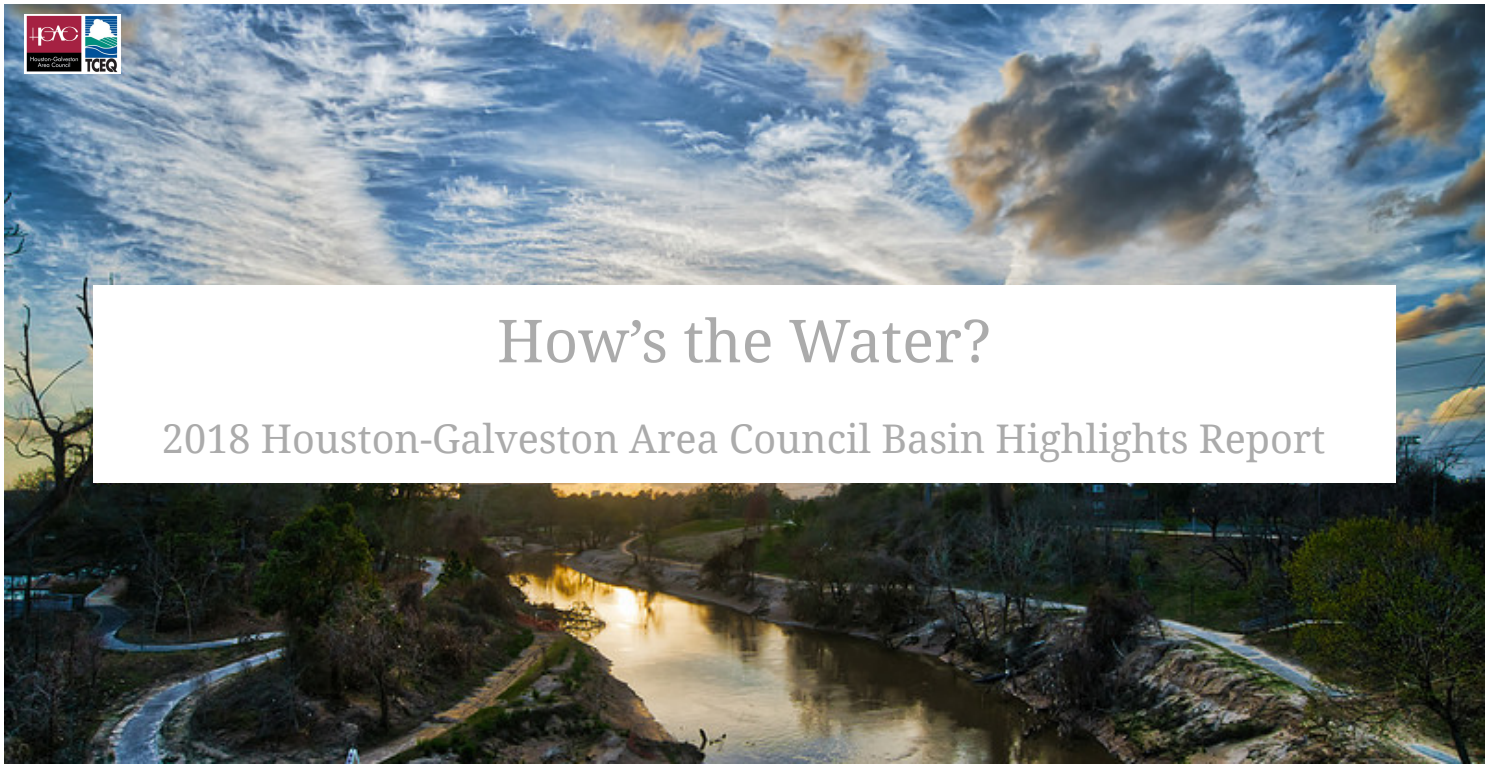


How's the Water?

2018 Houston-Galveston Area Council Basin Highlights Report

Watershed Characterizations for the Houston Ship Channel/Buffalo Bayou Tidal, Chocolate Bayou Tidal, and Chocolate Bayou Above Tidal

Clean water is essential.

Just as clean water is essential for life itself, it is also essential for the quality of our lives.

Water is all around us. It flows through rural areas, our neighborhoods, and our cities. These waterways come in all shapes and sizes, from small drainage ditches and meandering creeks to seemingly lazy bayous and major rivers. All of them connect to one of the most productive estuaries in the nation, Galveston Bay, and ultimately the Gulf of Mexico.

We walk and picnic near them, splash, swim, fish, and sail on them. Keeping them clean must be a priority for all of us. These waters help fuel a strong economy, bringing in billions of dollars a year and providing tens of thousands of jobs in commercial and recreational fishing and tourism.

The 2018 Basin Highlights Report provides an overview of water quality and data trends in the Houston-Galveston region's surface waters.

Houston Ship Channel

This report characterizes the Houston Ship Channel/Buffalo Bayou Tidal (Segment 1007), Chocolate Bayou Tidal (Segment 1107), and Chocolate Bayou Above Tidal (Segment 1108) watersheds to identify

• Specific water quality issues and trends.

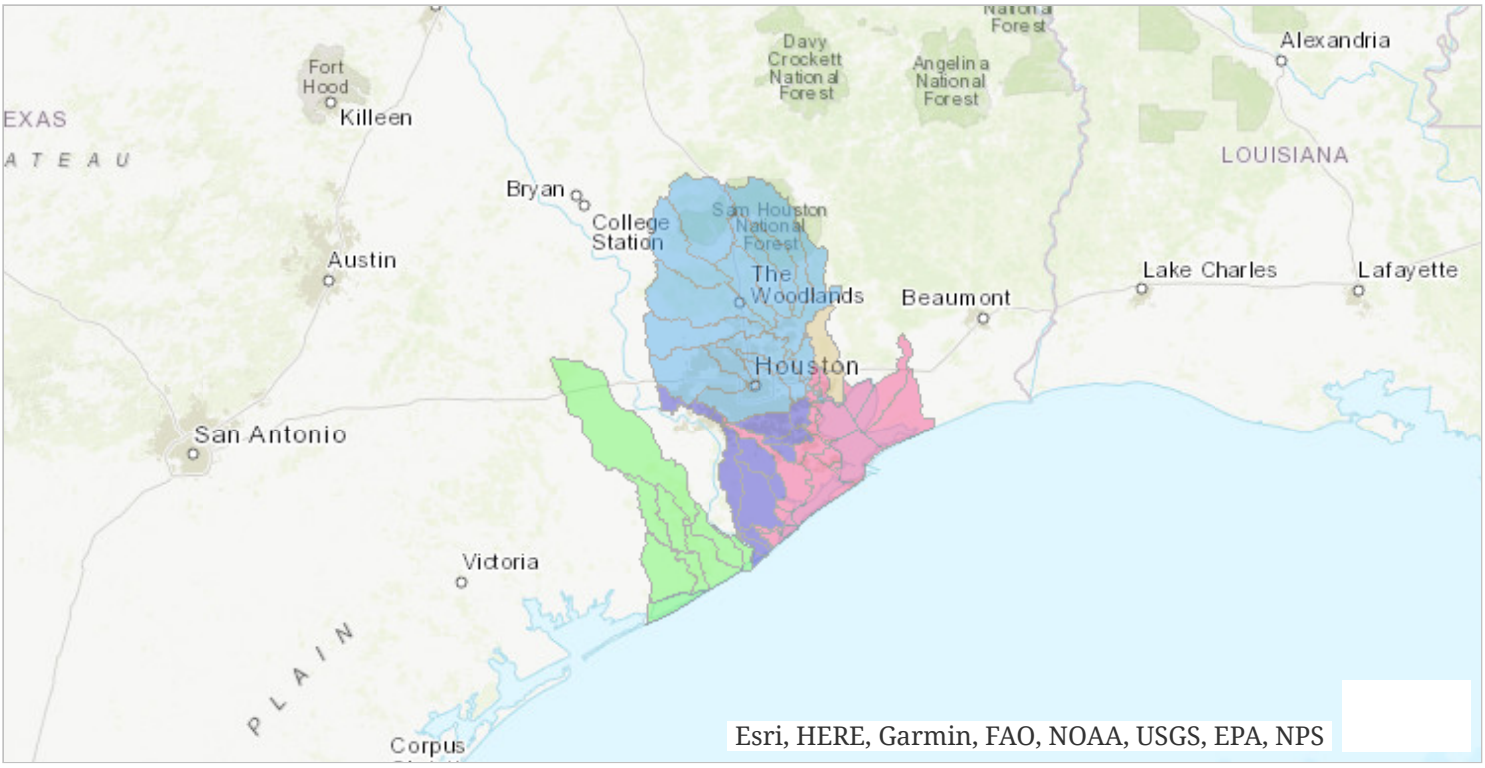
• Sources of point and nonpoint pollution.

• Current strategies and plans to reduce pollution within these watersheds.

• Current and potential stakeholders working within these watersheds

Since 1991, the Texas Clean Rivers Program (link: https://www.tceq.texas.gov/waterquality/clean-rivers) (CRP) has provided a framework for addressing water quality issues through an all-inclusive watershed approach. In partnership with the Texas Commission on Environmental Quality (TCEQ) and local water authorities, the Clean Rivers Program manages and conducts water quality monitoring, evaluation, and public outreach to improve water quality within the state.

H-GAC Clean Rivers Program Basins



Bays and Estuaries

Brazos-Colorado Coastal Basin

San Jacinto River Basin

San Jacinto-Brazos Coastal Basin

Trinity-San Jacinto Coastal Basin

H-GAC's Clean Rivers Program (link: http://www.h-gac.com/community/water/rivers/default.aspx) organizes and conducts ambient surface water quality monitoring and assessment in four basins: San Jacinto River Basin, Trinity-San Jacinto Coastal Basin, San Jacinto-Brazos Coastal Basin, and Colorado-Brazos Coastal Basin.

The basins include all or a portion of 15 counties and 131 cities, towns, villages, and census-designated places, with a population of almost seven million people.

H-GAC works with seven partners to conduct water monitoring within the basins:

• City of Houston Health Department.

• City of Houston Drinking Water Operations.

• Environmental Institute of Houston, University of Houston-Clear Lake (EIH).

• Harris County Pollution Control Services Department.

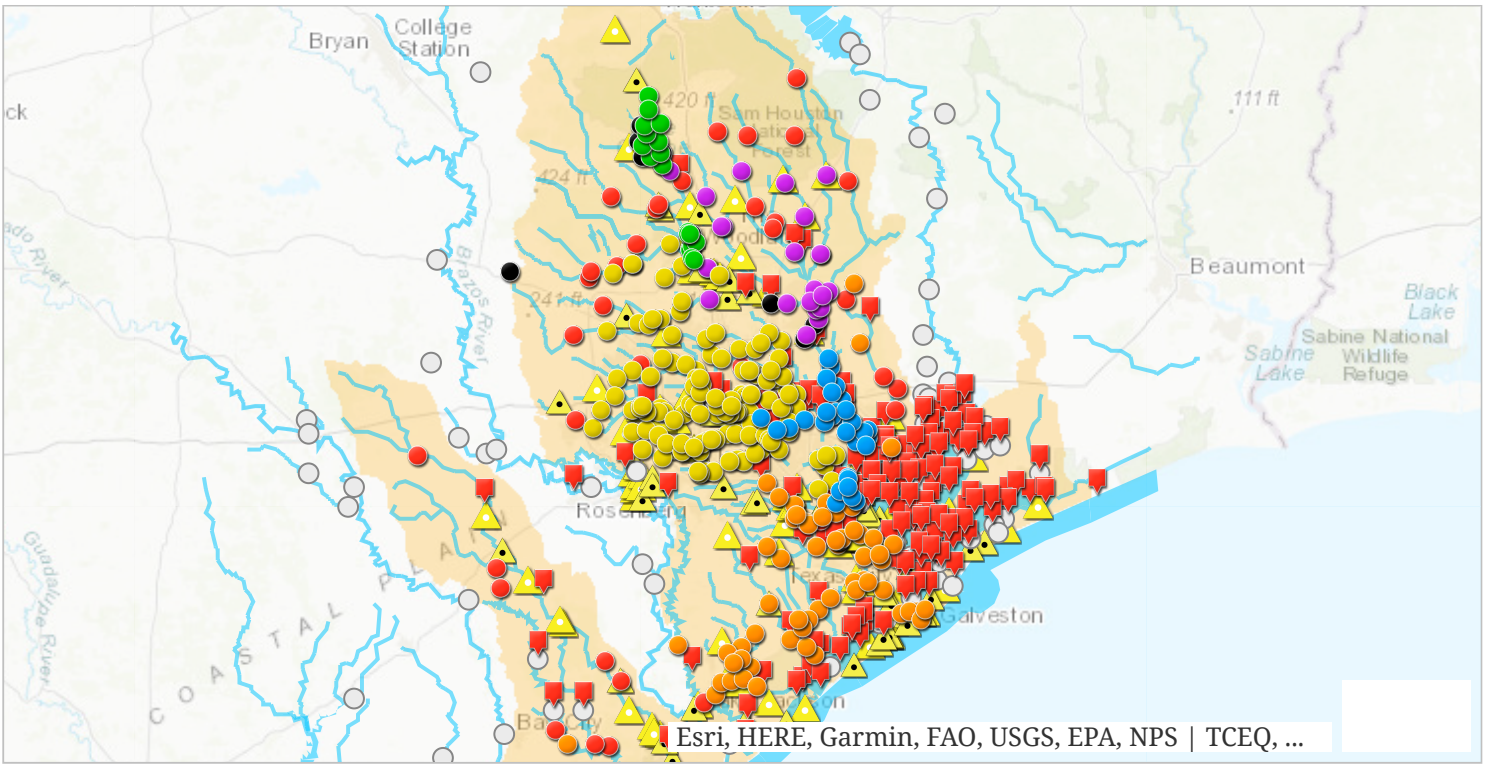
• San Jacinto River Authority (SJRA).

• Texas Research Institute for Environmental Studies (TRIES).

• United States Geological Survey (USGS).

H-GAC and partners collect water quality data at more than 400 monitoring locations. The data are used to analyze, evaluate, and communicate water quality conditions to stakeholders and community members.

Clean Rivers Program Monitoring Stations



Each shape on the map represents a monitoring station. Click on a monitoring station to learn more about it and to view the water quality data collected at that location. For more information, please visit www.h-gac.com/go/wrim (link: https://www.h-gac.com/go/wrim) .

- **Harris County Pollution Control**
- **San Jacinto River Authority**
- **Environmental Institute of Houston**
- **Houston Health Department**
- **Houston Water Quality Control**
- **USGS**
- **H-GAC**
- **TCEQ**
- **Neighboring CRP Agencies**
- **Texas Stream Team Monitoring Sites**
- **HCFCD/City of Houston PWE: Inactive**
- **Texas Stream Team Monitoring Sites: Inactive**

Bacteria

Bacteria Impairments and Concerns

Not Impaired

Concern

Impaired

Eight percent of lakes, 58 percent of freshwater streams, and 56 percent of tidal streams in the H-GAC basins have an impairment or concern for bacteria. No bays are impaired for enterococci bacteria but may be impaired for oyster harvesting due to elevated concentrations of fecal coliform bacteria.

Bacteria concentrations are measured to ensure a water body is safe for recreation. Enterococci is collected in tidal waterways, while E. coli is collected in freshwater. Both are found in the digestive tracts of people and other animals and are used as indicators of the presence of sewage and pathogens (such as infectious bacteria, viruses, and protozoans). High bacterial concentrations may cause gastrointestinal illnesses or skin infections in swimmers or others who come into direct contact with the water.

Sources of bacterial contamination include:

• Untreated wastewater treatment facility (WWTF) releases.

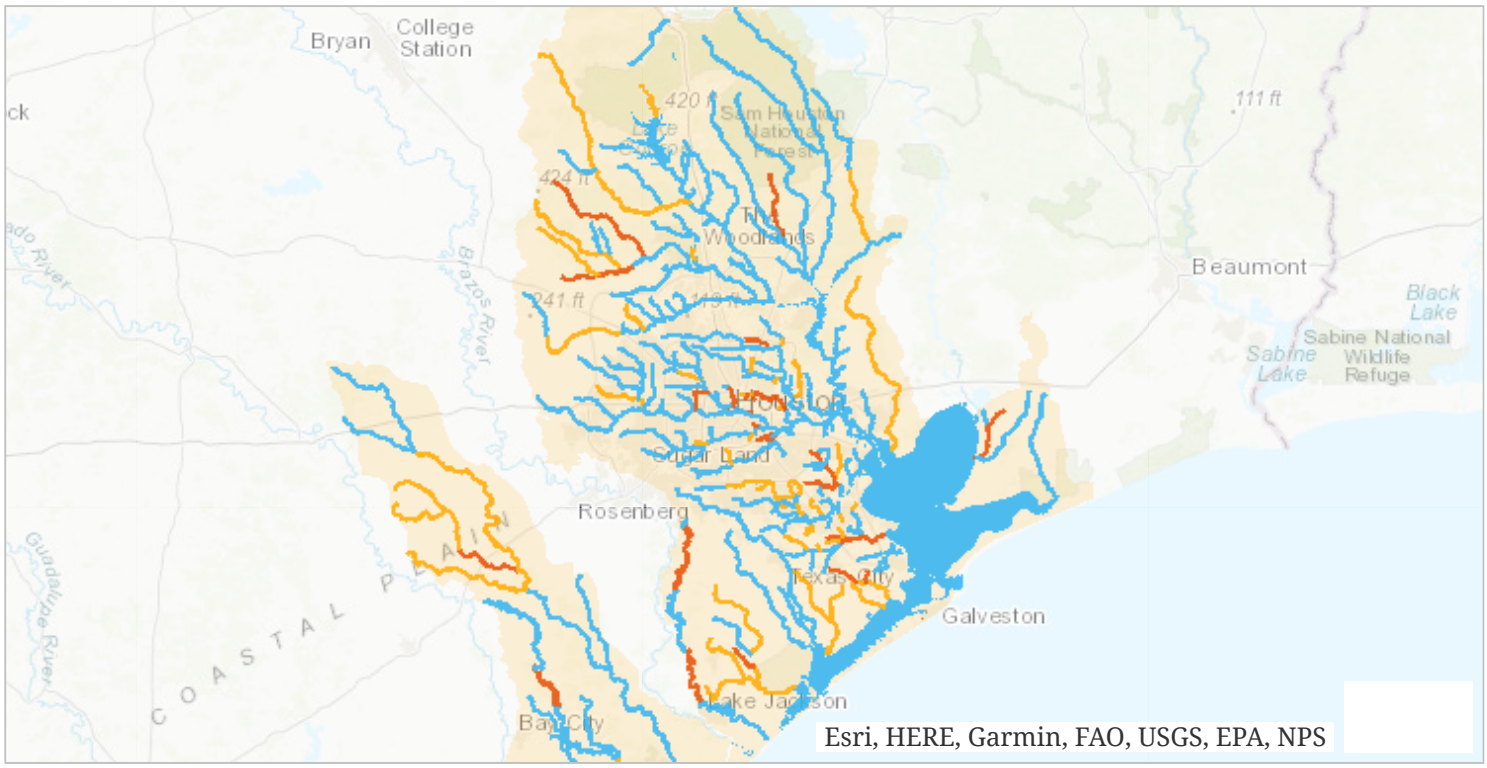
• Sanitary sewer overflows.

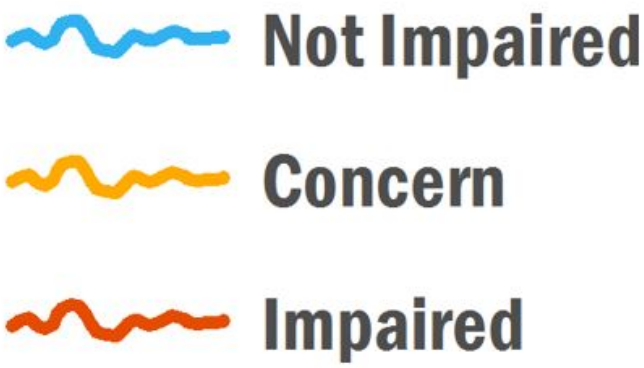
• Failing on-site sewage facilities (septic systems).

• Fecal waste from livestock, pets, feral hogs, and wildlife.

Since 2002, bacteria levels improved or remained consistent across the H-GAC CRP basins; only 6 percent of the assessed waterbodies worsened, 25 percent improved, and 69 percent stayed the same.

Dissolved Oxygen Impairments and Concerns





Eight percent of lakes, 29 percent of freshwater streams, 33 percent of tidal streams, and 7 percent of bays in the H-GAC basins have an impairment or concern for dissolved oxygen (DO).

DO levels are measured to ensure a water body can support aquatic life. Higher levels of DO can support more abundant and diverse aquatic species. DO levels fluctuate naturally based on season and time of day; however, human influence can have a negative effect. Sudden or prolonged decreases in DO could result in fish kills.

DO can be negatively impacted by

• High concentrations of nutrients causing algal blooms.

• Sediment from construction sites.

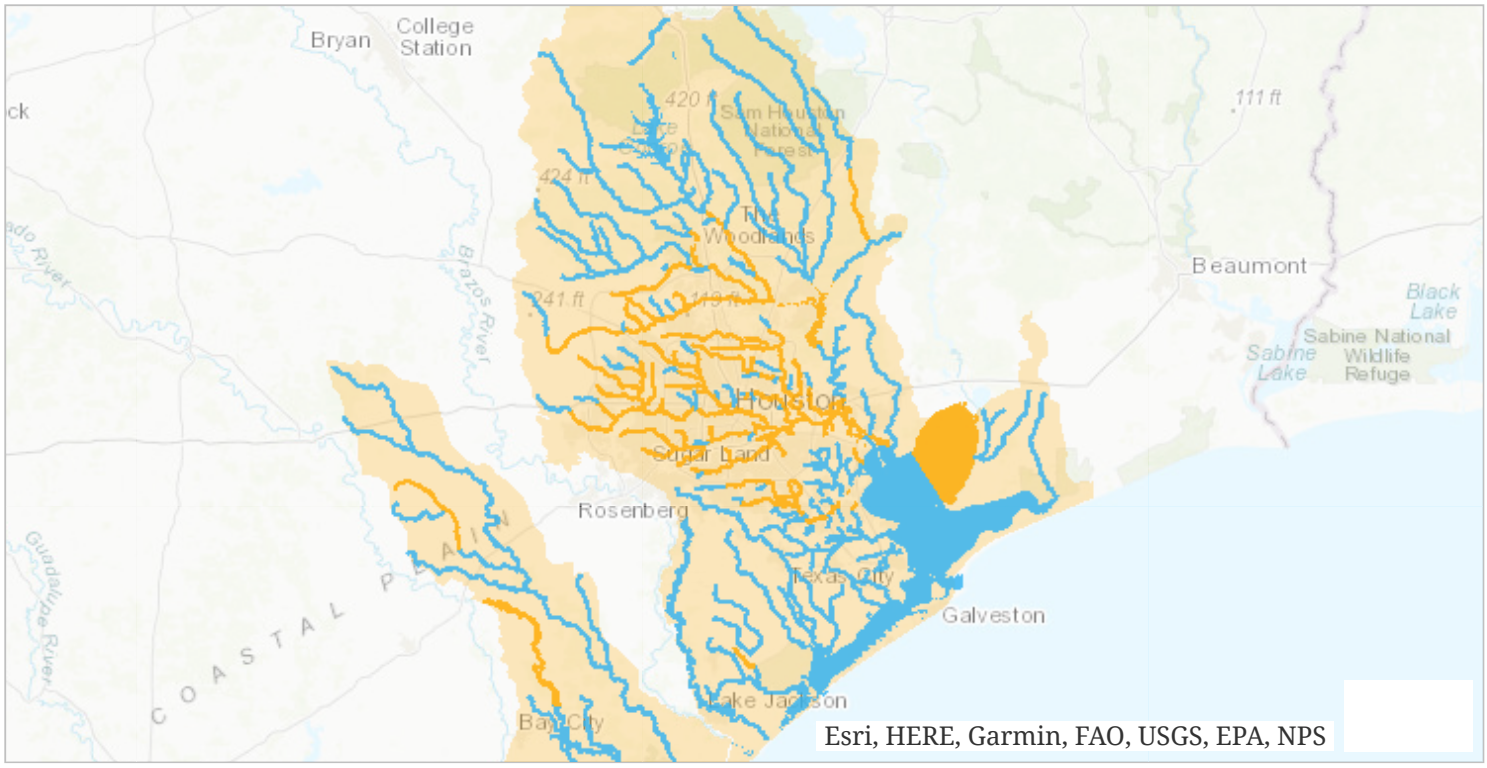
• Overgrazing of livestock.

• Stream channel modification and development.

• Reduced riparian tree cover.

Since 2002, DO levels improved or remained consistent in most waterways. In the assessed basins, 6 percent got worse, 16 percent improved, and 78 percent stayed the same.

Nutrient Impairments and Concerns



Not Impaired

Concern

Forty percent of lakes, 37 percent of freshwater streams, 33 percent of tidal streams, and 36 percent of bays in the H-GAC basins have a concern for nutrients.

Nutrients, including phosphorus and nitrogen, occur naturally in surface waters. They are an important part of a healthy aquatic ecosystem. However, human factors can contribute excessive nutrients to water bodies. High concentrations of nutrients can result in algal blooms, which can depress DO levels and produce toxins that are harmful to humans and aquatic species.

Sources of nutrient pollution include

• Fertilizer runoff from lawns and agricultural fields.

• Manure.

• Sewage treatment plant discharges.

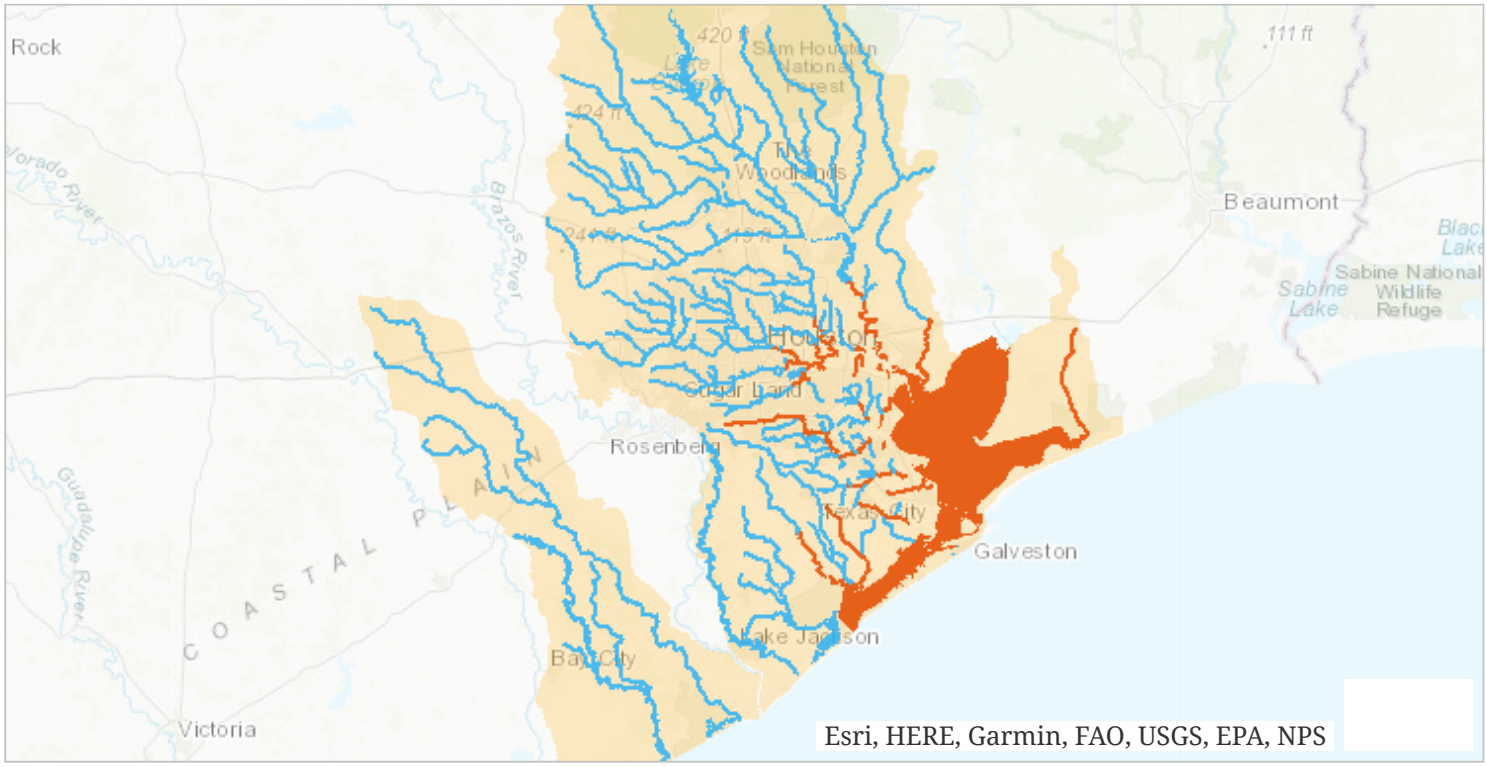
• Stormwater runoff.

• Failing on-site sewage facilities, including septic systems.

Since 2002, nutrient levels increased in 31 percent of area waterways. Nutrient levels decreased in 17 percent of the waterways and remained the same in 52 percent.

PCBs/Dioxin

PCBs and Dioxin Impairments and Concerns



Not Impaired

Impaired

Two percent of freshwater streams, 56 percent of tidal streams, and 67 percent of bays have an impairment for PCBs and Dioxin. No lakes are impaired.

PCBs and Dioxin are broad groups of synthetic organic compounds developed for industrial purposes or are by-products of industrial processes. PCBs and Dioxin are toxic and carcinogenic. PCBs and Dioxin are legacy pollutants, meaning they can remain in the environment long after they are introduced. Both accumulate in the fatty tissue of marine life, and humans can be exposed through consumption of contaminated fish and shellfish. The TDSHS advises adults to consume no more than one 8-ounce meal per month of all fish species or blue crab caught in Chocolate Bayou Tidal. Women of childbearing age and children under 12 should not consume any fish or blue crab from this area.

Regional Changes to Water Quality


Hurricane Harvey Photos

Hurricane Harvey

On Friday, August 25, 2017, Hurricane Harvey hit the Texas coast between Port Aransas and Port O'Connor. By Monday, the storm had dumped over 27 trillion gallons of rain, and large areas of Houston and the surrounding areas were under water.


Recovery Effects from Hurricane Harvey

Regional Population Growth

Since 1990, the Houston-Galveston regional economy has grown dramatically, fueling rapid population growth. The population of Harris County has grown by 67 percent in the past 27 years to 4.7 million people, becoming the third largest county in the United States. The total population for the 13-county region is approximately seven million, about the same as Arizona, the nation's 14th most populous state.

More people means more concrete, sanitary sewer systems, onsite sewage facilities, fertilizers, and dogs, all of which influence water quality.

So, How's the Water?

Approximately 80 percent of monitored water bodies in the H-GAC region do not meet state standards or screening criteria levels for bacteria, dissolved oxygen, nutrients, or other water quality parameters. The good news is water quality is improving. However, progress has been incremental, and in some cases, little change is evident.

Clean water is essential to the region, and up-to-date information is essential to understanding its complex water quality issues.

To illustrate the region's impairments or concerns, the Clean Rivers Program compiles a comprehensive summary chart of regional water quality for six parameters, covering 54 waterway segments in four basins and bays and estuaries.

Click here to view the 2018 Water Quality Summary Chart (link: http://arcgis02.h-gac.com/bhr2018/doc/FrogChart_2018.pdf) .

Photo Credits: City of Houston Health Department, Harris County Flood Control District, United States Marine Corp, John Stephen Chandler/flickr (link: https://flic.kr/p/24tJGp4)

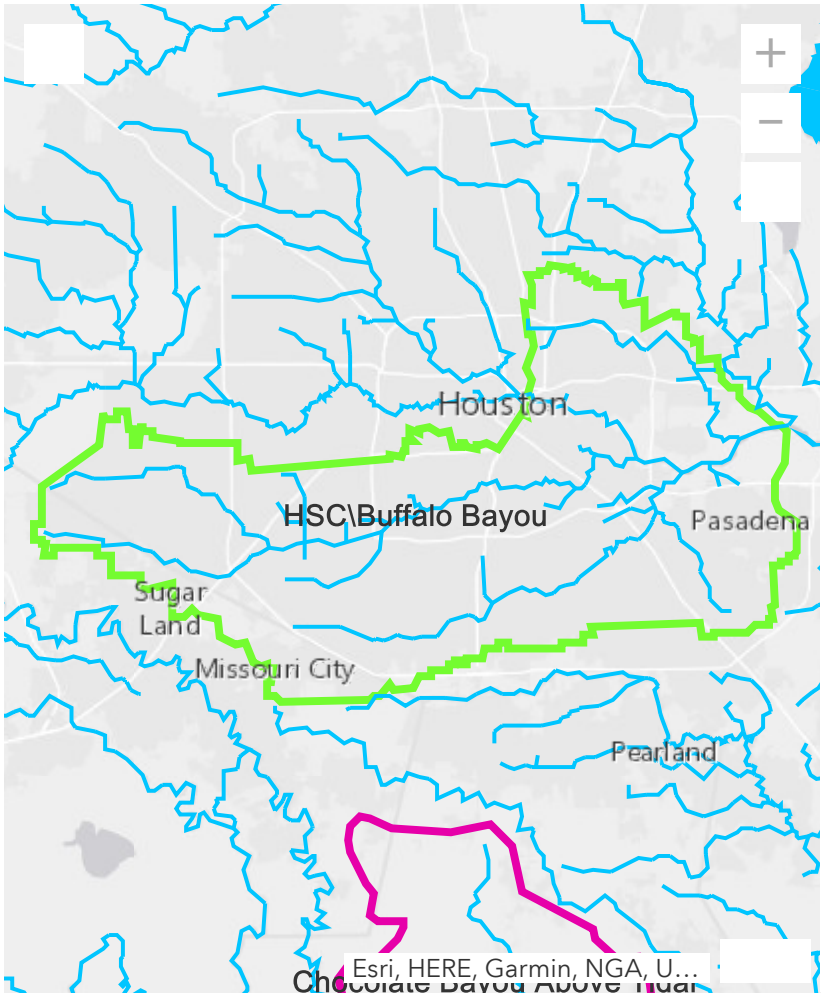
The application was prepared in cooperation with and financed though funding from the Texas Commission on Environmental Quality.

Houston-Galveston Area Council

P.O. Box 22777 | Houston, TX 77227-2777 | www.h-gac.com (link: http://www.h-gac.com)

1007 Introduction

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/0DiX09.



Legend

AU (Streams)

AU (Water Bodies)

Watersheds

- Chocolate Bayou Above Tidal
- Chocolate Bayou Tidal
- HSC\Buffalo Bayou

SEGMENT DESCRIPTION

1007 HSC/Buffalo Bayou Tidal Segment Map (On Right)

As defined in the Texas Surface Water Quality Standards (TSWQS), the Houston Ship Channel/Buffalo Bayou Tidal segment (1007) extends from a point immediately upstream of Greens Bayou in Harris County to a point 100 meters upstream of US 59 in Harris County, including tidal portions of tributaries.

Segment 1007 includes the Houston Ship Channel (HSC), Buffalo Bayou Tidal, and several tidal and nontidal tributaries. The watershed is urban, heavily developed, and includes portions of the cities of Houston, Jacinto City, Missouri City, Pasadena, South Houston, Stafford, and Galena Park, and the cities of Bellaire, West University Place and Southside Place.

Classified segment 1007 has eight assessment units (AUs). Twenty unclassified segments contain a total of 26 AUs.

(link available only in online story)Click to View the 1007 HSC/Buffalo Bayou Tidal Assessment Unit Map (link available only in online story)

The Texas Commission on Environmental Quality (TCEQ) defines the classified segment AUs as:

- **1007_01** Houston Ship Channel—From a point immediately upstream of Greens Bayou Tidal to immediately upstream of the 69th Street WWTP outfall.
- **1007_02** Sims Bayou Tidal—From the Houston Ship Channel confluence to a point 11 km (6.8 mi) upstream.
- **1007_03** Hunting Bayou Tidal—From the Houston Ship Channel confluence to IH-10.
- **1007_04** Brays Bayou Tidal—From the Houston Ship Channel confluence to downstream of IH-45.
- **1007_05** Vince Bayou Tidal—From the Houston Ship Channel confluence to SH 225.
- **1007_06** Berry Bayou—From the Houston Ship Channel confluence to a point 2.4 km upstream of the Sims Bayou confluence.
- **1007_07** Buffalo Bayou—From immediately upstream of 69th Street wastewater treatment plant outfall to US 59.
- **1007_08** Little Vince Bayou Tidal—From the Vince Bayou confluence to SH 225.

The unclassified tributaries contributing to the classified segment 1007 have been divided into individual segments.

1007 HSC/Buffalo Bayou Tidal Unclassified Segments		
Segment Number	**Segment Name**	**Assessment Units**
1007A	Canal C-147 Tributary of Sims Bayou Tidal	1007A_01
1007B	Brays Bayou Above Tidal	1007B_01, 1007B_02
1007C	Keegans Bayou Above Tidal	1007C_01
1007D	Sims Bayou Above Tidal	1007D_01, 1007D_02, 1007D_03
1007E	Willow Waterhole Above Tidal	1007E_01
1007F	Berry Bayou Above Tidal	1007F_01
1007G	Kuhlman Gully Above Tidal	1007G_01
1007H	Pine Gully Above Tidal	1007H_01
1007I	Plum Creek Above Tidal	1007I_01
1007K_01	Country Club Bayou Above Tidal	1007K_01
1007L	Unnamed Tributary of Brays Bayou	1007L_01
1007M	Unnamed Tributary of Hunting Bayou	1007M_01
1007N	Unnamed Tributary of Sims Bayou	1007N_01
1007O	Unnamed Tributary of Buffalo Bayou	1007O_01
1007R	Hunting Bayou Above Tidal	1007R_01, 1007R_02, 1007R_03, 1007R_04
1007S	Poor Farm Ditch	1007S_01
1007T	Bintliff Ditch	1007T_01
1007U	Mimosa Ditch	1007U_01
1007V	Unnamed Tributary of Hunting Bayou	1007V_01
1007W	Harris County Flood Control District (HCFD) Channel D-138/Chimney Ditch	1007W_01

Click to View the 1007 HSC/Buffalo Bayou Tidal Subwatersheds Map (link available only in online story)

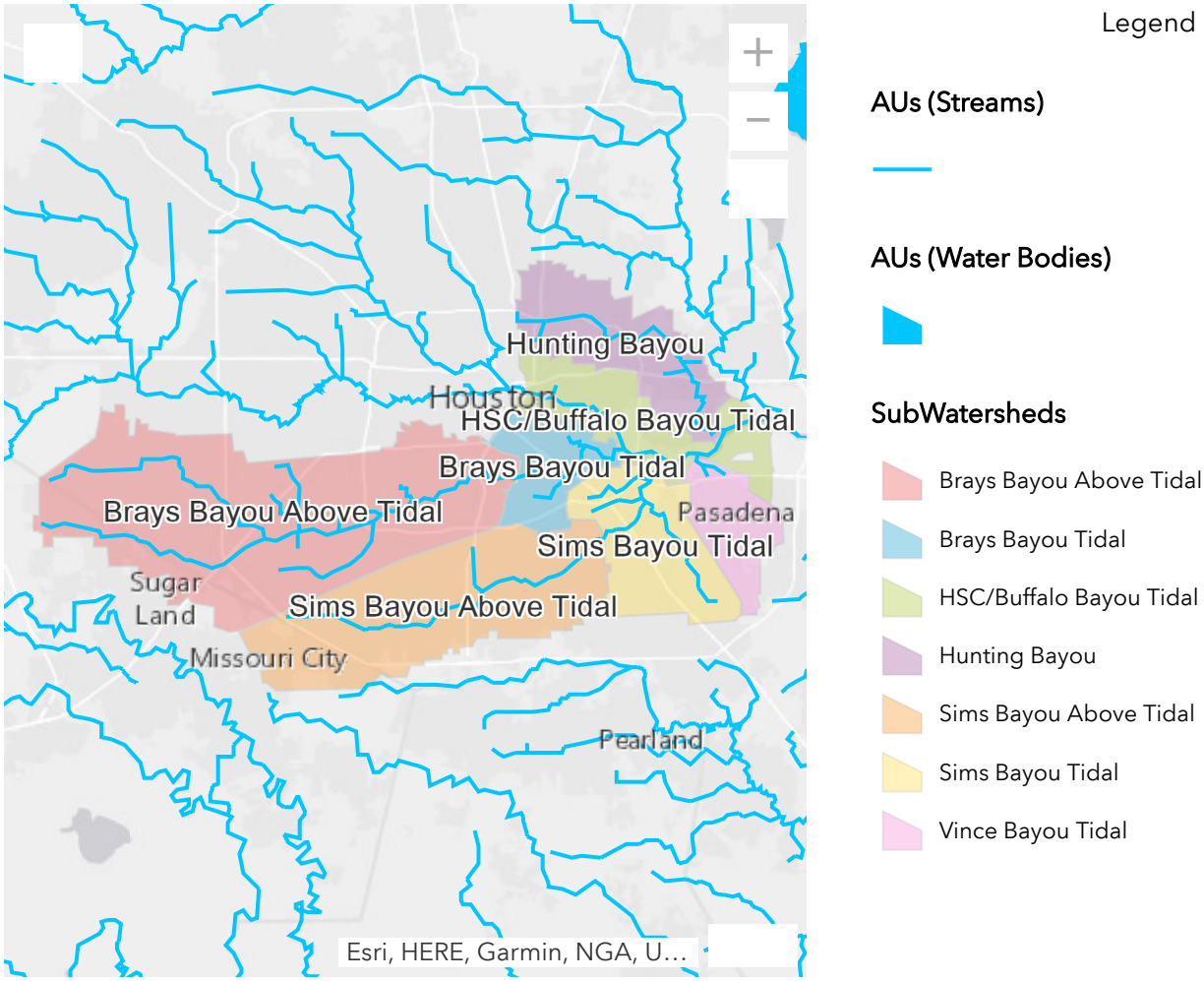
Segment 1007 is not a linear waterway. It includes the tidal portions of six tributary bayous. For this characterization, H-GAC has divided 1007 into seven subwatersheds by identifying the predominant water body in each. This allows a more detailed investigation of the characteristics, water quality issues, and potential pollution sources in the segment.

