HOUSTON-GALVESTON AREA COUNCIL

HOW'S THE WATER?

2021

Basin Summary Report

Houston-Galveston Area Council

This report is prepared in cooperation with the Texas Commission on Environmental Quality under the authorization of the Texas Clean Rivers Act.

Houston-Galveston Area Council

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

THE TEXAS CLEAN RIVERS PROGRAM

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2021 BASIN SUMMARY REPORT

EXECUTIVE SUMMARY

Acknowledgments

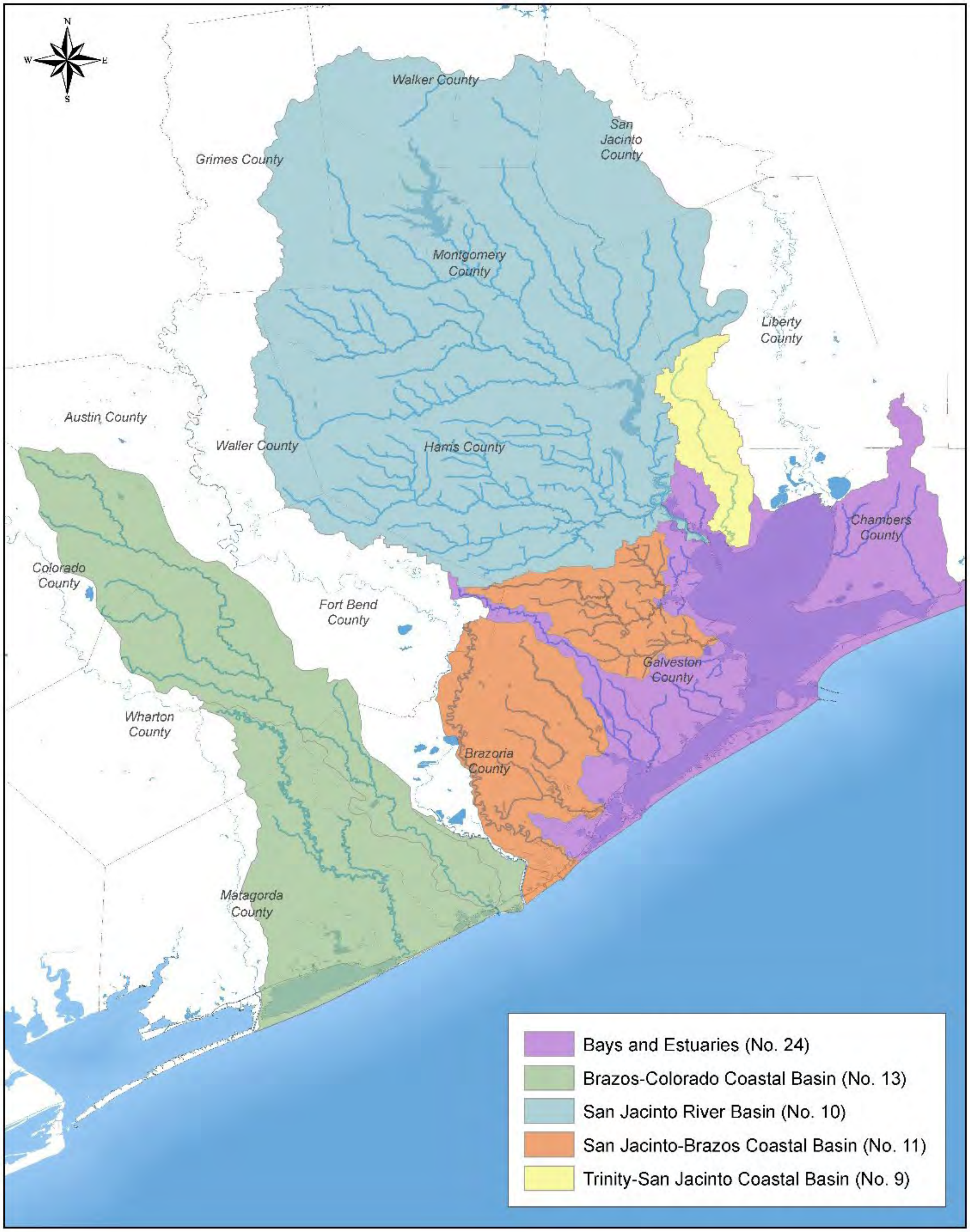
The Houston-Galveston Area Council's Water Resources Staff thanks all of our Clean Rivers Program Partners for their hard work and dedication to this program. This is especially true in 2020 and 2021. The teams responsible for water quality monitoring found a way to continue monitoring safely during the COVID-19 pandemic. It would have been easy to say, "this is just too hard" and shut down monitoring until things were back to normal. That didn't happen. Crews deployed and adapted to new protocols to keep themselves and others protected. In many cases that meant riding in separate vehicles or putting up barriers to separate from one another in the same vehicle. Accessing the workplace was more challenging and certainly data review, quality assurance, and analysis were performed differently. Completing these tasks over Zoom or Teams is more difficult than being together in an office or lab. The bottom line is, due to these efforts, no water quality data collection was lost due to COVID-19.

Introduction

The Basin Summary Report, produced every five years, outlines water quality issues in the Houston-Galveston Area Council (H-GAC) Clean Rivers Program region based on technical analysis of historical and current trends. This summary document highlights significant findings, activities and accomplishments, and recommendations from the report. The full report is available at https://datalab.h-gac.com/bsr2021/.

Basins in the H-GAC Region

H-GAC's Clean Rivers Program region includes watersheds in all or a portion of 15 counties. The streams and rivers in the region drain into coastal bays and estuaries that eventually reach the Gulf of Mexico.



Regional Issues

Bacteria continues to be the most widespread and pervasive pollutant in the region. After many years of seeing more streams getting better than were getting worse, that trend has changed. In this assessment, more streams segments are getting worse (7 segments) than are getting better (3 segments). The good news is that 81% of stream miles remain stable for bacteria, despite rapidly increasing population and development. There is better news for Dissolved Oxygen (DO) concentrations. DO levels are getting better in more streams than are getting worse. Concerns for nutrients are also decreasing, with 31% of stream miles showing increasing concentrations of nutrients compared to 33% five years ago. PCBs and Dioxins continue to be a problem; but these levels remain constant. The long-term challenge will be to maintain and improve water quality despite the cumulative impacts that will come with projected population growth and ongoing urban development.

2021 REGIONAL WATER QUALITY SUMMARY

The numbers represent the percent of total segment length that is impaired or of concern for each parameter. Cells without numbers (blanks) represent stream segments that are currently meeting state standards but may be improving or degrading for each parameter.

DO = Dissolved Oxygen Bact = Bacteria Chl-a = Chlorophyll a Nutr = Nutrients PCB = PBC/Dioxins OTHER = See Below

Basin	Watershed	Segment	DO	Bact	Chl-a	Nutr	PCB	Other*	Frogs
Trinity-San Jacinto Coastal	Cedar Bayou Tidal	0901	14.2	100			85.8		🐸
	Cedar Bayou Above Tidal	0902	82.7	82.7				**	🐸🐸🐸
San Jacinto River	Buffalo Bayou Above Tidal	1014	12.0	77.9		64.7			🐸🐸🐸
	Buffalo Bayou Tidal	1013	34.2	77.8		43.6		**	🐸🐸
	Caney Creek	1010	16.8	69.2					🐸🐸🐸
	Cypress Creek	1009	18.8	80.3		80.3		10.3	🐸🐸🐸
	East Fork San Jacinto River	1003		85.7					🐸🐸🐸
	Greens Bayou Above Tidal	1016	6.4	95.8		85.3			🐸🐸🐸
	Houston Ship Channel	1006		44.7	7.1	68.4	39.8	22.2	🐸🐸🐸
	Houston Ship Channel Buffalo Bayou Tidal	1007	13.0	70.2		68.9	28.7	0.9	🐸🐸🐸
	Houston Ship Channel/ San Jacinto River Tidal	1005					100		🐸🐸🐸
	Lake Conroe	1012			55.7**	55.7**			🐸🐸🐸🐸
	Lake Creek	1015	40.1	12.1				30.7	🐸🐸🐸🐸
	Lake Houston	1002	20.9	7.0		20.9		0.1	🐸🐸🐸🐸
	Peach Creek	1011		100				15.4	🐸🐸🐸
	San Jacinto River Tidal	1001					36.5		🐸🐸🐸🐸
	Spring Creek	1008	0.3	80.5	0.6	23.8		11.4	🐸🐸🐸
	West Fork San Jacinto River	1004		53.6		**		16.6	🐸🐸🐸🐸
	White Oak Bayou Above Tidal	1017	11.7	87.0		79.6			🐸🐸
San Jacinto-Brazos Coastal	Armand Bayou Tidal	1113	61.7	69.6	21.4	17.0	23.4	12.1	🐸🐸🐸
	Bastrop Bayou Tidal	1105	43.6	69.6					🐸🐸🐸
	Chocolate Bayou Above Tidal	1108		100					🐸🐸🐸
	Chocolate Bayou Tidal	1107		100			100		🐸
	Clear Creek Above Tidal	1102	23.8	78.8		60.8	48.4	13.1	🐸🐸
	Clear Creek Tidal	1101	38.6	78.0	4.7	31.8	29.2		🐸🐸🐸
	Dickinson Bayou Above Tidal	1104		54.5					🐸🐸🐸🐸
	Dickinson Bayou Tidal	1103	86.9	100	2.8	2.8	43.6		🐸
	Old Brazos River Channel Tidal	1111							🐸🐸🐸🐸🐸
	Oyster Creek Above Tidal	1110	59.3	64.5				96.8	🐸🐸🐸
	Oyster Creek Tidal	1109	100	100					🐸🐸🐸

Basin	Watershed	Segment	DO	Bact	Chl-a	Nutr	PCB	Other*	Frogs
Brazos-Colorado Coastal	San Bernard River Above Tidal	1302	61.5	80.6		10.9		7.3	
	San Bernard River Tidal	1301	100	100					
	Caney Creek Above Tidal	1305	27.4	39.1		57.6		13.9	
	Caney Creek Tidal	1304	46.8	97.9	36.8				
Bays & Estuaries	Barbours Cut	2436				100	100		
	Bastrop Bay / Oyster Lake	2433							
	Bayport Ship Channel	2438			100	100	100	100	
	Black Duck Bay	2428			100	100	100		
	Burnet Bay	2430			85.9	100	100		
	Cedar Lakes +	2442							
	Chocolate Bay	2432	32.6	78.5			39.0		
	Christmas Bay	2434							
	Clear Lake	2425		4.7	76.2	76.2	80.9	69.3	
	Drum Bay	2435							
	East Bay	2423	30.1		100		100		
	East Matagorda Bay	2441							
	Lower Galveston Bay	2439			100	61.7	100		
	Moses Lake	2431		34.3	14.3		21.4		
	San Jacinto Bay	2427				100	100		
	Scott Bay	2429				100	100		
	Tabbs Bay	2426				34.8	61.5		
	Texas City Ship Channel	2437			100	100	100		
	Trinity Bay	2422	11.7	25.5	76.1		89.9		
	Upper Galveston Bay	2421		7.3	89.7	91.1	87.5		
	West Bay	2424	6.0	11.7	11.4	8.2	82.6		
	Gulf of Mexico	2501						100	

Chart Key

Severe, multiple water quality impairment(s) or concern(s) exist in a majority of the waterbody.

Significant, multiple water quality impairment(s) or concerns exist in the waterbody.

Water quality impairment(s) or concern(s) exist in a substantial portion of the waterbody.

Water quality impairment(s) or concern(s) exist in the waterbody.

No significant water quality impairments or concerns exist in the waterbody.

GETTING BETTER

GETTING WORSE

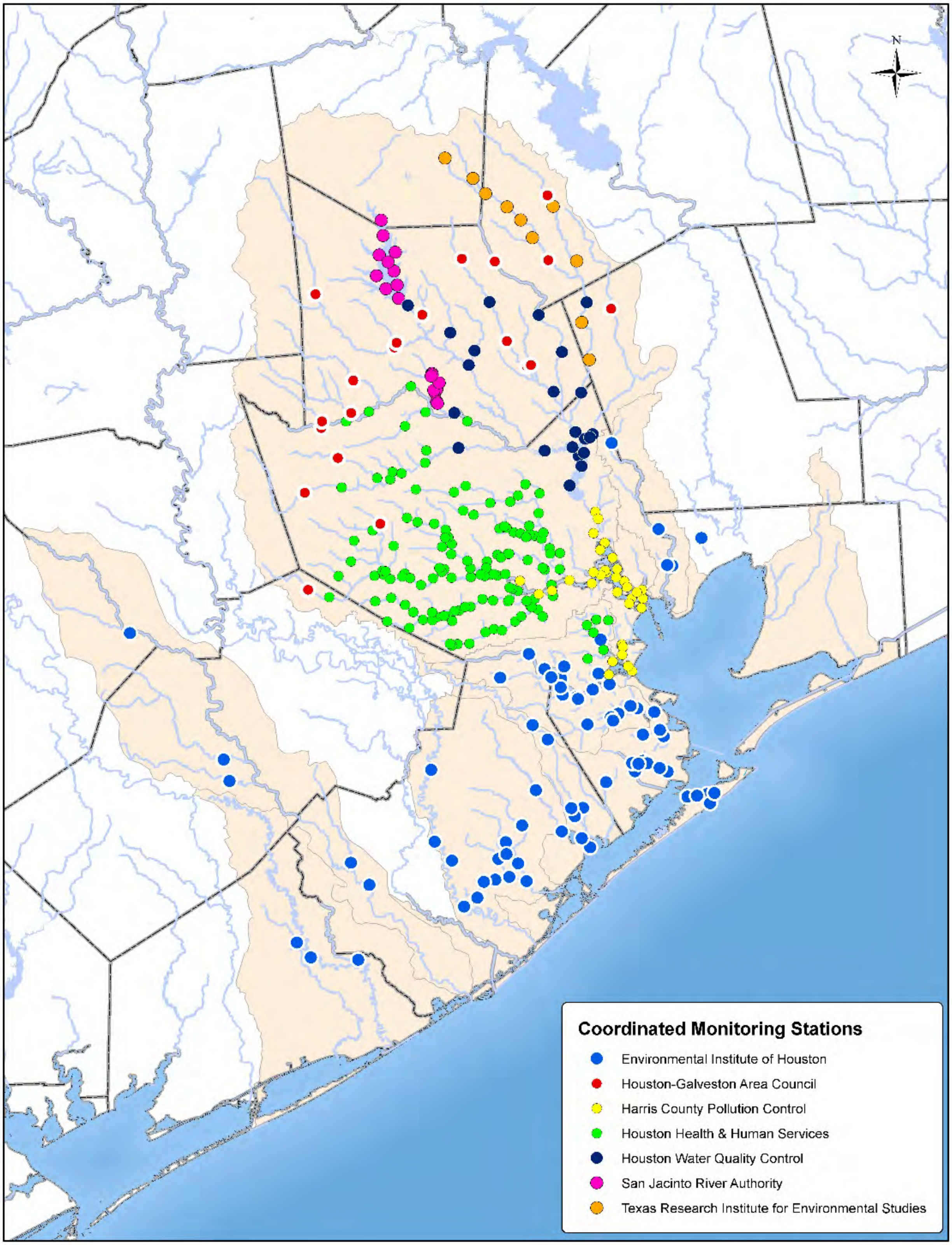
* *Other includes parameters such as metals in water, metals in sediment, impaired habitat, impaired benthic macroinvertebrates, impaired fish communities, sediment toxicity, fecal coliform, mercury in fish tissue and fish contamination.*

** *Frog Chart analysis differs with the TCEQ 2020 Integrated Report due to an updated period of record (2013-2020).*

\+ *This segment was not assessed due to insufficient data.*

Water Quality Monitoring

Routine water quality monitoring is conducted through a coordinated regional effort at over 450 sites by eight partner agencies. H-GAC's Clean Rivers Program partners meet quarterly to discuss monitoring challenges, sampling protocols and equipment management, and to serve as a forum for sharing information from the Texas Commission on Environmental Quality (TCEQ) regarding quality assurance or data management issues. All monitoring is completed under a TCEQ-approved Quality Assurance Project Plan, and all samples are analyzed by National Environmental Laboratory Accreditation Program (NELAP) accredited laboratories.


N
Coordinated Monitoring Stations
Environmental Institute of Houston
Houston-Galveston Area Council
Harris County Pollution Control
Houston Health & Human Services
Houston Water Quality Control
San Jacinto River Authority
Texas Research Institute for Environmental Studies

Leveraging Funds
H-GAC's Clean Rivers Program combines program funding with in-kind partnerships, allowing the program to acquire additional data to enhance the assessment process and support findings.

Cost Savings
Coordinating monitoring efforts through H-GAC's Clean Rivers Program have helped partner agencies reduce costs by minimizing duplicated monitoring sites. These savings are reinvested in expanded monitoring, special studies, and other tools to better assess regional water quality whenever possible.

Clean Rivers Program Special Projects

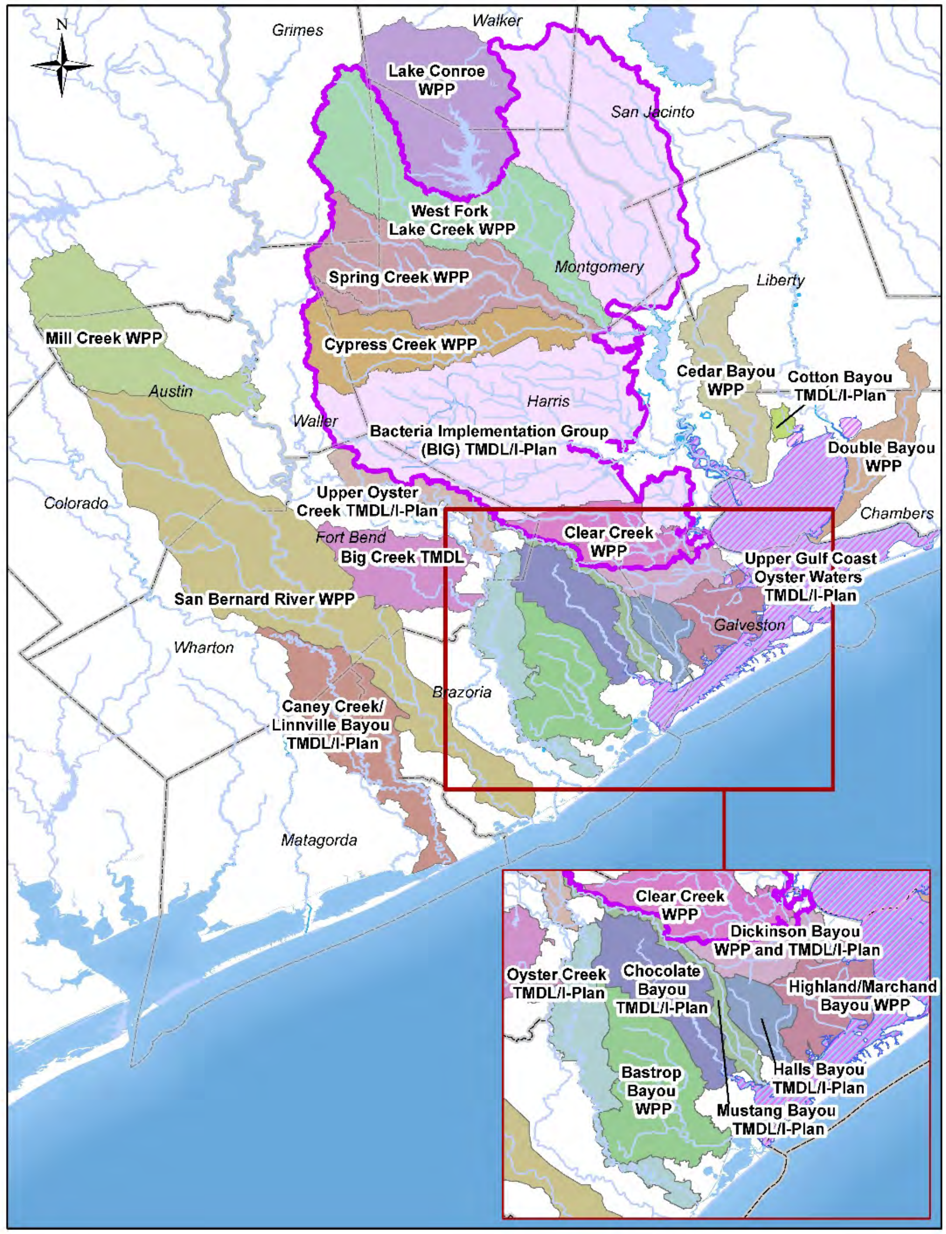
In addition to routine monitoring, H-GAC's Clean Rivers Program funds special projects to collect more data and identify problem areas.

- H-GAC, with the help of local partner agencies, conducted targeted monitoring in 10 watersheds with some of the highest levels of bacteria in the region. The goal was to find bacteria sources in the watersheds and relay those findings to responsible parties in those jurisdictions for correction.
- H-GAC conducted a Monitoring Efficiencies Analysis to evaluate regional monitoring activities and determine ways the local Clean Rivers Program partnership can improve efficiencies in the program.
- H-GAC, with the help of local partner agencies, continued to conduct 24-hour dissolved oxygen (DO) monitoring to verify or determine the extent of impairment and better evaluate DO fluctuations over a 24-hour period.

More information about Clean Rivers Program special projects is available at https://datalab.h-gac.com/bsr2021/.

Non-Clean Rivers Program Water Quality Initiatives

Based on Clean Rivers Program monitoring, H-GAC works with local stakeholders to develop plans to protect water quality, including Watershed Protection Plans and Total Maximum Daily Load Implementation Plans. One of the most successful local initiatives continues to be the Bacteria Implementation Group, a partnership of government, business, and community leaders working to implement a plan for reducing bacteria in the region's water bodies. Local partners worked to use low impact development to improve water quality and worked to address the problem of failing on-site sewage facilities through repair and replacement or connection to sanitary sewer.



Public Outreach

H-GAC informs and educates citizens and local governments about watershed stewardship and existing water quality issues through a variety of methods, including developing and distributing publications, providing educational information at special events, hosting workshops and forums, providing data in interactive formats, maintaining informative websites, and providing community education and volunteer opportunities.

Coordination and cooperation among a variety of agencies involved in water quality matters is key to educating more people about the importance of protecting water quality.

Public outreach was severely impacted by the COVID-19 pandemic. There were no in-person events held during 2020. H-GAC and other local agencies were able to pivot and began hosting and participating in remote events via online platforms.

Public Outreach Highlights

TRASH BASH®

H-GAC helps coordinate the River, Lakes, Bays 'N Bayous Trash Bash®, the largest single-day waterway cleanup in Texas. Since 2016, more than 15,000 volunteers have cleaned 643 miles of shoreline and removed almost 250 tons of trash, while learning about regional water quality issues through interactive displays and games. Due to the pandemic and local and regional restrictions of large gatherings, Trash Bash® was cancelled in 2020 and was run as a hybrid event in 2021.

CLEAN WATERS INITIATIVE

The Clean Waters Initiative program offers free workshops to help local governments, landowners, and residents develop effective strategies to reduce pollution in area waterways. More than 500 participants attended 10 workshops in the past five years.

TEXAS STREAM TEAM

Since 2016, 120 volunteers in the regional Texas Stream Team program collected water quality samples at 134 sites throughout the region. This data supplements professional monitoring data.

COMMUNITY EVENTS

H-GAC hosts educational booths promoting proper pet waste disposal and addressing other regional water quality issues at over a dozen community events each year. Typical events include World Oceans Day, Bay Day, and the Sam Houston Area Council's - Annual Scout Fair, which has over 15,000 participants each year.

Local Efforts to Reduce Bacteria

The East Aldine Management District (District) and Harris County made significant improvements in the East Aldine area's water and sanitary sewer infrastructure. There were over 4,500 single-family homes in East Aldine that relied on shallow water wells for drinking water and traditional septic tank systems for wastewater treatment. Utilizing $43 million in Community Development Block Grants received by Harris County, Texas Water Development Board grants, the District's general funds, and District issued bonds, new water and wastewater service is being provided to 1,336 homes and an estimated 3,600 residents. The District and Harris County targeted Aldine communities with the highest septic tank failure rates (>30%) and a prevalence of private wells. Water quality monitoring in the area shows a 20% reduction in bacteria levels in areas downstream of the project along Greens and Halls bayous.

H-GAC's Homeowner Wastewater Assistance program repaired or replaced 39 on-site sewage facilities for low- to moderate- income homeowners in watersheds throughout the region. This work was made possible through two Supplemental Environmental Projects – one with the TCEQ and the other with the Harris County District Attorney's Office. Funds are directed to H-GAC from settlements for wastewater violations and the resulting penalties. These projects not only protect the families that reside in these homes, but also improve the quality of life in their communities and ultimately improve water quality in area waterbodies.

Significant Findings

Bacteria
44% of stream miles impaired
3 stream segments are getting better
7 stream segments are getting worse

Dissolved Oxygen
18% of stream miles impaired
5 stream segments are getting better
4 stream segments are getting worse

Nutrients
31% of stream miles exceeding screening levels
18 stream segments are getting better
11 stream segments are getting worse

Chlorophyll-a
17% of stream miles exceeding screening levels
2 stream segments are getting better
13 stream segments are getting worse

PCBs and Dioxins
53% of tidal streams impaired
34% of stream miles impaired
Levels neither increased nor decreased

Recommendations

In developing the Basin Summary Report, H-GAC identified strategies and practices to improve water quality. These include, but are not limited to:

- Encourage the addition of water quality features to stormwater systems.
- Encourage Water Quality Management Plans or similar projects for agricultural properties.
- Use regional best management practices and on-site sewage facilities databases to prioritize problem areas.
- Offer educational webinars to reach a broader audience.
- Expand the Bacteria Implementation Group area to increase connectivity of best management practices with neighboring watersheds.
- Support development and implementation of watershed-based plans.
- Continue expanding routine water quality monitoring by adding new local agencies to the Regional Water Quality Monitoring Network.
- Continue conducting targeted bacteria monitoring in priority watersheds.
- Continue expanding Texas Stream Team volunteer monitoring in priority areas.

Conclusion

The region's population is projected to increase by 3.5 million by 2040. As the region grows, monitoring, protecting, and improving water quality will become even more important than it is today. H-GAC's Clean Rivers Program will continue to provide high quality data to assess water health and provide insight as to what needs to be done to maintain or improve the quality of the region's waterways. The region could face many water quality issues in the future. However, when communities work together to prioritize these issues and put focused effort on solving problems, there has been great success. There are many recommendations for improving water quality in this summary and in the full 2021 Basin Summary Report at https://datalab.h-gac.com/bsr2021/. These recommendations may not be appropriate for improving water quality in all areas. They are strategies that communities can select from to fix problems identified in their areas. With sustained effort and increased awareness, the region can work together to protect and improve water quality for years to come.

For a detailed summary of all watersheds in the region and for more information about H-GAC's Clean Rivers Program efforts since 2016, refer to the full **2021 Basin Summary Report**. Access the full report at https://datalab.h-gac.com/bsr2021/.

INTRODUCTION

INTRODUCTION

Background and Overview

Clean water is essential to the survival of all living things. The Houston-Galveston area has 16,000 miles of streams and shoreline providing a network of valuable habitat and ecosystem services for the region, connecting freshwater streams to productive coastal estuaries and connecting us to nature and to each other. Clean water is a foundation for our economy, contributing $3.5 billion annually statewide through ecotourism, oyster harvesting, and commercial fishing/shrimping. Nationally, Port Houston is the Number 1 U.S Port in waterborne tonnage, supports over 3 million jobs and generates over 800 billion in economic value.

However, approximately 80% of the assessed stream miles within the region fail to meet state water quality standards or screening criteria for one or more parameters. Projected population growth will continue to strain the health of waterways if proper management practices are not established. The Houston-Galveston Area Council (H-GAC) and its local partners are working to improve and protect water quality through the Clean Rivers Program (CRP) and other regional efforts.

The Texas Clean Rivers Act

The Texas Clean Rivers Act requires river authorities to prepare written water quality assessment reports, such as this Basin Summary Report, for their respective basins and present the reports to the Governor, Texas Commission of Environmental Quality (TCEQ), Texas State Soil and Water Conservation Board (TSSWCB), and Texas Parks and Wildlife Department (TPWD).

The Act also established the Texas Clean Rivers Program (CRP), funded by fees paid by wastewater discharge permittees and water rights holders. The Clean Rivers Program, under the direction of the TCEQ, requires continuous assessment of ambient water quality to identify key issues and develop management strategies statewide. Written program reports submitted to government officials and state agencies provide input and guidance for water resource policy and decision-making efforts.

The Clean Rivers Program includes such initiatives as basin-wide water quality monitoring strategies and simultaneous expiration of wastewater permits within watersheds to allow for more coordinated permitting. The Clean Rivers Program promotes pollution prevention at its source in order to reduce the cost associated with wastewater treatment and to prevent the need for remediation of damaged ecosystems resulting from pollutant releases.

Results from the Clean Rivers Program process help set the agenda for all other water quality management programs, including:

- Monitoring
- Standards development
- Permitting
- Enforcement
- Public outreach
- Field investigation
- Research

At the same time, these programs use the basin assessment process to ensure that data needs are addressed and match local priorities. In the end, the underlying goal of the entire Clean Rivers Program process is to most effectively use the public funds targeted for water quality protection.

Clean Rivers Program Objectives

- Provide quality-assured data to state agencies, river authorities, and local governments for use in water quality decision-making.
- Utilize established scientific and statistical methods to evaluate current water quality issues and their relative risks to public health and the environment.
- Evaluate current and historical data to identify where additional information is needed.
- Prioritize water quality issues and problem areas for future studies and implementation efforts.
- Promote cooperative watershed planning and conduct comprehensive assessments that consider a broad range of pollution threats.

- Develop and maintain cooperative partnerships with river authorities, local governments, state agencies, private industry, conservation organizations, and other local and regional entities to improve understanding of current and future water quality problems.
- Use public outreach and education to involve citizens and private organizations in watershed management and protection efforts.
- Provide effective administration and leveraging of funds to maximize effectiveness of watershed activities.
- Adapt program to emerging water quality issues.

H-GAC and Clean Rivers

H-GAC, an established Council of Governments (COG) and regional planning agency for the Gulf Coast State Planning Region, has more than 40 years of regional environmental planning and public outreach experience. H-GAC continues to develop a comprehensive regional Geographic Information System (GIS) for data analysis and modeling techniques. Many key agencies and individuals normally involved in regional water quality programming already work cooperatively under the umbrella of H-GAC's existing environmental committees and programs.

H-GAC is designated as the lead agency responsible for regional water quality assessment for the San Jacinto River Basin, Trinity-San Jacinto Coastal Basin, San Jacinto-Brazos Coastal Basin, Brazos-Colorado Coastal Basin, and Bays and Estuaries in this region. H-GAC oversees all aspects of Clean Rivers Program monitoring in these basins with the following tasks in mind:

- Project Administration
- Quality Assurance
- Water Quality Monitoring
- Data Management
- Data Analysis and Reporting
- Stakeholder Participation and Public Outreach

H-GAC's Clean Rivers Program project staff regularly updates H-GAC's Board of Directors and Natural Resources Advisory Committee (NRAC) on progress and results. Board approval is required for major actions, including entry into contracts with TCEQ and TSSWCB, and approval of subcontracts.

Clean Rivers Program Steering Committee

H-GAC's Clean Rivers Program is guided by a Steering Committee that serves as the primary forum for discussion of various water quality issues raised during the assessment process. The Steering Committee includes representatives from local government, state and federal agencies, key interest groups, and several members of H-GAC's NRAC. The Steering Committee normally meets one or two times per year depending on project milestones and administrative needs. Meetings allow the Steering Committee to advise H-GAC staff on Clean Rivers Program matters, including:

- Developing work plans and budgets
- Monitoring progress toward project milestones
- Reviewing draft and final basin reports
- Focusing monitoring and implementation efforts to priority areas
- Providing regional perspective and local expertise to the assessment process
- Communicating information between member representative groups and the Clean Rivers Program
- Providing opportunities for public comments and questions about program activities

H-GAC Local Monitoring Partners

As part of the regional Quality Assurance Project Plan (QAPP), H-GAC works with local agencies to conduct water quality monitoring throughout the region. H-GAC's Clean Rivers Program leverages program funding for these partnerships, allowing the program to increase monitoring stations and provide additional data that benefits the overall assessment process. Program partners meet quarterly to discuss monitoring challenges, sampling protocols, equipment problems, and to serve as a forum for sharing information from the TCEQ regarding quality assurance or data management issues. Monitoring sites are funded wholly or in part by the Clean Rivers Program. Coordinating monitoring efforts through this program allows partner agencies to reduce costs by minimizing duplicated monitoring events. These savings can then be reinvested in expanded monitoring, special studies, and other tools to better assess regional water quality.

Partners include:

- City of Houston Drinking Water Operations
- City of Houston Health Department

- Environmental Institute of Houston
- Harris County Department of Pollution Control Services
- Houston-Galveston Area Council
- San Jacinto River Authority
- Texas Commission on Environmental Quality Region 12
- Texas Research Institute for Environmental Studies
- US Geological Survey

Purpose of the Basin Summary Report

The Basin Summary Report (BSR) is produced every five years and outlines water quality issues within H-GAC's five basins based on public and committee input, as well as technical analysis of historical, current, and projected water quality trends. This work is completed in accordance with TCEQ guidelines, which specify a range of evaluation techniques that achieve a comprehensive assessment of water quality issues within each basin and the region. In years when the Basin Summary Report is not due, H-GAC produces a Basin Highlights Report that contains a summary of activities in the various basins. Past reports can be found on H-GAC's website.

The BSR complements TCEQ's Texas Integrated Report of Surface Water Quality. The Integrated Report is completed every two years and describes the status of Texas' natural waters based on historical data, CRP data, and reports like the BSR. As a result of this report, streams found to be out of compliance with state-designated standards or uses may be placed on the 303(d) list of impaired waters by the TCEQ, potentially triggering additional special studies and implementation efforts to improve water quality. Data and analyses presented in this BSR are based on the results of the 2020 Texas Integrated Report.

Basin Entities

A core element to successfully achieving program objectives is continuous coordination and cooperation with a variety of agencies involved in regional water quality matters. The following is a list of basin entities that work cooperatively with H-GAC on existing environmental committees and programs:

Local Monitoring Partners & Contractors

The **Houston-Galveston Area Council** (H-GAC) is the lead monitoring agency for the Clean Rivers Program in this region. H-GAC conducts sampling on a quarterly basis from 20 monitoring stations. Sampling has included special flow monitoring and 24-hour dissolved oxygen monitoring at a few sites each year to collect the necessary data to allow the Texas Commission on Environmental Quality (TCEQ) to determine whether individual water bodies support the state of Texas water quality standards for dissolved oxygen concentrations.

The **City of Houston Health Department** (HHD) is a local Clean Rivers Program monitoring partner collecting samples from 133 sites throughout the city. HHD also receives and responds to complaints from the citizens of Houston through the Service Helpline "311" to investigate water quality concerns and public nuisances. In addition to enforcing HHD's Code of Ordinances for threats to Municipal Separate Storm Sewer Systems (MS4), they work in coordination with the City of Houston Public Works and Engineering Department to help identify sources of elevated bacteria and in many cases identify opportunities for correction. HHD is involved in public outreach efforts including conducting public education presentations about the 'Protect Our Pipes' initiative, coordination of the Trash Bash site at Brays Bayou in partnership with the Galveston Bay Estuary Program (GBEP), as well as participation in the City of Houston's annual Earth Day celebration.

The **City of Houston Drinking Water Operations** (DWO) is a local Clean Rivers Program monitoring partner assessing the quality of Lake Houston water and the waterways flowing into the lake. They collect samples at 22 monitoring stations. Their primary responsibility is 'source water protection' for the City of Houston and other cities that rely upon Lake Houston water for a safe drinking water supply. Houston's Drinking Water Operations supports the WaterWorks Education Center which features interactive exhibits and fun education activities for kids of all ages. Its mission is to promote water education, conservation, and stewardship.

As a local Clean Rivers Program monitoring partner, **Harris County Pollution Control Services** (HCPCS) collects samples at 33 stations, focusing on the Houston Ship Channel, the San Jacinto River below the Lake Houston dam downstream to Galveston Bay, the various side bays along the ship channel, and Clear Lake. In addition to an active environmental complaint investigation program, HCPCS staff inspect and monitor approximately 450 municipal wastewater treatment facilities and 212 industrial wastewater treatment facilities permitted by the TCEQ.

The **Environmental Institute of Houston** (EIH), located at the University of Houston - Clear Lake, is a regional leader in building partnerships in research, education, and outreach. Research activities focus on water resources, wetlands, fisheries, and wildlife conservation and management. H-GAC contracted EIH to monitor 76 water quality stations in the southern half of the region where there are no local programs to conduct monitoring efforts. In addition to routine sampling, EIH also conducts special flow monitoring activities and 24-hour dissolved oxygen monitoring at selected sites. Besides research, EIH offers a robust environmental education program and several outreach programs. Besides continuing education for teachers, all levels of school-aged kids have several choices of different program as well as summer nature camps. EIH staff provide seminars and workshops to citizens and technical audiences oriented towards conservation of biodiversity and non-renewable as well as renewable resources.

Sam Houston State University's **Texas Research Institute for Environmental Studies** (TRIES) is a research facility dedicated to providing research expertise and resources needed for addressing current environmental issues and helping to ensure a sustainable future. Since there are no local agencies available to conduct surface water quality monitoring in the northern portions of the San Jacinto River Basin, H-GAC's Clean Rivers Program contracted with TRIES to conduct water quality monitoring on the East Fork San Jacinto River and several of its tributaries. A total of 10 monitoring stations are sampled on a quarterly basis.

The **San Jacinto River Authority** (SJRA) is an active Clean Rivers Program partner, monitoring 10 sites on Lake Conroe and nine sites in The Woodlands area. SJRA is a government agency that develops and manages water resources for the San Jacinto River watershed outside of Harris County. Its focus is on long-term regional projects related to water supply and wastewater treatment, including participation in the Region H Water Planning Group. SJRA also works to protect source water and completed a WPP for Lake Conroe in 2015, with subsequent updates. Additionally, SJRA is now responsible for the operation of a new water treatment plant that provides drinking water to several utility districts in Montgomery County.

During the last five years, SJRA has developed two highly successful educational outreach tools. First, 'Know Your Watershed' includes a website mapping tool to find your home or business location within the watershed and a Story Map virtual tour of floating down the San Jacinto River from the Lake Conroe dam to Lake Houston. Second, SJRA created a 'Flush Campaign' to stop people from flushing unacceptable materials down the sanitary sewers. Patty Potty, the 'Flush Campaign' spokesperson, is on a crusade to promote sewer-friendly behaviors which will help prevent collection system overflows which pollute the environment and result in costly repairs of wastewater collection facilities.

The **Eastex Environmental Laboratory** (Eastex) in Coldspring is contracted to analyze all surface water samples collected by the Houston-Galveston Area Council and the Environmental Institute of Houston. Eastex also conducts analyses on all Total Kjeldahl Nitrogen (TKN) and chlorophyll-*a* samples collected by all program partners throughout the year. Eastex is accredited through the National Environmental Laboratory Accreditation Program (NELAP) and complies with all additional Clean Rivers Program quality assurance (QA) and quality control (QC) requirements outlined in the currently TCEQ approved Quality Assurance Project Plan (QAPP).

Galveston Bay Estuary Program

Through coordination of local research and protection efforts, TCEQ's Galveston Bay Estuary Program (GBEP) serves as a central focus for developing, prioritizing, and funding solutions to improve water quality in the Galveston Bay Watershed. GBEP maintains the Galveston Bay Plan, a Comprehensive Conservation and Management Plan for the water bodies and estuary of Galveston Bay. Funding for a variety of local water quality projects is guided by feedback from GBEP's various stakeholder workgroups.

H-GAC has partnered with GBEP on the development and partial funding of watershed protection plans for Bastrop Bayou (approved in 2016), Cedar Bayou (approved in 2016), and the West Fork San Jacinto River (approved in 2018) which are currently in implementation. H-GAC also partnered with GBEP on the expansion of the Coastal Communities Outreach and Education Project, funding for a Targeted Bacteria Monitoring Project, and support for the River, Lakes, Bays 'N Bayous Trash Bash® and other regional efforts. GBEP staff members provide guidance and serve as stakeholders and technical advisors for these projects.

Texas State Soil and Water Conservation Board (TSSWCB)

The Texas State Soil and Water Conservation Board (TSSWCB) is the state agency that administers Texas's soil and water conservation laws and coordinates conservation and nonpoint source pollution abatement programs throughout the state. TSSWCB offers technical assistance to the state's 216 soil and water conservation districts.

TSSWCB staff members provide guidance and serve as stakeholders and technical advisors for many H-GAC projects and programs. TSSWCB is a significant partner with H-GAC on watershed-based plans such as the Cedar Bayou Watershed Protection Plan (WPP) and the Caney Creek TMDL Implementation Plan (I-Plan). One of the primary services provided by the TSSWCB is support for development of water quality management plans (WQMPs) with local landowners and agricultural producers. TSSWCB funds technicians in the Cedar Bayou, Double Bayou and Caney Creek watersheds to support WQMP development. WQMPs improve water quality by providing landowners with financial and technical incentives to use voluntary best management practices. H-GAC staff coordinate with TSSWCB on shared efforts, including TSSWCB's Regional Watershed Coordinating Steering Committee. TSSCWB has been a supporting partner in some H-GAC outreach efforts, including various "Growing Green" workshops designed to put landowners in touch with agricultural agencies.

Texas A&M AgriLife Extension Service

The Texas A&M AgriLife Extension Service (AgriLife) provides a diverse array of educational programs, activities, and resources to the citizens of Texas. One such program, the Texas Watershed Steward Program, provides science-based, watershed education to help citizens and stakeholders identify and take action to address local water quality impairments. Participants learn about the nature and function of watersheds, potential causes of water quality impairments, the steps required to develop a watershed protection plan (WPP), and various strategies they can recommend to protect or restore water quality in their area. AgriLife also holds workshops on feral hog management and riparian ecology. H-GAC partnered with AgriLife on holding a Riparian and Stream Ecosystem Training event in 2018 in the San Jacinto River Watershed and another in the Cedar Bayou Watershed in 2019.

AgriLife's Texas Community Watershed Partners Program coordinates with H-GAC and other organizations to support the development and implementation of watershed-based plans for water bodies found in the San Jacinto-Brazos Coastal Basin (Basin 11) and Brazos-Colorado Coastal Basin (Basin 13), and several other water bodies in the H-GAC region, including Cedar Bayou, the West Fork San Jacinto River and Lake Creek, Cypress Creek, and Spring Creek. Support consists of lending technical assistance to plan development, implementing best practice demonstrations like Exploration Green and Sheldon Lake State Park restoration, and public outreach on such topics as on-site sewage facilities (OSSFs), feral hogs, and low impact development (LID).

Since 2015, AgriLife has participated with the TCEQ in the Clean Water Act Section 319(h) project to develop and update an On-Site Sewage Facility Inventory in the Coastal Zone of

Texas. The project's focus is to implement activities to reduce overall loading of contaminants from these facilities by targeting areas of concern in the Coastal Zone of Texas. H-GAC collaborates with AgriLife to support the project and supply on-site sewage facility data. To ensure successful collaboration in data exchange with H-GAC and other agencies, AgriLife hosts training sessions for the management and sharing of spatial data. The project also focuses on trainings for homeowners so that they can properly operate and maintain their own facilities.

Galveston Bay Foundation

The Galveston Bay Foundation (GBF) is a nonprofit organization established in 1987. It is managed by a Board of Directors whose members represent sport and commercial fishing groups, government agencies, recreational users, environmental groups, and shipping, development, and business interests. GBF's mission is to preserve, protect, and enhance the natural resources of the Galveston Bay estuarine system through advocacy, conservation, education, and research programs. GBF is the lead partner in the Galveston Bay Oyster Waters Total Maximum Daily Load (TMDL) project.

H-GAC has partnered with GBF on water quality outreach programs like the "Cease the Grease" campaign for fats, oils, and grease disposal, and on volunteer water quality monitoring efforts across the region. H-GAC staff also participate on the committee overseeing GBF's Boater Waste Education program – 'Pump Don't Dump.' Additionally, H-GAC promotes GBF resources like Rain Barrel Workshops, the Galveston Bay Action Network (GBAN) pollution reporting tool, and the Galveston Bay Report Card in other projects. Representatives from GBF are also participating members of the Clean Rivers Program Basin Steering Committee and the Bacteria Implementation Group (BIG).

