

Targeted Bacteria Monitoring Project

Field Investigation Final Report

Assessment Unit 1017_03, White Oak Bayou Above Tidal



May 12, 2023

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Segment Description

Segment 1017 is White Oak Bayou Above Tidal (Figure 1). This segment contains an assessment unit (AU) of concern, AU 1017_03. This AU is a freshwater, perennial stream that is 2.62 km and is defined as being from the Cole Creek confluence to the Brickhouse Gully confluence in Harris County. There is one current (station ID: 15829) and two historic (station IDs: 11392 and 51830) surface water quality monitoring (SWQM) stations located on this AU. This AU has been selected for targeted monitoring due to a bacteria (*Escherichia coli*) seven-year geometric mean of 1624.8 MPN/100 mL (H-GAC QAPP, 2022). The AU was listed for exceedances of bacteria in the water (Recreation use) and has a current impairment category of 4a (TCEQ, 2022). The potential sources of bacteria are non-point source pollution, urban runoff, and sanitary sewer overflows (TCEQ, 2022).

The contributing watershed for this segment is 4.0 km² (Data source: HGAC and SWRC, 2023). The predominant soil group in the watershed is slow infiltration coverage and the land cover in the watershed is dominated by 99.62% developed land (Data source: United States Department of Agriculture Hydrologic Soil Groups from gSSURGO 2016 and National Land Cover Database NLCD 2019). There are no permitted wastewater outfalls in this immediate watershed (Data source: H-GAC), but there is a wastewater outfall at the most downstream portion of Cole Creek, which then flows directly into the most upstream portion of this AU. There are also 3 documented permitted on-site sewage facilities (OSSF) within the watershed, but no documented unpermitted OSSFs (Data source: H-GAC).

Background

Clean Rivers Program (CRP) routine monitoring data are analyzed each year as part of the Houston-Galveston Area Council (H-GAC) Basin Summary/Basin Highlights Report process. Bacteria continues to be the most prevalent pollutant in the H-GAC CRP Basins (H-GAC, 2022). The Bacteria Implementation Group (BIG), formed in 2008, oversees the Total Maximum Daily Load (TMDL) Implementation Plan (I-Plan). The BIG requested that H-GAC produce a list of the water bodies with the highest bacteria concentrations in the BIG project area and conduct targeted monitoring to identify potential bacteria sources.

Houston-Galveston Area Council, using information from previous Basin Highlights/Summary Reports, BIG annual reports, and previous targeted monitoring efforts, identified and selected waterways for targeted bacteria monitoring to refine our understanding of the spatial distribution of elevated bacterial concentrations contributing to these waterways. Phase 1 of this targeted monitoring project includes an intensive desktop review and a windshield survey (WS) of each AU catchment area, and sampling of the AU from primary road crossings. Phase 2 of this targeted monitoring project includes a field investigation (FI) of the entire AU conducted during dry conditions where all flowing point and non-point sources are evaluated.