The seven subwatersheds are:

- Brays Bayou Above Tidal.
- Brays Bayou Tidal.

- HSC/Buffalo Bayou Tidal.
- Hunting Bayou.
- Sims Bayou Tidal.
- Sims Bayou Above Tidal.
- Vince Bayou Tidal.

HYDROLOGICAL CHARACTERISTICS



1007 HSC/Buffalo Bayou Tidal Hydrology Map (On Right)

Segment 1007 is in the Gulf Coast Prairies and Marshes ecoregion. This region is characterized by salt grass marshes, tall grass prairies, live oak groves, and river bottom woodlands. The area is relatively flat, with maximum elevations of approximately 50–60 feet above sea level in the western portion of the watershed, down to sea level in the eastern portion.

Segment 1007 is 36.9 miles long. The combined length of the segment and its tributaries is 126.1 miles. The total drainage area for the watershed is 296 square miles.

Segment 1007 is part of Port Houston. The port's channel has been widened and deepened by dredging to accommodate barge traffic. The widest point of the channel is 530 feet with a maximum depth of 45 feet. Ship terminals, berths, docks, and industrial facilities are located along the channel.

Nearly all unclassified segments in 1007 are channelized for flood conveyance. Many have concrete flat bottoms and partial-trapezoidal concrete sides. Historically, little vegetative canopy was left along stream channels and banks. Stream banks were typically lined with lawn grass and mowed on a regular basis. However, through recent initiatives such as the Bayous Greenways Project, linear parks with tree canopy and native vegetation are being created along Brays, Sims, and Hunting bayous.

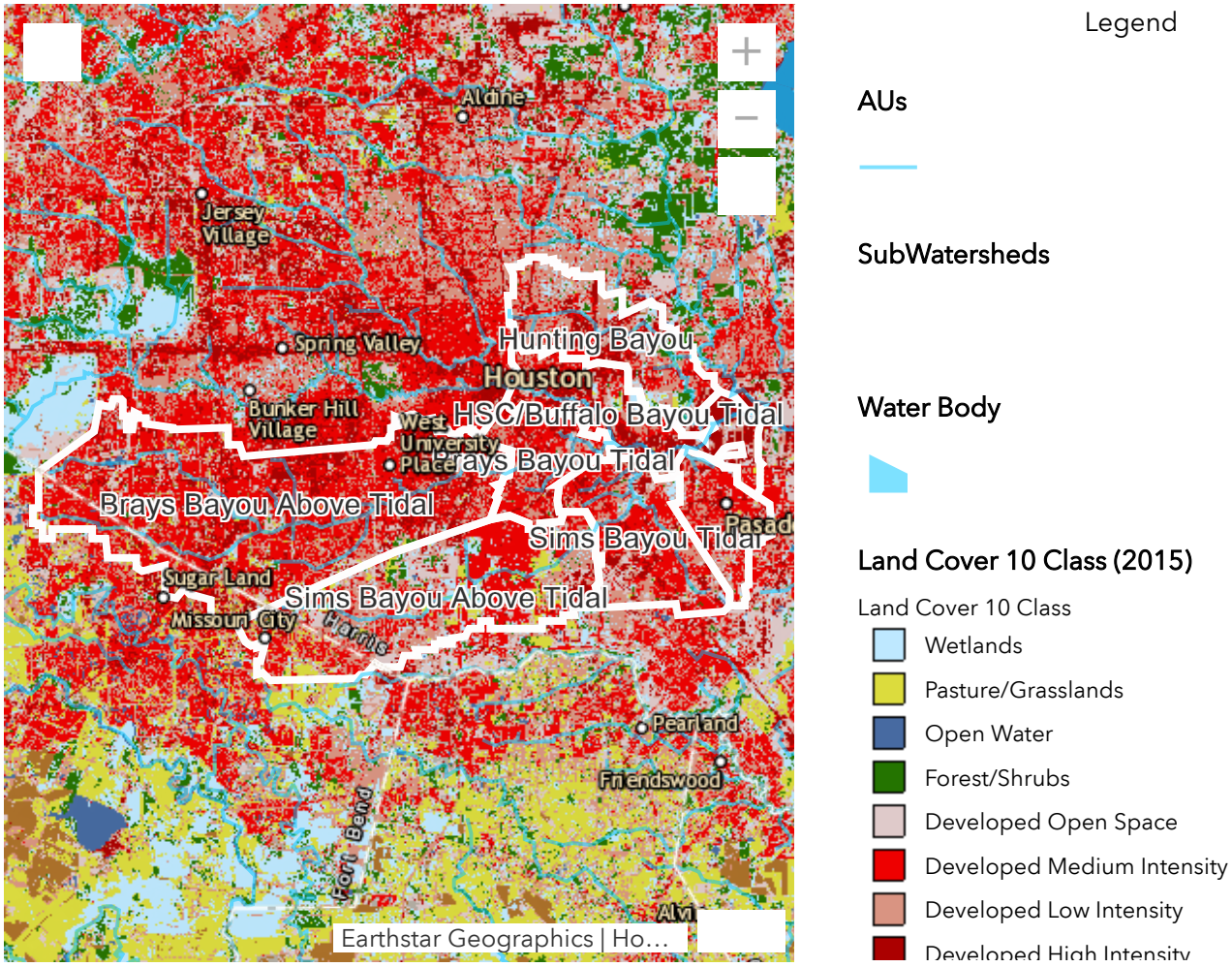
Harris County Flood Control District (HCFCD) has constructed several detention/retention basins/ponds to mitigate the effects of flash flooding in the watershed. Detention basins are generally connected to the bayous via spillways or controlled-release outlets.

HCFCD operates 28 stream gages with real-time elevation sensors and rainfall gages as part of the **HCFCD Flood Warning System** (link: https://www.harriscountyfws.org) . While these gages do not provide discharge data, they provide stream elevation data that can be used to estimate flow. This qualitative data could be used to augment the field parameter Flow Severity.

Click to View the U.S. Geological Survey Streamflow Gages (link available only in online story)

There are 15 active U.S. Geological Survey (USGS) streamflow gages collecting various types of streamflow and discharge data in this watershed. Eight gages provide real-time discharge data, meaning the instruments record stream flow data at 15- to 60-minute intervals and transmit the data at one- to four-hour intervals for posting on the USGS web site. Three gages provide real-time stage data but USGS only computes discharge during selected conditions, such as high flow. Three gages are set up as sample sites where instantaneous flow measurements are collected along with water samples. There are no time-series records available for either stage or discharge at these three. There is one stage-only gage site where USGS makes no attempt to compute a discharge. USGS provides only a continuous record of stage throughout the year. Those sites providing height/elevation data supply qualitative data about the flow conditions in the stream.

LAND COVER AND NATURAL CHARACTERISTICS



1007 Chocolate Bayou Tidal Land Cover Map (On Right)

The watershed is almost entirely developed, with widespread residential areas. The eastern portion (AUs 1007_01, 1007_05, 1007_07, 1007_08) has high concentrations of chemical and petrochemical industrial complexes. High-density commercial development is concentrated along all major highways. William P. Hobby International Airport is in the lower southeast quadrant of the watershed, and the Texas Medical Center complex is in the center of the watershed on both sides of Brays Bayou. Shopping centers and strip malls are adjacent to residential neighborhoods.

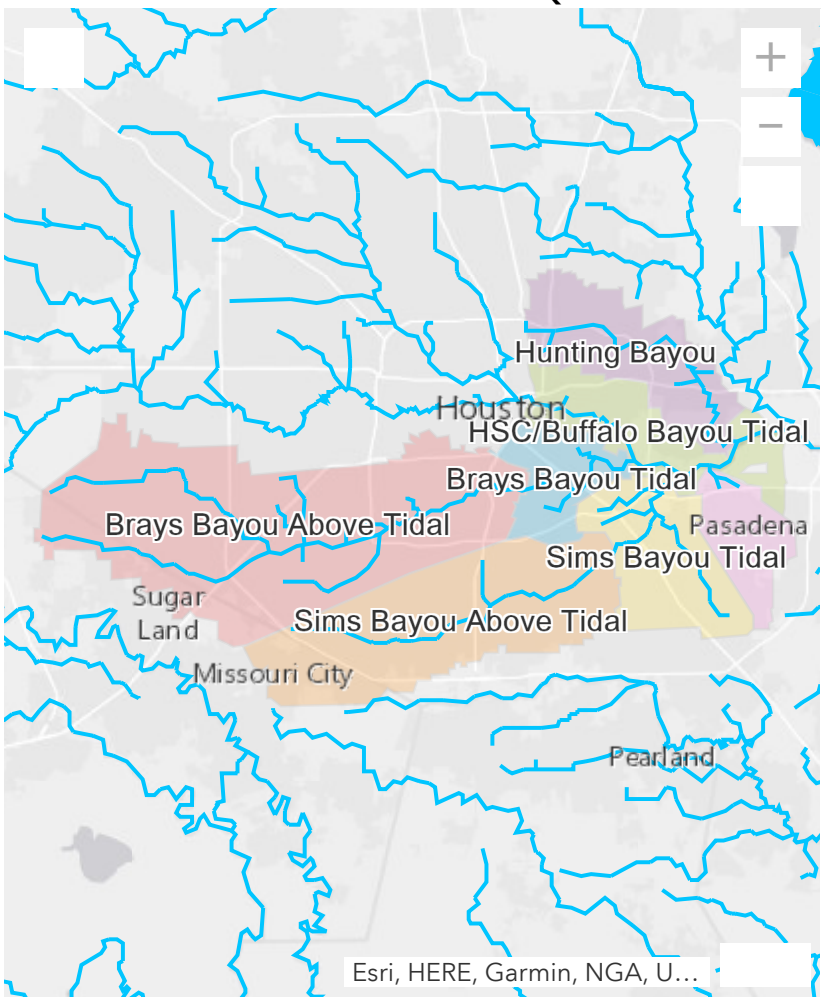
Land Cover for Segment 1007					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of Total)**	**% Change**
Barren Lands	743.02	0.39	692.32	0.36	-6.82
Agriculture	10,469.17	5.49	7,265.34	3.81	-30.60
Cultivated Crops	306.48	0.16	1,311.16	0.69	327.82
Pasture/Grasslands	10,162.70	5.33	5,954.17	3.12	-41.41
Developed	163,646.95	85.85	170,799.90	89.61	4.37
Developed, High Intensity	39,055.32	20.49	29,668.83	15.57	-24.03
Developed, Medium Intensity	33,119.92	17.38	47,507.94	24.92	43.44
Developed, Low Intensity	72,045.24	37.80	76,599.42	40.19	6.32
Developed, Open Space	19,426.48	10.19	17,023.71	8.93	-12.37
Forest/Shrubs	10,622.23	5.57	2,490.58	1.31	-76.55
Open Water	1,917.35	1.01	1,042.26	0.55	-45.64
Wetlands	3,213.41	1.69	8,321.73	4.37	158.97

A description of each land cover class in the land cover data set are as follows.

Description of Land Cover Classes	
Land Cover Class	**Class Description**
Developed, High Intensity	Contains significant land area and is covered by impervious surfaces (i.e., concrete, asphalt, and other constructed materials). Vegetation, if present, occupies < 20 percent of the landscape. Impervious surfaces account for 80 to 100 percent of the total cover. This class includes heavily built-up urban centers and large constructed surfaces in suburban and rural areas with a variety of land uses.
Developed, Medium Intensity	Contains areas with a mixture of impervious surfaces and vegetation or other cover. Impervious surfaces account for 50 to 79 percent of total area. This class commonly includes multi- and single-family housing areas, especially in suburban neighborhoods, but may include all types of land use.
Developed, Low Intensity	Contains areas with a mixture of impervious surfaces and substantial amounts of vegetation or other cover. Impervious surfaces account for 21 to 49 percent of total area. This class commonly includes single-family housing areas, especially in rural neighborhoods, but may include all types of land use.
Developed, Open Space	Contains areas with a mixture of some impervious surfaces, but mostly managed grasses or low-lying vegetation planted in developed areas for recreation, erosion control, or aesthetic purposes. Impervious surfaces account for less than 20 percent of total land cover. This class commonly includes large-lot single family housing units, parks, and golf courses.
Agriculture, Pasture/Grasslands	Contains both managed and unmanaged grasses, legumes, or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas can be subjective to intensive management, such as tilling, and utilized for grazing.
Agriculture, Cultivated	Contains areas intensely managed for the production of annual crops. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Barren Land	Contains areas of gravel pits, bedrock, sand dunes, and other accumulations of earth material. Generally, vegetation accounts for less than 10 percent of total cover.
Forest/Shrub	Includes two types of trees that cover greater than 20 percent of total vegetation cover. • *Forest*—areas dominated by all kinds of trees generally greater than 5 meters tall. • *Shrub*—areas dominated by shrubs generally less than 5 meters tall.
Open Water	Include areas of open water, generally with less than 25 percent cover of vegetation or soil.
Wetlands	Includes the area contains palustrine or estuarine vegetation that are periodically saturated or covered with water. Total vegetation coverage is greater than 20 percent.
Source: National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) Land Cover Classifications https://coast.noaa.gov/digitalcoast/training/ccap-land-cover-classifications.html	

Link to PDF table

DESCRIPTIONS OF WATER QUALITY ISSUES



Legend

AU (Streams)

AU (Water Bodies)

SubWatersheds

- Brays Bayou Above Tidal
- Brays Bayou Tidal
- HSC/Buffalo Bayou Tidal
- Hunting Bayou
- Sims Bayou Above Tidal
- Sims Bayou Tidal
- Vince Bayou Tidal

(link available only in online story)Click to View 1007 HSC/Buffalo Bayou Tidal Monitoring Stations Map (link available only in online story)

There are 62 routine monitoring stations in 1007 sampled on a regular (quarterly or more) basis. Twenty-one stations are on the classified segment. The rest are on the 20 unclassified segments. Where there is only one monitoring station on an unclassified segment, the station is located as far downstream and as close to the confluence with the next water body as possible to collect water samples from the most representative location. There are three organizations monitoring water quality in 1007—TCEQ Field Operations Division (FO), City of Houston Health Department (HH), and Harris County Pollution Control Services Department (HC).

Click to View Segment 1007 Monitoring Stations Table (link: http://arcgis02.h-gac.com/bhr2018/doc/1007_Segment_1007_Monitoring_%20Stations.pdf)

Summary of Water Quality Impairments and Concerns

Classified Assessment Units

(link available only in online story)Click to View the 1007 HSC/Buffalo Bayou Tidal PCB and Dioxin Impairment Map (link available only in online story)

All eight Assessment Units (AUs) in the classified segment of 1007 are listed in the 02014 Texas Integrated Report for Clean Water Act Sections 305(b and 303(d) (IR) for a Texas Department of State Health Services (TDSHS) Restricted and No Consumption of Edible Fish Tissue Advisory due to PCBs and dioxin. **The TDSHS advises adults to consume no more than one eight-ounce meal per month of all fish species or blue crab caught in Chocolate Bayou Tidal. Women of childbearing age and children under 12 should not consume any fish or blue crab from this area.**

All eight AUs are impaired for chlordane, dieldrin, and heptachlor epoxide in edible tissue. Five AUs have concerns for ammonia, six AUs have concerns for nitrate, and all eight AUs have concerns for total phosphorus. AU 1007_05 is impaired for toxicity in sediment as well as bacteria.

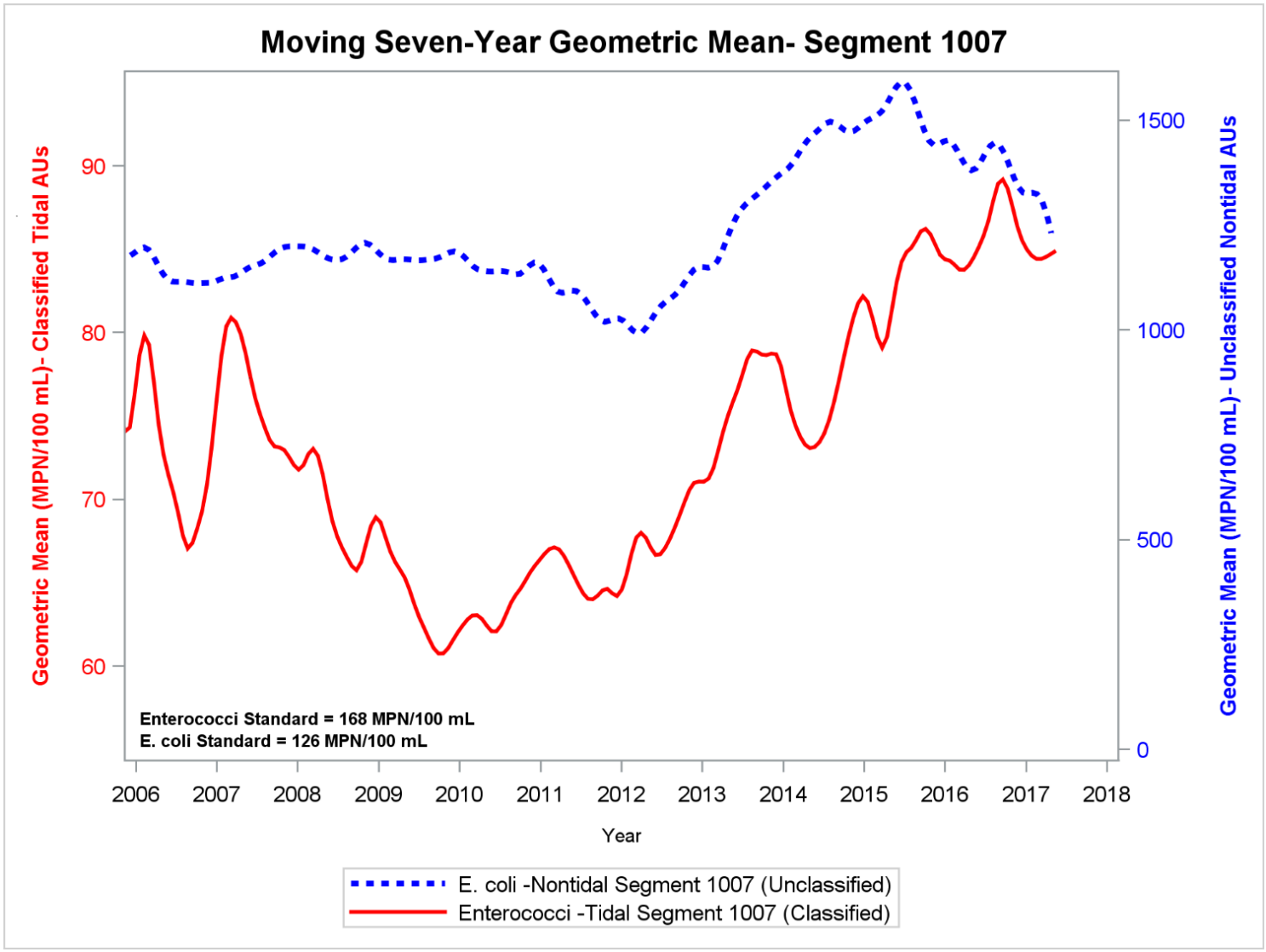
Unclassified Assessment Units

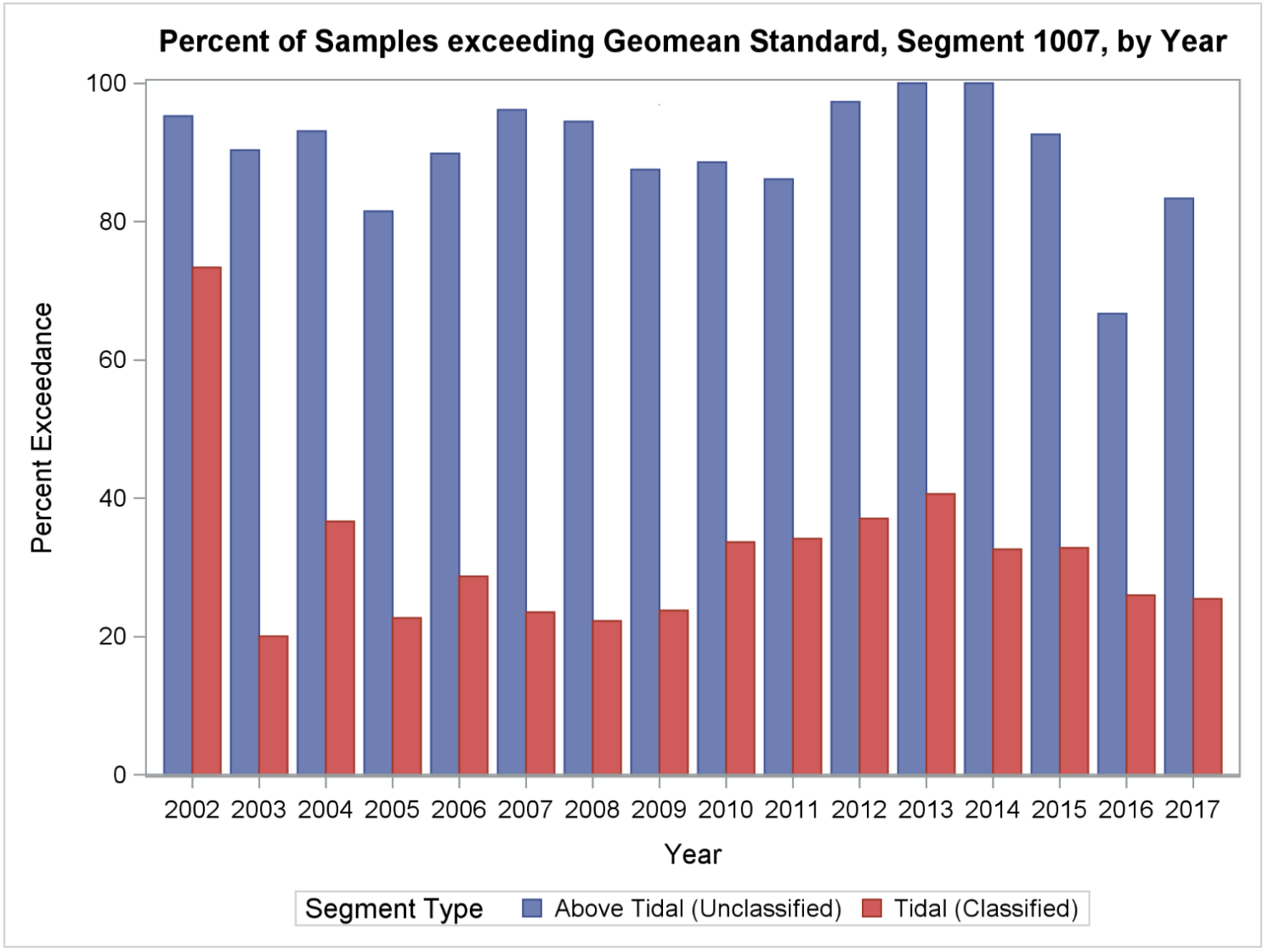
Click to View the 1007 HSC/Buffalo Bayou Tidal Bacteria Impairment and Concern Map (link available only in online story)

Nineteen of the 20 unclassified segments are impaired for bacteria concentrations above the contact recreation standard and five of the 20 unclassified segments exhibit depressed dissolved oxygen (DO) levels. Most of the unclassified segments have concerns for nutrients, including ammonia, nitrate and total phosphorus.

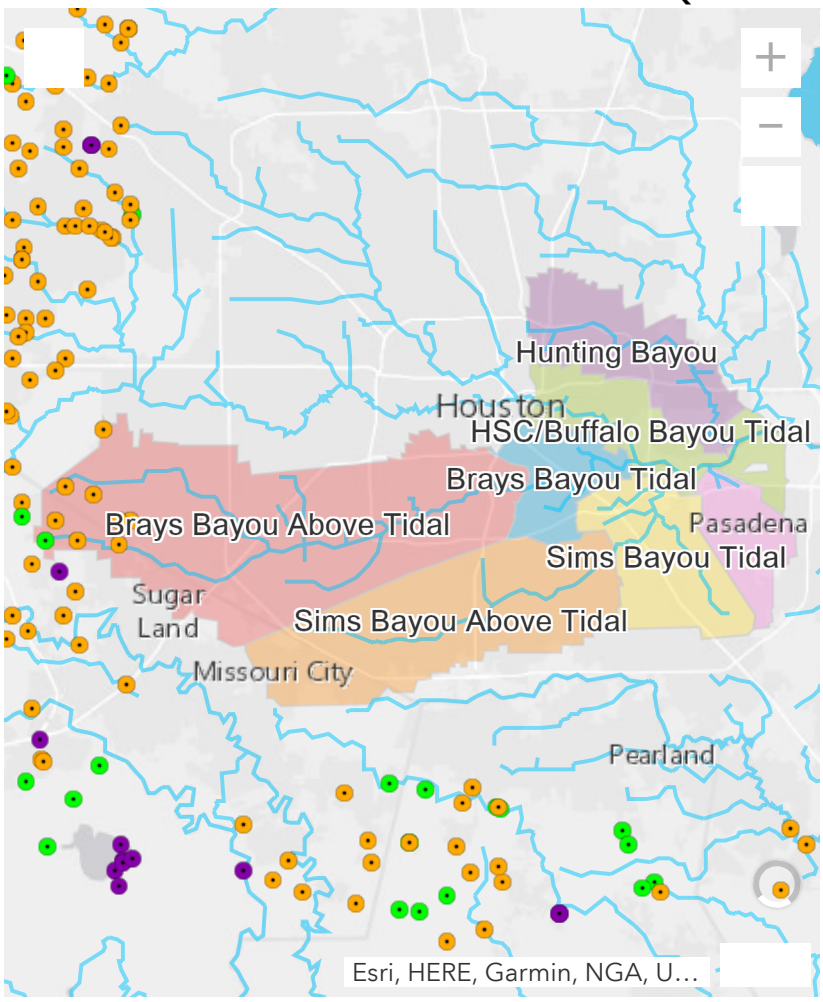
Watershed Bacteria Summary

H-GAC compared the seven-year geometric means and percentage of samples exceeding the standard for all tidal and all freshwater AUs in segment 1007. The geometric mean of bacteria results and the percentage of samples exceeding a water quality standard or screening level during the 2014 Integrated Report (December 1, 2005–November 30, 2012) is included in the tables for each subwatershed. H-GAC calculated the equivalent quantities (from June 1, 2010–May 31, 2017) from routine monitoring data and included it in the table.


Moving Seven-Year Geometric Mean- Segment 1007
Geometric Mean (MPN/100 mL)- Classified Tidal AUs
Geometric Mean (MPN/100 mL)- Unclassified Nontidal AUs
90
80
70
60
1500
1000
500
0
Enterococci Standard = 168 MPN/100 mL
E. coli Standard = 126 MPN/100 mL
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
E. coli -Nontidal Segment 1007 (Unclassified)
Enterococci -Tidal Segment 1007 (Classified)


Percent of Samples exceeding Geomean Standard, Segment 1007, by Year
Percent Exceedance
100
80
60
40
20
0
2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017
Year
Segment Type
Above Tidal (Unclassified)
Tidal (Classified)

POTENTIAL SOURCES OF WATER QUALITY ISSUES



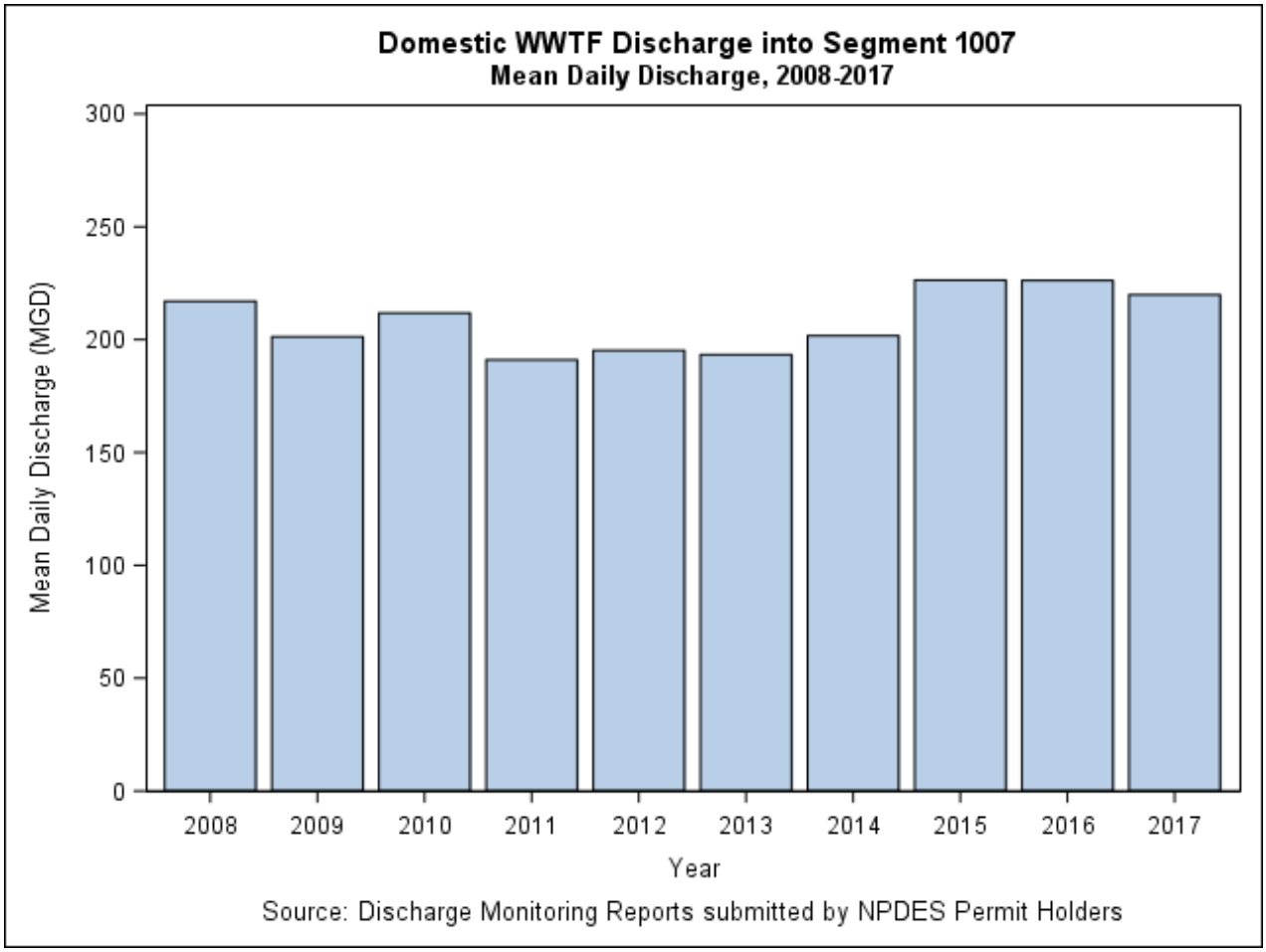
1007 HSC/Buffalo Bayou Tidal Wastewater Treatment Facility Outfalls Map (On Right)

There are many potential sources contributing to water quality issues in Segment 1007:

- Rapid urbanization and increased impervious land cover, such as parking lots and roadways, contribute pollutants associated with vehicular traffic.
- Industrialized areas, including multiple rail and freight yards, contribute sediment, bacteria, nutrients, and chemicals.
- Poorly installed, missing, and failing stormwater pollution prevention fencing or devices allow excessive amounts of sediment to wash from construction sites.
- Failure to properly dispose of pet waste from yards and parks contribute bacteria and nutrients.
- Improper fertilizer usage contributes nutrients.
- Illegal direct connections and discharges to the storm sewer system and improper disposal from waste haulers contribute a variety of pollutants.
- Sanitary sewer overflows (SSOs) and failing or improperly maintained on-site sewage facilities (OSSFs) may contribute bacteria.
- Municipal or industrial wastewater treatment facilities (WWTFs) discharges may intermittently contribute pollutants.

Wastewater Treatment Facilities

There are 42 domestic and 37 industrial permitted WWTFs in the watershed. Most permits require regular Discharge Monitoring Reports (DMR) to TCEQ and U.S. Environmental Protection Agency (EPA). DMRs were available for 40 domestic and 34 industrial facilities. Of the 74, 34 domestic and 11 industrial WWTFs reported bacteria compliance data. H-GAC obtained and analyzed available DMR data.

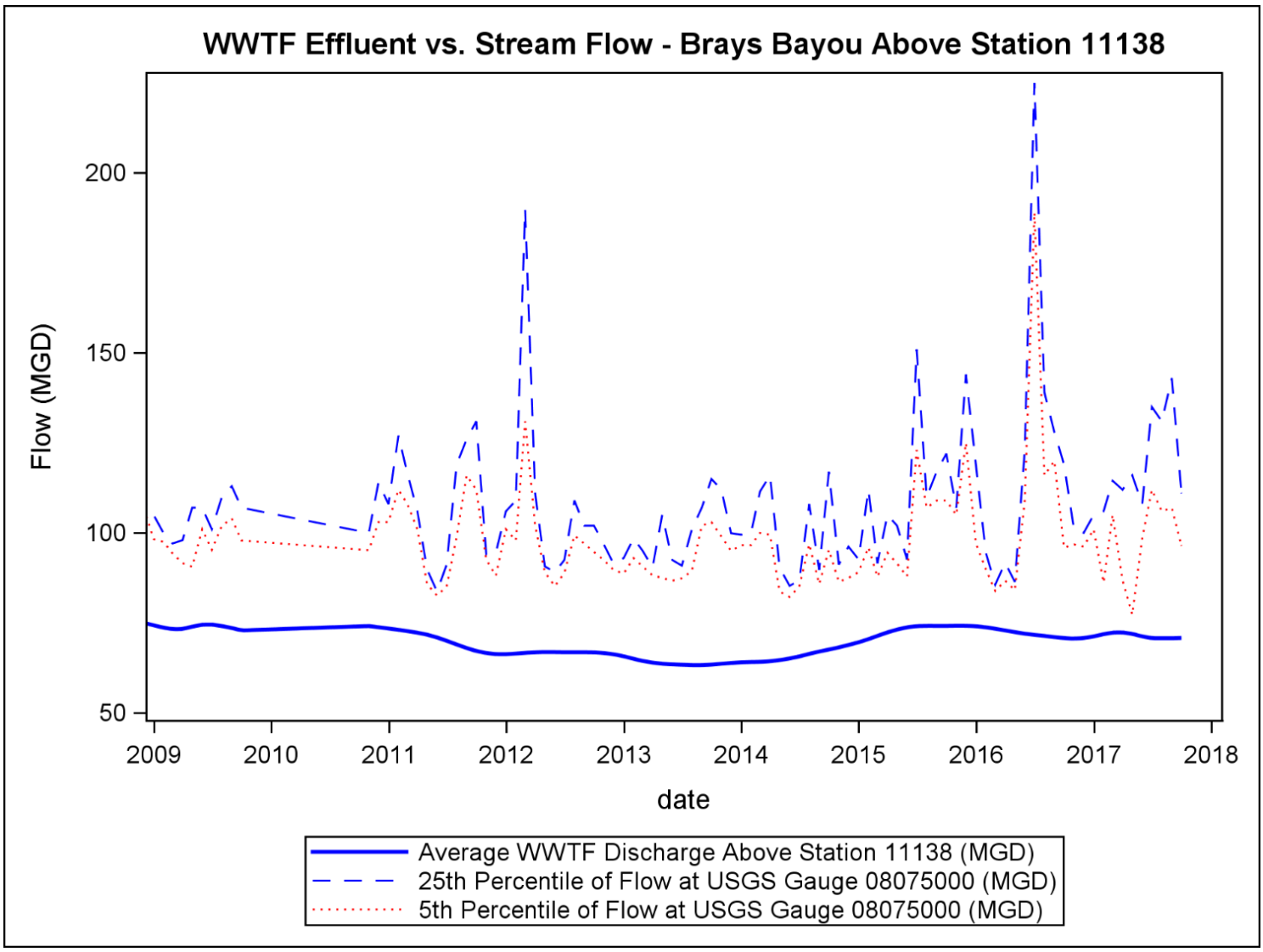


WWTFs are not typically required to report nutrient species identified as concerns during Clean Water Act assessment (Texas IR), so direct estimation of the contribution to the watershed from permitted discharges is not possible. Most permittees are required to monitor the appropriate indicator bacteria in effluent and report these data in the DMR. The table below summarizes DMR reports of geometric mean and reporting period maximum values for the indicator bacteria from 2012 through 2017.

Discharge Monitoring Report Summary for Indicator Bacteria from 2012 through 2017								
Year	Total Number of Geomean Results Reported from Permittees with Permit Limits	Number of Samples Exceeding Geomean Limit	Percent Samples Exceeding Geomean Limit	Total Number of Grab/Max Results Reported from Permittees with Permit Limits	Number of Samples Exceeding Grab/ Max Limit	Percent Samples Exceeding Grab/Max Limit	Geomean of Geomean Results*	Geomean of Daily Max Results*
2012	197	2	1.0	210	12	5.7	2.5	8.8
2013	318	4	1.3	353	22	6.2	2.3	7.8
2014	377	6	1.6	433	31	7.2	2.3	7.9
2015	397	7	1.8	463	29	6.3	2.2	8.1
2016	403	8	2.0	475	40	8.4	2.1	8.8
2017	309	6	1.9	363	28	7.7	2.1	7.5
*MPN/100mL								

WWTFs and Nutrients

Many freshwater streams in this watershed can be considered effluent dominated, meaning in during periods of normal flow, WWTF effluent is a significant proportion of the total observed flow (and most of the flow during low-flow periods), as illustrated for monitoring station 11138 on Brays Bayou Above Tidal.



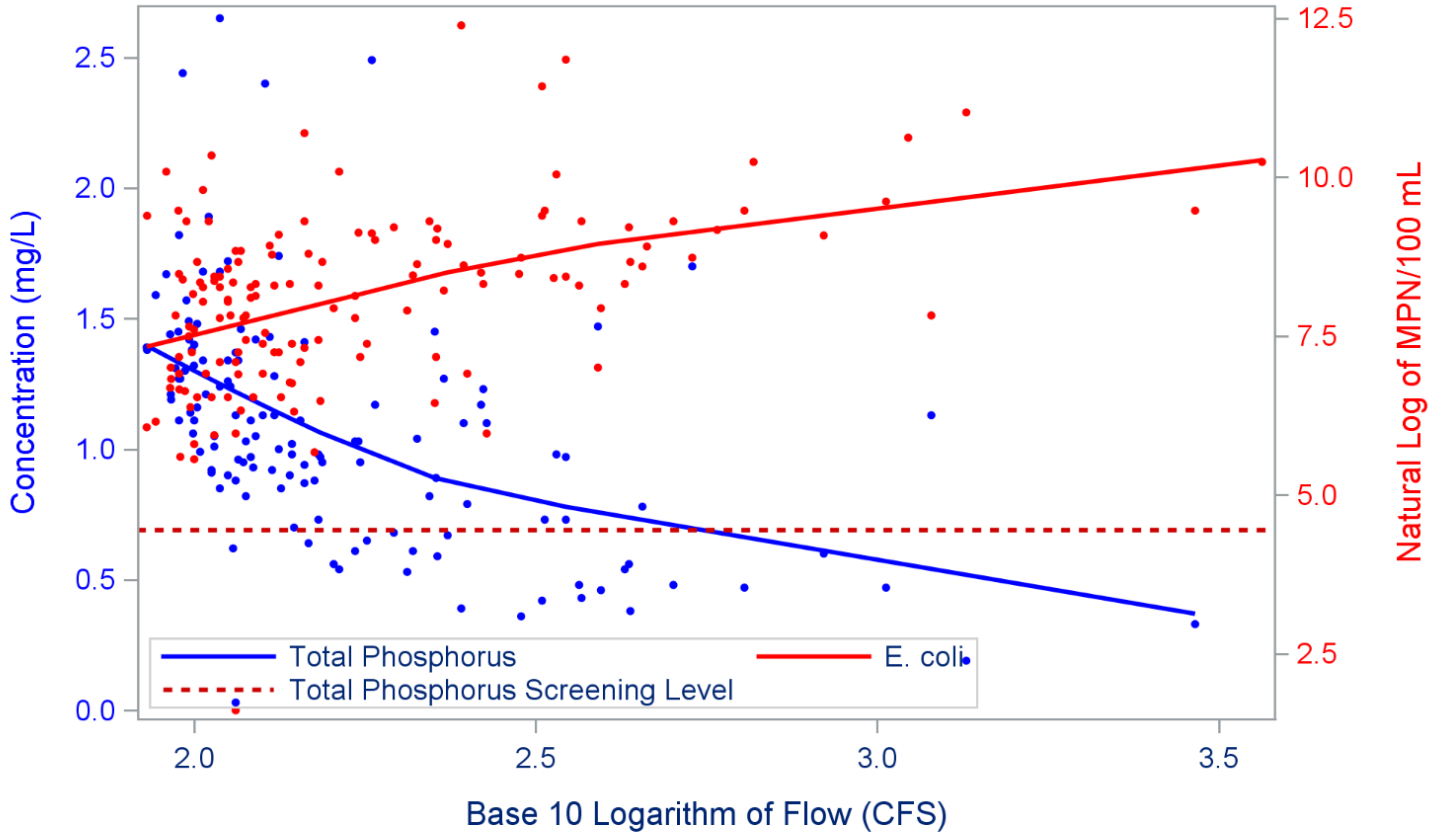
The effluent from WWTFs can have high concentrations of nutrients, and samples taken during low-flow periods usually exceed screening levels for these nutrients. Monitoring stations 11138 and 11140 on Brays Bayou Above Tidal illustrate the relationship between flow, total phosphorus, and *E. coli.*

This is a common pattern in effluent-dominated reaches of streams in this watershed—high nutrients and low bacteria density at low flows, and low nutrient concentrations with higher bacteria densities at higher flows during rain events. Increases in bacteria density could also be a result of nonpoint sources.