Houston Advanced Research Center

The Houston Advanced Research Center (HARC) is a 501(c)(3) organization that supports independent research and analysis of energy, air, and water issues. Their mission is to supply information that will help build a sustainable future that balances economic development with the conservation of natural resources. HARC utilizes data collected through Clean Rivers Program efforts for various water quality reports in the region including development of the Galveston Bay Report Card, Galveston Bay Status and Trends, the Regional Monitoring Database, which includes not only water quality data but also data for indicator species in the bay, and the Double Bayou Watershed Protection Plan (funded by the TSSWCB).

Gulf-Houston Regional Conservation Plan

Houston Wilderness facilitates the Gulf-Houston Regional Conservation Plan (Gulf-Houston RCP) as a long-term collaborative of environmental, business and governmental entities working together to create an ecosystem continuity and connectivity plan for the Gulf-Houston Region. The plan was originally developed to attract conservation funding from the RESTORE Act funds following the Deepwater Horizon disaster in 2010. H-GAC project staff serve on the Steering Committee for the group, representing water quality projects and local government.

Harris County Flood Control District

The Harris County Flood Control District (HCFCD) was created by the Texas Legislature in 1937 in response to the 1929 and 1935 floods that devastated the region. Their ultimate mission is to provide effective flood damage reduction projects in Harris County that also correspond to community and natural values. To accomplish this mission, the HCFCD devises flood damage reduction plans, implements those plans, and manages the long-term maintenance of infrastructure. In recent years, these plans included a water pollution prevention component as well as flood reduction. 'Clean Waterways – Clean Water, Clear Choice' is their educational outreach program.

Representatives from HCFCD serve as members of the Clean Rivers Program Basin Steering Committee and also provide input and feedback on the development of other water quality projects in the region such as the Bacteria Implementation Group (BIG). Following the major floods experienced in April 2016 (Tax Day Flood) and May 2016 (Memorial Day Flood), plus the major flooding due to Hurricane Harvey, a bond package of $2.5 Billion was passed in August 2018 to finance additional flood damage reduction projects over the coming years.

Bayou Preservation Association

The Bayou Preservation Association is a nonprofit organization with the mission to celebrate, protect and restore the natural richness of all our bayous and streams. The organization advocates for responsible management of Houston-area bayous through collaborative projects and educational efforts that promote public awareness and environmental stewardship. Such projects include hosting an annual symposium related to water quality, stream corridor restoration projects and working with H-GAC to develop a local Texas Stream Team Citizen

Scientist group. Bayou Preservation Association is also working with H-GAC on a bacteria source tracking project where student interns perform targeted bacteria sampling to identify potential sources of fecal contamination. Additionally, representatives from the Bayou Preservation Association serve as participating members and stakeholders for several committees and workgroups involved in regional water quality projects, including the Clean Rivers Program Basin Steering Committee.

Staff Membership on Committees and Advisory Boards throughout Region

The following is a list of program committees and advisory boards in the region where H-GAC staff involved in Clean Rivers Program serve as members.

Galveston Bay Council and Subcommittees

North Houston Association Environmental Committee

Galveston Bay Foundation (GBF) Cease the Grease

Gulf-Houston Regional Conservation Plan

Regional Watershed Coordinator Steering Committee (RWCSC)

GBF Boater Waste Education - Pump Don't Dump

Bayou Preservation Association Advisory Board

Bayou Preservation Association Trash Free Bayous Committee

Bayou Preservation Association Bayou Citizen Science Committee

HCFCD Citizens Advisory Committee

EIH Advisory Board

Partners in Litter Prevention

Texas Forests and Drinking Water Partnership

Houston Area Urban Forestry Council

USDA State Technical Advisory Committee, Urban subcommittee

Tree Strategy Implementation Group

Stream Corridor Restoration Committee (Bayou Preservation Association)

Save Water Texas Coalition

The Save Water Texas Coalition (SWTC) is made up of cities, water agencies, water professionals, community leaders, and educators who are dedicated to raising public awareness about the critical need for water conservation and water reuse measures in order to assure sustainability of our finite groundwater and surface water resources in Harris, Montgomery and Fort Bend Counties.

North Central Texas Council of Governments (NCTCOG) – Trash Free Waters grant

H-GAC has partnered with the North Central Texas Council of Governments (NCTCOG) and the Meadows Center for Water and the Environment to establish unified, coordinated approach to litter abatement and community engagement in the six river basins in the Dallas-Fort Worth and Houston-Galveston regions. This is a 3-year project which started in FY 2020.

Regional Conservation Framework

The Regional Conservation Framework project is an effort by H-GAC and the Houston Endowment to expand the capacity of our local governments to use conservation practices to enhance resiliency, quality of life and address environmental concerns that include poor water quality. The purpose of the framework is to identify ways to promote, coordinate, and support voluntary conservation projects by local governments and other partners.

Partners in Litter Prevention

Partners in Litter Prevention is a consortium of stakeholders in the Houston-Galveston region united in their vision to see the region free from trash and plastic pollution. Together, these stakeholders developed a Trash Action Plan. The purpose of the Trash Action Plan is to serve as a guidance document and central point of reference for improved collaboration and coordination among the multitude of stakeholders across the greater Houston-Galveston region to avoid duplication and optimize the efficiency and efficacy of efforts. The Trash Action Plan details the goals and associated strategies for seeing this vision come to fruition. H-GAC has been a leader in this effort, alongside the Houston Advanced Research Center and Black Cat GIS, since 2015, helping to plan the annual symposium and contact stakeholders.

Other Participants

Area residents play a key oversight role throughout the Clean Rivers process through their review of assessment results and through attendance and input at committee meetings and other Clean Rivers events.

H-GAC's local government members and other interested individuals and organizations receive updates on Clean Rivers Program progress through newsletters, staff presentations, and distribution of basin assessment report summaries and other program materials across the region.

PUBLIC OUTREACH

Public Involvement and Outreach

Many people do not realize daily behaviors, including not picking up pet waste, pouring fats, oils and grease down the drain, and lack of maintenance and repair of on-site sewage facilities (OSSF) can cause significant water quality issues. Effective public outreach and education programs designed to raise awareness and influence behavioral changes are a crucial part of the watershed management process.

In this fast-paced world of internet, apps and social media, it has become easier to reach more people. However, it has become more difficult is to get them to see and understand your message. There is so much information coming at all of us, every day. It can be hard to break through the noise and actually deliver your message. It is also important to understand that there are vulnerable populations throughout our region that do not have access to the internet, apps, and social media. We need to be able to connect with them as well.

The Houston-Galveston Area Council (H-GAC) informs and educates citizens and local governments about watershed stewardship and existing water quality issues through a variety of methods including; developing and distributing publications, providing educational information at special events, hosting workshops and forums, providing data in interactive and analytical formats, maintaining informative websites, and providing other community education and volunteer opportunities. H-GAC also provides opportunities for stakeholders to learn more about local water quality problems and solicits stakeholder assistance in resolving these problems.

Basin Steering Committee

The Steering Committee is an essential component of the public participation process that provides meaningful input from citizens, local businesses and industry, environmental organizations, and other local and state agencies that reside in or near the watersheds within the four basins overseen by H-GAC. It serves as the primary forum for discussion of various water quality issues raised through the assessment process.

The Steering Committee normally meets one or two times per year depending on project milestones and administrative needs. Meetings allow the Steering Committee to advise H-GAC staff on CRP matters, including:

- Developing work plans and budgets
- Monitoring progress toward project milestones
- Reviewing draft and final basin reports
- Focusing monitoring and implementation efforts to priority areas
- Providing regional perspective and local expertise to the assessment process
- Communicating information between member representative groups and CRP
- Providing opportunities for public comments and questions about CRP activities

Texas Stream Team

Texas Stream Team is a state-wide network of trained volunteers and partners who collect surface water quality information. The program is coordinated state-wide by the Meadows Center for Water and the Environment at Texas State University. H-GAC is a Texas Stream Team partner and coordinates, trains, and certifies regional volunteers who collect quality-assured data that can help inform environmentally sound decisions. Regional Texas Stream Team monitoring efforts are also supported by the Galveston Bay Foundation, Bayou Preservation Association, and the City of Sugar Land. Since 2016, 120 Texas Stream Team monitors have collected samples at 134 sites in the H-GAC region.

Water Resources Information Map (WRIM)

The Water Resources Information Map (WRIM) is designed to display H-GAC's Clean Rivers Program water quality data (including the Texas Stream Team water quality data). The main goal of the WRIM is to provide easily accessible, high quality data to a broad spectrum of stakeholders. Water resource managers, researchers, teachers and students and many others can review water quality data for the entire region or just a very specific stream or water body. Entire data sets can be downloaded, or users can see a summary of the data they are interested in while using the WRIM.

Professional monitoring data is uploaded to the WRIM three times per year, whereas volunteer monitoring data is updated monthly. H-GAC strives to utilize the latest technology for this purpose. As a result, the WRIM receives changes on a regular basis. Due to some large changes in presentation capabilities of software in the last year, the WRIM will be receiving a new look in 2021.

Public Engagement

H-GAC Clean Rivers Staff are members of numerous committees throughout the region. As a result, this involvement provides opportunities for staff to discuss program progress and give Clean Rivers Program updates to those committees.

H-GAC Water Resources staff host dozens of public meetings each year. Whether related to Total Maximum Daily Load projects, Watershed Protection Planning, the Natural Resources Advisory Committee, or Coastal Communities, there is a staff member present that can give a water quality perspective for H-GAC's Clean Rivers Program and provide relevant information to the discussion.

On-Site Sewage Facilities Program

In the Houston-Galveston region, many homeowners and businesses use On-Site Sewage Facilities (OSSFs) to treat and dispose of wastewater on their properties. H-GAC offers numerous programs, workshops, and resources for homeowners, real estate professionals, and the public. These programs can be accessed through H-GAC's website.

On-Site Sewage Facility Mapping Tool

H-GAC maintains and updates an On-Site Sewage Facility database using data acquired from Authorized Agents within the region. This database includes permitted on-site sewage facility locations and related permit data. H-GAC staff also evaluate and estimate the probable locations of unpermitted systems, such as those installed before permitting was required.

H-GAC's online On-Site Sewage Facilities Mapping Tool allows people to view the locations of permitted OSSFs by age, authorized agent or permitting authority, number of permits per square mile, and likely locations of unpermitted systems. H-GAC also provides numerous fact sheets about OSSFs and pollution prevention.

Real Estate Inspector Course

H-GAC offers a Real Estate Inspector Course that instructs real estate inspectors on the operation and maintenance of OSSFs. Additionally, the course provides information of rules and regulations, as well as methods to conduct a real estate inspection of a home's OSSF as part of a real estate transaction. This course is approved by the Texas Real Estate Commission for continuing education credits.

Homeowner Education Course

H-GAC's Homeowner Education Course instructs homeowners on the proper operation and maintenance of their OSSFs. This course provides information such as the basic types of systems (conventional and aerobic) and details how these systems function and how to recognize (and prevent) a malfunction of the system. While this course does not authorize a homeowner to perform their own maintenance, it does educate the homeowner on the maintenance requirements for these systems.

Homeowner Wastewater Assistance Program

H-GAC's Homeowner Wastewater Assistance Program assists qualified homeowners with the repair or replacement of their failed OSSFs. This project specifically addresses failing (or nonexistent) on-site sewage facilities as a means of targeting nonpoint source pollution and improving water quality within the Houston-Galveston region. This program is funded through a TCEQ Supplemental Environmental Project, with additional funding through the Harris County District Attorney's Office. Since its inception, there have been 14 repairs and 26 replacements completed in the region.

Clean Waters Initiative (CWI)

H-GAC's Clean Waters Initiative (CWI) program offers free workshops to help local governments, landowners, and residents develop effective strategies to reduce pollution in area water bodies. Workshop attendance ranges from 40 to 60 participants. Workshop topics since 2015 focused on the following:

- Better Public Engagement Practices
- Estuaries and Freshwater Inflows
- Funding Sources for Water and Wastewater-related Infrastructure
- Land Use Management Techniques
- Municipal Separate Storm Sewer System Minimum Control Measures
- On-site Sewage Facility Remediation Projects
- Trends & Technology in Wastewater Treatment
- Using Watershed Based Plans to Improve Water Quality
- Water Quality and Public Health
- Water Quality and Transportation

Natural Resources Advisory Committee

The Natural Resources Advisory Committee (NRAC) is a committee of the H-GAC Board of Directors. Its primary roles are to advise the Board on matters involving natural resources and to serve as a roundtable for regional stakeholders. The NRAC is composed of representatives from the counties, municipalities, businesses, regional governments, conservation groups, and other regional interests. Water quality is a primary focus of the group discussions.

Parks and Natural Areas Subcommittee

The Parks and Natural Areas Subcommittee (PNA) of the NRAC serves as a forum for discussion of issues related to parks and natural areas and promotes the PNA Award Program. The PNA subcommittee and roundtable facilitates information exchange and planning efforts between various stakeholders and collaborators to protect and preserve parks and natural areas across the region. Roundtable topics since 2015 focused on the following:

- Researching and Applying for Funding
- Parks Development and Cultural Resources
- Equity in Planning and Practice
- Nature and Outdoor Health
- Featured Parks in the Region
- Featured City Parks Departments
- Park Promotion and Working with Consultants
- Greenspace and Flooding

Since 2015, the PNA Award Program has recognized 86 projects that serve as models for planning and implementation for parks and natural areas in the region. An interactive map of past winners and special recognition recipients can be found here.

Water Innovation Strategies of Excellence (WISE) Awards Subcommittee

The Water Innovation Strategies of Excellence (WISE) Awards Subcommittee of the NRAC serves as a guiding body for the WISE Awards development, promotion, and implementation. Initiated in 2019, the WISE Awards recognize innovative strategies and projects in the Houston-Galveston region that serve as models for improving water quality. The WISE awards program has given six awards and special recognition to seven projects over the last two years for their innovative strategies for improving water quality in the H-GAC region. The next cycle of the WISE Awards is anticipated to begin during the summer of 2021.

Our Great Region 2040

The Houston-Galveston region is composed of 13 counties and 120-plus cities and towns within the Houston-Galveston Area Council (H-GAC) area. More than 6 million people call the region home. By 2040, the region will add another 3.7 million residents to this total, along with 2 million more jobs. Our Great Region 2040 is a plan to be one of the greatest places to live, work, and succeed by 2040. It is the result of the efforts of hundreds of organizations and thousands of people from across our area. In 2016, Our Great Region Awards were established to celebrate projects offering effective solutions and new opportunities in the following categories:

- **The Connection Award** honors a project that advances two or more of the plan's strategies through innovative partnerships.
- **The Diligence Award** honors an implemented project that executed a creative and tenacious project approach to overcome challenges to implementation.
- **The Reach Award** honors a project that demonstrates exemplary public participation.
- **The Opportunity Award** honors a project that helps to overcome disparities in access to opportunity.
- **The Excellence Award** is the highest honor bestowed in the Our Great Region Awards, recognizing projects that are best advancing the vision of the Our Great Region 2040 plan in urban, rural, suburban, and coastal areas of our region.

Coastal Communities

In collaboration with TCEQ, H-GAC developed the Coastal Communities Outreach and Education program to provide resources and services to small coastal communities. Through the program, H-GAC created a website serving as an online "toolbox" to assist small coastal communities in developing or enhancing water quality outreach and education campaigns for their residents. The program focuses on four influences on water quality:

- On-Site Sewage Facilities
- Pet Waste
- Fats, Oils and Grease
- Litter and Illegal Dumping

The website includes outreach messages, model and partner resources, information on funding opportunities, and more. Support from the Galveston Bay Estuary Program will allow H-GAC to add to the toolbox and reach more communities in the next year.

Bailey's Prairie Pump-Out Project

Thanks to funding from Olin, H-GAC was able to initiate a program to pump-out On-Site Sewage Facilities in the community of Bailey's Prairie in Brazoria County. As part of this program, homeowners who participated in a Homeowner Education Course and learned about the proper operation and maintenance of their On-Site Sewage Facilities were provided with a free pump-out of their systems.

Low Impact Development

Low Impact Development (LID) strikes a balance between the conservation of natural resources and the economics of successful development. H-GAC encourages the use of LID practices in the region. H-GAC maintains a website for local governments, developers, and landowners. The LID website includes:

- LID Guidebook
- Interactive Mapping Tool of Regional LID Projects
- LID Toolbox
- LID Resources

Riparian Workshop

H-GAC partnered with the Texas Water Resources Institute of Texas A&M AgriLife to hold two riparian and stream ecosystem workshops in 2018 to enhance stakeholder knowledge in watersheds of the San Jacinto River Basin. The workshops educated over 100 participants in maintenance and restoration practices for riparian areas of impaired waterways. The workshops were held in conjunction with watershed protection efforts.

Industry Sponsored Grants

H-GAC's Water Resources Group has received community grants from both DOW and Olin Corporation to improve water quality in Brazoria County. Grant funds were utilized to sponsor a new River, Lakes, Bays 'N Bayous Trash Bash® location along Oyster Creek in Lake Jackson, provide pet waste stations at parks throughout Brazoria County, augment the repair and replacement of On-Site Sewage facilities and conduct a community septic tank pump-out in the community of Bailey's Prairie.

Events/Booths

Bayou Preservation Symposium

This is an annual event focusing on a wide variety of topics related to water quality and the protection of waterways throughout the region. H-GAC participates each year by hosting a table with outreach materials and/or displays about watersheds, water quality, or pollution prevention. Staff also participate in the planning of this event and are generally speakers at the event.

State of the Bay Symposium

This event is held every two to three years and is sponsored by the Galveston Bay Estuary Program. H-GAC participates by hosting a table/display of Clean Rivers Program outreach materials and items highlighting all department water related projects. H-GAC staff have also moderated and made presentations at many of the sessions at this multiple day symposium.

River, Lakes, Bays 'N Bayous Trash Bash®

H-GAC, the Texas Conservation Fund, and a steering committee of volunteers coordinate the Rivers, Lakes, Bays 'N Bayous Trash Bash®, the largest single-day waterway cleanup event in Texas, held annually since 1994. Originally established by H-GAC's Clean Rivers Program, Trash Bash® averages over 4,000 volunteers each year and promotes environmental stewardship of the Galveston Bay Watershed through public education by utilizing hands-on educational tools and developing partnerships between environmental, government, and private organizations. Despite the 2020 cleanup being cancelled due to COVID-19 regional concerns, since 2016 more than 15,000 volunteers have removed almost 250 tons of trash from nearly 640 miles of shoreline.

Sam Houston Area Council - Annual Scout Fair

Each year the Sam Houston Area Council sponsors Scout Fair. Scouts and their families from across the region come to the all-day event to visit hundreds of booths that provide fun learning opportunities for all. Each year approximately 15,000 people attend the event. Clean Rivers Staff have hosted a booth at the event each year for the last decade. Hands on activities included:

- *What Watershed Do You Live in?*
- Pitch the Poop pet waste education
- Defeat the Grease Monster
- Low Impact Development game.

Bay Day

H-GAC hosted a booth annually at Bay Day between 2017 and 2019. Galveston Bay Foundation's annual festival at Kemah Boardwalk gives visitors the opportunity to learn about the importance of Galveston Bay in their everyday lives through a variety of hands-on educational exhibits. H-GAC CRP staff helped visitors locate the watershed they live in and brought interactive games to discuss the impact of pet waste and improper disposal of fats, oils, and grease on our bayous and bay.

Due to COVID-19, this event is now being held virtually.

World Oceans Day Festival

H-GAC hosted a booth annually at Artist Boat's World Oceans Day Festival between 2016 and 2018. The World Oceans Day Festival brings the international day of ocean celebration to Galveston with interactive exhibits and activities to educate the public about marine debris and other issues our oceans face. Partner organizations hosted booths exhibiting H-GAC's educational games in 2019.

Nurture Nature

Nurture Nature is the City of Baytown's annual environmental festival, attracting thousands of residents. H-GAC has used this opportunity to provide educational materials and games at a booth to highlight water quality and watershed issues in the area, including the Cedar Bayou Watershed Protection Plan.

Migration Celebration

Migration Celebration is an annual event held by the Friends of Brazoria Wildlife Refuges to educate the public on a variety of conservation and wildlife issues. From 2011 – 2015, H-GAC project staff presented educational materials and games at a booth to increase awareness of water quality and watershed issues.

Houston World Series of Dog Shows

In 2016, H-GAC hosted a booth at the Houston World Series of Dog Shows. This annual event attracts more than 40,000 spectators, participants, and vendors each year. H-GAC promoted a message about reducing bacteria in waterbodies using the Pitch the Poop game and giveaways of pet waste bag dispensers.

Brazosport College Partnership

In 2019, H-GAC partnered with Brazosport College to provide two different training opportunities to area residents. A Texas Stream Team training allowed participants to learn how to test physical and chemical parameters in area streams and become trained volunteer monitors. An On-Site Sewage Facility (OSSF) Homeowner Education Course allowed participants to learn about proper maintenance to help increase the longevity of their system.

Harris County On-Site Seminar

The Annual Harris County On-Site Seminar is presented by the Harris County Engineering Department and brings together local, regional, and state On-Site Sewage Facility professionals, including maintenance providers, sanitarians, installers, and permitting entities. Numerous presentations each year provide a broad overview of topics related to On-Site Sewage Facilities. In the past, H-GAC has presented on topics such as:

- Water Quality Monitoring
- Homeowner Education Course
- Homeowner Wastewater Assistance Program
- Watershed-Based Plans

Texas Environmental Health Association

In 2019, H-GAC staff presented at the Gulf Coast Texas Environmental Health Association (TEHA) meeting. Presentations for this meeting included an overview of H-GAC's Homeowner Wastewater Assistance Program, as well as a discussion of H-GAC's water quality monitoring activities in the region. That same year, staff was invited to the Annual TEHA State Meeting in Austin to present on the Homeowner Wastewater Assistance Program.

Other Events Related to Water Quality

H-GAC staff hosted booths and participated in many other events throughout the last five years. Attendees were able to engage in interactive games that demonstrate the importance of picking up pet waste, keeping drains free of fats, oils and grease, and watershed education. Some of these events included the City of Houston Water Fest, City of Houston Water Week, Nature Fest, Nature 4 Health and Pearland Day.

Brochures and Outreach Materials

In support of the various public outreach and education activities, H-GAC staff develops resource materials to assist in encouraging behaviors that promote good water quality in the region.

Pet Waste Bags

In 2013, H-GAC purchased 10,000 pet waste bags and dispensers for outreach purposes. The pet waste bags are a tool for implementing best management practices regarding bacteria and are distributed to local stakeholders and outreach event attendees who sign the Pet Waste Pollutes Pledge or play the Pitch the Poop interactive game. An estimated 6,000+ pet waste bag dispensers and refills were distributed between 2015 and 2020.

Supplemental Environmental Project Brochure

Brochures for H-GAC's Supplemental Environmental Project to replace failing On-Site Sewage Facilities, known at the Homeowner Wastewater Assistance Program, were made available at numerous public meetings. The purpose of these brochures were not only to directly communicate with eligible homeowners, but also to provide information to local government officials for their outreach activities.

Clean Rivers Program Special Projects

Site Characterization Special Studies

Six monitoring stations were selected for site characterizations during FY2015. Two sites were selected from Cedar Bayou and four sites from Bastrop Bayou. Two documents were produced, one for Cedar Bayou and one for Bastrop Bayou. The site characterization reports were completed in August 2015 and are available from H-GAC upon request.

H-GAC 24-hour Dissolved Oxygen Monitoring

H-GAC initiated 24-hour dissolved oxygen (DO) monitoring to verify or determine the extent of DO impairment in priority sub-segments within the region. Over the last five years, H-GAC has conducted DO monitoring at 14 stations throughout the region. Five sites continue to be monitored during FY2021.

Sites and years monitored include:

TABLE: 24-Hour Dissolved Monitoring Activities

Station ID	Site Description	Years Monitoring Conducted
20461	Mill Creek at Hardin Store Rd.	2015, 2016, 2017
20462	Walnut Creek at Decker Prairie – Rosehill Road	2016, 2017, 2018
20463	Brushy Creek at Glenmont Estates Blvd.	2016, 2017, 2018
16611	Magnolia Creek at Bay Area Blvd.	2015, 2016, 2017
18818	Unnamed Tributary to Clear Creek Tidal	2015, 2016
11367	Lake Creek at Honea-Egypt Road	2016, 2017, 2018
18191	Lake Creek at FM 149	2017, 2018
20451	Spring Branch at SH 242	2017, 2018
21965	Spring Branch at Shakey Hollow Road	2018, 2019, 2020, 2021
21957	Mill Creek at FM 149	2017, 2018, 2019
11490	Oyster Creek at SH 35	2019 (TMDL), 2020, 2021
11493	Oyster Creek at FM 1462	2019 (TMDL), 2020, 2021
21079	Cary Bayou at Raccoon Drive	2021
22232	Cotton Bayou at westbound I-10 frontage road	2021

EIH Biological Characterizations / Aquatic Life Monitoring

Between 2017 and 2019, the University of Houston – Clear Lake, Environmental Institute of Houston (EIH) completed two and one-half biological assessments. These assessments were conducted to determine if the selected streams met their assigned Aquatic Life Use (ALU) designation per the state of Texas Water Quality Standards. During each assessment, fish communities, macrobenthic invertebrate communities, and physical habitat data were collected along with 24-hour dissolved oxygen monitoring. EIH conducted monitoring events at sites 11148 (Little White Oak Bayou at Trimble Road) and site 21957 (Mill Creek at FM 149) during June 2017 (the Index Period). One monitoring event was conducted in August 2017 (the Critical Period) at site 21957 but not at 11148. In August 2018 (the Critical Period) and June 2019 (the Index Period), monitoring events were conducted at station 11331 (Cypress Creek at SH 249).

EIH found that not all sites met their assigned ALUs. Results from the initial event on Little White Oak Bayou indicated the ALU would not be supporting its ALU. As a result, monitoring efforts were moved to another site. The Mill Creek site ALU was fully supported while the Cypress Creek site appeared to partially support its ALU designation. The completed reports are available upon request.

Monthly Flow Monitoring for TCEQ Permits Section

Between September of 2018 and December of 2020 H-GAC and partner agencies conducted monthly flow monitoring at six sites. Three sites were in the West Fork of the San Jacinto River watershed, two sites were on Oyster Creek, and one site was on an unnamed tributary of Mary's Creek in Pearland. The monitoring was a permit support request from the TCEQ and occurred at the following sites:

- 11243 West Fork San Jacinto River at SH 242
- 11181 Crystal Creek at FM 1314
- 16626 Stewarts Creek at S. Loop 336
- 11491 Oyster Creek at Sims Rd / Brazoria CR 30
- 11493 Oyster Creek at FM1462
- 18636 Unnamed Tributary of Mary's Creek in Pearland

In addition to flow monitoring, standard water quality parameters and field observations were collected, but no water samples were taken for laboratory analysis. Water samples are routinely taken at these sites by a Clean Rivers Program partner agency.

Targeted Monitoring

H-GAC's Targeted Monitoring Project aims at investigating ten assessment units (AUs) in various land cover settings to identify bacteria sources. Four assessment units will be assessed in an urban setting, four assessment units within a suburban setting, and two assessment units within a rural setting (see accompanying table). These assessment units are considered to have the highest bacteria concentrations in the region. Most of the prioritized waterways have bacteria geometric mean greater than 15 times the state's water quality standard for contact recreation. Once results of the project are determined (late FY 2021), they will be reported to the appropriate authorities for possible remediation. Results and recommendations will be provided to the Bacteria Implementation Group so that appropriate jurisdictions have the resources necessary to implement bacteria reduction measures.

TABLE: Assessment Units for Targeted Monitoring

Predominant Land Cover Type	AU ID	AU Name	Relative Bacteria Geometric Mean (MPN/100 mL)
Urban	1007T_01	Bintliff Ditch	24.46
Urban	1017E_01	Unnamed tributary of White Oak Bayou	17.22
Urban	1007U_01	Mimosa Ditch	15.37
Urban	1016D_01	Unnamed Tributary of Greens Bayou	15.11
Suburban	1004J_01	White Oak Creek	26.39
Suburban	1103G_01	Unnamed Tributary of Gum Bayou	15.26
Suburban	2432A_02	Mustang Bayou	11.68
Suburban	1101D_01	Robinson Bayou (tributary of Clear Creek)	6.62
Rural	1104_01	Dickinson Bayou Above Tidal	14.11
Rural	1103E_01	Cedar Creek (tributary of Dickinson Bayou)	1.96

Monitoring Efficiencies Analysis

In FY 2020, H-GAC initiated the Monitoring Efficiencies Analysis project to evaluate regional monitoring activities and determine ways in which H-GAC and its partners can improve efficiencies in our monitoring activities. H-GAC regularly met with the Clean Rivers Program Technical Advisory Group to examine the frequency and locations of monitoring on an assessment unit level in an effort to identify any duplication of effort.

Through this project, H-GAC will determine 1) if savings can be realized by improving efficiencies in regional monitoring activities, and 2) what projects can be funded by those cost savings. Increased monitoring efficiencies within the Clean Rivers Program would be used to fund future special studies and targeted monitoring under the FY 2022 – 2023 contract.

Non-Clean Rivers Program Special Projects

Water Quality Management Plan

As part of a Clean Waters Act Section 604(b) grant from TCEQ, H-GAC develops the Regional Water Quality Management Plan for the Houston-Galveston area. Through this project, H-GAC acquires and maintains data and provides analysis regarding wastewater infrastructure, watershed planning, and sources of nonpoint source pollution that impact water quality in the region. Project staff members work closely with the Clean Rivers Program and others to support water quality efforts by creating and providing high quality data sources. Examples of data sources maintained through this project include a regional on-site sewage facility location database and comprehensive wastewater infrastructure databases related to permitted discharges and service area boundaries. Under this project, H-GAC also serves as a regional coordinator of water quality efforts, including facilitation of the Natural Resources Advisory Committee (NRAC).

Supplemental Environmental Project – Homeowner Wastewater Assistance Program Coordination

H-GAC's Supplemental Environmental Project (the Homeowner Wastewater Assistance Program) is coordinated under the Water Quality Management Plan. This project specifically addresses failing (or nonexistent) on-site sewage facilities as a means of targeting nonpoint source pollution and improving water quality within the Houston-Galveston region. For more information on this project, refer to Section 2.5.4.

Natural Resources Advisory Committee (NRAC)

H-GAC staff facilitate the Natural Resources Advisory Committee through the 604(b) grant. This body provides policy recommendations to H-GAC's Board of Directors and serves as a regional roundtable for coordinating environmental efforts. The NRAC provides an efficient communications network and point of contact with other local and regional water quality decision makers. The Parks and Natural Areas subcommittee of the NRAC promotes innovation in park and natural area projects and hosts an annual awards event. NRAC also hosts the annual Water Innovation Strategies of Excellence award program to highlight exceptional projects and efforts that improve water quality in the region. For more information on NRAC, refer to Section 2.7.

On-Site Sewage Facility Database

H-GAC maintains and updates an on-site sewage facility database using data acquired from Authorized Agents within the region. This database includes permitted on-site sewage facility locations and related permit data. H-GAC staff also evaluate and estimate the probable locations of unpermitted systems, such as those installed before permitting was required.

OSSF Outreach and Education

Through H-GAC's Outreach and Education programs, staff conducts educational training courses on basic on-site sewage facility maintenance and fundamentals of operation. These training courses are offered to homeowners, real estate inspectors, and other interested parties as requested.

San Bernard Watershed Coordination

H-GAC supports the ongoing engagement of stakeholders in the San Bernard River Watershed and the implementation of its WPP by supporting the activities of local partners, assisting in identifying funding opportunities, and holding meetings and workshops. Since 2015, H-GAC has held or partnered on a series of meetings with the Friends of the River San Bernard and supported that organization in developing watershed materials. H-GAC also supports ongoing Texas Stream Team monitoring in this basin.

Urban Forestry Support and Coordination

Support for urban forestry issues has become a major focus of H-GAC in recent years, originating with our development of the Houston Area Urban Forests project in coordination with local governments and forestry organizations to guide urban forestry efforts for water quality and other ecosystem services. As part of these activities, H-GAC staff worked regularly with various entities, such as Houston Wilderness, The Nature Conservancy, and Trees for Houston, to provide data for urban forestry research projects. Staff served on various local and state committees (including the Texas Forests and Drinking Water Partnership and the board of the Houston Area Urban Forestry Council), made presentations at several conferences, and published national journal articles related to these efforts. H-GAC continues to work with its local partners to promote forests and conservation to enhance regional resilience and water quality.

Wastewater Outfalls and Service Area Boundaries

The Wastewater Outfalls Geographic Information System (GIS) dataset identifies the location of wastewater treatment facility outfalls for the region. The Service Area Boundaries GIS dataset is a companion dataset to the Wastewater Outfalls and is a spatial representation of the service area boundaries of domestic wastewater dischargers in the region. Typically, boundary data includes the service areas of municipalities, public districts, and private utilities. These datasets are updated annually.

Wastewater Data Analysis

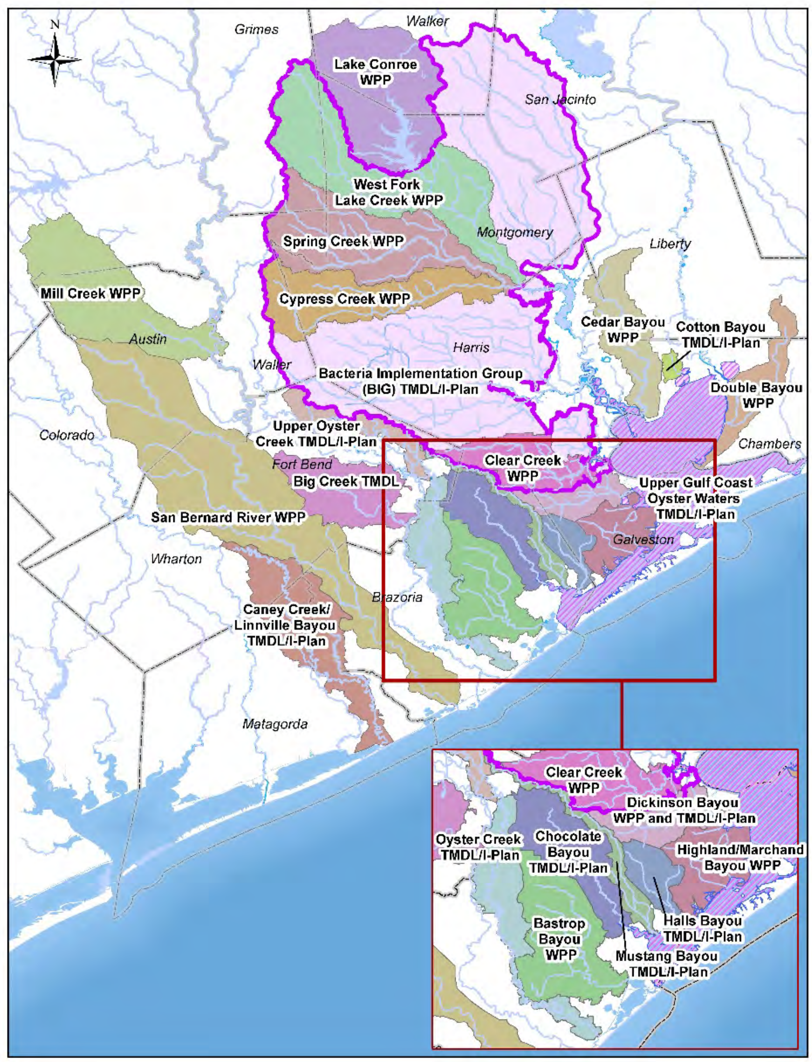
H-GAC acquires self-reported Discharge Monitoring Report data for regional permitted facilities and uses this data to evaluate bacteria permit exceedances in the region. H-GAC also acquires self-reported Sanitary Sewer Overflow data, and analyzes this data to evaluate the number, volume, frequency, and causes of these overflows.

Coordination with Other Projects and Outreach

H-GAC staff members develop and maintain relationships with other local and state governments, community groups, and other organizations related to water quality efforts. H-GAC staff routinely attend meetings of, or otherwise supported, numerous organizations involved in water quality efforts throughout the region.

Watershed-Based Plans

Watershed-based plans are stakeholder led efforts to address water quality concerns and/or impairments. These can be categorized into two different plan types, watershed protection plans (WPP) and total maximum daily load (TMDL) implementation plans (I-Plan).



Watershed Protection Plans

A WPP is developed to address state water quality standard impairments identified by TCEQ. Other water related concerns of importance to community stakeholders may also be targeted in these documents. WPPs are entirely voluntary in nature and contain no regulatory requirements.

San Bernard River – The San Bernard River flows through Austin, Colorado, Wharton, Fort Bend, and Brazoria counties in the western side of the region. Bacteria impairments led to the development of a WPP facilitated by H-GAC and TCEQ, starting in 2009, which was approved in 2017. The plan identified best management practices to address contributions from livestock, domestic pets, wildlife, OSSFs, and other sources. Elements of the WPP are currently in implementation through coordination between H-GAC and the Friends of the River San Bernard.

Dickinson Bayou – The Dickinson Bayou watershed is located within the San Jacinto-Brazos Coastal Basin, southeast of Houston and west of Galveston Bay. TCEQ determined that parts of Dickinson Bayou have impairments for both elevated levels of bacteria and low dissolved oxygen. A WPP was developed by the Dickinson Bayou Watershed Partnership in 2006. The Texas AgriLife Texas Community Watershed Partners, under contract with TCEQ, has been coordinating stakeholder involvement, via the Dickinson Bayou Watershed Partnership, for development of this plan. H-GAC has been a partner and participant in these efforts. The TCEQ accepted the Dickinson Bayou Watershed Partnership's WPP in May of 2009 and submitted to EPA for approval. The plan is currently being revised to address EPA's concerns.

Cedar Bayou – Cedar Bayou is a direct tributary to Galveston Bay, located at the eastern edge of Harris County and western Liberty and Chambers counties. From its headwaters west of Dayton to its mouth near Baytown, the bayou has a variety of water quality issues. H-GAC worked with the TSSWCB and local partners to develop a WPP to address high levels of bacteria and other contaminants. The WPP identified best management practices including OSSF remediation, pet waste management, education and outreach, and agricultural programs. The WPP was approved in 2016, and implementation of select BMPs has begun. H-GAC remains involved in the project as part of the broader Cedar Bayou Initiative to enhance the bayou's resilience and water quality.

West Fork San Jacinto River – The West Fork of the San Jacinto River and its tributary, Lake Creek, are primary sources of water for the Lake Houston reservoir. In recent years, this waterway has developed elevated levels of fecal bacteria. H-GAC worked with TCEQ and local stakeholders to address these issues and other stakeholder concerns (sediment, trash, nutrients, DO levels) through a WPP, approved in 2019. Project staff are actively working to implement elements of the WPP along with similar efforts in other parts (Cypress Creek and Spring Creek) of the greater Lake Houston Watershed. See www.westforkwpp.com for more information.

Cypress Creek – Cypress Creek, which flows from its headwaters in the historic Katy Prairie of Waller County through the rapidly developing suburbs of northern Harris County, has elevated levels of fecal waste and other water quality concerns. Working with TCEQ and local stakeholders, H-GAC is currently developing a WPP for Cypress Creek and coordinating water quality concerns with various large-scale flood management projects in the watershed. See www.cypresspartnership.com for more information.

Spring Creek – Spring Creek runs east from headwaters in Waller County to a confluence with the West Fork of the San Jacinto River and forms part of the border between Montgomery and Harris Counties. Water quality issues – primarily high levels of fecal waste – are prevalent throughout the Spring Creek Watershed and are of particular concern as Spring Creek is a source of water for the Lake Houston reservoir. H-GAC in cooperation with TCEQ facilitate a community partnership working to address water quality and other issues of importance identified by stakeholders including trash and sedimentation in waterways. The partnership will assess sources of pollution and identify reduction strategies to be incorporated into a WPP. This project began in late 2019 and the development of the WPP document is expected to continue well into 2021. See www.springcreekpartnership.com for more information.

Highland Bayou – The Highland Bayou and Marchand Bayou watersheds are located in mainland southeastern Galveston County. Marchand Bayou is a tributary that flows into Highland Bayou, which then drains into Jones Bay and the West Bay of Galveston Bay. Texas AgriLife Texas Community Watershed Partners is the lead agency for the Highland Bayou project. The WPP focus is to address water quality issues, including water quality impairments from high bacteria levels and low dissolved oxygen (DO) levels. The WPP is currently in draft form.

More information is available at:

https://agrilife.org/highlandbayou/project-data-2/highland-bayou-characterization/

Bastrop Bayou – The Bastrop Bayou watershed drains a mix of land uses in rapidly growing eastern Brazoria County, including active agricultural production and small urban centers. The watershed protection plan was approved by the TCEQ, accepted by the EPA in August 2016, and is being implemented by local stakeholders. Implementation efforts include education and outreach activities, remediation of failing septic and aerobic wastewater systems, installation of pet waste management systems, and promotion of voluntary best management practices for agriculture.

Total Maximum Daily Load/Superfund/Implementation Plans

A total maximum daily load (TMDL) is part of a regulatory process triggered when a waterway is placed on the 303(d) list of impaired water bodies. The TMDL is a calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards. This process can result in the development of an Implementation Plan (I-Plan) which is a formal document outlining measures to address water quality concerns and describe policy recommendations to bring impaired waters back into compliance.

Upper Oyster Creek – Upper Oyster Creek in north eastern Fort Bend County is a modified series of waterways with numerous impoundments, supply canal diversions, and other modifications. Its watershed includes growing areas around Sugar Land and Missouri City, southwest of Houston. Elevated bacteria and depressed DO levels triggered TMDL studies by the TCEQ. H-GAC worked with TCEQ and local partners to develop an Implementation Plan (I-Plan) for bacteria and DO. The I-Plan was approved in January 2014. The I-Plan calls for local partners to address bacteria through education and outreach and management of human and wildlife sources of bacteria. Implementation is in its seventh year, being guided by H-GAC with funding from TCEQ and substantial efforts on behalf of local stakeholders through stormwater programs and other projects.

Dickinson Bayou – Dickinson Bayou can be found in central Galveston County and terminates in Upper Galveston Bay. The Texas Community Watershed Partners of Texas AgriLife (http://agrilife.org/dickinsonbayou/) oversees the implementation of the Dickinson Bayou Bacteria Reduction I-Plan. The I-Plan was approved in January 2014. The stakeholders have also developed a draft WPP (see above) to address bacteria and dissolved oxygen. HGAC has been a partner and participant in these efforts.

The I-Plan outlines seven specific implementation measures to reduce bacteria in Dickinson Bayou:

1. Manage OSSFs
2. Address WWTFs & collection systems
3. Address animal waste
4. Restore and repair riparian zones
5. Preserve and restore natural wetlands
6. Construct stormwater treatment wetlands
7. Implement stormwater Best Management Practices (BMP)

Implementation measures are currently underway. The Texas Community Watershed Partners program is implementing under funding from the Galveston Bay Estuary Program to address this watershed and others found in Galveston and Brazoria Counties.

Bacteria Implementation Group – Since 2008, a group of government, business, and community leaders as members of the Bacteria Implementation Group (BIG) have joined to develop and implement the BIG I-Plan.

The BIG project area includes approximately 5 million people and waterways, mostly Basin 10, in part of 10 counties: Brazoria, Fort Bend, Galveston, Grimes, Harris, Liberty, San Jacinto, Walker, and Waller. The I-Plan was completed in January 2013. Since that time the project area has expanded to include the Armand Bayou TMDL project area in 2015, East and West Fork of the San Jacinto River TMDL project are in 2016 and Jarbo Bayou TMDL project area in 2018. The project area increased in size from 2,202.7 square miles to 3,259.89 square miles.

The BIG is well into the implementation phase of the TMDL process. The group has overseen overall reduction in bacteria concentrations with 57 of the 227 assessment units seeing improvement. The BIG uses Houston-Galveston region CRP data to benchmark environmental progress toward implementation goals as directed in the I-Plan through the production of an Annual Report. All BIG materials are available online.

Implementation activities have included stormwater management and physical channel improvements, routine infrastructure maintenance and illicit discharge detection programs, onsite sewage facility inspection programs and repair, replacement and abandonment efforts, and public outreach initiatives related to sanitary sewer overflows from fats, oils, and grease, and proper disposal of pet waste.