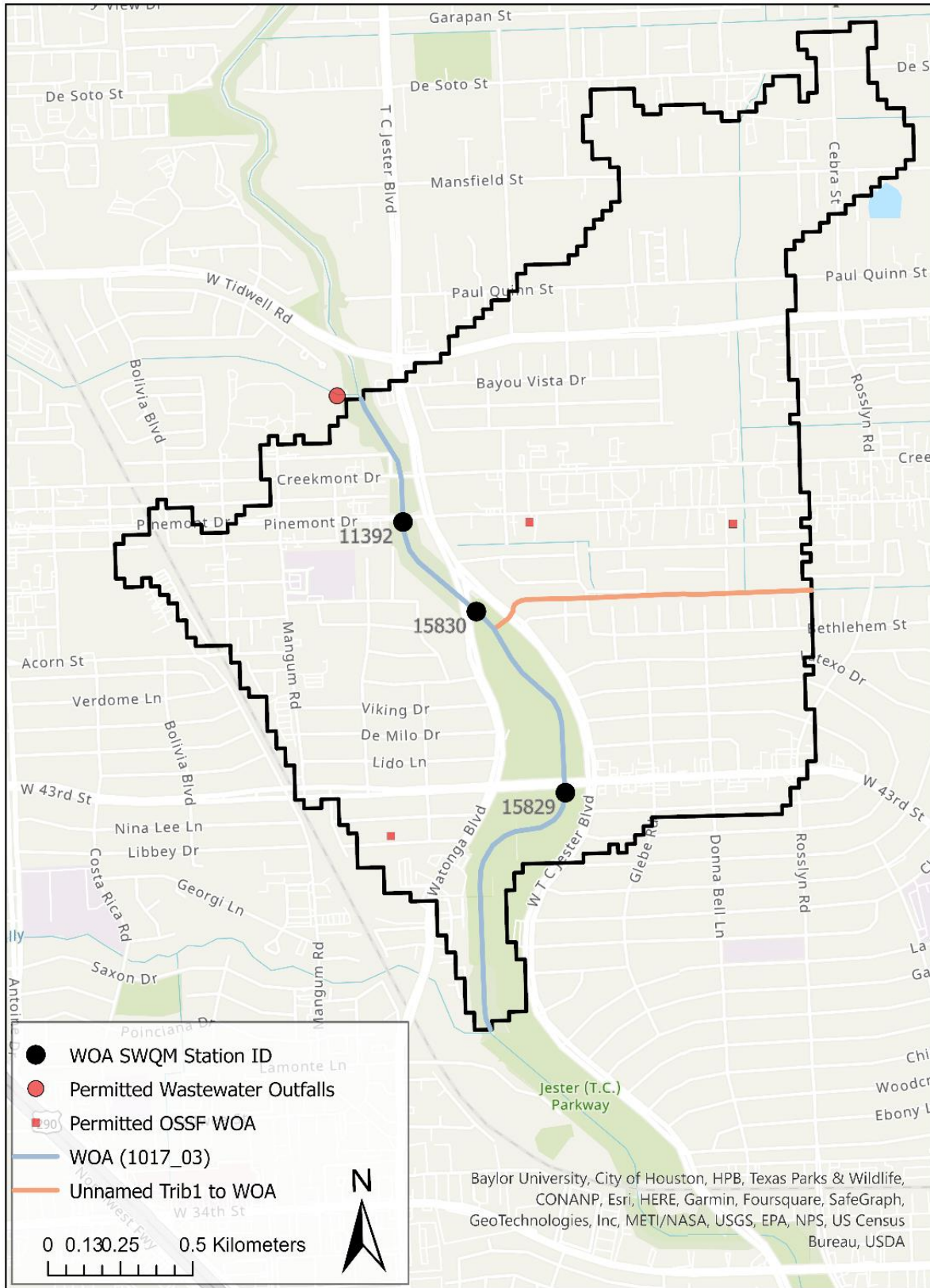


Figure 1 Watershed Map for White Oak Bayou Above Tidal, AU 1017_03.

Desktop Review

Methods

The intensive desktop review included an evaluation of permitted discharges, outfalls, and potential sources of point source and nonpoint source pollution that may contribute to bacteria loading in the AU. Using Google Earth imagery and GIS, the locations of wastewater treatment facilities, permitted OSSFs, and potential locations of unpermitted OSSFs were identified. Other potential sources such as landfills and industrial facilities were also identified. Parks were noted, as these can contribute to bacterial sources through runoff of animal wastes but also provide opportunity for contact recreation. Bridge crossings and other entry points were identified to provide access into the stream to collect bacteriological samples.

Results

The results of the desktop review indicated that this AU is located predominantly in an urban/suburban area with many roads, single-family and multi-family residences, along with some businesses and parking lots within this watershed and bordering the bayou. The majority of this AU is confined within a series of parks that are connected by the White Oak Bayou Greenway Trail and has a walking/biking trail that follows the bayou throughout this entire AU. The following potential sources were identified: TC Jester Dog Park just upstream of the confluence with Brickhouse Gully, Watonga Drive Bridge Bat Colony, and a grouping of manufacturing businesses located near the bayou at Creekmont Drive. Publicly accessible entry points into the stream were identified at the TC Jester Park, near the intersection of Watonga Blvd. and TC Jester Blvd., at Creekmont Dr., and near the confluence of Cole Creek and White Oak Bayou Above Tidal.

Windshield Survey

Methods

Field events must take place during dry weather (after 3 or more days without significant rainfall in the watershed). This ensures that any flowing water into the AU are not stormwater. Windshield surveys of the watershed were conducted and bacteria sampling was performed at public access points throughout the AU (primarily at bridge crossings). The survey consisted of driving the catchment area to confirm identified pollution sources found during the desktop review and to find any potential sources not identified during that review. Bridge crossings chosen for sampling were spatially distributed to provide a spatial snapshot of bacteria concentrations in the AU and identify sections of the AU where elevated bacteria concentrations were found. Those areas with elevated bacteria levels identified in the WS monitoring were focused on during the Phase 2, FI.

Assessment Units, sample collection and laboratory methods, and data handling practices are detailed in Appendix J of the FY 2022-2023 H-GAC Multi-Basin Clean Rivers Program Quality Assurance Project Plan (H-GAC QAPP, 2022). For all WSs, field personnel documented the latitude and longitude of sample location. All bacteria samples were analyzed by a National Environmental Laboratory Accreditation Program (NELAP)-Accredited laboratory.

Results and Recommendations

The WS was conducted on March 6, 2023. At that time, it had been four days since the last significant rainfall in the watershed. A total of six samples were collected on AU 1017_03 and one on the contributing tributary during the WS (Table 1 and Figure 2).

Table 1. Windshield survey bacteria results from sampling on 03/06/2023 on White Oak Bayou Above Tidal (AU 1017_03). Samples were taken at bridge crossings and other publicly accessible points. US = Upstream, DS = Downstream, LB = Left Bank, RB = Right Bank.

Sample ID	Latitude	Longitude	<i>E. coli</i> Sample Results (MPN/100 mL)	Comments
WOA-WS-01	29.82682	-95.45621	309	Smells of effluent.
WOA-WS-02	29.83272	-95.45321	183	
WOA-WS-03	29.83702	-95.45517	292	Possible encampment under pedestrian bridge.
WOA-WS-04	29.83822	-95.45625	185	Two flowing outfalls US on RB. Bats and bat droppings present.
WOA-WS-05	29.84281	-95.45876	262	Very shallow but very swift moving water.
WOA-WS-06	29.84526	-95.46008	288	Smells of effluent. Observed 2 soft-shell turtles US of confluence.
T1WOA-WS-01	29.83771	-95.45505	683	Sample collected from trib to WOA. Bats living under bridge over trib. Smells of guano and observed dropping on bank.

Based upon the results of the WS and ground-truthing, a FI covering the entire length of the AU and the unnamed tributary into White Oak Bayou Above Tidal was recommended. Based on the results of the WS, we expected to identify potential non-point sources or point sources of elevated bacteria near the following portions of the AU:

- 1) The unnamed tributary that flows into this AU just downstream of the TC Jester Blvd. and Watonga Blvd. intersection where sample T1WOA-WS-01 was taken. Considering the elevated bacteria level (683 MPN/100 mL) found in this tributary and the noticeably lower bacteria level (185 MPN/100 mL) from the sample collected upstream of the confluence with this tributary, this tributary was targeted for a full FI.
- 2) WOA-WS-01, which was collected near the TC Jester Park ~0.13 mi upstream of the confluence with Brickhouse Gully. This sample had an elevated bacteria level (309 MPN/100

mL) compared to the sample collected ~0.50 mi upstream at the bridge at 43rd St. (183 MPN/100 mL).