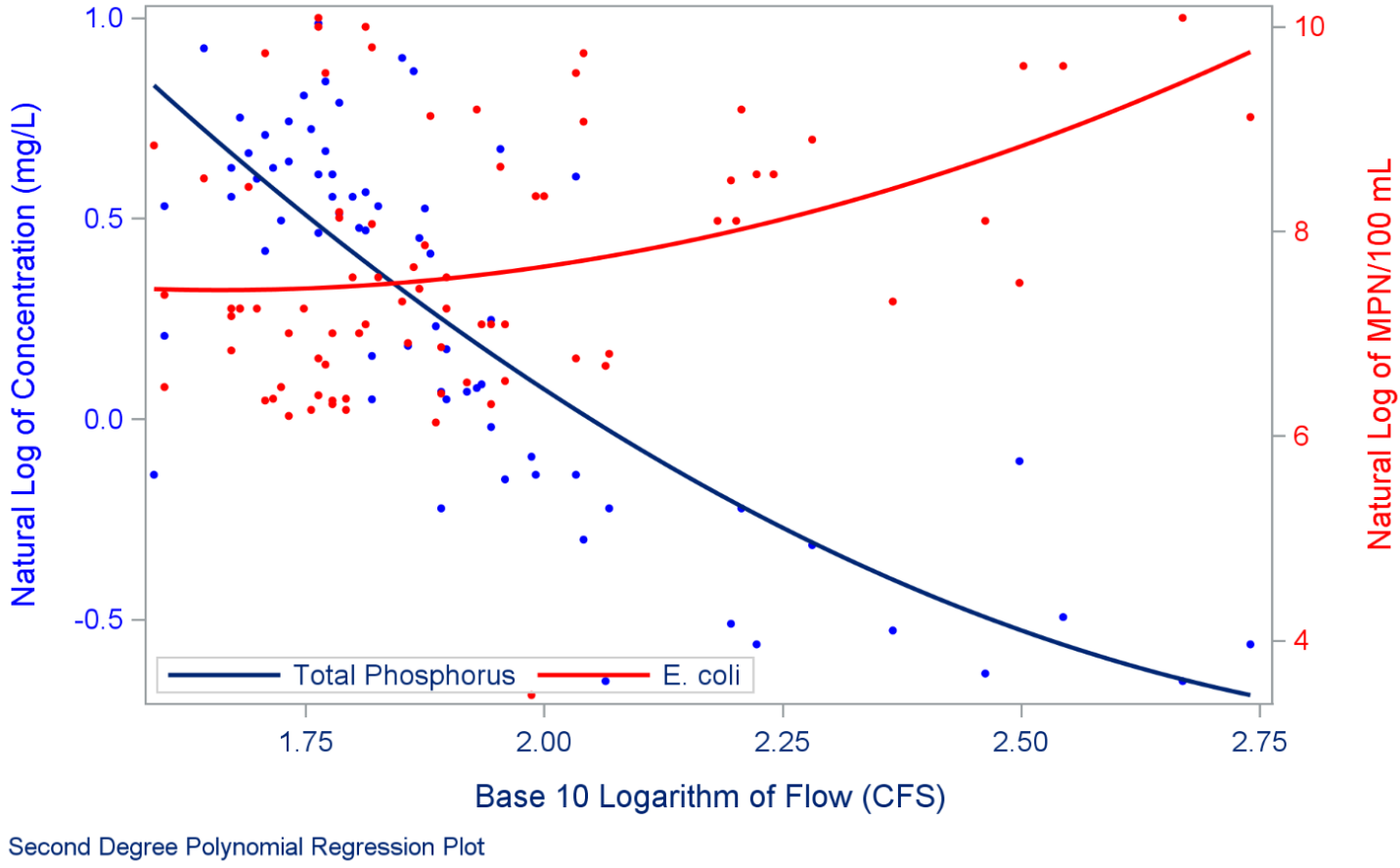
Correlation between Total Phosphorus Concentration, E. Coli Density, and Flow Conditions

Monitoring Station 11138 Segment: 1007B

Brays Bayou Above Tidal



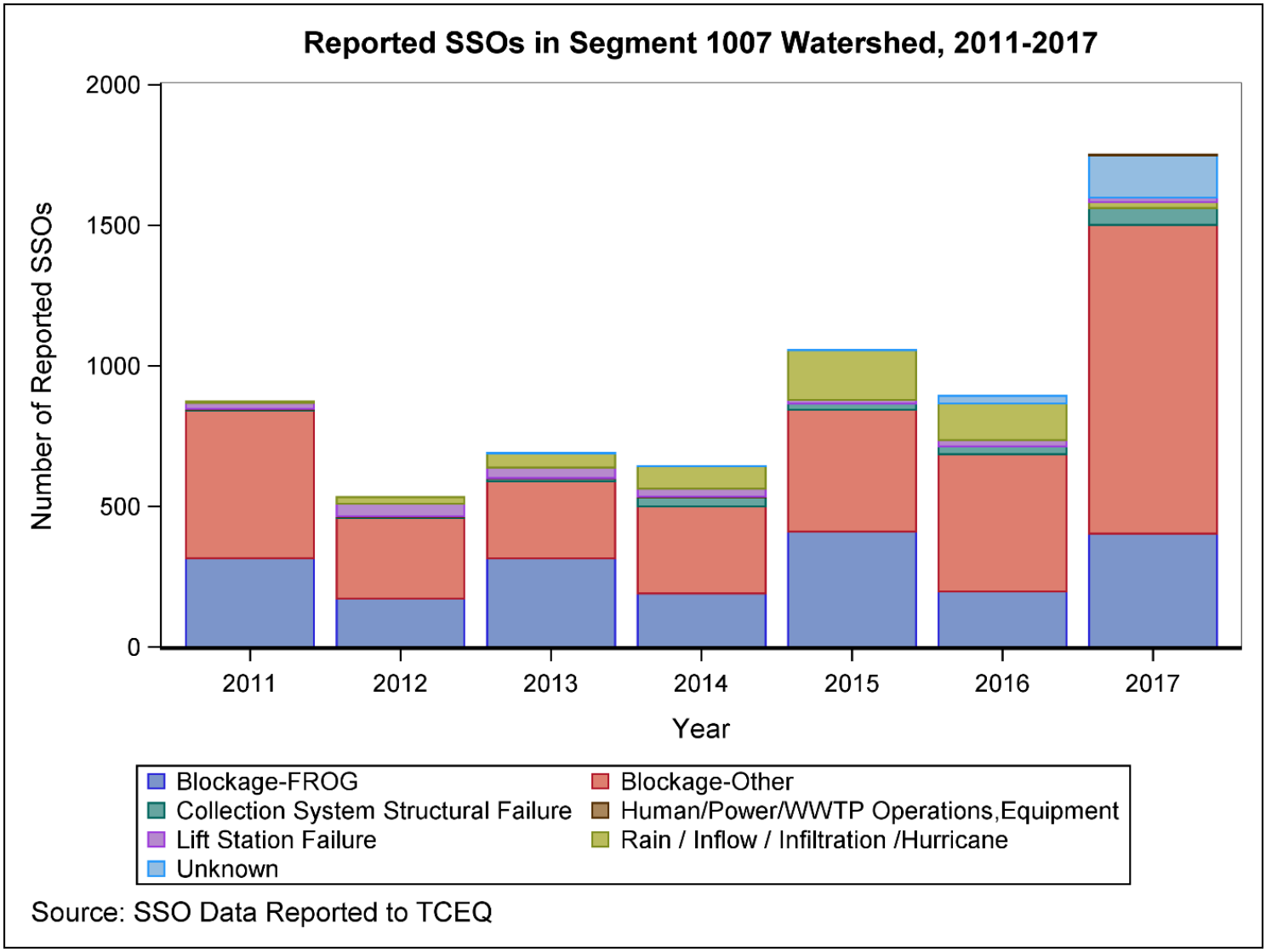
Locally-Weighted Least Squares (LOESS) Plot



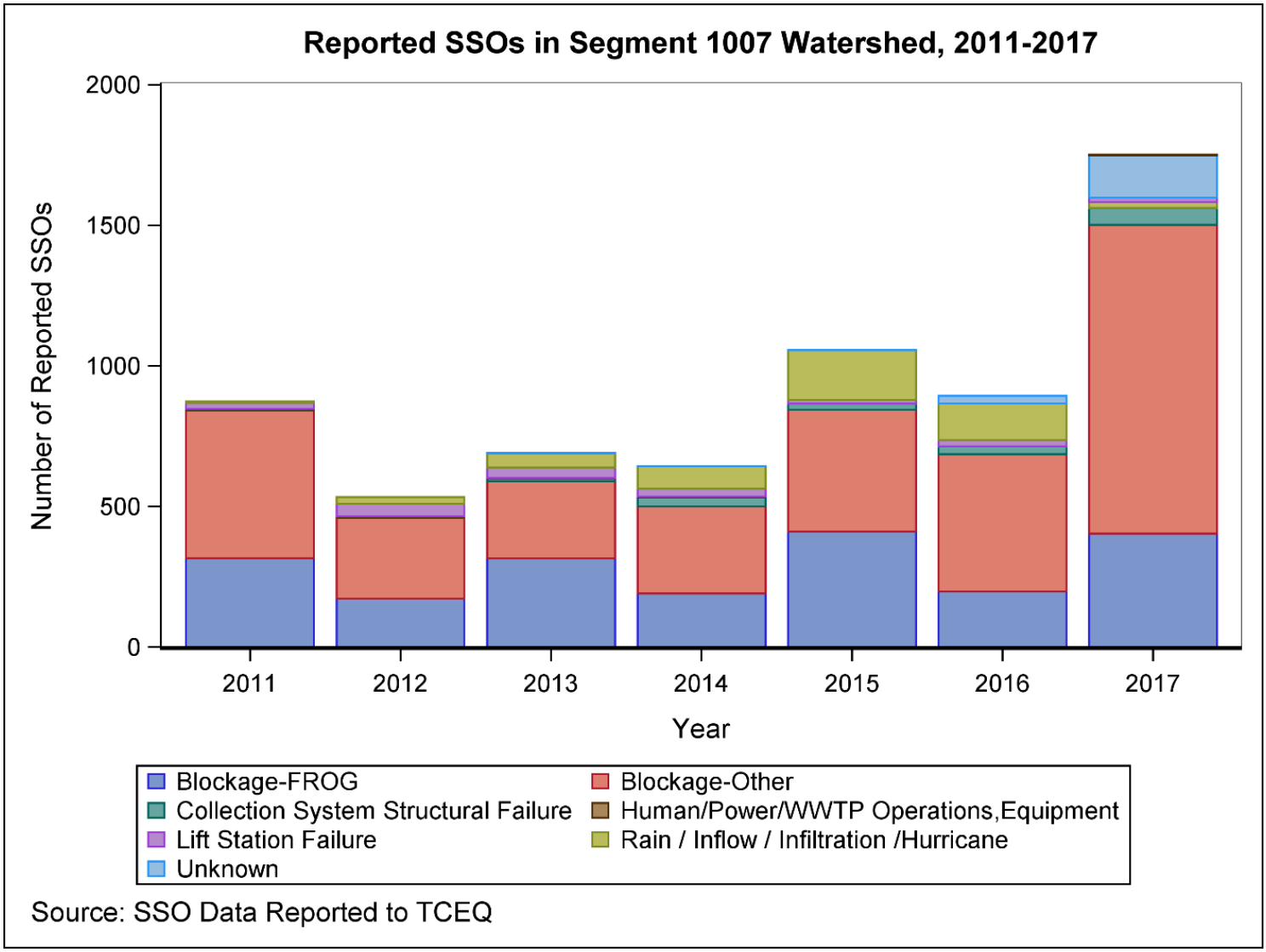
Sanitary Sewer Overflows

Click to View Sanitary Sewer Overflows Events by Watersheds Map (link available only in online story)

The failure of sanitary sewer systems (SSSs), commonly due to blockages from fats, rags/roots, oils, and grease (FROG), equipment malfunctions, or operator errors, often results in sanitary sewer overflows (SSOs). SSOs discharge untreated sewage to the surface and sometimes into area waterways. The microbial pathogens and other pollutants present in SSOs can cause or contribute to contamination of drinking water supplies, water quality impairments, beach closures, shellfish bed closures, and other environmental and human health problems. SSOs may be a significant source of bacteria in this watershed. H-GAC routinely analyzes SSO data reported by permittees to TCEQ.

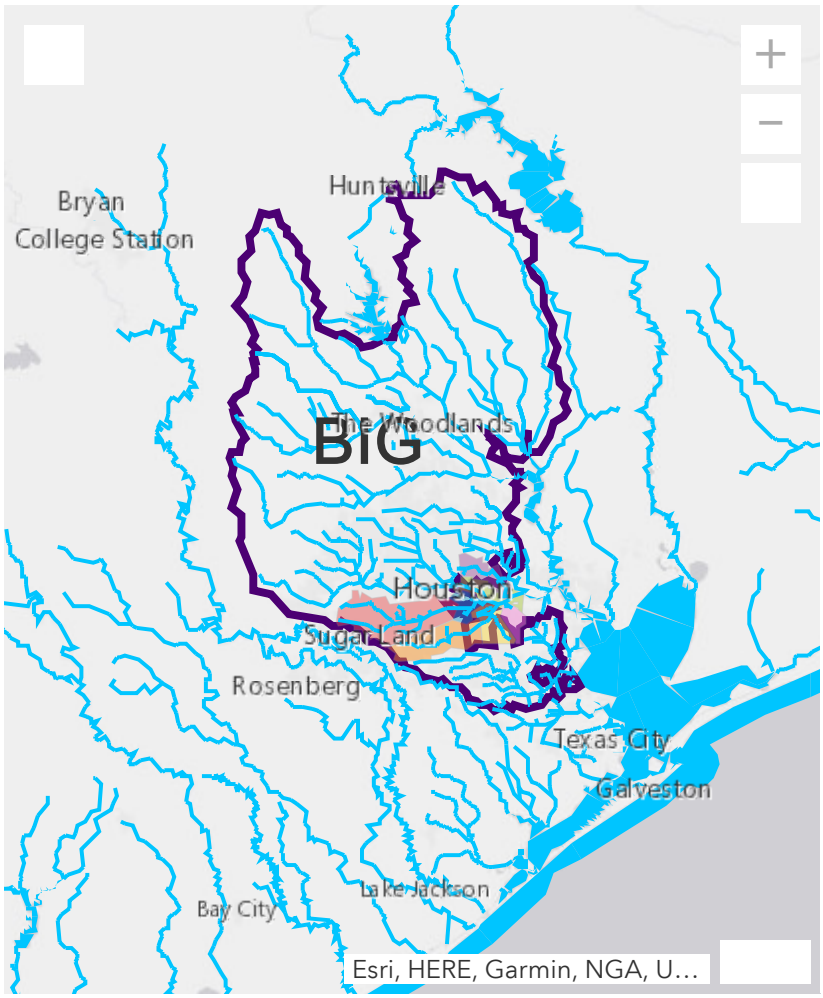


Source: SSO Data Reported to TCEQ



Source: SSO Data Reported to TCEQ

POTENTIAL STAKEHOLDERS



1007 HSC/Buffalo Bayou Tidal Watershed and the BIG TMDL Project Area Map (On Right)

The Segment 1007 watershed is part of the Bacteria Implementation Group (BIG) Total Maximum Daily Load (TMDL) project area charged with implementing a bacteria reduction plan for the Houston-Galveston region. The BIG committee is comprised of representatives of county and city governments, business and industry, conservation groups, engineering companies, utility districts, resource agencies, academia, and residents. The group tracks the efforts of various programs addressing bacteria impairments in area waterways.

The BIG I-Plan was approved by the TCEQ in 2013. The project area was expanded in 2016 to include all portions of the East and West Forks of the San Jacinto River, and in 2018, Jarbo Bayou, a small impaired tributary to Clear Lake in Galveston County.

Stakeholders are targeting sanitary sewer overflows, failing on-site sewage facilities, and encouraging the use of best management practices to address bacteria in stormwater

runoff. Information about the BIG can be found online.

ONGOING PROJECTS

Total Maximum Daily Load Projects

Segment 1007 is included in TMDL projects for bacteria, PCBs and dioxin, and dissolved nickel.

Bacteria

The *Top Five Most and Top Five Least Impaired Water bodies Project* was developed by the BIG in 2016 to address waterways not meeting the state water quality standard for bacteria. After assessing 72 waterways using Clean Rivers Program data and site visits, H-GAC staff identified five with the highest bacteria concentrations and five closest to meeting state water quality standards. With input from water quality professionals and representatives from local jurisdictions, two streams from each list were formally investigated to identify the sources of the bacteria. The goal of the project was to significantly reduce bacteria levels and see these waterways removed from the 2014 IR.

Canal C-147, located in 1007, was one of the water bodies investigated. The project was completed in August 2017. H-GAC is pursuing funding to continue this project.

PCBs and Dioxin

In 1990, DSHS issued an advisory warning people that dioxins were found in the edible tissue of catfish and blue crab caught in the Houston Ship Channel and Upper Galveston Bay. The original advisory has been renewed, revised, or combined with other consumption advisories, the latest issued in 2015. Analysis and modeling completed in 2008 confirmed dioxin is a legacy contaminant in sediment, and the primary source is believed to be the San Jacinto Waste Pits located along the San Jacinto River just north of the I-10 bridge. Currently, EPA is negotiating with the responsible parties on remediation design and removal methods. The TMDL project is ongoing.

In October 2001, the DSHS issued an advisory warning people to limit or eliminate consumption of all species of finfish caught in the Houston Ship Channel and Galveston Bay due to PCBs found in edible fish tissue. The original advisory has been renewed, revised, or combined with other advisories, the latest issued in 2015. Analysis and modeling confirmed PCBs are legacy pollutants from unknown sources found in sediment throughout the bay system. The TMDL project is ongoing.

Nickel

Fourteen TMDLs for nickel in the Houston Ship Channel System were approved by the EPA in 2003. Based on TMDL analyses and the allocation summarized for every municipal and industrial permit, nickel loading to the Houston Ship Channel System will be controlled through implementation of the Texas Pollutant Discharge Elimination System (TPDES) program for wastewater discharges. Nonpoint sources of nickel were determined not to be significant enough to require specific additional managements measures. In 1007, model simulations performed for the TMDL predicted concentrations of less than half the assimilative capacity of the water body.

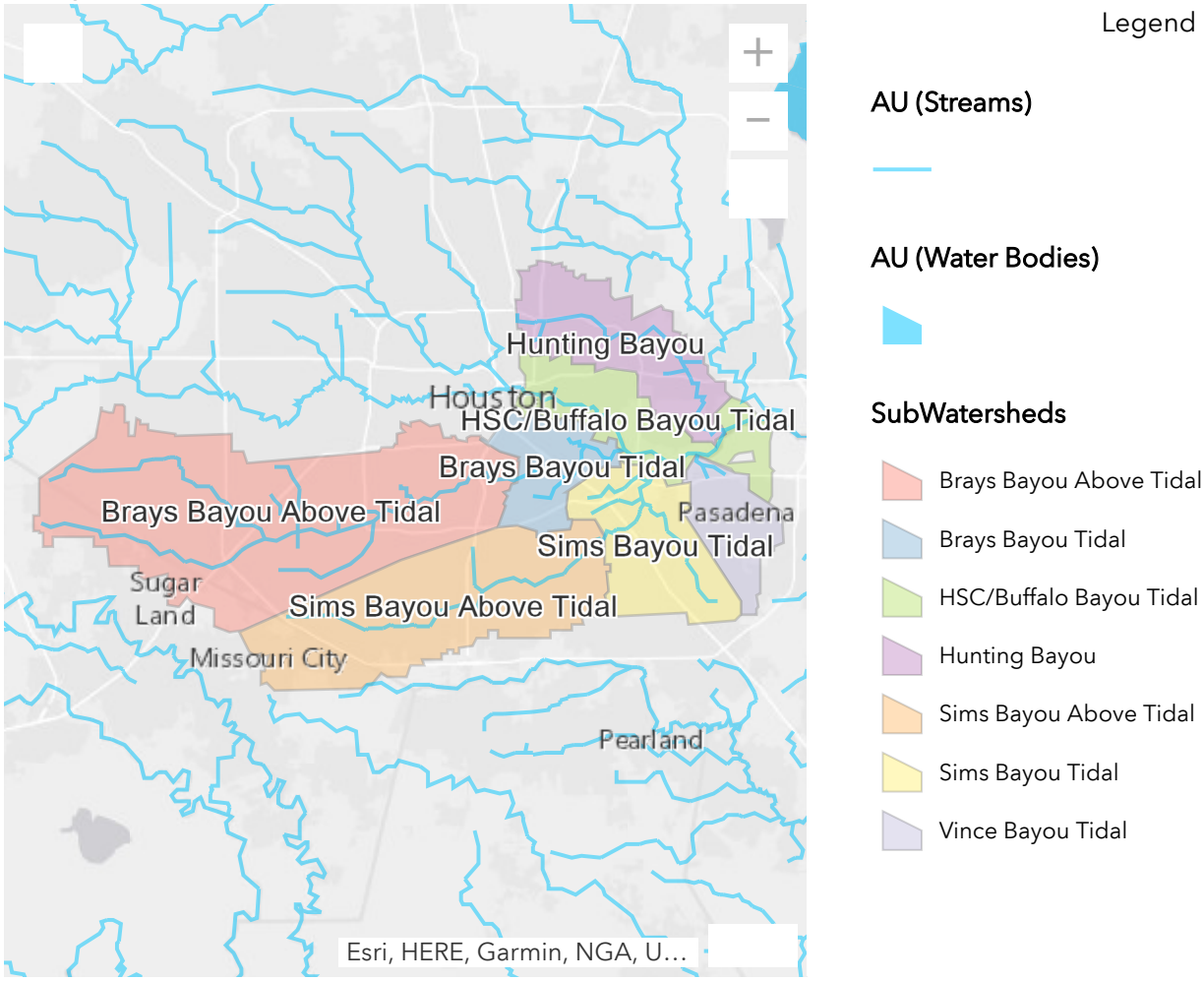
Bayou Greenways 2020

Over half of Harris County residents live within 1.5 miles of the Bayous Greenways 2020 initiative. This initiative, which includes Brays, Sims, and Hunting bayous, creates linear parks and greenways by increasing functionality, reducing flooding, and improving water quality.

Harris County Flood Control District (HCFCD)

HCFCD purchases large tracts of land to create stormwater control basins to mitigate flooding. Every subwatershed in 1007 has one or more of these basins to help control stormwater flows. Besides being detention or retention basins, some basins are designed to include pollution reduction components.

MAJOR WATERSHED EVENTS

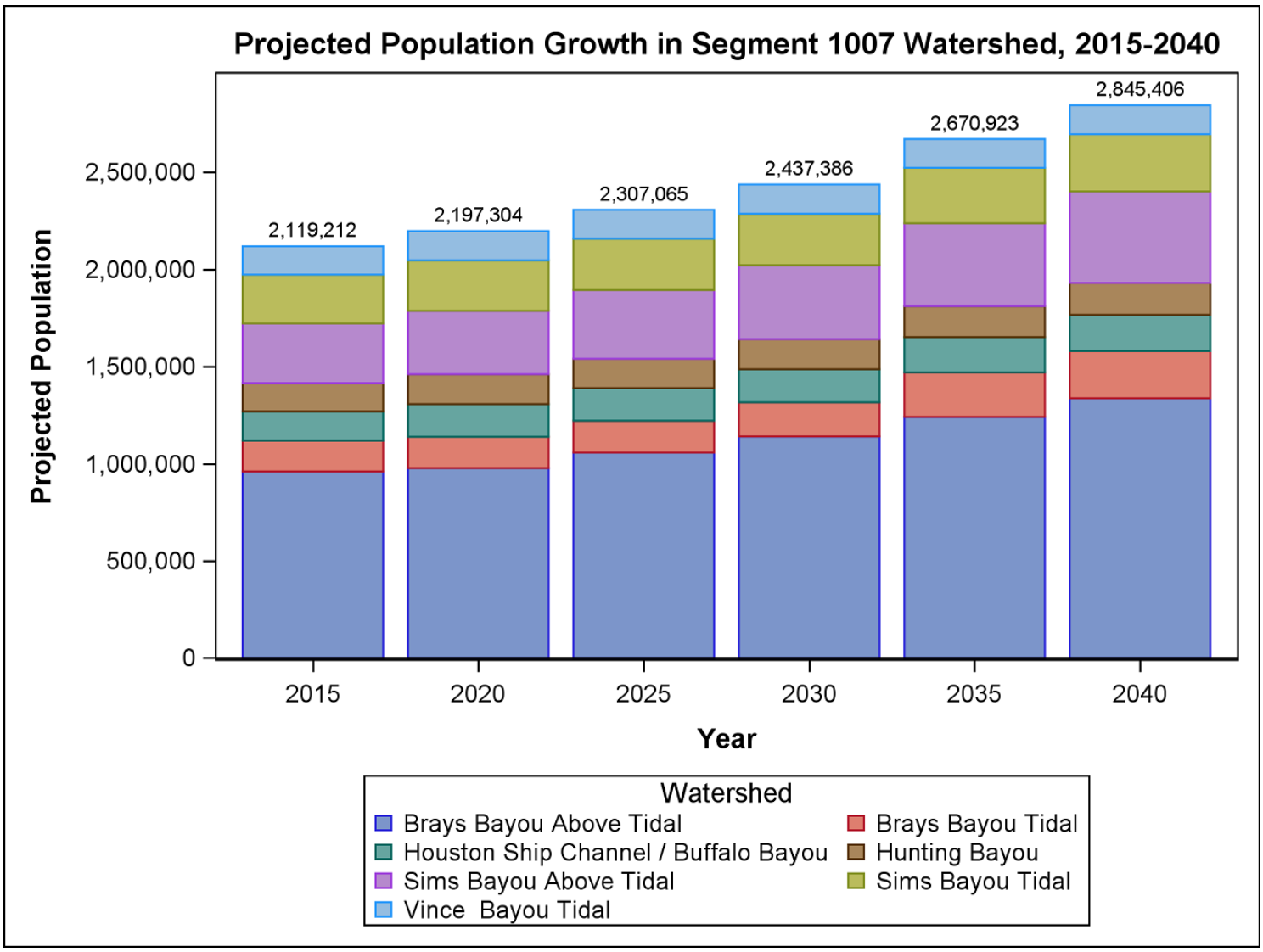


1007 HSC Buffalo Bayou Tidal Subwatersheds Map (On Right)

Population Growth

The population living in the watershed is forecast to increase by more than 34 percent by 2040, with the greatest population increases expected in the Sims Bayou Above Tidal (53 percent) and Brays Bayou Tidal (52 percent) subwatersheds. This projection is not unexpected for Sims Bayou Above Tidal, considering the availability of large tracts of undeveloped land. Brays Bayou Tidal, located near the Texas Medical Center and south of downtown Houston, is expected to undergo densification. There are many older, single family neighborhoods being revitalized to include condos and apartment complexes.

Brays Bayou Above Tidal is also densifying and is projected to have a 39 percent increase in household population.



Projected Population for Segment 1007						
Subwatershed	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Brays Bayou Above Tidal	960,098	977,233	1,057,222	1,140,476	1,240,698	1,336,730
Brays Bayou Tidal	158,669	161,408	163,905	175,384	229,276	242,692
HSC/Buffalo Bayou	150,357	167,998	167,598	170,222	181,603	186,605
Hunting Bayou	145,792	153,922	151,269	154,785	159,416	164,335
Sims Bayou Above Tidal	306,998	326,229	353,898	380,825	426,396	470,768
Sims Bayou Tidal	251,019	259,965	264,284	264,924	285,584	294,671
Vince Bayou Tidal	146,279	150,549	148,889	150,770	147,950	149,605
Projected Population	**2,119,212**	**2,197,304**	**2,307,065**	**2,437,386**	**2,670,923**	**2,845,406**

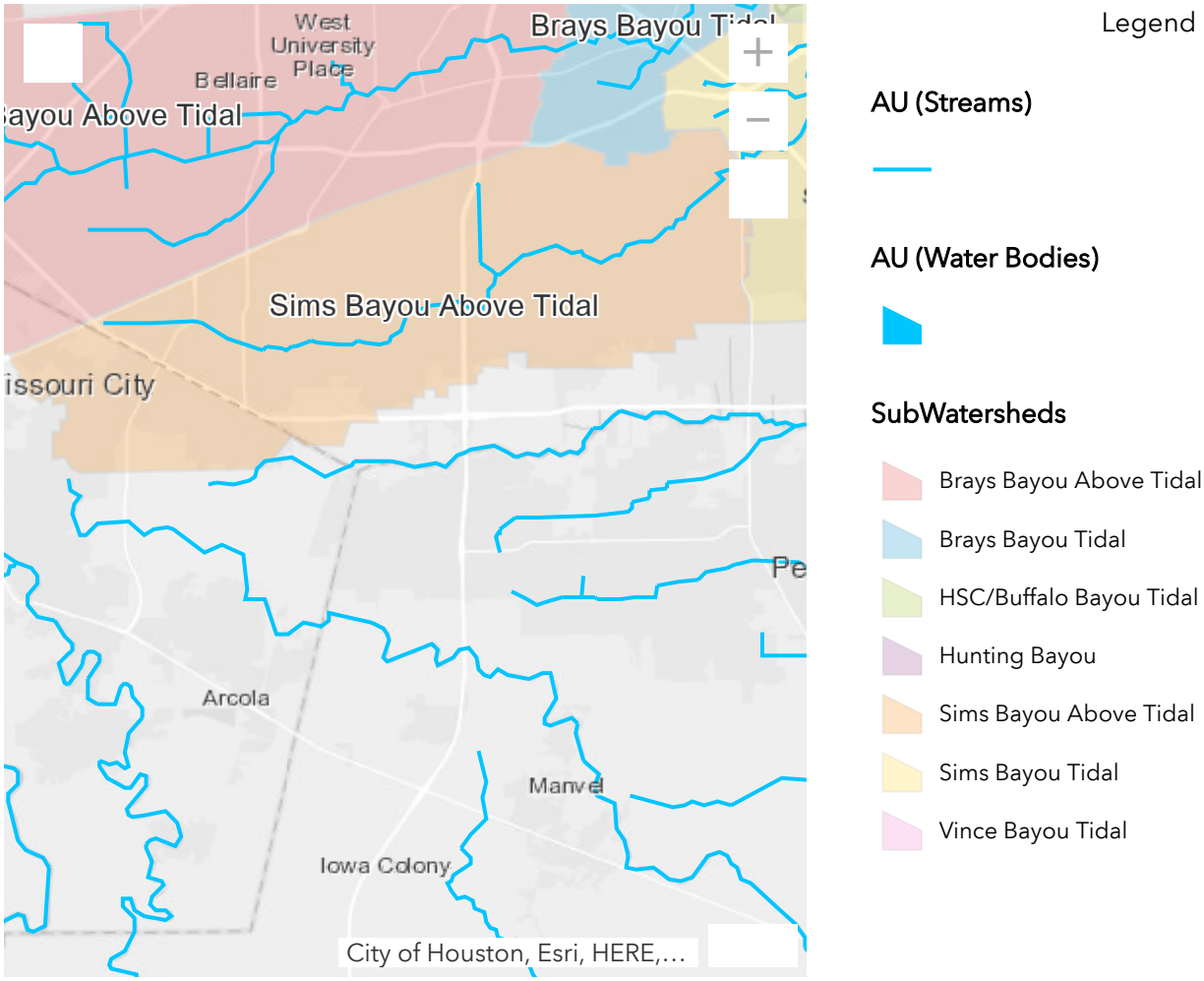
RECOMMENDATIONS FOR IMPROVING WATER QUALITY

- Address bacteria and various other concerns through stakeholder involvement and best management practices. Continue implementing the TMDL I-Plan through the **BIG** (link: http://www.h-gac.com/community/water/tmdl/BIG/default.aspx) .
- Continue to analyze DMRs and SSO data submitted by permitted WWTFs and present results to TCEQ, wastewater permittees, local governments/utility districts, and local stakeholders.
- Support programs that oversee the maintenance, repair, and replacement of **on-site sewage facilities** (link: http://www.h-gac.com/community/water/ossf.aspx) .
- Expand volunteer monitoring with **Texas Stream Team** (link: http://www.h-gac.com/community/water/texas_stream_team/default.aspx) in areas without professional monitoring.
- Pursue installation of signage informing the public of PCBs and dioxin fish consumption advisories at popular fishing locations along waterways.
- Promote preservation of vegetative buffers and tree canopies to reduce erosion, increase DO, and provide habitat for native aquatic species.
- Continue public education about proper disposal of pet waste, household fats, oils, and grease, and litter reduction.

- Implement Texas SmartScape (link: http://www.txsmartscape.com/) and YardWise (link: https://yardwise.recyclingstar.org/about-us) programs.
- Encourage regulators and responsible parties to work together remediate Superfund sites.
- Monitor phosphorus levels from WWTFs to determine if controls are needed.
- Improve operation and maintenance of WWTFs and collection systems to minimize bacteria contributions.

Brays Bayou Above Tidal Subwatershed

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/10anv.



SUBWATERSHED DESCRIPTION

Brays Bayou Above Tidal Subwatershed Map (On Right)

The Brays Bayou Above Tidal subwatershed is in northeast Fort Bend County and southwest Harris County. The total area is 111.56 square miles, and includes the cities of Bellaire, West University, and Southside Place and portions of the cities of Houston, Meadows Place, Missouri City, Stafford, Sugarland, and Mission Bend.

Flooding has been a major issue in the subwatershed. According to the Harris County Flood Control District (HCFCD), historically Brays Bayou averages severe flooding once a decade, but three major flooding events have occurred in the last three years.

HYDROLOGIC CHARACTERISTICS

Click to View the Brays Bayou Above Tidal USGS Streamflow Gages Map (link available only in online story)

Four U.S. Geological Survey (USGS) streamflow gages are located within the Brays Bayou Above Tidal Subwatershed. One gage is located on assessment unit (AU) 1007C_01 and 3 are located on 1007B_01. Flow is measured is cubic feet per second (CFS).

Brays Bayou Above Tidal Streamflow Gages			
Site Number	**Station Name**	**Realtime Monitoring**	**Mean Flow (CFS) 2010 - 2017**
08074760	Brays Bayou at Alief, TX	Yes – Continuous	62.9
08074800	Keegans Bayou at Roark Rd, Houston, TX	Yes – Partial	60.89 *
08074810	Brays Bayou at Gessner Dr, Houston, TX	Yes – Continuous	165.67
08075000	Brays Bayou at Houston, TX	Yes – Continuous	340.6
*Flow measured only during high-flow events			

LAND COVER AND NATURAL CHARACTERISTICS

Click to see the Brays Bayou Above Tidal Land Cover Map (link available only in online story)

More than 92 percent of the Brays Bayou Above Tidal subwatershed is developed. Recent development has been mostly low and medium intensity. Forest/shrubs and agriculture each cover roughly the same acreage. Agriculture and wetlands have increased, while forest/shrub cover has decreased.

Land Cover for Brays Bayou Above Tidal					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of total)**	**% Change**
Agriculture	2092.50	2.93	3044.50	4.26	45.50
Pasture/Grasslands	1958.58	2.7	1969.14	2.8	0.54
Cultivated Crops	133.92	0.2	1075.37	1.5	702.97
Barren Lands	171.91	0.2	228.23	0.3	32.76
Developed	66056.38	92.52	66313.82	92.88	0.39
High Intensity	16158.00	22.6	10594.22	14.8	-34.43
Medium Intensity	31850.06	44.6	36489.05	51.1	14.57
Low Intensity	11091.81	15.5	14466.59	20.3	30.43
Open Space	6956.51	9.7	4763.96	6.7	-31.52
Forest/Shrubs	2583.19	3.6	317.83	0.4	-87.70
Open Water	181.94	0.3	209.11	0.3	14.93
Wetlands	312.71	0.4	1285.17	1.8	310.97

DESCRIPTION OF WATER QUALITY ISSUES

Click to see the Brays Bayou Above Tidal subwatershed Assessment Units Map (link available only in online story)

Unclassified segment 1007B is the longest waterway in the subwatershed. It is divided into two AUs. 1007B is fed by seven tributaries. Each of the seven tributaries has one AU for a total of nine AUs in the subwatershed.

Brays Bayou Above Tidal Assessment Units Descriptions				
AU ID	**Segment ID**	**Segment Name**	**Class**	**Type**
1007B_01	1007B	Brays Bayou Above Tidal	Unclassified	Freshwater Stream
1007B_02	1007B	Brays Bayou Above Tidal	Unclassified	Freshwater Stream
1007C_01	1007C	Keegan's Bayou Above Tidal	Unclassified	Freshwater Stream
1007E_01	1007E	Willow Waterhole Bayou Above Tidal	Unclassified	Freshwater Stream
1007L_01	1007L	Unnamed tributary of Brays Bayou	Unclassified	Freshwater Stream
1007S_01	1007S	Poor Farm Ditch	Unclassified	Freshwater Stream
1007T_01	1007T	Bintliff Ditch	Unclassified	Freshwater Stream
1007U_01	1007U	Mimosa Ditch	Unclassified	Freshwater Stream
1007W_01	1007W	Harris County Flood Control Ditch D 138	Unclassified	Freshwater Stream

Brays Bayou Above Tidal Water Quality Issues						
AU_ID	Parameter	Level of Support	% Samples Exceeding Standard/ Screening Level 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard/ Screening Level H-GAC 2010-2017	Geomean H-GAC 2010-2017
1007B_01	Ammonia	CS	53.2	.	37.9	.
1007B_01	*E. coli*	NS	.	1873	94.8	1539
1007B_01	Nitrate	CS	84.8	.	83.7	.
1007B_01	Total Phosphorus	CS	74.6	.	80.6	.
1007B_02	Ammonia	CS	92.5	.	51.6	.
1007B_02	*E. coli*	NS	.	1059	87.1	500
1007B_02	Nitrate	CS	65.7	.	90.3	.
1007B_02	Total Phosphorus	CS	95.5	.	98.4	.
1007C_01	Ammonia	CS	30.4	.	24.6	.
1007C_01	*E. coli*	NS	.	907	86.5	732
1007C_01	Nitrate	CS	92.2	.	92.1	.
1007C_01	Total Phosphorus	CS	89.6	.	91.3	.
1007E_01	*E. coli*	NS	.	812	82.5	718
1007S_01	Ammonia	CS	43.1	.	7.9	.
1007S_01	*E. coli*	NS	.	1420	87.3	1109
1007S_01	Nitrate	CS	29.2	.	63.5	.
1007S_01	Total Phosphorus	CS	26.2	.	42.9	.
1007T_01	Ammonia	CS	28.8	.	25.4	.
1007T_01	*E. coli*	NS	.	4208	92.1	2421
1007U_01	Dissolved Oxygen Grab	CS	12.5	.	91.8	.
1007U_01	*E. coli*	NS	.	2891	98.4	1815
FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern; CN – Concern for near-nonattainment of the TSWQS based on numeric criteria; CS – Concern for water quality based on screening levels						

Bacteria

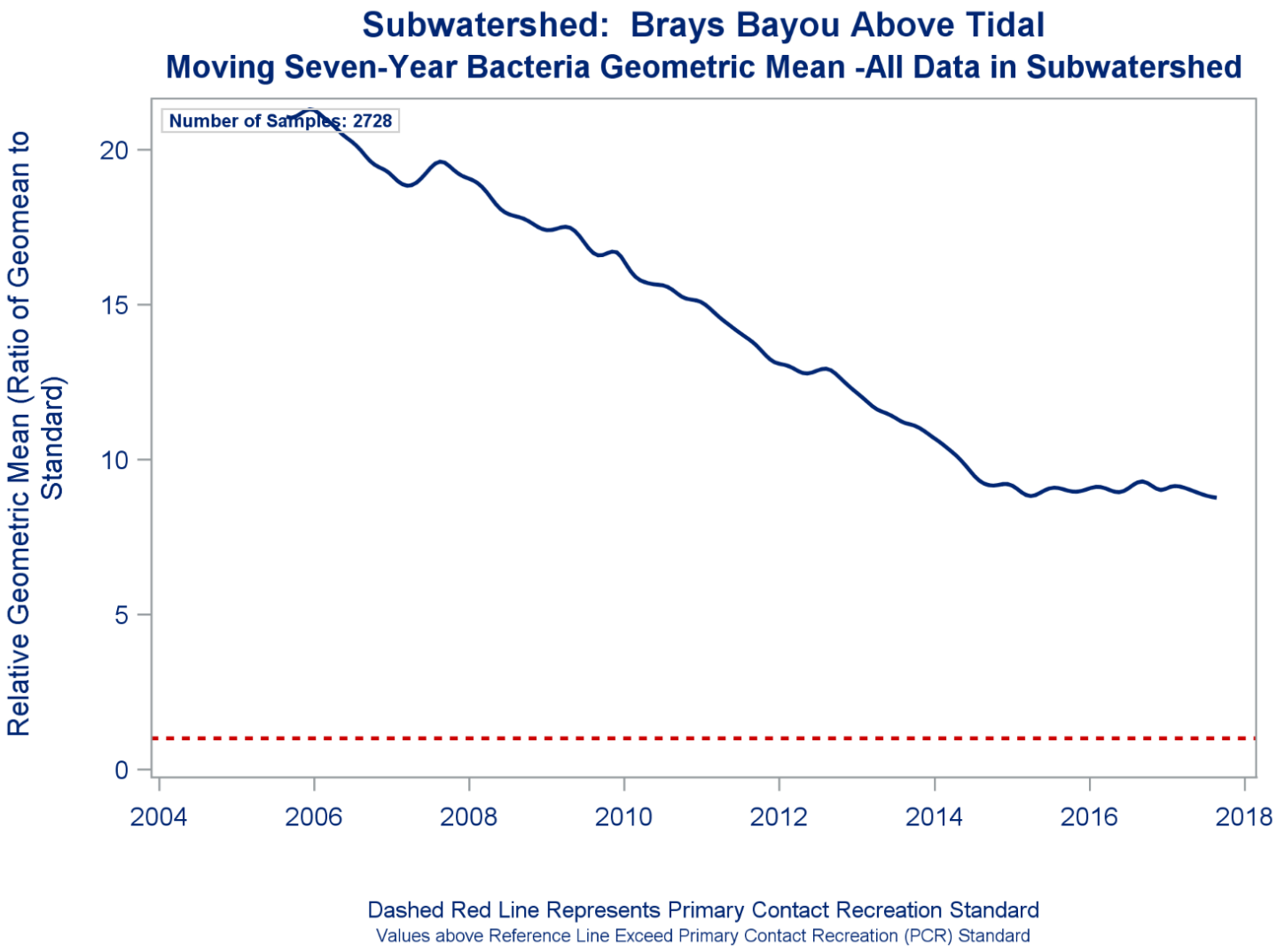
Click to View the Brays Bayou Above Tidal Bacteria Impairment Map (link available only in online story)

Six of the nine AUs are impaired for contact recreation use due to high density of *E. coli* bacteria, with a bacteria geomean ranging from 500 to 2,421 MPN/100mL. The other three AUs have experienced occasional high density of *E. coli* in individual samples, but the bacteria geomeans are within water quality standards.