Oyster Waters – The Upper Gulf Coast Oyster Waters TMDL covers Trinity, Upper, Lower and West Galveston Bay for recreational oyster fishing. The I-Plan, led by the Galveston Bay Foundation (GBF) with support from H-GAC, addresses 11 TMDLs related to bacterial contamination of oysters in and around Galveston Bay.

The I-Plan was approved by the TCEQ in August 2015. The I-Plan addresses bacteria sources, technical and financial needs, monitoring and outreach efforts, and a schedule of activities for each of the stakeholder-developed management measures that will be used to reduce bacteria levels.

GBF meets regularly with project partners to implement I-Plan tasks. Implementation has included a Cease the Grease campaign aimed at reducing the impacts of fats, oils, and grease, monitoring bacteria levels at marinas, and a boater waste education campaign. Implementation of these measures began in 2014.

Dioxin/PCB – Stakeholder involvement efforts for the PCB/dioxin TMDL project for the Houston Ship Channel and Upper Galveston Bay began in May of 2000 due to the issuance of consumption advisories by the Texas Department of State Health Services for PCBs and dioxins in fish tissue. Data collection and modeling has finished. It is believed that elevated levels of PCBs and dioxins in recreational fish and shellfish is the result of legacy pollutants found in the Houston Ship Channel.

As a result of stakeholder input, the San Jacinto River Waste Pits were identified as a primary contributor of dioxin to the Galveston Bay Estuary. In 2008, the U.S. Environmental Protection Agency, Region 6, listed the San Jacinto River Waste Pits as a Superfund Site.

San Jacinto Waste Pits – H-GAC is participating in stakeholder involvement and public outreach efforts related to the San Jacinto River Waste Pits Super Fund Site. In addition to working with the EPA to provide stakeholder engagement opportunities in conjunction with the Dioxin TMDL project, H-GAC is working with Harris County Attorney's Office and other stakeholders to persuade the EPA to proceed with emergency remediation measures and public education efforts pertaining to the site.

Chocolate Bay – This project is composed of three watersheds: Chocolate Bayou, Mustang Bayou and Halls Bayou. All are found in eastern Brazoria County and Western Galveston County. Each watershed is impaired for contact recreation due to elevated bacteria levels. TMDL projects are underway for each. A single Chocolate Bay I-Plan will be developed to cover all three watersheds and is expected to be finished in 2023.

Oyster Creek – Oyster Creek south of Missouri City traverses central Brazoria County before terminating at the Intracoastal Waterway. A TMDL project is underway due to elevated bacteria levels. A draft TMDL has been completed and a future I-Plan will be finished in 2022.

Caney Creek – Caney Creek is a water body that begins in southeastern Wharton County and forms the border between Matagorda County and Brazoria County before terminating at the Intracoastal Waterway. A TMDL project is underway to address a bacteria impairment. A draft TMDL has been completed and a future I-Plan will be finished in 2022.

Big Creek – Big Creek can be found draining central Fort Bend County where it terminates at the Brazos River adjacent to Brazos Bend State Park. A TMDL is underway due to elevated levels of bacteria. The TMDL will be delivered in 2021 and an I-Plan is expected in 2023.

Cotton Bayou – Cotton Bayou is found in western Chambers County traversing south eastward from the City of Mont Belvieu before terminating at Cotton Lake near Trinity Bay. A TMDL project is underway for elevated bacteria. A draft TMDL is expected in 2022 and the I-Plan will follow in 2023.

Nickel – The Houston Ship Channel was impaired due to elevated levels of nickel found in the 1990s. However, TCEQ hosted a public meeting in 2020 to inform stakeholders that the nickel impairment was being rescinded. TCEQ determined that the method for collecting the nickel data was flawed.

More information on the various watershed-based plans can be found online here.

Trust for Public Lands "Greenprint"

H-GAC partnered with the Trust for Public Land and local stakeholders to develop the West Fork San Jacinto River Greenprint to provide data-driven analyses for conservation priorities in the watershed with a focus on improving water quality and providing access to water-based recreation. The project was completed in 2016 and helped guide subsequent water quality efforts like the West Fork San Jacinto River and Lake Creek WPP by highlighting priority areas for voluntary conservation and identifying likely areas of high impact to water quality.

Galveston Bay Estuary Program Targeted Monitoring Projects

Funding from the Galveston Bay Estuary Program (GBEP) allowed H-GAC to complete a targeted bacteria monitoring project in 2017, referred to as the Top Five Most and Top Five Least Impaired Water Bodies Project. The project focused targeted monitoring efforts on assessment units (AUs) from streams in the Bacteria Implementation Group's (BIG) area with some of the highest bacteria geometric means. Monitoring efforts aimed to identify potential sources of bacteria in the waterways by testing for *E. coli* at outfalls and tributaries and reporting findings to local jurisdictions for corrective action.

With support from GBEP, H-GAC partnered with Bayou Preservation Association to initiate a similar targeted bacteria monitoring project in up to six watersheds in 2020. With continued targeted bacteria monitoring efforts, H-GAC hopes to help make improvements in some of the most bacteria-impaired waterways in the region.

Trash Free Waters

H-GAC has partnered with the North Central Texas Council of Governments (NCTCOG) and the Meadows Center for Water and the Environment to establish a unified, coordinated approach to litter abatement and community engagement in the six river basins in the Dallas-Fort Worth and Houston-Galveston regions.

Through this 3-year project, H-GAC seeks to:

1. Increase Adopt-A-Spot locations through Trash Free Texas and support a common and support a common Trash Collection Database for the state.
2. Provide outreach and engagement support for regional clean-up events through partnerships with local governments, recreational clubs (such as cycling and running clubs) and Keep Texas Beautiful affiliates.
3. Work with Texas-based restaurants to reduce usage of single-use plastic.
4. Share project successes with other councils of government and replicate this work across the state.

United States Geological Survey – Freshwater Flows to Galveston Bay

To better characterize sources of freshwater inflow and understand sediment and nutrient delivery into the Galveston Bay estuary, the United States Geological Survey (USGS) installed an acoustic doppler velocity meter (ADVM) on the San Jacinto River near Sheldon, TX. The ADVM collects measurements of velocity and acoustic backscatter. The velocity data, along with instant discharge data obtained from an acoustic doppler current profiler, will be used to calibrate an index-velocity rating to compute continuous streamflow data. The backscatter and velocity data, along with nutrient and suspended sediment data, will be modeled to determine the feasibility of using the ADVM to predict real-time nutrient and suspended sediment concentrations in the San Jacinto River. This data will provide a more complete picture of the volume and water quality of freshwater inflows to Galveston Bay.

United States Geological Survey – Freshwater Flows from the San Jacinto River

Freshwater inflows play a key role in nutrient and sediment transport needed to support ecosystem health and biodiversity. However, extreme flooding events such as those observed along the Texas gulf coast in recent years can have adverse ecological effects. The United States Geological Survey in partnership with the Texas Water Development Board and the Galveston Bay Estuary Program are monitoring data from sites on the San Jacinto and Trinity Rivers—the two main sources of inflow to Galveston Bay. While monitoring on the San Jacinto River is still in the early phases of development, flow and nutrient and sediment concentrations on the Trinity River have been recorded since 2009. Preliminary analyses shed light on our understanding of flow dynamics in flood conditions and how sediment and nutrient delivery are impacted. Specifically, high flow events on the Trinity River divert west of the main channel into Old River Lake. Further study is needed to understand the role of Old River Lake in regulating nutrient and sediment loading in Galveston Bay.

Bacteria Source Tracking

To better characterize sources of bacteria that are entering the Trinity and Galveston bays, Texas A&M University (TAMU) initiated a bacteria source tracking (BST) study to help decision makers determine the most appropriate management measures needed to reduce bacteria in the waterbodies. Each of the selected waterbodies drain directly into the bays and were listed as impaired in the 2020 Texas Integrated Report. Most of the land serviced by the watersheds examined were classified as undeveloped, agricultural, or developed land.

The TAMU's Texas Water Resources Institute (TWRI) conducted monthly bacteria sampling at one site on several water bodies for one year. The BST analysis in the Trinity River and Galveston Bay indicate that wildlife (non-avian and avian) were the leading contributors of *E. coli* in the five selected sample sites with variable levels of human contributions across the sites.

Water Resources Websites

Clean Waters Initiative

Coastal Communities

Homeowner Wastewater Assistance Program

LID Designing For Impact

Natural Resources Advisory Committee

On-site Sewage Facilities Mapping Tool

Pet Waste Pollutes

River, Lakes, Bays 'n Bayous Trash Bash

Trash Free Texas

Texas Stream Team

Water Outreach Engagement Materials

WATER QUALITY REVIEW

Water Quality Review

Data Analysis Methodology

The following information is presented to allow another individual to understand and re-create the analyses conducted by H-GAC. Throughout the watershed summaries, many of the texts and graphs available can be translated by reviewing the methodology provided below.

TCEQ Assessment Methodology

The provisions of sections 305(b) and 303(d) of the Clean Waters Act (CWA) require the TCEQ to identify water bodies in the state that do not satisfy the uses or meet the numerical criteria (parameter concentrations) defined in the Texas Surface Water Quality Standards (TSWQS). The TCEQ provides a report to the EPA (the Texas Integrated Report of Surface Water Quality, hereinafter referred to as the IR), every two years. The report includes identification of impaired waters (the 303(d) List), a list of water bodies evaluated, identification of water bodies either newly listed or removed from the 303(d) List, and other supporting information. References to impairments and concerns in the Basin Summary Report are based on information contained in the 2020 IR.

TCEQ has divided the water bodies of the state into distinct segments that generally represent natural watersheds. Each water body is given a number that indicates the river basin and segment. If Appendix A of the TSWQS (found in the Texas Administrative Code [TAC], Title 30, §307) specifies use and numerical criteria for the segment, it is considered a classified segment. Tributaries that flow into a classified segment are termed unclassified water bodies and are generally assessed against the standards that apply to the classified segment. An exception would be water bodies that are listed in Appendix D of the TSWQS.

For rivers and streams, each segment is subdivided into hydrologically distinct units referred to as an assessment unit (AU). The endpoints of an AU are typically at hydrologically distinct areas along a segment. Each segment may be divided into more than one AU, and each AU may contain more than one monitoring station. Ideally, an AU should be no more than 25 miles in length and the monitoring station should be located in an area that is hydrologically representative of the AU. Larger bodies of water like reservoirs, bays, and estuaries, will generally have at least one AU that is representative of the central area of the water body, and one AU for each tributary arm feeding into it. The determination of standards attainment or non-attainment is based on water quality conditions in the AU. Impairments and concerns usually apply to the AU rather than the entire segment. Chloride, sulfate, and total dissolved solids standards attainment are based upon the average concentration in the entire segment, and impairments apply to the entire segment.

Numerical criteria assigned to a segment are tied to TSWQS defined uses, which include aquatic life use (ALU), recreational use (contact or noncontact), domestic water supply use, general use, and fish consumption use. Fish consumption uses and impairments are derived from the Department of State Health Services (DSHS) fish advisories based on DSHS fish surveys.

Each classified segment is assigned an ALU based on physical, chemical, and biological characteristics. There are four ALU categories assessed: limited, intermediate, high, and exceptional. A number of methods are used to assess support of the ALU, including dissolved oxygen criteria, toxic substances in water criteria, ambient water and sediment toxicity test results, and indices for habitat, benthic macroinvertebrate and fish communities. This biological assessment involves an evaluation of the available instream habitat and the diversity and distribution of fish and macrobenthic invertebrates in a water body, which can vary as a result of changes in the aquatic environment caused by natural and/or non-natural events. Non-natural agents of change include anthropogenic pollution, instream habitat alteration, and disruption of the instream flow conditions to which the biological community is adapted. Species abundance, distribution, and diversity data are used to calculate a numerical indicator known as the index of biotic integrity (IBI). Separate IBIs are calculated for benthic macroinvertebrates and nekton (fish). A "habitat score" is also calculated. When the IBI or habitat score falls outside a statistically-derived range, a concern or impairment is identified. Biological assessment involves collecting, counting and identifying the organisms that constitute the biological community, and using these findings to calculate the IBI. Calculation of the IBI is complex and is discussed in detail in the TCEQ *Surface Water Quality Monitoring Procedures, Volume 2: Methods for Collecting and Analyzing Biological Assemblage and Habitat Data*.

TCEQ uses data collected during the most recent seven-year period (December 1 through November 30 of the preceding year) for the IR. An attempt is made to compile a spatially and temporally representative dataset. Samples must be collected over at least two years, no more than two-thirds of the data can represent a single year, and no more than one-third of the samples should be from the same season. Samples obtained during low flow events (as defined in the TCEQ guidance document) may be excluded. At least 10 samples (20 samples for bacteria) are required to determine standard attainment or nonattainment, but four or more samples can be used to establish a concern. If there is insufficient data to determine standards attainment and/or support of the designated use, that information is noted in the IR.

Nonsupport for most designated uses is established by evaluating the number of times a water quality standard was exceeded. Statistical methods are applied to the calculation of exceedance thresholds to ensure that the chance of claiming that an AU is impaired when in reality it is not (a Type I error), remains fixed. These exceedance thresholds (the number or exceedances required to consider an AU impaired) vary with sample size and parameter. Calculation of the threshold for delisting an AU follows the same logic, but the number of exceedances required to change the status of the AU is not the same in each case. Standards may also be stated in terms of the median concentration or geometric mean (the average of the logarithms of sample results, converted back to a natural number). For indicator bacteria (*E. coli*, enterococci), the evaluation of standards attainment involves comparison of the seven-year geometric mean to the WQS. For new bacteria listings, the value of the lower boundary of an 80 percent confidence interval must exceed the WQS, but an AU will only be delisted for bacteria if the actual geometric mean falls below the WQS. The current WQS includes a single-sample limit for bacteria in addition to the geometric mean limit, but the single-sample criterion has not been used for assessing CWA compliance since the 2010 assessment.

Each impairment in an AU is assigned to one of two categories; 4 or 5. Only those AUs with category 5 impairments are included on the 303(d) list of impaired waters. Category 5 includes:

- Impairments of water quality parameters for which a total maximum daily load (TMDL) project is under way, scheduled or will be scheduled (5a)
- Cases where review of water quality standards for that AU is appropriate (5b)
- Cases where additional data must be collected before a TMDL is scheduled (5c)

In this report, H-GAC staff addresses the impairment and concern status in the 2020 IR for each assessed classified segment and unclassified water body within the H-GAC service region. A total of 57 segment watersheds are discussed in detail in Watershed Summary documents.

Introduction to H-GAC's Data Analysis

The identification of long- and short-term trends is important to many of our stakeholders, and these trends are important components of H-GAC's work, particularly in relation to the evaluation and revision of our regional monitoring efforts and priorities. Several methods of analyses were used by H-GAC 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 TCEQ-validated data from January 1, 2000 through May 31, 2020, to focus on recent trends in water quality in the H-GAC service area.

All data management and statistical analysis was performed using Statistical Analysis System (SAS) version 9.4. Complete details of data selection, preparation, and analysis can be found in the SAS code used to select, format, and analyze data for this report is available upon request.

Data Selection and Processing

Water quality data used for analyses in this report were extracted from a dataset downloaded from the Surface Water Quality Monitoring Information System (SWQMIS). 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 CRP region (in general, basins 9, 10, 11, 13, 24 and 25), collected from January 1, 2000, through May 31, 2020, were combined. Flow data from USGS gaging stations in TCEQ Region 12 were downloaded from the USGS website.

Variables in each data set were transformed as appropriate, and new variables were created to facilitate analysis and the 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 that were collected at a depth greater than 0.3 meters, or that were not collected under a routine ambient monitoring program, were deleted. If a parameter (or parameters) was measured multiple times per month in the same year at the same station, only the first result for the same month, year, and parameter for the station was retained. This is because multiple results clustered in one temporal region of the time series have the potential to bias the interpretation of trend analysis and the representative station selection procedure (described below), if included.

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 CRP LOQ, values were transformed to one-half of the H-GAC CRP LOQ in an attempt to minimize the identification of trends caused by changing analytical methods. For example, in the case of nitrate-nitrogen and total phosphorus, if the result was reported at or below the highest commonly used LOQ, a value of one-half of that LOQ (0.1 and 0.03 mg/L, respectively) was used for trend analysis. 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.

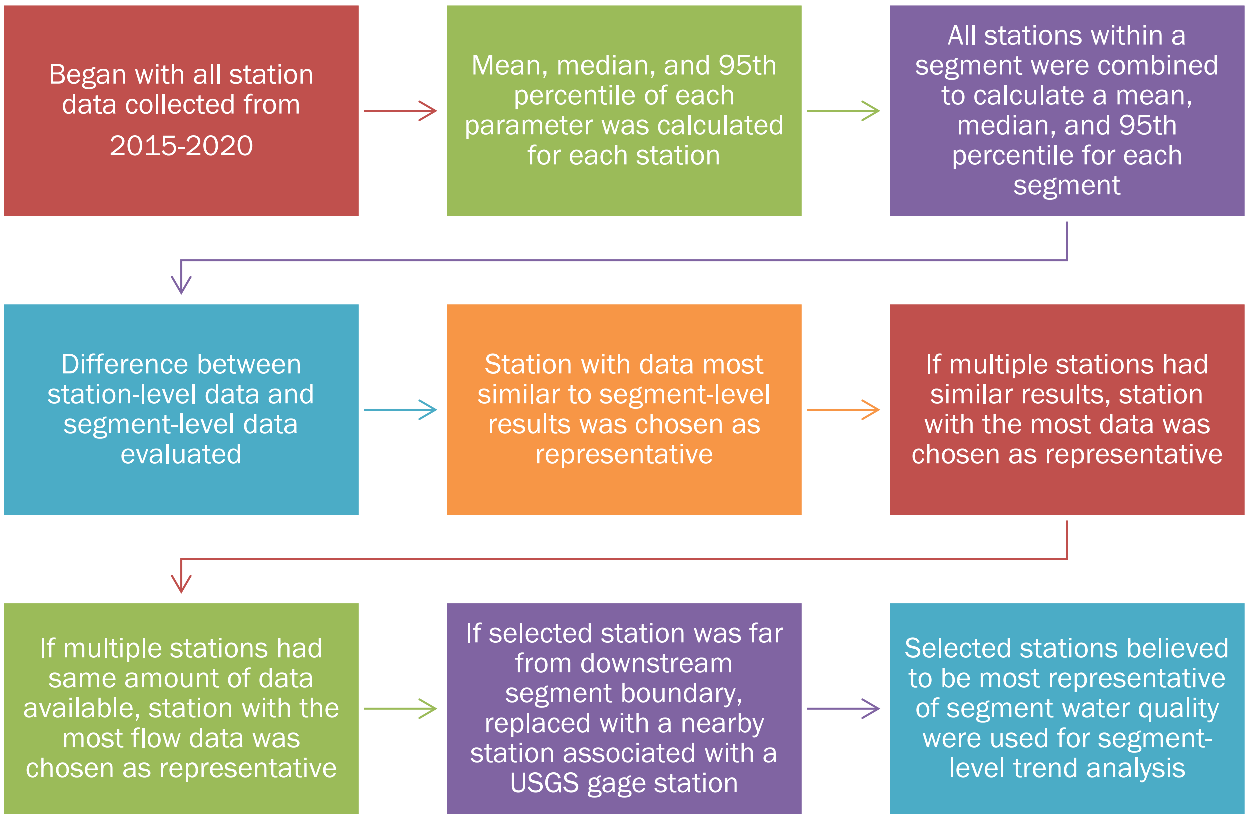
The following parameters were selected for analysis:

- 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)
    - Only one of these parameters was used in our analyses. 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)
- Days since last significant rainfall (72053)

Data Section for Trend Analysis

Data from selected stations believed to be most representative of segment water quality were compiled for segment-level trend analysis. At each stage of the selection process, rankings were evaluated and were subject to revision on the basis of best professional judgment. A table of all data for stations that were monitored in each of the past three years (2018-2020) was compiled. The mean, median, and 95th percentiles were calculated and added to the table for each station/parameter combination as well as for station/parameter combinations for each segment as a whole. The differences between station/parameter and segment/parameter metrics (both absolute and as a percentage of the segment mean) were calculated as were the number of observations (n) for each category. The number of USGS and ADP-obtained flow measurements made at that station was also determined. The stations with a mean value for a given parameter that was numerically closest to the mean value for the segment as a whole were ranked as “1” using SAS procedures (PROC SORT followed by PROC RANK). The station with a ranking of “1” on the most number of parameters was tentatively identified as the representative station for that segment. If two stations had the same number of highest-ranked parameters, the length of the time series (number of distinct years with data) was considered, and the station with data in the greatest number of years represented was selected. The results of this process were then reviewed for reasonableness and consistency. If doubt remained about which station to select, the station with the most flow measurements (preferably from USGS stations) was selected. In almost all cases, the station selected on the basis of numeric criteria was located near the downstream boundary of the segment. If the selected station was located far from the boundary, further evaluation was performed and another station was selected. Refer to the flow chart below for a simplified explanation of the representative station selection process.



Process used to select representative stations for each segment

If there were no data for a parameter in a segment during one year in the 20-year time period, additional data were added from the geographically closest station in the segment (for that year and parameter only). This process continued until a time series with at least four data points for each of 15 years (up to 180 data points) was produced, if possible. If there were fewer than 20 data points or a time series range of less than seven years for a parameter in a segment, it was deleted from the trend data subset and not included in the trend analysis.

For station-level trend analysis, a data set containing data for all stations in the 2021 Coordinated Monitoring Schedule (CMS) was compiled. The station-level trends supplemented the evaluation of segment-level trends. If the segment-level trend identified from analysis of data collected at the representative station(s) selected differed significantly from a trend (or absence of a trend) suggested by data collected at other stations within the segment, the discrepancy was noted in the water quality trend narratives or the dataset was re-evaluated. In addition, the station-level dataset was transposed to allow analysis of inter-parameter relationships, correlations with flow measurements and rain event reports, and other analyses as deemed appropriate. These analyses supplemented interpretation of observed trends, and in some cases suggested relationships that might not be evident from trend analysis alone.

A table of descriptive statistics for each parameter was produced for every monitoring station and segment (see Appendix). In addition to basic summary statistics, water quality standard and screening level exceedance statistics were calculated.

Trend Analysis Methodology

The first stage of trend analysis at both the segment- and the station-level was nonparametric correlation analysis (Kendall's tau-b) of the parameter value with the sample collection date to identify correlations that were significant at $p < 0.054$. 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. LOESS (locally-weighted least squares) regression and correlation of flow-adjusted residuals was applied to stations' associated flow data. 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 are included in each Watershed Summary document along with a detailed qualitative discussion explaining whether the water quality parameter is increasing, decreasing, or stable over time, and why that may be the case. If the selected station is near a USGS gauging station, flow data is plotted as well. If the trend is described as "Increasing" or "Decreasing" it means the calculated p-value is below the threshold of 0.054 selected by H-GAC. Trends identified as "Stable" have a calculated p-value greater than 0.054. 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. 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."

In addition, LOESS plots of the parameter value against time were made for every segment/parameter and station/parameter combination, whether a statistically significant trend was present or not.

Trend Analysis for the "Frog Chart"

A conservative trend analysis was performed using seven years of recent data (June 1, 2013 through May 31, 2020) at up to three representative monitoring stations on the 2021 CMS in the classified portion of each watershed to detect trends at the watershed level for the H-GAC "Frog Chart". The representative stations used were the same as those selected for the trend analysis that appeared in the 2021 Basin Summary Report "Frog Chart" and were chosen by comparing parameter statistics for each station to the statistics for the whole segment. 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 0.0545.

Moving Geometric Mean Plots (Moving Geomeans)

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

Water Quality Summary

Regional Concerns

- Most water bodies in the region are considered unsuitable for recreational activities like swimming due to high bacteria levels.
- Approximately 44% of stream miles are impaired for bacteria.
- A concern for nutrients is present for about 31% of stream miles.
- Approximately 18% of stream miles have low levels of dissolved oxygen.
- Nearly 51% of tidal streams (34% of stream miles) are impaired by dioxin or PCBs in fish tissue.

Frog Chart

2021 REGIONAL WATER QUALITY SUMMARY

The numbers represent the percent of total segment length that is impaired or of concern for each parameter. Cells without numbers (blanks) represent stream segments that are currently meeting state standards but may be improving or degrading for each parameter.

DO = Dissolved Oxygen Bact = Bacteria Chl-a = Chlorophyll a Nutr = Nutrients PCB = PBC/Dioxins OTHER = See Below

Basin	Watershed	Segment	DO	Bact	Chl-a	Nutr	PCB	Other*	Frogs
Trinity-San Jacinto Coastal	Cedar Bayou Tidal	0901	14.2	100			85.8		🐸
	Cedar Bayou Above Tidal	0902	82.7	82.7				**	🐸🐸🐸
San Jacinto River	Buffalo Bayou Above Tidal	1014	12.0	77.9		64.7			🐸🐸🐸
	Buffalo Bayou Tidal	1013	34.2	77.8		43.6		**	🐸🐸
	Caney Creek	1010	16.8	69.2					🐸🐸🐸
	Cypress Creek	1009	18.8	80.3		80.3		10.3	🐸🐸🐸
	East Fork San Jacinto River	1003		85.7					🐸🐸🐸
	Greens Bayou Above Tidal	1016	6.4	95.8		85.3			🐸🐸🐸
	Houston Ship Channel	1006		44.7	7.1	68.4	39.8	22.2	🐸🐸🐸
	Houston Ship Channel Buffalo Bayou Tidal	1007	13.0	70.2		68.9	28.7	0.9	🐸🐸🐸
	Houston Ship Channel/ San Jacinto River Tidal	1005					100		🐸🐸🐸
	Lake Conroe	1012			55.7**	55.7**			🐸🐸🐸🐸
	Lake Creek	1015	40.1	12.1				30.7	🐸🐸🐸🐸
	Lake Houston	1002	20.9	7.0		20.9		0.1	🐸🐸🐸🐸
	Peach Creek	1011		100				15.4	🐸🐸🐸
	San Jacinto River Tidal	1001					36.5		🐸🐸🐸🐸
	Spring Creek	1008	0.3	80.5	0.6	23.8		11.4	🐸🐸🐸
	West Fork San Jacinto River	1004		53.6		**		16.6	🐸🐸🐸🐸
	White Oak Bayou Above Tidal	1017	11.7	87.0		79.6			🐸🐸
San Jacinto-Brazos Coastal	Armand Bayou Tidal	1113	61.7	69.6	21.4	17.0	23.4	12.1	🐸🐸🐸
	Bastrop Bayou Tidal	1105	43.6	69.6					🐸🐸🐸
	Chocolate Bayou Above Tidal	1108		100					🐸🐸🐸
	Chocolate Bayou Tidal	1107		100			100		🐸
	Clear Creek Above Tidal	1102	23.8	78.8		60.8	48.4	13.1	🐸🐸
	Clear Creek Tidal	1101	38.6	78.0	4.7	31.8	29.2		🐸🐸🐸
	Dickinson Bayou Above Tidal	1104		54.5					🐸🐸🐸🐸
	Dickinson Bayou Tidal	1103	86.9	100	2.8	2.8	43.6		🐸
	Old Brazos River Channel Tidal	1111							🐸🐸🐸🐸🐸
	Oyster Creek Above Tidal	1110	59.3	64.5				96.8	🐸🐸🐸
	Oyster Creek Tidal	1109	100	100					🐸🐸🐸

Basin	Watershed	Segment	DO	Bact	Chl-a	Nutr	PCB	Other*	Frogs
Brazos-Colorado Coastal	San Bernard River Above Tidal	1302	61.5	80.6		10.9		7.3	🐸🐸🐸
	San Bernard River Tidal	1301	100	100					🐸🐸
	Caney Creek Above Tidal	1305	27.4	39.1		57.6		13.9	🐸🐸🐸
	Caney Creek Tidal	1304	46.8	97.9	36.8				🐸🐸🐸
Bays & Estuaries	Barbours Cut	2436				100	100		🐸🐸
	Bastrop Bay / Oyster Lake	2433							🐸🐸🐸🐸🐸
	Bayport Ship Channel	2438			100	100	100	100	🐸
	Black Duck Bay	2428			100	100	100		🐸🐸
	Burnet Bay	2430			85.9	100	100		🐸🐸
	Cedar Lakes +	2442							
	Chocolate Bay	2432	32.6	78.5			39.0		🐸🐸🐸
	Christmas Bay	2434							🐸🐸🐸🐸🐸
	Clear Lake	2425		4.7	76.2	76.2	80.9	69.3	🐸🐸
	Drum Bay	2435							🐸🐸🐸🐸🐸
	East Bay	2423	30.1		100		100		🐸🐸
	East Matagorda Bay	2441							🐸🐸🐸🐸
	Lower Galveston Bay	2439			100	61.7	100		🐸🐸
	Moses Lake	2431		34.3	14.3		21.4		🐸🐸🐸
	San Jacinto Bay	2427				100	100		🐸🐸
	Scott Bay	2429				100	100		🐸🐸
	Tabbs Bay	2426				34.8	61.5		🐸🐸🐸
	Texas City Ship Channel	2437			100	100	100		🐸🐸
	Trinity Bay	2422	11.7	25.5	76.1		89.9		🐸🐸
	Upper Galveston Bay	2421		7.3	89.7	91.1	87.5		🐸🐸
	West Bay	2424	6.0	11.7	11.4	8.2	82.6		🐸🐸🐸
	Gulf of Mexico	2501						100	🐸🐸🐸

Chart Key

🐸
Severe, multiple water quality impairment(s) or concern(s) exist in a majority of the waterbody.

🐸🐸
Significant, multiple water quality impairment(s) or concerns exist in the waterbody.

🐸🐸🐸
Water quality impairment(s) or concern(s) exist in a substantial portion of the waterbody.

🐸🐸🐸🐸
Water quality impairment(s) or concern(s) exist in the waterbody.

🐸🐸🐸🐸🐸
No significant water quality impairments or concerns exist in the waterbody.

GETTING BETTER

GETTING WORSE

* *Other includes parameters such as metals in water, metals in sediment, impaired habitat, impaired benthic macroinvertebrates, impaired fish communities, sediment toxicity, fecal coliform, mercury in fish tissue and fish contamination.*

** *Frog Chart analysis differs with the TCEQ 2020 Integrated Report due to an updated period of record (2013-2020).*

\+ *This segment was not assessed due to insufficient data.*

Watershed Summaries

Watershed Summaries include water quality information for each formally defined stream segment in the basins for which the Houston-Galveston Area Council (H-GAC) conducts or manages monitoring, water quality assessment, and stakeholder outreach. Water quality impairments and concerns are identified in the Texas Integrated Report of Surface Water Quality (IR) for Clean Water Act Sections 305(b) and 303(d). The IR is a comprehensive evaluation of the condition of surface waters in Texas. It is based on monitoring data from most recent seven-year period and provides resource managers with a tool for making informed decisions when directing agency programs. It identifies water bodies that are not meeting standards set for their use in the Texas Surface Water Quality Standards, published in Title 30, Chapter 307 of the Texas Administrative Code (TAC). The Federal Clean Water Act requires the TCEQ to submit an updated IR to the U.S. Environmental Protection Agency (EPA) every two years. H-GAC used the most recently approved 2020 IR for this 2021 Basin Summary Report.

Watershed Summaries for each segment can be accessed through the Story Map Basin Collection of which you are interested in or through segment list on the Frog Chart. To access summaries through the map, click on the bookmarked watershed area you are interested in. The Story Map will jump to the watershed segment and you may review the summary by scrolling through the map features and associated text. Each watershed summary includes the following information:

- Segment Number
- Segment Name
- Segment Length
- Watershed Area
- Designated Uses
- Number of Active Monitoring Stations
- Texas Stream Team Monitors
- Permitted Outfalls
- Degree of Impairment (by percent of stream or water body impaired)
- FY 2021 Active Monitoring Stations
- Standards and Screening Criteria
- Water Quality Issues
- Segment Discussion

The Water Quality Issues summary tables include an overview of each water quality issue affecting the watershed, a comparison of impairments and concerns identified in the 2020 IR, descriptions of the affected areas, possible causes and influences or concerns voiced by stakeholders, and possible solutions or actions to be taken to address the identified issues. Also included are narrative segment discussions of watershed characteristics, water quality issues, special studies and projects completed in the watershed, water quality trends, and recommendations.

Watershed maps and links to statistical graphs accompany the discussions to illustrate spatial variability and water quality trends that H-GAC considers important or unexpected. Typically, graphs are a plotted measure of parametric values over time where the trend is statistically significant. Some graphs may also include additional parameters that are believed to be associated with the critical parameter plotted (ex. a graph showing Dissolved Oxygen (DO) trends over time may also incorporate instantaneous flow data to help readers better visualize the relationship between DO and flow). In some cases, the annual median or geometric mean, rather than individual measurements, are plotted. Flow data from a United States Geological Survey (USGS) gauging station has been added to the charts when the station is associated with the TCEQ monitoring station.

LIST OF PARAMETERS

Table 1 - Water Quality Parameters by Type

FIELD PARAMETERS	CONVENTIONAL PARAMETERS	ORGANICS	BACTERIA
Dissolved Oxygen Flow pH Salinity Secchi Transparency Temperature	Ammonia-N Chloride Chlorophyll-*a* Nitrate-N Nitrite-N Total Phosphorus Sulfate Total Dissolved Solids Total Kjeldahl Nitrogen Total Suspended Solids	Dioxin PCBs	*Escherichia coli* (*E. coli*) Enterococci

Table 2 - Field Parameters

PARAMETER	POTENTIAL IMPACTS	POTENTIAL CAUSES
Dissolved Oxygen (DO)	The most important component for the survival of aquatic life is oxygen. DO is essentially the amount of oxygen available in water. Low DO will suffocate aquatic species, and a high amount of DO will reduce water odors.	Elevated levels of organic nutrients can cause an overabundance of bacteria and algae, which depletes oxygen from water. Human-caused increases in water temperature will also lower the capacity for water to hold oxygen.
Flow Instantaneous Flow Flow Severity	Flow conditions affect water quality. Aquatic species are adapted to specific in-stream flow patterns. Low flow events, associated with hot summer months, can severely alter a stream habitat. High flow events associated with heavy rain or melting snow 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.
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.
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 is also used as a measurement of eutrophication, the natural aging progression of a water body.	An abundance of algae and plants or excessive levels of Total Suspended Solids (TSS) will decrease the ability for light to transmit through the water column.
Temperature	The types of aquatic life that can survive in a waterbody are dependent upon the water	Releases of water from reservoirs can contribute to drops in temperature.

	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.	Temperatures will increase with the removal of flora from riparian areas or from the release of heated water from industrial activities.

Table 3 – Conventional Parameters

PARAMETER	POTENTIAL IMPACTS	POTENTIAL CAUSES
Ammonia-Nitrogen (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), can deplete natural resistances to bacterial infections, and can 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 from discharges of untreated sewage and industrial wastewater.
Chloride (Cl^{-1})	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* is a photosynthetic pigment found in green plants and is an indicator of the presence of algae in the water. It is used to monitor the trophic status of lakes or the primary productivity of ecosystems.	Elevated levels of nutrients could result in high concentrations of algal biomass.
Nitrogen Nitrate-(NO_3-N) Nitrite-(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 that can cause brown blood disease in fish by preventing the transfer of oxygen by hemoglobin. Nitrites can also adversely affect human health, especially children under the age of 3.	Nutrient sources are usually found in runoff from fertilizers and livestock facilities. They are also present in the effluent of wastewater treatment facilities.
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 will decrease dissolved oxygen levels.	Phosphates occur naturally from the decomposition of organisms. Sources also include the weathering of rock material and runoff from fertilizers.
Sulfate (SO_4^{-2})	In the absence of oxygen and with a pH below 8, bacteria will reduce sulfate ions to sulfide ions. Sulfide ions will cause serious and unpleasant odor problems.	Sulfate is derived from rocks and soils containing gypsum, iron sulfides, and organic compounds. Sulfur containing fossil fuels,

	Sulfates in sediment can also alter soil composition and hinder or prevent growth of native plants.	heavy industrial activities, and some fertilizers are also potential sources for sulfates.
Total Suspended Solids (TSS)	An increase in the amount of total suspended solids (TSS) will 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 will create excess levels of TSS. Unsound agricultural practices can also contribute to soil erosion into waterways.

Table 4 - Organic Parameters

PARAMETER	POTENTIAL IMPACTS	POTENTIAL CAUSES
Dioxin	Dioxin is a family of polychlorinated chemicals. It is carcinogenic and 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.
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.

Table 5 - Bacteria Parameters

PARAMETER	POTENTIAL IMPACTS	POTENTIAL CAUSES
Bacteria *Escherichia coli* (*E. coli*) Enterococci	*Escherichia coli* and Enterococci are bacterial indicator species for the presence of fecal matter, pathogenic bacteria, and viruses.	Malfunctioning or failing on-site sewage facilities, untreated domestic sewage, improper disposal of grease, and runoff from agricultural and livestock activities can cause an overabundance of bacteria and other pathogens.

WATER QUALITY TECHNICAL PRIMER

The Water Quality Technical Primer is provided as an overview of general water quality terminology. In combination with the Glossary, the Technical Primer provides background and defines terminologies and methodologies used to acquire, analyze, and report the data that is presented in the Basin Summary Report.

THE FEDERAL CLEAN WATER ACT

The Clean Water Act establishes the basic structure for regulating pollutant discharges, pollutant loadings in water, and regulating surface water quality standards. The goal of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 U.S.C. §1251(a)).

Amendments to The Clean Water Act in 1977:

- Established the basic structure for regulating pollutant discharges into the waters of the United States;
- Gave the US Environmental Protection Agency (EPA) the authority to implement pollution control programs such as setting wastewater standards for industry;
- Maintained existing requirements to set water quality standards for all contaminants in surface waters;
- Made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions;
- Funded the construction of sewage treatment plants under the construction grants program; and
- Recognized the need for planning to address the critical problems posed by nonpoint source pollution.

Pollution

The Texas Administrative Code defines pollution as "the alteration of the physical, thermal, chemical, or biological quantity of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose."

There are two categories of pollution: Point Source and Nonpoint Source Pollution.

Point Source pollution is any source of pollution that is subject to regulation and is permitted. An example of a point source is a permitted wastewater treatment facility effluent discharge.

Nonpoint Source (NPS) pollution is any source that is not subject to regulation, that is diffuse and does not have a single point of origin, or is not introduced into a receiving stream from a specific outfall. NPS pollution typically results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification.

TEXAS SURFACE WATER QUALITY STANDARDS

The **Texas Surface Water Quality Standards** (TSWQS) establish numerical and narrative 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. The standards are developed to maintain the quality of surface waters. 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 and Texas Water Code. The TSWQS are codified in Title 30, Chapter 307 of the Texas Administrative Code. The standards are approved by the EPA.

The TSWQS are designed to:

- designate the uses, or purposes, for which the state's water bodies should be suitable;
- establish numerical and narrative goals for water quality throughout the state; and
- provide a basis on which TCEQ regulatory programs can establish reasonable methods to implement and attain the state's goals for water quality.

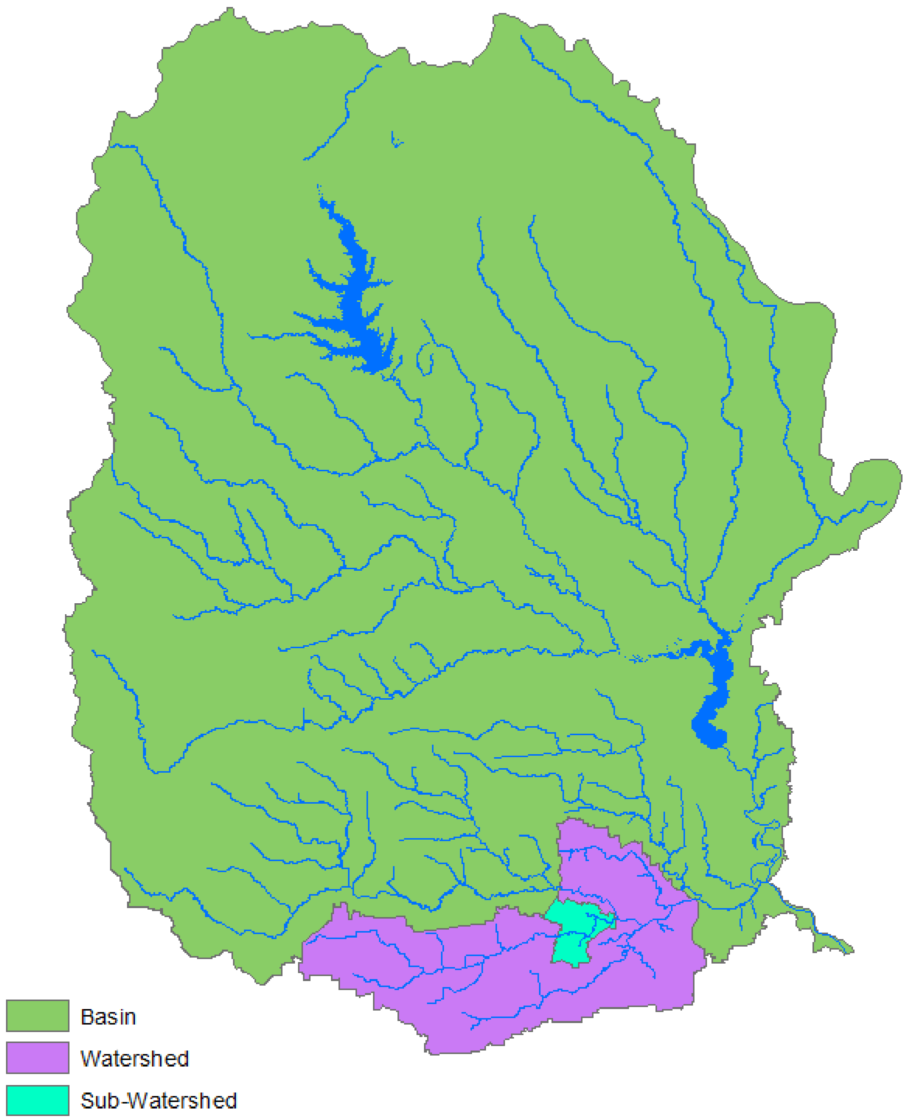
The criteria adopted and incorporated into the **standards** are the allowable concentrations of pollutants in State, Territory, and authorized Tribal waters and are developed for the protection of aquatic life and human health. Impairments occur when water quality conditions do not meet the assigned uses or criteria as defined in the TSWQS.

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 and bound by two major river basins and a bay or other outlet to the ocean.

Watersheds can be broken down into even smaller drainage areas, which are referred to as **sub-watersheds**. For example, a sub-watershed could be defined as the drainage area of a small creek, stream, or portion of a stream that is part of the drainage area for a tributary, which is part of a major river drainage basin.

Figure 1 – General Map showing basin, watershed, and subwatershed levels

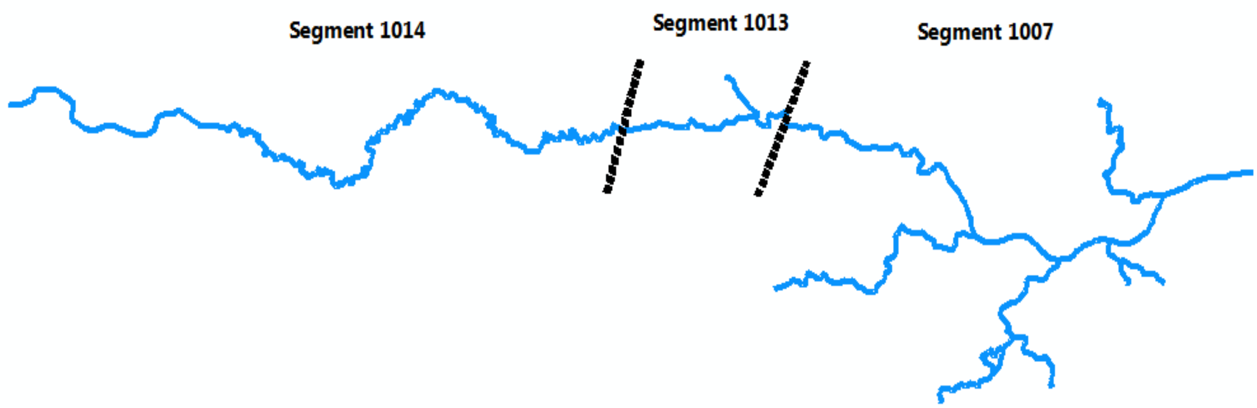


WATER BODIES, SEGMENTS, AND ASSESSMENT UNITS

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. Segments can be either classified or unclassified.