3) WOA-WS-05, which was collected from the upstream side of the bridge at Creekmont Drive. This sample had an elevated bacteria level (262 MPN/100 mL) compared to the sample collected ~0.35 mi downstream of the area (185 MPN/100 mL).

Field Investigation

Methods

The FI was a thorough survey where a team of two, either walked or paddled the entire assessment unit and sampled any water observed flowing into the stream. Water could be flowing in from a pipe, culvert, natural tributary, or earthen ditch. Flowing water was categorized into two source types: permitted outfalls or unpermitted outfalls. Permitted outfalls included wastewater facilities and municipal separate storm sewer systems (MS4). Any pipe greater than 12 inches (in.) in diameter was assumed to be permitted by our field crews. When flowing water was observed from a permitted outfall, two samples were collected.

One sample was collected immediately downstream of the outfall where the flowing outfall was mixing with the ambient water. The second sample was taken upstream of the flowing outfall outside of the realm of influence from the outfall to provide the ambient bacteria levels of the assessment unit in that area. The second type of source was an unpermitted outfall, which was any other flowing source of water that was not assumed to be permitted including flowing small (<12 in. diameter) “homemade” pipes and tributaries.

When a flowing unpermitted outfall was observed, the bacteria sample was taken directly from the source. If the source was a flowing pipe, the sample was collected directly from the pipe, before it entered the AU. If it was an open-top earthen ditch or natural tributary, the sample was collected from far enough into the inflow source that there was no mixing with the receiving water. In some cases, when no flowing permitted or unpermitted outfalls were observed in an extended section of the AU, a single ambient reference sample was taken mid-stream. Left and right bank references are oriented with the observer facing downstream.

Assessment Units, collection and laboratory methods, and data handling practices are detailed in Appendix J of the FY 2022-2023 H-GAC Multi-Basin Clean Rivers Program Quality Assurance Project Plan (H-GAC QAPP, 2022). For all field investigations the field team recorded location of the flowing outfall (latitude and longitude), the diameter, material, and water depth of the flowing outfall, and documented site conditions by taking photos and other relevant notes. All bacteria samples were collected following procedures listed in Appendix J of the FY 2022-2023 H-GAC Multi-Basin Clean Rivers Program Quality Assurance Project Plan (H-GAC QAPP, 2022) and analyzed by a National Environmental Laboratory Accreditation Program (NELAP)-Accredited laboratory.

Results

The FI was conducted on April 3, 2023 (seventeen days since last significant rainfall) and a total of 41 bacteria samples were collected on the main AU and a contributing tributary. The values of the bacteria samples collected from downstream of permitted outfalls, directly from unpermitted outfalls, or as ambient samples are summarized in Table 2 and Figure 3. Based on the data collected, three locations with elevated *E. coli* bacteria levels measured during the FI are recommended for high priority, and three locations for low priority investigation by the proper authorities. High priority sites had the highest potential bacteria loading observed and are recommended to be the areas for local authorities to focus efforts on should there be insufficient resources to address all referral sites. As time and resources allow the low priority and investigate further referrals also are recommended for further investigation. These locations are summarized in Table 2 and Figure 4. In addition, three locations were flagged where ambient or upstream samples had elevated bacteria levels with no obvious explanations. Further investigation of these areas by the proper authorities are recommended. Each of these referrals are summarized by site, herein. The referral summaries are listed in order of priority (High, Low, then Investigate Further). Within each priority group, sites are listed from downstream to upstream.

Table 2: Field investigation bacteria results from sampling on 4/3/2023 on White Oak Above Tidal (Assessment Unit 1017_03) and a contributing tributary. Referrals (gray rows): N = No, Y-H = Yes – High Priority, Y-L = Yes-Low Priority, IF = Investigate Further, US = Upstream, DS = Downstream, LB = Left Bank, RB = Right Bank.

Sample ID	Lat	Long	DS or Direct <i>E. coli</i> Sample Results (MPN/100 mL)	US <i>E. coli</i> Sample Results (MPN/100 mL)	Difference* DS - US (MPN/100 mL)	Referral	Comments
WOA-FI1-01	29.82508	-95.45609	1,610	NA	NA	IF	Ambient sample taken just upstream of confluence with Brickhouse Gully.
WOA-FI1-02	29.82654	-95.45623	200	NA	NA	N	Water coming in from unknown source- possibly from metal panel on concrete banks. Sheen on water.
WOA-FI1-03-D	29.82662	-95.45622	310	410	-100	N	Tributary (concrete-lined ditch on RB) had just a trickle. Did not sample directly from it.
WOA-FI1-04-D	29.82857	-95.45619	750	100	650	Y-H	Metal pipe discharges onto concrete lining. Just a trickle from pipe on LB.
WOA-FI1-05-D	29.83118	-95.45479	310	200	110	Y-L	Decent amount of flow (more than a trickle). Sampled by an open-air concrete lined ditch. RB
WOA-FI1-06-D	29.83261	-95.45316	310	410	-100	N	Decent flow. Effluent odor. LB
WOA-FI1-07-D	29.83551	-95.45370	2,430	300	2,130	Y-H	Water is brownish in color. LB
WOA-FI1-08	29.83746	-95.45541	2,430	NA	NA	IF	Ambient sample taken from tributary upstream of confluence with AU. Bat droppings observed on banks upstream of sample area.
WOA-FI1-09-D	29.83790	-95.45591	410	200	210	Y-L	Right Bank by pipe inaccessible. Collected sample at estimated mixing zone. Water depth in pipe estimated.
WOA-FI1-10-D	29.83837	-95.45646	310	100	210	N	Pipe on inaccessible bank (RB). Pipe measurements estimated. Bat colony living under bridge and bat droppings observed on banks.
WOA-FI1-11-D	29.83853	-95.45673	200	310	-110	N	Large amount of bat droppings on banks. Decent flow from pipe. Pipe is on an inaccessible bank (RB). Pipe measurements estimated.
WOA-FI1-12-D	29.84030	-95.45853	100	410	-310	N	Large amounts of algae directly in front of pipe on LB to water's edge.
WOA-FI1-13-D	29.84199	-95.45860	520	200	320	Y-H	Flow just a trickle and moves through lots of algae. LB

