watershed.
- It was mentioned that there may be old grandfathered in OSSFs in this watershed than are not shown on the map.
- Berry Bayou watershed is one of the larger AUs on the Most Wanted list measuring at 12.69 square miles.
- Concrete lining is common in most areas, many of which are newly constructed or are currently under construction, making accessibility an issue in some areas.

3-Little White Oak:
- A slight decreasing trend in *E. coli* concentrations detected.
- Geomean is still well above the 126 MPN/100 mL standard at 1975 MPN/100 mL.
- LDC curve shows dry weather bacteria exceedances are common.
- Highly mixed use area with potential for illicit discharges.
- No wastewater outfalls are located along this AU.
- Lift station upstream of station 16648.
- City of Houston conducted a characterization in 2009 and found homes discharging gray water into Little White Oak.
- A fish kill occurred last summer from unknown causes.
- Bayou Preservation characterizations found high chlorine levels and low *E. coli*. City of Houston found leaking potable water in that area which may have been the chlorine source.
- A lot of interest in this AU due to the lack of information and knowledge about bacteria point sources. Workgroup curious about what the cause of
high *E. coli* concentrations are in a highly urbanized and residential area with no WWTF outfalls.

4-Mimosa Ditch:
- Slight decreasing trend detected for *E. coli* in this AU.
- Geometric mean is 2133 MPN/100 mL compared to the 126 MPN/100 mL standard.
- *E. coli* concentrations have been significantly higher than the standard even during dry periods.
- Mimosa Ditch watershed borders City of Houston and City of Bellaire but is in the City of Houston jurisdiction.
- Bellaire WWTF outfall located on the downstream end of the AU.
- High dry weather flows at Rice are suspect.
- Likely that bacteria sources are originating from the northern portions of the watershed with the majority of inputs coming from underground.
- Underground systems may make it difficult to identify bacteria sources.

5-Bintliff Ditch:
- Trend analysis detected slight decreasing trend in *E. coli* concentrations in Bintliff Ditch.
- Bacteria geomean is 2133 MPN/100 mL
- High *E. coli* concentrations during dry periods are common.
- Accessibility is an issue; chain link fences/gates and high vegetation on private property block access in many areas.
- Samples collected from bridges due to difficult accessibility.
- Underground system north of Bellaire.
- City of Houston found leaking storm drain last year, problem has been fixed.
- Bayou Preservation and City of Houston assessments found areas adjacent to Hwy 59 as problem areas for both stems.

10. Review of Top 5 Most Likely to Succeed AUs

The workgroup reviewed statistical graphs and subwatershed maps for each AU on the Top 5 Most Likely to Succeed list. Graphical analysis included moving seven-year bacteria geomeans, *E. coli* trend analysis, LDCs, *E. coli* vs days since last rain, and station comparison plots. Maps included outfall locations, OSSFs, land use information, and potential bacteria sources. The following are important notes and considerations pertinent to each AU based on the analysis provided.

1-Canal C-147:
- *E. coli* trend analysis and moving geomeans have been decreasing.
- Nearly half the data points collected still exceed the 126 MPN/100 mL geomean.
- *E. coli* geomean is 157 MPN/100 mL.
- *E. coli* exceedances during dry weather periods occur on an infrequent basis.
- Canal located in unincorporated Fort Bend County in the City of Missouri City.
- Flea market and bull fighting in eastern portion of the watershed.
- Recently constructed wastewater treatment facility in the area. Would be interesting to compare before and after samples to see the impact.
- No previous characterizations or assessments we are aware of have taken place in this area.
- Good option for further assessment.

2-Upper Panther Branch:
- Moving seven-year geometric means have been decreasing to near compliance, but current *E. coli* geomean is still slightly above the 126 MPN/100 mL standard at 133 MPN/100 mL.
- *E. coli* exceedances during dry periods are rare.
- Comparison of monitoring stations upstream and downstream of the WWTF outfall revealed similar fluctuations in bacteria concentrations for both stations.
- San Jacinto River Authority does the monitoring for this AU.
- Wildlife is a likely contributor of bacteria in this AU.
- Concentrated area of OSSFs NE of the AU with a small tributary running through that area. No monitoring stations are located immediately downstream of these OSSFs so any potential bacteria loadings from OSSFs would go undetected.
- No previous characterizations or assessments we are aware of have taken place in this area.
- Good option for further assessment.