Classified Segments

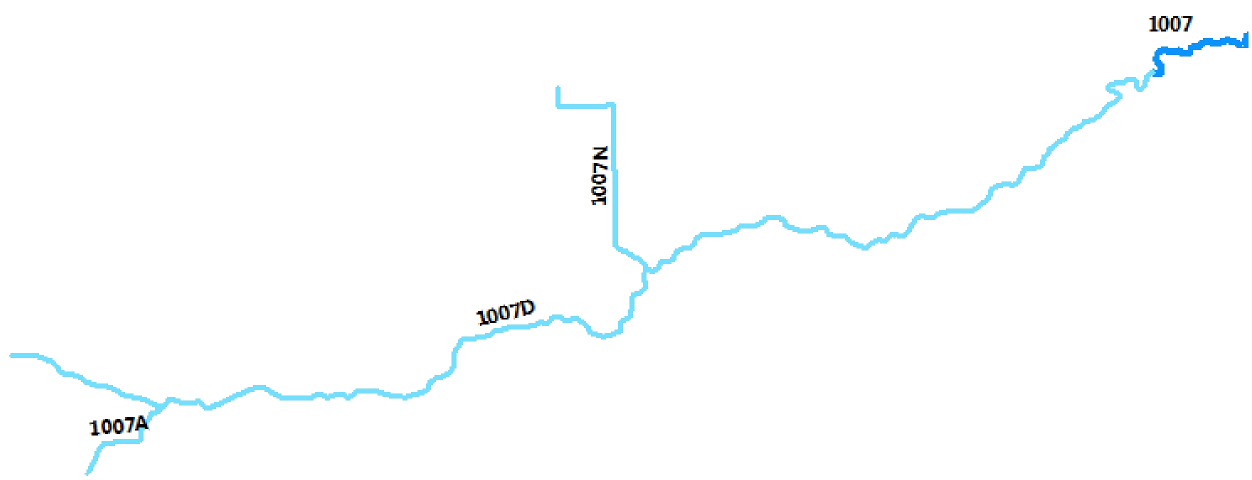
A **classified segment** is a water body (or portion of a water body) that is individually defined in the TSWQS. Typically, classified segments are major waterways. Site specific numerical criteria are developed to evaluate the uses and overall water quality of a classified segment. The parameters evaluated include bacteria, nutrients, and dissolved oxygen.



Site-specific numerical criteria are developed to evaluate the uses and water quality of classified segments. These uses include aquatic life use and recreational use (discussed later in the primer).

Unclassified Segments

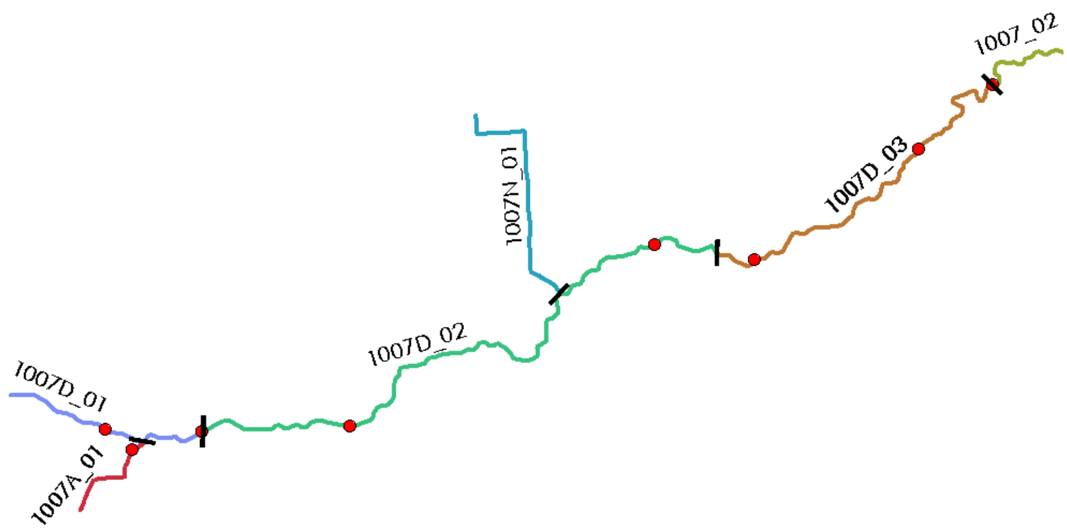
Unclassified segments are often tributaries of classified segments. These segments are usually assessed based on the criteria of the classified segment into which they flow. However, some unclassified segments have been assigned specific water quality standards in the TSWQS. Unclassified segments are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



Assessment Units (AUs)

For assessment purposes, each segment is subdivided into hydrologically-distinct units, or **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-digit code as the segment followed by an AU identifier (e.g., _01, _02, etc.). If there are multiple AUs, the assessment units will generally be in sequential order (e.g., 1007D_01, 1007D_02, etc.). Each AU is evaluated separately as part of the assessment.

For example, Sims Bayou Above Tidal (1007D) is divided into three AUs. The red dots 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 parent stream 1007D.



WATER QUALITY AND DESIGNATED USES

As defined in the TSWQS, a water body can be assigned specific uses including aquatic life, public water supply, and contact recreation use. Designated uses typically have corresponding numeric criteria listed in the TSWQS. General criteria apply across the entire state, but if sufficient information is available for a specific water body, the site-specific standards may be developed .

Aquatic Life Use

Aquatic life use (ALU) is determined by the amount of dissolved oxygen and the abundance and diversity of species. Aquatic life use 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. This use is assessed using 24-hour dissolved oxygen data along with **nekton** and **macrobenthic invertebrate** community evaluations.

Public Water Supply Use

Public water supply use includes an evaluation of chloride, sulfates, and total dissolved solids in the water body. Criteria for these parameters are set so that public water supplies are capable of treating and delivering water of acceptable quality.

Recreational Use

Recreational use refers to how safely a water body can support activities that involve the possibility of ingesting or coming into contact with water. If activities are likely to result in ingestion of water (swimming, diving, tubing, surfing, wading by children), bacteria concentrations need to be lower. The TSWQS protects human health by setting numeric criteria in a water body relative to the types of recreational activity occurring on that water body. Fecal indicator bacteria levels are measured to determine risk. Criteria are expressed as the number of bacteria per 100 milliliters (mL) of water [in terms of colony-forming units (CFU), most probable number (MPN), or other applicable reporting measures]. The presence of fecal indicator bacteria in waters suggests that human and animal wastes may be reaching the assessed waters. In freshwater, the indicator organism is *Escherichia coli* (*E. coli*). Enterococci bacteria are the indicator for tidal water bodies.

There are four categories of recreational use, which are based on the type and frequency of recreation. Primary contact recreation refers to activities such as swimming, diving, and waterskiing. These activities are presumed to have a high likelihood of ingesting water. Secondary Contact Recreation refers to activities that have limited body contact, such as wading, fishing, and canoeing. If such activities are occurring frequently, the designation is Secondary Contact Recreation 1. If the activities are less frequent due to physical characteristics such as steep banks or limited public access, the designation is Secondary Contact Recreation 2. A waterbody 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 water bodies unless there is evidence to show that the water body is not used for primary contact recreation. A Recreational Use Attainability Analysis (RUAA) is necessary to change the presumed use of a water body.

Table 1 – Recreational Use Categories for Freshwater

Category	Description	*E. coli* Geometric Mean Criterion (MPN/100 mL)	*E. coli* Single Grab Criterion (MPN/100 mL)
Primary Contact Recreation 1 (PCR1)	Activities that pose a significant risk of ingestion of water (e.g., swimming, wading by children, water skiing, diving, tubing, surfing, and the following whitewater activities: kayaking, canoeing, and rafting). Classified segments are designated for primary contact recreation 1 unless sufficient site-specific information demonstrates that elevated concentrations of FIB frequently occur due to sources of pollution that cannot be reasonably controlled by existing regulations; wildlife sources of bacteria are unavoidably high; there is limited aquatic recreational potential; or primary or	126	399

Category	Description	*E. coli* Geometric Mean Criterion (MPN/100 mL)	*E. coli* Single Grab Criterion (MPN/100 mL)
	secondary contact recreation is considered unsafe for other reasons such as ship and barge traffic.		
Secondary Contact Recreation 1 (SCR1)	Activities that commonly occur but have limited body contact incidental to shoreline activity (e.g., wading by adults, fishing, canoeing, kayaking, rafting, and motor boating). These activities are presumed to pose a less significant risk of water ingestion than primary contact recreation.	630	NA
Secondary Contact Recreation 2 (SCR2)	Activities with limited body contact incidental to shoreline activity (e.g., fishing, canoeing, kayaking, rafting and motor boating) that are presumed to pose a less significant risk of water ingestion than secondary contact recreation 1. These activities occur less frequently than secondary contact recreation 1 due to physical characteristics of the water body or limited public access.	1,030	NA
Noncontact Recreation (NCR)	Activities that do not involve a significant risk of water ingestion, such as those with limited body contact incidental to shoreline activity, including birding, hiking, and biking. Noncontact recreation use may also be assigned where primary and secondary contact recreation activities should not occur because of unsafe conditions, such as ship and barge traffic.	2,060	NA

Table 2 – Recreational Use Categories for Saltwater

Category	Description	Enterococci Geometric Mean Criterion (MPN/100 mL)	Enterococcus Single Grab Criterion (MPN/100 mL)
Primary Contact Recreation 1 (PCR1)	Activities that pose a significant risk of ingestion of water (e.g., swimming, wading by children, water skiing, diving, tubing, surfing, and the following whitewater activities: kayaking, canoeing, and rafting). Classified segments are designated for primary contact recreation 1 unless sufficient site-specific information demonstrates that elevated concentrations of FIB frequently occur due to sources of pollution that cannot be reasonably controlled by existing regulations; wildlife sources of bacteria are unavoidably high; there is limited aquatic recreational potential; or primary or secondary contact recreation is considered unsafe for other reasons such as ship and barge traffic.	35	104

Secondary Contact Recreation 1 (SCR1)	A secondary contact recreation 1 use for tidal streams and rivers can be established on a site-specific basis if justified by a use-attainability analysis and the water body is not a coastal recreation water as defined by the Beaches Environmental Assessment and Coastal Health Act of 2000 (Beach Act).	175	NA
Noncontact Recreation (NCR)	A noncontact recreation use for tidal streams and rivers can be established on a site-specific basis if justified by the use-attainability analysis and the water body is not a coastal recreation water as defined by the Beach Act.	350	NA

WATER QUALITY MONITORING

Surface Water Quality Monitoring (SWQM) Program

TCEQ's Surface Water Quality Monitoring Program evaluates the physical, chemical, and biological characteristics to ensure that it is suitable for general or designated uses. Water quality is monitored and evaluated in relation to human health concerns, ecological conditions, and designated uses. Data collected under the SWQM program is utilized by the TCEQ to provide a basis for effective policies that promote the protection, restoration, and wise use of the state's surface water.

Surface water samples are collected for assessment purposes following the methodologies outlined in TCEQ's *Surface Water Quality Monitoring Procedures Volume 1: Physical and Chemical Monitoring Methods* (TCEQ Publication RG-415) (colloquially referred to as "SWQM Procedures"). The guidelines outlined in the SWQM Procedures manual document the methods and the quality assurance procedures that must be used to demonstrate that data collected by monitoring personnel across the state are of a known and adequate quality. All data collected by H-GAC and its partners are collected following SWQM procedures.

Water quality data, including data collected under SWQM and the Clean Rivers Program, are stored in the **Surface Water Quality Monitoring Information System (SWQMIS)**. This database is used to enter, manage, track, and report on water quality-related data.

Coordinated Monitoring Schedule (CMS)

The Coordinated Monitoring Schedule (CMS) is the combined schedule for all surface water quality monitoring in Texas. Monitoring entities within a basin or region meet annually to establish and coordinate monitoring schedules as a way to ensure appropriate coverage, reduce duplication of effort, and better utilize available resources.

The CMS lists:
- monitoring stations
- collecting entities
- submitting entities
- monitoring type
- parameters
- monitoring frequency

The Coordinated Monitoring Schedule is available online at cms.lcra.org.

Quality Assurance Project Plan (QAPP)

H-GAC's Clean Rivers Program **Quality Assurance Project Plan (QAPP)** describes H-GAC's quality assurance policies, management structure, and procedures used to implement the quality assurance requirements for the Clean Rivers Program. These policies and procedures are necessary to verify and validate data collected for the Clean Rivers Program. The QAPP is reviewed and approved by TCEQ to help ensure that all data generated are of known and documented quality, deemed acceptable for their intended use and that the data have been collected and managed in such a way as to guarantee its reliability. Only quality-assured data may be used for water quality assessments or other regulatory purposes. H-GAC's current and previous QAPP documents are available on H-GAC's website at h-gac.com.

Monitoring Types

Monitoring activities may be divided into the following categories:
- Routine Monitoring
- Special-Study Monitoring
- Permit-Support Monitoring
- Systematic Monitoring

The type of monitoring conducted by the Clean Rivers Program is usually **routine**, meaning it is monitoring that is scheduled in advance without intentionally trying to target any certain environmental condition, with samples being collected regardless of the conditions encountered. Routine monitoring, at a minimum, includes field measurements [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** for a detailed description of each parameter.

Another monitoring type conducted by the Clean Rivers Program is biased monitoring (monitoring 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 Waters Act require the TCEQ to provide the *Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)* (Integrated Report) 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.

For the assessment, TCEQ evaluates data collected during a seven-year period. The timeframe is extended to 10 years (if needed) to attain the minimum number of data points needed for the assessment.

Each assessed water body is identified as:

- Fully Supporting: at least 10 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 levels of concern, CN and CS. CN means there is concern for near nonattainment of the TSWQS based on numeric criteria. A concern status of CN indicates that standards are not being met, but there is insufficient data to fully assess the water body. CS means that there is a concern for water quality based on **screening levels**. Screening levels are used when there is not a defied standard (as with nutrients) and are derived from statistical distributions of statewide water quality monitoring data, with the 85th percentile for each applicable parameter is used as the screening level criteria.
- Impaired – Data indicates that the water body does not meet standards. Impaired waterbodies are placed on the 303(d) List.

When a water body is determined to be impaired, several things must happen:

- The water body must be listed on the 303(d) List;
- An evaluation must be undertaken to determine what is preventing the water body from supporting its designated use(s) or if the use(s) are appropriate;
- Steps must be taken to either remedy the problem, collect additional data, or evaluate which uses are appropriate for the water body. These steps may include additional monitoring, development of a Total Maximum Daily Load (TMDL) or Watershed Protection Plan (WPP), or a review of the water quality standards.

After assessment, water bodies are placed into one of five categories (with subcategories). These categories indicate the water quality status of the water body.

Table 3 – Categories on the 303(d) List

Category	Description
1	Attaining all water quality standards and no use is threatened.
2	Attaining some water quality standards and no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.
3	Insufficient data and information are available to determine if any water quality standard is attained.
4	Water quality standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.
4a	TMDL has been completed and approved by EPA.
4b	Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.
4c	Nonsupport of the water quality standard is not caused by a pollutant.
5	The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.
5a	A TMDL is underway, scheduled, or will be scheduled.
5b	A review of the water quality standards for the water body will be conducted before a TMDL is scheduled.
5c	Additional data and information will be collected before a TMDL is scheduled.

If a previously assessed AU has insufficient data available during the assessment period for the most recent Integrated Report, this results in a carry-forward of the impairment listing from the previous report.

MANAGEMENT MEASURES FOR IMPAIRED WATER BODIES

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

- A **Total Maximum Daily Load (TMDL)** is a method used to determine the amount (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 waterbody'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.

- A **Watershed Protection Plan (WPP)** is a community and 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.

- A **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. If there is a consensus among stakeholders and resource agencies that a presumed or designated use may not be appropriate for a water body, a UAA may be conducted to determine the most appropriate use(s).

- A **Recreational Use Attainment Analysis (RUAA)** is used to determines if contact recreation use occurs in a waterbody. A waterway may have physical characteristics or limited public access that would not warrant a contact recreation use designation.

ACRONYMS & ABBREVIATIONS

ALU	Aquatic Life Use
AU	Assessment Unit
BIG	Bacteria Implementation Group
BMP	Best Management Practices
CFS	Cubic feet per second
CFU	Colony-forming Unit
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, oils, and grease
FS	Fully-supporting designated use
FY	Fiscal year
HCFCD	Harris County Flood Control District
H-GAC	Houston-Galveston Area Council
I-Plan	Implementation Plan
IR	*Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)*
km	kilometer
L	liter
LOESS	Locally-Weighted Least Squares Plot
LOQ	Limit of Quantitation
mg	milligram
mg/L	milligram per liter
MGD	Millions of gallons per day
mi	mile
mL	milliliter
MPN	Most Probably Number
MS4	Municipal Separate Storm Sewer System
NC	No concern
NCR	Non-contact recreation
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source pollution
NS	Nonsupport for 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
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
TMDL	Total Maximum Daily Load
TPDES	Texas Pollutant Discharge Elimination System
TRIES	Texas Research Institute for Environmental Studies
TSS	Total suspended solids
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
UAA	Use attainability analysis
USGS	U.S. Geological Survey
WPP	Watershed Protection Plan
WWTF	Wastewater treatment facility

GLOSSARY OF TERMS

A

Algae - 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 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) – A designation assigned to an individual water body segment based upon the potential to support aquatic life.

Assessment Unit (AU) – The smallest geographic areas 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.

B

Basin – Large geographic areas generally containing one or more watersheds.

Benthos - Aquatic bottom-dwelling organisms including worms, leeches, snails, flatworms, burrowing mayflies and clams.

Best Management Practices - Schedules of activities, maintenance procedures, and other management practices to prevent or reduce the pollution of water to the maximum extent practicable. Best management practices include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

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.

C

Channelization - Straightening and deepening streams so water will move faster. A method of flood control that disturbs fish and wildlife habitats and can interfere with a water body’s ability to assimilate waste.

Chloride (Cl^{-1}) - 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 growing plants.

Chlorophyll *a* - A photosynthetic pigment found in all green plants. The concentration of chlorophyll *a* is used to estimate phytoplankton biomass (all of the phytoplankton in a given area) in 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.

Conductivity - 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.

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 to support and protect desired uses.

D

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 that may be 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. It is considered carcinogenic and can disrupt the reproductive and immune systems in humans.

Dissolved Oxygen - 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.

Dissolved Oxygen (DO) Measurements, 24-hour – 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.

E

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 indicates 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.

F

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.

Fully Supporting – The water body meets Texas Surface Water Quality Standards (TSWQS) or supports its designated uses.

H

Habitat - The area in which an organism lives.

I

Impaired – A designation for an associated use (aquatic life, contact recreation, etc.) where a water quality standard is not attained.

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.

L

Limit of Quantitation (LOQ) – The lowest concentration of a substance that can be accurately measured under specific 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."

M

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

Monitoring – The process of sampling and analyzing water quality parameters over time.

Municipal Separate Storm Sewer System (MS4) – A conveyance (or system of conveyances) that is owned by a state, city, town, village, or other public entity that discharges to waters of the United States, is designed to collect or convey stormwater (e.g., storm drains, pipes, ditches), is not a combined sewer, and is not part of a sewage treatment plant or publicly owned treatment works.

N

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 - Aquatic recreational pursuits not involving a significant risk of water ingestion and limited body contact incidental to shoreline activity - including fishing, and commercial and recreational boating. *See also* contact recreation.

Nonpoint Source (NPS) Pollution - A pollution source that is not subject to regulation, that is diffuse and does not have a single point of origin, or is not introduced into a receiving stream from a specific outfall. NPS pollution typically results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrologic modification.

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.

O

Outfall - A designated point of effluent discharge.

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

P

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

Phosphorus - A nutrient that is essential to the growth of organisms. It can be the nutrient that limits the primary productivity of water. In excessive amounts from wastewater, agricultural drainage, and certain industrial waste it also contributes 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.

Point Source pollution - Any source of pollution that is subject to regulation and is permitted. An example of a point source is a permitted wastewater treatment facility effluent discharge.

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

Q

Quality Assurance Project Plan (QAPP) – A written document outlining the procedures a monitoring project will use to ensure the data it collects and analyzes meets project requirements.

R

Recreational Use Attainment Analysis (RUAA) – A Use Attainment Analysis designed to determine if contact recreation is an appropriate use of 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 that is scheduled in advance without intentionally trying to target a certain environmental condition. Routine monitoring typically consists of field measurements, conventional chemical parameters, bacteria, and flow measurements.

Runoff - The part of precipitation or irrigation water that runs off land into streams and other surface water.

S

Screening Level – Established targets (instream concentrations) for parameters that establish targets that can be directly compared to monitoring data. Screening levels are derived from long-term monitoring data or published levels of concern.

Sediment - Particles and/or clumps of 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.

Sonde – A multi-parameter water quality monitoring device that calculates and records field parameters.

Standards - The designation of water bodies for desirable uses and the narrative and numerical criteria deemed necessary to protect those uses.

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

Subwatershed – Any of several drainage areas that flow to a specific location and collectively form a watershed.

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.

SWQMIS – Surface Water Quality Monitoring Information System. A database that serves as a repository for surface water quality monitoring data for the state of Texas.

T

Texas Surface Water Quality Standards (TSWQS) – Standards that establish explicit goals for the water quality of streams, rivers, lakes, and bays throughout the state. The Standards are developed to maintain the quality of surface waters in Texas so that it supports public health and enjoyment and protects aquatic life, consistent with the sustainable economic development of the state. Water quality standards identify appropriate uses for the state’s surface waters, including aquatic life, recreation, and sources of public water supply. The TSWQS are codified in Title 30, Chapter 307 of the Texas Administrative Code.

Tidal - Descriptive of 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 24xx, all streams with the word tidal in the segment name, and the Gulf of Mexico.

Total Dissolved Solids - The amount of material (inorganic salts and small amounts of organic material) dissolved in water and commonly expressed as a concentration in terms of milligrams per liter.

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

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

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

U

Use Attainability Analysis (UAA) – A structured scientific assessment of the factors affecting a water body’s attainment of specified uses.

W

Water body – Refers to any mass of water (lake, bay, river, creek, bayou, etc.).

Water Quality – The chemical, physical, and biological characteristics of water.

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

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WATERSHED SUMMARIES

BASIN 09

Trinity-San Jacinto Coastal Basin

0902 – Cedar Bayou Above Tidal

0901 – Cedar Bayou Tidal

Segment Number: 0902				Name: Cedar Bayou Above Tidal	
Length:	25 miles	**Watershed Area:**	145 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	3	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	29

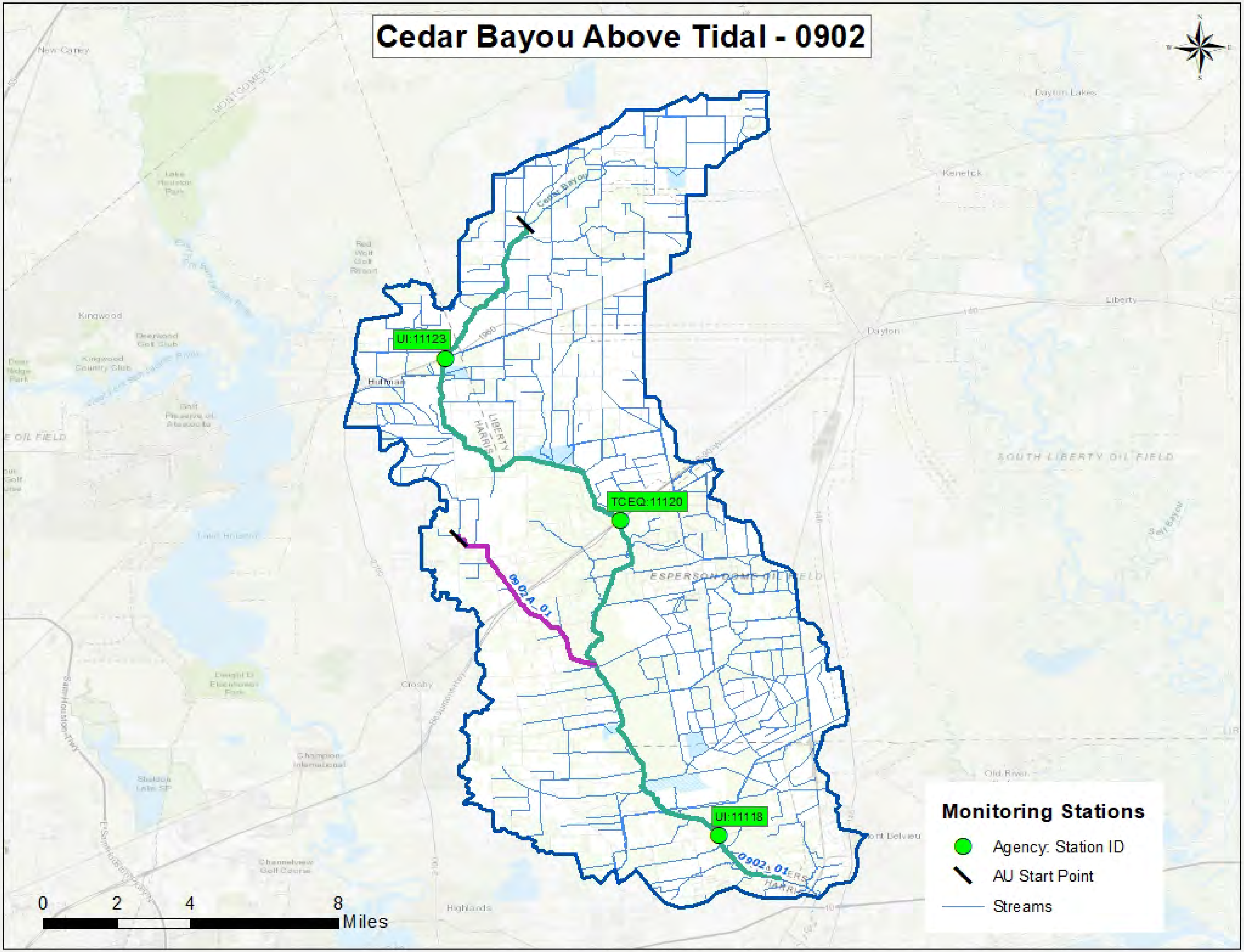
DESCRIPTION

- Segment 0902 (Perennial Stream w/ High ALU): **Cedar Bayou Above Tidal** (classified water body) – From a point 2.2 km (1.4 miles) upstream of IH 10 in Chambers/Harris County to a point 7.4 km (4.6 miles) upstream of FM 1960 in Liberty County

- Segment 0902A (Perennial Steam w/ Limited ALU): **Adlong Ditch** (unclassified water body) – From the confluence of Cedar Bayou Above Tidal to the intersection of Stoker Rd and Ramsey Rd

FY 2021 Routine Active Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11118	0902	CEDAR BAYOU ABOVE TIDAL 30 M DOWNSTREAM OF FM 1942 AT EAST BANK	UI	Quarterly	Field, Conventional, Bacteria, Flow
11120	0902	CEDAR BAYOU ABOVE TIDAL 20 M DOWNSTREAM OF US 90 NORTHEAST OF CROSBY	LL	Biannual	Field, Conventional, Flow
11120	0902	CEDAR BAYOU ABOVE TIDAL 20 M DOWNSTREAM OF US 90 NORTHEAST OF CROSBY	FO	Quarterly	Field, Conventional, Bacteria, Flow
11123	0902	CEDAR BAYOU ABOVE TIDAL 45 M DOWNSTREAM OF FM 1960 NORTHEAST OF HUFFMAN	UI	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
LL = Trinity River Authority Lake Livingston Project
UI = University of Houston Clear Lake – Environmental Institute of Houston



Cedar Bayou Above Tidal - 0902
UI:11123
TCEQ:11120
UI:11118
0902A_01
0902_01
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0
2
4
8
Miles

Segment 0902 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	Dissolved Oxygen (mg/L) (grab):	5.0
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Ammonia (mg/L):	0.33
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Nitrate-N (mg/L):	1.95
pH (standard units):	6.5-9.0	Orthophosphate Phosphorus (mg/L):	0.37
E. coli (MPN/100 mL) (grab):	399	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (geometric mean):	126	Chlorophyll *a* (µg/L):	14.1
Chloride (mg/L as Cl):	200		
Sulfate (mg/L as SO_4):	150		
Total Dissolved Solids (mg/L):	700		

The designated Public Water Supply use for 0902 was removed from the Texas State Surface Water Quality Standards that were adopted on February 7, 2018.

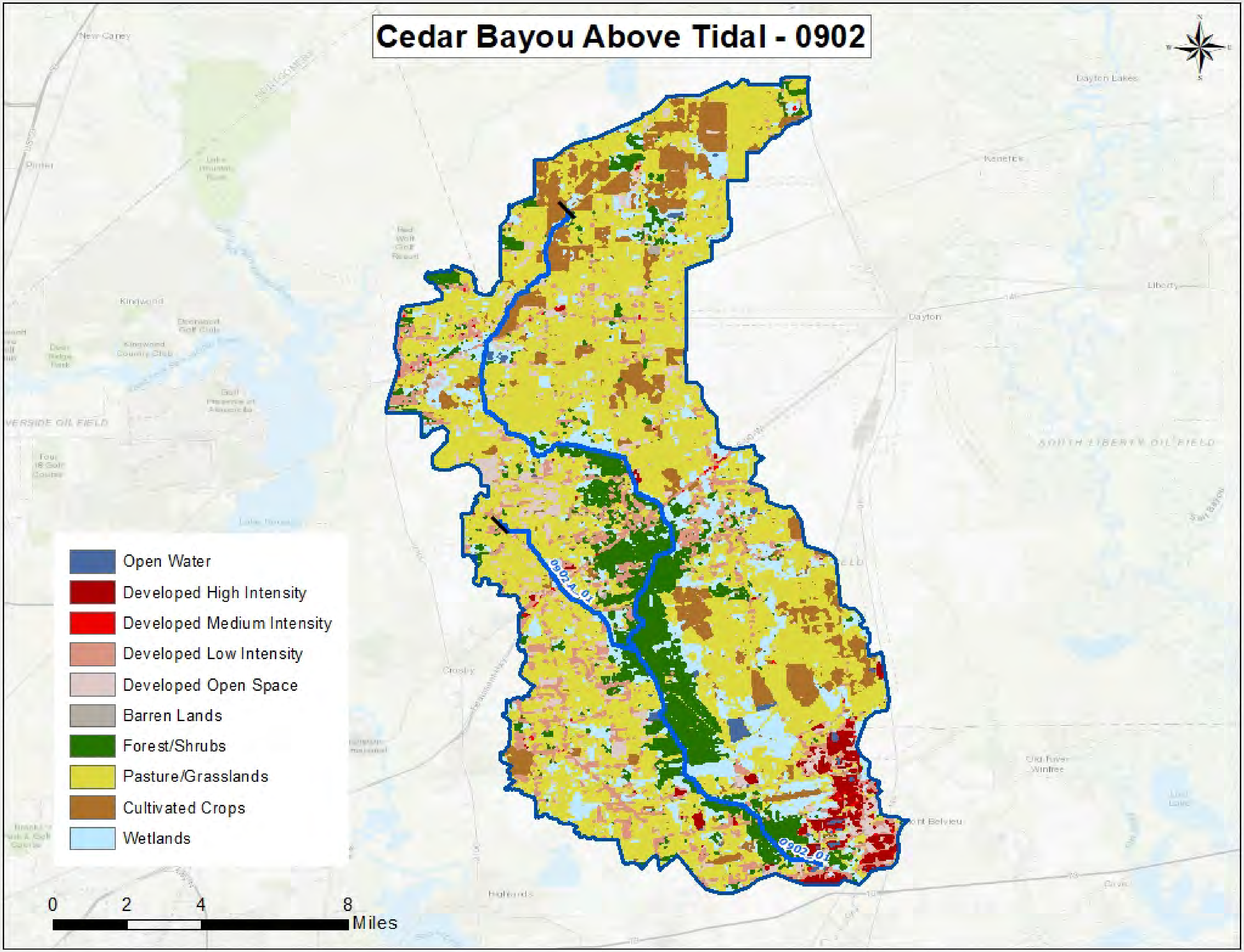
Segment Discussion

Watershed Characteristics and Land Cover: Cedar Bayou Above Tidal lies in the coastal plain between the Trinity and San Jacinto rivers. The segment originates approximately 4.6 miles upstream of Farm-to-Market 1960 in Liberty County and extends to the start of the Cedar Bayou Tidal segment (0901) approximately 1.4 miles above Interstate 10. This segment represents the border between Harris and Chambers Counties. In the northern portion of the watershed, the path and banks of the waterway have been heavily modified as it flows through developed lands. This portion of Cedar Bayou receives water from manmade drainage conveyances, such as Adlong Ditch, as well as stormwater runoff from adjacent lands. The Cedar Bayou Above Tidal segment also passes through the industrialized areas west of the City of Mont Belvieu.

This watershed covers approximately 93,000 acres. Agriculture comprised 75.52 percent of the watershed area in 2008, but decreased to 58.00 percent of the watershed in 2018. However, Agriculture is still the predominant land use, with many small hobby farms scattered throughout the watershed. Principal crops include turf/sod, rice, and hay. Developed lands have increased by 214 percent from 2008 to 2018, from 4,653 acres (5.00 percent) to 14,613 acres (15.69 percent). Rapid expansion of industrial operations, including refineries and oil and gas extraction operations, are currently underway in the southeastern portion of the watershed in and around the city of Mont Belvieu. Residential development is concentrated in the extreme southern portion of the watershed in the city of Mount Belvieu near Baytown. Some residential development occurs northwest of U.S. Highway 90. Because the watershed is not highly developed, on-site sewage facilities are the primary method of waste treatment.

Segment 0902 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	70,333.07	75.52	54,024.48	58.00	-23.19
Barren Lands	148.34	0.16	498.23	0.53	235.88
Developed	4,653.36	5.00	14,612.85	15.69	214.03
Forest/Shrubs	1,350.37	1.45	10,242.65	11.00	658.51
Open Water	823.97	0.88	471.54	0.51	-42.77
Wetlands	15,825.75	16.99	13,294.32	14.27	-16.00
TOTAL	**93,134.86**	**100.00**	**93,144.06**	**100.00**	



Cedar Bayou Above Tidal - 0902
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0902A_01
0902_01
0 2 4 8
Miles
Dayton
Liberty
SOUTH LIBERTY OIL FIELD
Kingwood
Crosby
Mont Belvieu

Water Quality Issues:

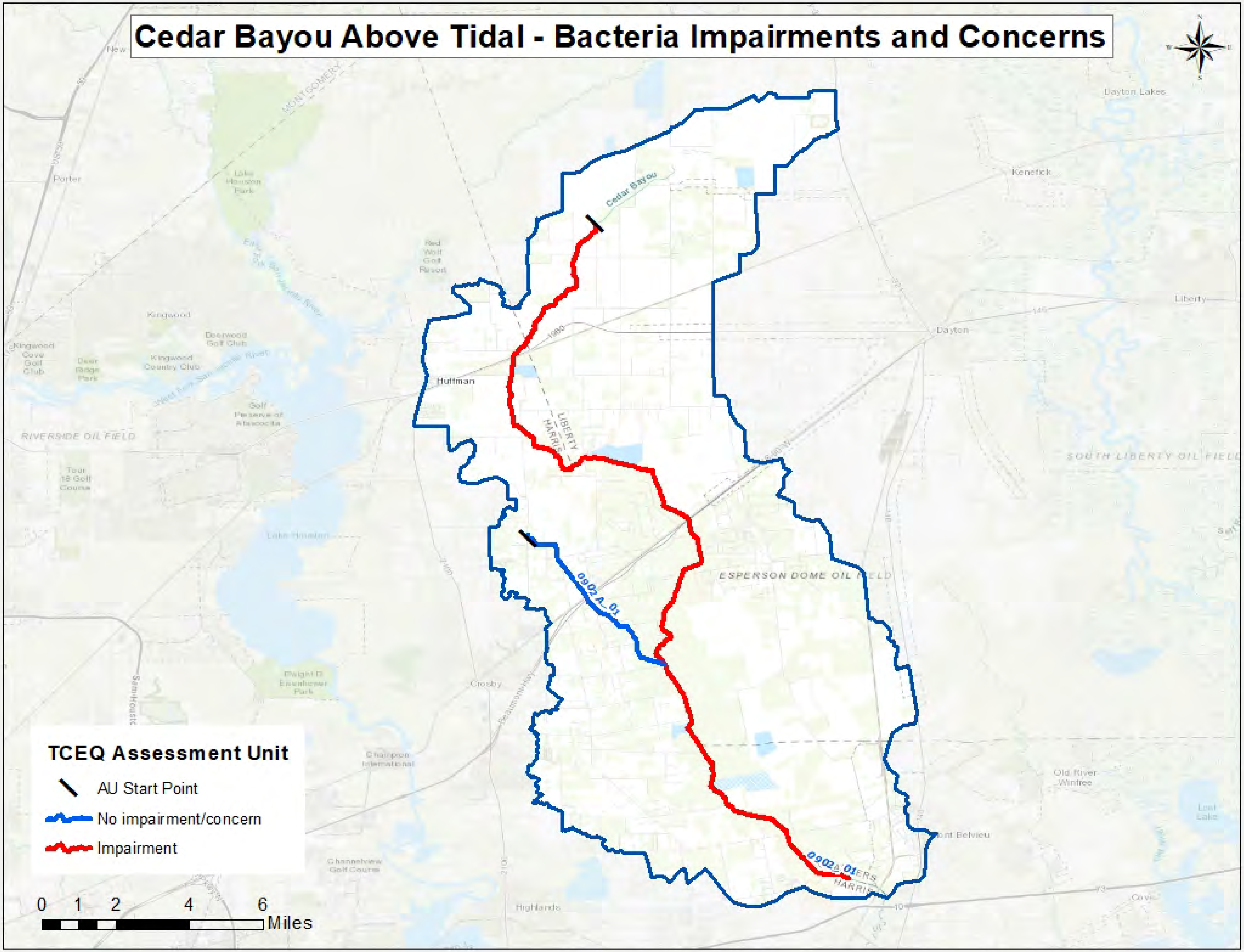
Bacteria Impairments and Concerns
Cedar Bayou Above Tidal (0902) is identified as not supporting its recreation use designation due to elevated levels of bacteria. The *E. coli* geometric mean was 168.51 MPN/100 mL based on 125 results evaluated during the period of 12/01/11 – 11/30/18.

Dissolved Oxygen Impairments and Concerns
Cedar Bayou Above Tidal is listed as impaired in the 2020 Texas Integrated Report due to depressed dissolved oxygen. For the period of 12/01/11 – 11/30/18, the 24-hour dissolved oxygen average was below the criteria of 5 mg/L for 5 of 19 samples. This water body also has a concern for impaired macrobenthic community in water.

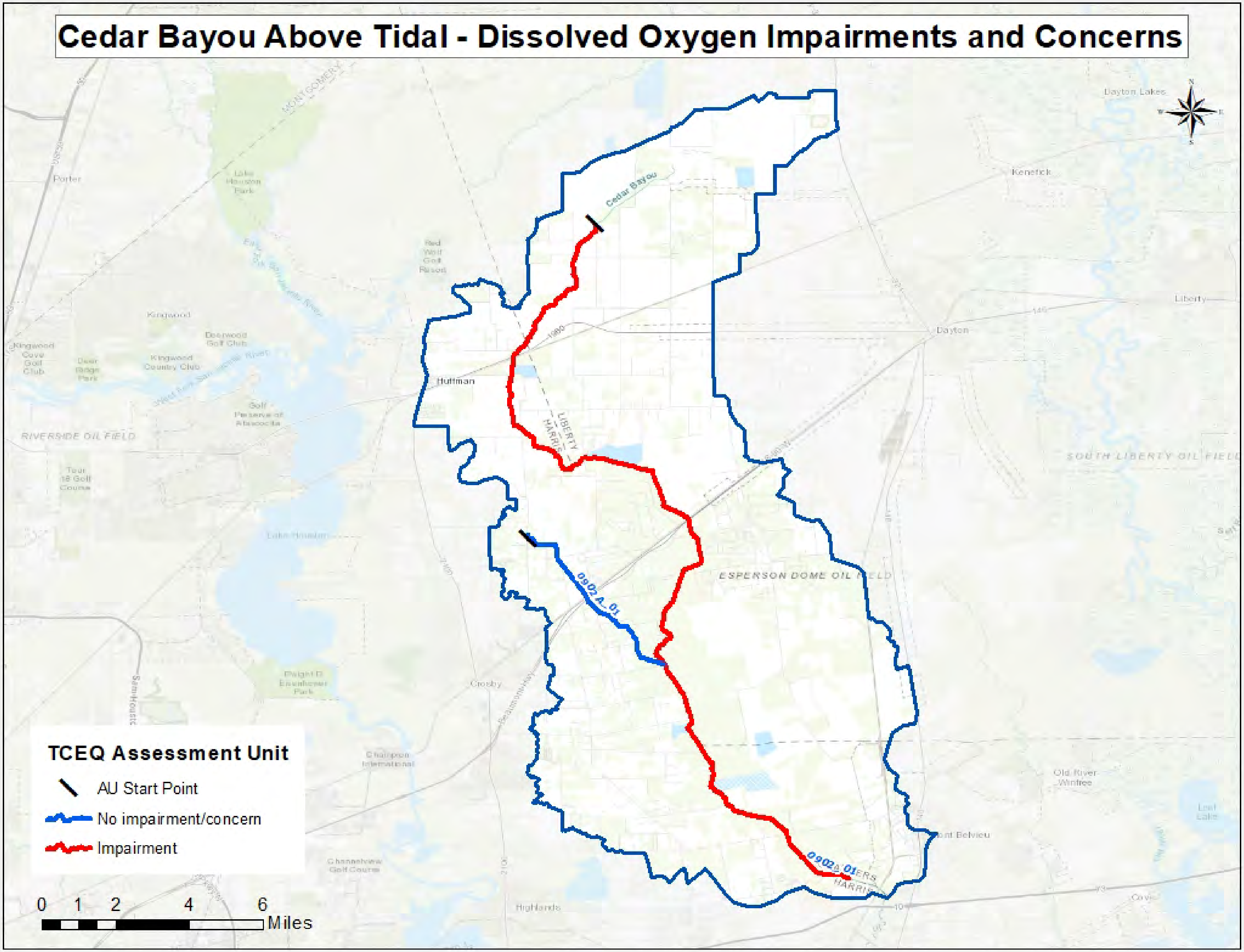
Nutrient Concerns
There were no concerns for nutrient screening levels in Cedar Bayou Above Tidal. However, numerous values exceeded the nutrient screening levels. This included 16 of 164 results (9.8 percent) for ammonia, 5 of 172 results (2.9 percent) for nitrate, 23 of 169 results (13.6 percent) for total phosphorus, and 8 of 141 results (5.7 percent) for chlorophyll-a.

For Adlong Ditch (0902A), there is a concern for ammonia-nitrogen screening levels, with 6 of 20 samples (30 percent) exceeding the screening level of 0.33 mg/L.