E. coli density is stable in the watershed, except for 1007B_01. Nonparametric correlation analysis indicates that while the level is decreasing, seasonal Kendall analysis (a test for

trend when data collected over time have changed during different months of the year, possibly showing that the trend is different in different seasons) suggests the data are seasonally variable, and the density is increasing when adjusted for seasonality. This could indicate a trend developing for a particular season within the overall trend.

The density of *E. coli* in Brays Bayou Above Tidal remains high (roughly 10 times the standard). Moving geometric mean plots show the decline has been significant but improvement appears to have stalled.



Dissolved Oxygen

Click to View Brays Bayou Above Tidal Dissolved Oxygen Concerns Map (link available only in online story)

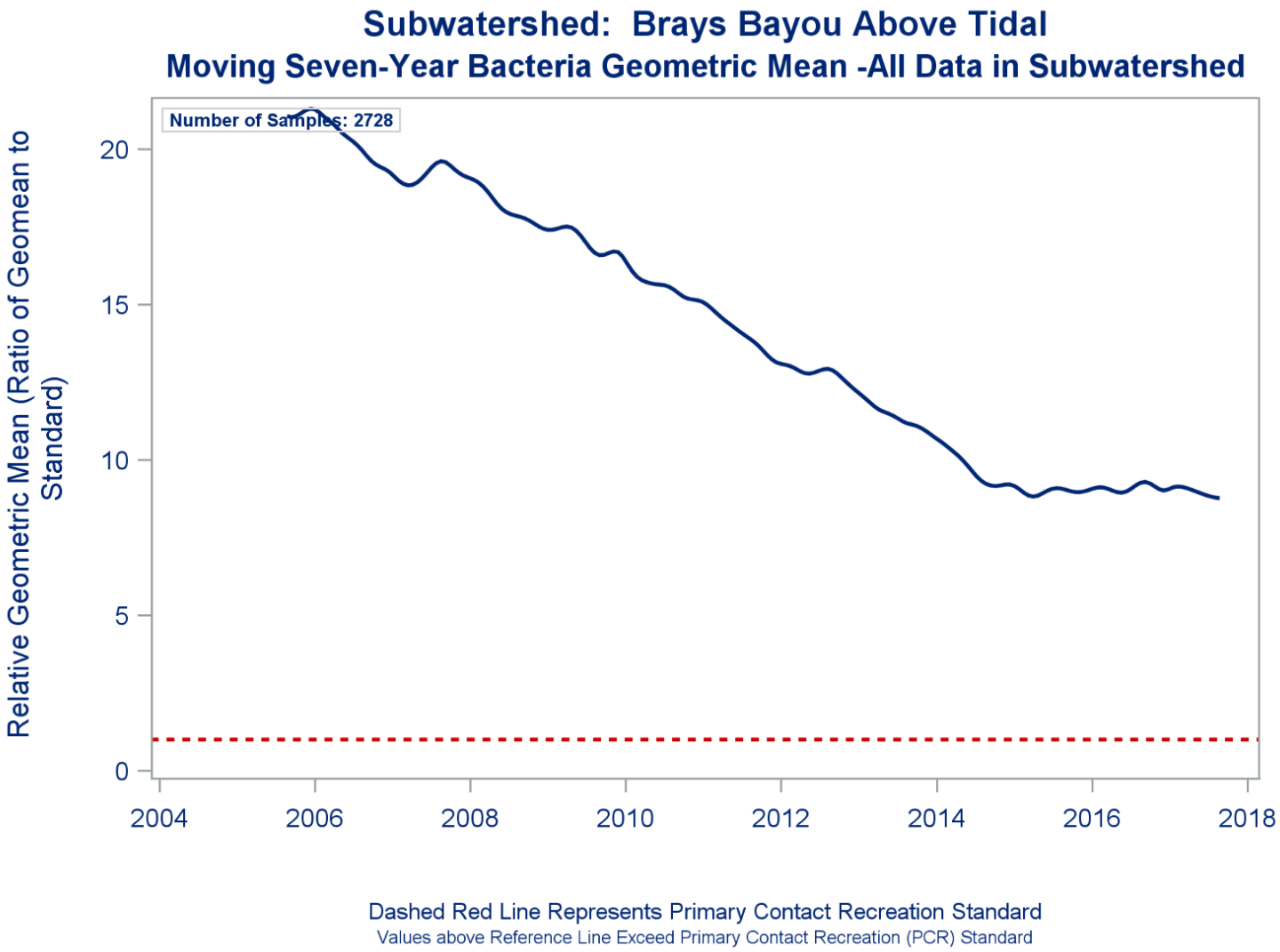
Eight AUs in this subwatershed fully support Dissolved Oxygen (DO) standards. Only 1007U_01 has a concern for low levels of DO. The 2014 Integrated Report indicates 12.5

percent of DO samples were below the grab screening level. H-GAC's analysis of data from 2010 to 2017 indicates 91.8 percent of DO samples were below the grab screening level. The water bodies in this subwatershed are primarily concrete-lined and maintained channelized ditches and streams, so they have been given a Limited Aquatic Life Use (ALU) designation. This means the DO grab screening level is 3.0 mg/L and the minimum is 2.0 mg/L. DO concentrations are increasing in 1007B_01, 1007B_02, and 1007S_01, and stable elsewhere.

Nutrients

Click to View Bray Bayou Above Tidal Nutrient Concerns Map (link available only in online story)

Elevated nutrient concentrations are found in five of the AUs of this subwatershed. Ammonia, nitrate, and total phosphorus are a concern in AUs 1007B_01, 1007B_02, and 1007S_01. Elevated concentrations of ammonia are the only nutrient concern identified in 1007T_01. H-GAC trend analysis for these AUs shows that total phosphorus and nitrate levels continue to increase in 1007B_01 and _02, and 1007S_01, but are decreasing in 1007T_01 and stable in 1007U_01.



Trends

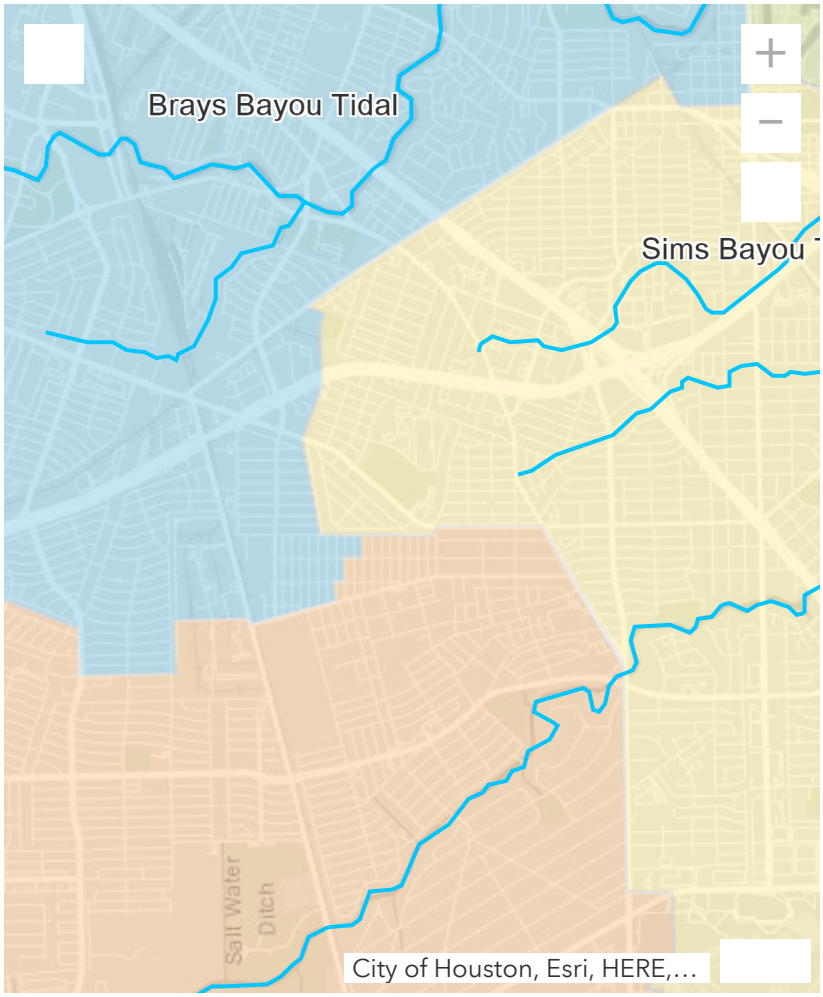
H-GAC's data analysis identified significant trends for common water quality parameters. These trends are illustrated in the table below. Graphs illustrating these trends can be found in the appendix.

Parameter Trends Found in Brays Bayou Above Tidal Subwatershed										
AU	*E. coli*	DO	Ammonia	Nitrate	TKN	T Phos	TSS	Temp	pH	Sp Cond
1007B_01	⇩	⇧	⇩	⇧		⇧		⇧		⇩
1007B_02		⇧	⇩	⇧		⇧	⇩	⇧	⇧	
1007C_01	⇩		⇩			⇧		⇧	⇩	
1007E_01	⇩	⇧	⇧		⇩		⇧		⇧	
1007L_01										
1007S_01		⇧	⇩	⇧		⇧	⇩			
1007T_01					⇩	⇩			⇩	⇩
1007U_01										
1007W_01										

⇧indicates the trend is increasing. ⇩indicates the trend is decreasing.
Red is getting worse. Green is getting better. Yellow is trending but of no concern at this time.

Brays Bayou Tidal Subwatershed

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/1i41Pj.



Legend

AU (Streams)

AU (Water Bodies)

SubWatersheds

- Brays Bayou Above Tidal
- Brays Bayou Tidal
- HSC/Buffalo Bayou Tidal
- Hunting Bayou
- Sims Bayou Above Tidal
- Sims Bayou Tidal
- Vince Bayou Tidal

SUBWATERSHED DESCRIPTION

Brays Bayou Tidal Subwatershed Map (On Right)

The Brays Bayou Tidal subwatershed is in south-central Harris County. The total area is 17.07 square miles and is completely within the City of Houston.

Brays Bayou Tidal is part of the classified segment 1007 (Houston Ship Channel (HSC)/Buffalo Bayou Tidal). The tidal portion has a length of 6.85 miles and has two unclassified tributaries, 1007G (Kuhlman Gully) and 1007K (Country Club Bayou Above Tidal). The combined length of the unclassified segments is 2.34 miles.

HYDROLOGIC CHARACTERISTICS

Click to View the Brays Bayou Tidal USGS Streamflow Gages map (link available only in online story)

Two U.S. Geological Survey (USGS) streamflow gages are located on Brays Bayou Tidal. Flow is measured in cubic feet per second (CFS).

Brays Bayou Tidal Streamflow Gages			
Site Number	**Station Name**	**Realtime Monitoring**	**Mean Flow (CFS) 2010 - 2017**
08075110	Brays Bayou at MLK Jr Blvd, Houston, TX	Yes – Partial	No Data Found
08075120	Brays Bayou at Lidstone Ave, Houston, TX	No – Discrete Sample only	

LAND COVER AND NATURAL CHARACTERISTICS

Click to View the Brays Bayou Tidal Land Cover Map (link available only in online story)

More than 97 percent of the Brays Bayou Tidal subwatershed is developed, with nearly 50 percent of the development being medium intensity. The rest is almost evenly distributed between low and high intensity development. In this subwatershed, overall development decreased slightly to accommodate the construction of stormwater detention/retention basins, accounting for the slight increase of wetland acreage between 2006 and 2015.

Land Cover for Brays Bayou Tidal					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of Total)**	**% Change**
Agriculture	17.59	0.16	31.70	0.29	80.22
Pasture/Grasslands	17.59	0.2	31.70	0.3	80.22
Cultivated Crops	0.00	0.0	0.00	0.0	0.0
Barren Lands	3.34	0.0	46.35	0.4	1,289.27
Developed	10,738.27	98.32	10,636.35	97.38	-0.95
High Intensity	3,200.25	29.3	1,907.79	17.5	-40.39
Medium Intensity	4,856.98	44.5	5,383.04	49.3	10.83
Low Intensity	1,847.56	16.9	2,774.11	25.4	50.15
Open Space	833.48	7.6	571.41	5.2	-31.44
Forest/Shrubs	115.66	1.1	51.97	0.5	-55.06
Open Water	40.69	0.4	10.64	0.1	-73.84
Wetlands	6.67	0.1	145.20	1.3	2,076.24

DESCRIPTION OF WATER QUALITY ISSUES

Click to View the Brays Bayou Tidal Assessment Unit Map (link available only in online story)

Brays Bayou Tidal subwatershed has three AUs. 1007_04 is part of the classified (tidal) segment. 1007G_01 and 1007K_01 are on unclassified, freshwater tributaries.

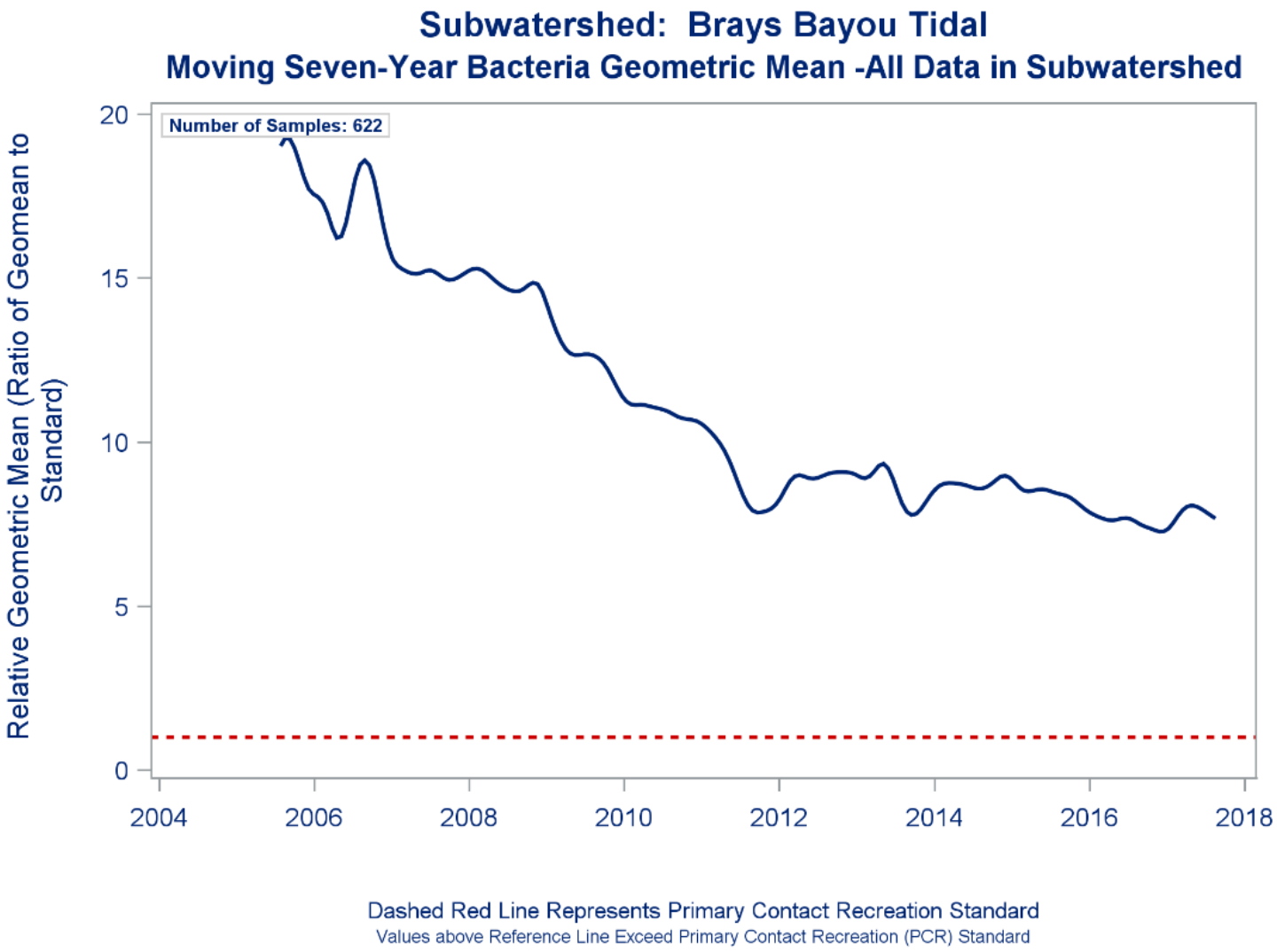
Brays Bayou Tidal Water Quality Issues						
AU_ID	Parameter	Level of Support	% Samples Exceeding Standard/ Screening Level 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard/ Screening Level H-GAC 2010-2017	Geomean H-GAC 2010-2017
1007_04	Ammonia	CS	66.3	.	42.1	.
1007_04	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_04	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_04	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_04	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007_04	Nitrate	CS	95.1	.	97.7	.
1007_04	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_04	Total Phosphorus	CS	66.5	.	76.7	.
1007G_01	Dissolved Oxygen Grab	CS	36.7	.	95.2	.
1007G_01	*E. coli*	NS	.	1352	85.7	1010
1007K_01	Ammonia	CS	35.6	.	6.3	.
1007K_01	Dissolved Oxygen 24hr Avg	CN	33.3	.	72.1	.
1007K_01	Dissolved Oxygen 24hr Min	NS	50.0	.	72.1	.
1007K_01	Dissolved Oxygen Grab	CS	33.3	.	72.1	.
1007K_01	Dissolved Oxygen Grab	NS	13.8	.	72.1	.
1007K_01	*E. coli*	NS	.	1458	92.1	1664

*Samples not collected
FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern;
CN – Concern for near-nonattainment of the TSWQS based on numeric criteria;
CS – Concern for water quality based on screening levels

Click to View the Brays Bayou Tidal Bacteria Impairment Map (link available only in online story)

The two freshwater AUs do not support contact recreation because the *E. coli* bacteria geomean exceeds the state standard. The seven-year geomean for both AUs is greater than 1,000 MPN. The classified segment AU (1007_04) does not have a recreation use due to a navigation and industrial water use designation. The H-GAC seven-year geomean

analysis of enterococci samples for this AU was 123, below the general use standard of 168 MPN/100 mL.



Dissolved Oxygen

Click to View the Brays Bayou Tidal Dissolved Oxygen Concerns Map (link available only in online story)

While there is no concern with Dissolved Oxygen (DO) grab screening levels or grab minimum in 1007_04, the freshwater AUs are problematic. 1007G_01, which has a high Aquatic Life Use (ALU) designation, has a concern for depressed DO grab-sample levels. 1007K_01 is an unmaintained, channelized stream with an intermediate ALU designation. It does not support the 24-hour DO minimum or the grab sample minimum.

Nutrients

Click to View the Brays Bayou Tidal Nutrient Concerns Maps (link available only in online story)

Ammonia, nitrate, and total phosphorus are concerns in 1007_04. Ammonia is the only nutrient concern in 1007K_01.

Trends

H-GAC's data analysis identified significant trends for common water quality parameters. These trends are illustrated in the table below. Graphs illustrating these trends can be found in the appendix.

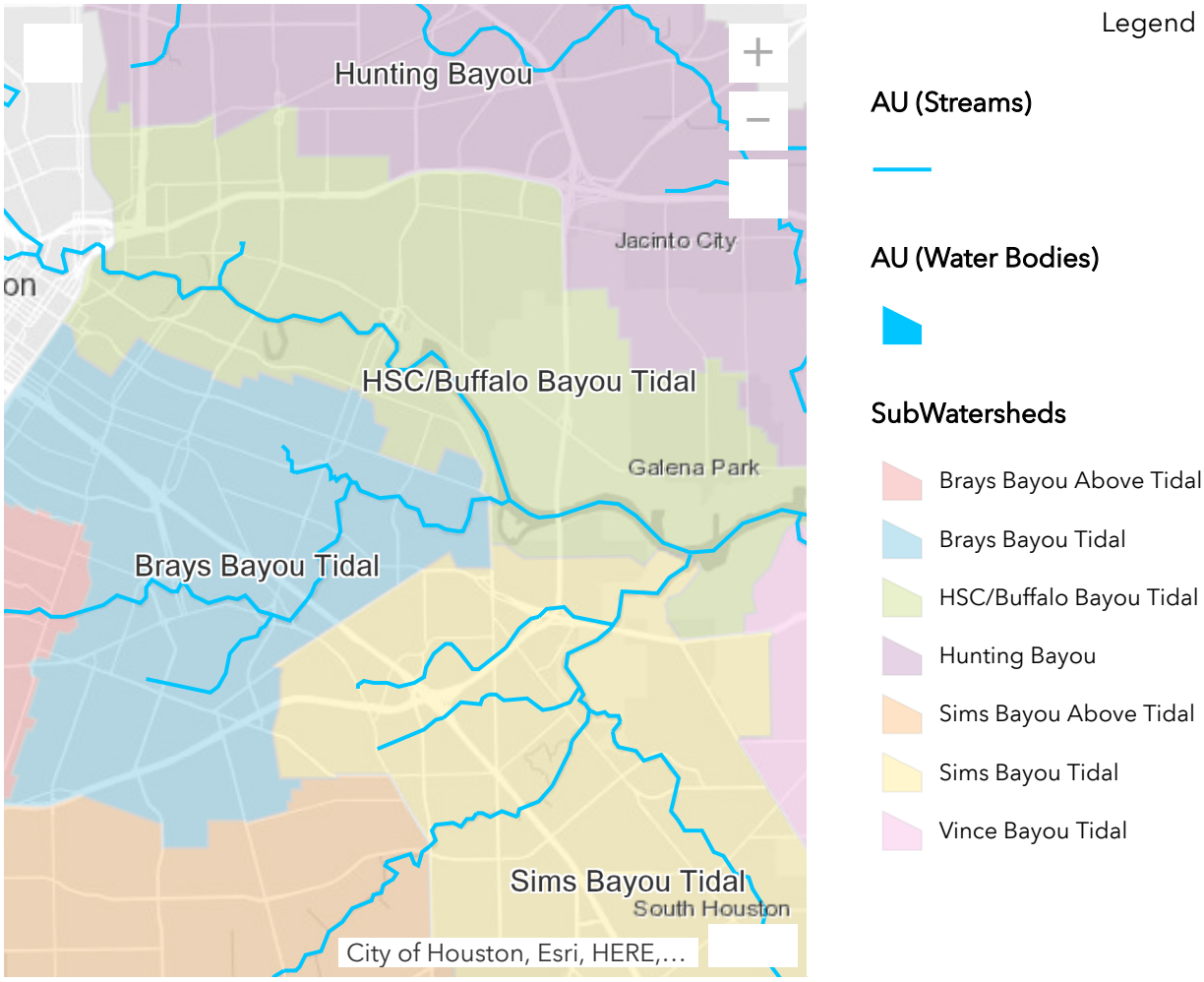
Parameter Trends Found in Brays Bayou Tidal Subwatershed

AU	*E. coli*	DO	Nitrate	T Phos
1007_04		⇧	⇩	⇧
1007G_01			⇩	
1007K_01	⇩		⇩	⇧

⇧ indicates the trend is increasing. ⇩indicates the trend is decreasing. Red is getting worse. Green is getting better.

HSC/Buffalo Bayou Tidal Subwatershed

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/1nqSyb.



SUBWATERSHED DESCRIPTION

HSC/Buffalo Bayou Tidal Subwatershed Map (On Right)

The HSC/Buffalo Bayou Tidal subwatershed located in southeast Harris County. The total area is 29.43 miles and includes portions of the cities of Houston, Galena Park, and Pasadena.
The main stem of the classified segment 1007 HSC/Buffalo Bayou Tidal is located within this subwatershed. The classified segment has a length of 14.07 miles and has one unclassified tributary, 1007O (known locally as Japhet Creek).

HYDROLOGIC CHARACTERISTICS

Click to View the HSC/Buffalo Bayou Tidal USGS Streamflow Gages Map (link available only in online story)

Four U.S. Geological Survey (USGS) streamflow gages are located on HSC/Buffalo Bayou Tidal.

HSC/Buffalo Bayou Tidal Streamflow Gages			
Site Number	**Station Name**	**Realtime Monitoring**	**Mean Flow (CFS) 2010 – 2017**
08074620	Buffalo Bayou at Hirsch St, Houston, TX	No – Discrete Samples only	
08074700	Buffalo Bayou at 69th St, Houston, TX	No – Discrete Samples only	
08074710	Buffalo Bayou at Turning Basin, Houston, TX	No – Stage only	

LAND COVER AND NATURAL CHARACTERISTICS

Click to View the HSC/Buffalo Bayou Tidal Land Cover Map (link available only in online story)

The HSC/Buffalo Bayou Tidal subwatershed is 91 percent developed. Open water and wetlands make up 7 percent of the remaining land cover, including stormwater detention/retention basins built in the subwatershed to help with flood mitigation.

Land Cover for HSC/Buffalo Bayou Tidal					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of Total)**	**% Change**
Agriculture	505.50	2.68	159.27	0.85	-68.49
Pasture/Grasslands	474.25	2.5	156.51	0.8	-67.00
Cultivated Crops	31.25	0.2	2.76	0.0	-91.17
Barren Lands	117.63	0.6	86.44	0.5	-26.52
Developed	16168.95	85.84	17165.43	91.13	6.16
High Intensity	6723.96	35.7	7083.59	37.6	5.35
Medium Intensity	6215.99	33.0	4903.16	26.0	-21.12
Low Intensity	2119.52	11.3	3686.80	19.6	73.95
Open Space	1109.48	5.9	1491.87	7.9	34.47
Forest/Shrubs	281.40	1.5	71.16	0.4	-74.71
Open Water	1115.12	5.9	651.83	3.5	-41.55
Wetlands	647.55	3.4	702.02	3.7	8.41

DESCRIPTION OF WATER QUALITY ISSUES

Click to View the HSC/Buffalo Bayou Tidal Assessment Units Map (link available only in online story)

The Houston Ship Channel/Buffalo Bayou Tidal subwatershed includes three AUs. Two AUs (1007_01 and 1007_07) are part of the classified (tidal) segment and the other AU (1007O_01) is on an unclassified, freshwater tributary.

HSC/Buffalo Bayou Tidal Assessment Unit Descriptions				
AU ID	**Segment ID**	**Segment Name**	**Class**	**Type**
1007_01	1007	Houston Ship Channel/Buffalo Bayou Tidal	Classified	Tidal Stream
1007_07	1007	Houston Ship Channel/Buffalo Bayou Tidal	Classified	Tidal Stream
1007O_01	1007O	Unnamed Tributary of Buffalo Bayou	Unclassified	Freshwater Stream

HSC/Buffalo Bayou Tidal Water Quality Issues						
AU_ID	Parameter	Level of Support	% Samples Exceeding Standard/ Screening Level 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard/ Screening Leve H-GAC 2010-2017I	Geomean H-GAC 2010-2017
1007_01	Ammonia	CS	42.5	.	32.6	.
1007_01	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_01	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_01	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_01	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007_01	Nitrate	CS	96.9	.	92.5	.
1007_01	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_01	Total Phosphorus	CS	36.4	.	45.8	.
1007_07	Ammonia	CS	30.5	.	26.5	.
1007_07	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_07	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_07	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_07	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007_07	Nitrate	CS	82.3	.	84.0	.
1007_07	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_07	Total Phosphorus	CS	67.2	.	68.2	.
1007O_01	Ammonia	CS	26.9	.	25.8	.
1007O_01	Dissolved Oxygen 24hr Avg	NS	85.7	.	23.5	.
1007O_01	Dissolved Oxygen 24hr Min	NS	100.0	.	23.5	.
1007O_01	Dissolved Oxygen Grab	CS	68.9	.	23.5	.
1007O_01	Dissolved Oxygen Grab	NS	62.2	.	23.5	.
1007O_01	*E. coli*	NS	.	1521	74.2	723

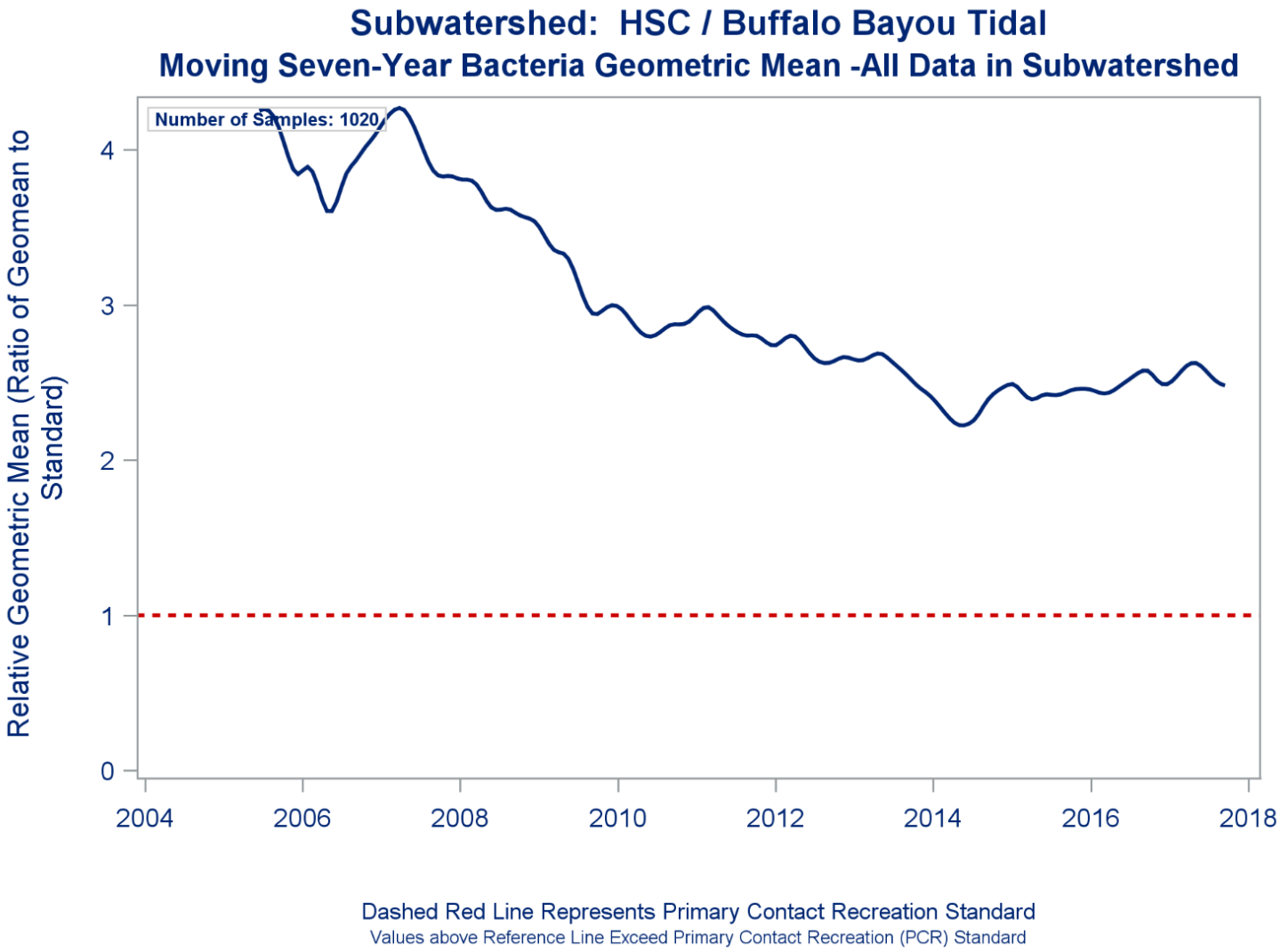
*Samples not collected
FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern;
CN – Concern for near-nonattainment of the TSWQS based on numeric criteria;
CS – Concern for water quality based on screening levels

Bacteria

Click to View the HSC/Buffalo Bayou Bacteria Impairments Map (link available only in online story)

1007O_01 does not support the contact recreation standard due to high levels of *E.coli*. H-GAC's calculation of the bacteria geomean showed a decrease since the data were

analyzed for the 2014 Integrated Report (IR). The City of Houston has made improvements to the wastewater collection system in this area and the water quality samples may reflect these improvements. H-GAC's seven-year geometric means of enterococci density were 58 and 92 MPN/100 mL on 1007_01 and 1007_07 respectively. However, the classified segment has no contact recreation standard since its designated uses include navigation and industrial water.



Dissolved Oxygen

Click to View the HSC/Buffalo Bayou Tidal Dissolved Oxygen Impairments and Concerns Map (link available only in online story)

1007O_01 displays depressed Dissolved Oxygen (DO) concentrations. In the 2014 IR the grab minimum, the 24-hour average, and the 24-hour minimum did not meet the standard. There was also a concern for the DO grab screening level in the same AU.

According to H-GAC's analysis of the DO grab data collected between 2010 and 2017, DO screening levels have not improved.

Nutrients

Click to View the HSC/Buffalo Bayou Tidal Nutrient Concerns Map (link available only in online story)

Data for ammonia, nitrate, and total phosphorus indicate a concern in 1007_01 and 1007_07, and an ammonia concern in 1007O_01. H-GAC's analysis supports the 2014 IR.

Trends

H-GAC's data analysis identified significant trends for common water quality parameters. These trends are illustrated in the table below. Graphs illustrating these trends can be found in the appendix.

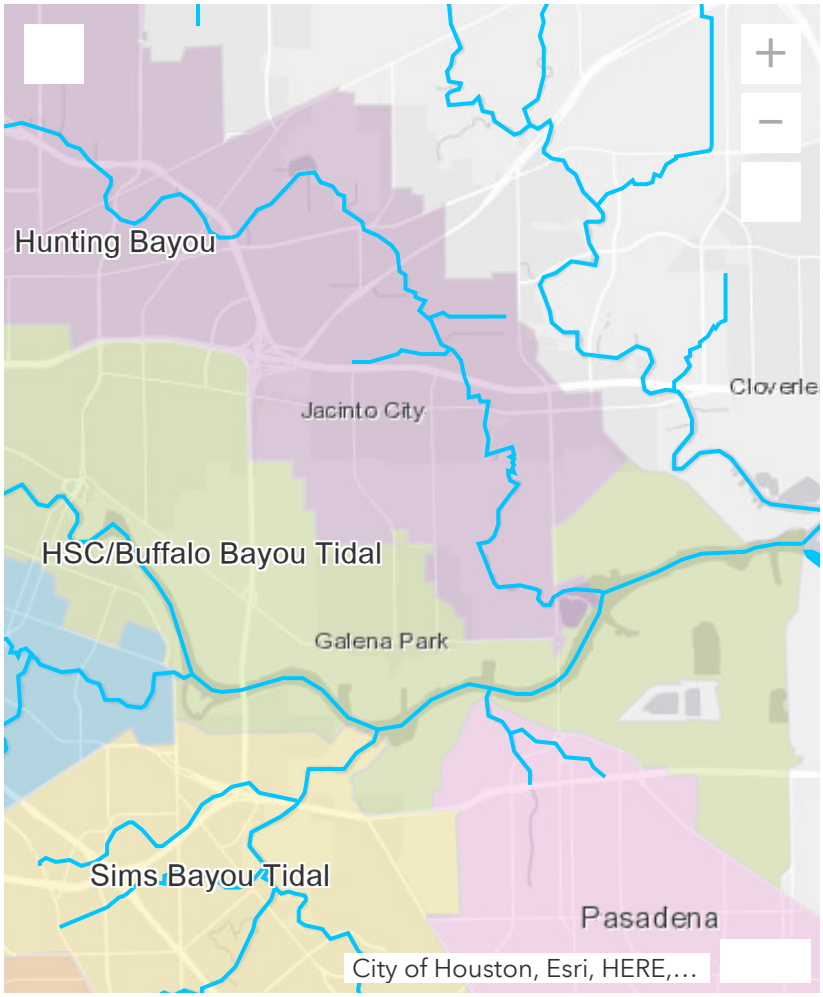
Parameter Trends Found in HSC/Buffalo Bayou Tidal Subwatershed

AU	Ammonia	Nitrate	T Phos	TSS
1007_01	⇩		⇧	⇧
1007_07		⇧		⇧
1007O_01				

⇧ indicates the trend is increasing. ⇩indicates the trend is decreasing. Red is getting worse. Green is getting better.

Hunting Bayou Subwatershed

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/09fqf9.



SUBWATERSHED DESCRIPTION

Hunting Bayou Subwatershed Map (On Right)

The Hunting Bayou subwatershed is in central Harris County. The total area of the subwatershed is 30.98 miles and contains portions of the cities of Houston, Galena Park, and Jacinto City.

Hunting Bayou Tidal is part of the classified segment 1007 (Houston Ship Channel (HSC)/Buffalo Bayou Tidal). The tidal portion has a length of 4.69 miles. The above tidal portion of Hunting Bayou is an 11.14-mile-long unclassified segment. The above tidal portion also has two unnamed, unclassified tributaries.

HYDROLOGIC CHARACTERISTICS

Click to View the Hunting Bayou USGS Streamflow Gages Map (link available only in online story)

There are two continuous monitoring U.S. Geological Survey (USGS) streamflow gages in Hunting Bayou Above Tidal. Flow is measured in cubic feet per second (CFS).

Hunting Bayou Streamflow Gages			
Site Number	**Station Name**	**Realtime Monitoring**	**Mean Flow (CFS) 2010 – 2017**
08075763	Hunting Bayou at Hoffman St, Houston, TX	Yes – Continuous	7.59
08075770	Hunting Bayou at IH 610, Houston, TX	Yes – Continuous	27.79

LAND COVER AND NATURAL CHARACTERISTICS

Click to View the Hunting Bayou Land Cover Map (link available only in online story)

The Hunting Bayou subwatershed is 84 percent developed with 37 percent low intensity. High intensity development is primarily found in the central area of the subwatershed where a large industrial complex is located. Man-made wetlands and development have replaced forest/shrubs land cover in this subwatershed.

Land Cover for Hunting Bayou					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of Total)**	**% Change**
Agriculture	560.54	2.83	287.40	1.45	-48.73
Pasture/Grasslands	531.52	2.7	269.68	1.4	-49.26
Cultivated Crops	29.02	0.1	17.72	0.1	-38.94
Barren Lands	77.33	0.4	78.37	0.4	1.34
Developed	16352.41	82.48	16674.58	84.11	1.97
High Intensity	4230.62	21.3	3648.06	18.4	-13.77
Medium Intensity	6101.12	30.8	4225.85	21.3	-30.74
Low Intensity	4132.61	20.8	7390.60	37.3	78.84
Open Space	1888.07	9.5	1410.07	7.1	-25.32
Forest/Shrubs	1692.93	8.5	871.20	4.4	-48.54
Open Water	160.28	0.8	16.29	0.1	-89.84
Wetlands	982.23	5.0	1897.89	9.6	93.22

DESCRIPTION OF WATER QUALITY ISSUES

Click to View the Hunting Bayou Assessment Unit Map (link available only in online story)

The Hunting Bayou subwatershed contains seven Assessment Units (AUs). 1007_03 is part of the classified (tidal) segment and the other six AUs are on unclassified, freshwater tributaries.