3-Lower Panther Branch:
- Moving seven-year bacteria geomeans have been fluctuating slightly above the standard since 2006.
- Nearly half the samples collected have exceeded the state bacteria standard with concentrations reaching as high as 10,000 MPN/100 mL between 2011-2013.
- Current *E. coli* geomean is 156 MPN/100 mL.
- *E. coli* exceedances during dry weather occurs on an infrequent basis.
- San Jacinto River Authority does the monitoring for this AU.
- Increasing bacteria trends are likely related to increased development in the area.
- Feral hogs may be a potential source here.
- No previous characterizations or assessments we are aware of have taken place in this area.
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- 4-Clear Creek Above Tidal:
  - Moving seven-year bacteria geomeans have been fluctuating above the standard since late 2005.
  - Trend analysis detected stable *E. coli* trends with more than half the samples collected still exceeding the state standard.
  - *E. coli* geomean for this AU is 169 MPN/100 mL.
  - New development in the area.
  - No WWTF outfalls located in this AU.
  - AU supports wildlife; alligator gars are commonly seen in this AU.
  - Environmental Institute of Houston (EIH) does the monitoring for this AU.
  - There would be value in comparing historical data from upstream stations to downstream stations to help identify problem areas.
  - Very high flows at times would make it difficult to find bacteria sources.

- 5-Cowart Creek:
  - Moving seven-year bacteria geomeans have been fluctuating above the standard since late 2005.
  - *Stable E. coli* trend detected for this AU with more than half the samples collected exceeding the state standard.
  - *E. coli* geomean is currently 161 MPN/100 mL.
  - Frequent and extreme exceedances were common around 2006-2007 but have since improved.
  - Relatively easy access along the AU, but may run into accessibility issues on private properties.
  - There are possibly more grandfathered in OSSFs present in this watershed that are not on the current maps.
  - Horses and other animals living on small ranchettes may be a potential contributor of bacteria.
  - Environmental Institute of Houston (EIH) does the monitoring in this AU.
  - No previous characterizations or assessments we are aware of have taken place in this area.

11. Top 5 / Least 5 Prioritizations

- Based on the available information, the workgroup discussed how to prioritize the Top 5 / Least 5 list based on where we should focus our characterizations moving forward.
<table>
<thead>
<tr>
<th>Top 5 Most Wanted</th>
<th>Top 5 Most Likely to Succeed</th>
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<tbody>
<tr>
<td>1) Rummel Creek (1014N_01)</td>
<td>1) Canal C-147 (1007A_01)</td>
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<tr>
<td>2) Little White Oak Bayou (1013A_01)</td>
<td>2) Upper Panther Branch (1008B_02)</td>
</tr>
<tr>
<td>3) Mimosa Ditch (1007U_01)</td>
<td>3) Lower Panther Branch (1008C_02)</td>
</tr>
<tr>
<td>4) Betty Bayou Above Tidal (1007F_01)</td>
<td>4) Cowart Creek (1102A_02)</td>
</tr>
<tr>
<td>5) Bintliff Ditch (1007T_01)</td>
<td>5) Clear Creek Above Tidal (1102_04)</td>
</tr>
</tbody>
</table>

12. Next Steps:

- H-GAC staff will begin conducting field surveys and collecting baseline data for the Top 2 AUs on each list in June, 2016.
- If no bacteria hits are detected during any of the Top 2 / Least 2 assessments, H-GAC staff will move down the prioritization list and assess the next AU listed.
- Workgroup will convene again in late summer/early fall to review baseline data and discuss findings.