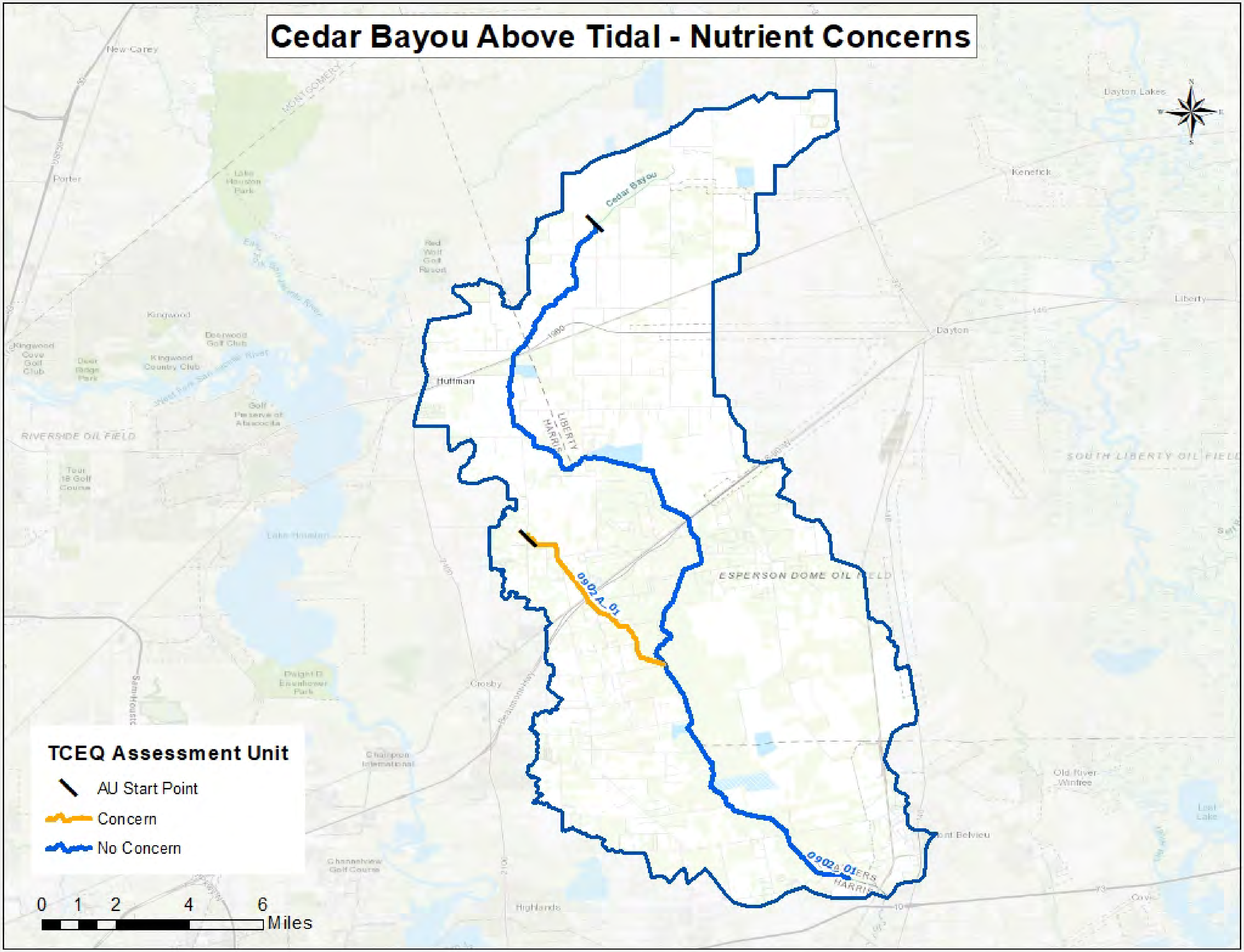
PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.



Cedar Bayou Above Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0 1 2 4 6
Miles
0902A_01
Cedar Bayou
Huffman
Crosby
Dayton
Liberty
Kenefick
Dayton Lakes
Porter
Kingwood
Highlands
Old River-Winfree
ESPERSON DOME OIL FIELD
RIVERSIDE OIL FIELD
SOUTH LIBERTY OIL FIELD
LIBERTY
HARRIS



Cedar Bayou Above Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0 1 2 4 6
Miles
0902A_01
Cedar Bayou
Huffman
Dayton
Liberty
Kenefick
Dayton Lakes
Crosby
Highlands
Porter
Kingwood
Lake Houston
ESPERSON DOME OIL FIELD
RIVERSIDE OIL FIELD
SOUTH LIBERTY OIL FIELD
LIBERTY
HARRIS



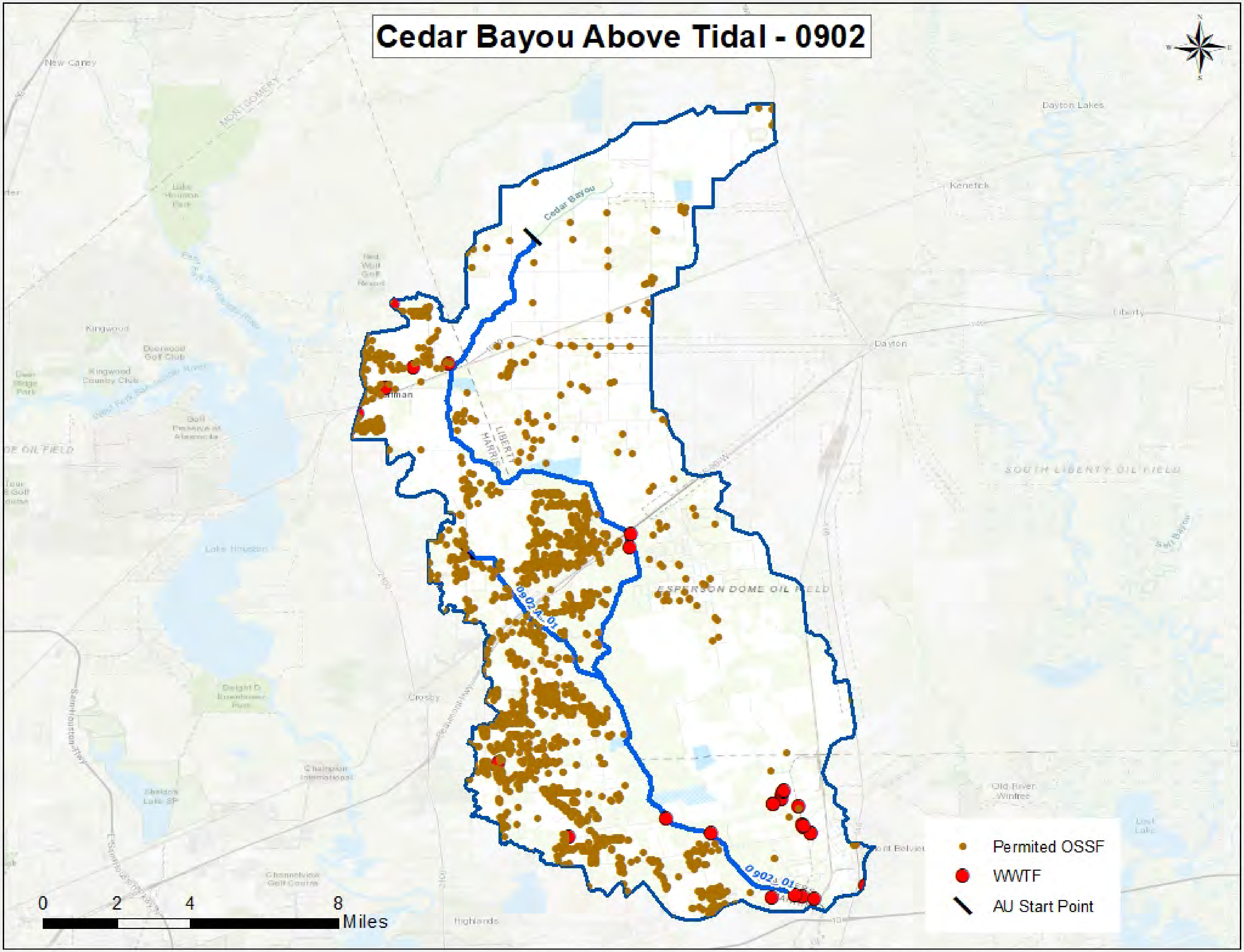
Cedar Bayou Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
Concern
No Concern
0 1 2 4 6
Miles
0902A_01
0902A_01
Cedar Bayou
Huffman
Crosby
Dayton
Liberty
Kenefick
Dayton Lakes
Highlands
ESPERSON DOME OIL FIELD
RIVERSIDE OIL FIELD
SOUTH LIBERTY OIL FIELD
Lake Houston
Porter
New Carey
Kingwood

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Cedar Bayou Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 29 permitted wastewater outfalls in the Cedar Bayou Tidal watershed. In some areas, on-site sewage facilities are the primary source of wastewater disposal. These systems are primarily located in the western portion of the watershed. There are 1,789 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Cedar Bayou Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 26 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Cedar Bayou Above Tidal watershed.

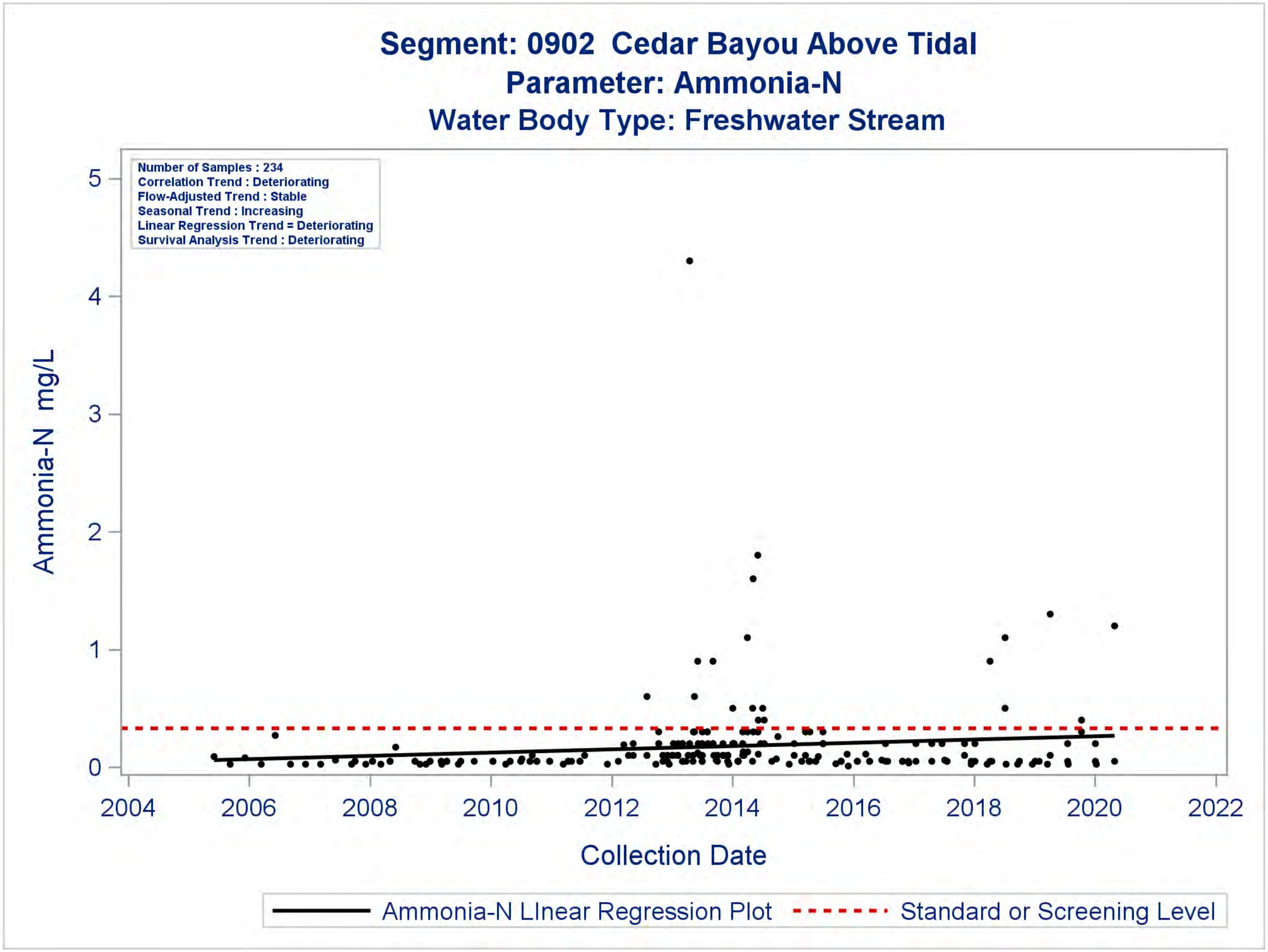

Cedar Bayou Above Tidal - 0902
Permited OSSF
WWTF
AU Start Point
0 2 4 8 Miles
Cedar Bayou
0902A_01
0902_01
ESPERSON DOME OIL FIELD
SOUTH LIBERTY OIL FIELD
Dayton
Dayton Lakes
Kenefick
Liberty
Crosby
Highlands
Kingwood
Lake Houston
New Caney

Trend Analysis:

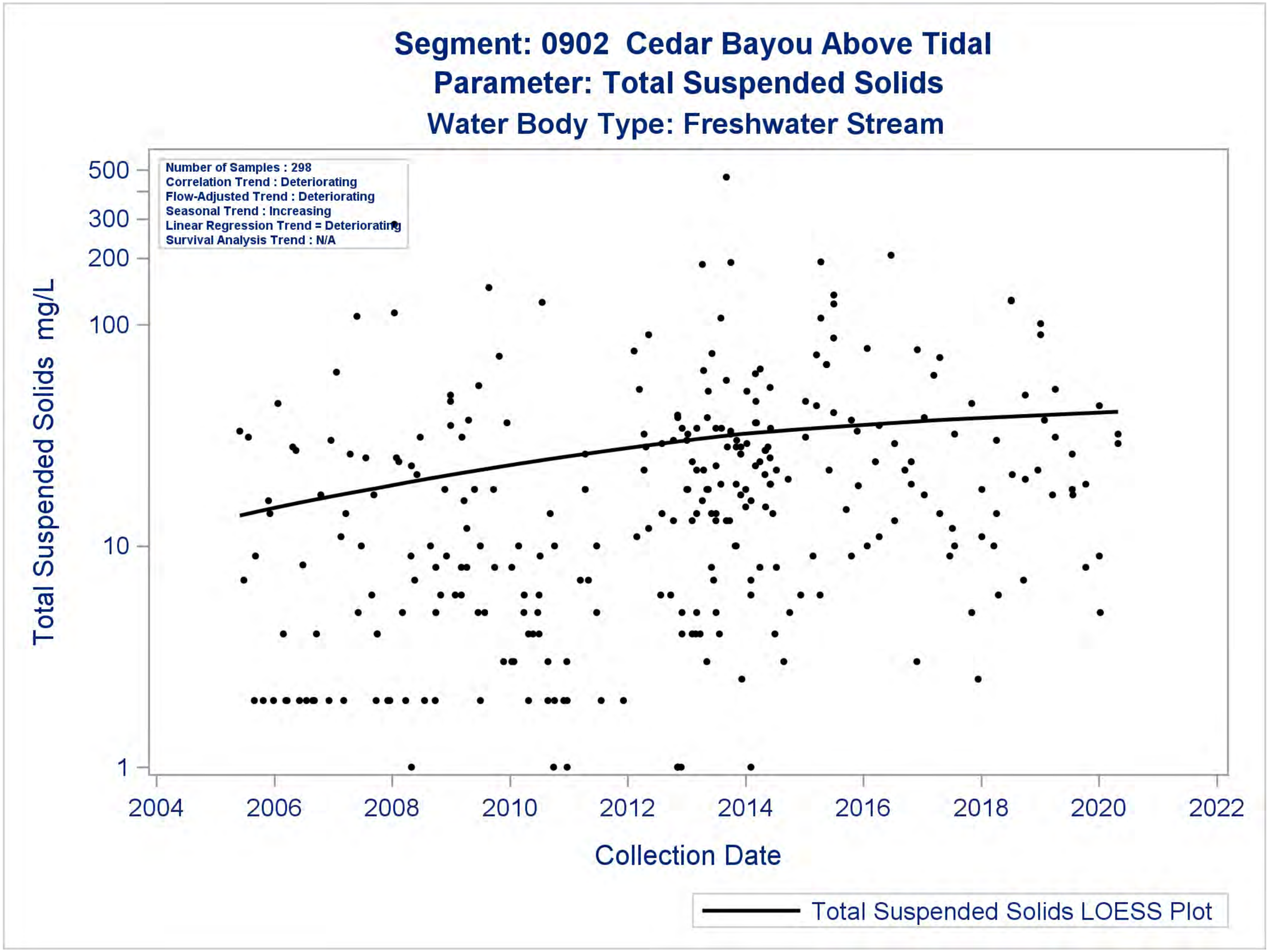
Regression analysis of segment data revealed four significant increasing parameter trends for Cedar Bayou Above Tidal – ammonia, total suspended solids (TSS), total phosphorous (TP), and Sulfate. Majority of samples collected since 2000 have nutrient concentrations that fall below the set screening criteria but sample concentrations above the screening criteria are becoming more frequent. There is also an increasing trend with instantaneous flow in this segment; however, there was a drought between late 2009 and 2012 so there was little rain to create high flow events in the stream. Subsequently, the instantaneous flow trend is probably a result of normal flow returning to the stream after the drought. Chloride concentrations in this assessment unit (AU) are trending down which also may be related to the low flows during the drought when the chloride concentrations were the highest for this segment. This is also a decreasing trend for chloride at station 11120 which is located in the middle of the classified segment.

A total of five monitoring stations have been sampled within this segment over the last fifteen years. Three stations are located on the classified segment and two were on the unclassified segment. The unclassified segment sites were only sampled for a few years. Data collection began at stations 11118, 21080, and 21081 in 2012 for the Cedar Bayou watershed protection plan (WPP) project with only station 11118 being continued for a few more years. Stations 11120 and 11123 have been monitored since 2000 and 2007 respectively. All monitoring stations reflect the same variation in nutrient levels except for stations 11118 and 11123. Station 11118 indicates a decrease in total Kjeldahl nitrogen (TKN) since 2012 and station 11123 shows an increasing trend for ammonia. The increasing nitrate trend seen on the unclassified segment, 0902A, has data from only 3 years so it would require additional data to confirm the increasing trend.

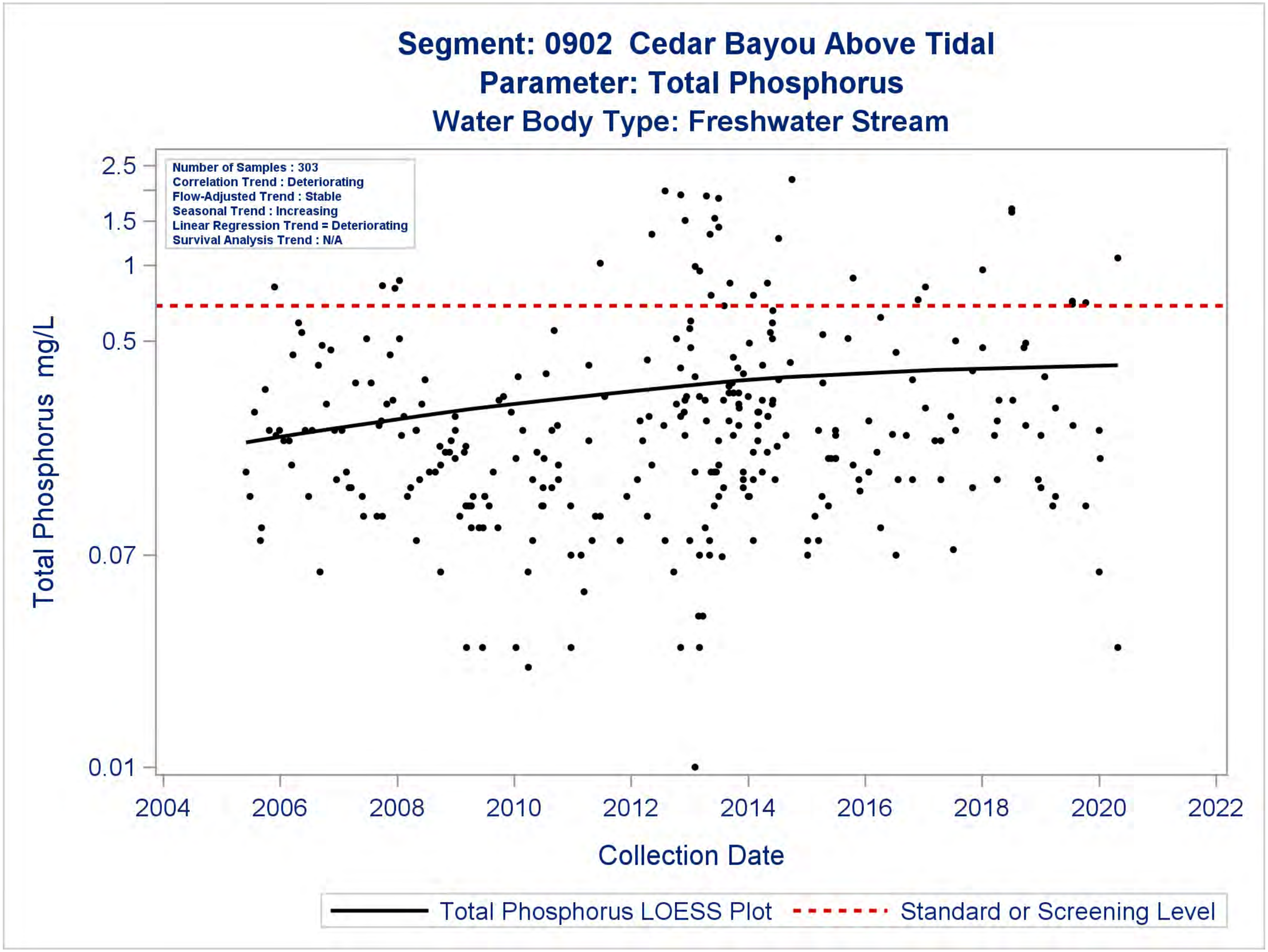
No significant trend was observed for DO levels throughout the watershed.



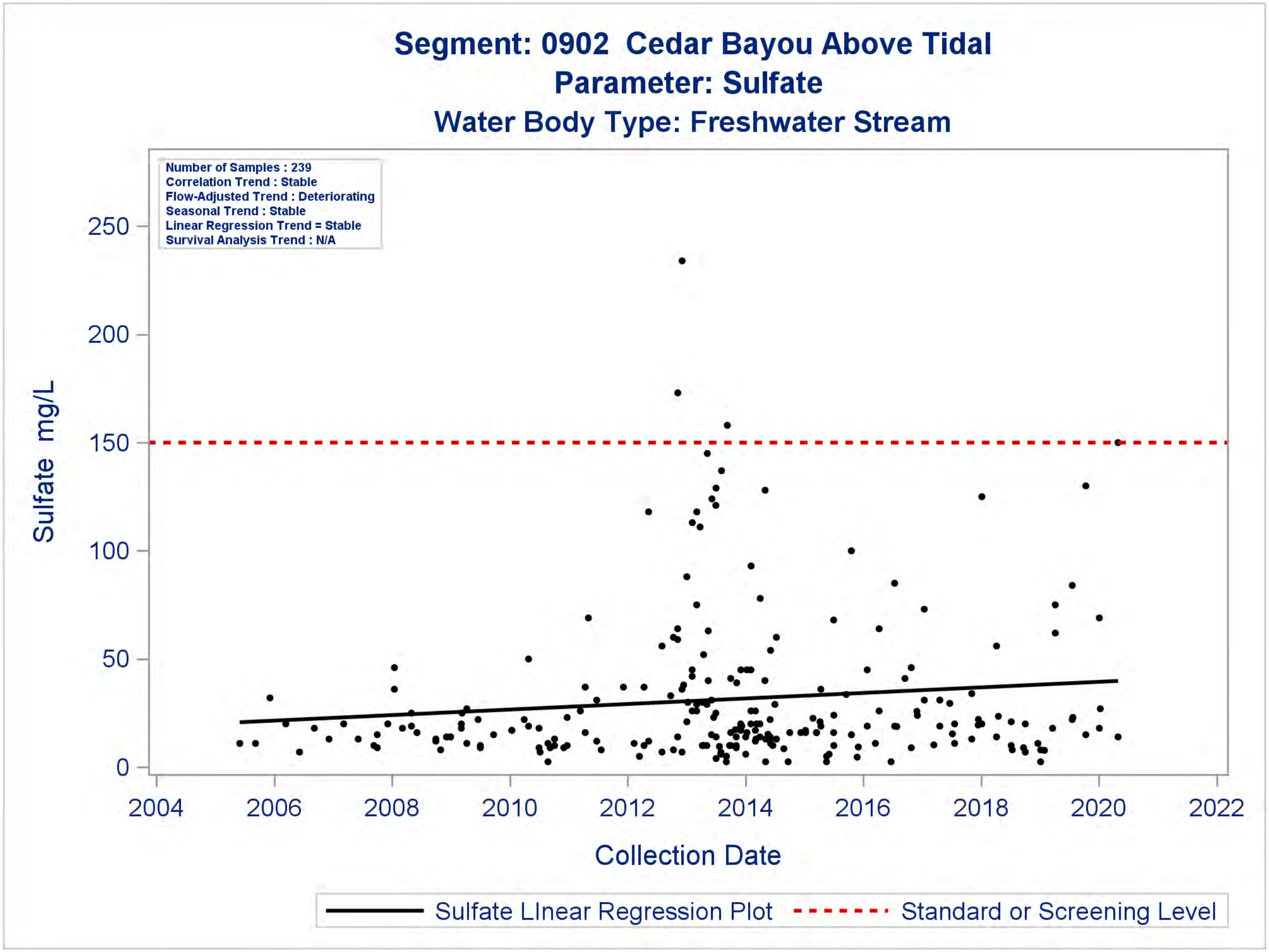
Segment: 0902 Cedar Bayou Above Tidal
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 234
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
0
1
2
3
4
5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



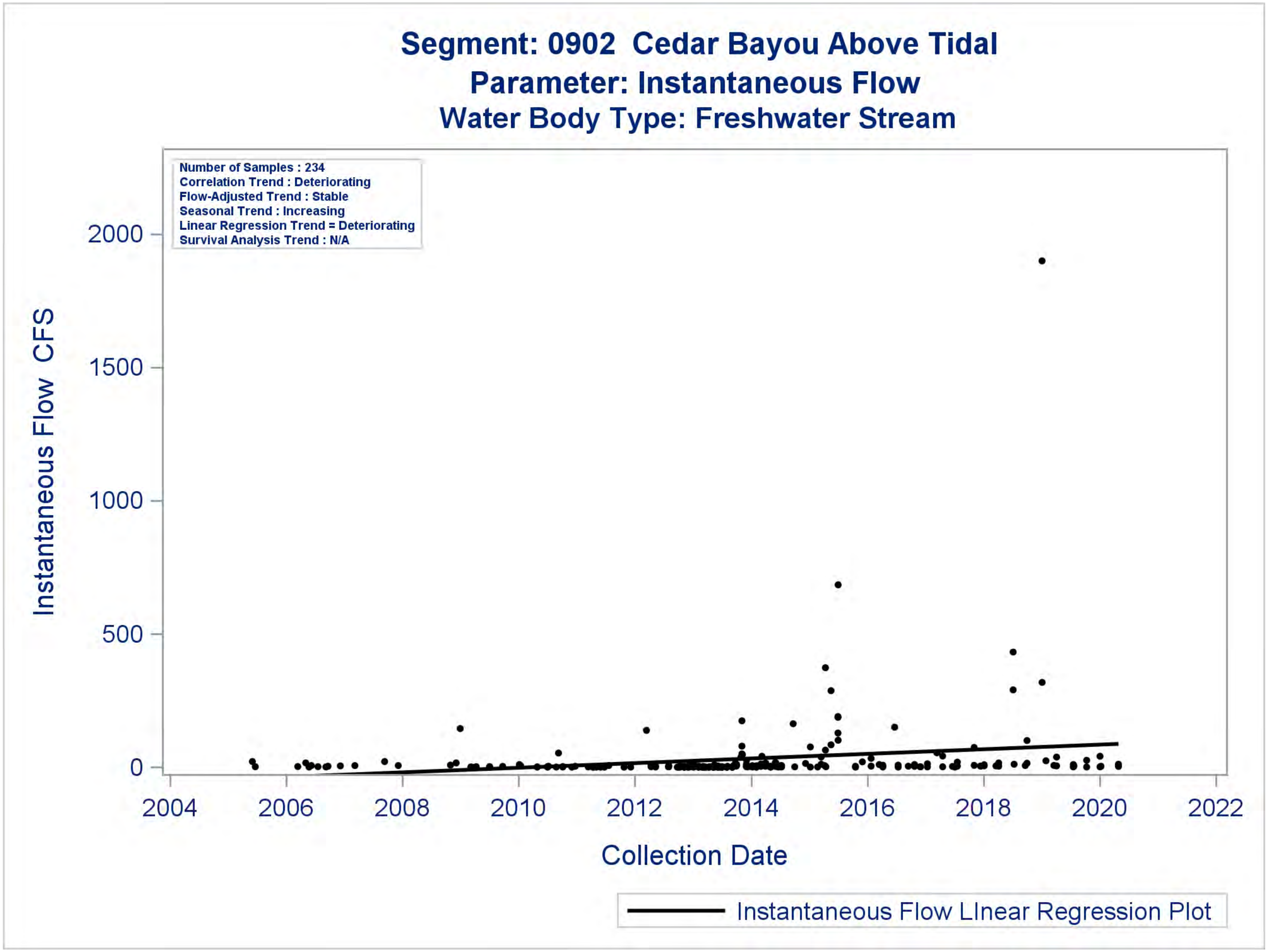
Segment: 0902 Cedar Bayou Above Tidal
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 298
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
500
300
200
100
10
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot



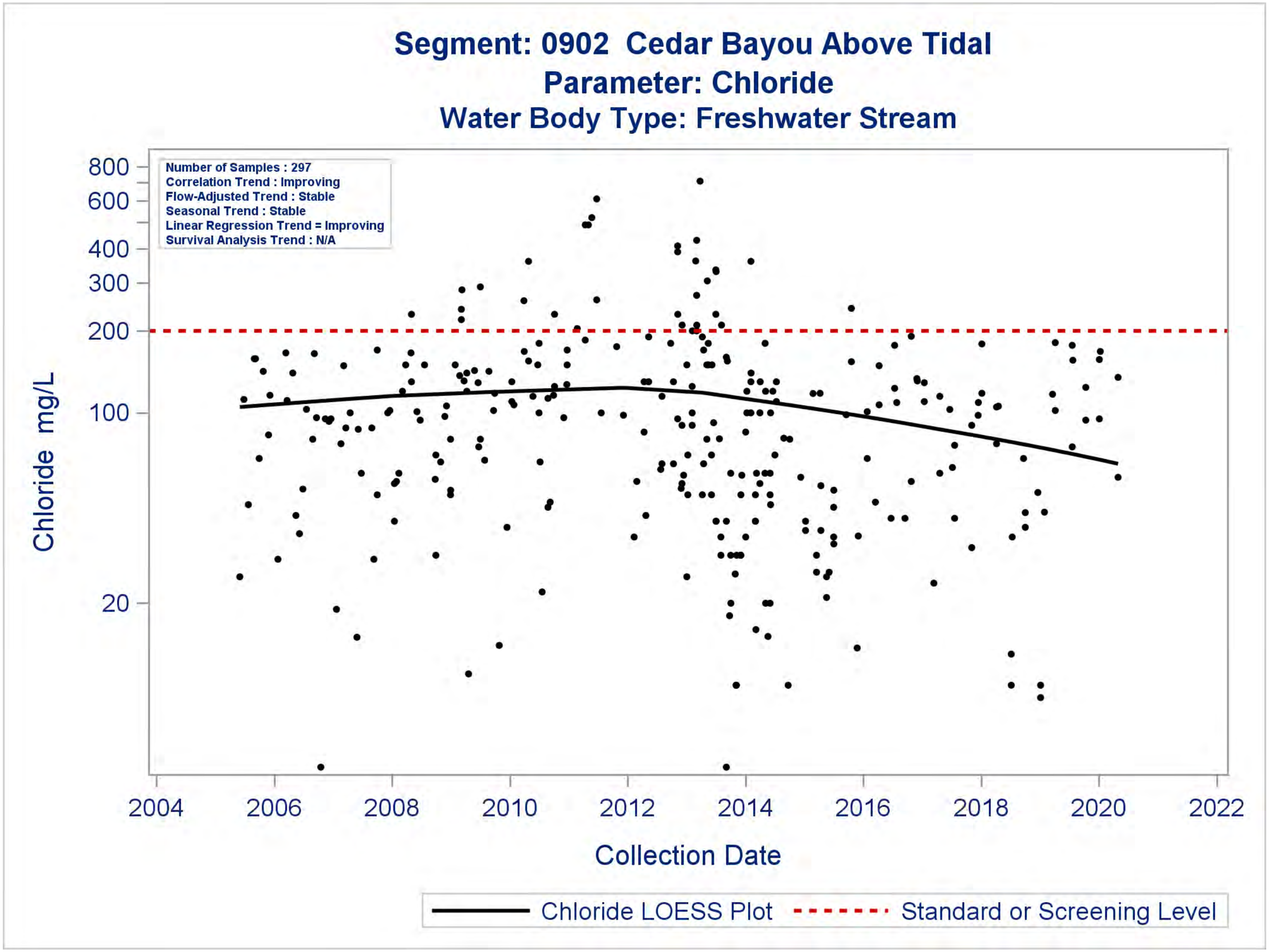
Segment: 0902 Cedar Bayou Above Tidal
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 303
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
2.5
1.5
1
0.5
0.07
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



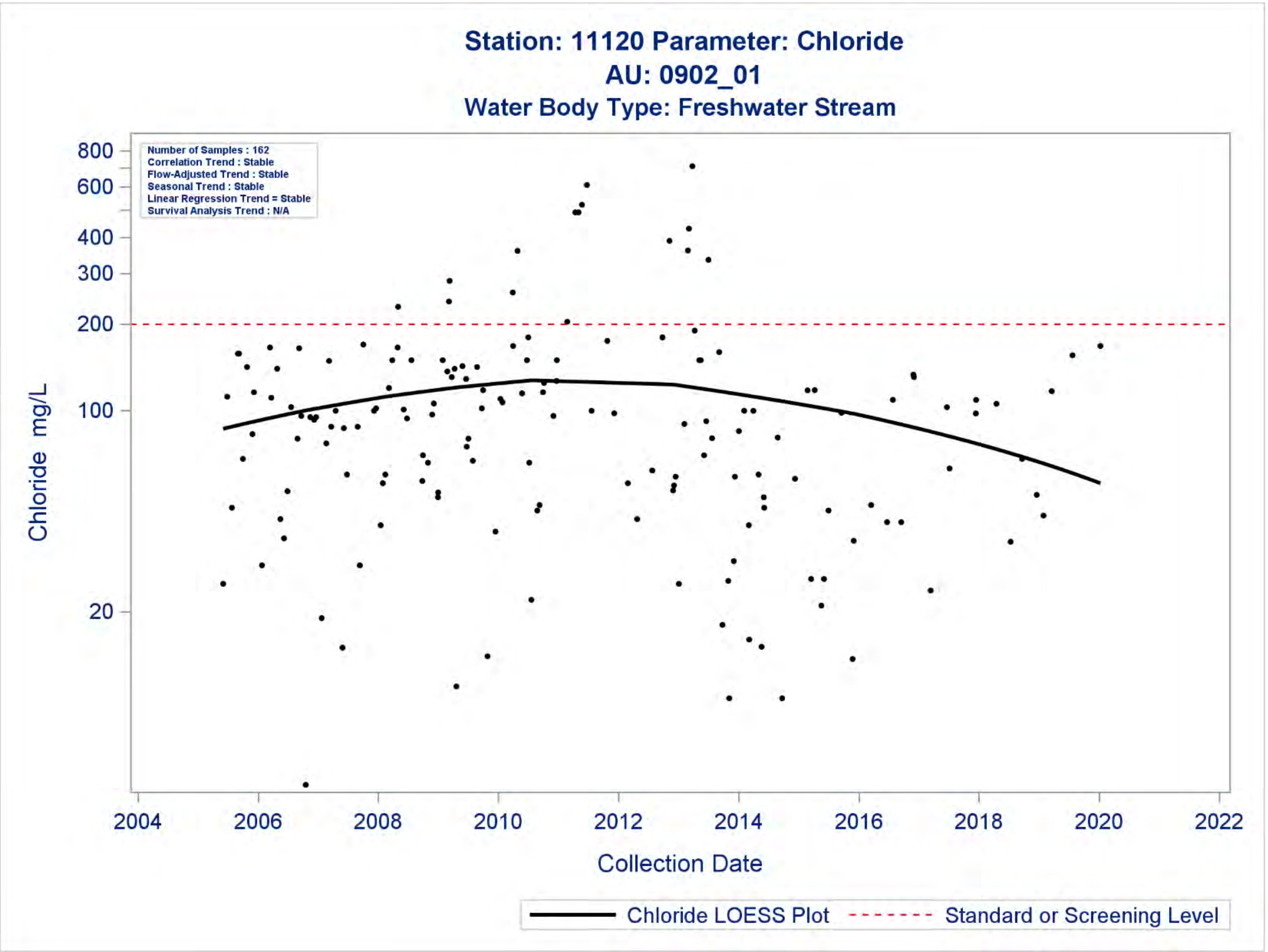
Segment: 0902 Cedar Bayou Above Tidal
Parameter: Sulfate
Water Body Type: Freshwater Stream
Number of Samples : 239
Correlation Trend : Stable
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Sulfate mg/L
250
200
150
100
50
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Sulfate LInear Regression Plot
Standard or Screening Level



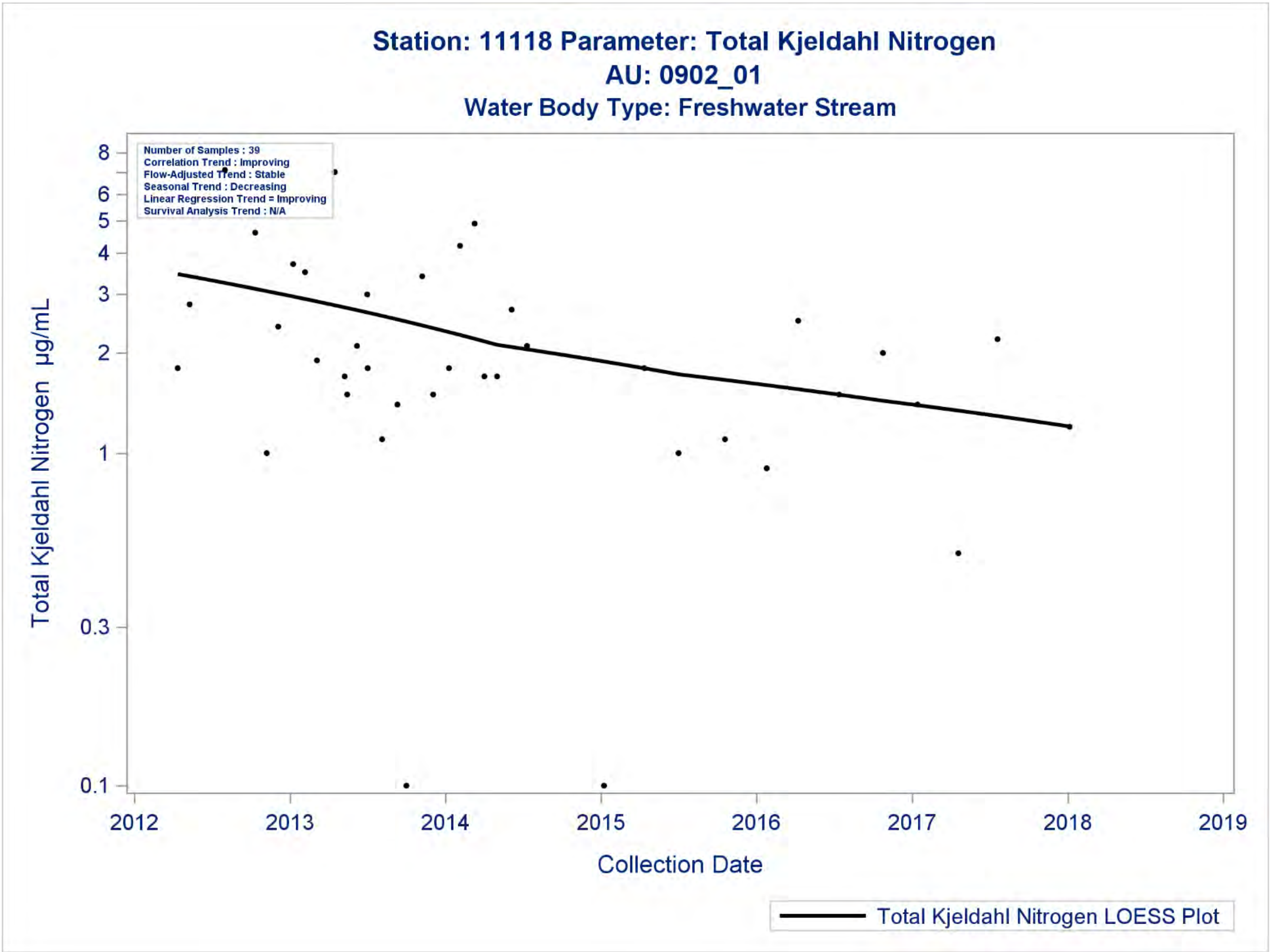
Segment: 0902 Cedar Bayou Above Tidal
Parameter: Instantaneous Flow
Water Body Type: Freshwater Stream
Number of Samples : 234
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Instantaneous Flow CFS
2000
1500
1000
500
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Instantaneous Flow LInear Regression Plot



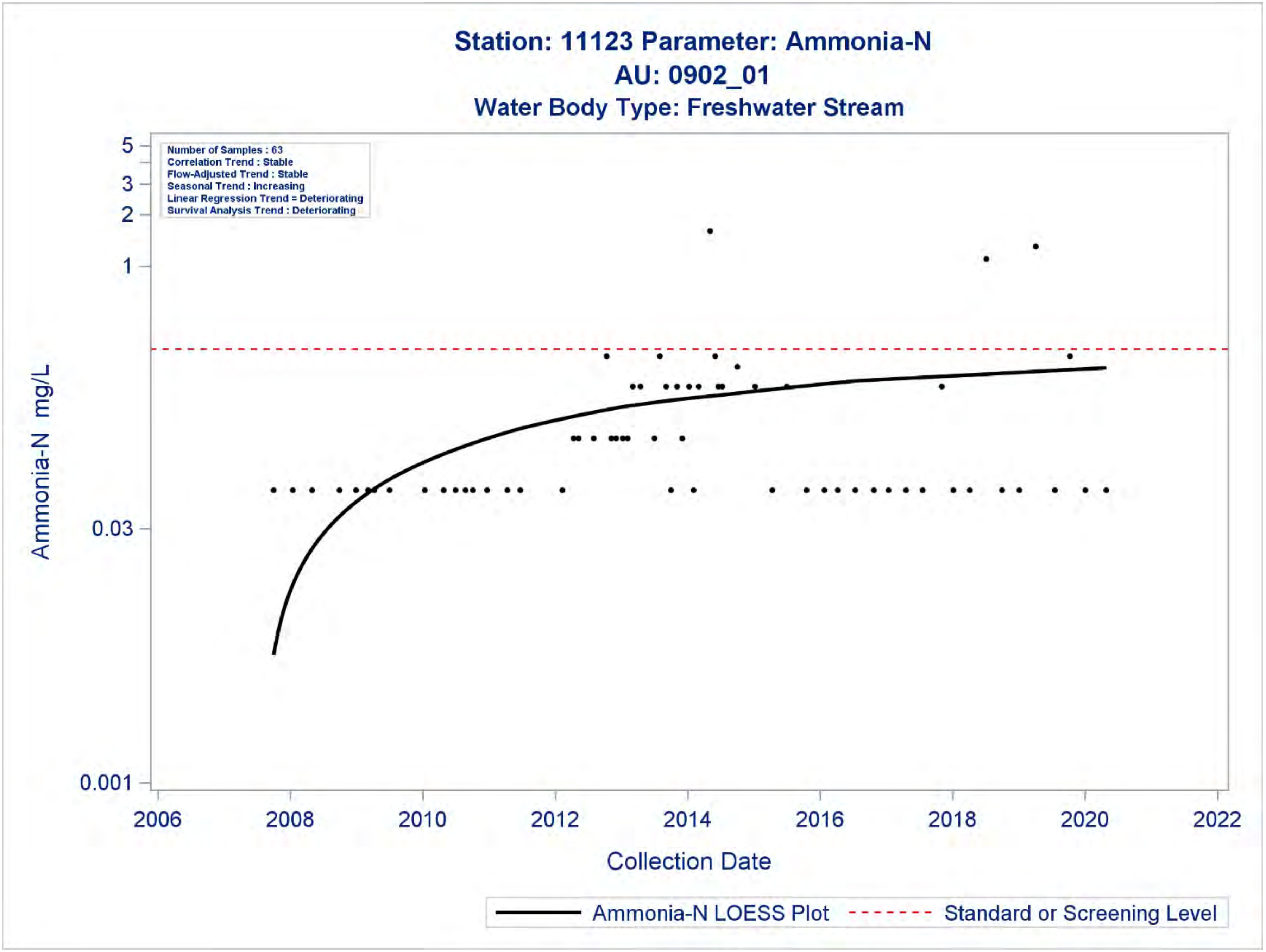
Segment: 0902 Cedar Bayou Above Tidal
Parameter: Chloride
Water Body Type: Freshwater Stream
Number of Samples : 297
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Chloride mg/L
800
600
400
300
200
100
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LOESS Plot
Standard or Screening Level