Sample ID	Lat	Long	DS or Direct <i>E. coli</i> Sample Results (MPN/100 mL)	US <i>E. coli</i> Sample Results (MPN/100 mL)	Difference* DS - US (MPN/100 mL)	Referral	Comments
WOA-FI1-14-D	29.84477	-95.46004	860	630	230	N	At the confluence with Cole Creek (RB). Flowing quickly. Wastewater treatment plant discharge visible into Cole Creek.
WOA-FI1-NS-1	29.83194	-95.45317	NA	NA	NA	N	Not sampled. Cracked left bank. Suspect sheen on water pooled in crack.
WOA-T1-FI1-01	29.83836	-95.45287	100	NA	NA	N	First sample of the tributary of White Oak Bayou above tidal. Ambient sample taken due to lack of samples take beforehand. Gray-black layer on right bank substrate.
WOA-T1-FI1-02-D	29.83838	-95.45197	100	100	0	N	Unable to tell if water is flowing from pipe on RB because of minimal flow and pipe partially submerged.
WOA-T1-FI1-03-D	29.83843	-95.44956	410	< 100	310	Y-L	Water color slightly brown. Bottom of pipe rusted out. RB
WOA-T1-FI1-04-D	29.83844	-95.44731	< 100	< 100	0	N	RB
WOA-T1-FI1-05-D	29.83838	-95.44637	520	< 100	420	IF	Sampled small trib of main tributary. LB
WOA-T1-FI1-06-D	29.83868	-95.44640	100	< 100	0	N	Trickling pipe on LB.
WOA-T1-FI1-07-D	29.84090	-95.44637	< 100	< 100	0	N	2 pipes (1 on each bank and are almost directly across from each other). This sample was from pipe on LB.
WOA-T1-FI1-08-D	29.84091	-95.44643	100	< 100	0	N	Same upstream of WOA-T1-FI1-07-U. 2 pipes on each bank. This sample was from pipe on RB.
WOA-T1-FI1-09-P	29.84096	-95.44632	100	NA	NA	N	Leaking pipe on LB over tributary. The valves above pipe are highly corroded and leaking.
WOA-T1-FI1-10	29.84350	-95.44634	< 100	NA	NA	N	Ambient sample of stem that runs into tributary of WOA. This stem is providing water into tributary while the main tributary is disconnected to the upstream portion by ~8m. Stopped sampling.
WOA-T1-FI1-NS-1	29.83839	-95.45017	NA	NA	NA	N	Not sampled. Plastic pipe on RB just barely dripping.
WOA-T1-FI1-NS-2	29.83832	-95.45391	NA	NA	NA	N	Not sampled. 29.83832, -95.45391 to 29.83835, -95.45204: small fish kill of catfish and sunfish, continued to be scattered while walking upstream. Bass also seen. Once first bridge was reached, no more dead fish were seen. Lots of crawfish claws on substrate.