13. Adjourn
Appendix C: AU Intensive Study: Little White Oak Bayou
Figure C1. Windshield survey route for Little White Oak Bayou
Table C1. Bacteria screening results for Little White Oak Bayou

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Date</th>
<th>Time</th>
<th>Sample Type</th>
<th>Outfall Characteristics</th>
<th>Latitude</th>
<th>Longitude</th>
<th>E. coli (cfu/100ml)</th>
<th>Comments/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>7/13/2016</td>
<td>8:57</td>
<td>Outfall</td>
<td>Metal pipe 24&quot; 0.5&quot;</td>
<td>29.7975</td>
<td>-95.37048</td>
<td>575</td>
<td>Waypoint No. 040. Foam and algae present. Small fish in water.</td>
</tr>
<tr>
<td>003</td>
<td>7/13/2016</td>
<td>9:28</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.79464</td>
<td>-95.37029</td>
<td>450</td>
<td>Waypoint No. 042. Lots of trash. Large birds nearby.</td>
</tr>
<tr>
<td>005</td>
<td>7/13/2016</td>
<td>10:27</td>
<td>Outfall</td>
<td>Concrete storm drain 48&quot; 4&quot;</td>
<td>29.79247</td>
<td>-95.36649</td>
<td>1025</td>
<td>Waypoint No. 044. Water from outfall cooler with a chlorine smell. Three people observed on bank.</td>
</tr>
<tr>
<td>007</td>
<td>7/13/2016</td>
<td>10:56</td>
<td>Outfall</td>
<td>Metal pipe 24&quot; 0.5&quot;</td>
<td>29.79076</td>
<td>-95.3639</td>
<td>0</td>
<td>Waypoint No. 046. Sweet smell. Soil discoloration below outfall opening.</td>
</tr>
<tr>
<td>008</td>
<td>7/18/2016</td>
<td>8:31</td>
<td>Outfall</td>
<td>Concrete storm drain 120&quot; 30&quot;</td>
<td>29.79039</td>
<td>-95.36263</td>
<td>0</td>
<td>Waypoint No. 047. Fish. Large waterfall sound.</td>
</tr>
<tr>
<td>009</td>
<td>7/18/2016</td>
<td>8:45</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.78994</td>
<td>-95.36188</td>
<td>TNTC</td>
<td>Waypoint No. 048. Upstream of bend/large storm drain.</td>
</tr>
<tr>
<td>010</td>
<td>7/18/2016</td>
<td>8:54</td>
<td>Outfall</td>
<td>Concrete storm drain 108&quot; 3&quot;</td>
<td>29.78984</td>
<td>-95.36163</td>
<td>TNTC</td>
<td>Waypoint No. 049. Large storm drain. Strange smell - acid?</td>
</tr>
<tr>
<td>013</td>
<td>7/18/2016</td>
<td>10:22</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.7851</td>
<td>-95.36685</td>
<td>TNTC</td>
<td>Waypoint No. 052. Upstream of Main St. bridge. Lots of rocks and ripples.</td>
</tr>
<tr>
<td>014</td>
<td>7/18/2016</td>
<td>11:18</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.7826</td>
<td>-95.3706</td>
<td>TNTC</td>
<td>Waypoint No. 049 (yellow gos). Downstream of 45. Adjacent to stormwater wetlands.</td>
</tr>
<tr>
<td>015</td>
<td>7/18/2016</td>
<td>11:39</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.7819</td>
<td>-95.3707</td>
<td>TNTC</td>
<td>Waypoint No. 050 (yellow gos). Lots of gar.</td>
</tr>
<tr>
<td>017</td>
<td>7/20/2016</td>
<td>8:44</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.8008</td>
<td>-95.37254</td>
<td>10900</td>
<td>Waypoint No. 053.</td>
</tr>
<tr>
<td>018</td>
<td>7/20/2016</td>
<td>9:10</td>
<td>Outfall</td>
<td>Concrete storm drain 72&quot; Unkown</td>
<td>29.80378</td>
<td>-95.37322</td>
<td>13300</td>
<td>Waypoint No. 054. Fish jumping. Downstream of Calvalcade bridge. Sampled at mouth of storm drain.</td>
</tr>
<tr>
<td>022</td>
<td>7/20/2016</td>
<td>10:25</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.8084</td>
<td>-95.37589</td>
<td>9450</td>
<td>Waypoint No. 058. Surface water adjacent to outfall No. 066. Redish tint to sediment.</td>
</tr>
<tr>
<td>023</td>
<td>7/20/2016</td>
<td>10:44</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.8115</td>
<td>-95.37593</td>
<td>4300</td>
<td>Waypoint No. 059. Downstream of underground 610.</td>
</tr>
<tr>
<td>024</td>
<td>7/20/2016</td>
<td>11:00</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.8158</td>
<td>-95.37767</td>
<td>5800</td>
<td>Waypoint No. 060. Upstream of 610 underground.</td>
</tr>
<tr>
<td>025</td>
<td>7/20/2016</td>
<td>11:20</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.8190</td>
<td>-95.37845</td>
<td>TNTC</td>
<td>Waypoint No. 061. Surface water sample downstream of Stokes bridge.</td>
</tr>
</tbody>
</table>
Appendix D: AU Intensive Study:

Rummel Creek
Figure D1. Windshield survey route for Rummel Creek
Table D1. Bacteria screening results for Rummel Creek

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Date</th>
<th>Time</th>
<th>Sample Type</th>
<th>Outfall Characteristics</th>
<th>Latitude</th>
<th>Longitude</th>
<th>E. coli (cfu/100ml)</th>
<th>Comments/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>031</td>
<td>7/11/2016</td>
<td>9:00</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.76429</td>
<td>-95.5607</td>
<td>125</td>
<td>Low flow. Algae present</td>
</tr>
<tr>
<td>034</td>
<td>7/11/2016</td>
<td>10:03</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.76519</td>
<td>-95.56248</td>
<td>525</td>
<td>Old and rusty water pipe nearby.</td>
</tr>
<tr>
<td>035</td>
<td>7/11/2016</td>
<td>10:40</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.772</td>
<td>-95.5694</td>
<td>425</td>
<td>Waypoint No. 032. Small fish present. Sample taken from inside the Edith L. Moore Nature Sanctuary</td>
</tr>
<tr>
<td>037</td>
<td>7/11/2016</td>
<td>11:12</td>
<td>Outfall</td>
<td>Concrete storm drain</td>
<td>29.77559</td>
<td>-95.57374</td>
<td>100</td>
<td>Waypoint No. 034. Heavy algae inside outfall and in water.</td>
</tr>
<tr>
<td>038</td>
<td>7/11/2016</td>
<td>11:30</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.7763</td>
<td>-95.5733</td>
<td>400</td>
<td>Waypoint No. 035. Downstream of concrete slab (erosion control?). Small fish present.</td>
</tr>
</tbody>
</table>
Appendix E: AU Intensive Study:

Canal C-147
Figure E1. Windshield survey route for Canal C-147
Table E1. Bacteria screening results for Canal C-147