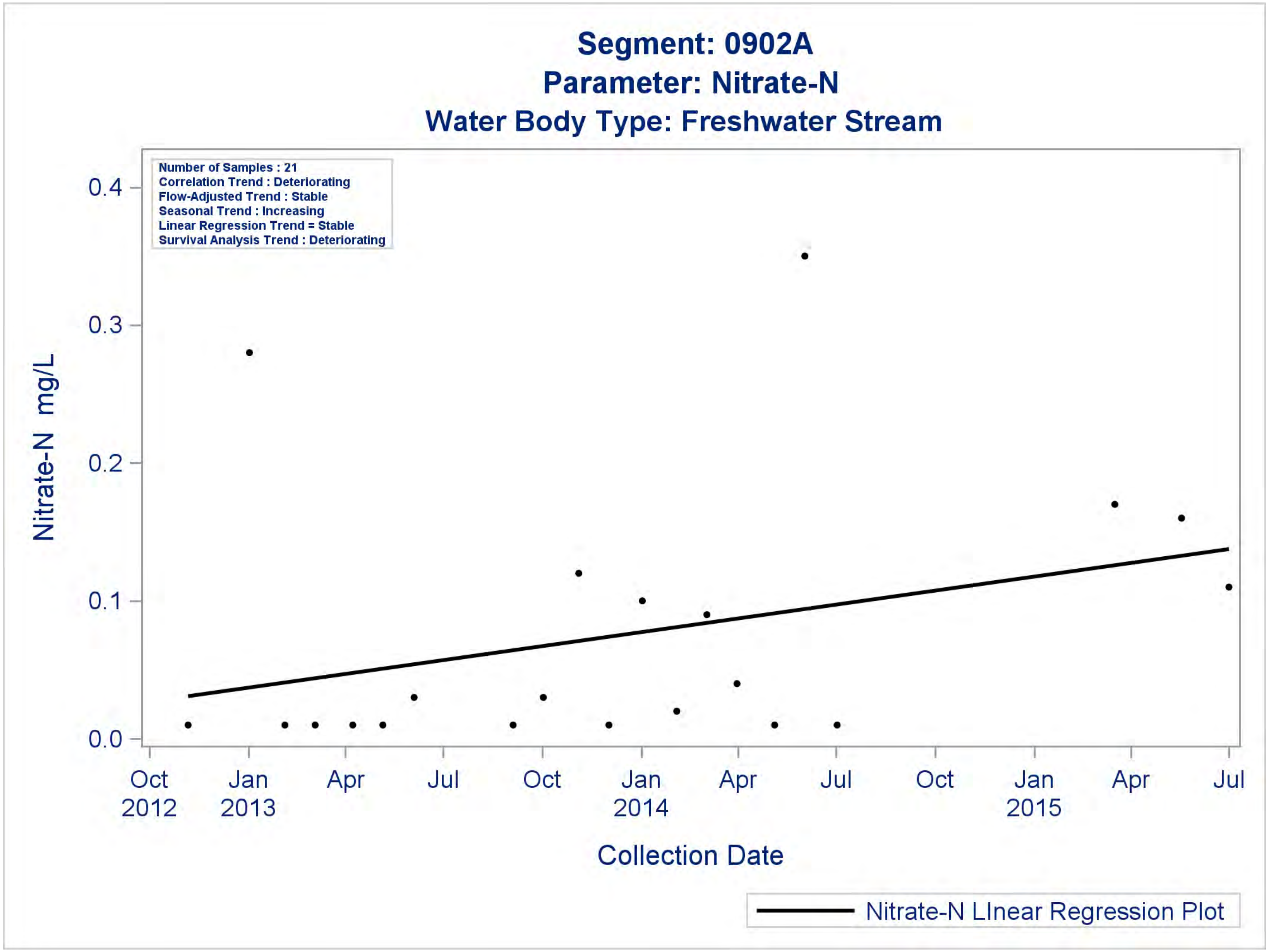


Station: 11120 Parameter: Chloride
AU: 0902_01
Water Body Type: Freshwater Stream
Number of Samples : 162
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
800
600
400
300
200
100
20
Chloride mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LOESS Plot
Standard or Screening Level



Station: 11118 Parameter: Total Kjeldahl Nitrogen
AU: 0902_01
Water Body Type: Freshwater Stream
Number of Samples : 39
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
8
6
5
4
3
2
1
0.3
0.1
2012
2013
2014
2015
2016
2017
2018
2019
Collection Date
Total Kjeldahl Nitrogen LOESS Plot


Station: 11123 Parameter: Ammonia-N
AU: 0902_01
Water Body Type: Freshwater Stream
Number of Samples : 63
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
5
3
2
1
0.03
0.001
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level



Segment: 0902A
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 21
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0.0
0.1
0.2
0.3
0.4
Oct 2012
Jan 2013
Apr
Jul
Oct
Jan 2014
Apr
Jul
Oct
Jan 2015
Apr
Jul
Collection Date
Nitrate-N LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	Entire Segment (0902) I	• Construction stormwater controls failing • Urbanization and increased impervious cover • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Improper or no pet waste disposal • Developments with malfunctioning or failing OSSFs • Animal waste from agricultural production	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Adequate construction oversight • Improve compliance and enforcement of existing stormwater quality permits • Add water quality features to stormwater systems • Regionalize chronically non-compliant WWTFs • More public education on pet waste disposal • More public education regarding OSSF operation and maintenance • Encourage Water Quality Management Plans or similar projects for agricultural properties • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways
Low Dissolved Oxygen Concentrations (24-hour DO)	Entire Segment (0902) I	▪ Excessive nutrients and organic matter from SSOs, malfunctioning OSSFs, agricultural operations, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetated canopy removed	• Detrimental effect on aquatic biological community	• More public education about proper disposal of household fats, oils, and grease • Increase OSSF maintenance and repairs • More public education regarding OSSF operation and maintenance • More outreach to farmers in watershed to minimize fertilizer runoff • More public education on pet waste disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating • Conserve or plant canopy trees and habitat along waterways to maintain/create vegetated riparian buffer zones

				• Conserve or restore trees and habitat along waterways to maintain/create vegetated riparian buffer zones
Elevated Ammonia-Nitrogen Concentrations	0902A C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Impaired Macrobenthic Community in Water	Entire Segment (0902) C	• Construction stormwater controls failing • Urbanization and increased impervious cover • Agricultural runoff from row crops, fallow fields pastures, and animal operation	• Detrimental effect on aquatic biological community	• Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways

Special Studies:

H-GAC worked with the Texas Soil and Water Conservation Board to develop a watershed protection plan address elevated levels of bacteria and other contaminants in Cedar Bayou. The Cedar Bayou Watershed Protection Plan was approved in 2016. H-GAC remains involved in the project as part of the broader Cedar Bayou Initiative to enhance the bayou's resilience and water quality. For more information, please refer to the Public Involvement and Outreach section of the Basin Summary Report.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation and coordination.
- Continue collecting water quality data to evaluate the impact of the watershed protection plan.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 0901 Name: Cedar Bayou Tidal

Length:	19 miles	**Watershed Area:**	57 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	3	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	23

DESCRIPTION

- Segment 0901 (Tidal Stream w/ high ALU): **Cedar Bayou Tidal** (classified water body) – From the confluence with Galveston Bay 1.0 km (0.6 miles) downstream of Tri-City Beach Road in Chambers County to a point 2.2 km (1.4 miles) upstream of IH-10 in Chambers/Harris County.

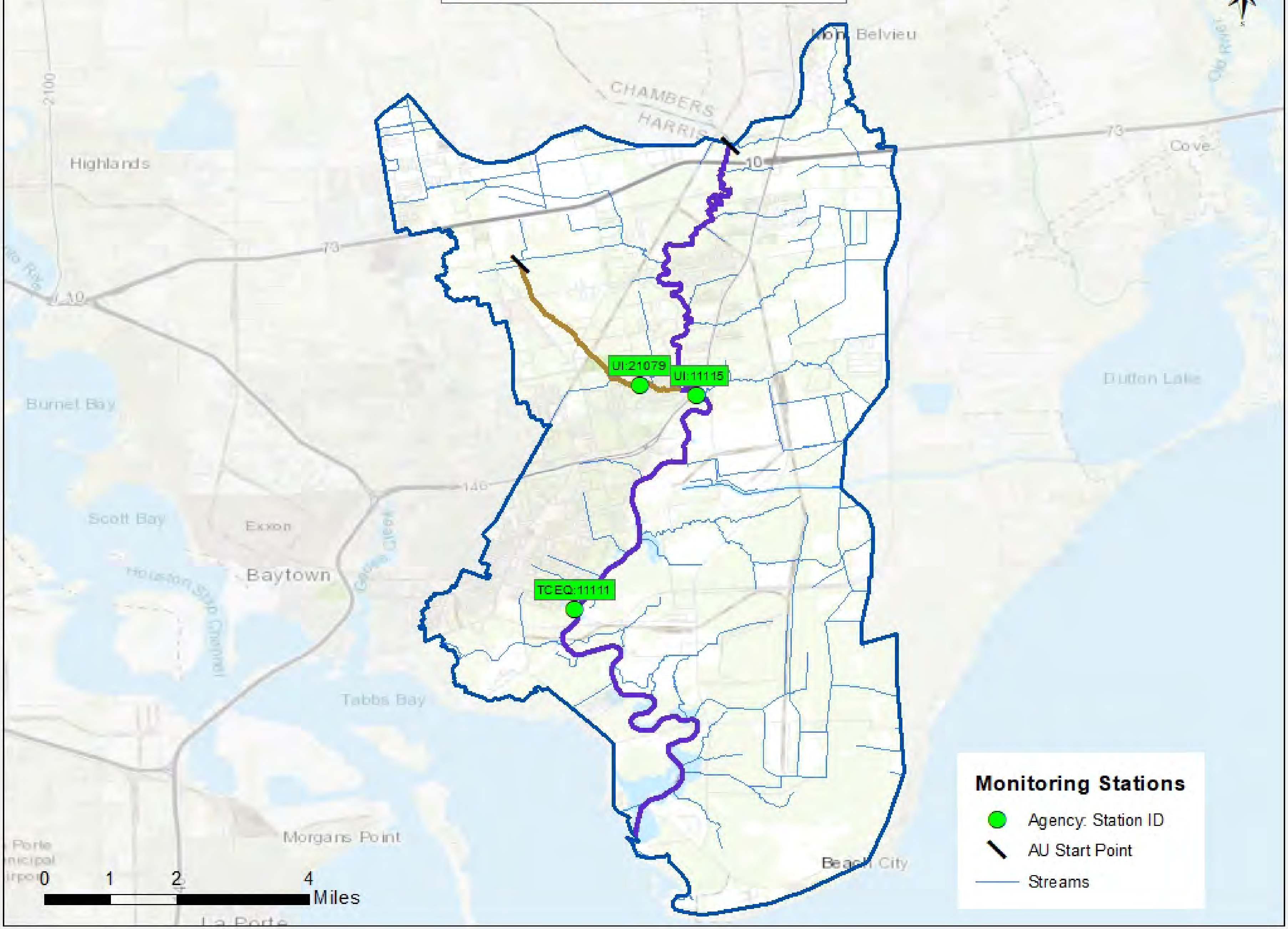
- Segment 0901A (Tidal Stream): **Cary Bayou** (unclassified water body) – From the confluence with Cedar Bayou Tidal to 0.8 km upstream of East Archer Rd.

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11111	0901	CEDAR BAYOU TIDAL AT ROSELAND PARK NEAR WEST BANK 245 M UPSTREAM OF SPUR 55	FO	Quarterly	Field, Conventional, Bacteria
11115	0901	CEDAR BAYOU TIDAL MID CHANNEL 45 M DOWNSTREAM OF SH 146 NORTHEAST OF BAYTOWN	UI	Quarterly	Field, Conventional, Bacteria
21709	0901A	CARY BAYOU IMMEDIATELY UPSTREAM OF RACCOON DRIVE BRIDGE IN BAYTOWN	UI	Quarterly	Field, Conventional, Bacteria, 24hr DO

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston

Cedar Bayou Tidal - 0901



Segment 0901 Water Quality Standards and Screening Levels			
Standards	**Tidal Stream**	**Screening Levels**	**Tidal Stream**
Temperature (°C/°F)	35 / 95	Dissolved Oxygen (mg/L) (grab)	4.0
Dissolved Oxygen *(24-Hr Average)* (mg/L)	4.0	Ammonia-N (mg/L):	0.46
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0	Orthophosphate Phosphorus (mg/L):	0.46
pH (standard units)	6.5-9.0	Total Phosphorus-P (mg/L):	0.66
Enterococci (MPN/100mL) (grab)	104	Chlorophyll *a* (µg/L):	21
Enterococci (MPN/100mL) (geometric mean)	35		

Segment Discussion

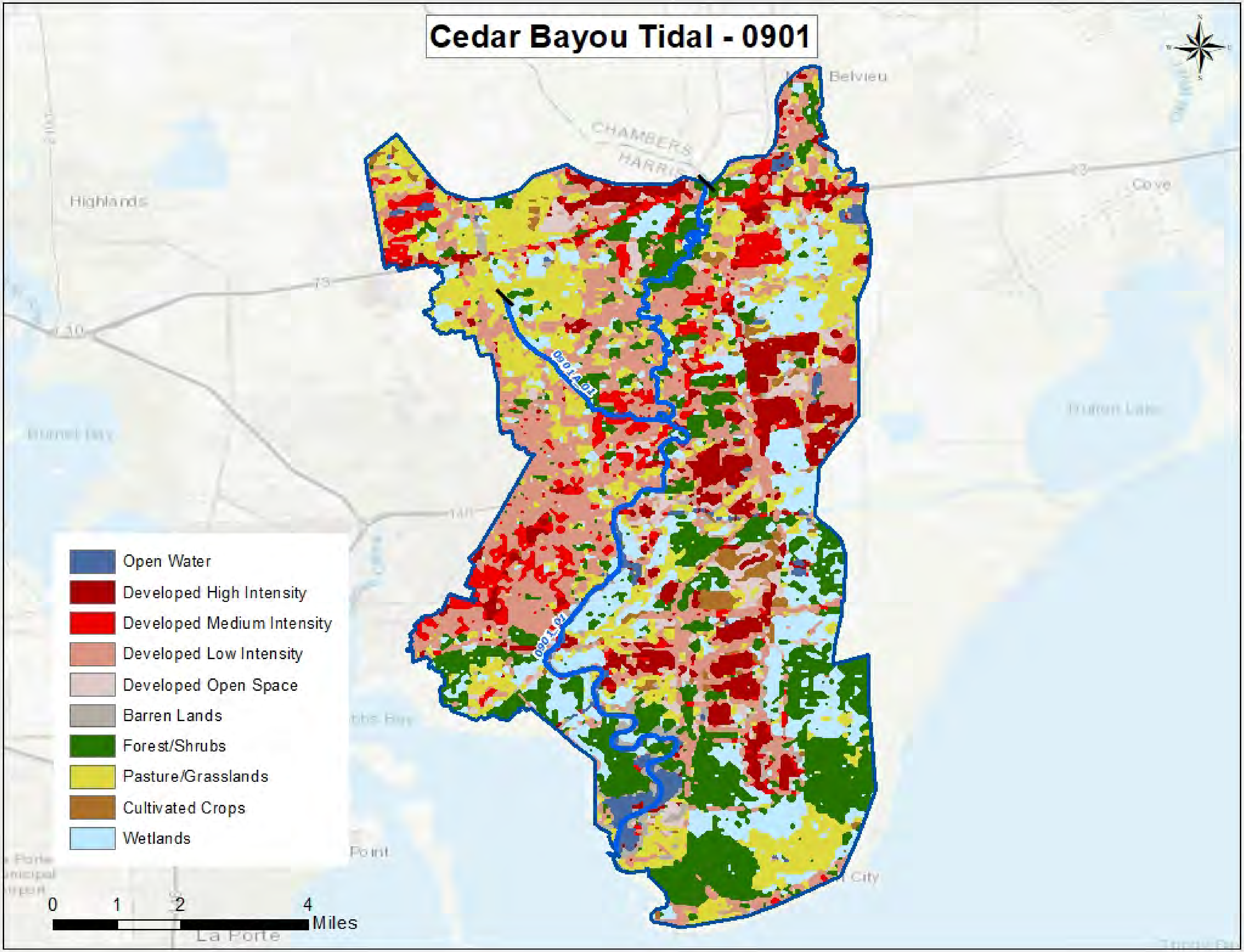
Watershed Characteristics and Land Cover: The Cedar Bayou Tidal segment (0901) lies in the coastal plain between the Trinity and San Jacinto Rivers and drains directly into Upper Galveston Bay. The tidal segment originates 1.4 miles upstream of Interstate 10 in Chambers/Harris County at the end of Cedar Creek Above Tidal segment (0902). The segment forms the border between Chambers and Harris counties. Cedar Bayou Tidal receives flow from Cary Bayou in the City of Baytown, as well as several small intermittent tributaries. The segment also receives stormwater flow from the City of Baytown. Barge traffic is prevalent on the lower portion of the segment. Recreational activity, such as boating, is common throughout the segment, although only small boats can go upstream of Texas State Highway 146.

The Cedar Bayou Tidal watershed area covers approximately 36,700 acres. In 2008, agricultural uses were the largest land use category at 33.98 percent, followed by developed land at 29.71 percent and wetlands at 27.7 percent. Between 2008 to 2018, developed lands increased from 10,902 acres to 14,889 acres, or from 29.71 percent to 40.58 percent of the watershed. During this same timeframe, agricultural lands decreased from 12,470 acres to 7,573 acres, a decrease of slightly over 39 percent. Wetlands acreage decreased from 10,004 acres to 6,082 acres.

Large tracts of land in the northwest and east-northeast areas of the segment are dedicated to cultivated crops such as grass farms. Residential development is concentrated in the west central portion and along Texas State Highway 146 in the City of Baytown. Large industrial facilities are located primarily along the eastern shoreline of the bayou, but other industrial developments are also scattered throughout the watershed. The heavily industrialized portion of the City of Mont Belvieu is situated in the northeastern corner of the segment.

Segment 0901 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	12,470.05	33.98	7,573.39	20.64	-39.27
Barren Lands	152.78	0.42	883.35	2.41	478.17
Developed	10,901.73	29.71	14,888.80	40.58	36.57
Forest/Shrubs	2,178.34	5.94	6,421.39	17.50	194.78
Open Water	985.87	2.69	839.09	2.29	-14.89
Wetlands	10,004.60	27.27	6,082.24	16.58	-39.21
TOTAL	**36,693.38**	**100.00**	**36,688.26**	**100.00**	



Cedar Bayou Tidal - 0901
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1
2
4
Miles
Highlands
Belvieu
CHAMBERS
HARRIS
Cove
La Porte
0901_01
0901_01

Water Quality Issues:

Bacteria Impairments and Concerns
For Cedar Bayou Tidal (0901), the 2020 assessment found the geometric mean for enterococci was 110.53 MPN/100 mL based on 152 samples collected during the period of 12/01/11 – 11/30/18. This value exceeds the water quality standard of 35 MPN/100 mL.

In Cary Bayou (0901A), recreation use is not supported as the enterococci geometric mean was 431.92 MPN/100 mL.

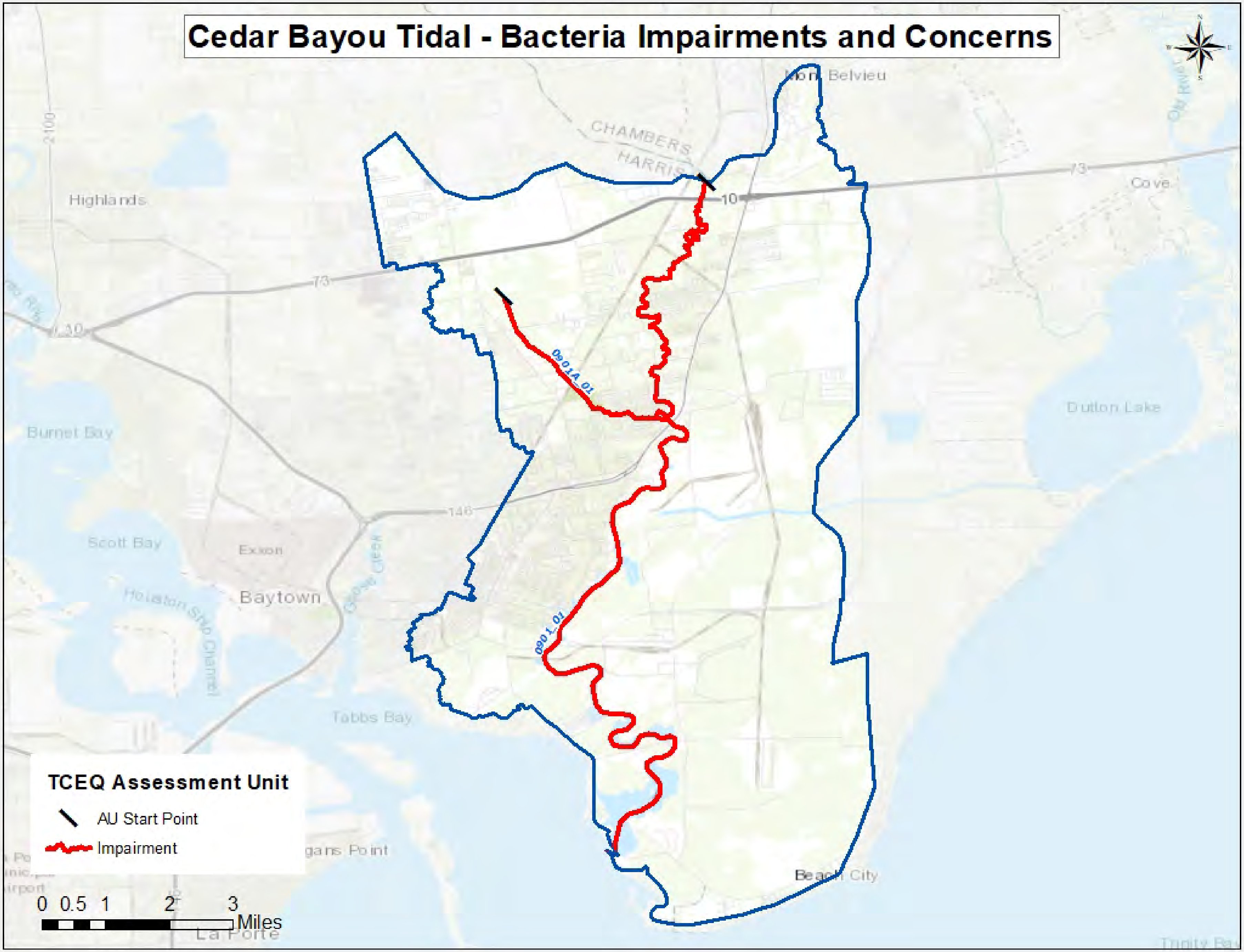
Dissolved Oxygen Impairments and Concerns
There are no identified impairments or concerns for dissolved oxygen in Cedar Bayou Tidal.

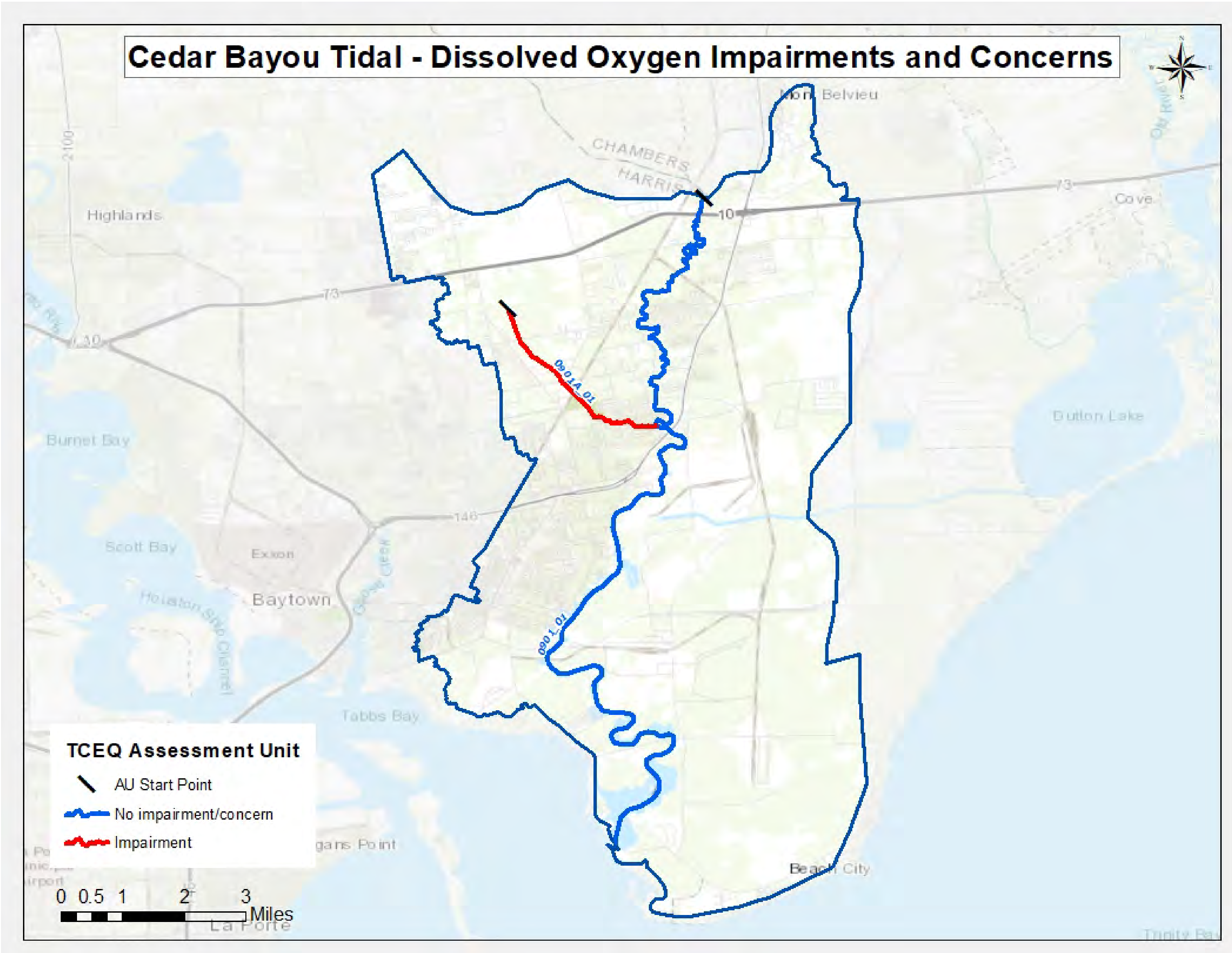
Cary Bayou (0901A) is not supporting its designated aquatic life use due to low dissolved oxygen, with 4 of 22 samples (18.2 percent) below the dissolved oxygen grab minimum and 7 of 22 samples (31.8 percent) below the dissolved oxygen grab screening level.

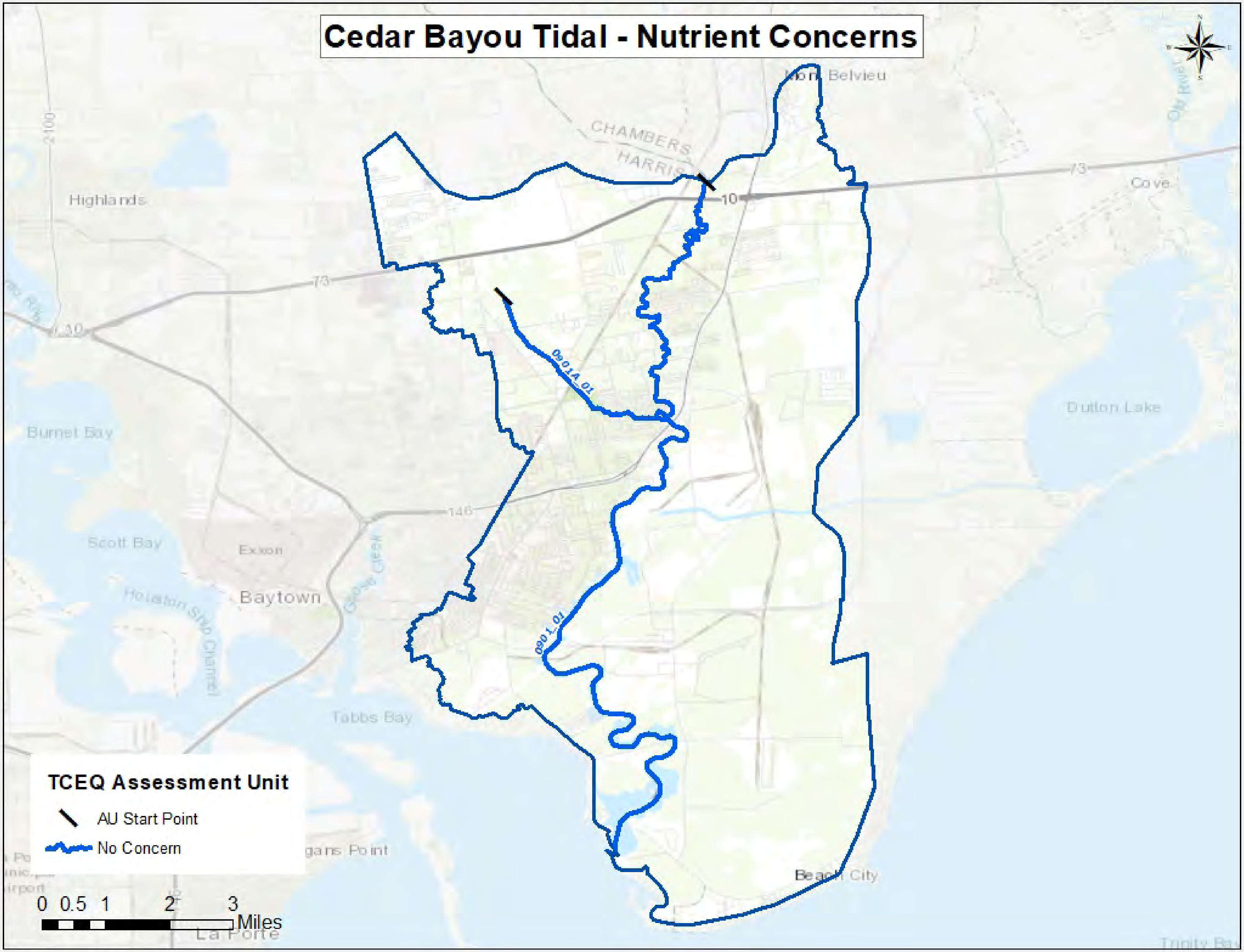
Nutrient Concerns
In segment 0901, there were numerous values that exceeded the nutrient screening levels. This included 8.9 percent of ammonia results, 8.8 percent of nitrate results, 15.6 percent of total phosphorus results, and 8.9 percent of chlorophyll-a results. However, there were no concerns for these nutrient parameters.

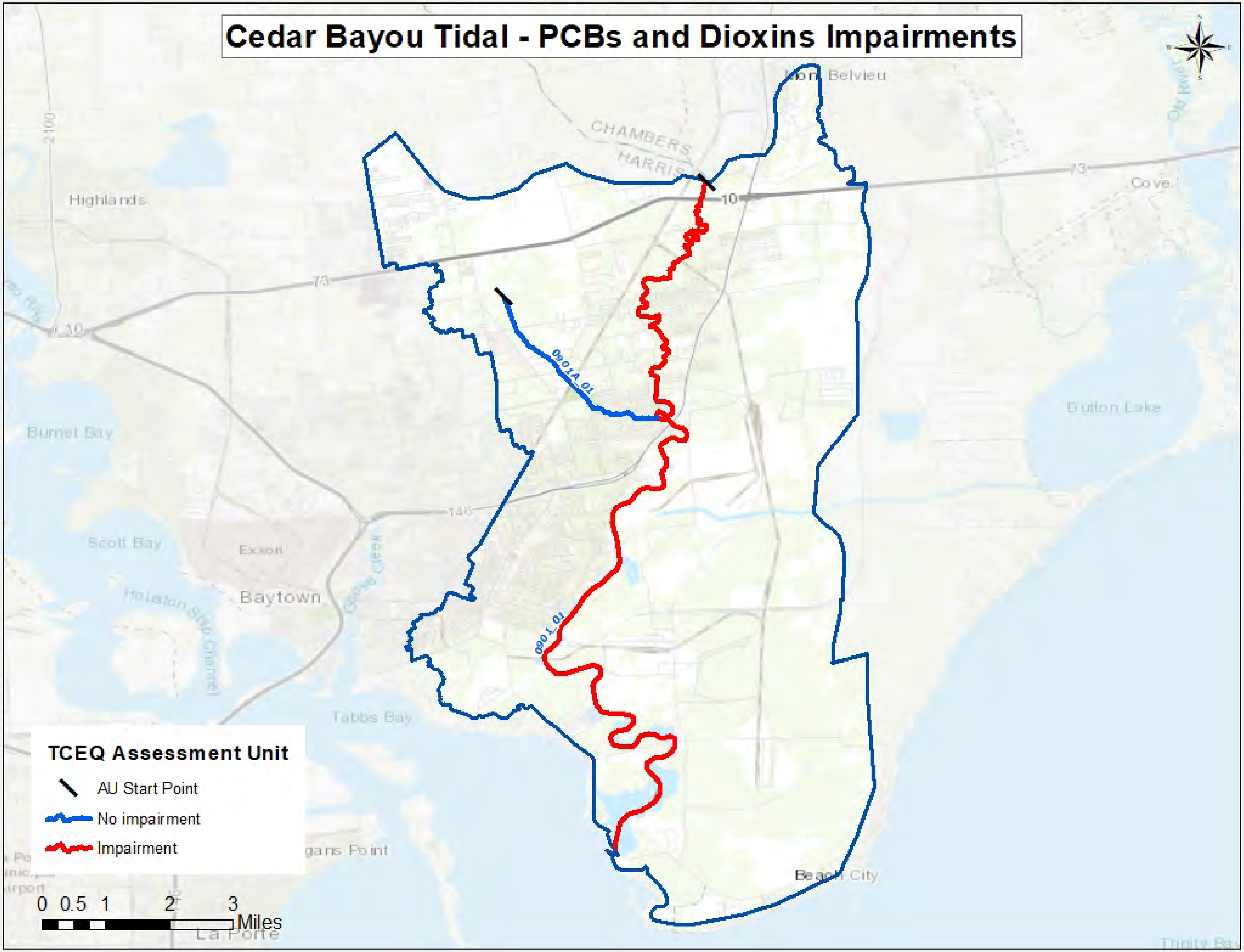
In segment 0901A 12.5 percent of both ammonia and chlorophyll-a results exceeded the nutrient screening levels There were no concerns for these nutrient parameters.

PCBs and Dioxin Impairments
In the 2020 Integrated Report, contact recreation use and fish consumption for specific species of finfish and shellfish are not supported for Cedar Bayou Tidal (0901). The Texas Department of State Health Services has issued a Limited Consumption Fish Advisory for this water body due to high levels of dioxin in all species of catfish, spotted seatrout and blue crab.


Cedar Bayou Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
Impairment
0 0.5 1 2 3
Miles
0901A_01
0901_01
Mont Belvieu
CHAMBERS
HARRIS
Highlands
Cove
Dutton Lake
Burnet Bay
Scott Bay
Exxon
Baytown
Houston Ship Channel
Goose Creek
Tabbs Bay
Beach City
La Porte
Trinity Bay


Cedar Bayou Tidal - Dissolved Oxygen Impairments and Concerns
Mont Belvieu
CHAMBERS
HARRIS
Highlands
Cove
10
73
146
0901A_01
0901_01
Dutton Lake
Burnet Bay
Scott Bay
Exxon
Baytown
Houston Ship Channel
Goose Creek
Tabbs Bay
Beach City
La Porte
Trinity Bay
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0 0.5 1 2 3
Miles


Cedar Bayou Tidal - Nutrient Concerns
Mont Belvieu
CHAMBERS
HARRIS
Highlands
Cove
73
10
146
0901A_01
0901_01
Burnet Bay
Dutton Lake
Scott Bay
Exxon
Baytown
Houston Ship Channel
Goose Creek
Tabbs Bay
Beach City
TCEQ Assessment Unit
AU Start Point
No Concern
0 0.5 1 2 3 Miles
La Porte
Trinity Bay


Cedar Bayou Tidal - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
0 0.5 1 2 3
Miles
0901A_01
0901_01
Highlands
Burnet Bay
Scott Bay
Exxon
Baytown
Houston Ship Channel
Tabbs Bay
Dutton Lake
Cove
Beach City
CHAMBERS
HARRIS
La Porte
Trinity Bay

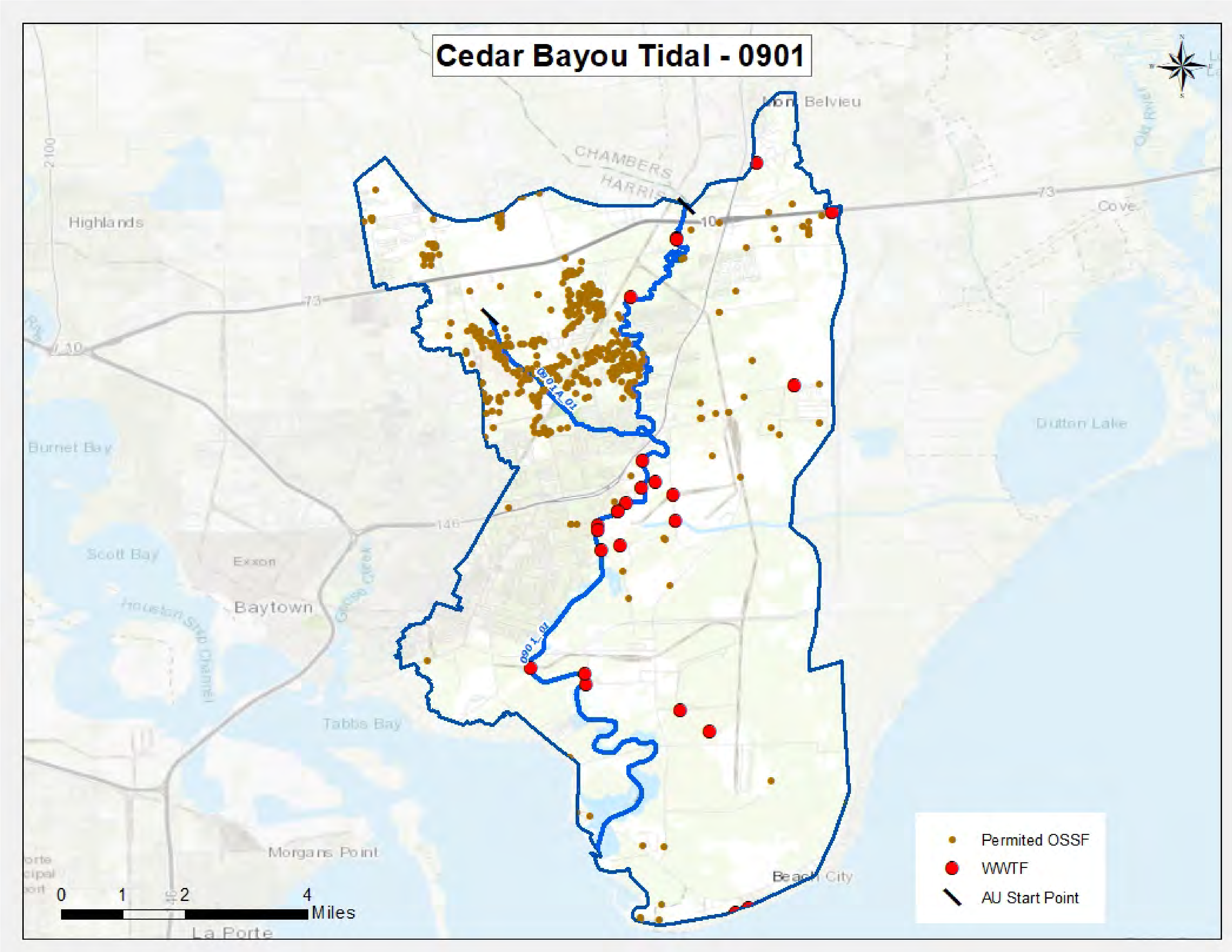
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Cedar Bayou Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 23 permitted wastewater outfalls in the Cedar Bayou Tidal watershed. In some areas, on-site sewage facilities are the primary source of wastewater disposal. There are 472 permitted OSSFs in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Cedar Bayou Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 359 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

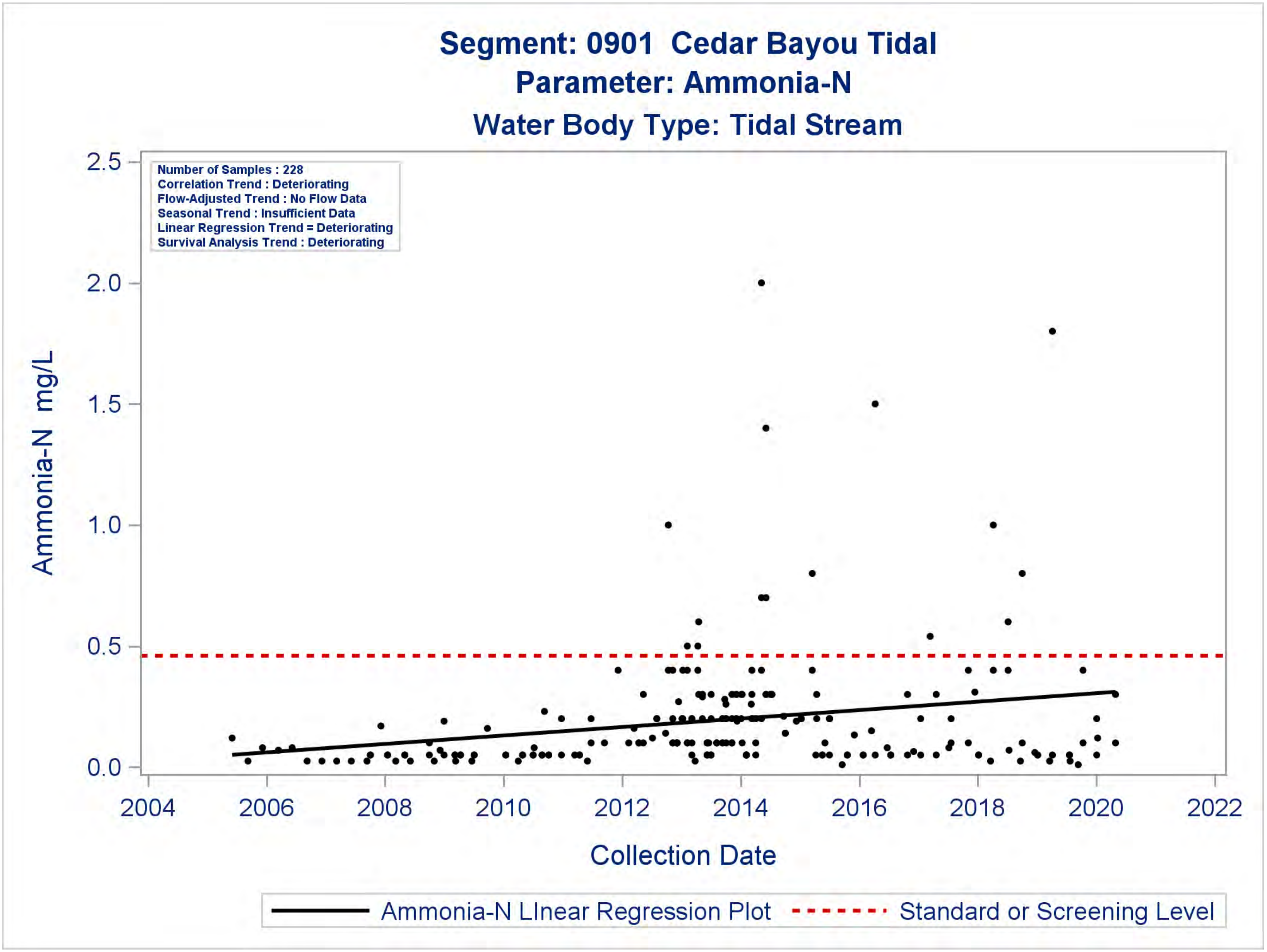
For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Cedar Bayou Tidal watershed.