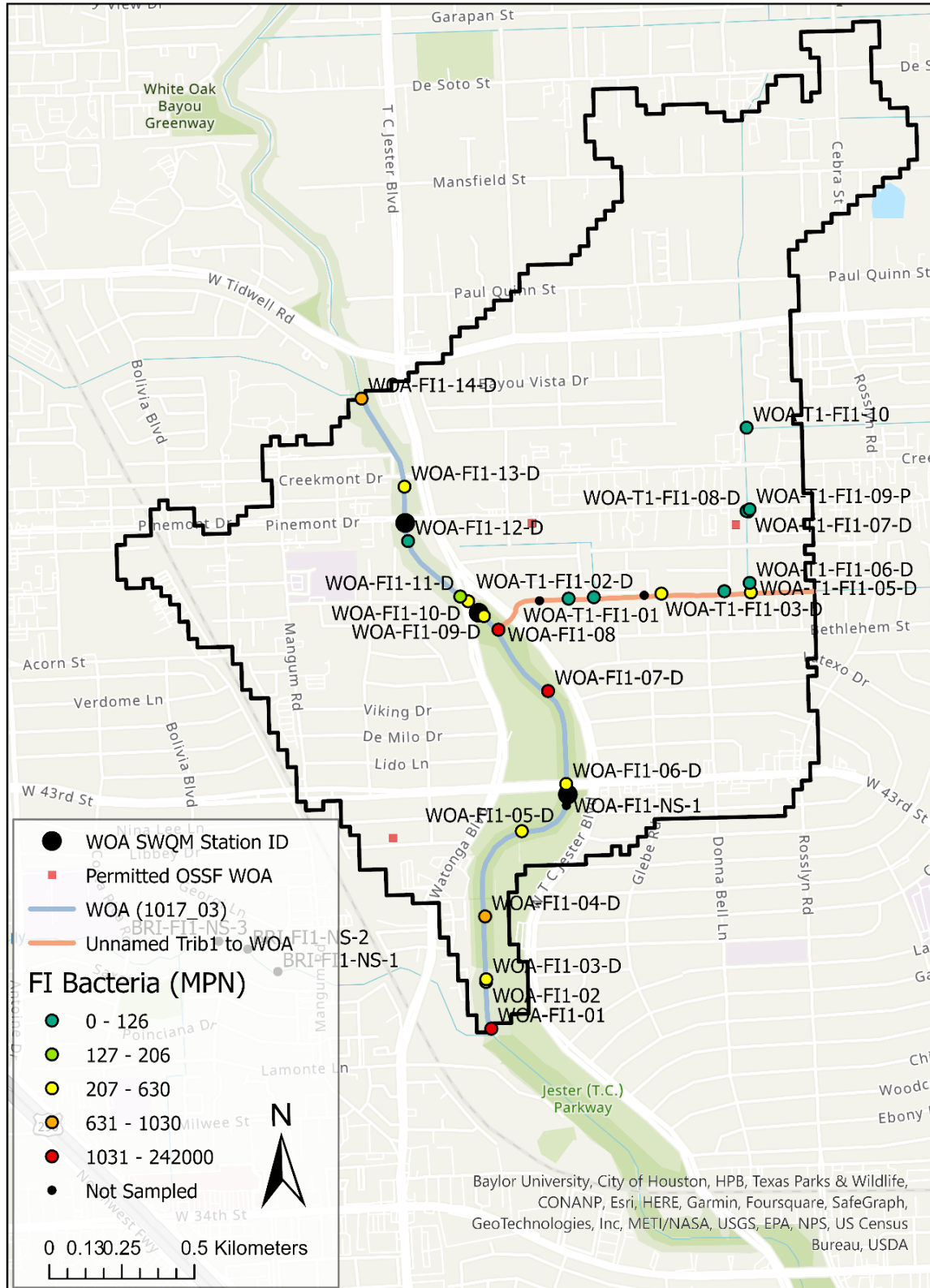


Figure 3: Field investigation bacteria sampling results from 4/3/2023 on White Oak Bayou Above Tidal (Assessment Unit 1017_03).

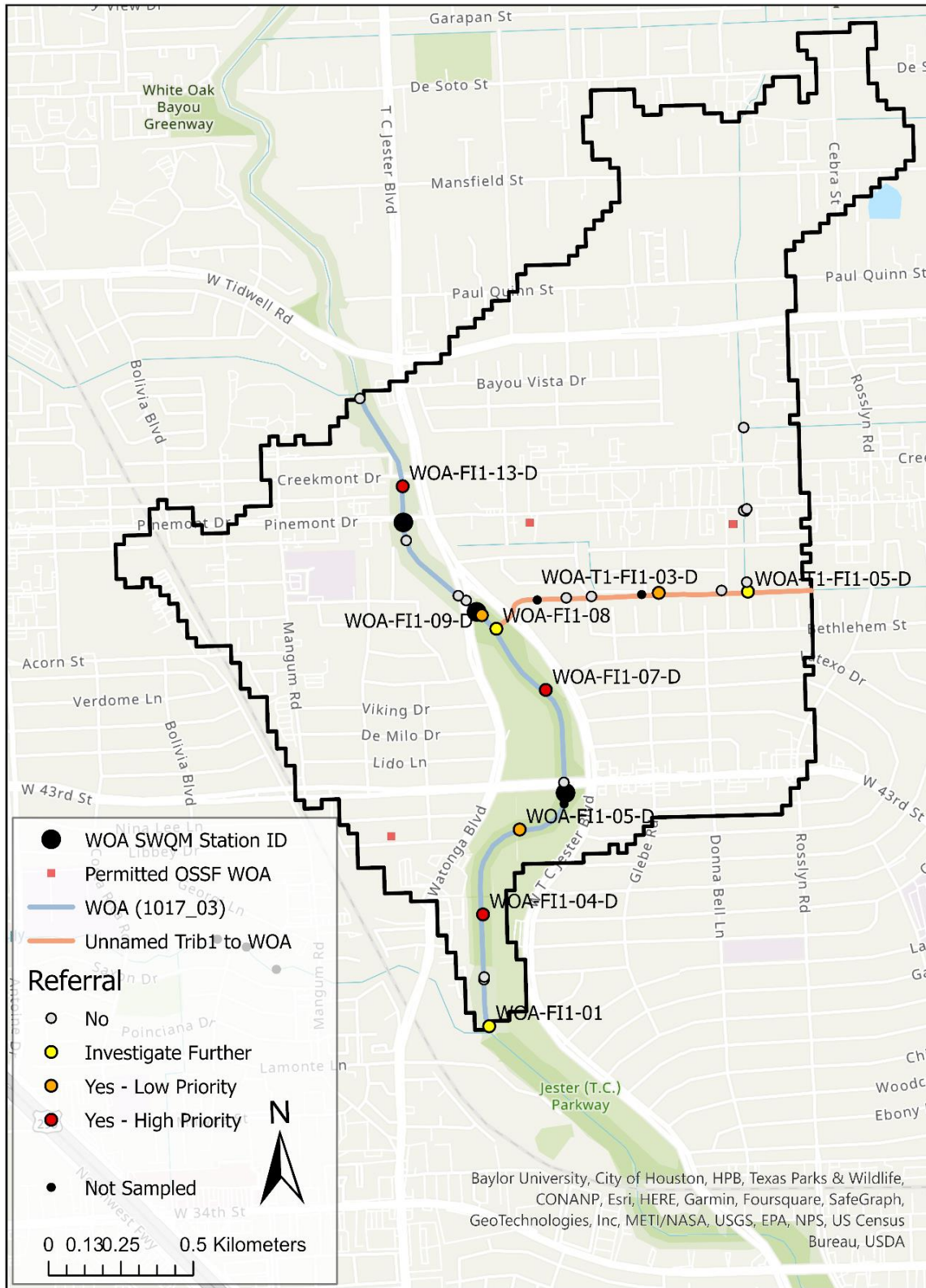


Figure 4: Field investigation sites sampled on 4/3/23 and identified for referral to the proper authorities on White Oak Bayou Above Tidal (Assessment Unit 1017_03).