Hunting Bayou Assessment Unit Descriptions				
AU ID	**Segment ID**	**Segment Name**	**Class**	**Type**
1007_03	1007	Houston Ship Channel/Buffalo Bayou Tidal	Classified	Tidal Stream
1007M_01	1007M	Unnamed Tributary of Hunting Bayou	Unclassified	Freshwater Stream
1007R_01	1007R	Hunting Bayou Above Tidal	Unclassified	Freshwater Stream
1007R_02	1007R	Hunting Bayou Above Tidal	Unclassified	Freshwater Stream
1007R_03	1007R	Hunting Bayou Above Tidal	Unclassified	Freshwater Stream
1007R_04	1007R	Hunting Bayou Above Tidal	Unclassified	Freshwater Stream
1007V_01	1007V	Unnamed Tributary of Hunting Bayou	Unclassified	Freshwater Stream

Hunting Bayou Water Quality Issues						
AU_ID	Parameter	Level of Support	% Samples Exceeding Standard/ Screening Level 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard/ Screening Level H-GAC 2010-2017	Geomean H-GAC 2010-201
1007_03	Nitrate	CS	54.7	.	50.0	.
1007_03	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_03	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_03	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_03	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_03	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007M_01	Dissolved Oxygen Grab	CS	12.8	.	95.2	.
1007M_01	*E. coli*	NS	.	375	61.9	320
1007R_01	Ammonia	CS	60.3	.	68.3	.
1007R_01	Dissolved Oxygen 24hr Min	NS	60.0	.	79.4	.
1007R_01	Dissolved Oxygen Grab	CS	37.7	.	79.4	.
1007R_01	Dissolved Oxygen Grab	NS	13.0	.	79.4	.
1007R_01	*E. coli*	NS	.	2625	81.0	1318
1007R_02	Dissolved Oxygen Grab	CS	18.5	.	90.2	.
1007R_02	*E. coli*	NS	.	244	69.4	305
1007R_03	Dissolved Oxygen Grab	CS	15.2	.	95.2	.
1007R_03	*E. coli*	NS	.	361	70.3	410
1007R_04	Dissolved Oxygen 24hr Avg	CN	50.0	.	98.4	.
1007R_04	Dissolved Oxygen 24hr Min	NS	75.0	.	98.4	.
1007R_04	*E. coli*	NS	.	600	87.1	1977
1007R_04	Nitrate	CS	25.0	.	34.9	.
1007V_01	*E. coli*	NS	.	345	66.7	306

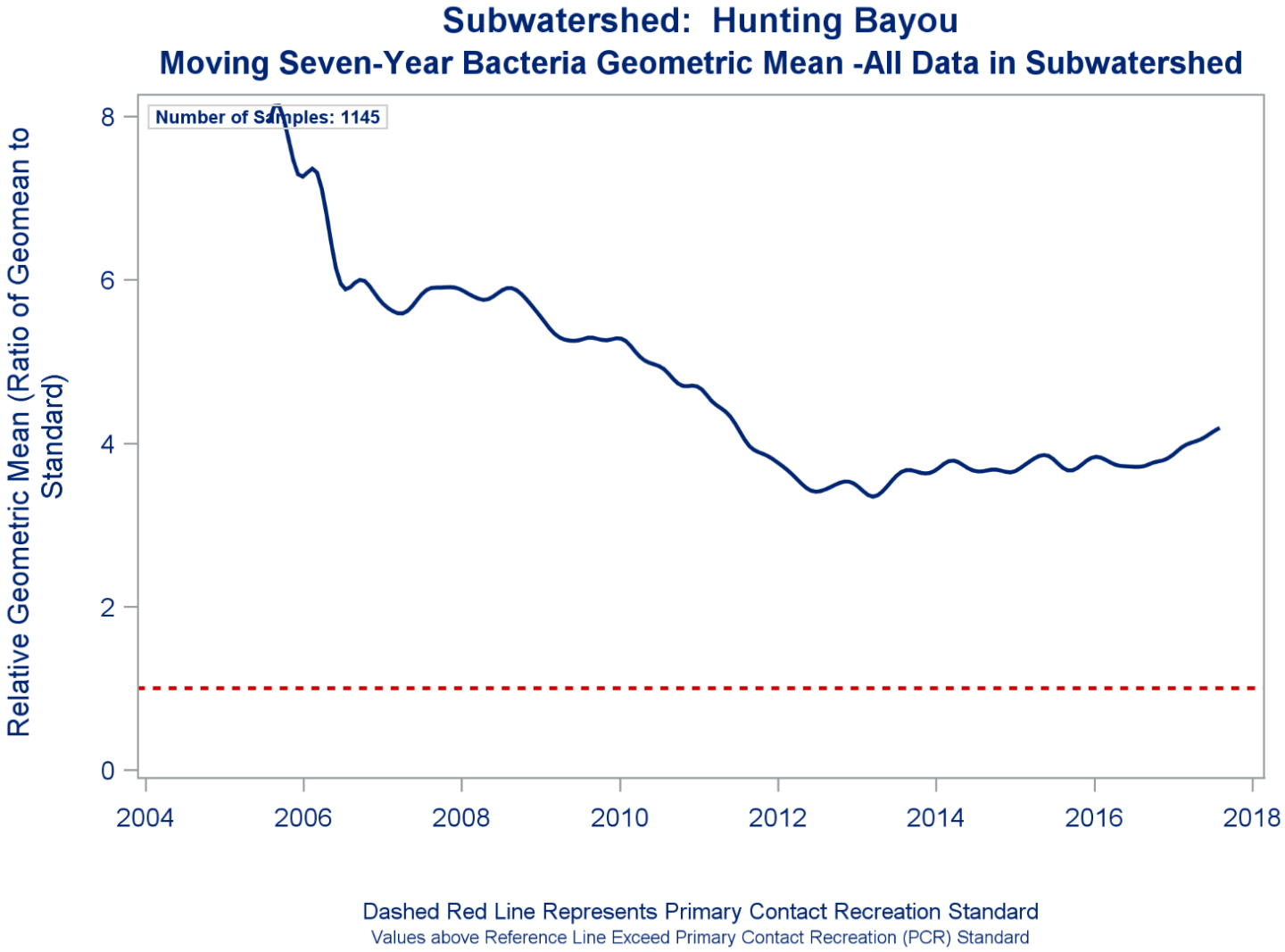
*Samples not collected
FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern;
CN – Concern for near-nonattainment of the TSWQS based on numeric criteria;
CS – Concern for water quality based on screening levels

Bacteria

Click to View Hunting Bayou Bacteria Impairments Map (link available only in online story)

All six freshwater AUs are impaired for contact recreation use due to high levels of *E. coli*. The geomean is 1318 MPN/100 mL for 1007R_01 and 1977 MPN/100 mL for 1007R_04.

H-GAC's analysis shows a decrease in the bacteria geomean for 1007R_01 from 2625 MPN/100 mL in the 2014 IR to 1318 MPN/100 mL. H-GAC's analysis for 1007R_04 also shows an increase in the bacteria geomean from the 2014 IR from 600 MPN/100 mL to 1977. The remaining four AUs have *E. coli* geomeans of 410 MPN/100 mL or less.



Dissolved Oxygen

Click to View Hunting Bayou Dissolved Oxygen Impairments and Concerns Map (link available only in online story)

Four AUs (1007R_01, 1007R_02, 1007R_03, 1007R_04) have concerns or impairments for Dissolved Oxygen (DO). There is a concern with grab DO screening levels in 1007R_01, 1007R_02, and 1007R_03. 1007R_01 and 1007R_04 are also impaired for 24-hour DO minimums and DO grab minimum. The Aquatic Life Use (ALU) designation for this segment is Intermediate and the DO mean for attainment is 4.0 mg/L.

Nutrients

Click to View the Hunting Bayou Nutrient Concerns Map (link available only in online story)

There are three AUs with nutrient concerns within this subwatershed. There are concerns for nitrate in 1007_03 and 1007R_04. 1007R_01 has a concern for ammonia.

Trends

H-GAC's data analysis identified significant trends for common water quality parameters. These trends are illustrated in the table below. Graphs illustrating these trends can be found in the appendix.

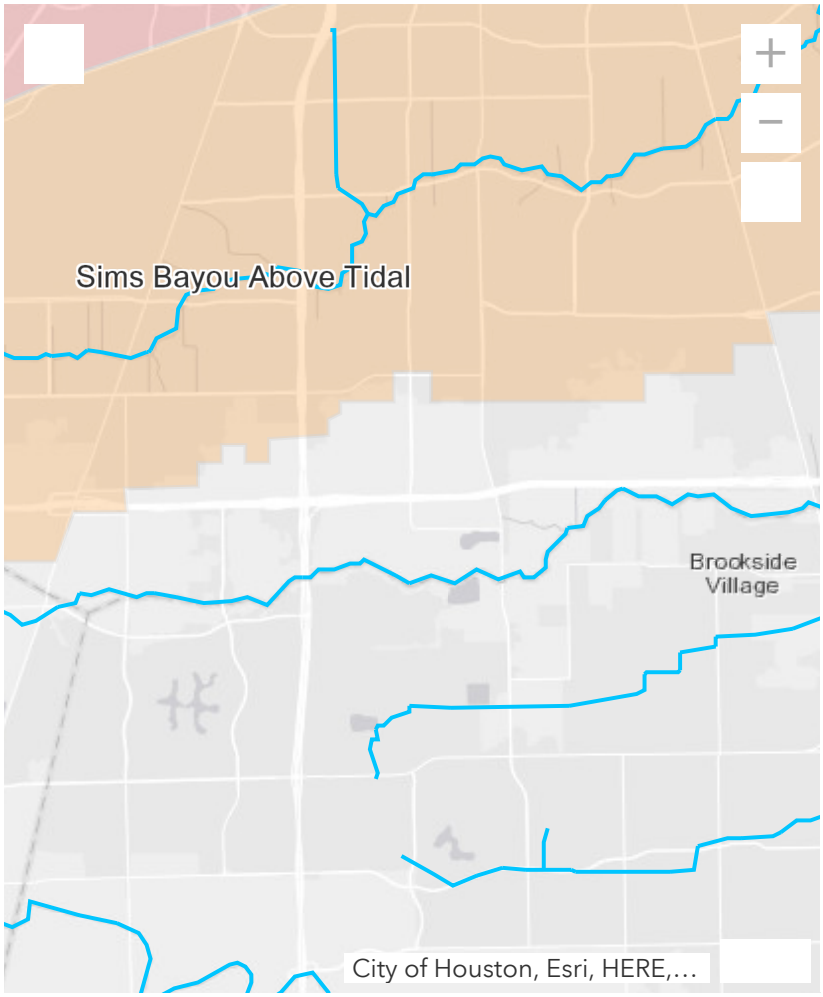
Parameter Trends Found in Hunting Bayou Subwatershed

AU	*E. coli*	DO	Ammonia	Nitrate	TKN	T Phos	pH
1007_03			⇧	⇩			
1007M_01			⇧	⇩	⇩	⇩	⇧
1007R_01	⇩						⇧
1007R_02				⇩	⇩		⇧
1007R_03							⇧
1007R_04	⇧					⇧	⇧
1007V_01		⇧	⇩	⇩	⇩		⇧

⇧ indicates the trend is increasing. ⇩indicate the trends is decreasing.
Red is getting worse. Green is getting better. Yellow is trending but of no concern at this time.

Sims Bayou Above Tidal Subwatershed

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/1DeqXW.



SUBWATERSHED DESCRIPTION

Sims Bayou Above Tidal Subwatershed Map (On Right)

The Sims Bayou Above Tidal subwatershed is in northeast Fort Bend County and southwest Harris County. The total area is 63.56 square miles and includes portions of the cities of Houston, Stafford, and Missouri City.

Sims Bayou Above Tidal (1007D) is a 15.15-mile-long unclassified segment. It has two unclassified tributaries, Canal C-147 (1007A) and an Unnamed Tributary (1007N).

HYDROLOGIC CHARACTERISTICS

Click to View the Sims Bayou Above Tidal USGS Streamflow Gages Map (link available only in online story)

Two U.S. Geological Survey (USGS) streamflow gages are located on Sims Bayou Above Tidal. Flow is measured in cubic feet per second (CFS).

Sims Bayou Above Tidal Streamflow Gages			
Site Number	**Station Name**	**Realtime Monitoring**	**Mean Flow (CFS) 2010 – 2017**
08075400	Sims Bayou at Hiram Clarke St, Houston, TX	Yes – Continuous	36.133
08075500	Sims Bayou at Houston, TX	Yes – Partial	

LAND COVER AND NATURAL CHARACTERISTICS

Click to View the Sims Bayou Above Tidal Land Cover Map (link available only in online story)

The Sims Bayou Above Tidal subwatershed is 80 percent developed, increasing by 20 percent between 2006 and 2015, with the biggest increases found in low and medium intensity development. There is still undeveloped land in this subwatershed, but between 2006 and 2015 approximately 50 percent of the total agricultural land was lost. Through efforts of the Harris County Flood Control District, the acreage in wetlands has increased by nearly 259 percent but the total acreage of forest/shrubs decreased by 80 percent.

Land Cover for Sims Bayou Above Tidal					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of Total)**	**% Change**
Agriculture	6,967.35	17.13	3,570.17	8.78	-48.76
Pasture/Grasslands	6,870.41	16.9	3,355.53	8.2	-51.16
Cultivated Crops	96.94	0.2	214.63	0.5	121.41
Barren Lands	338.55	0.8	140.48	0.3	-58.51
Developed	26,967.07	66.29	32,602.87	80.15	20.90
High Intensity	2,609.30	6.4	2,508.34	6.2	-3.87
Medium Intensity	11,360.62	27.9	13,358.47	32.8	17.59
Low Intensity	7,844.92	19.3	10,907.02	26.8	39.03
Open Space	5,152.22	12.7	5,829.04	14.3	13.14
Forest/Shrubs	5,233.26	12.9	1,012.87	2.5	-80.65
Open Water	263.77	0.6	86.81	0.2	-67.09
Wetlands	907.96	2.2	3,264.76	8.0	259.57

DESCRIPTION OF WATER QUALITY ISSUES

Click to View the Sims Bayou Above Tidal Assessment Unit Map (link available only in online story)

The Sims Bayou Above Tidal subwatershed includes five AUs on unclassified, freshwater tributaries.

Sims Bayou Above Tidal Assessment Unit Descriptions				
AU ID	**Segment ID**	**Segment Name**	**Class**	**Type**
1007A_01	1007A	Canal C-147	Unclassified	Freshwater Stream
1007D_01	1007D	Sims Bayou Above Tidal	Unclassified	Freshwater Stream
1007D_02	1007D	Sims Bayou Above Tidal	Unclassified	Freshwater Stream
1007D_03	1007D	Sims Bayou Above Tidal	Unclassified	Freshwater Stream
1007N_01	1007N	Unnamed Tributary of Sims Bayou	Unclassified	Freshwater Stream

Sims Bayou Above Tidal Water Quality Issues						
AU_ID	Parameter	Level of Support	% Samples Exceeding Standard/ Screening Level 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard/ Screening Level H-GAC 2010-2017	Geomean H-GAC 2010-2017
1007A_01	Dissolved Oxygen Grab	CN	*	.	100.0	.
1007A_01	*E. coli*	NS	.	247	39.7	145
1007D_01	*E. coli*	NS	.	252	70.9	393
1007D_01	Nitrate	CS	57.5	.	34.7	.
1007D_01	Total Phosphorus	CS	56.5	.	37.9	.
1007D_02	Ammonia	CS	49.6	.	31.0	.
1007D_02	*E. coli*	NS	.	921	81.7	906
1007D_02	Nitrate	CS	48.9	.	65.1	.
1007D_02	Total Phosphorus	CS	63.6	.	74.4	.
1007D_03	Ammonia	CS	67.3	.	27.8	.
1007D_03	*E. coli*	NS	.	933	88.8	1041
1007D_03	Nitrate	CS	48.0	.	75.9	.
1007D_03	Total Phosphorus	CS	67.3	.	83.4	.
1007N_01	Ammonia	CS	79.1	.	66.7	.
1007N_01	Dissolved Oxygen Grab	CS	33.8	.	90.3	.
1007N_01	*E. coli*	NS	.	576	72.6	335
*The exceedance rate was not included in TCEQ documents FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern; CN – Concern for near-nonattainment of the TSWQS based on numeric criteria; CS – Concern for water quality based on screening levels						

Bacteria

Click to View the Sims Bayou Above Tidal Bacteria Impairments Map (link available only in online story)

All five AUs are impaired for contact recreation use due to high levels of *E. coli*. The bacteria geomeans calculated by H-GAC are nearly the same as those calculated for the 2014 Integrated Report (IR). Three are slightly lower and two are slightly higher than in the IR. The exceedance between 2010 and 2017 was greater than 70 percent for four of the five AUs.

Dissolved Oxygen

Click to View the Sims Bayou Above Tidal Dissolved Oxygen Concerns Map (link available only in online story)

1007N_01 is the only AU with Dissolved Oxygen (DO) concerns, with 90 percent of the samples below the grab screening level.

Nutrients

Click to View the Sims Bayou Above Tidal Nutrient Concerns Map (link available only in online story)

1007D_02 and 1007D_03 have concerns for ammonia, nitrate and total phosphorus. 1007D_01 has concerns for nitrate and total phosphorus. AU 1007N_01 has a concern for ammonia. 1007A_01 has no identified concerns for excessive nutrient concentrations.

Trends

H-GAC's data analysis identified significant trends for common water quality parameters. These trends are illustrated in the table below. Graphs illustrating these trends can be found in the appendix.

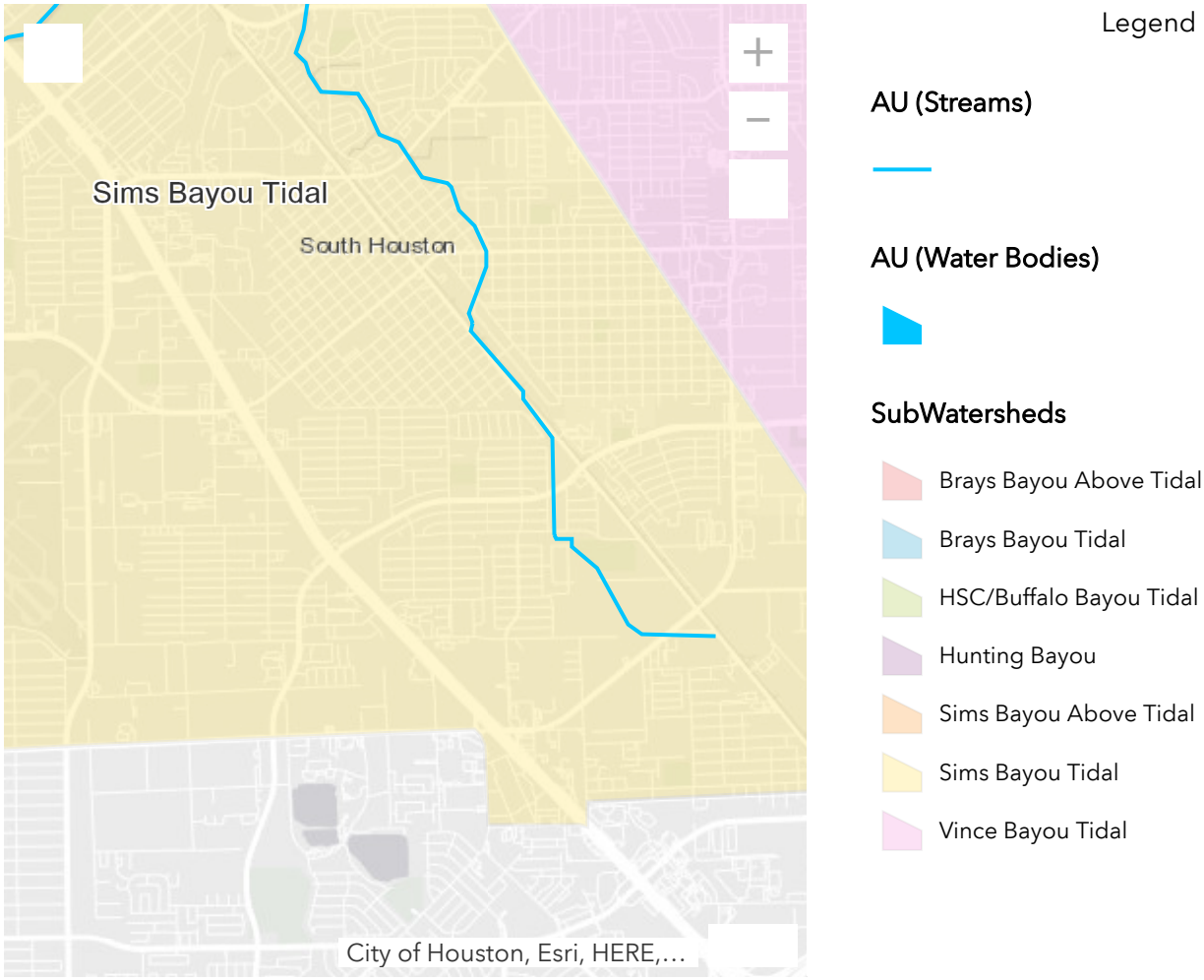
Parameter Trends Found in Sims Bayou Above Tidal Subwatershed

AU	*E. coli*	DO	Ammonia	Nitrate	TKN	T Phos	TSS
1007A_01	⇩	⇧	⇩	⇧	⇩	⇧	⇩
1007D_01		⇧	⇩	⇩	⇩	⇩	
1007D_02		⇧	⇩		⇩		
1007D_03		⇧	⇩	⇧	⇩	⇧	
1007N_01							

⇧ indicates the trend is increasing. ⇩indicates the trend is decreasing.
Red is getting worse. Green is getting better.

Sims Bayou Tidal Subwatershed

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/0WyOnz.



SUBWATERSHED DESCRIPTIONS

Sims Bayou Tidal Subwatershed Map (On Right)

The Sims Bayou Tidal subwatershed in south Harris County. The total area is 29.96 square miles and contains portions of Houston, South Houston, and Pasadena.

Sims Bayou Tidal is part of the classified segment 1007 (Houston Ship Channel(HSC)/Buffalo Bayou Tidal). The tidal portion of Sims Bayou is 8.79 miles long. Sims Bayou Tidal has three unclassified tributaries: Berry Bayou (1007F), Pine Gully (1007H), and Plum Creek (1007I).

HYDROLOGIC CHARACTERISTICS

Click to View the Sims Bayou Tidal USGS Streamflow Gages (link available only in online story)

One U.S. Geological Survey (USGS) streamflow gage is in the Sims Bayou Tidal subwatershed. This continuous streamflow gage is located on Berry Bayou at Nevada Street. Flow is measured in cubic feet per second (CFS).

Sims Bayou Tidal Streamflow Gage			
Site Number	**Station Name**	**Realtime Monitoring**	**Mean Flow (CFS) 2010 – 2017**
08075605	Berry Bayou at Nevada St, Houston, TX	Yes – Continuous	9.56

LAND COVER AND NATURAL CHARACTERISTICS

Click to View the Sims Bayou Tidal Land Cover Map (link available only in online story)

The Sims Bayou Tidal subwatershed is 94 percent developed, primarily medium intensity development. Wetland land cover increased at the same rate forest/shrubs land cover decreased. William P. Hobby Airport is in the southwest portion of the subwatershed and an industrial area is in the northeast corner.

Land Cover for Sims Bayou Tidal					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of Total)**	**% Change**
Agriculture	265.85	1.39	87.29	0.46	-67.16
Pasture/Grasslands	253.84	1.3	86.60	0.5	-65.88
Cultivated Crops	12.01	0.1	0.69	0.0	-94.28
Barren Lands	33.58	0.2	57.86	0.3	72.28
Developed	17,751.18	92.60	18,041.94	94.12	1.64
High Intensity	4,242.91	22.1	2,728.98	14.2	-35.68
Medium Intensity	7,336.97	38.3	8,032.56	41.9	9.48
Low Intensity	3,878.07	20.2	5,220.43	27.2	34.61
Open Space	2,293.24	12.0	2,059.97	10.7	-10.17
Forest/Shrubs	645.55	3.4	147.55	0.8	-77.14
Open Water	134.90	0.7	58.83	0.3	-56.39
Wetlands	337.66	1.8	775.26	4.0	129.60

DESCRIPTION OF WATER QUALITY ISSUES

Click to View the Sims Bayou Tidal Assessment Unit Map (link available only in online story)

The Sims Bayou Tidal subwatershed includes five AUs. Two AUs (1007_02 and 1007_06) are part of the classified (tidal) segment and three AUs are on the unclassified, freshwater tributaries.

Sims Bayou Tidal Assessment Unit Descriptions				
AU ID	**Segment ID**	**Segment Name**	**Class**	**Type**
1007_02	1007	Sims Bayou Tidal	Classified	Tidal Stream
1007_06	1007	Berry Bayou Tidal	Classified	Tidal Stream
1007F_01	1007F	Berry Bayou Above Tidal	Unclassified	Freshwater Stream
1007H_01	1007H	Pine Gully Above Tidal	Unclassified	Freshwater Stream
1007I_01	1007I	Plum Creek Above Tidal	Unclassified	Freshwater Stream

Sims Bayou Tidal Water Quality Issues						
AU_ID	Parameter	Level of Support	% Samples Exceeding Standard/ Screening Level 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard/ Screening Level H-GAC 2010-2017	Geomean H-GAC 2010-2017
1007_02	Ammonia	CS	63.4	.	35.8	.
1007_02	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_02	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_02	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_02	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007_02	Nitrate	CS	83.4	.	91.4	.
1007_02	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_02	Total Phosphorus	CS	69.1	.	86.4	.
1007_06	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_06	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_06	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_06	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007_06	Nitrate	CS	92.6	.	96.8	.
1007_06	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_06	Total Phosphorus	CS	85.3	.	85.7	.
1007F_01	Ammonia	CS	44.1	.	30.2	.
1007F_01	E. coli	NS	.	2492	98.4	2251
1007F_01	Nitrate	CS	89.7	.	96.8	.
1007F_01	Total Phosphorus	CS	89.7	.	88.9	.
1007H_01	Ammonia	CS	55.9	.	30.2	.
1007H_01	Dissolved Oxygen 24hr Avg	NS	100.0	.	48.6	.
1007H_01	Dissolved Oxygen 24hr Min	NS	100.0	.	48.6	.
1007H_01	Dissolved Oxygen Grab	CS	66.7	.	48.6	.
1007H_01	Dissolved Oxygen Grab	NS	52.4	.	48.6	.
1007H_01	E. coli	NS	.	1221	93.5	1931
1007I_01	Ammonia	CS	49.3	.	47.6	.
1007I_01	Dissolved Oxygen 24hr Avg	NS	100.0	.	34.7	.
1007I_01	Dissolved Oxygen 24hr Min	NS	100.0	.	34.7	.
1007I_01	Dissolved Oxygen Grab	CS	67.5	.	34.7	.
1007I_01	Dissolved Oxygen Grab	NS	52.5	.	34.7	.
1007I_01	E. coli	NS	.	3763	91.9	2850

*Samples not collected
FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern;
CN – Concern for near-nonattainment of the TSWQS based on numeric criteria;
CS – Concern for water quality based on screening levels

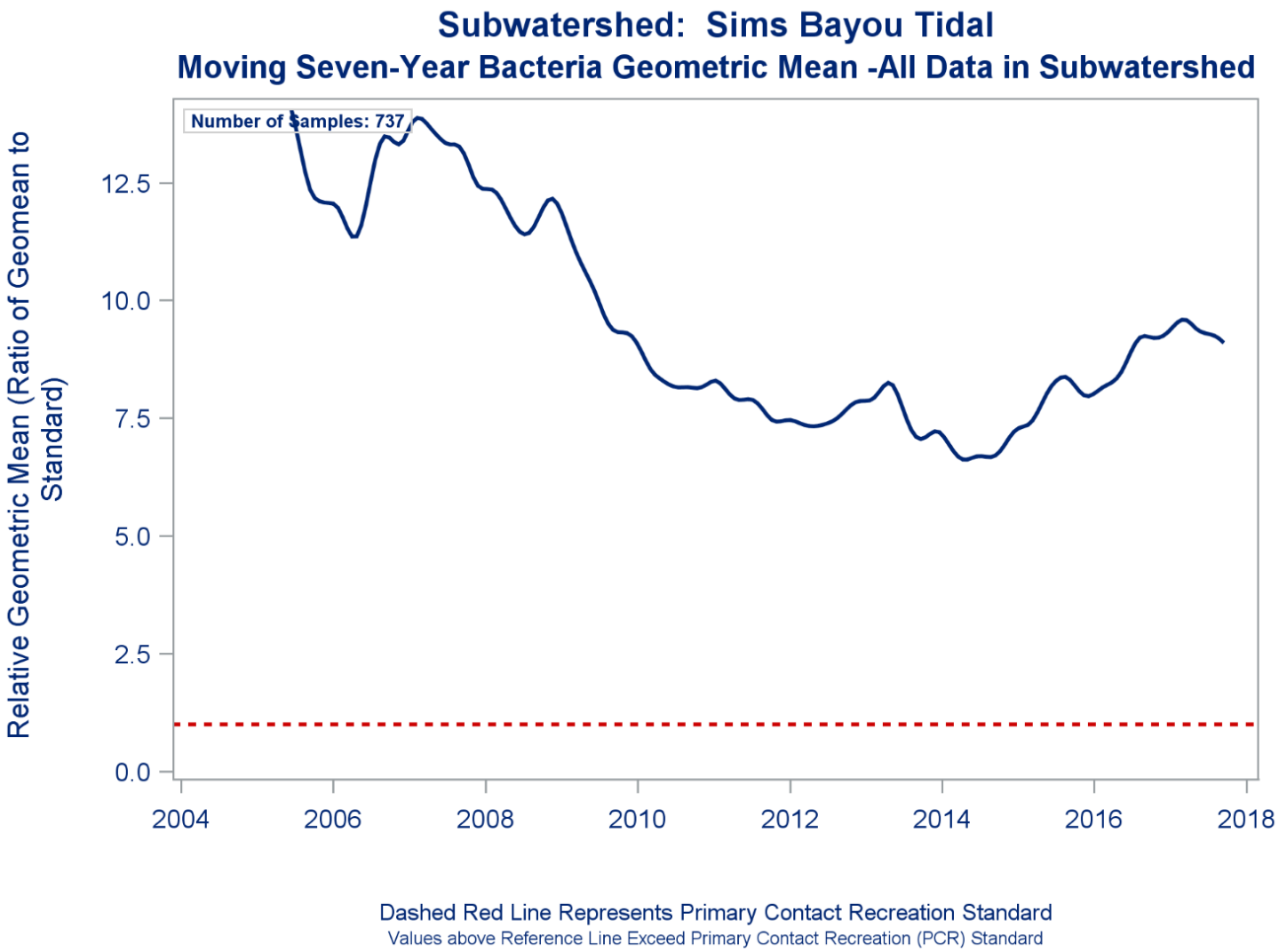
Bacteria

Click to View the Sims Bayou Bacteria Impairments Map (link available only in online story)

All three freshwater AUs have impaired contact recreation use due to high levels of *E. coli*. 1007H_01 has the lowest bacteria geomean with 1,931 MPN/100 mL and 1007I_01 has

the highest bacteria geomean with 2,850 MPN/100 mL. Ninety percent of samples taken between 2010 and 2017 exceed the standard.

The tidal AUs have no contact recreation use standard because their designated uses include navigation and industrial water supply.



Dissolved Oxygen

Click to View the Sims Bayou Tidal Dissolved Oxygen Impairments and Concerns Map (link available only in online story)

1007H_01 has both concerns and impairments associated with depressed Dissolved Oxygen (DO). There is a concern with grab screening levels and 24-hour averages. The grab DO minimum and 24-hour minimum do not support the standards despite the Intermediate Aquatic Life Use (ALU) designation for this segment. 1007I_01 also has a concern for DO grab screening levels and depressed grab minimums. H-GAC's data

analysis indicates the number of exceedances has decreased, but DO concentrations in at least a third of the samples were below the screening levels and standards.

Nutrients

Click to View the Sims Bayou Tidal Nutrient Concerns Map (link available only in online story)

There is at least one nutrient concern in each of the five AUs in this subwatershed. 1007_02 and 1007F_01 have concerns for ammonia, nitrates, and total phosphorus. 1007_06 has concerns for nitrates and total phosphorus. 1007H_01 and 1007I_01 have ammonia concerns, but the percent exceedance has decreased over the H-GAC seven-year monitoring period.

Trends

H-GAC's data analysis identified significant trends for common water quality parameters. These trends are illustrated in the table below. Graphs illustrating these trends can be found in the appendix.

Parameter Trends Found in Sims Bayou Tidal Subwatershed

AU	*E. coli*	DO	Ammonia	Nitrate	T Phos	TSS	pH
1007_02	⇧		⇩	⇧	⇧	⇩	
1007_06						⇧	⇧
1007F_01		⇧		⇧			
1007H_01			⇩	⇩		⇧	
1007I_01		⇩			⇩		

⇧ indicates the trend is increasing. ⇩ indicates the trend is decreasing.
Red is getting worse. Green is getting better. Yellow is trending but of no concern at this time.

Vince Bayou Tidal Subwatershed

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/9uam5.

Legend

AU (Streams)

AU (Water Bodies)

SubWatersheds

- Brays Bayou Above Tidal
- Brays Bayou Tidal
- HSC/Buffalo Bayou Tidal
- Hunting Bayou
- Sims Bayou Above Tidal
- Sims Bayou Tidal
- Vince Bayou Tidal

SUBWATERSHED DESCRIPTION

Vince Bayou Tidal Subwatershed (On Right)

The Vince Bayou Tidal subwatershed in southeast Harris County. The total area of this subwatershed is 15.28 square miles and contains portions of the cities of Houston, South Houston, and Pasadena.

Vince Bayou Tidal and its tributary Little Vince Bayou Tidal are both part of the classified segment 1007 (Houston Ship Channel (HSC)/Buffalo Bayou Tidal).

HYDROLOGIC CHARACTERISTICS

Click to View the Vince Bayou Tidal USGS Streamflow Gage Map (link available only in online story)

One continuous U.S. Geological Survey (USGS) streamflow gage is located on Vince Bayou in Pasadena. Flow is measured in cubic feet per second (CFS).

Vince Bayou Tidal Streamflow Gage			
Site Number	**Station Name**	**Realtime Monitoring**	**Mean Flow (CFS) 2010 – 2017**
08075730	Vince Bayou at Pasadena, TX	Yes – Continuous	16.05

LAND COVER AND NATURAL CHARACTERISTICS

Click to View the Vince Bayou Tidal Land Cover Map (link available only in online story)

The Vince Bayou Tidal subwatershed is 96 percent developed, with 12 percent high intensity. There has been an increase of more than 200 acres of wetlands in this subwatershed between 2006 and 2015. The increase could be a weather-related anomaly resulting in some lands being inundated at the time the satellite image was taken. Further investigation will be needed to verify.

Land Cover for Vince Bayou Tidal					
Land Cover Type	**2006 Area (Acres)**	**2006 Area (% of Total)**	**2015 Area (Acres)**	**2015 Area (% of Total)**	**% Change**
Agriculture	59.85	0.61	85.01	0.87	42.04
Pasture/Grasslands	56.52	0.6	85.01	0.9	50.43
Cultivated Crops	3.34	0.0	0.00	0.0	-100.00
Barren Lands	0.67	0.0	54.61	0.6	8,085.65
Developed	9,612.68	98.26	9,364.91	95.73	-2.58
High Intensity	1,890.28	19.3	1,197.85	12.2	-36.63
Medium Intensity	4,323.49	44.2	4,207.29	43.0	-2.69
Low Intensity	2,205.43	22.5	3,062.38	31.3	38.86
Open Space	1,193.48	12.2	897.39	9.2	-24.81
Forest/Shrubs	70.25	0.7	17.99	0.2	-74.38
Open Water	20.64	0.2	8.75	0.1	-57.60
Wetlands	18.61	0.2	251.42	2.6	1,250.68

DESCRIPTION OF WATER QUALITY ISSUES

Click to View the Vince Bayou Tidal Assessment Unit Map (link available only in online story)

The Vince Bayou Tidal subwatershed has two Assessment Units (AUs) on the classified (tidal) segment.

Vince Bayou Tidal Assessment Unit Descriptions				
AU ID	**Segment ID**	**Name**	**Class**	**Type**
1007_05	1007	Vince Bayou	Classified	Tidal Stream
1007_08	1007	Little Vince Bayou	Classified	Tidal Stream

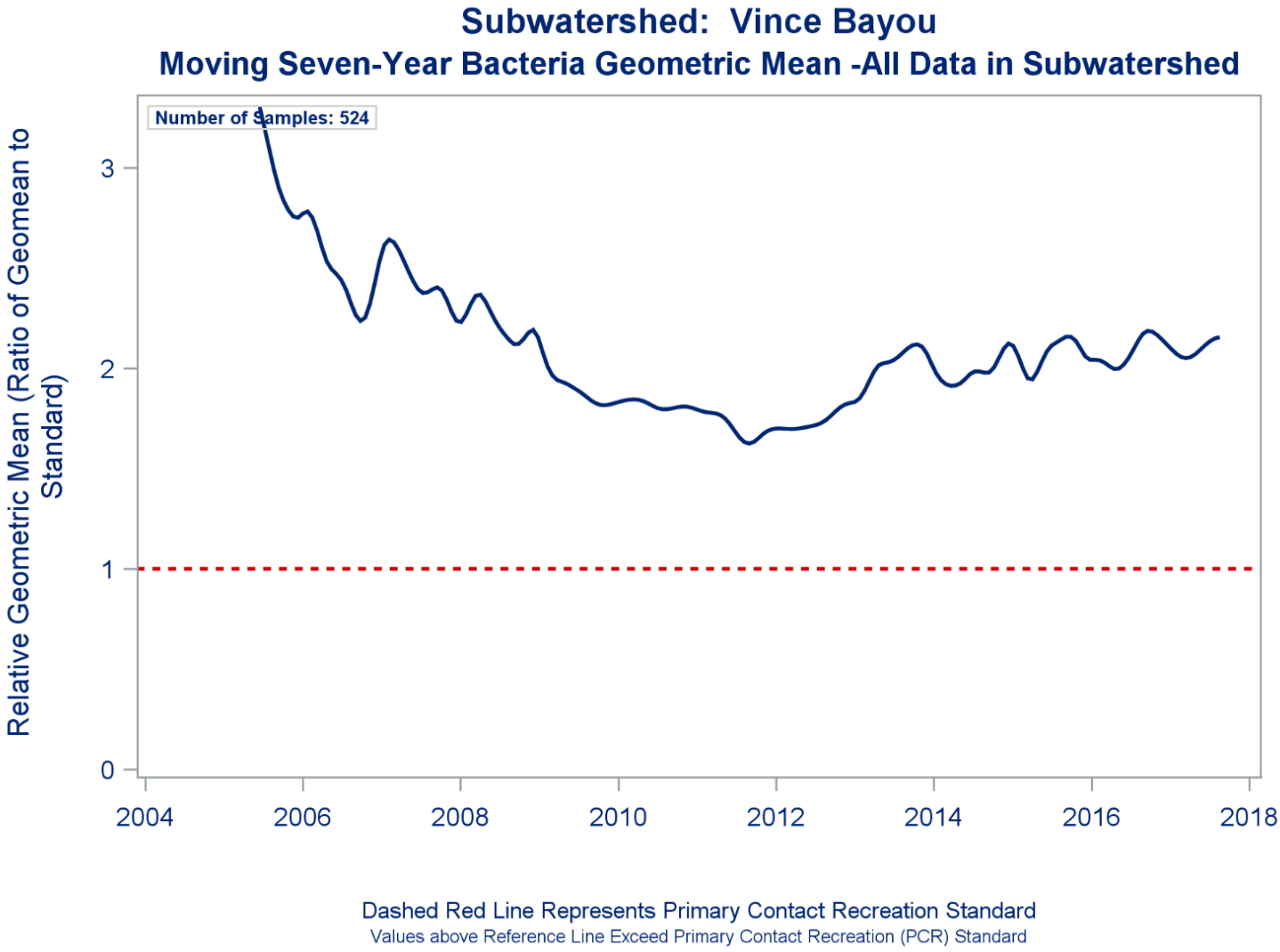
Vince Bayou Tidal Water Quality Issues						
AU_ID	Parameter	Level of Support/ Impairment Category	% Samples Exceeding Standard/ Screening Level 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard/ Screening Level H-GAC 2010-2017	Geomean H-GAC 2010-2017
1007_05	Ammonia	CS	30.9	.	35.3	.
1007_05	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_05	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_05	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_05	Enterococcus	NS	.	175	62.7	277
1007_05	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007_05	Nitrate	CS	85.5	.	80.8	.
1007_05	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_05	Total Phosphorus	CS	90.2	.	88.4	.
1007_08	Chlordane in Edible Tissue*	NS	.	.	0.0	.
1007_08	Dieldrin in Edible Tissue*	NS	.	.	0.0	.
1007_08	Dioxin in Edible Tissue*	NS	.	.	0.0	.
1007_08	Heptachlor Expoxide in Edible Tissue*	NS	.	.	0.0	.
1007_08	Nitrate	CS	79.3	.	65.1	.
1007_08	PCBs in Edible Tissue*	NS	.	.	0.0	.
1007_08	Total Phosphorus	CS	96.6	.	96.8	.

*Samples not collected
FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern;
CN – Concern for near-nonattainment of the TSWQS based on numeric criteria;
CS – Concern for water quality based on screening levels

Bacteria

Click to View the Vince Bayou Tidal Bacteria Impairments Map (link available only in online story)

1007_05 is impaired for general use due to high levels of enterococci. The 2014 Integrated Report (IR) found the bacteria geomean for enterococci for 1007_05 to be 175.33 MPN/100mL, above the 168 MPN/100mL bacteria geomean standard. H-GAC's analysis of bacteria data from 2010 to 2017 continues to support a bacteria impairment.



Dissolved Oxygen

Click to View the Vince Bayou Tidal Dissolved Oxygen Impairments and Concerns Map (link available only in online story)

Dissolved Oxygen is full supported in Vince Bayou Tidal.

Nutrients

Click to View the Vince Bayou Tidal Nutrient Concerns Map (link available only in online story)

AU 1007_05 has concerns for ammonia, nitrate, and total phosphorus. AU 1007_08 has concerns for total phosphorus and nitrate.

Trends

H-GAC's data analysis identified significant trends for common water quality parameters. These trends are illustrated in the table below. Graphs illustrating these trends can be found in the appendix.