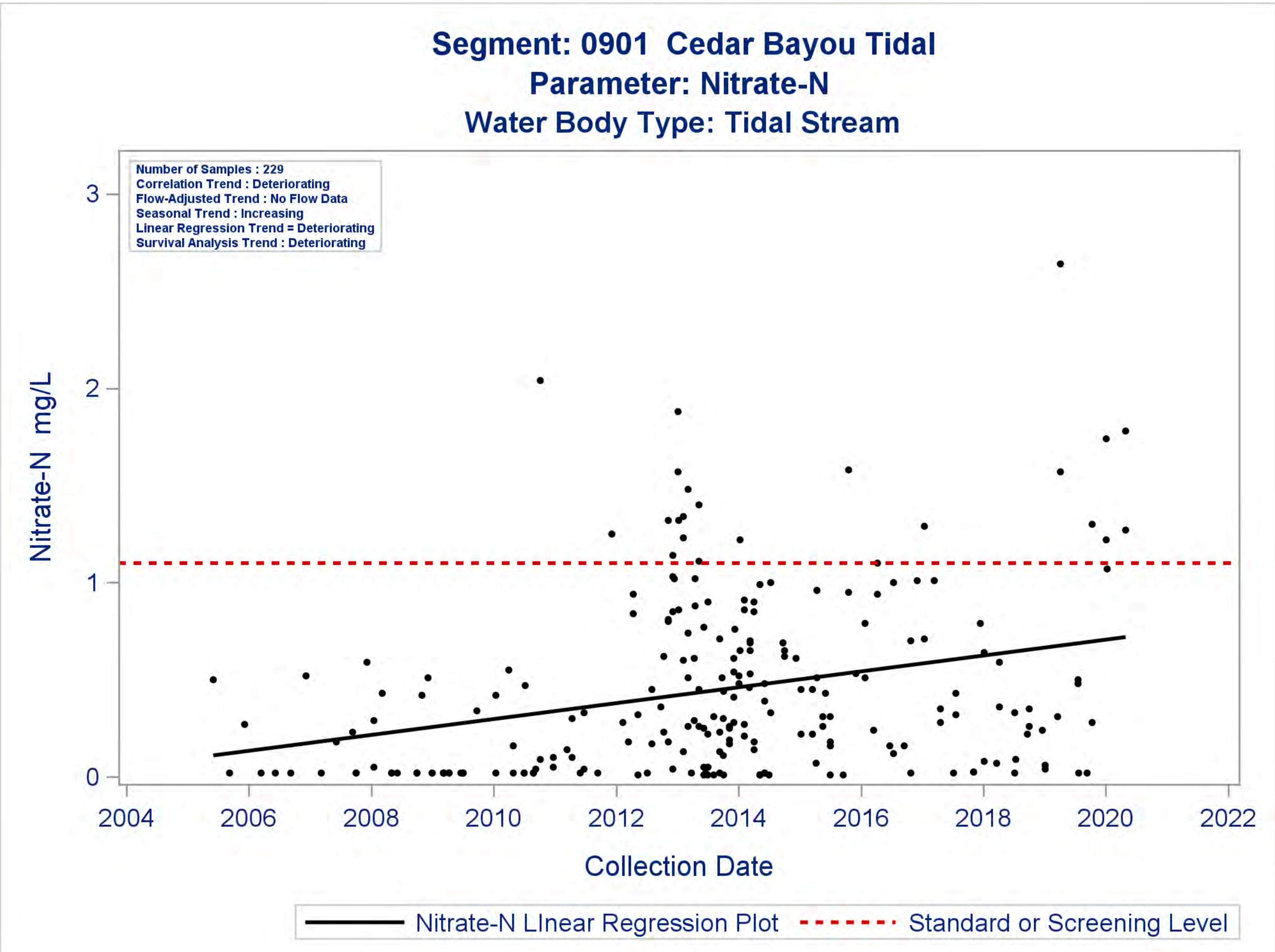
Cedar Bayou Tidal - 0901
Mont Belvieu
CHAMBERS
HARRIS
Highlands
Cove
Dutton Lake
Burnet Bay
Scott Bay
Exxon
Baytown
Houston Ship Channel
Goose Creek
Tabbs Bay
Morgans Point
La Porte
Beach City
0901A_01
0901_01
Permited OSSF
WWTF
AU Start Point
0
1
2
4
Miles

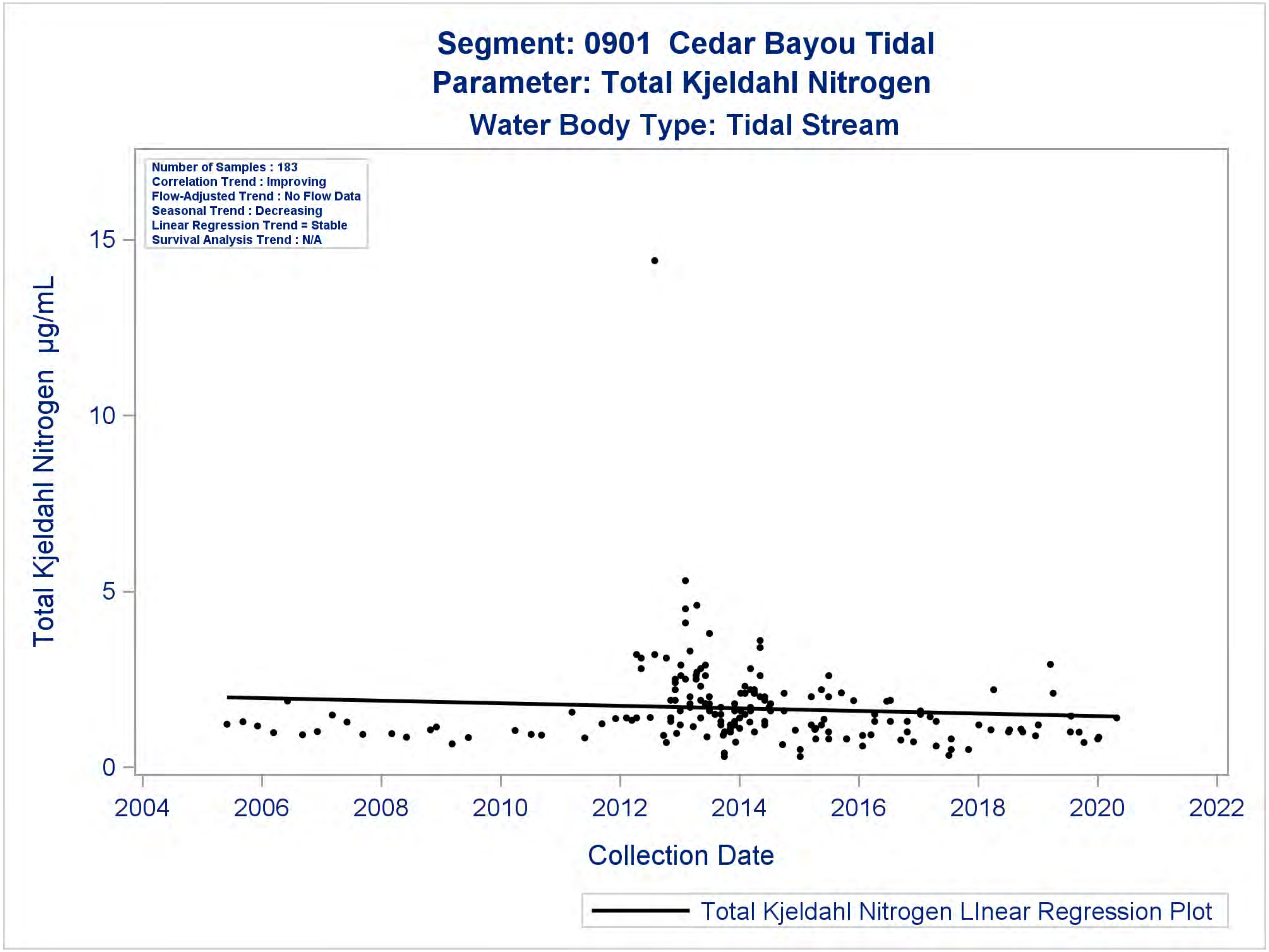
Trend Analysis:

Regression analysis of watershed data resulted in two statistically significant water quality parameter trends in this segment. Increasing trends include ammonia and nitrate. Ammonia levels have been increasing since 2012 with concentrations slowly approaching the 0.46 mg/L screening criteria. Beginning in late 2012 ammonia concentrations began to exceed the screening criteria and have continued to exceed the criteria occasionally since. The same ammonia trend was seen for station 11117. Analysis indicated total Kjeldahl nitrogen (TKN) was improving but that is only because during the time period from 2012 to 2015, there were monthly samples collected during the development of a watershed protection plan. The increased monitoring frequency captured some higher than previously recorded results. After 2015, the frequency of sampling was reduced to quarterly again and there are fewer samples with high TKN concentrations. TKN results from stations 11115 and 11117 also show a decreasing trend but the period of record only started in 2012 and ended in 2018. Parameters such as dissolved oxygen, enterococci, total phosphorus, total suspended solids, and chlorophyll *a* remain stable for this segment with high and low concentrations scattered throughout the period of record but indicating no significant trend in the results.



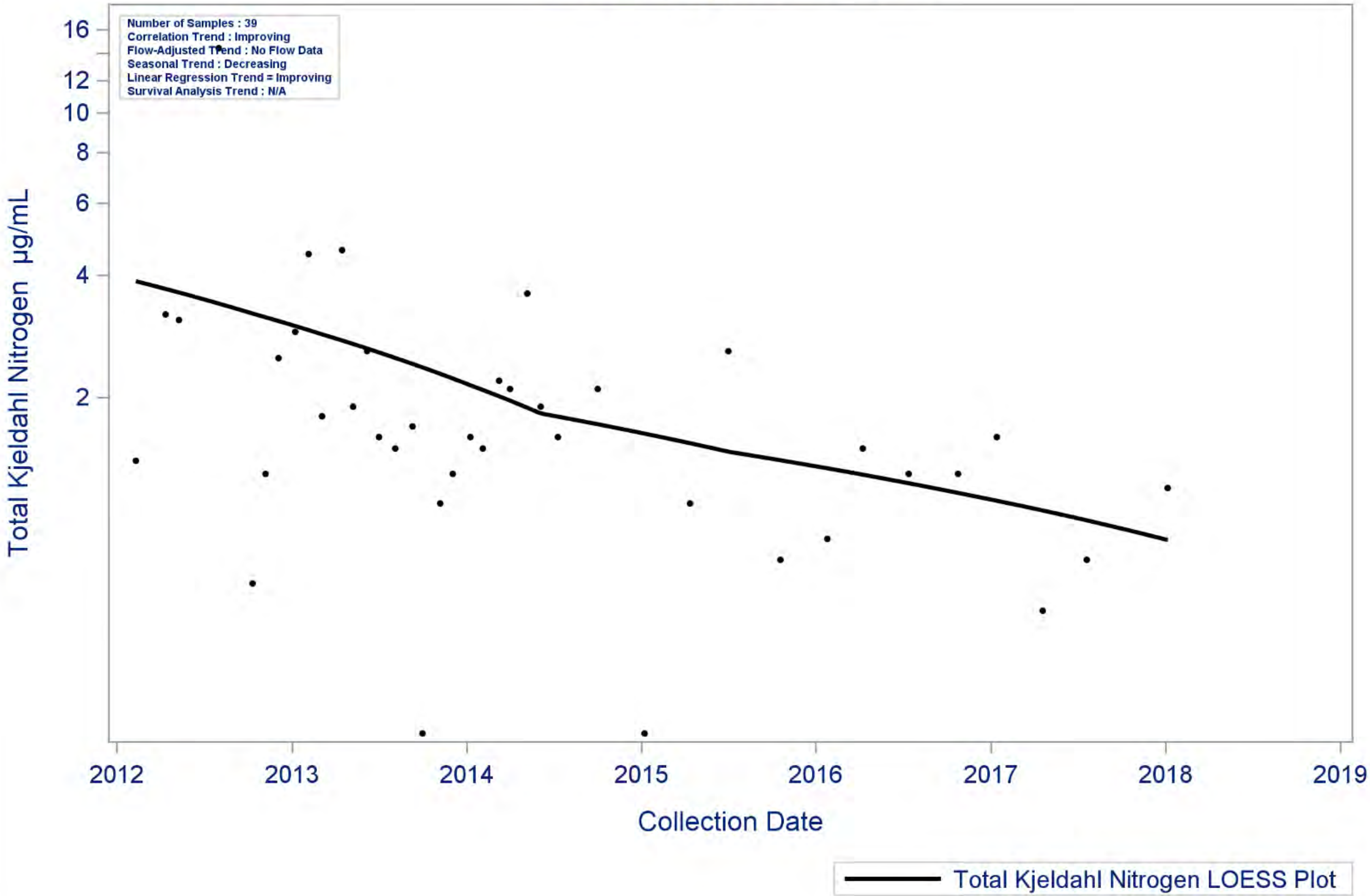
Segment: 0901 Cedar Bayou Tidal
Parameter: Ammonia-N
Water Body Type: Tidal Stream
Number of Samples : 228
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
2.5
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level


Segment: 0901 Cedar Bayou Tidal
Parameter: Nitrate-N
Water Body Type: Tidal Stream
Number of Samples : 229
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0
1
2
3
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level



Segment: 0901 Cedar Bayou Tidal
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 183
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
5
10
15
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot

Station: 11115 Parameter: Total Kjeldahl Nitrogen
AU: 0901_01
Water Body Type: Tidal Stream



Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	0901_01 I 0901A_01 I	• Construction stormwater controls failing • Urbanization and increased impervious cover • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Improper or no pet waste disposal • Developments with malfunctioning or failing OSSFs • Animal waste from agricultural production	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Adequate construction oversight • Improve compliance and enforcement of existing stormwater quality permits • Add water quality features to stormwater systems • Regionalize chronically non-compliant WWTFs • More public education on pet waste disposal • Improved education about OSSF maintenance • Encourage Water Quality Management Plans or similar projects for agricultural properties • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways
Dissolved Oxygen Grab Minimum, Screening Level	**DO Grab Min** 0901A_01 I **DO Grab Screening** C 0901A_01	▪ Excessive nutrients and organic matter from SSOs, malfunctioning OSSFs, agricultural operations, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetated canopy removed	• Detrimental effect on aquatic biological community	• More public education about proper disposal of household fats, oils, and grease • Increase OSSF inspections, maintenance, and repairs • More public education regarding OSSF operations and maintenance • More outreach to farmers in watershed to minimize fertilizer runoff • More public education on pet waste disposal • Conserve or restore trees and habitat along waterways to maintain/create vegetated riparian buffer zones
Dioxin/PCBs in Fish Tissue	0901_01 I	• Waste pit located along the San Jacinto River immediately upstream of	• The Texas DSHS has concluded that consuming some species of fish and crab from this water body pose an	• Continue monitoring and assessment of fish tissue to determine status of impairment

		I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	apparent hazard to public health. (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

H-GAC worked with the Texas Soil and Water Conservation Board to develop a watershed protection plan to address elevated levels of bacteria and other contaminants in Cedar Bayou. The Cedar Bayou Watershed Protection Plan was approved in 2016. H-GAC remains involved in the project as part of the broader Cedar Bayou Initiative to enhance the bayou's resilience and water quality. For more information, please refer to the Public Involvement and Outreach section of the Basin Summary Report.

This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue and the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Continue implementation of the watershed protection plan for Cedar Bayou.
- Address concerns found in this segment summary through stakeholder participation and coordination.
- Continue collecting water quality data to evaluate progress toward watershed protection plan goals.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

BASIN 10 (Upper Portion)

Upper San Jacinto Coastal Basin

1010 – Caney Creek

1009 – Cypress Creek

1003 – East Fork San Jacinto

1012 – Lake Conroe

1015 – Lake Creek

1002 – Lake Houston

1011 – Peach Creek

1008 – Spring Creek

1004 – West Fork San Jacinto

Segment Number:	1010	Name:	Caney Creek

Length:	11 miles	Watershed Area:	222 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	6	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	21

DESCRIPTION

- Segment 1010 (Perennial Stream): **Caney Creek** (classified water body) – From the confluence with the East Fork San Jacinto River in Harris County to SH 150 in Walker County

- Segment 1010A (Intermittent Stream with pools w/ intermediate ALU): **Dry Creek** (unclassified water body) — Intermittent stream with perennial pools from Caney Creek upstream to the confluence with an unnamed tributary approximately 3.6 km upstream of SH 242

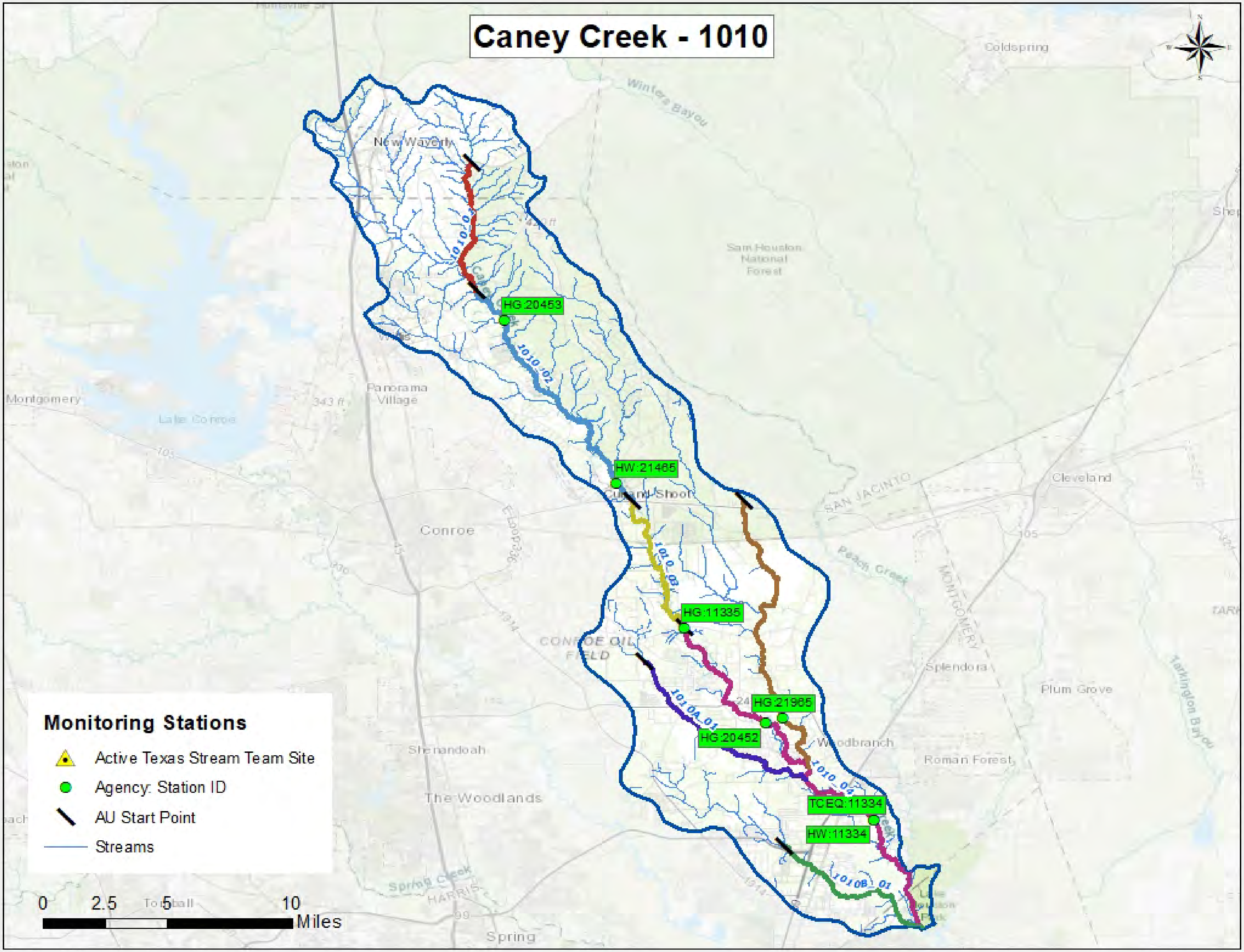
- Segment 1010B (Perennial Stream w/ high ALU): **White Oak Creek** (unclassified water body) – Perennial stream from the confluence with Caney Creek upstream to the confluence with an unnamed tributary approximately 2.08 km upstream of US 59

- Segment 1010C (Perennial Stream w/ high ALU): **Spring Branch** (unclassified water body) — From the Caney Creek confluence to a point 0.54 km (0.34 mi) upstream of SH 105

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11334	1010	CANEY CREEK IMMEDIATELY DOWNSTREAM OF FM 1485	HW	Bimonthly	Field, Conventional, Bacteria
11334	1010	CANEY CREEK IMMEDIATELY DOWNSTREAM OF FM 1485	FO	Quarterly	Field, Conventional, Bacteria, Flow
11335	1010	CANEY CREEK IMMEDIATELY UPSTREAM OF FM 2090 WEST OF SPLENDORA	HG	Quarterly	Field, Conventional, Bacteria, Flow
20452	1010	CANEY CREEK AT FIRETOWER ROAD WEST TO THE CITY OF WOODBRANCH	HG	Quarterly	Field, Conventional, Bacteria, Flow
20453	1010	CANEY CREEK AT COUNTY LINE ROAD IN MONTGOMERY COUNTY EAST TO THE CITY OF WILLIS	HG	Quarterly	Field, Conventional, Bacteria, Flow
21465	1010	CANEY CREEK AT MILLMAC ROAD NORTHEAST OF CUT AND SHOOT	HW	Bimonthly	Field, Conventional, Bacteria
21965	1010C	SPRING BRANCH IMMEDIATELY DOWNSTREAM OF SHAKEY HOLLOW WEST OF WOODBRANCH VILLAGE IN MONTGOMERY COUNTY	HG	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
HG = Houston-Galveston Area Council
HW = Houston Water Quality Control


Caney Creek - 1010
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
2.5
5
10
Miles
HG:20453
HW:21465
HG:11335
HG:21965
HG:20452
TCEQ:11334
HW:11334
1010_01
1010_02
1010_03
1010_04
1010A_01
1010B_01
New Waverly
Panorama Village
Montgomery
Lake Conroe
Conroe
Cut and Shoot
Conroe Oil Field
Shenandoah
The Woodlands
Spring
Woodbranch
Roman Forest
Splendora
Plum Grove
Cleveland
Coldspring
Sam Houston National Forest
Winters Bayou
Peach Creek
Spring Creek
Tarkington Bayou
San Jacinto
Montgomery
Harris

Segment 1010 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	50		
Sulfate (mg/L as SO_4):	50		
Total Dissolved Solids (mg/L):	300		

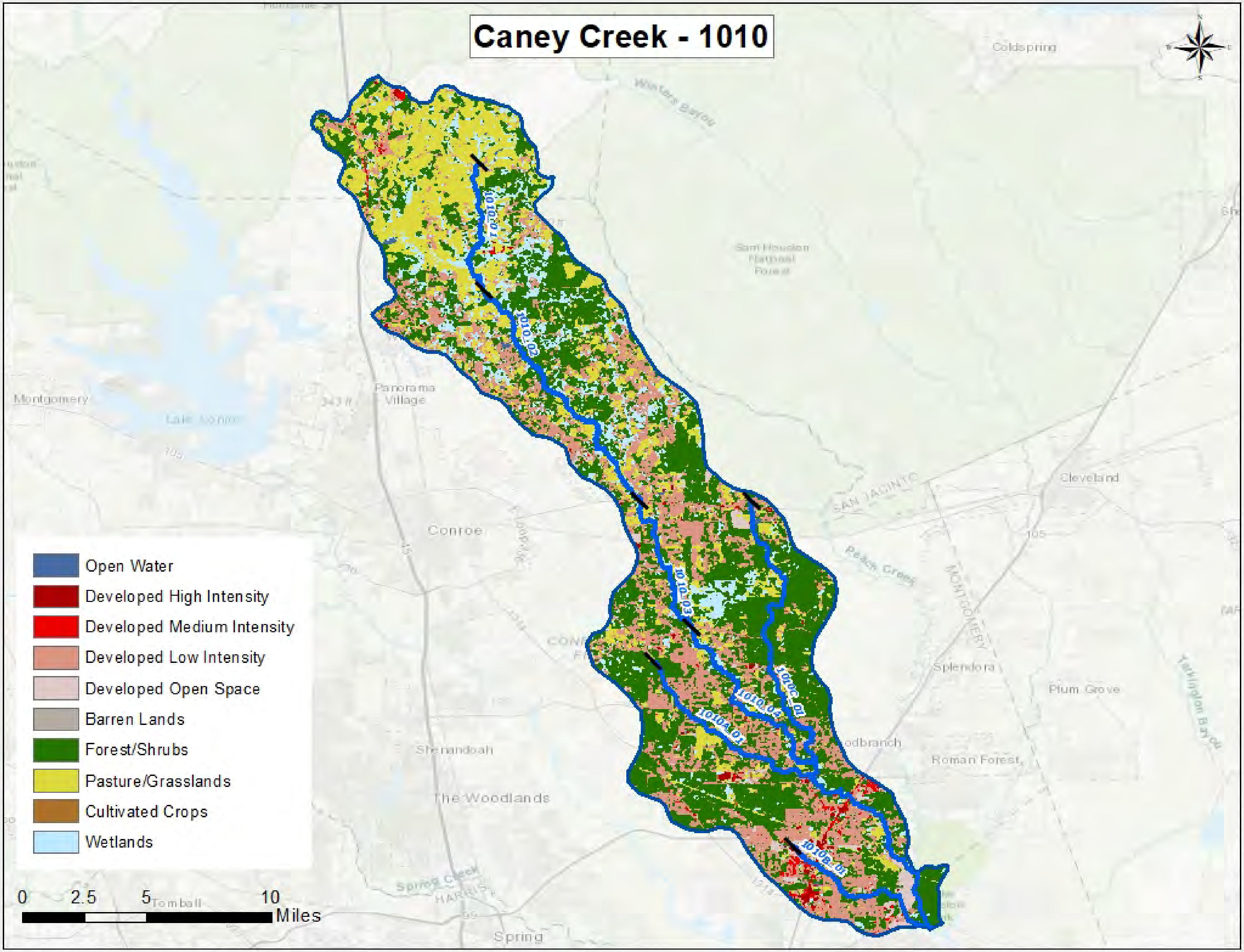
Segment Discussion

Watershed Characteristics and Land Cover: The Caney Creek (1010) segment begins near SH 150 in Walker County and flows to its confluence with the East Fork San Jacinto River in Harris County. Major tributaries include Camp, White Oak, Little Caney, McRae, and Dry Creeks, as well as Spring and West Fork Spring Branches. Caney Creek flows into the East Fork San Jacinto River and then to Lake Houston, a public drinking water supply.

The watershed is primarily forested, with Forests/Shrubs making up 41.00 percent of the land cover. Development in the form of small ranches, ranchettes and hobby farms has become common throughout the watershed. Cleared lands for cattle grazing and hay production make up most of the agricultural activities. Timber harvesting is also a present in the middle and upper reaches of the watershed. A few tracts of the Sam Houston National Forest lie in the very northern portions of the watershed. With the exception of the communities of New Waverly, Willis, and Cut and Shoot, most of the urbanized area is found in the lower portion of the watershed around U.S. Highway 59.

Segment 1010 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	48,889.22	34.42	27,826.99	19.59	-43.08
Barren Lands	1,442.44	1.02	644.05	0.45	-55.35
Developed	15,481.93	10.90	35,391.04	24.91	128.60
Forest/Shrubs	55,280.81	38.91	58,245.54	41.00	5.36
Open Water	1,174.24	0.83	314.02	0.22	-73.26
Wetlands	19,789.02	13.93	19,644.69	13.83	-0.73
TOTAL	**142,057.66**	**100.00**	**142,066.34**	**100.00**	


Caney Creek - 1010
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
2.5
5
10
Miles
1010_01
1010_02
1010_03
1010_04
1010A_01
1010B_01
1010C_01
Coldspring
Winters Bayou
Sam Houston National Forest
Montgomery
Panorama Village
Conroe
Cleveland
San Jacinto
Peach Creek
Montgomery
Splendora
Plum Grove
Roman Forest
Shenandoah
The Woodlands
Spring Creek
Harris
Tomball
Spring

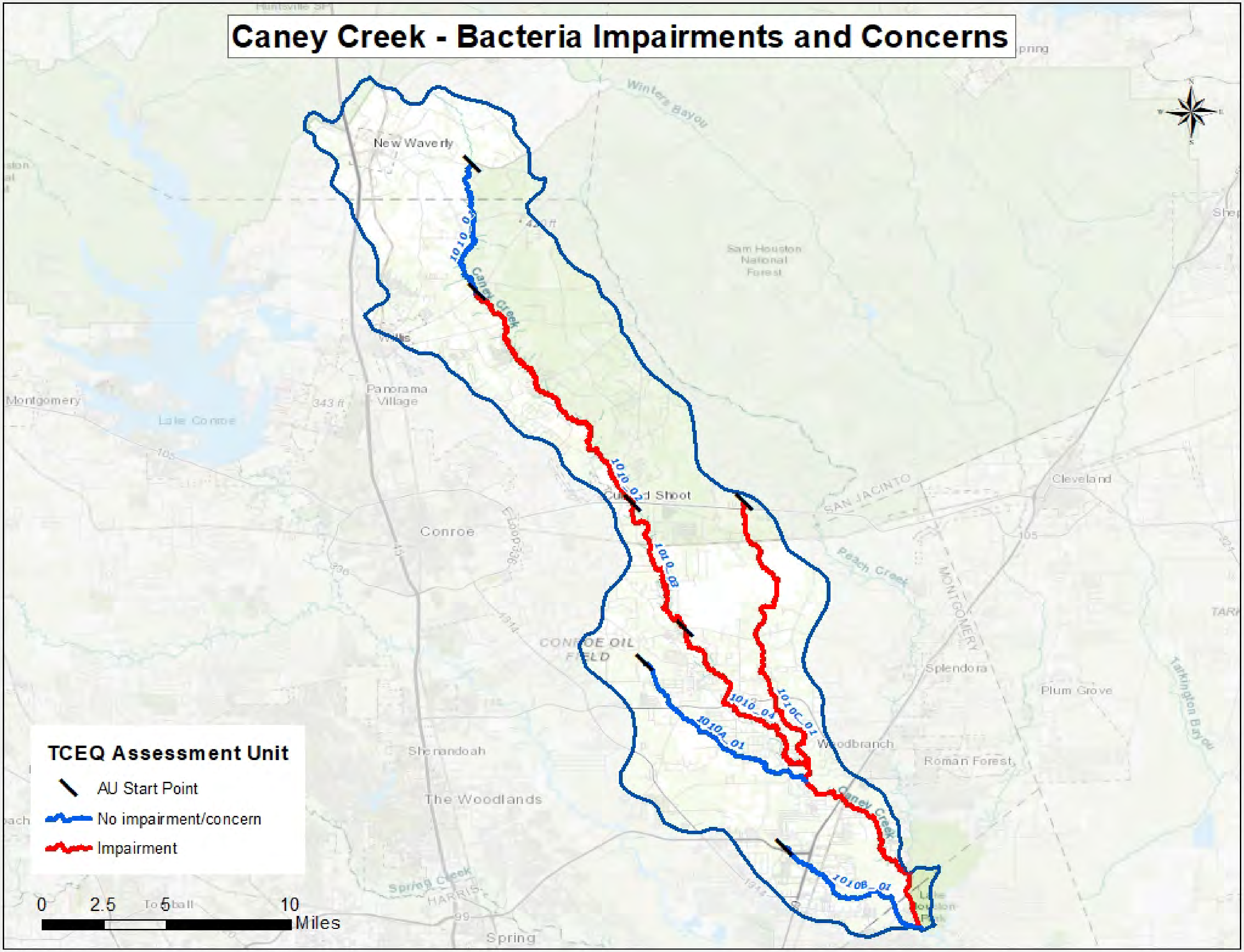
Water Quality Issues:

Bacteria Impairments and Concerns
Recreation use is not supported in three of four assessment units for Caney Creek (AUs 1010_02, 1010_03, and 1010_04). Moving from upstream to downstream, the *E. coli* geometric means were 203.31 MPN/100 mL in AU 1010_02, 220.69 MPN/100 mL in AU 1010_03, and 183.17 MPN/100 mL in AU 1010_04. Recreation use is also not supported in Spring Branch (1010C), with a geometric mean of 274.43 MPN/100 mL.

Dissolved Oxygen Impairments and Concerns
Aquatic life use is fully supported in Segment 1010. Aquatic life use is not supported in Spring Branch due to depressed dissolved oxygen.

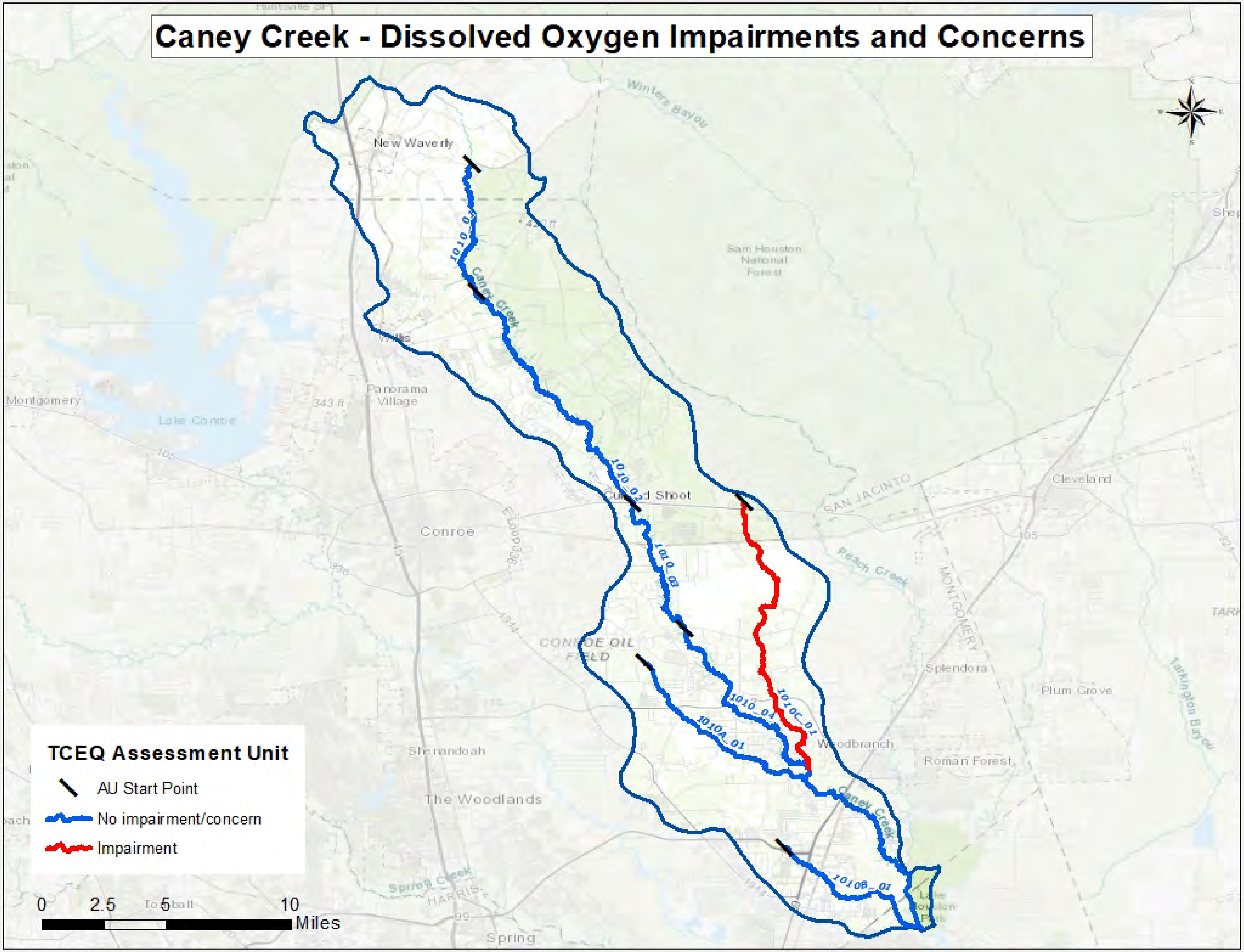
Nutrient Concerns
No nutrient concerns were identified in this watershed.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.



Caney Creek - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
2.5
5
10
Miles
New Waverly
Willis
Panorama Village
Conroe
Cut and Shoot
Montgomery
Lake Conroe
Sam Houston National Forest
Winters Bayou
Caney Creek
Peach Creek
SAN JACINTO
MONTGOMERY
Cleveland
Splendora
Plum Grove
Woodbranch
Roman Forest
Shenandoah
The Woodlands
Spring
Spring Creek
HARRIS
CONROE OIL FIELD
Tarkington Bayou
1010_04
1010_03
1010_02
1010_01
1010A_01
1010B_01
1010C_01

Caney Creek - Dissolved Oxygen Impairments and Concerns

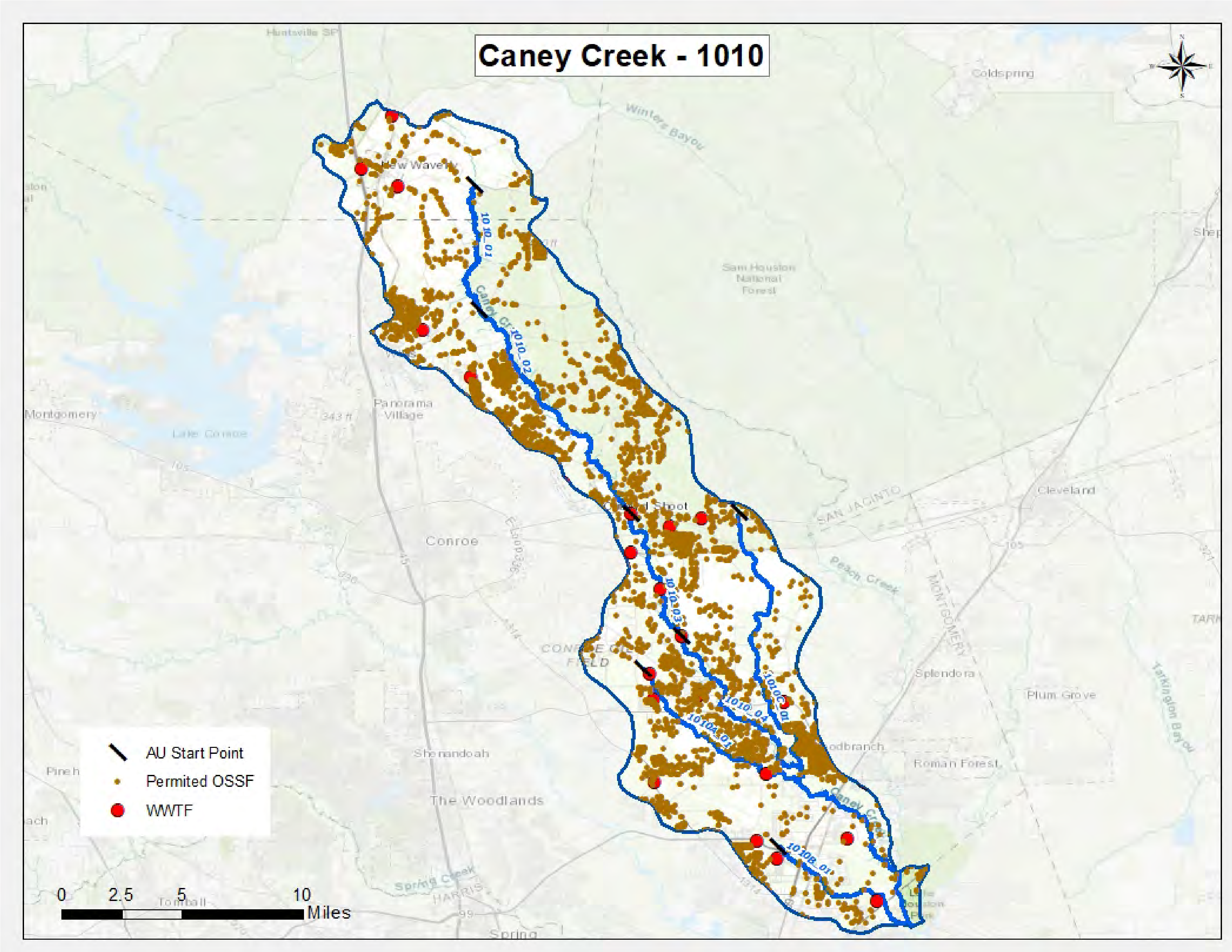


Potential Sources of Water Quality Issues: Caney Creek is a rural water body and rural sources of fecal bacteria, such as agriculture and failing on-site sewage systems, are the key sources.

There are 21 permitted wastewater outfalls in the Caney Creek watershed. In most areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 4,591 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Caney Creek watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 45 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Caney Creek watershed.