Referral site: WOA-FI1-04-D - High Priority

This is a 52 in. diameter metal pipe located on the left bank of White Oak Bayou Above Tidal. Water within the pipe was 0.25 in. deep and discharged onto a concrete lining before entering the AU. There is a walking trail that runs parallel with the bayou located on the left bank of this sampling location. Many joggers with dogs were observed utilizing this trail as the field crew was sampling. There is also a park with a public pool located on the left bank of this site, as well as many residential homes located in the adjacent area on the left bank. The area on the right bank is predominantly residential, with many apartment complexes and several schools. A sample taken 5.0 m downstream of the pipe had a bacteria value of 750 MPN/100 mL. The ambient sample collected upstream of the pipe had a bacteria value of 100 MPN/100 mL. This pipe is a high priority referral site for the proper local authority.



Referral site: WOA-FI1-07-D – High Priority

This is a 32 in. diameter metal pipe located on the left bank of White Oak Bayou Above Tidal. Water within the pipe was 0.6 in. deep and lightly flowing onto the concrete lining and bank before entering the segment. The water coming out of the pipe was noted to be brownish in color. There is a walking trail running parallel to the bayou on the left bank. The area on the left bank is predominately a single-family residential area. A sample taken 4.0 m downstream of the pipe had a bacteria value of 2,430 MPN/100 mL. The ambient sample collected upstream of the pipe had a bacteria value of 300 MPN/100 mL. This pipe is a high priority referral site for the proper local authority.



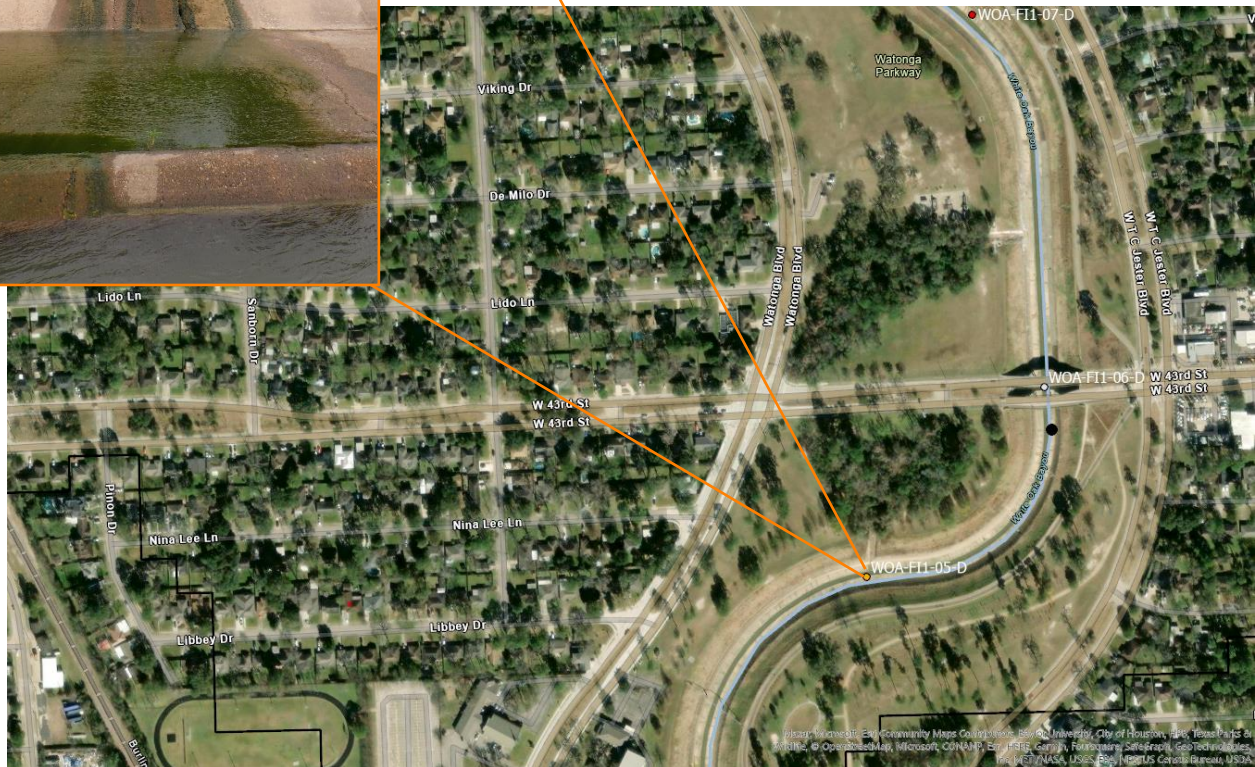
Referral site: WOA-FI1-13-D - High Priority

This is a 66 in. diameter metal pipe located on the left bank of White Oak Bayou Above Tidal. Water within the pipe was 1.0 in. deep and trickling through a large amount of algae before entering the AU. There is a walking trail that runs along the bayou. There are mostly small commercial and industrial properties located near this site. There is also a small lot with a port-o-potty where food trucks frequent on the left bank. A sample taken 15 m downstream of the pipe had a bacteria value of 520 MPN/100 mL. The ambient sample collected upstream of the pipe had a bacteria value of 200 MPN/100 mL. This pipe is a high priority referral site for the proper local authority.



Referral site: WOA-FI1-05-D – Low Priority

This is a concrete-lined, open-air ditch that flows into White Oak Bayou Above Tidal from the right bank. Water within the ditch was flowing onto the concrete lined right bank before flowing into the AU. The ditch is located between a small dense wooded area and the main AU. A sample collected from the ditch had a bacteria value of 310 MPN/100 mL. The ambient sample collected upstream of the ditch had a bacteria value of 200 MPN/100 mL. This ditch is a low priority referral site for the proper local authority.