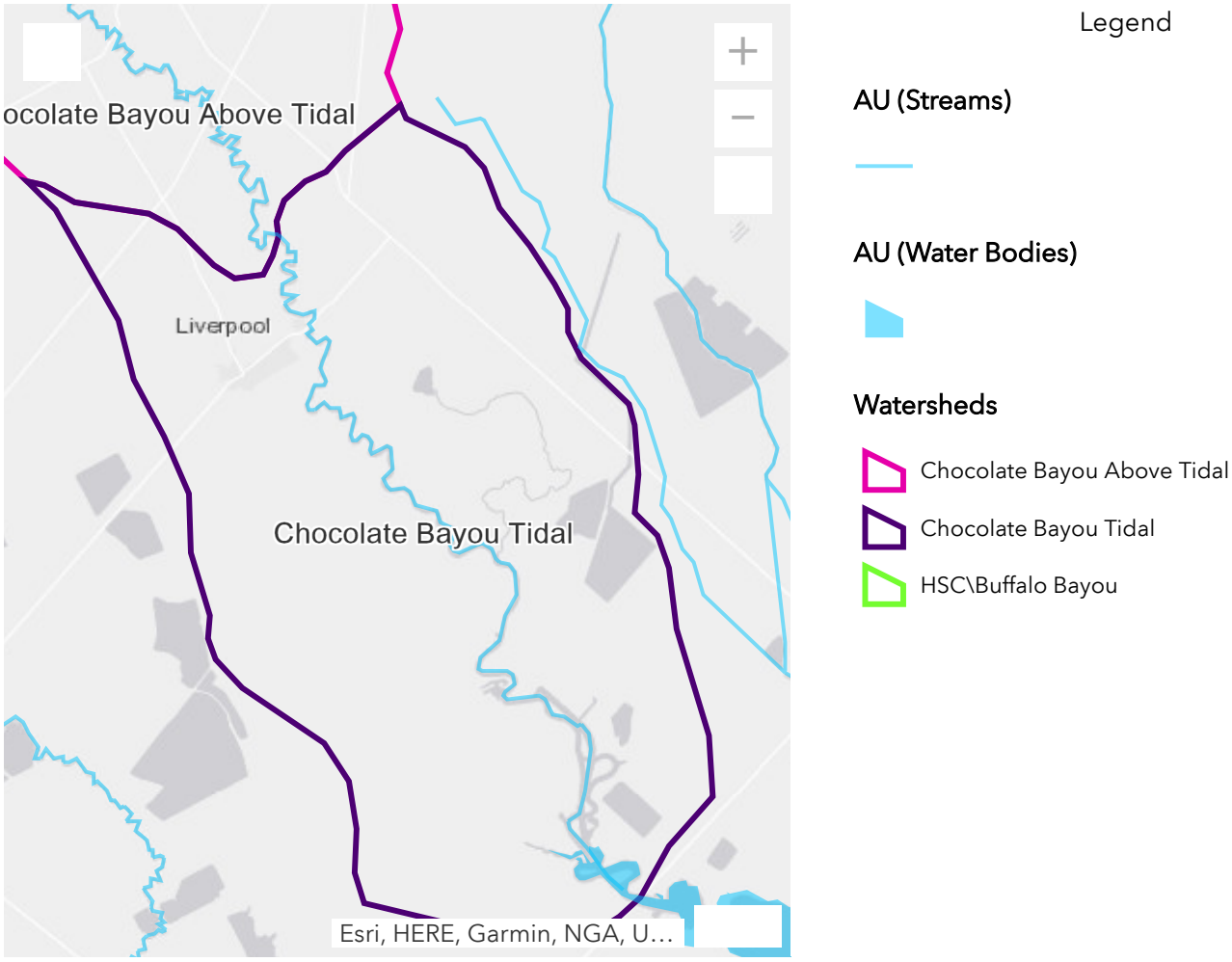
Parameter Trends Found in Vince Bayou Tidal Subwatershed

AU	DO	Ammonia	Nitrate	TKN	TSS	pH
1007_05		⇩	⇧	⇩	⇩	⇧
1007_08	⇧					

⇧ indicates the trend is increasing. ⇩indicates the trends is decreasing. Red is getting worse. Green is getting better. Yellow is trending but of no concern at this time.

CHOCOLATE BAYOU TIDAL (1107)

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/0rCK5u.



SEGMENT DESCRIPTION

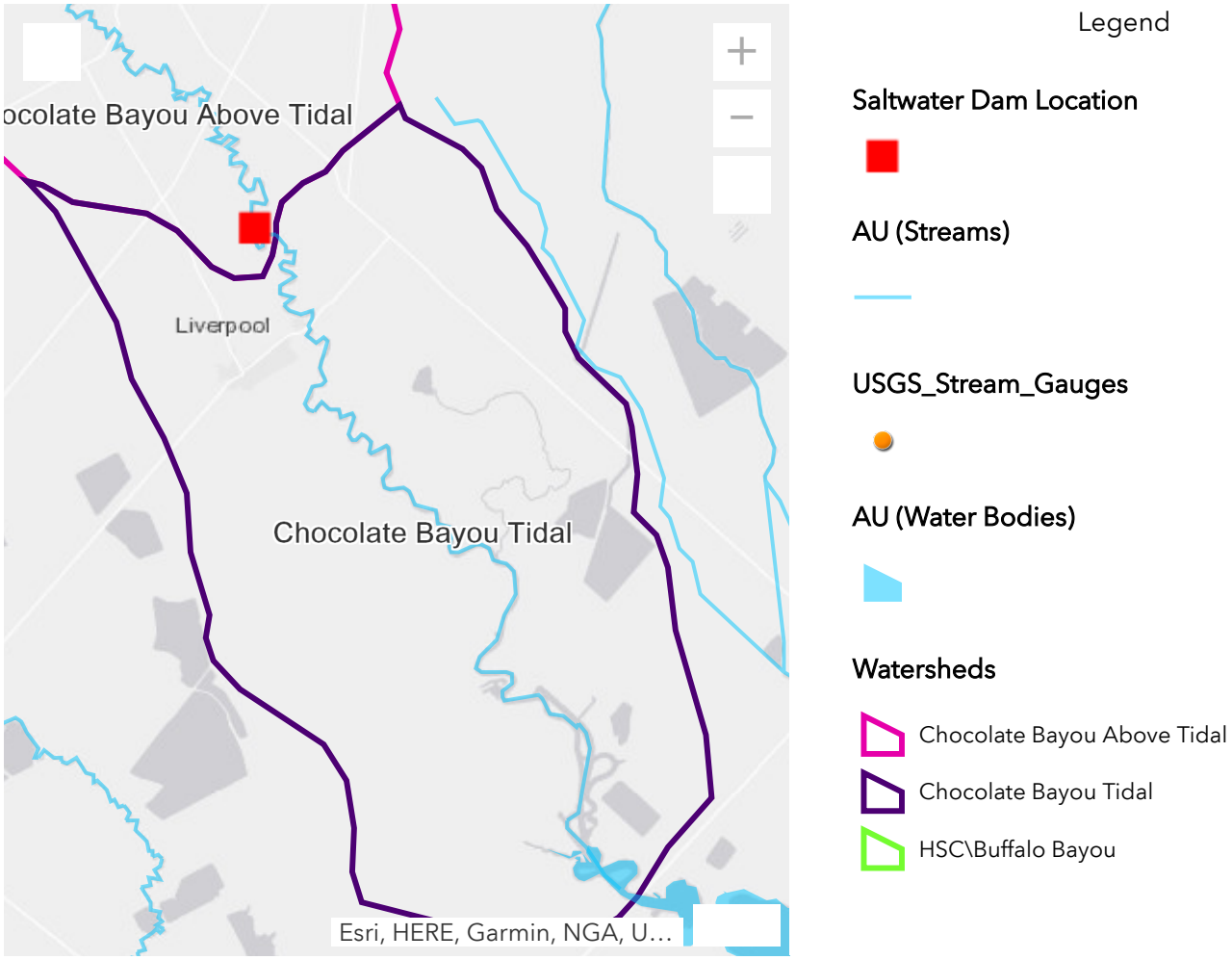
1107 Chocolate Bayou Tidal Segment Map (On Right)

Chocolate Bayou Tidal segment 1107 is in the Chocolate Bayou Tidal watershed in east Brazoria County. A saltwater barrier, immediately downstream of the confluence of Chocolate Bayou and the Chocolate Bayou Rice Canal, separates 1107 from Chocolate Bayou Above Tidal segment 1108. The waterway is 16 miles long with a total watershed area of 37 square miles. The major tributaries of 1107 are Corner, Pleasant, Cottonwood, Salt, and Perry bayous. The segment terminates at Chocolate Bay, which connects to West Galveston Bay.

Land use in the watershed is primarily agricultural, historically cotton cultivation. Current agricultural uses include rice, hay production, and cattle grazing. Liverpool, a small city of

approximately 500 residents, is located at the north end of the segment. The small agricultural communities of Amsterdam, Chocolate Bayou, Chocolate Bayou Springs, and Peterson Landing are in the watershed.

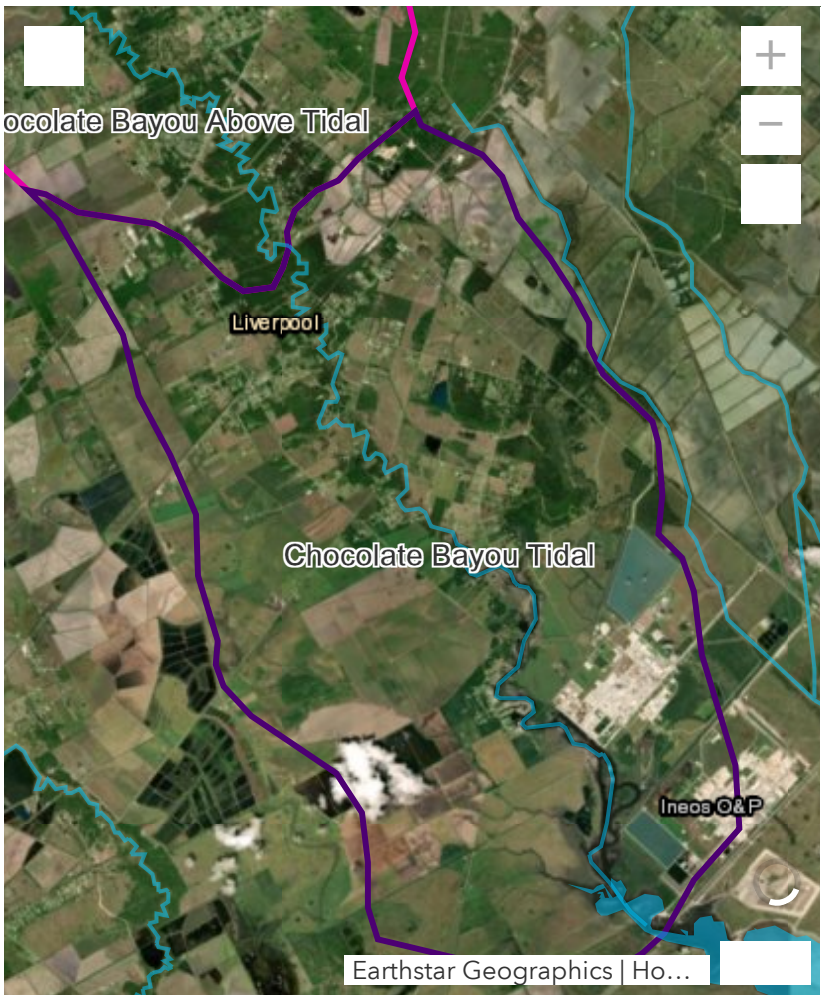
HYDROLOGICAL CHARACTERISTICS



1107 Chocolate Bayou Salt Water Dam Location (On Right)

1107 is in the Texas Coastal Plain at near sea level elevation. Downstream flow of the Chocolate Bayou and its tributaries is generally slow due to a 0.04 percent sloping relief found on the coastal plain. As a tidal segment, downstream freshwater flow can be impounded or reversed by rising and high tides. Riparian vegetation is still common along portions of 1107, however the natural hydrology of the bayou has been altered by instream channel modifications and the construction of supplemental drainage, irrigation, and supply canals.

LAND COVER AND NATURAL CHARACTERISTICS



Legend

AU (Streams)

AU (Water Bodies)

Watersheds

- Chocolate Bayou Above Tidal
- Chocolate Bayou Tidal
- HSC\Buffalo Bayou

Land Cover 10 Class (2015)

Land Cover 10 Class (2015)

- Wetlands
- Pasture/Grasslands
- Open Water
- Forest/Shrubs
- Developed Open Space

1107 Chocolate Bayou Tidal Land Cover Map (On Right)

Description of Land Cover Classes	
Land Cover Class	**Class Description**
Developed, High Intensity	Contains significant land area and is covered by impervious surfaces (i.e., concrete, asphalt, and other constructed materials). Vegetation, if present, occupies < 20 percent of the landscape. Impervious surfaces account for 80 to 100 percent of the total cover. This class includes heavily built-up urban centers and large constructed surfaces in suburban and rural areas with a variety of land uses.
Developed, Medium Intensity	Contains areas with a mixture of impervious surfaces and vegetation or other cover. Impervious surfaces account for 50 to 79 percent of total area. This class commonly includes multi- and single-family housing areas, especially in suburban neighborhoods, but may include all types of land use.
Developed, Low Intensity	Contains areas with a mixture of impervious surfaces and substantial amounts of vegetation or other cover. Impervious surfaces account for 21 to 49 percent of total area. This class commonly includes single-family housing areas, especially in rural neighborhoods, but may include all types of land use.
Developed, Open Space	Contains areas with a mixture of some impervious surfaces, but mostly managed grasses or low-lying vegetation planted in developed areas for recreation, erosion control, or aesthetic purposes. Impervious surfaces account for less than 20 percent of total land cover. This class commonly includes large-lot single family housing units, parks, and golf courses.
Agriculture, Pasture/Grasslands	Contains both managed and unmanaged grasses, legumes, or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas can be subjective to intensive management, such as tilling, and utilized for grazing.
Agriculture, Cultivated	Contains areas intensely managed for the production of annual crops. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Barren Land	Contains areas of gravel pits, bedrock, sand dunes, and other accumulations of earth material. Generally, vegetation accounts for less than 10 percent of total cover.
Forest/Shrub	Includes two types of trees that cover greater than 20 percent of total vegetation cover. • *Forest*—areas dominated by all kinds of trees generally greater than 5 meters tall. • *Shrub*—areas dominated by shrubs generally less than 5 meters tall.
Open Water	Include areas of open water, generally with less than 25 percent cover of vegetation or soil.
Wetlands	Includes the area contains palustrine or estuarine vegetation that are periodically saturated or covered with water. Total vegetation coverage is greater than 20 percent.
Source: National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) Land Cover Classifications https://coast.noaa.gov/digitalcoast/training/ccap-land-cover-classifications.html	

Link to PDF table (link: http://arcgis02.h-gac.com/bhr2018/doc/Description_LandCover_Classes.pdf)

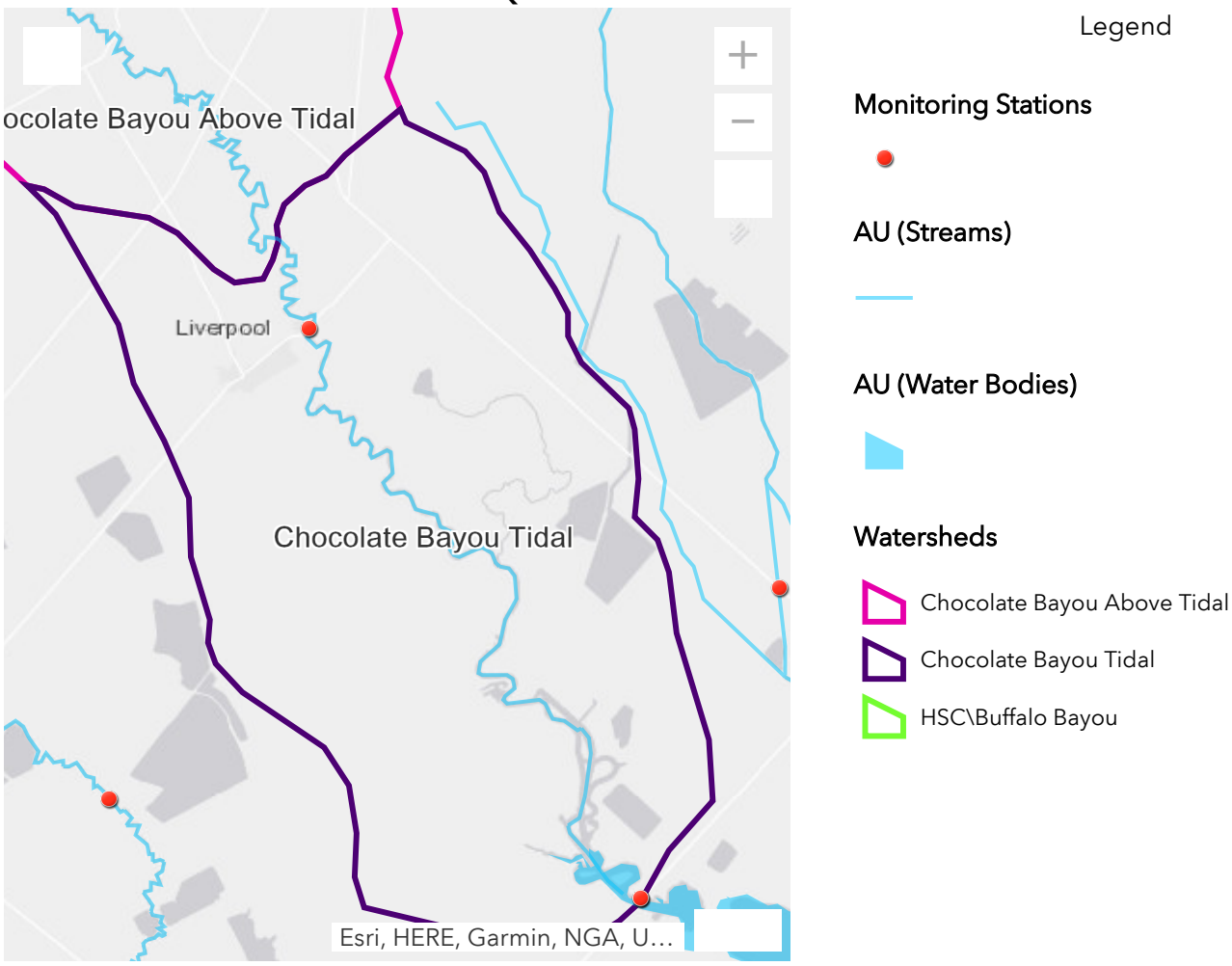
Segment 1107 is in the Texas Coastal Plain region, characterized by prairies, marsh lands, and strips of riparian hardwoods and pine forest influenced by the sea, wind, rain, and hurricanes. Native vegetation includes prairie grasses, live oak woodlands, and many varieties of salt-tolerant plants. Marsh and wetlands provide habitat for numerous migratory bird and aquatic plants and animals.

The main land use is agriculture, comprising 54 percent of the area within the segment. Agricultural uses include cultivated crops and pastureland/grasslands. Agriculture is concentrated in the northeast and southwest portions of the watershed. Approximately 16 percent of the watershed area is developed land. Most of the development is ranchettes, homes, and light commercial use; however, some heavy industrial development is located at the southern end of the watershed near Chocolate Bay.

H-GAC analyzed land use trends from 2006 to 2015. Development has increased by 217.21 percent, replacing agriculture lands, forests, and wetlands.

Land Cover for Chocolate Bayou Tidal					
Land Cover Class Name	**Area Acres 2006**	**Area %**	**Area Acres 2015**	**Area %**	**% Change**
Agriculture	13482.10	57.41	12734.51	54.23	-5.55
Barren Lands	148.12	0.6307	651.79	2.78	340.04
Developed	1175.52	5.0056	3728.93	15.88	217.21
Forest/Shrubs	2940.48	12.521	2023.06	8.61	-31.20
Open Water	1155.38	4.9199	502.97	2.14	-56.47
Wetlands	4582.40	19.513	3842.75	16.36	-16.14
Total	23484.02	100	23484.02	100	N/A

DESCRIPTION OF WATER QUALITY ISSUES



1107 Chocolate Bayou Tidal Monitoring Stations Map (On Right)

Routine ambient water quality data are collected at monitoring stations 11478 and 21178 on 1107.

Monitoring Stations in Chocolate Bayou Tidal

Monitoring Stations in Chocolate Bayou Tidal			
Station	**Description**	**Collecting Entity**	**Assessment Unit**
11478	Chocolate Bayou Tidal FM 2004 Bridge south of Alvin	UI	1107_01
21178	Chocolate Bayou immediately upstream of Brazoria CR 171/Mustang Chocolate Bayou Road in Liverpool	UI	1107_01
UI – Environmental Institute of Houston, University of Houston – Clear Lake			

Field measurements, conventional chemical samples, and bacteria (enterococci) are collected at both sites. Flow is not collected at tidally influenced stations.

1107 is impaired for bacteria and PCB/Dioxin. Dissolved oxygen (DO) is fully supported, and Chlorophyll-*a* and nutrient samples are below screening levels.

Bacteria Impairment

*(link available only in online story)*Click to View the 1107 Chocolate Bayou Tidal Bacteria Impairments Map (link available only in online story)

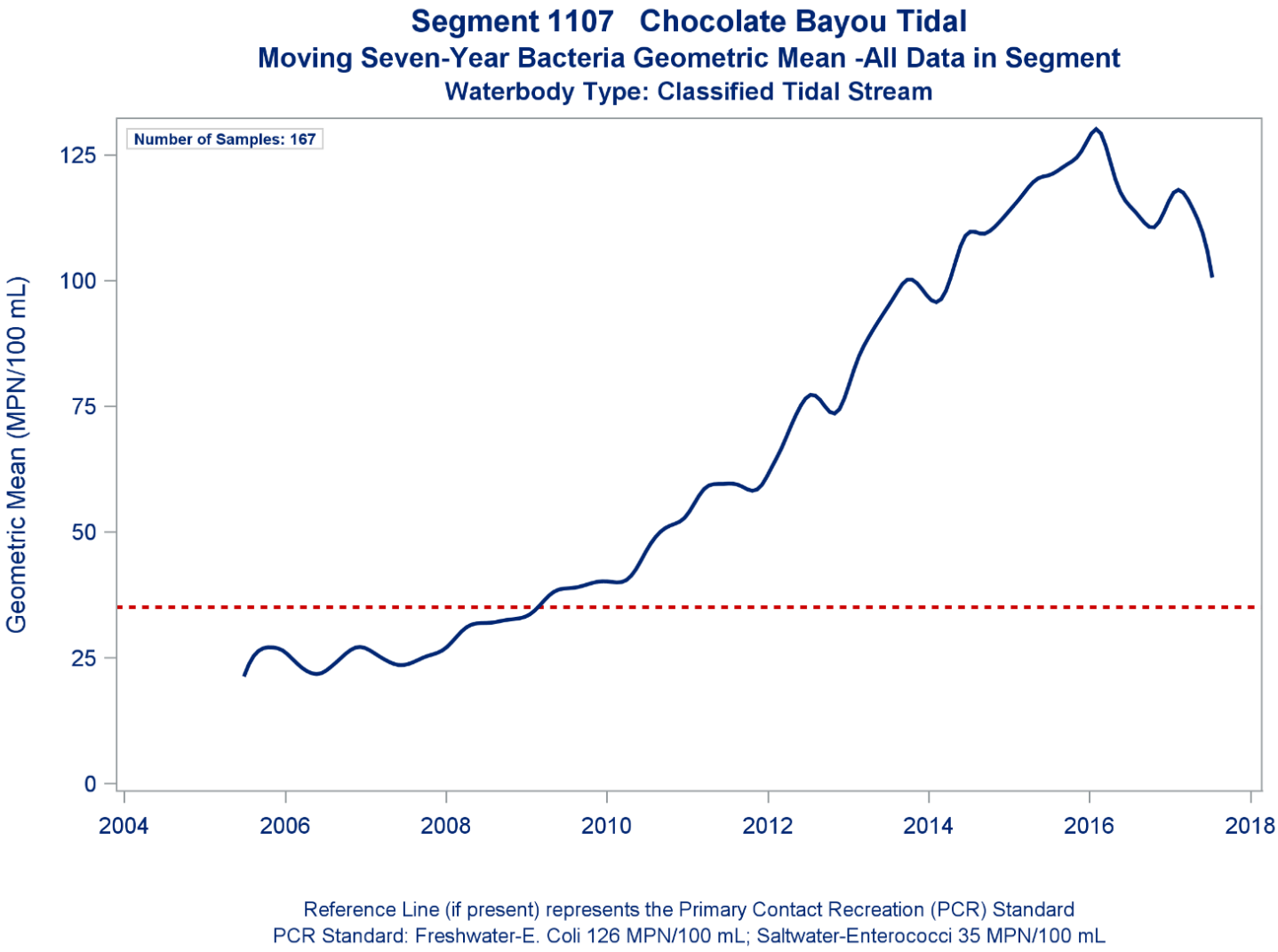
Assessment unit (AU) 1107_01 was listed in the *2014 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)* (IR) as impaired for contact recreation due to high levels of enterococci bacteria. The AU has been listed since 2010. The 2014 IR used data from 2005–2012 and found the bacteria geomean (seven-year average) for enterococci within this AU to be 81 MPN/100mL (Most Probable Number), more than twice the contact recreation standard of 35 MPN/100mL.

H-GAC analysis of bacteria data from 2010–2017 continues to support a bacteria impairment, and enterococci concentrations appear to be increasing in this segment.

Chocolate Bayou Bacteria Comparison

AU_ID	Parameter	Level of Support	% Samples Exceeding Standard 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard H-GAC 2010 - 2017	Geomean H-GAC 2010 - 2017
1107_01	Enterococcus	NS	.	81.2	70.5	106.0

FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern;
CN – Concern for near-nonattainment of the TSWQS based on numeric criteria; CS – Concern for water quality based on screening levels



PCBs and Dioxin

*(link available only in online story)*Click to View the 1107 Chocolate Bayou Tidal PCBs and Dioxin impairments Map (link available only in online story)

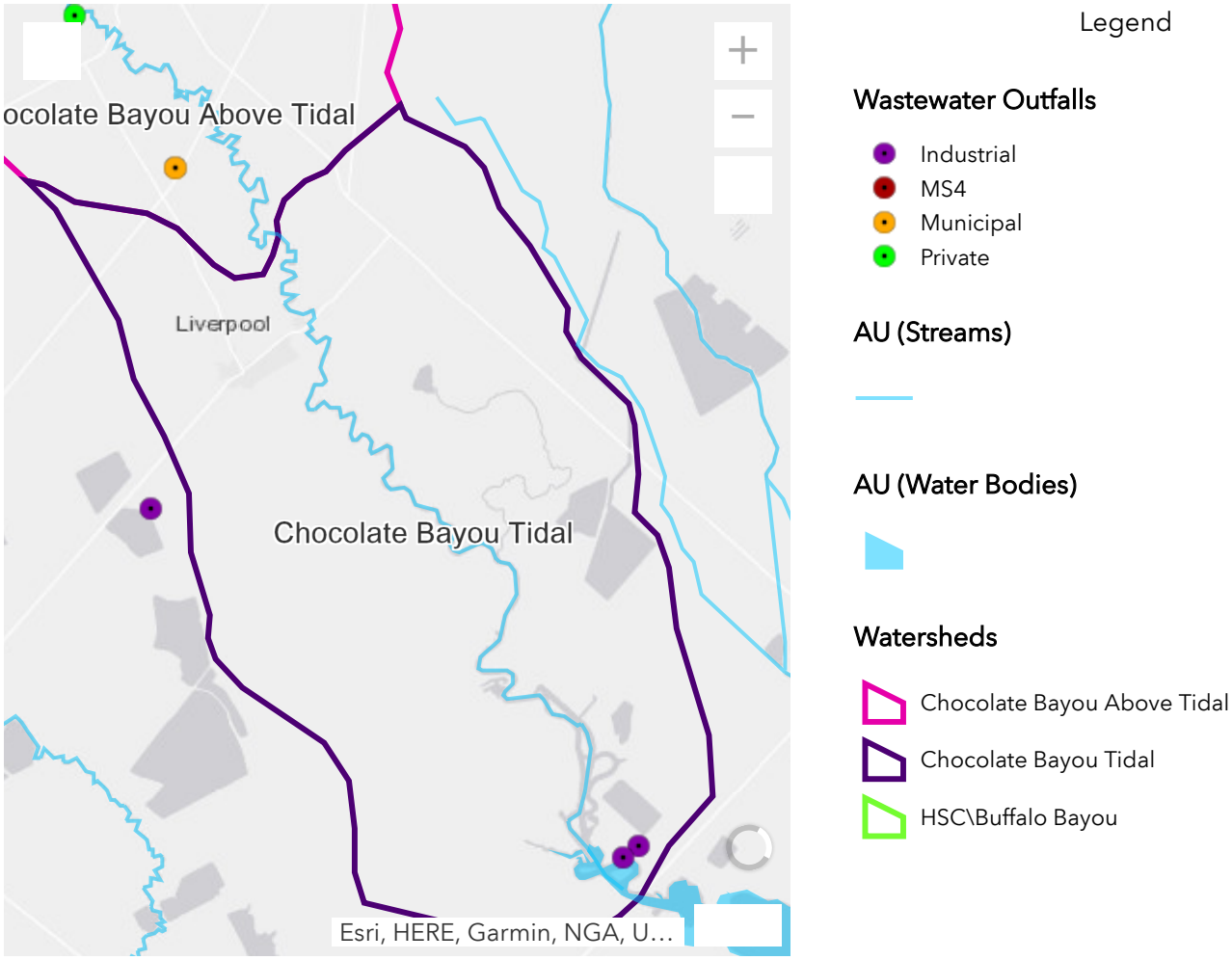
Chocolate Bayou Tidal is listed in the 2014 Integrated Report for a Texas Department of State Health Services (TDSHS) Restricted and No Consumption of Edible Fish Tissue Advisory due to PCBs and Dioxin. **The TDSHS advises adults to consume no more than one eight-ounce meal per month of all fish species or blue crab caught in Chocolate Bayou Tidal. Women of childbearing age and children under 12 should not consume any fish or blue crab from this area.**

Trends

H-GAC's data analysis identified significant trends for two common water quality parameters. Both enterococci bacteria and total phosphorus concentrations are

increasing in this waterway. Graphs illustrating these trends can be found in the appendix.

POTENTIAL SOURCES OF WATER QUALITY ISSUES



Potential sources of fecal indicator bacteria in 1107 include wastewater treatment facility (WWTF) effluent, failing on-site sewage facilities, livestock, and other nonpoint sources.

Wastewater Treatment Facilities

1107 Chocolate Bayou Tidal Wastewater Treatment Facility Outfalls Map (On Right)

One domestic and nine industrial permitted WWTF outfalls are in the watershed.

The permitted maximum daily flow for these facilities range from 50,000 gallons per day to eight million gallons (MGD) per day.

WWTF permit requirements necessitate self-reporting in the form of Discharge Monitoring Reports (DMRs). H-GAC obtained DMRs and permit information from the Environmental Protection Agency (EPA 2017 (link: https://www.epa.gov/enviro/pcs-icis-overview)).

DMRs include single-grab and geometric mean exceedance information, number of bacteria samples collected, and monthly effluent flow. DMRs for 2016 were available for four facilities.

Based on the 2016 self-reported monitored effluent results, one facility reported all compliance samples exceeded the geometric mean and single-grab permit limit. At another facility, one quarter of the samples exceeded the geometric mean and single grab sample limits. The remaining two facilities did not have any samples exceeding the geometric mean or single-grab samples.

DMR Data Analysis for Chocolate Bayou Tidal						
NPDES	**Indicator Bacteria**	**Limits (Geomean/ Grab)**	**Samples (Geomean/ Grab)**	**Samples Exceeding Permit Limit (Geomean/ Grab)**	**Percent Exceedance (Geomean/ Grab)**	**Most Recent Data**
TX0003875	Enterococci	35/89	12/12	0/2	0.0/16.7	12/31/16
TX0004821	Enterococci	35/104	10/10	10/10	100/100	12/31/16
TX0105261	Enterococci	35/104	12/12	3/3	25/25	12/31/16
TX0119041	Enterococci	35/104	4/4	0/0	0/0	12/31/16

On-site Sewage Facilities

Click to View the 1107 Chocolate Bayou Tidal On-site Sewage Facilities (OSSF) Density Map (link available only in online story)

The Chocolate Bayou Tidal watershed contains 399 on-site sewage facilities permitted through Brazoria County. H-GAC established a geographic model to identify potential locations for grandfathered (systems installed prior to the mandatory 1989 permitting date) or illegal systems (systems installed without a permit). The model excludes the locations of known systems and properties within sanitary sewer service area boundaries. Remaining residential, commercial, and industrial properties are assumed to have on-site sewage facilities. The model identified 549 potential grandfathered or illegal systems within the watershed. Typically, grandfathered and illegal systems have much higher failure rates than permitted systems. Due to the high number of grandfathered systems, H-GAC works with local partners to repair and/or replace failing systems through the Wastewater Assistance Program (link: http://www.h-gac.com/community/water/ossf.aspx), funded by Supplemental Environmental Projects (SEP).

Livestock

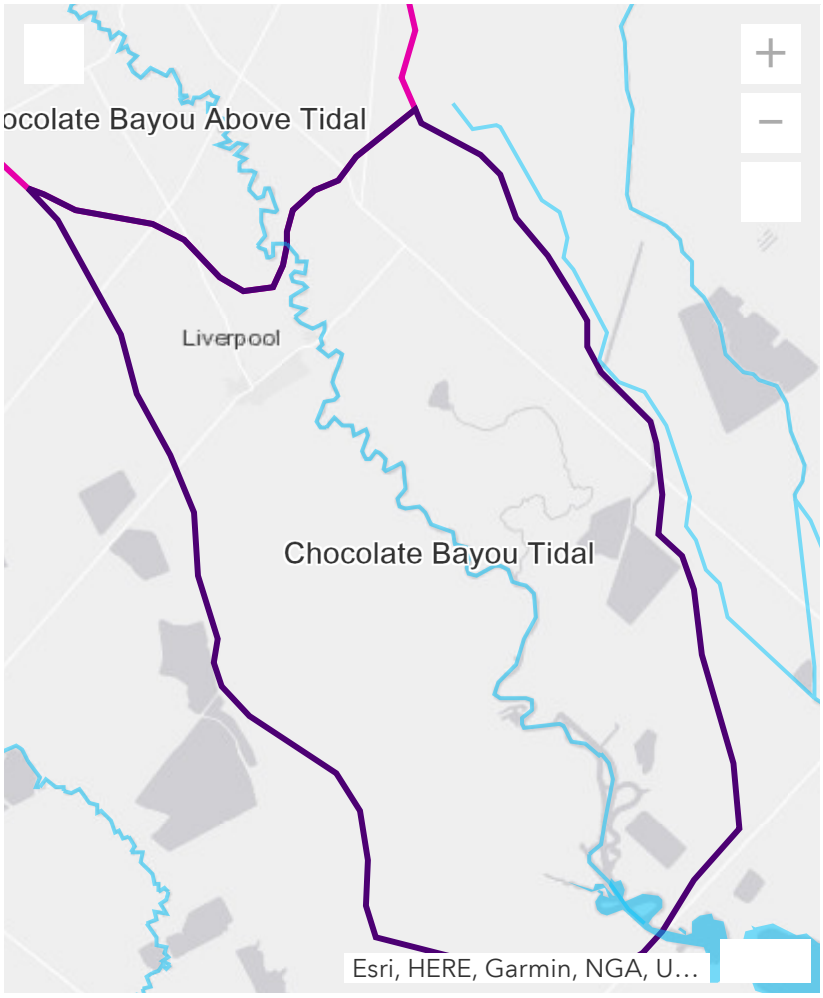
Click to View the 1107 Chocolate Bayou Tidal Acreage of Pastures and Grasslands Map (link available only in online story)

Cattle are potentially a large contributor of nonpoint source bacteria pollution within the watershed. Based on the acreage of pasture and grasslands and U.S. Department of Agriculture estimates of cattle per acre, as many as 2,100 head of cattle may be present within the watershed. Best management practices, such as alternative water sources and cross fencing, may prevent cattle from entering and/or defecating in or near the bayou.

Other Nonpoint Sources

Other sources of bacterial pollution may include fecal waste from pets, stray dogs and cats, feral hogs, and native wildlife. The improper disposal of solid and liquid waste is also an issue within the watershed. Animal carcasses (mainly deer and feral hogs) are butchered and discarded in the bayou and its tributaries. Trash, yard clippings, appliances, tires, and mattresses are also illegally dumped. Vacuum trucks (vehicles that haul human sewage from septic systems, portable toilets, and campgrounds) have been known to illegally discharge into the bayou.

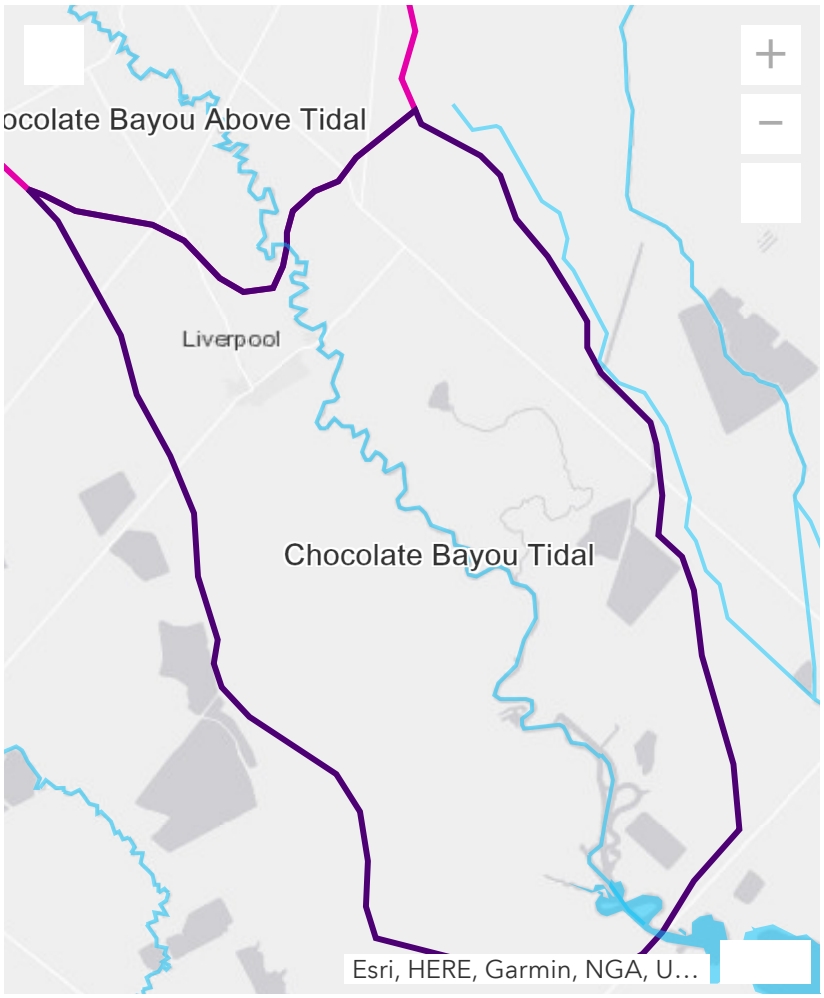
POTENTIAL STAKEHOLDERS



1107 Chocolate Bayou Tidal Watershed Map (On Right)

- City of Liverpool
- Brazoria County
- Utility Districts
- Galveston Bay Estuary Program (GBEP)
- Chambers of Commerce
- Community Groups
- Environmental and Conservancy Groups, such as the Galveston Bay Foundation (GBF)
- Homeowner Associations
- Drainage Districts
- TCEQ Region 12
- Texas AgriLife Extension Offices
- Texas State Soil and Water Conservation Board
- Texas Parks and Wildlife
- Industry

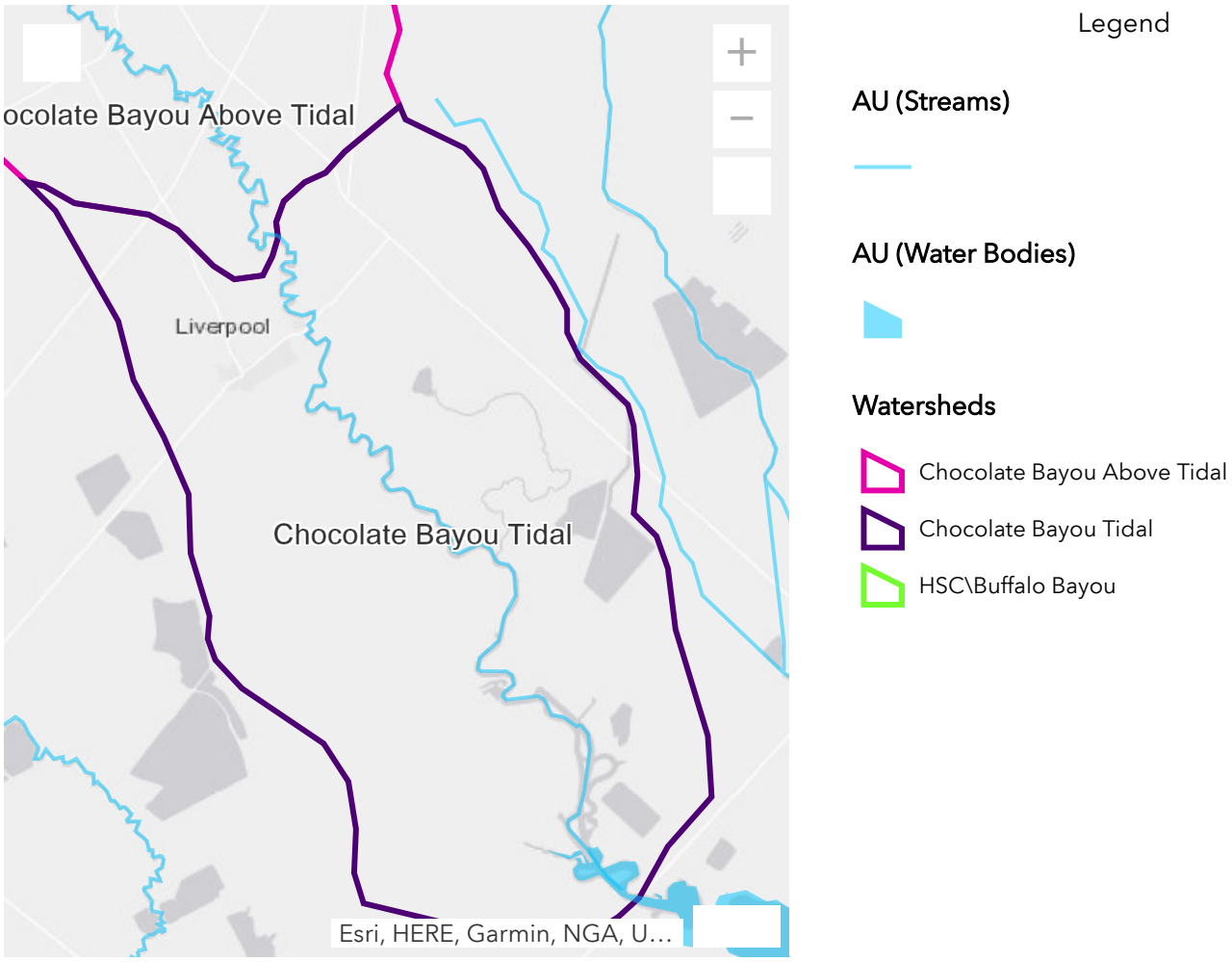
ONGOING PROJECTS



H-GAC, with support from the TCEQ, is developing a Total Maximum Daily Load (TMDL) Implementation Plan (I-Plan) for bacteria for 1107 and 1108. A TMDL is a regulatory plan for impaired waterways identifying the maximum amount of pollution the water body can receive and still meet water quality standards. H-GAC facilitates the development of a stakeholder driven I-Plan to map a framework for reducing bacteria concentrations in Chocolate Bayou.