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Date</th>
<th>Time</th>
<th>Sample Type</th>
<th>Outfall Characteristics</th>
<th>Material</th>
<th>Pipe Diameter</th>
<th>Depth of Water</th>
<th>Latitude</th>
<th>Longitude</th>
<th>E. coli (cfu/100ml)</th>
<th>Comments/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>008</td>
<td>6/30/2016</td>
<td>9:00</td>
<td>Outfall</td>
<td>Metal pipe lined with rubber</td>
<td>24&quot;</td>
<td>1.5&quot;</td>
<td></td>
<td>29.61648</td>
<td>-95.45901</td>
<td>800</td>
<td>Outfall upstream of CRP monitoring station. Some algae present</td>
</tr>
<tr>
<td>009</td>
<td>6/30/2016</td>
<td>9:10</td>
<td>SW</td>
<td>Concrete channel</td>
<td>29.61599</td>
<td>-95.45975</td>
<td></td>
<td>9:00</td>
<td>Outfall upstream of CRP monitoring station. Some algae present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>010</td>
<td>6/30/2016</td>
<td>9:21</td>
<td>SW</td>
<td>Concrete channel</td>
<td>29.61424</td>
<td>-95.46069</td>
<td></td>
<td>9:21</td>
<td>Manhole on either side of bridge crossing. Slight yellow tint to water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>011</td>
<td>6/30/2016</td>
<td>9:32</td>
<td>SW</td>
<td>Concrete channel</td>
<td>29.61206</td>
<td>-95.46129</td>
<td></td>
<td>9:32</td>
<td>Cliff swallows and ducks present. Some algae present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>012</td>
<td>6/30/2016</td>
<td>9:38</td>
<td>Tributary</td>
<td>Concrete lined at discharge point; natural channel upstream</td>
<td>29.61161</td>
<td>-95.46149</td>
<td></td>
<td>9:38</td>
<td>Small. Some algae present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>013</td>
<td>6/30/2016</td>
<td>9:51</td>
<td>Outfall</td>
<td>Concrete storm drain (left)</td>
<td>114&quot;</td>
<td>6&quot;</td>
<td></td>
<td>29.61424</td>
<td>-95.46475</td>
<td>TNC</td>
<td>Algae common</td>
</tr>
<tr>
<td>014</td>
<td>6/30/2016</td>
<td>9:52</td>
<td>Outfall</td>
<td>Concrete storm drain (right)</td>
<td>108&quot;</td>
<td>3&quot;</td>
<td></td>
<td>29.61415</td>
<td>-95.46475</td>
<td>TNC</td>
<td>Algae common</td>
</tr>
<tr>
<td>015</td>
<td>6/30/2016</td>
<td>10:03</td>
<td>SW</td>
<td>Concrete channel; natural channel upstream</td>
<td>29.61405</td>
<td>-95.46519</td>
<td></td>
<td>10:03</td>
<td>Concrete lining ends here; natural channel upstream of bridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>016</td>
<td>6/30/2016</td>
<td>10:37</td>
<td>SW</td>
<td>2 metal outfall pipes directly upstream; natural channel</td>
<td>30&quot;</td>
<td>0&quot;</td>
<td></td>
<td>29.60781</td>
<td>-95.46939</td>
<td>TNC</td>
<td>Downstream of 2 outfalls (not flowing). Lots of fish at mouth of outfalls</td>
</tr>
<tr>
<td>017</td>
<td>6/30/2016</td>
<td>10:26</td>
<td>Tributary</td>
<td>Natural channel</td>
<td>29.60601</td>
<td>-95.47043</td>
<td></td>
<td>10:26</td>
<td>TNC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>018</td>
<td>6/30/2016</td>
<td>10:48</td>
<td>Outfall</td>
<td>Metal pipe with concrete lining at discharge point</td>
<td>29.60564</td>
<td>-95.47581</td>
<td></td>
<td>10:48</td>
<td>Algae common</td>
<td></td>
<td></td>
</tr>
<tr>
<td>019</td>
<td>6/30/2016</td>
<td>11:51</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.60504</td>
<td>-95.47677</td>
<td></td>
<td>11:51</td>
<td>Upstream of Beltway 8 bridge. Lots of fish, big and small. Some algae present</td>
<td></td>
<td></td>
</tr>
<tr>
<td>020</td>
<td>6/30/2016</td>
<td>11:38</td>
<td>Tributary</td>
<td>Natural channel</td>
<td>29.60412</td>
<td>-95.47678</td>
<td></td>
<td>11:38</td>
<td>Trib adjacent to WWTF outfall; 2 different color waters at mixing point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>021</td>
<td>6/30/2016</td>
<td>12:01</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.60413</td>
<td>-95.47684</td>
<td></td>
<td>12:01</td>
<td>SW downstream of WWTF outfall &amp; upstream of tributary; 2 different color waters at mixing point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>022</td>
<td>6/30/2016</td>
<td>12:16</td>
<td>Outfall</td>
<td>Metal pipe</td>
<td>29.60406</td>
<td>-95.47752</td>
<td></td>
<td>12:16</td>
<td>WWTF outfall; high flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>023</td>
<td>6/30/2016</td>
<td>12:19</td>
<td>Outfall</td>
<td>Metal pipe with concrete lining at discharge point</td>
<td>30&quot;</td>
<td>1&quot;</td>
<td></td>
<td>29.60406</td>
<td>-95.47842</td>
<td>TNC</td>
<td>Lots of vegetation growing out of outfall</td>
</tr>
<tr>
<td>024</td>
<td>6/30/2016</td>
<td>12:22</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.60413</td>
<td>-95.47890</td>
<td></td>
<td>12:22</td>
<td>WWTF outfall; upstream of WWTF outfall &amp; upstream of tributary; 2 different color waters at mixing point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>025</td>
<td>6/30/2016</td>
<td>12:37</td>
<td>Outfall</td>
<td>Metal pipe lined with rubber; concrete at discharge</td>
<td>29.60392</td>
<td>-95.48441</td>
<td></td>
<td>12:37</td>
<td>Water had a sweet smelling odor similar to detergent or soap; thick algal growth at discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>026</td>
<td>6/30/2016</td>
<td>12:49</td>
<td>Outfall</td>
<td>Metal pipe</td>
<td>29.60384</td>
<td>-95.48948</td>
<td></td>
<td>12:49</td>
<td>Yellow tinted water; lots of fish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>027</td>
<td>6/30/2016</td>
<td>13:00</td>
<td>SW</td>
<td>Natural channel</td>
<td>29.60379</td>
<td>-95.49318</td>
<td></td>
<td>13:00</td>
<td>WWTF outfall; high flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>028</td>
<td>6/30/2016</td>
<td>13:14</td>
<td>SW</td>
<td>2 concrete lined storm drains directly upstream; natural channel</td>
<td>29.60378</td>
<td>-95.49982</td>
<td></td>
<td>13:14</td>
<td>WWTF outfall; high flow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix F: AU Intensive Study:

Upper Panther Branch
Figure F1. Windshield survey route for Upper Panther Branch
### Table F1. Bacteria screening results for Upper Panther Branch

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Date</th>
<th>Time</th>
<th>Sample Type</th>
<th>Outfall Characteristics</th>
<th>E. coli (cfu/100mL)</th>
<th>Comments/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>004</td>
<td>7/26/2016</td>
<td>10:11</td>
<td>SW</td>
<td>Natural channel</td>
<td>134</td>
<td>Waypoint No. 065. Wide channel. Sweet smell. Chlorine test strip &gt;1.0ppm, &lt;4.0ppm</td>
</tr>
<tr>
<td>005</td>
<td>7/26/2016</td>
<td>10:35</td>
<td>Tributary</td>
<td>Natural channel</td>
<td>100</td>
<td>Waypoint No. 067. Tributary No. 068. Chlorine smell. Chlorine test strip ~4.0ppm</td>
</tr>
<tr>
<td>006</td>
<td>7/26/2016</td>
<td>10:44</td>
<td>Tributary</td>
<td>Natural channel</td>
<td>580</td>
<td>Waypoint No. 068. Tributary No. 069. Red color. Chlorine test strip ~0.8ppm</td>
</tr>
<tr>
<td>007</td>
<td>7/26/2016</td>
<td>11:07</td>
<td>Tributary</td>
<td>Natural channel</td>
<td>60</td>
<td>Waypoint No. 069. Tributary No. 070. Chlorine smell. Chlorine test strip ~4.0ppm</td>
</tr>
<tr>
<td>008</td>
<td>7/26/2016</td>
<td>11:54</td>
<td>SW</td>
<td>Natural channel</td>
<td>50</td>
<td>Waypoint No. 072. Downstream of tributary 071. Chlorine smell. Chlorine test strip ~10.0ppm</td>
</tr>
<tr>
<td>010</td>
<td>7/27/2016</td>
<td>10:02</td>
<td>Tributary</td>
<td>Natural channel</td>
<td>390</td>
<td>Waypoint No. 074. Tributary No. 073.</td>
</tr>
<tr>
<td>013</td>
<td>7/27/2016</td>
<td>10:52</td>
<td>SW</td>
<td>Natural channel</td>
<td>400</td>
<td>Waypoint No. 076. SW sample upstream of Bear Branch. Chlorine smell/wetland H₂S smell.</td>
</tr>
<tr>
<td>014</td>
<td>7/27/2016</td>
<td>10:57</td>
<td>Outfall</td>
<td>Natural channel</td>
<td>20</td>
<td>Waypoint No. 077. SW sample at wastewater treatment outfall. Chlorine smell.</td>
</tr>
<tr>
<td>015</td>
<td>7/27/2016</td>
<td>11:10</td>
<td>SW</td>
<td>Natural channel</td>
<td>260</td>
<td>SW sample upstream of wastewater treatment outfall.</td>
</tr>
</tbody>
</table>