Referral site: WOA-FI1-09-D – Low Priority

This is a 60 in. diameter concrete pipe located on the right bank of White Oak Bayou Above Tidal. Water within the pipe was estimated to be 0.25 in. deep and was slowly flowing down cracks in the concrete-lined bank before entering the segment. There are a small number of commercial buildings located in the area on the right bank, but the area is mostly single-residence homes. There is a walking trail along the right bank at this site. The right bank was inaccessible to the field crew at this location so the sample was collected at the estimated mixing zone 20 m downstream of the pipe and had a bacteria value of 410 MPN/100 mL. The ambient sample collected upstream of the pipe had a bacteria value of 200 MPN/100 mL. This pipe is a low priority referral site for the proper local authority.



Referral site: WOA-T1-FI1-03-D – Low Priority

This is a 32 in. diameter metal pipe located on the right bank of tributary 1 of White Oak Bayou Above Tidal. Water within the pipe was 0.25 in. deep and trickling into the AU. The bottom of the pipe was rusted out and the water color was noted to be slightly brown. The area surrounding the site on both banks includes single-family residences with some small industrial properties located on the other side of the residential neighborhood on the right bank. A sample 0.3 m downstream of the pipe had a bacteria value of 410 MPN/100 mL. The ambient sample collected upstream of the pipe had a bacteria value of < 100 MPN/100 mL. This pipe is a low priority referral site for the proper local authority.



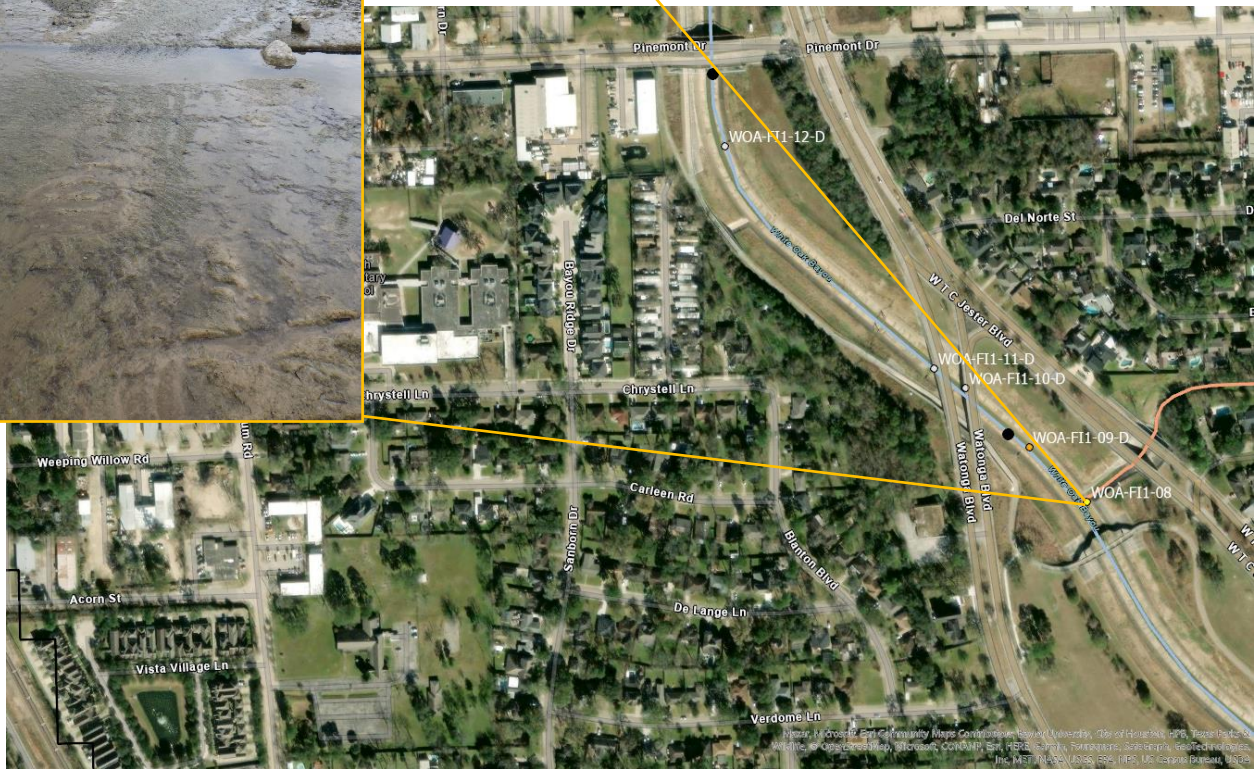
Referral site: WOA-FI1-01 – Investigate Further

This was an ambient sample taken at the most downstream portion of White Oak Bayou Above Tidal before the confluence with Brickhouse Gully. The ambient sample was taken just upstream of the mixing zone with Brickhouse Gully and had a bacteria value of 1,610 MPN/100 mL. The next sample taken upstream at WOA-FI1-02 had a bacteria value of 200 MPN/100 mL. There were no potential point sources observed between these two samples. Further investigation is recommended by the proper local authority to determine the source of elevated bacteria upstream of the segment. There are apartments and single-family homes located upstream of the site, as well as a small dog park on the left bank.