H-GAC, supported by TCEQ, has launched a three-year project to help small communities in coastal watersheds inform residents about steps they can take to reduce pollution, specifically fecal bacteria levels, in local waterways. The project complements existing watershed protection plans and bacteria reduction projects in the region by supporting residential outreach and education. The four areas of emphasis are pet waste; fats, oils and grease; on-site sewage facility maintenance; and litter/illegal dumping abatement.

MAJOR WATERSHED EVENTS



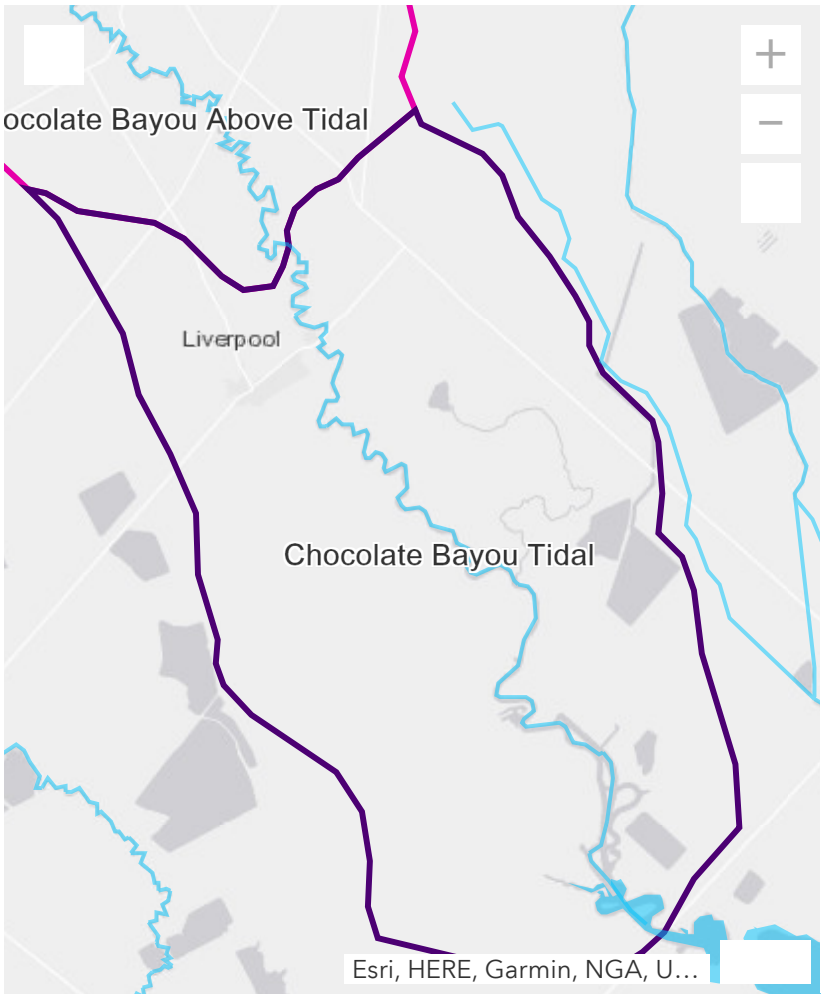
Population Growth

Due to changing demographics and an aging population base, the H-GAC 2016 Regional Growth Forecast anticipates population in the watershed will decrease by almost half by 2040. The 2040 Forecast Model assumes population growth in Brazoria County will be in the larger urban communities of Pearland, Manvel, and Alvin.

Although it is premature to anticipate the impact on water quality, a decrease in population could lower point and nonpoint source pollution.

Population Trends in Chocolate Bayou Tidal				
Watershed	**Projected Population**			
	2015	**2020**	**2030**	**2040**
Chocolate Bayou Tidal	1,278	1,099	883	686

RECOMMENDATIONS FOR IMPROVING WATER QUALITY

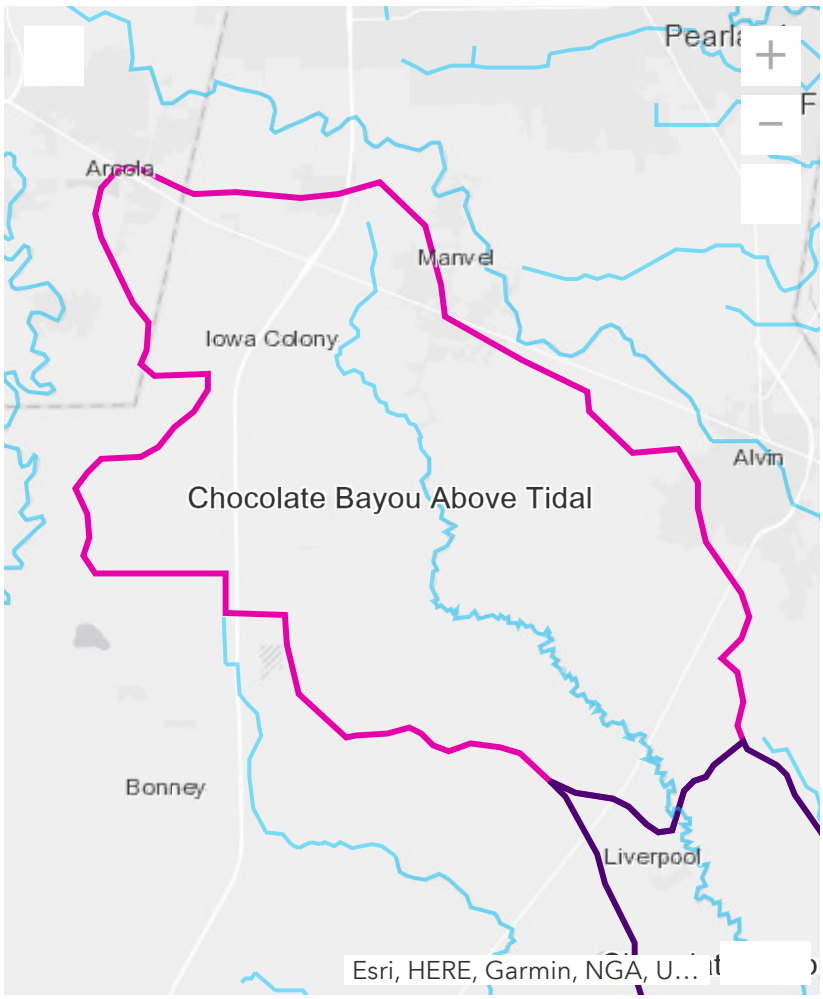


- Address bacteria and various other concerns through stakeholder involvement and best management practices.
- Continue to analyze DMR data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders.
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities.
- Continue collecting water quality data and expand monitoring efforts to support actions associated with the TMDL program.
- Pursue new local partners to collect additional data to help detect problem areas.
- Expand volunteer monitoring with Texas Stream Team in areas without professional monitoring.
- Support programs to responsibly eliminate feral hog populations in the watershed.
- Consult stakeholders to identify illegal dumping sites and work to improve signage and/or install cameras if needed.

- Pursue installation of signage informing the public of PCBs and Dioxins fish consumption advisories at popular fishing locations along the bayou.

CHOCOLATE BAYOU ABOVE TIDAL (1108)

This story was made with Esri's Story Map Journal.
Read the interactive version on the web at https://arcg.is/0OSbKe.



Legend

AU (Streams)

AU (Water Bodies)

Watersheds

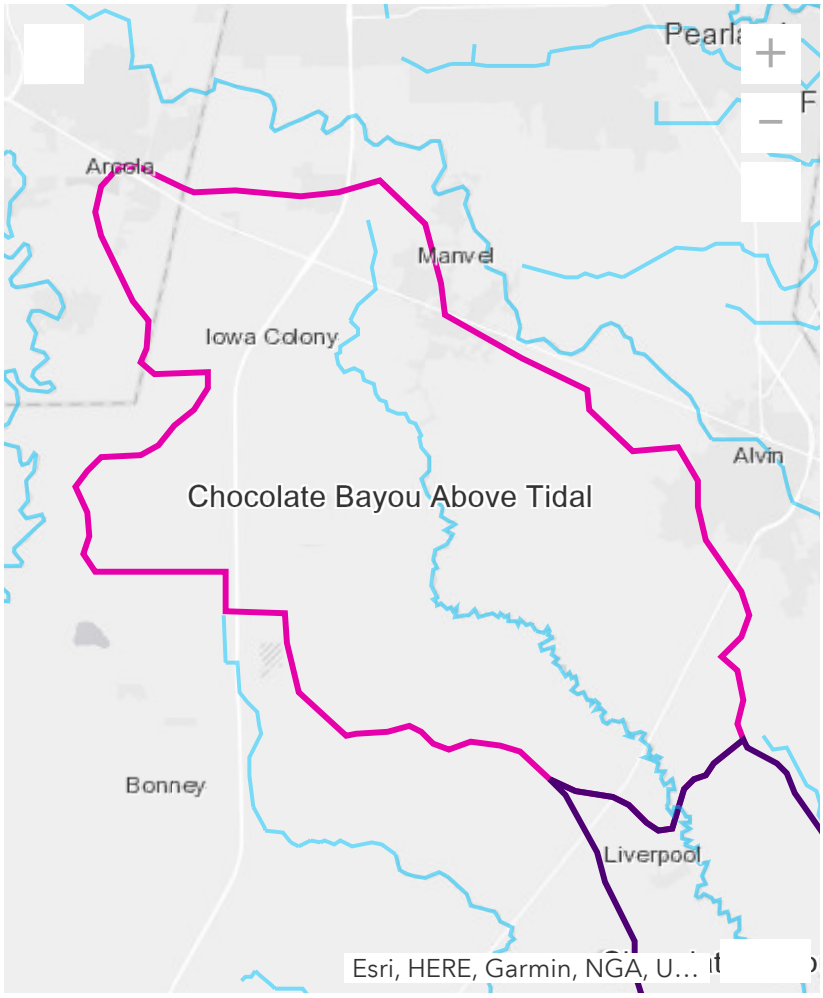
- Chocolate Bayou Above Tidal
- Chocolate Bayou Tidal
- HSC\Buffalo Bayou

SEGMENT DESCRIPTION

1108 Chocolate Bayou Segment Map (On Right)

Chocolate Bayou Above Tidal segment 1108 is in the Chocolate Bayou Above Tidal watershed in northeast Brazoria County. Segment 1108 begins approximately 2.5 miles south of FM 1128, south of Manvel and terminates at a saltwater barrier downstream of the confluence with the Chocolate Bayou Rice Canal. Major tributaries include Hays Creek and the West Fork of Chocolate Bayou, which begins in southeast Fort Bend County outside of the City of Arcola. The segment is 22 miles long with a total watershed area of 110 square miles. The watershed includes the cities of Arcola, Manvel and Alvin, and the village of Iowa Colony.

HYDROLOGICAL CHARACTERISTICS



Legend

AU (Streams)

AU (Water Bodies)

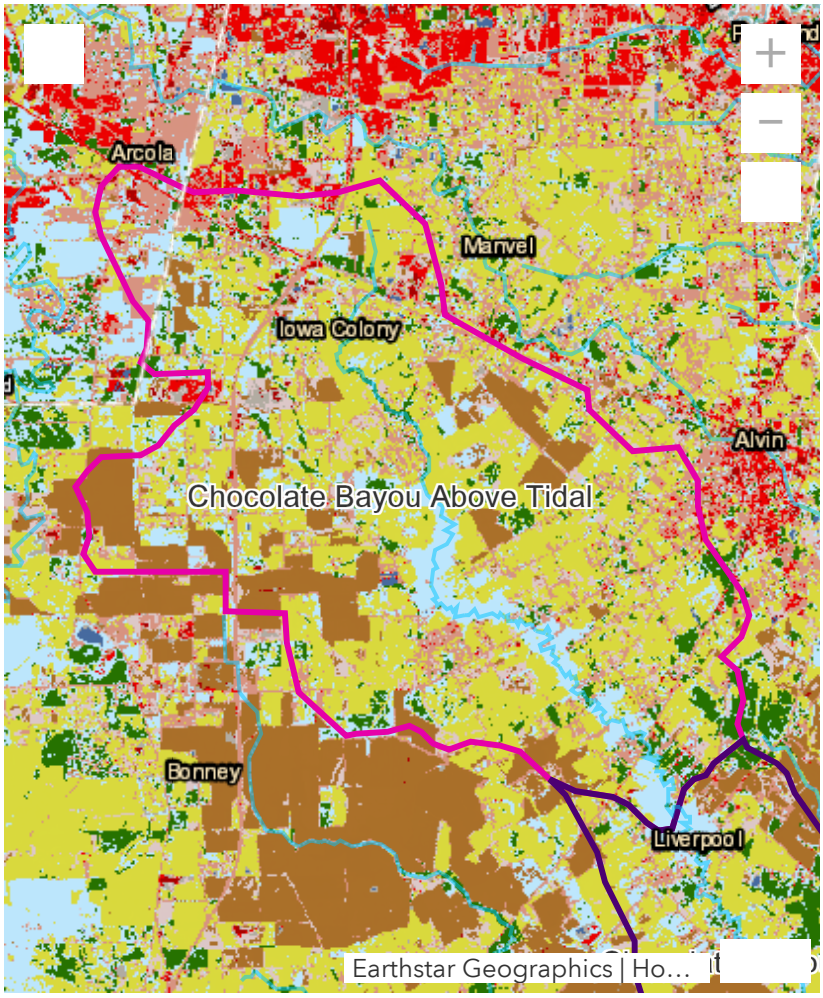
Watersheds

- Chocolate Bayou Above Tidal
- Chocolate Bayou Tidal
- HSC\Buffalo Bayou

1108 Chocolate Bayou Above Tidal Hydrology Map (On Right)

The topography of the watershed ranges from just over 50 feet above sea level in Fort Bend County near Arcola to sea level at the salt water barrier. The bayou and its tributaries are generally slow due to a 0.04 percent sloping relief found in the region. The natural hydrology in this watershed has been altered by instream channel modifications. Many irrigation and supply canals are in the watershed.

LAND COVER AND NATURAL CHARACTERISTICS



Legend

AU (Streams)

AU (Water Bodies)

Watersheds

- Chocolate Bayou Above Tidal
- Chocolate Bayou Tidal
- HSC\Buffalo Bayou

Land Cover 10 Class (2015)

Land Cover 10 Class (2015)

- Wetlands
- Pasture/Grasslands
- Open Water
- Forest/Shrubs
- Developed Open Space

1108 Chocolate Bayou Above Tidal Land Cover Map (On Right)

Description of Land Cover Classes	
Land Cover Class	**Class Description**
Developed, High Intensity	Contains significant land area and is covered by impervious surfaces (i.e., concrete, asphalt, and other constructed materials). Vegetation, if present, occupies < 20 percent of the landscape. Impervious surfaces account for 80 to 100 percent of the total cover. This class includes heavily built-up urban centers and large constructed surfaces in suburban and rural areas with a variety of land uses.
Developed, Medium Intensity	Contains areas with a mixture of impervious surfaces and vegetation or other cover. Impervious surfaces account for 50 to 79 percent of total area. This class commonly includes multi- and single-family housing areas, especially in suburban neighborhoods, but may include all types of land use.
Developed, Low Intensity	Contains areas with a mixture of impervious surfaces and substantial amounts of vegetation or other cover. Impervious surfaces account for 21 to 49 percent of total area. This class commonly includes single-family housing areas, especially in rural neighborhoods, but may include all types of land use.
Developed, Open Space	Contains areas with a mixture of some impervious surfaces, but mostly managed grasses or low-lying vegetation planted in developed areas for recreation, erosion control, or aesthetic purposes. Impervious surfaces account for less than 20 percent of total land cover. This class commonly includes large-lot single family housing units, parks, and golf courses.
Agriculture, Pasture/Grasslands	Contains both managed and unmanaged grasses, legumes, or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas can be subjective to intensive management, such as tilling, and utilized for grazing.
Agriculture, Cultivated	Contains areas intensely managed for the production of annual crops. Crop vegetation accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.
Barren Land	Contains areas of gravel pits, bedrock, sand dunes, and other accumulations of earth material. Generally, vegetation accounts for less than 10 percent of total cover.
Forest/Shrub	Includes two types of trees that cover greater than 20 percent of total vegetation cover. • *Forest*—areas dominated by all kinds of trees generally greater than 5 meters tall. • *Shrub*—areas dominated by shrubs generally less than 5 meters tall.
Open Water	Include areas of open water, generally with less than 25 percent cover of vegetation or soil.
Wetlands	Includes the area contains palustrine or estuarine vegetation that are periodically saturated or covered with water. Total vegetation coverage is greater than 20 percent.
Source: National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) Land Cover Classifications https://coast.noaa.gov/digitalcoast/training/ccap-land-cover-classifications.html	

Link to PDF table (link: http://arcgis02.h-gac.com/bhr2018/doc/Description_LandCover_Classes.pdf)

Segment 1108 is in the Texas Coastal Plain region, characterized by prairies, marsh lands, and strips of riparian hardwoods and pine forest influenced by the sea, wind, rain, and hurricanes. Native vegetation includes prairie grasses, live oak woodlands, and many varieties of wetland plants. The marsh and wetlands provide habitat for numerous migratory birds and aquatic plants and animals.

Agriculture is the dominant type of land use. Over 54 percent of the area within the watershed is used for crop cultivation or as pasture land for livestock. Agricultural fields are concentrated in the middle portion of the watershed. About 21 percent of the area is developed. Much of the development is in or adjacent to the cities of Alvin, Iowa Colony, and Manvel.

H-GAC analyzed land use trends from 2006 to 2015. Developed land increased by 94.06 percent, replacing primarily agriculture lands. Wetland acreage increased by 40.27 percent during this period, replacing agricultural lands and forest.

Land Cover for Chocolate Bayou Above Tidal					
Land Cover Class Name	**Area Acres 2006**	**Area %**	**Area Acres 2015**	**Area %**	**% Change**
Agriculture	46368.90	65.39	38420.49	54.18	-17.14
Barren Lands	70.72	0.10	647.77	0.91	815.94
Developed	7752.84	10.93	15044.80	21.22	94.06
Forest/Shrubs	7371.62	10.40	4185.13	5.90	-43.23
Open Water	428.18	0.60	103.36	0.15	-75.86
Wetlands	8916.45	12.57	12506.87	17.64	40.27
Total	70908.72	100	70908.72	100	N/A

DESCRIPTIONS OF WATER QUALITY ISSUES

Legend

Monitoring Stations

Watersheds

- Chocolate Bayou Above Tidal
- Chocolate Bayou Tidal
- HSC\Buffalo Bayou

AU (Streams)

AU (Water Bodies)

1108 Chocolate Bayou Above Tidal Monitoring Stations Map (On Right)

Ambient water quality data is collected at station 11484 by the Environmental Institute of Houston - University of Houston Clear Lake. Field measurements, conventional chemical samples, bacteria (*E. coli*), and flow data are collected at the site.

Segment 1108 is impaired for bacteria. Dissolved oxygen (DO) is fully supported, and nutrient samples are below screening levels.

Bacteria Impairment

Click to View the 1108 Chocolate Bayou Above Tidal Bacteria Impairments Map (link available only in online story)

Assessment Unit (AU) 1108_01 was listed in the 2014 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) (IR) as impaired for contact recreation due to high levels of E. coli bacteria. This is the first time this AU was listed. The 2014 IR used data from 2005–2012 and found the geomean (seven-year average) for E. coli to be 159.03

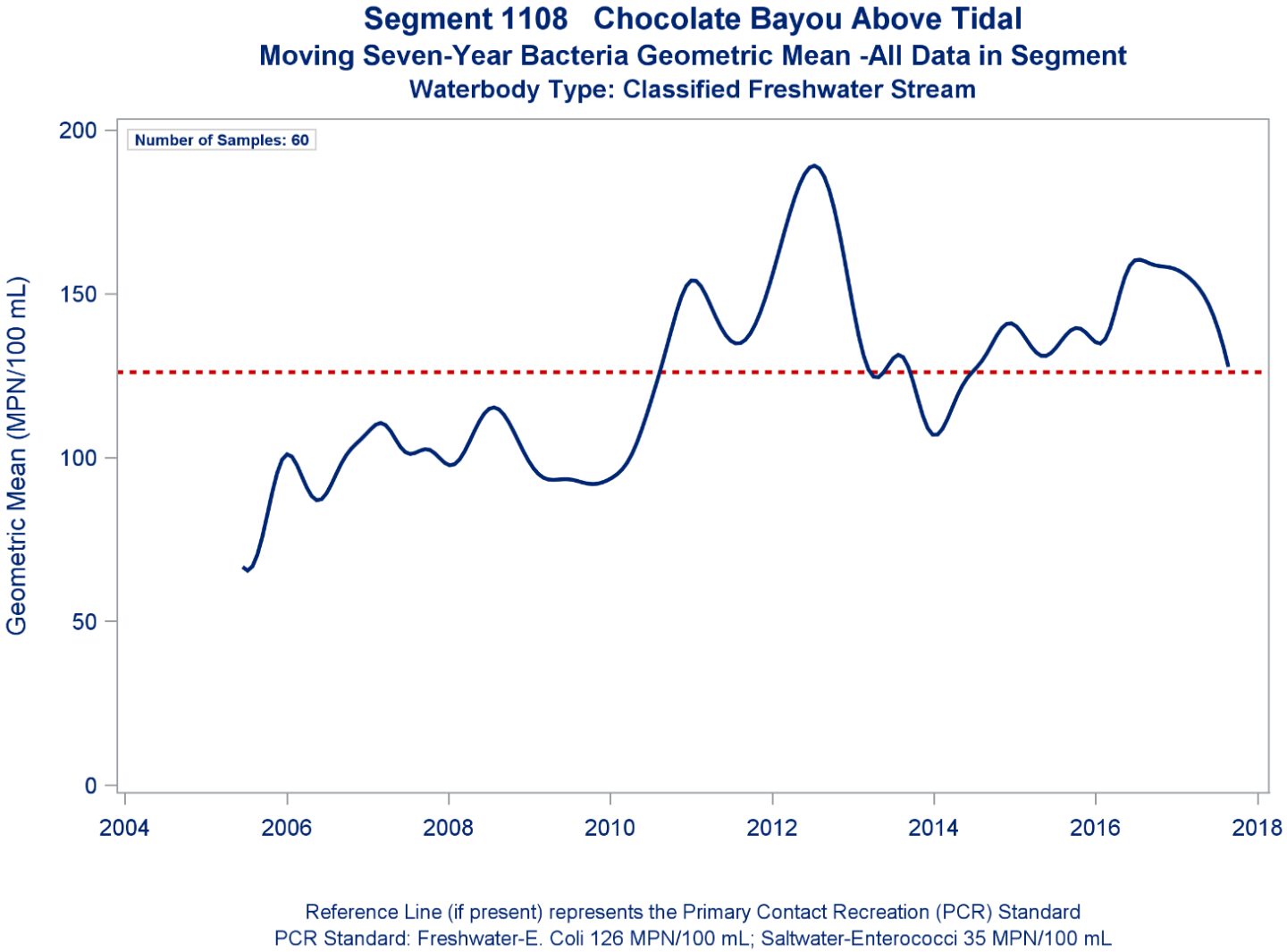
MPN/100mL (Most Probable Number), above the standard of 126 MPN/100mL.

H-GAC analysis of bacteria data from 2010 to 2017 continues to support a bacteria impairment, and shows that E. coli concentrations remain above the standard.

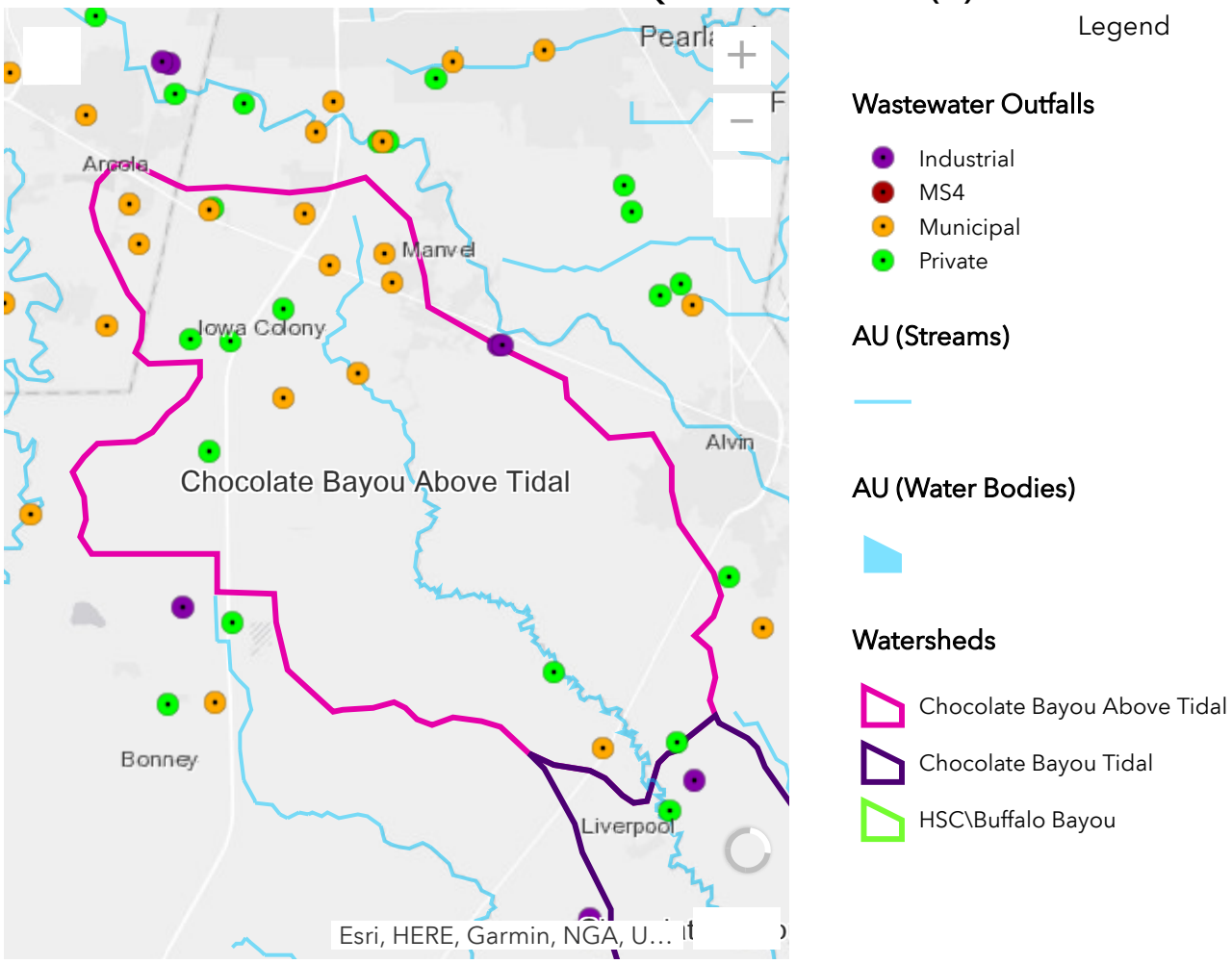
Chocolate Bayou Above Tidal Bacteria Comparison

AU_ID	Parameter	Level of Support	% Samples Exceeding Standard 2014 IR	Geomean 2014 IR	% Samples Exceeding Standard H-GAC 2010 - 2017	Geomean H-GAC 2010 - 2017
1108_01	E. coli	NS	.	159.0	47.8	148.8

FS – Fully supporting designated use; NS – Nonsupport for a designated use, NC – No Concern; CN – Concern for near-nonattainment of the TSWQS based on numeric criteria; CS – Concern for water quality based on screening levels



POTENTIAL SOURCES OF WATER QUALITY ISSUE(S)



Potential sources of fecal indicator bacteria in 1108 include wastewater treatment facility (WWTF) effluent, sanitary sewer overflows (SSOs), failing onsite sewage facilities, livestock, and other nonpoint sources.

Wastewater Treatment Facilities

1108 Chocolate Bayou Wastewater Treatment Facility Outfalls Map (On Right)

There are 21 permitted WWTF outfalls, two industrial and 19 domestic, in the watershed.

The permitted maximum daily flow for these facilities range from 25,000 gallons per day to 1.2 million gallons (MGD) per day. Self-reporting discharge monitoring report (DMR) data for 2016 was available for 11 of these facilities. None of the samples in any of the 11 facilities exceeded the permit limit for geomean or grab sample. H-GAC will continue to analyze DMR data when available to rule out WWTF discharges as a potential source for bacterial contamination.

Sanitary Sewer Overflows (SSOs)

Click to View the 1108 Chocolate Bayou Above Tidal Sanitary Sewer Overflows (SSOs) Map (link available only in online story)

SSOs are unauthorized discharges from WWTFs. SSOs in dry weather often result from blockages caused by tree roots, grease, or other debris in sewer collection pipes. During storm events, SSOs can be caused by inflow and rainfall infiltration.

SSO data are reported by permittees to TCEQ, which provided the data for analysis. Municipalities report the cause, an estimate of the size (in gallons), and a general location of the SSO. Fourteen SSOs were reported in 1108 between 2012 and 2016, ranging from 300 to 45,000 gallons.

On-site Sewage Facilities (OSSFs)

Click to View the 1108 Chocolate Bayou Tidal On-site Sewage Facilities (OSSFs) Density Map (link available only in online story)

The Chocolate Bayou Above Tidal watershed contains 2,422 on-site sewage facilities permitted through Brazoria County. H-GAC established a geographic model to identify potential locations for grandfathered (systems installed prior to the mandatory 1989 permitting date) or illegal systems (systems installed without a permit). The model excludes the locations of known systems and properties within sanitary sewer service area boundaries. Remaining residential, commercial, and industrial properties are assumed to have onsite sewage facilities. The model identified 4,188 potential grandfathered or illegal systems within the watershed. Typically, grandfathered and illegal systems have much higher failure rates than permitted systems. Due to the high number of grandfathered systems, H-GAC works with local partners to repair and/or replace failing systems through the Wastewater Assistance Program (link: http://www.h-gac.com/community/water/ossf.aspx) , funded by Supplemental Environmental Projects (SEP).

Livestock

Click to View the 1108 Chocolate Bayou Above Tidal Acreage of Pastures and Grasslands Map (link available only in online story)

Cattle are potentially a large contributor to nonpoint source bacteria pollution in the watershed. Based on the acreage of pasture and grasslands and U.S. Department of Agriculture estimates of cattle per acre, as many as 6,400 head of cattle may be present within the watershed. Best management practices, such as alternative water sources,

cross fencing, and cattle exclusion devices may prevent cattle from entering and/or defecating in or near the bayou.

Other Nonpoint Sources

Other sources of bacterial pollution may include fecal waste from pets, stray dogs and cats, feral hogs, and native wildlife. The improper disposal of solid and liquid waste is also an issue within the watershed. Animal carcasses (mainly deer and feral hogs) are butchered and discarded in the bayou and its tributaries. Trash, yard clippings, appliances, tires, and mattresses are also illegally dumped. Vacuum trucks (vehicles that haul human sewage from septic systems, portable toilets, and campgrounds) have been known to illegally discharge into the bayou.

POTENTIAL STAKEHOLDERS

1108 Chocolate Bayou Above Tidal Watershed Map (On Right)

- Cities of Arcola, Manvel, Alvin, Village of Iowa Colony
- Brazoria County
- Utility Districts

- Galveston Bay Estuary Program (GBEP)
- Chambers of Commerce
- Community Groups
- Environmental and Conservancy Groups, such as the Galveston Bay Foundation (GBF)
- Homeowner Associations
- Drainage Districts
- TCEQ Region 12
- Texas AgriLife Extension Offices
- Texas State Soil and Water Conservation Board
- Texas Parks and Wildlife
- Industry

ONGOING PROJECTS

+

−

H-GAC, with support from TCEQ, is developing a Total Maximum Daily Load (TMDL) Implementation Plan (I-Plan) for bacteria for segments 1107 and 1108. A TMDL is a regulatory plan for impaired waterways identifying the maximum amount of pollution the water body can receive and still meet water quality standards. H-GAC facilitates the

development of a stakeholder driven I-Plan to map a framework for reducing bacteria concentrations in Chocolate Bayou.

H-GAC, supported by TCEQ, launched a three-year project to help small communities in coastal watersheds inform residents about steps they can take to reduce pollution, specifically fecal bacteria levels, in local waterways. The project complements existing watershed protection plans and bacteria reduction projects by supporting residential outreach and education. The four areas of emphasis are pet waste; fats, oils and grease; on-site sewage facility maintenance; and litter/illegal dumping abatement.

MAJOR WATERSHED EVENTS

The H-GAC 2016 Regional Growth Forecast anticipates population will increase by 199 percent in the watershed by 2040.

Most of the population growth in 1108 is anticipated to take place along Texas State Highway 6 and Texas State Highway 288 in Alvin, Manvel, Arcola, Iowa Colony, and unincorporated portions of Brazoria and Fort Bend counties. Pastures and agricultural fields will be converted to residential and light commercial development. As the

population grows, it is anticipated that sanitary sewer lines, WWTFs, and on-site sewage facilities will need to be upgraded or built.

Population Trends in Chocolate Bayou Above Tidal				
Watershed	**Projected Population**			
	2015	**2020**	**2030**	**2040**
Chocolate Bayou Above Tidal	29,552	43,429	70,559	88,231

RECOMMENDATIONS FOR IMPROVING WATER QUALITY

- Address bacteria and various other concerns through stakeholder involvement and best management practices.
- Continue to analyze DMR data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders.
- Support programs that oversee the maintenance, repair, and replacement of **on-site sewage facilities**.

- Continue collecting water quality data and expand monitoring efforts to support actions associated with the **TMDL program**.
- Pursue new local partners to collect additional data to help better isolate problem areas.
- Expand volunteer monitoring with **Texas Stream Team** in areas without professional monitoring.
- Support programs to responsibly eliminate feral hog populations in the watershed.
- Consult stakeholders to identify illegal dumping sites and improve signage and/or cameras, if needed.

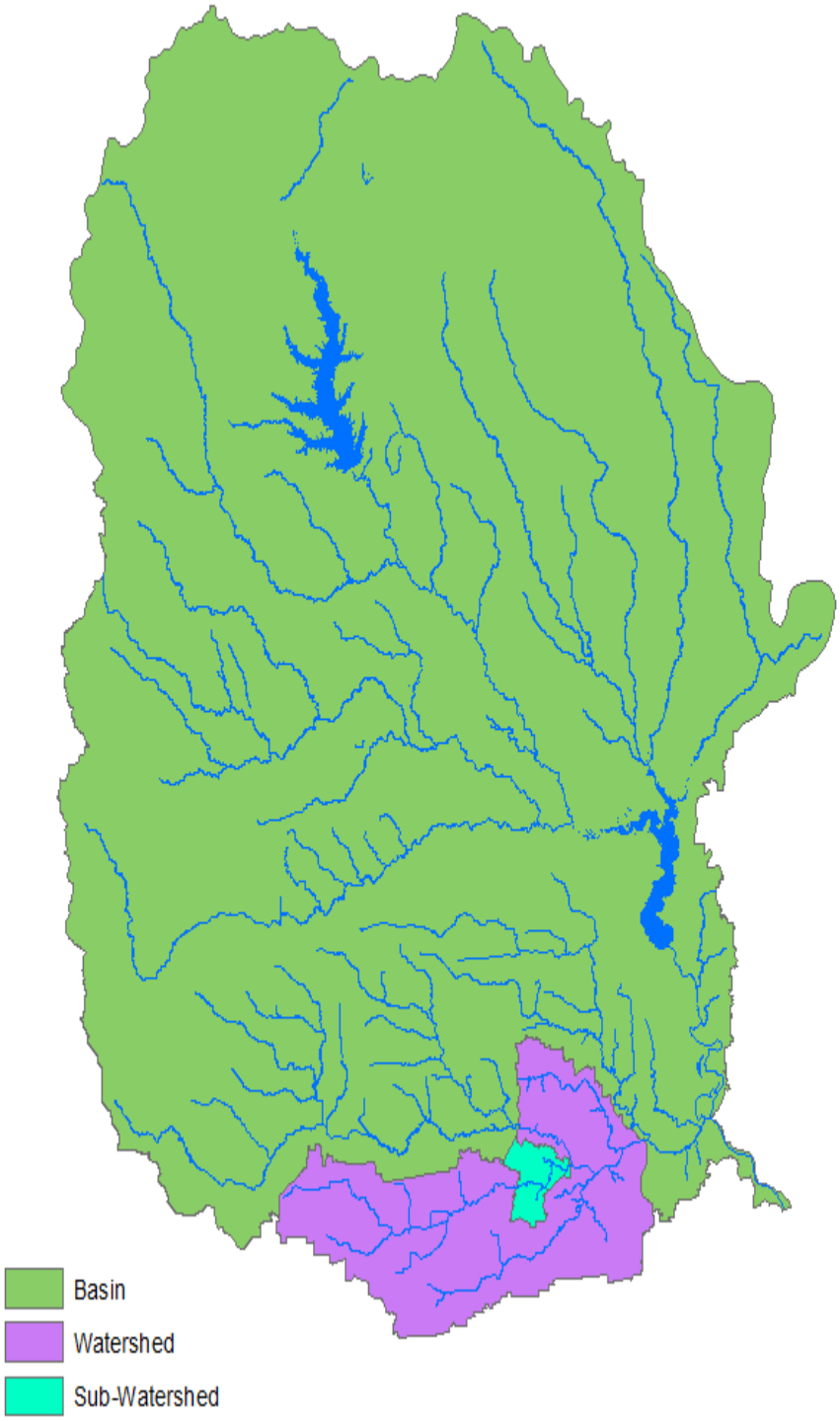
Water Quality Technical Primer

Texas Surface Water Quality Standards

The **Texas Surface Water Quality Standards** (TSWQS) establish goals to maintain the quality of streams, rivers, lakes, and bays throughout the state. Appendix A and Appendix D of the TSWQS establish the geographic boundaries and the appropriate standards for each body of water. Standards ensure public health and enjoyment, protect aquatic life, and remain consistent with the sustainable economic development of the state. The Texas Commission on Environmental Quality (TCEQ) develops the TSWQS under the authorization of the U.S. Clean Water Act (CWA) and Texas Water Code. The standards are approved by the U.S. Environmental Protection Agency (EPA).

Drainage Areas - Basins, Watersheds, and Sub-Watersheds

A **watershed** is a defined geographic area that waterways flow through on the way to a common body of water. **Basins** are larger geographic areas generally containing one or more watersheds. A **river basin** is a collection of watersheds drained by a major river and tributaries. A **coastal basin** is a collection of watersheds adjacent to the coastline that water flows through on its way to the ocean. Typically, coastal basins are between two major river basins. Watersheds can be broken down into smaller drainage areas called **subwatersheds**.

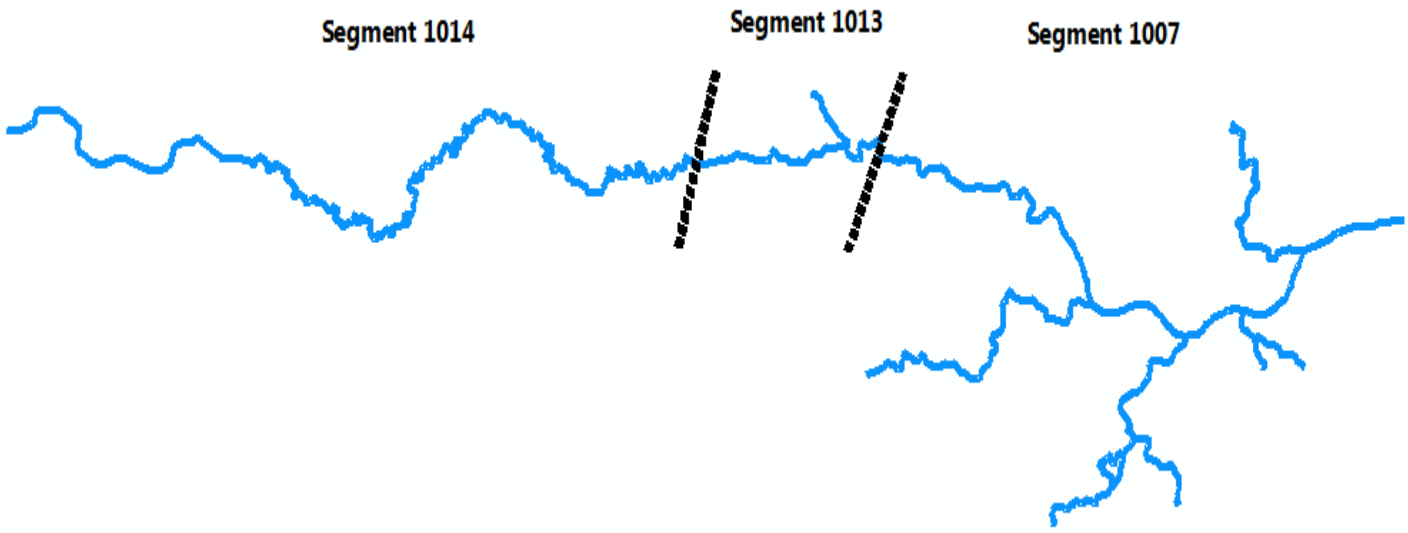


Water bodies, Segments, and Assessment Units

Water Bodies and Segments

The term **water body** is used to refer to any mass of water. A water body can be contained in a lake or a bay, or flow, such as a river, creek, or bayou. The TCEQ divides water bodies in the state into distinct **segments** that generally represent natural watersheds, and are intended to have similar chemical, physical, and hydrological characteristics. Each segment is assigned a four-digit code. The first two digits identify the river basin, and the last two digits identify the segment.