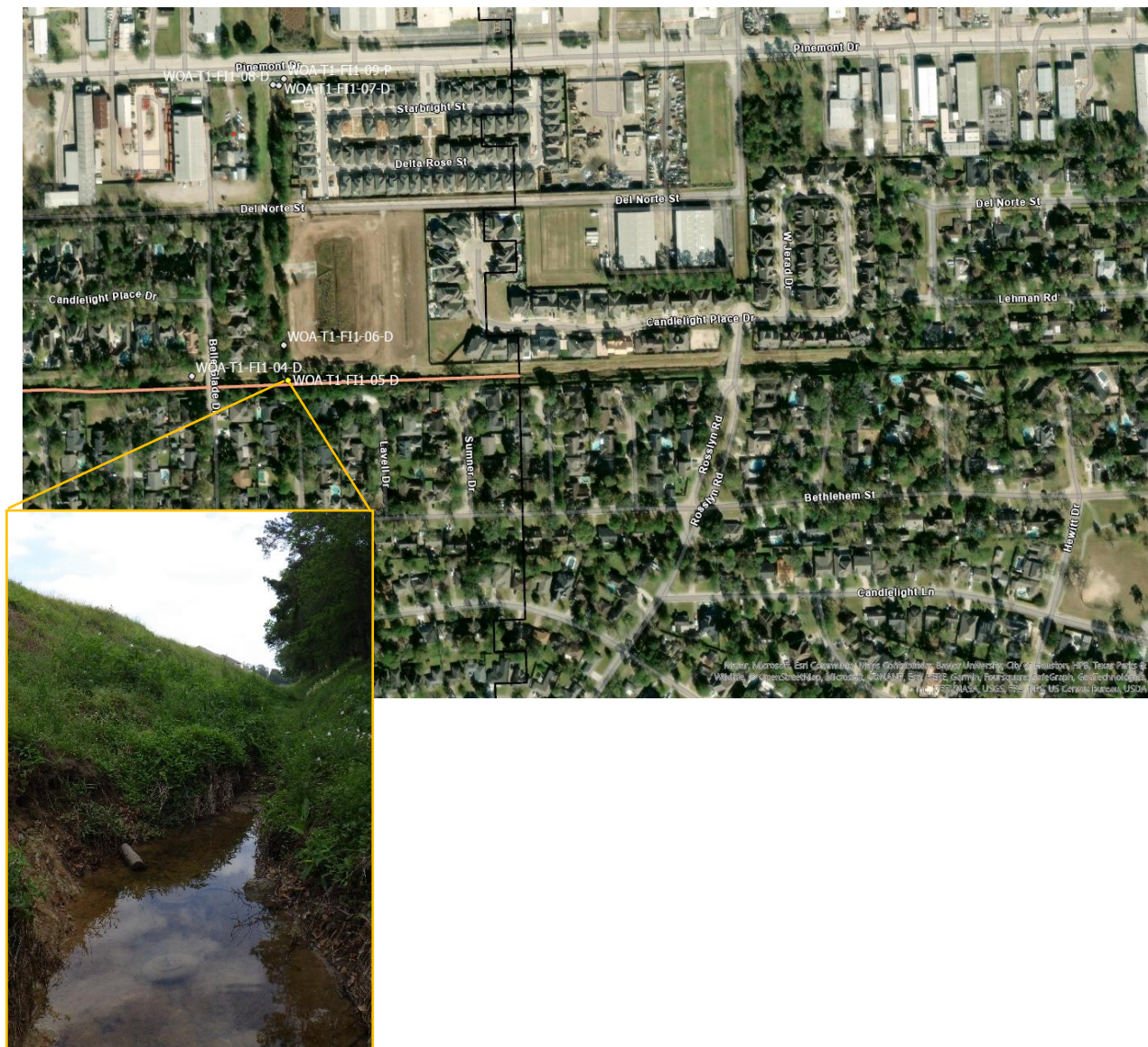
Referral site: WOA-FI1-08 – Investigate Further

This was an ambient sample taken at the most downstream portion of tributary 1 of White Oak Bayou Above Tidal before it flows into the main AU. The ambient sample was taken just downstream of the bridge of TC Jester Blvd. that runs over the tributary and had a bacteria value of 2,430 MPN/100 mL. There was a sample collected approximately 286 m upstream of this sample which was 100 MPN/100 mL, but there were no pipes that were observed to be flowing into the tributary in between these samples at the time of sampling. The TC Jester Blvd. bridge did have a colony of bats living under it and there was a large amount of bat droppings on both banks. Further investigation is recommended by the proper local authority to determine the source of elevated bacteria underground and upstream of the segment.



Referral site: WOA-T1-FI1-05-D – Investigate Further

This was an ambient sample taken at the most downstream portion of a small stem of tributary 1 of White Oak Bayou Above Tidal. The ambient sample collected from the smaller branch of the tributary had a bacteria value of 520 MPN/100 mL and an ambient sample collected on the main stem of tributary 1 upstream of this confluence was < 100 MPN/100 mL. Further investigation is recommended by the proper local authority to determine the source of elevated bacteria in this section of the tributary. There are single-family homes located upstream of the site on both banks.



List of Acronyms and Abbreviations

AU	Assessment Unit
BIG	Bacteria Implementation Group
CRP	Clean Rivers Program
DS	Downstream
E. Coli	Escherichia coli
FI	Field Investigation
FY	Fiscal Year
GIS	Geographic Information Systems
H-GAC	Houston-Galveston Area Council
IF	Investigate Further
in.	inch
I-Plan	Implementation Plan
km	kilometer
LB	Left Bank
m	meter
mL	milliliter
MPN	Most probable number
N	No
NELAP	National Environmental Laboratory Accreditation Program
NLCD	National Land Cover Database
OSSF	On-Site Sewage Facilities
QAPP	Quality Assurance Project Plan
RB	Right Bank
SWQM	Surface Water Quality Monitoring
SWRC	Stroud Water Research Center
T or trib.	Tributary
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
US	Upstream
WOA	White Oak Above Tidal 1017_03
WS	Windshield Survey
Y-H	Yes – High Priority
Y-L	Yes-Low Priority

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