For example, Buffalo Bayou, a water body within the San Jacinto River Basin (Basin 10), has been divided into three segments: 1014–Buffalo Bayou Above Tidal, 1013–Buffalo Bayou Tidal, and 1007–Houston Ship Channel (HSC)/Buffalo Bayou Tidal. The different characteristics of each section warrant division into three separate segments.



Classified Segments

The TCEQ has designated segments 1014, 1013, and 1007 as classified segments, meaning these segments are described in the TSWQS. Typically, **classified segments** are major waterways.

Site-specific numerical criteria are developed to evaluate the uses and water quality of classified segments. The parameters evaluated include bacteria and dissolved oxygen. **Aquatic life use (ALU)** consists of five categories: minimal, limited, intermediate, high, and exceptional. In Texas, water bodies not specifically listed in Appendix A or D of the TSWQS are presumed to have a high aquatic life use and corresponding dissolved oxygen criteria. Higher uses are protected where they are attainable. Water bodies included in Appendix A or D have adjusted uses based on dissolved oxygen data and **nekton** and **macrobenthic invertebrate** community evaluations. Segments 1007, 1107, and 1108 are all included in Appendix A of the TSWQS, indicating site-specific uses that deviate from the criteria for high aquatic life use.

It is critical to protect human health in water bodies used for recreation. The TSWQS protects human health by setting numeric criteria for bacteria in a waterbody relative to the types of recreation occurring on that waterbody. Indicator bacteria levels are measured to determine risk. In freshwater, the indicator is Eschericia coli (E. coli) bacteria. Enterococci bacteria are measured in tidal water bodies

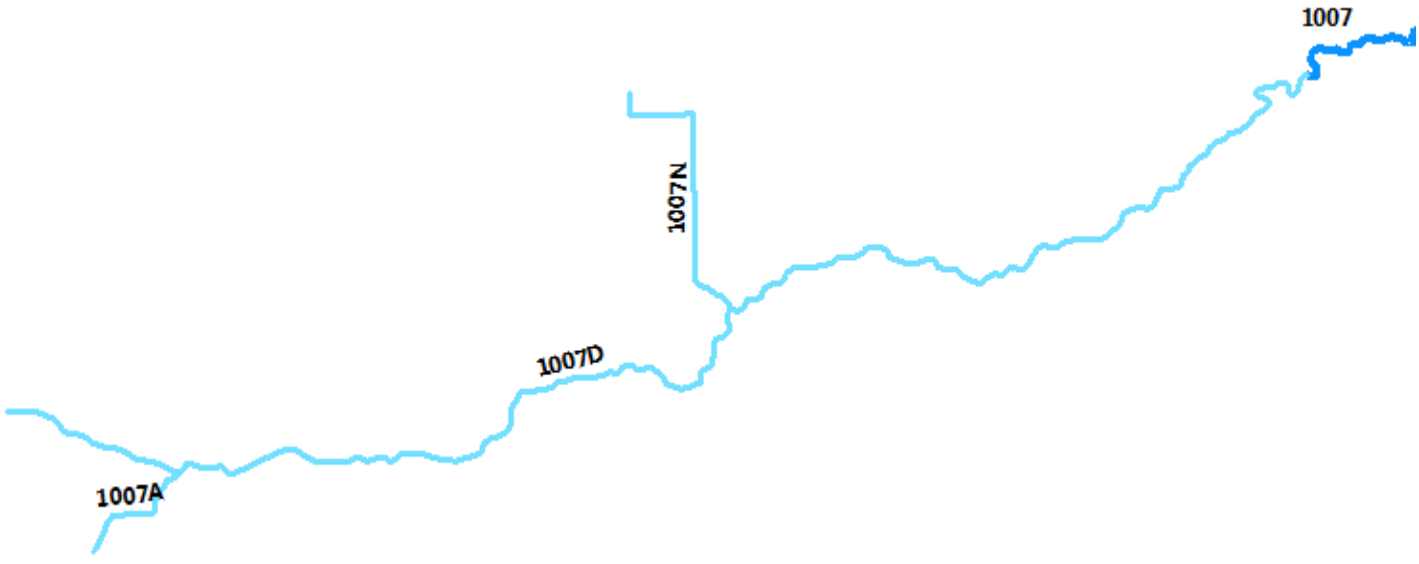
If activities are likely to result in ingestion of water (swimming, diving, tubing, surfing, wading by children), bacteria concentrations need to be lower. Categories of **recreational use** are based on the type and frequency of recreation. Primary contact recreation refers to activities involving a high likelihood of ingesting water. Secondary contact recreation refers to activities with limited body contact, such as boating, fishing, and canoeing. If such activities occur frequently, the designation is secondary contact recreation A water body could be classified as supporting noncontact recreation if conditions are unsafe to engage in any activities in the water. Primary contact recreation is the presumed recreational use in Texas waterbodies unless there is evidence to show

that the waterbody is not used for primary contact recreation. A Recreational Use Attainability Analysis (RUAA), discussed later in this primer, is necessary to change the presumed use of a waterbody.

Unclassified Segments

Unclassified segments are often tributaries of classified segments. These segments are usually assessed based on the criteria of the classified segment into which they flow. Some unclassified segments have been assigned specific water quality standards in the TSWQS. Unclassified segments are assigned the same four-digit code as the classified segment and a letter specific to that waterway.

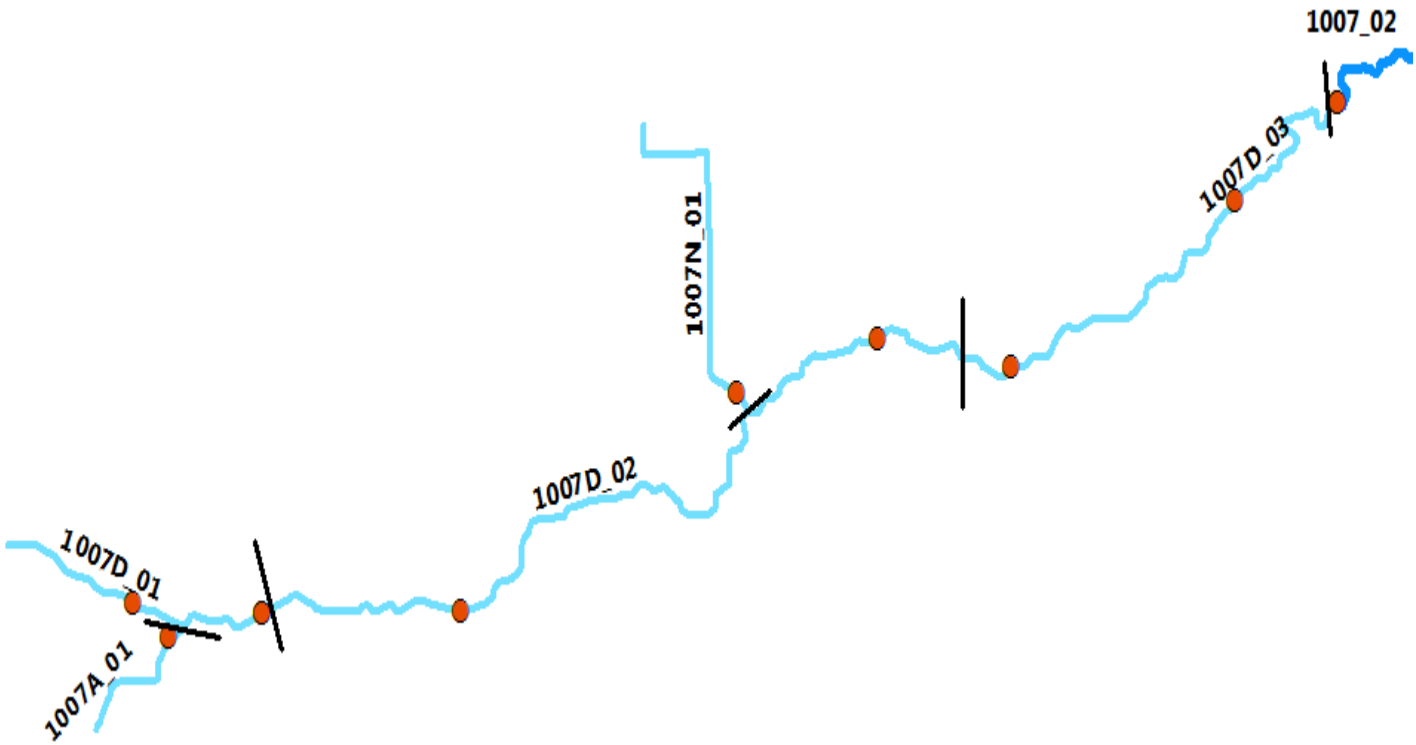
For example, Sims Bayou Above Tidal is an unclassified segment identified as 1007D. The first four digits represent classified segment 1007 (HSC/Buffalo Bayou Tidal) that Sims Bayou Above Tidal flows into, and a letter unique to Sims Bayou Above Tidal (D). Sims Bayou Above Tidal has two major tributaries, also unclassified (1007A and 1007N).



Assessment Units (AUs)

Each segment is subdivided into hydrologically-distinct **assessment units** (AUs). AUs are the smallest geographic areas of a water body that can support a designated or site-specific use. A segment may have one or multiple AUs, depending on water quality conditions or flow in different sections of the water body. Each AU has the same four- or five-character code as the segment followed by an _01. If the there are multiple AUs, the assessment units will generally be in sequential order (i.e. 1007D_01, 1007D_02).

For example, Sims Bayou Above Tidal has been divided into three AUs. The red dots in the graphic below represent monitoring stations. Monitoring stations have been placed on the downstream and upstream ends of each AU in 1007D. The smaller tributaries, 1007A and 1007N, have one monitoring station close to the confluence with the unclassified segment 1007D.



Water Quality Monitoring

The term **water quality** is used to describe the chemical, physical, and biological characteristics of water for general or designated uses. Water quality **monitoring** is the process of sampling and analyzing water quality parameters over time. The type of monitoring conducted by the Clean Rivers Program (CRP) is **routine**, meaning it is monitoring that is scheduled in advance without intentionally trying to target any certain environmental condition; samples are collected regardless of the conditions encountered. Routine monitoring generally consists of field measurements (Dissolved Oxygen [DO], pH, specific conductance, temperature), conventional chemical parameters (nutrients, chloride, sulfate), bacterial measurements (E. coli or enterococci), and flow measurements (if applicable for that water body). Please see the **List of Parameters Appendix (http://arcgis02.h-gac.com/bhr2018/parameters.html)** for a detailed description of each parameter.

Monitoring can include biased (targeted to a season, time, or condition) measurements, such as **24-hour DO**. In this procedure, a **data sonde** (a water-quality monitoring device that calculates and records field parameters) is deployed to measure DO every 15 minutes for 24 hours. After the deployment period, the data is analyzed and the 24-hour average and absolute minimum are calculated. The DO average and absolute minimum are used to assign an ALU category to a water body. For example, exceptional aquatic life use has a 24-hour average of 6.0 mg/L and an absolute minimum of 4.0 mg/L.

Assessment of Water Quality Data

The provisions of sections 305(b) and 303(d) of the Clean Water Act require the TCEQ to provide the Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) (IR) to the EPA every two years. The report contains a list of water bodies evaluated, water

bodies assessed by basin, impaired water bodies (303(d) List), water bodies of concern, water bodies either newly listed or removed from the 303(d) List, and other supporting information.

Each assessed water body is identified as:

- Fully supporting: At least ten data points (20 for bacteria) are available for an assessment, and the water body meets TSWQS or supports designated uses
- Of concern: There are two types of water body concern, CN and CS. CN means there is concern for near nonattainment of the TSWQS based on numeric criteria. CS means there is concern for water quality based on **screening levels**. Screening levels are derived from statistical distributions of statewide water quality monitoring data, and the 85th percentile for each applicable parameter is used as the screening criteria level.
- Impaired: Data indicates that the water body does not meet standards. Impaired water bodies are placed on the 303(d) List.

Management Measures for Impaired Water Bodies

If sufficient data is available to determine that a water body is impaired and does not meet standards, a management measure can be utilized to address the impairment.

- **Total Maximum Daily Load (TMDL)** is a method used to determine the amount (i.e. load) of a pollutant an impaired waterbody can receive daily and still meet water quality standards and designated uses. After a load is calculated for the pollutant sources, an implementation plan (I-Plan) is drafted by the water body's stakeholders outlining management measures to be used to return the target

pollutant to the calculated load. An I-Plan's management measures are usually voluntary actions but can, if recommended by stakeholders, include regulatory actions.

- **Use Attainability Analysis (UAA)** determines if the natural characteristics of a water body cannot attain the currently designated uses and/or criteria. Natural characteristics include temperature, pH, DO, diversity of aquatic organisms, amount of streamflow, and physical conditions such as depth.
- A **Recreational Use Attainment Analysis (RUAA)** is like a UAA but determines if contact recreation use is appropriate for a water body. A waterway may have physical characteristics or limited public access that would not warrant a contact recreation use designation.

Watershed Characterization Methodology

The identification of long- and short-term trends is important to many stakeholders, and these trends are important components of the Houston-Galveston Area Council's work, particularly in relation to the evaluation and revision regional monitoring efforts and priorities. H-GAC staff used several methods of analyses to characterize surface water quality in the H-GAC region. Trend analysis can identify cases where the value of a water quality parameter is changing over time. Statistical tests are performed to distinguish statistically significant trends from random and seasonal variation. While it might seem reasonable to use all the data available for these analyses, as the amount of data increases the likelihood of finding a statistically significant but unimportant trend also increases. To minimize this, H-GAC performed trend analysis on the most recent 15 years (June 2002–May 2017) of Texas Commission on Environmental Quality (TCEQ)-validated data to highlight recent trends in water quality in the region. All data management and statistical analysis was performed using Statistical Analysis System (SAS) version 9.3.

Data Selection and Processing

For analyses in this report, H-GAC staff selected water quality data collected between June 1, 2002 and May 31, 2017 from data downloaded from the Surface Water Quality Monitoring Information System (SWQMIS) on November 14, 2017. SWQMIS is a database that serves as the repository for surface water quality data for the state of Texas. All data used for these analyses were collected under a TCEQ-approved Quality Assurance Project Plan (QAPP). Qualified data (data added to SWQMIS with qualifier codes that identify quality, sampling, or other problems that may render the data unsuitable) were excluded from the download. All data for all stations in the H-GAC

Clean Rivers Program region (in general, basins 9, 10, 11, 13, and 24) were combined. Available flow data from U.S. Geological Survey (USGS) gaging stations in the Segment 1007 watershed were downloaded from the USGS website on January 8, 2018.

Variables in each data set were transformed as appropriate, and new variables were created to facilitate analysis and graphical display of results. In some cases, data from two or more STORET (method) codes were combined because the results obtained from each method can be considered equivalent. Any data collected at a depth greater than 0.3 meters, or not collected under a routine ambient monitoring program, were deleted.

Censored data (data reported as < [parameter limit of quantitation (LOQ)] were transformed to a value of one-half the parameter LOQ associated with the data, with some important exceptions. Because nutrient quantitation limits have been lowered over time, the presence of data censored at many different LOQs in the same dataset poses several problems. If the data for a given parameter are censored at values well above a later, lower LOQ value, trend analysis could suggest a trend where no real water quality trend is present. There is no ideal solution to this problem. Editing the censored data alone would limit, but not eliminate, false trends. In cases where some of the data reflected use of a lower LOQ than the current H-GAC Clean Rivers Program LOQ, values were transformed to one-half of the H-GAC Clean Rivers Program LOQ to minimize the identification of trends caused by changing analytical methods. H-GAC does not believe the impact from this transformation is significant. The impact of this analysis would be most pronounced for parameter trends typically found at concentrations at or near the quantitation limit in that specific water body.

The following parameters were selected for analysis:

- Instantaneous flow (00061)
- Specific conductance (00094)
- Temperature (00010)

- Dissolved Oxygen (00300)
- Secchi transparency (00078)
- pH (00400)
- E. coli (31699)
- Enterococci (31701)
- Chlorophyll a (32211)
- Total phosphorus (00665)
- Ammonia-nitrogen (00610)
- Nitrate + nitrite (00630) and nitrate (00620)
    - Nitrate+nitrite was selected when available, but some labs have reported nitrate rather than nitrate+nitrite. These two parameters were considered equivalent for the purpose of analysis.
- Total Kjehldahl nitrogen (00625)
- Total suspended solids (00530)

Data Selection for Trend Analysis

H-GAC staff performed segment-level trend analysis on a 15-year data series (if available) from the most downstream station in each classified and unclassified segment. If that station did not have a significant series of flow data associated with sampling events, and the next station upstream had a significant flow data series (preferably from a USGS gaging station), the next upstream station was selected instead. Trends were also evaluated at the assessment unit (AU) level, and graphs showing results from individual stations within each AU were also produced for review.

Trend analysis methodology

The first stage of trend analysis for both segments and AUs was nonparametric correlation analysis (Kendall's tau-b) of the parameter value with the sample collection date to identify correlations that were significant at p <0.05. these potential trends were then evaluated with up to four other methods. simple linear regression of the natural log of the parameter value on the time variable was performed for all data in the subset selected by h-gac for trend analysis. flow-adjusted trends were obtained through correlation of residuals from loess (locally-weighted least squares) regression in cases where instantaneous flow data were available. if there were no temporal gaps in the time-series (missing years, consistently missing seasons), seasonal kendall >Sen Slope estimation/Theil regression was run. If more than 15 percent of the data were censored at the analytical limit of quantitation, survival analysis (Tobit analysis in SAS PROC LIFEREG) was performed.

Plots of selected statistically-significant trends were produced for segments and AU in each of the three watersheds selected for this report. Each graph includes an inset showing the results of multiple trend analyses. If the trend is described as Increasing or Decreasing it means the calculated p-value is below the threshold of 0.05 selected by H-GAC. Trends identified as Stable have a calculated p-value greater than 0.05. When evaluating the results of several trend analyses of a given parameter, H-GAC placed the most weight on the Kendall correlation because nonparametric methods are insensitive to outliers in the time series. However, if Kendall correlation differed from the results of seasonal trend analysis or flow-weighted analysis, the data were further evaluated. If no flow data were available, the flow-adjusted trend appears as Not Calculated (indicating no flow data is available) or Insufficient Data (indicating only one flow value exists and a correlation could not be calculated). If the seasonal Kendall/Sen Slope trend was not calculated due to gaps (missing seasons) in the time series, the seasonal Kendall trend appears as Not Calculated. Survival analysis was only applied in those cases where the

amount of censored data could bias the results of the other methods. H-GAC set the threshold at 15 percent or more censored data. If fewer than 15 percent of the data were censored, survival analysis was not performed, and the trend appears as Not Applicable on graphs.

H-GAC staff conducted a variety of targeted analyses showing the relationship between parameter values and flow conditions for each monitoring station. These analyses supplemented interpretation of observed trends, and in some cases suggested relationships that might not be evident from trend analysis alone. Graphs of statistically significant flow dependencies were produced in cases where instantaneous flow data were available.

Trend analysis for the Regional Water Quality Summary

In 2015, H-GAC staff compiled a subset of stations in classified segments believed to be most representative of segment water quality by selecting one to three stations that were statistically representative of a given parameter in a given segment. Means and standard deviations of parameter values are calculated for each station, and those stations with means and standard deviations closest to the overall mean and standard deviation for the segment and parameter combination were selected. Preference was given to stations where stream flow was measured, and final selections were reviewed for reasonableness. In most cases, the station or stations at the most downstream location of the segment was the most statistically representative. Selection relied on SAS procedures PROC MEANS and PROC RANK. The same subset of stations has been used since 2015 to allow consistent comparisons across regional water quality summaries created for different years.

A conservative trend analysis was performed using seven years of recent data (June 1, 2010 – May 31, 2017) at the selected representative monitoring stations in the classified portion of each watershed to detect trends at the watershed level for the H-GAC Regional Water Quality Summary. Trends were identified by nonparametric correlation analysis and simple linear regression. Because nonparametric methods are less sensitive to extreme values in the data than parametric techniques like linear regression, trends that were suggested by linear regression analysis alone were not included in the chart.

Trends (for the "Frog Chart" analysis) were considered statistically significant if the p-value was below 0.05. 0.05 is the standard significance level used in most applications; H-GAC feels that selecting all results with p-values LE 0.10 produces too many real, but unimportant, trends. In part, this is due to the large amount of data collected in our region – the more data one analyzes, the more likely it is that one will find a result – and identify a "trend" - that is statistically different from randomness ("no trend"). 0.0545 rounds to 0.055, which in "arithmetic rounding becomes 0.06 when expressed as one significant figure.

Moving Geometric Mean Plots

In addition to trend analysis, H-GAC created plots of seven-year geometric means for indicator bacteria for each segment. These are a type of moving- or rolling-average plot, and they are constructed by calculating the geometric mean of all data collected up to seven years before a given sample was collected and plotting it (on the y-axis) against the collection date (on the x axis) of the last sample in the series. A smoothed line (penalized B-spline) is fitted to the time series. One can assess the change in bacterial density over

time from this sort of plot more easily than from a simple plot of density versus time. These plots are more meaningful for segments with historical bacteria data than for segments recently added to monitoring schedules (typically unclassified segments).

Watershed Characterizations

H-GAC used SAS to produce tables showing impairments and concerns for each AU, monitoring stations in each AU and segment, and a variety of other summary data to aid in the characterization of water quality issues in each watershed. In most cases, the source of the tabulated information was TCEQ (Integrated Reports and assessment results, the Coordinated Monitoring Schedule, station inventory reports, AU and segment GIS shapefiles).

Acronyms

ALU	Aquatic Life Use
AU	Assessment unit
BIG	Bacteria Implementation Group
BMP	Best Management Practices
CFS	Cubic feet per second
CMS	Coordinated Monitoring Schedule
CN	Concern for near-nonattainment
CRP	Clean Rivers Program
CS	Concern for screening levels
CWA	Clean Water Act
DMR	Discharge Monitoring Report
DO	Dissolved oxygen
EIH	Environmental Institute of Houston, University of Houston-Clear Lake
EPA	U.S. Environmental Protection Agency
FROG	Fats, rags, oil, and grease
FS	Fully-supporting designated use
GBEP	Galveston Bay Estuary Program
GBF	Galveston Bay Foundation
HCFCD	Harris County Flood Control District
H-GAC	Houston-Galveston Area Council
HSC	Houston Ship Channel
I-Plan	Implementation plan
IR	*Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)*
km	Kilometer
L	Liter

L	Liter
LOESS	Locally-weighted least squares plot
LOQ	Limit of quantitation
mg	Milligram
MGD	Millions of gallons per day
mi	Mile
mL	Milliliter
MPN	Most probable number
NC	No concern
NCR	Noncontact recreation
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source pollution
NS	Nonsupport for a designated use
OSSF	On-site sewage facility
PCB	Polychlorinated biphenyl
PCR	Primary contact recreation
QAPP	Quality assurance project plan
RUAA	Recreational use attainment analysis
SAS	Statistical Analysis System
SEP	Supplemental environmental project
SJRA	San Jacinto River Authority
SSO	Sanitary sewer overflow
SSS	Sanitary sewer system
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TDS	Total dissolved solids
TDSHS	Texas Department of State Health Services
TKN	Total Kjeldahl Nitrogen

TKN	Total Kjeldahl Nitrogen
TMDL	Total maximum daily load
TPDES	Texas Pollutant Discharge Elimination System
TRIES	Texas Research Institute for Environmental Studies
TSS	Total suspended solids
TSWQS	Texas Surface Water Quality Standards
UAA	Use attainability analysis
USGS	U.S. Geological Survey
WPP	Watershed protection plan
WWTF	Wastewater treatment facility

List of Parameters

Parameter	Potential Impacts	Potential Causes
Ammonia-N (NH_3-N)	Elevated levels of ammonia can injure or kill aquatic life, such as fish and invertebrates. In fish, even low concentrations of ammonia can damage sensitive tissues such as gills, deplete natural resistances to bacterial infections, and hinder reproductive capacities and growth.	Ammonia occurs naturally as a by-product of protein metabolism and decomposition. Ammonia can also enter a water body from runoff of fertilizers, livestock waste, and discharges of untreated sewage and industrial wastewater.
Chloride (Cl^-)	Although small amounts of chlorides are essential to proper cell function in plants and animals, large concentrations of chlorides can damage aquatic life physiology and hinder reproductive fertility and growth.	Chlorides occur naturally from the weathering and erosion of sedimentary rocks. Agricultural runoff, industrial wastewater, petroleum industrial activities, salt water intrusions, and effluent from wastewater treatment facilities are sources of chlorides.
Chlorophyll-*a*	Chlorophyll-*a*, a photosynthetic pigment found in green plants, is an indicator of the presence of algae in water. It is used to monitor the biological productivity of lakes and streams.	Elevated levels of nutrients could result in an overabundance of algae.
Dioxin	Dioxin is a family of polychlorinated chemicals. a carcinogen, it is detrimental to animal and human health.	Dioxin is present in the waste from the paper bleaching process and from the combustion of chlorinated compounds.
Dissolved Oxygen (DO)	Oxygen is the most important	Elevated levels of organic

Dissolved Oxygen (DO)	Oxygen is the most important component for the survival of aquatic life. Dissolved Oxygen is essentially the amount of oxygen available in water. Low dissolved oxygen can suffocate aquatic species.	Elevated levels of organic nutrients can cause an overabundance of bacteria and algae, which depletes oxygen from water. Human-caused increases in water temperature industrial discharges can also lower the capacity for water to hold oxygen.
***E. coli* and Enterococci Bacteria**	*Escherichia coli* (*E. coli*) *and* enterococci are bacterial indicator species for the presence of fecal matter, pathogenic bacteria, and viruses. *E. coli* is the indicator bacteria for freshwater, while enterococci are used as an indicator in saltwater.	Malfunctioning or failing on-site sewage facilities (OSSFs), untreated domestic sewage, improper disposal of grease, and runoff from agricultural and livestock activities can cause an overabundance of bacteria and other pathogenic organisms.
Flow Instantaneous Flow (Quantitative) Flow Severity (Qualitative)	Flow conditions affect water quality. Aquatic species are adapted to specific instream flow patterns. Low flow events, associated with hot summer months, can severely alter a stream habitat. High flow events, such as those associated with heavy rain, can also disrupt an aquatic habitat.	Drought or heavy rain events can disrupt normal flow patterns. Impediments such as fallen trees, beaver dams, or man-made dams can disrupt or alter in-stream flow.
Nitrogen Nitrate-N (NO_3-N) Nitrite-N (NO_2-N)	An abundance of nutrients can increase plant and algal growth. Bacteria use oxygen in the decomposition of plant matter, which can reduce dissolved oxygen. Nitrites are an intermediate form of Nitrogen can cause brown blood disease in fish by preventing the transfer of oxygen by hemoglobin. Nitrites can also adversely affect human health.	Nutrient sources are usually found in runoff from fertilizers and livestock facilities. They are also present in the effluent of wastewater treatment facilities.
pH	Aquatic organisms have	Runoff from mining operations

pH	Aquatic organisms have evolved to live in a specific range of pH. Biological and chemical processes can be altered or affected if the pH drops or rises over certain thresholds. Fish species cannot survive if the pH drops below 4 or rises above 12.	Runoff from mining operations and discharges of industrial wastewater can alter the pH of a water body.
Phosphorus Total Phosphate-P	Most phosphorus compounds found in water are phosphates. Orthophosphate is consumed by aquatic plants and organisms and is considered the limiting factor for aquatic plant growth. High or excessive levels of orthophosphate results in higher yield in growth. Excessive plant growth can cause eutrophication, (the natural aging progression of a water body) which can decrease dissolved oxygen.	Phosphates occur naturally from the decomposition of organisms and the weathering of rock material. It can also result from fertilizer runoff.
Polychlorinated biphenyls (PCBs)	PCBs are acutely toxic, and can disrupt endocrine and neural processes in aquatic life and humans.	PCBs are found in dielectric fluids used in transformers, capacitors, and coolants.
Salinity	Salinity is the measurement of conductive ions in the water. High levels of sodium sulfate and magnesium sulfate produce a laxative effect in drinking water. High levels of total dissolved solids can cause an unpleasant taste in potable water.	Weathering or erosion of rocks, salt mining, and salt water intrusions are sources of increased salinity.
Secchi Transparency	Secchi transparency is used to calculate the depth at which natural light can penetrate the water column. It also used as a measurement of eutrophication.	An abundance of algae and plants or excessive levels of total suspended solids can decrease the ability for light to transmit through the water column.
Specific Conductance	Specific conductance is the	The conductivity of water is

Specific Conductance	Specific conductance is the measure of the water's capacity to carry an electrical current. It is indicative of the amounts of total solids present in a water body.	The conductivity of water is increased by the presence of salt-forming substances such as sulfate, chloride, and sodium.
Sulfate (SO_4^{2-})	In the absence of oxygen and with a pH below 8, bacteria can reduce sulfate ions to sulfide ions. Sulfide ions can cause serious and unpleasant odor problems. Sulfates in sediment can also alter soil composition and hinder or prevent growth of native plants.	Sulfate is derived from rocks and soils containing gypsum, iron sulfides, and organic compounds. Sulfur-containing fossil fuels, heavy industrial activities, and some fertilizers are also potential sources for sulfates.
Temperature	The types of aquatic life that can survive in a water body are dependent upon water temperature. Water temperature can affect levels of dissolved oxygen. Water with a high temperature has less capacity to hold oxygen. As the water temperature drops, cold-blooded animals such as fish can become more susceptible to pathogenic stress or shock, which can lead to infections or death.	Releases of water from reservoirs can contribute to drops in temperature. Temperatures can increase with the removal of flora from riparian areas or from the release of heated water from industrial activities.
Total Dissolved Solids (TDS)	Elevated amounts of total dissolved solids can be corrosive to sewer and plumbing fixtures. High TDS may also affect the aesthetic quality of water.	Elevated amounts of TDS occur naturally from salt deposits, salt water intrusions, and sedimentary rock high in carbonate. Salt mining, petroleum exploration, potable water treatments, wastewater discharges, and chemical, stormwater, or fertilizer runoff can increase the amounts of TDS.
Total Suspended Solids (TSS)	An increase in the amount of	High erosion events, usually

Total Suspended Solids (TSS)	An increase in the amount of total suspended solids can decrease the ability for light to penetrate through the water column. This can decrease the productivity of aquatic plants. As excessive amounts of TSS settle and become sediment, benthic habitats can be altered or destroyed.	High erosion events, usually coinciding with the removal of riparian floral species and severe flow events, can create excess levels of total suspended solids. Unsound agricultural practices can also contribute to soil erosion into waterways.

Glossary

24-Hour Dissolved Oxygen (DO) Measurements - The measurement of dissolved oxygen over a 24-hour period using deployed, unattended, automated equipment preset to record and store field measurements over one 24-hour period. These measurements are used to assess Aquatic Life Use.

Algae - Aquatic plants that lack true roots, stems and leaves. For the physical assessment described in this document, algae consist of nonvascular plants that attach to rocks and debris or float freely in the water. Such plants may be green, blue-green, or olive-green, and are slimy to the touch. They usually have a coarse filamentous structure.

Ambient - The existing water quality in a particular water body.

Ammonia-Nitrogen (NH_3-N) - Ammonia, naturally occurring in surface and wastewaters, is produced by the breakdown of compounds containing organic nitrogen.

Aquatic Life Use (ALU) - Refers to a use designation for a water body and how well it can support abundant and diverse aquatic life

Assessment Unit (AU) - The smallest geographic area of a water body that can support a designated or site-specific use.

Attainable Use - A use that can be reasonably achieved by a water body in accordance with its physical, biological and chemical characteristics whether it is currently meeting that use or not. Guidelines for the determination and review of attainable uses are provided in the standards implementation procedures. The designated use, existing use, or presumed use of a water body may not necessarily be the attainable use.

Basin - A large geographic drainage area comprised of watersheds. See River Basin and Coastal Basin.

Benthos/Benthics - *see Macrobenthic Invertebrate*

Best Management Practices (BMP) - Schedules of activities, maintenance procedures, and other practices to prevent or reduce the pollution of water to the maximum extent practicable.

Bloom - The accelerated growth of algae and/or higher aquatic plants in a body of water. Bloom is often related to pollutants that increase the rate of growth.

Channelization - Straightening and deepening streams so water will move faster.

Chloride (Cl^-) - One of the major inorganic ions in water and wastewater. Concentrations can be increased by industrial processes. High chloride concentrations can affect metallic objects and plants.

Chlorophyll-*a* - A photosynthetic pigment found in all green plants. The concentration of chlorophyll-*a* is used to estimate the phytoplankton in an area of surface water.

Classified - Refers to a water body that is listed and described in Appendix A or Appendix C of the Texas Surface Water Quality Standards.

Coastal Basin - A collection of watersheds adjacent to the coastline that water flows through on its way to the ocean.

Contact Recreation - Recreational activities involving a significant risk of ingestion of water; including wading by children, swimming, water skiing, diving, and surfing. *See also* noncontact recreation.

Conventional Parameters - A list of basic parameters that require laboratory analyses. The parameters frequently include, but are not limited to, solids (TSS, TDS, VSS), nutrients (nitrogen and phosphorus compounds), chlorides, sulfates, hardness, and TOC.

Criteria - Water-quality conditions that are to be met in order to support and protect desired uses.

Data Sonde - A water-quality monitoring device that calculates and records field parameters.

Designated Use - A use that is assigned to specific water bodies in Appendix A or in Appendix D of the Texas Surface Water Quality Standards. Typical uses designated for specific water bodies include domestic water supply, categories of Aquatic Life Use, kinds of recreation, and aquifer protection.

Dioxin - A family of polychlorinated chemicals found in waste from the paper bleaching processes and the combustion of chlorinated compounds. Dioxin is considered carcinogenic and can disrupt the reproductive and immune systems in humans.

D**issolved Oxygen (DO)** - The oxygen freely available in water. Dissolved oxygen is vital to fish and other aquatic life and for the prevention of odors. Traditionally, the level of dissolved oxygen has been accepted as the single most important indicator of a water body's ability to support desirable aquatic life.

Effluent - Wastewater (treated or untreated) that flows out of a treatment plant or industrial outfall (point source) prior to entering a water body.

Enterococci - A subgroup of fecal streptococcal bacteria (mainly *Streptococcus faecalis* and *Streptococcus faecium*) found in the intestinal tracts and feces of warm-blooded animals. It is used as an indicator of the potential presence of pathogens.

Escherichia coli (E. coli) - *E. coli* is a member of the total coliform group of bacteria found in feces. It is an indicator of fecal contamination and possible presence of enteric pathogens (viral, protozoan, and bacterial pathogens of the gastrointestinal route).

Estuary - Regions of interaction between rivers and near shore ocean waters, where tidal action and river flow create a mixing of fresh and salt water.

Fecal Coliform - A subset of the coliform bacteria group that is found in the intestinal tracts and feces of warm-blooded animals. Heat-tolerant bacteria from other sources can sometimes be included. It is used as an indicator of the potential presence of pathogens.

Field Parameters - A list of basic tests generally collected in the field using equipment and meters. The list also includes visual observations.

Field Parameters - A list of basic tests generally collected in the field using equipment and meters. The list also includes visual observations.

General Use - Refers to the overall quality of water. Several water quality constituents are evaluated to ensure and safeguard the general use of a water body.

Habitat - The area in which an organism lives.

Impoundment - A body of water confined by a dam, dike, floodgate, or other barrier.

Indicator Organism - An organism, species or community that indicates the presence of a certain environmental condition or conditions.

Loess Plot - A graph that shows the relationship of two variables (measurements or parameter values) made using a technique that calculates the slope of the plotted line at different time periods (locally weighted least-squares regression), producing a line that usually shows inflections (change points) rather than a straight line that best fits all points. LOESS is not really an acronym, and can be thought of as "LOcal regrESSion."

Macrobenthic Invertebrate - Aquatic bottom-dwelling fauna. Common types are flat worms, leeches, snails, and various insect species.

Nekton - Free-swimming organisms (for example, fish, insects).

Nitrate-Nitrogen (NO_3-N) - A compound containing nitrogen that can exist as a dissolved solid in water. Excessive amounts can have harmful effects on humans and animals (>10 mg/L).

Nitrite-Nitrogen (NO_2-N) - An intermediate oxidation state in the nitrification process (ammonia, nitrite, and nitrate).

Noncontact Recreation (NCR) - Aquatic recreational pursuits not involving a significant risk of water ingestion and limited body contact incidental to shoreline activity, such as fishing, and commercial and recreational boating. *See also* contact recreation.

Nonpoint Source (NPS) - A pollution source that is diffuse and does not have a single point of origin or is not introduced into a receiving stream from a specific outfall. The pollutants are generally carried off the land by stormwater runoff. The commonly used categories for nonpoint sources are agriculture, forestry, urban, mining, construction, dams and channels, land disposal, and saltwater intrusion.

Nutrient - Any substance used by living things to promote growth. The term is generally applied to nitrogen and phosphorus in water and wastewater, but is also applied to other essential and trace elements.

Outfall - A designated point of effluent (treated liquid waste) discharge.

Oyster Waters - Waters producing edible species of clams, oysters, or mussels.

Parameter - Refers to a water quality constituent used to evaluate water quality.

pH - The hydrogen-ion activity of water caused by the breakdown of water molecules and presence of dissolved acids and bases.

Phosphorus - A nutrient essential to the growth of organisms. It can be the nutrient limiting the primary productivity of water. In excessive amounts from wastewater, agricultural drainage, and certain industrial waste it can contribute to the eutrophication (the natural aging progression) of lakes and other water bodies.

Pollution - The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water that renders it harmful, detrimental, or injurious to humans, animal life, vegetation, property, or the public health, safety, or welfare. Pollution may impair the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Polychlorinated Biphenyls (PCBs) - A class of organic compounds used in dielectric fluids in transformers, capacitors, and coolants. PCBs are highly toxic and are associated with endocrine disruption and neural toxicity in humans.

Public Drinking Water Supply - A water body designated to provide water to a public water system.

Recreational Use - Refers to how safely a water body can support activities that involve the possibility of ingesting or encountering water.

Recreational Use Attainment Analysis (RUAA) - An analysis determining the appropriate contact recreation use designation for a water body.

Reservoir - Any natural or artificial holding area used to store, regulate, or control water.

River Basin - The land area drained by a river and its tributaries.

Routine Monitoring - Monitoring activities that occur at least quarterly, and at a minimum, include collecting field measurements, conventional chemical parameters, bacterial measurements, and flow measurements.

Runoff - Precipitation or irrigation water that runs off land into water bodies.

Screening Criteria Levels - Concentration amounts derived from statistical distributions of statewide water quality monitoring data. The 85th percentile for each applicable parameter is used as the screening criteria level.

Sediment - Particles of sand, clay, silt, and plant or animal matter carried in water and deposited in reservoirs and slow-moving areas of streams and rivers.

Segment - A water body or portion of a water body that is individually defined and classified in the Texas Surface Water Quality Standards. A segment is intended to have relatively homogeneous chemical, physical, and hydrological characteristics. A segment provides a basic unit for assigning site-specific standards and for applying water quality management programs. Classified segments may include streams, rivers, bays, estuaries, wetlands, lakes, and reservoirs.

Specific Conductance - A measure of the carrying capacity for electrical current, in mhos/cm, of 1 cm^3 of water at 25°C. Dissolved substances in water dissociate into ions with the ability to conduct electrical current. Conductivity is a measure of how salty the water is. Salty water has high conductivity.

Stormwater - Rainfall runoff, snow-melt runoff, surface runoff, and drainage.

Subwatershed - Small drainage areas of a stream, creek, or portion of a larger water body.

Sulfate (SO_4^{2-}) - An ion derived from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Sulfates are widely distributed in nature.

Texas Surface Water Quality Standards (TSWQS) - Establishes explicit goals for the quality of water bodies and designates water bodies for appropriate uses, including the narrative and numerical criteria deemed necessary to protect those uses.

Tidal - Describes coastal waters subject to the ebb and flow of tides. For purposes of standards applicability, tidal waters are saltwater. Classified tidal waters include all bays and estuaries with a segment number that begins with 24--, all streams with the word tidal in the segment name, and the Gulf of Mexico.

Total Dissolved Solids (TDS) - The sum of nitrogen in ammonia (NH_3-N), ammonium (NH_4^+-N), and organically-bound nitrogen.

Total Kjeldahl Nitrogen (TKN) - The sum of nitrogen in ammonia (NH_3-N), ammonium (NH_4^+-N), and organically-bound nitrogen.

Total Maximum Daily Load (TMDL) - The total amount of a substance a water body can assimilate and still meet the Texas Surface Water Quality Standards.

Total Suspended Solids (TSS) - The amount of organic and inorganic suspended particles in water.

Tributary - A stream or river that flows into a larger one.

Unclassified Segment - Often tributaries of classified segments and do not have specific water quality standards assigned in the TSWQS. These segments are assessed based on the criteria of the classified segment into which they flow. However, there are exceptions to this rule. Some unclassified segments have been assigned specific water quality standards in the TSWQS. Unclassified segments are assigned the same four-digit code as the classified segment and a letter that is specific to that waterway.

Use Attainment Analysis (UAA) - This analysis determines if the natural characteristics of a water body cannot attain the currently designated uses and/or criteria

Water body - Refers to any mass of water. A water body can be contained, like a lake or a bay, or in motion, such as a river, creek, or bayou.

Water Quality - Used to describe the chemical, physical, and biological characteristics of water to ensure suitability for general or designated uses.

Water Quality Monitoring - The process of sampling and analyzing water quality parameters over time.

Watershed - The area of land from which precipitation drains to a single point. Watersheds are sometimes referred to as *drainage basins* or *drainage area*

Watershed Protection Plan (WPP) - A community-based, stakeholder-driven framework that uses a holistic/watershed approach to address potential sources of impaired waterways. The plan is developed with community involvement, and the measures to reduce pollutants are voluntary.