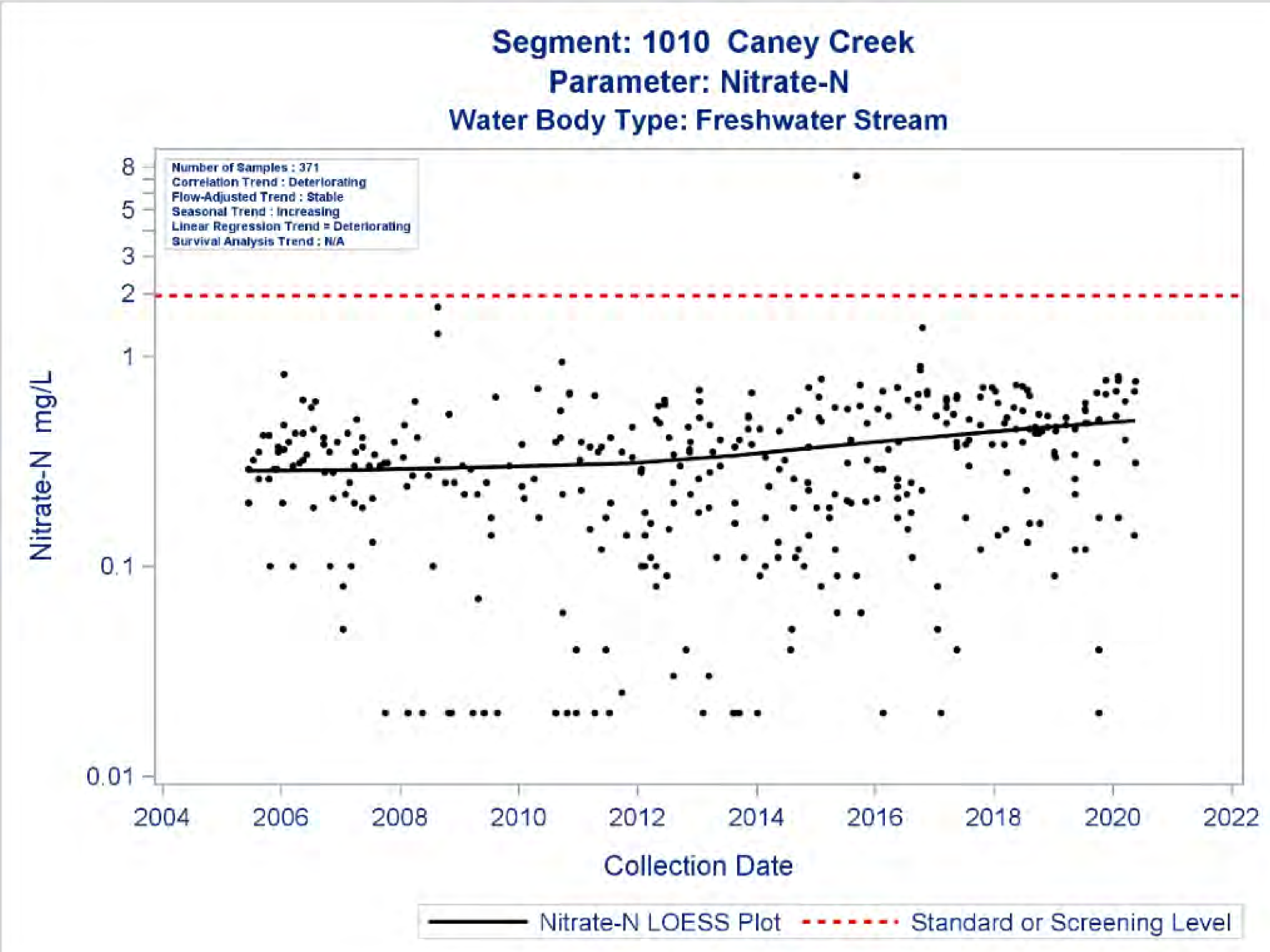
Caney Creek - 1010
AU Start Point
Permited OSSF
WWTF
0
2.5
5
10
Miles
1010_01
1010_02
1010_03
1010_04
1010A_01
1010B_01
1010C_01
Caney Cr
Winters Bayou
Sam Houston National Forest
Coldspring
Cleveland
Conroe
Montgomery
Lake Conroe
Panorama Village
The Woodlands
Shenandoah
Splendora
Plum Grove
Roman Forest
Peach Creek
Spring Creek
Spring
Tomball
SAN JACINTO
MONTGOMERY
HARRIS
Tarkington Bayou

Trend Analysis:

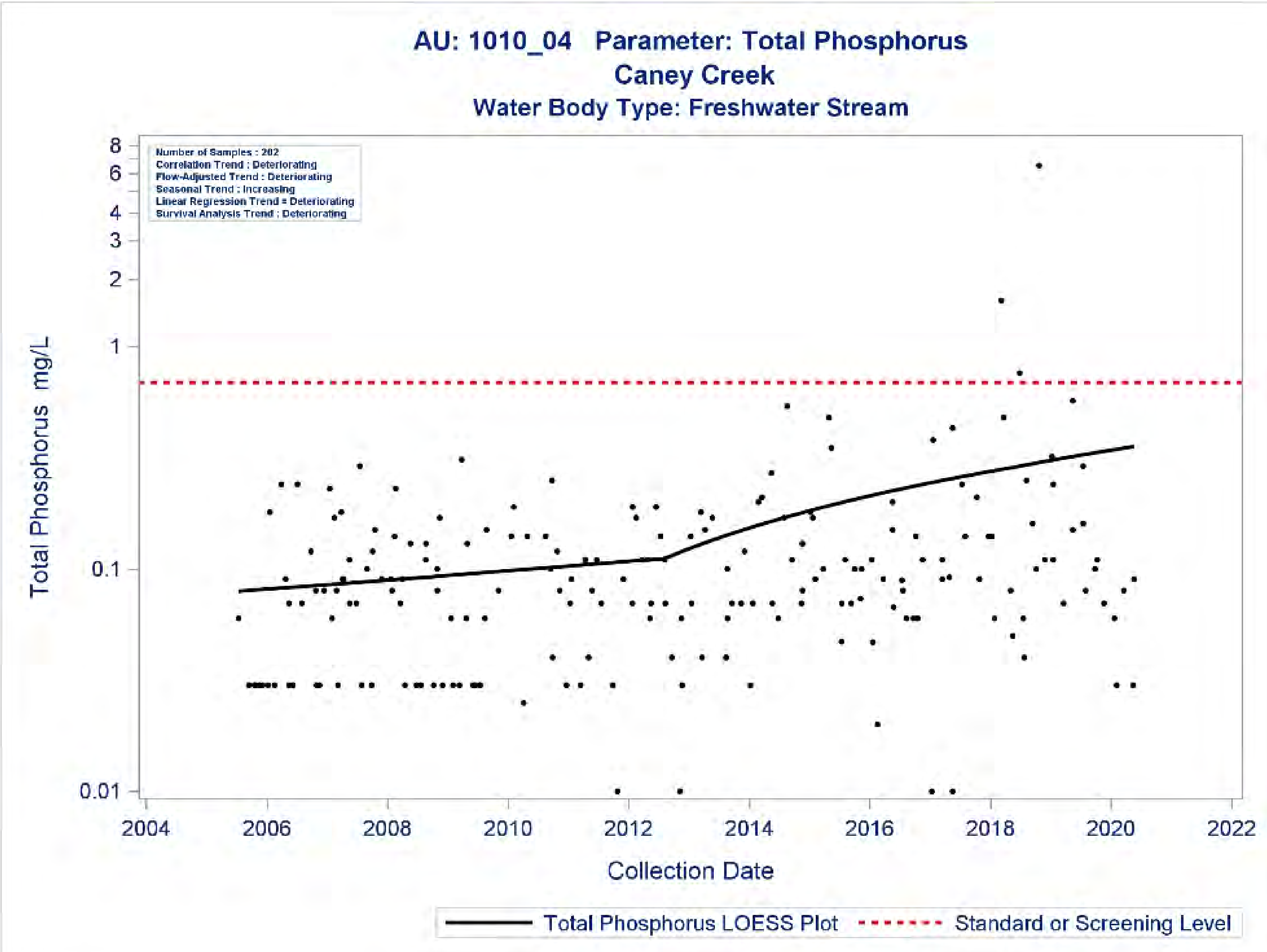
Regression analysis of data from the main segment of Caney Creek revealed statistically significant water quality trends for four parameters – increasing pH, nitrate, ammonia, and total phosphorous (TP), though the increasing trend in ammonia and TP are most significant in the furthest downstream AU 1010_04. While not statistically significant, total Kjeldahl nitrogen (TKN) levels appear to be improving, with a slight decreasing trend over the past few years. Although most nutrient concentrations are increasing, levels are still below the set screening criteria for ammonia, nitrate, and TP, so no concern is present at this time. Ammonia and nitrate are also increasing on Spring Branch segment 1010C, with a handful of ammonia samples above the screening level, but no concern is listed at this time.

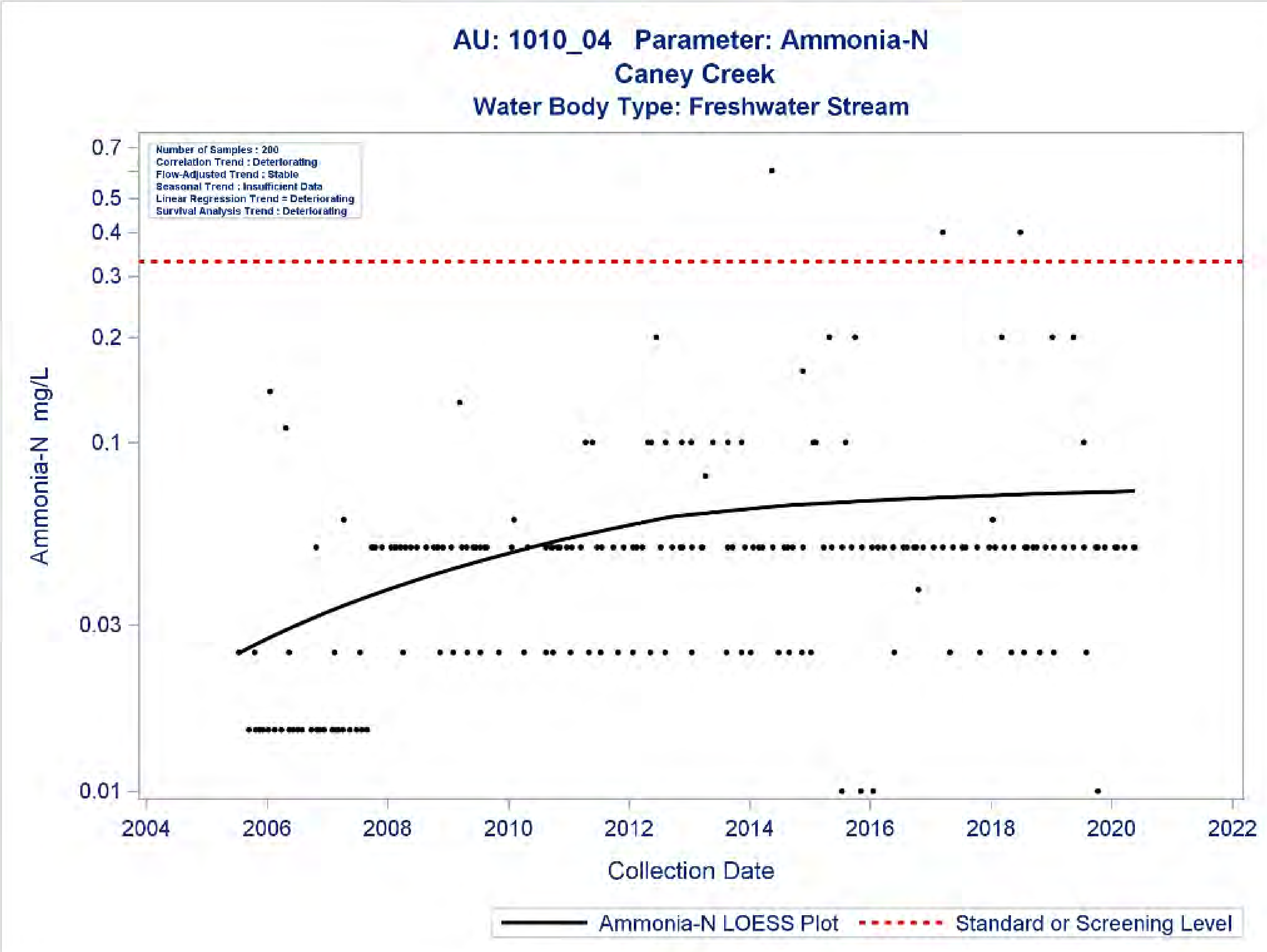
The 2020 Texas Integrated Report lists dissolved oxygen (DO) as impaired for Spring Branch. However, monitoring station 20451 was replaced with station 21965, a more representative stations, in early 2017 and there is insufficient data to determine a trend at this time. While more data is necessary to better evaluate variations in DO levels within this segment, existing data from grab samples shows that DO levels since the monitoring site switch in 2017 are generally at or above the standard.

Spring Branch and the majority of the main segment are impaired for bacteria. Regression analysis showed no significant change in E. coli levels during the period of record; however, while E. coli concentrations appear to be stable, they remain well above the 126 MPN/100 mL standard.



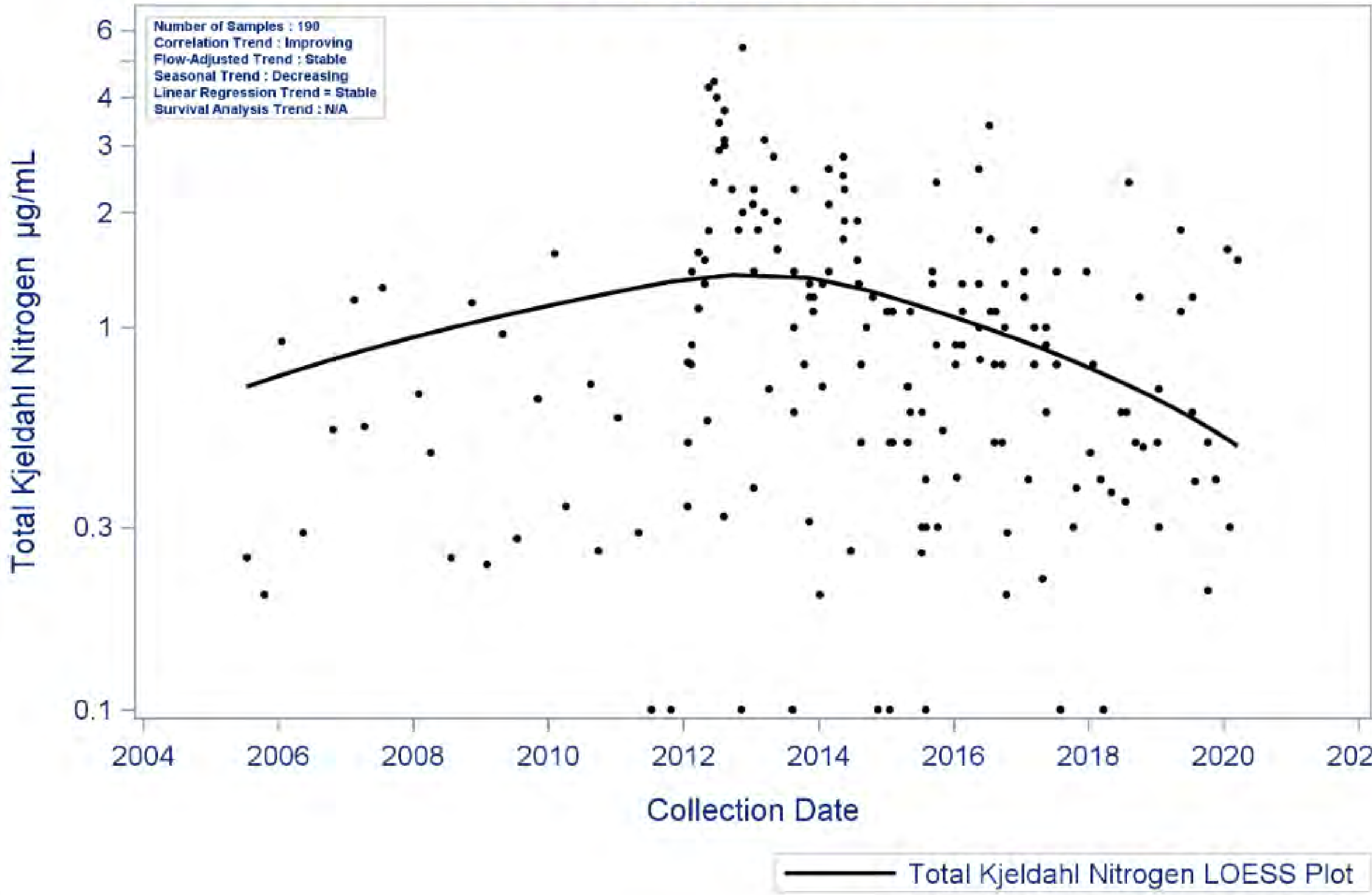
Segment: 1010 Caney Creek
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 371
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
8
5
3
2
1
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

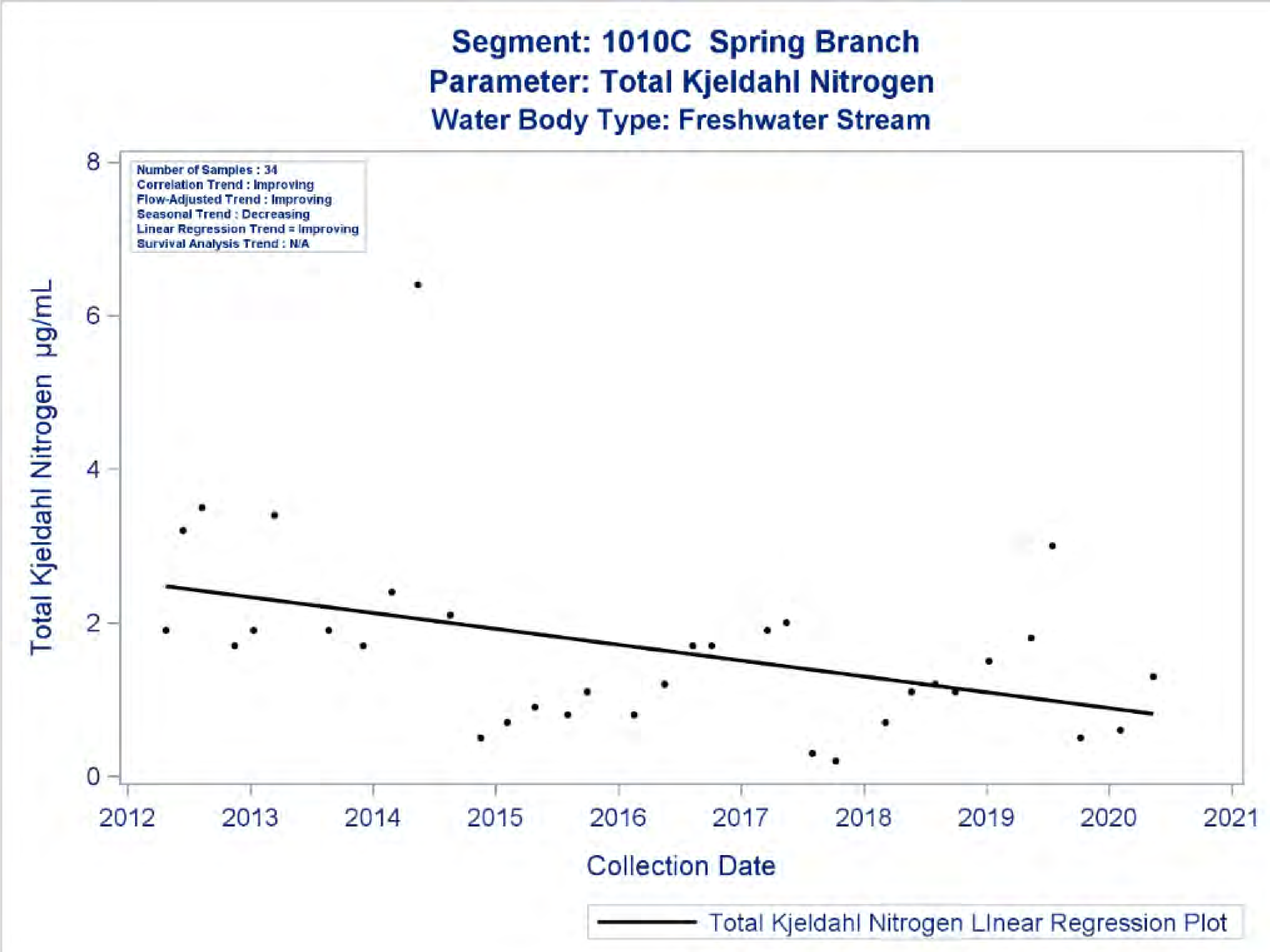

AU: 1010_04 Parameter: Total Phosphorus
Caney Creek
Water Body Type: Freshwater Stream
Number of Samples : 202
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Total Phosphorus mg/L
8
6
4
3
2
1
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



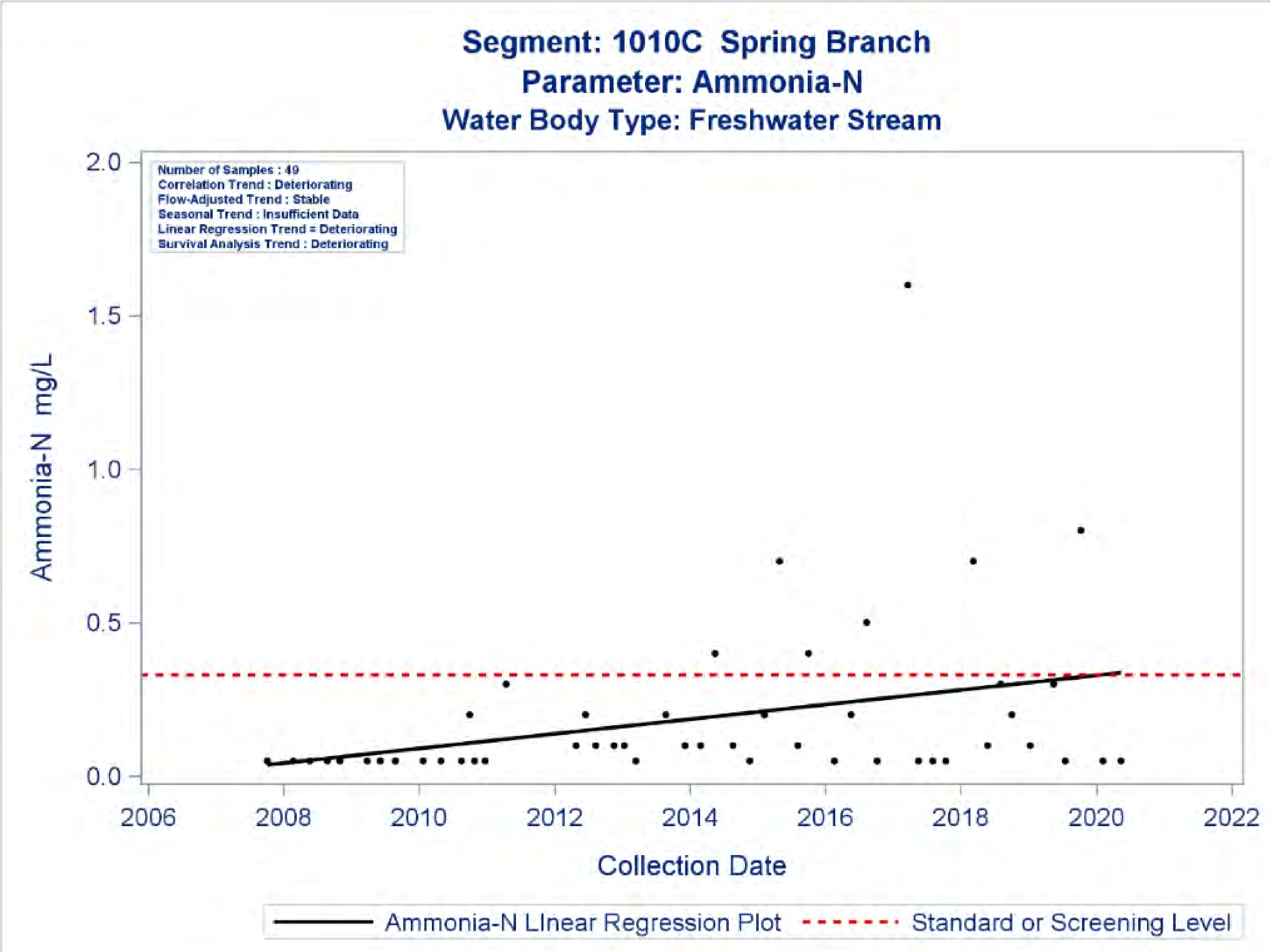
AU: 1010_04 Parameter: Ammonia-N
Caney Creek
Water Body Type: Freshwater Stream
Number of Samples : 200
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
0.7
0.5
0.4
0.3
0.2
0.1
0.03
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level

Segment: 1010 Caney Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream

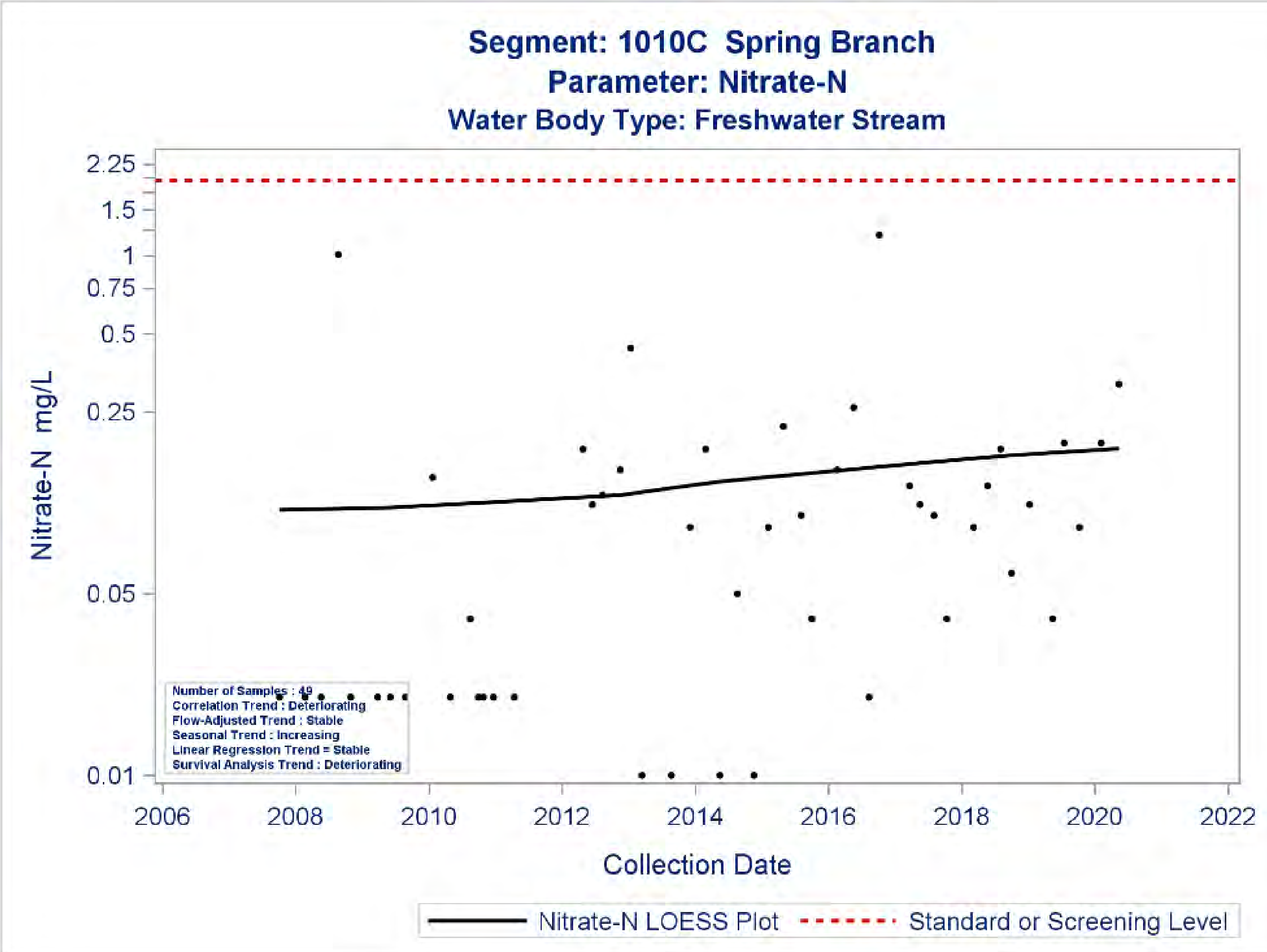




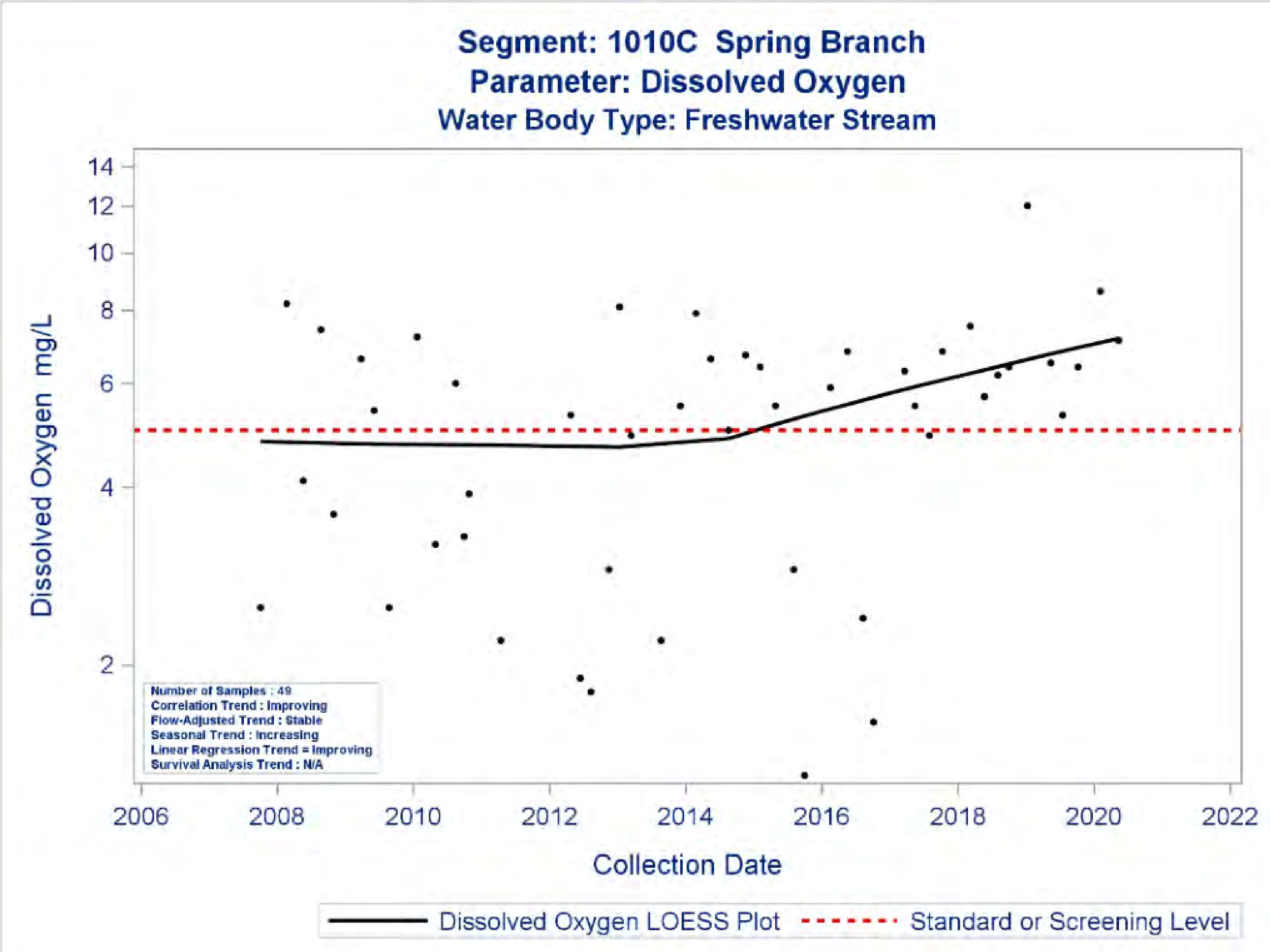
Segment: 1010C Spring Branch
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 34
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
2
4
6
8
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



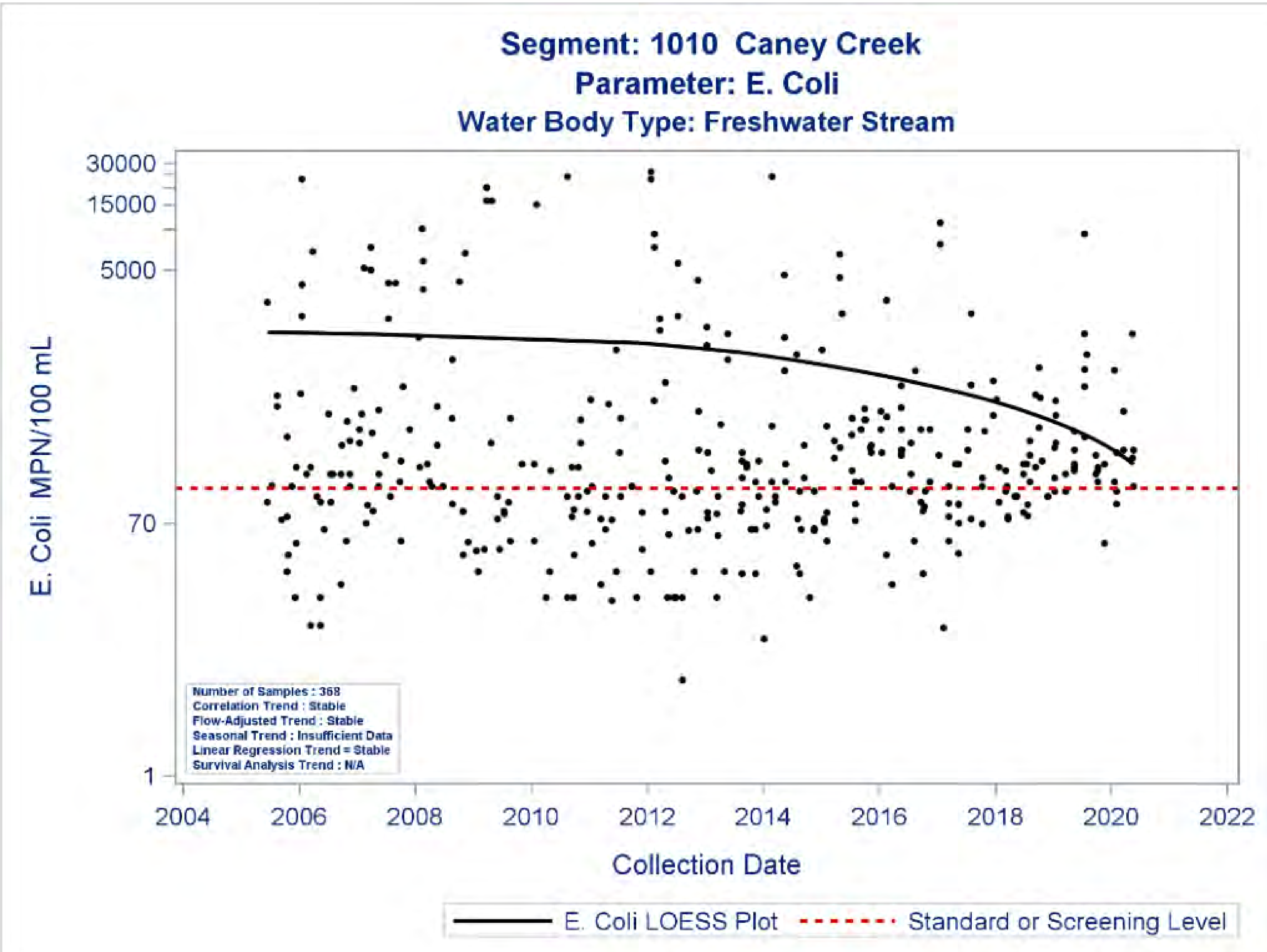
Segment: 1010C Spring Branch
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 49
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
2.0
1.5
1.0
0.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



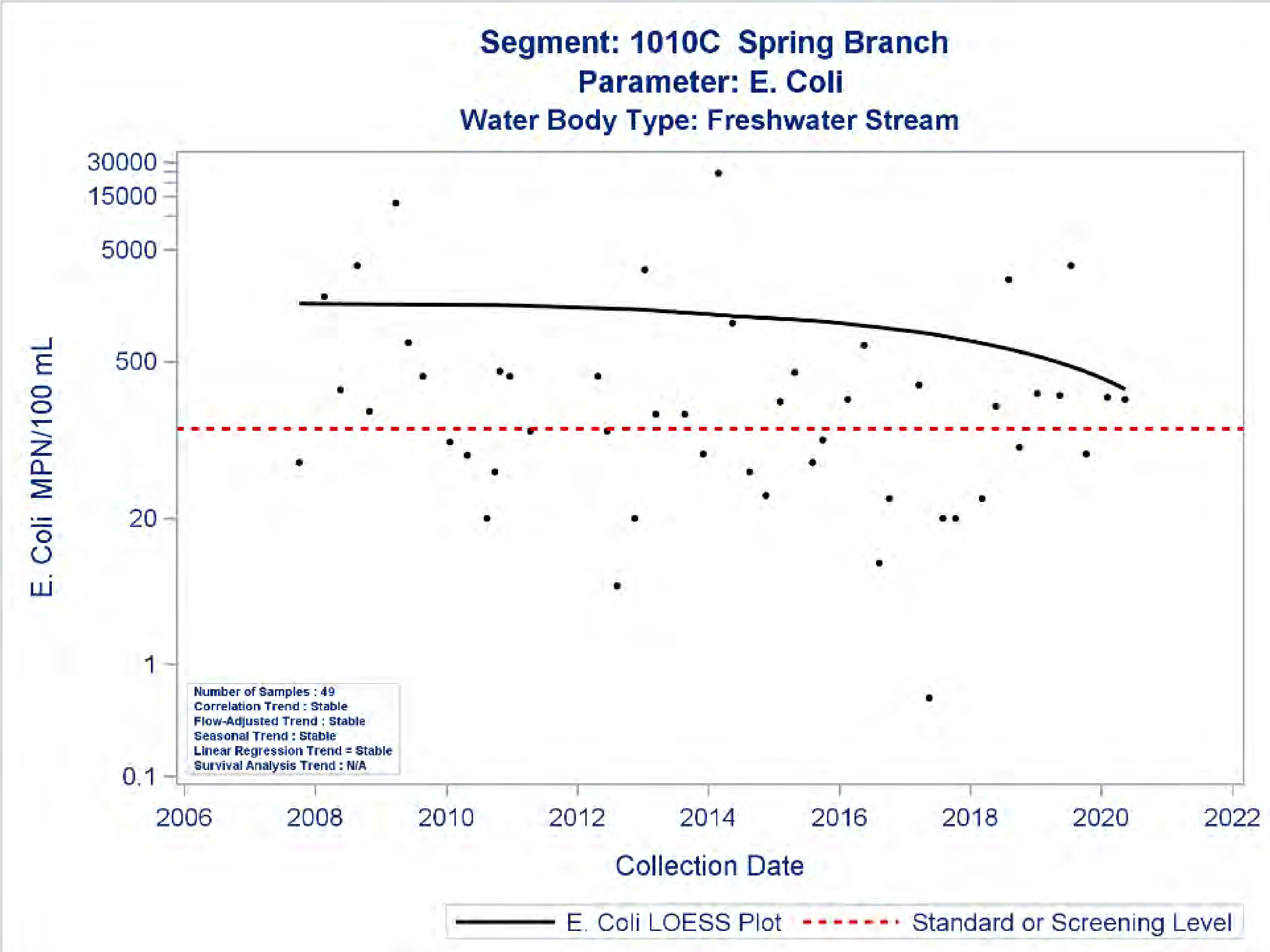
Segment: 1010C Spring Branch
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Nitrate-N mg/L
2.25
1.5
1
0.75
0.5
0.25
0.05
0.01
Number of Samples : 49
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : Deteriorating
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level



Segment: 1010C Spring Branch
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Dissolved Oxygen mg/L
14
12
10
8
6
4
2
Number of Samples : 49
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level



Segment: 1010 Caney Creek
Parameter: E. Coli
Water Body Type: Freshwater Stream
E. Coli MPN/100 mL
30000
15000
5000
70
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Number of Samples : 368
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
E. Coli LOESS Plot
Standard or Screening Level



Segment: 1010C Spring Branch
Parameter: E. Coli
Water Body Type: Freshwater Stream
E. Coli MPN/100 mL
30000
15000
5000
500
20
1
0.1
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Number of Samples : 49
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
E. Coli LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1010_02 I 1010_03 I 1010_04 I 1010C_01 I	• Animal waste from agricultural production and domestic animal facilities • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Presence of feral hogs and other wild animals • Direct and dry weather discharges • Poorly operated or undersized WWTFs • Waste haulers illegal discharges/improper disposal • WWTF non-compliance, overflows, and collection system by-passes • Improper or no pet waste disposal	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Improve stormwater controls in new developments by adding bacteria reduction measures • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education on pet waste disposal
Low Dissolved Oxygen Concentrations	1010C_01 I	▪ Agricultural runoff from row crops, fallow fields, and animal operations ▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Excessive organic matter from malfunctioning OSSFs, SSOs, agricultural operations, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste)	• Detrimental effect on aquatic biological community	• Add water quality features to stormwater systems • Develop and implement Water Quality Management Plans for individual agricultural properties • More public education regarding OSSF operation and maintenance • Increase OSSF maintenance and repairs • More public education on pet waste disposal

Special Studies:

The Caney Creek TMDL was initiated in 2016. The TMDL documents have been completed and the stakeholder I-Plan is drafted. The TMDL and I-Plan will be presented at a public meeting seeking comments in early 2021. Following the comment period, the documents will be presented to the TCEQ and the EPA for approval.

The Caney Creek segment is part of the larger geographic area covered under the Bacteria Implementation Group I-Plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, and grease
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 1009				Name: Cypress Creek	
Length:	52 miles	**Watershed Area:**	319 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	11	**Texas Stream Team Monitoring Stations:**	9	**Permitted WWTF Outfalls:**	115

DESCRIPTION

- Segment 1009 (Perennial Stream w/ high ALU): **Cypress** Creek (classified water body) – From the confluence with Spring Creek in Harris County to the confluence of Snake Creek and Mound Creek in Waller County

- Segment 1009A (Perennial Stream): **Dry Creek** (unclassified water body) – Perennial stream from the confluence with Cypress Creek upstream to the beginning of channelization at Jarvis Road, 0.6 km upstream from the confluence with Cypress Creek north of Hwy 290

- Segment 1009B (Perennial Stream): **Dry Gully** (unclassified water body) – Perennial stream from the point where channelization begins at Jarvis Road, which is 0.6 km upstream of the confluence with Cypress Creek, upstream to Spring Cypress Road, 1.2 km upstream of Jarvis Road north of Hwy 290

- Segment 1009C (Intermittent Stream w/ minimal ALU): **Faulkey Gully** (unclassified water body) – From the Cypress Creek confluence to a point 11.7 km (7.2 mi) upstream

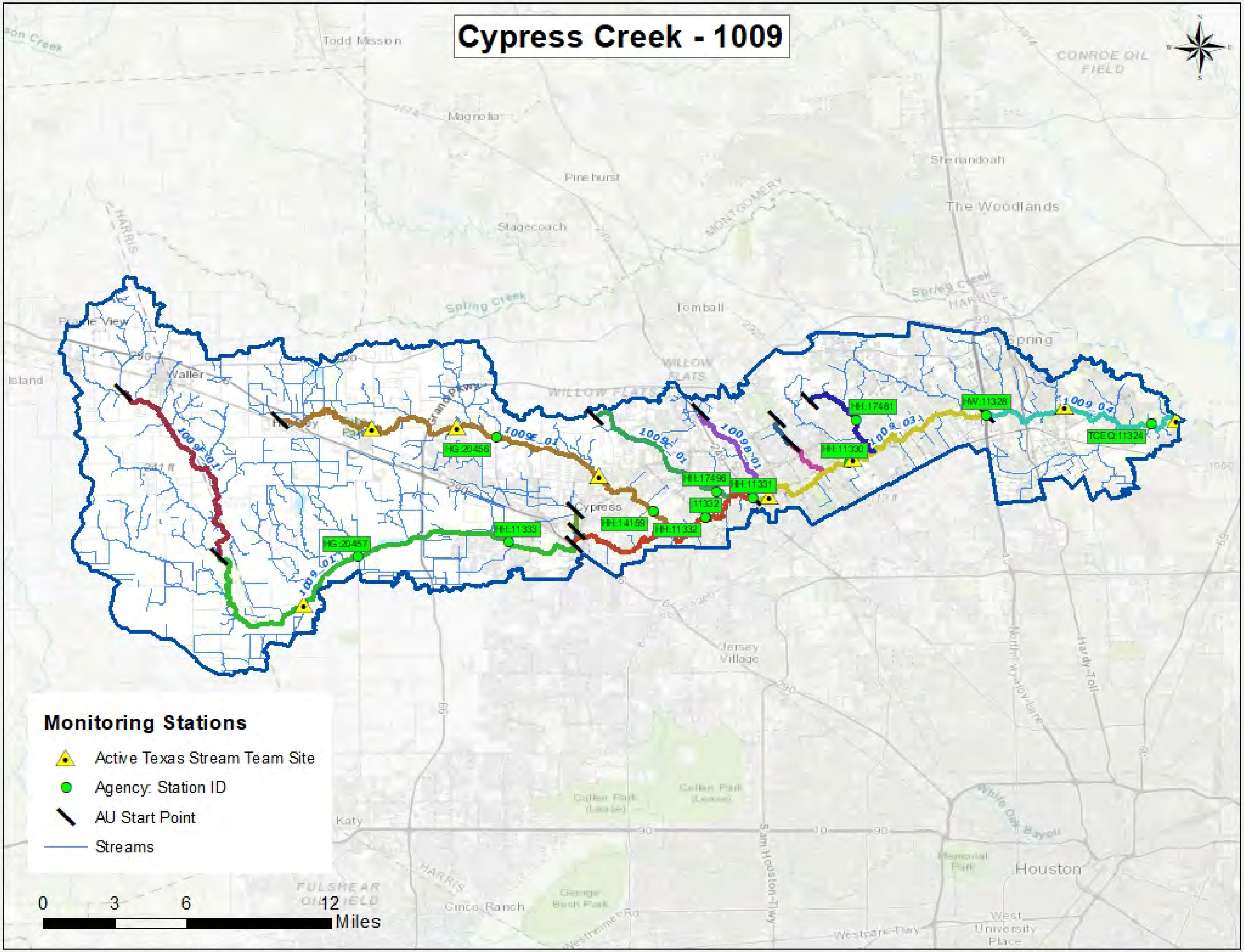
- Segment 1009D (Perennial Stream w/ high ALU): **Spring Gully** (unclassified water body) – From the Cypress Creek confluence upstream to near Spring Cypress Road

- Segment 1009E (Perennial Stream w/ high ALU): **Little Cypress Creek** (unclassified water body) – From the Cypress Creek confluence to a point 11 km (6.8 mi) upstream in Harris County

- Segment 1009F (Perennial Stream w/ high ALU): **Mound Creek** (unclassified water body) – From the confluence with Snake Creek, which together form Cypress, Creek upstream to an unnamed tributary 1.95 km (1/2 mi) upstream of FM 362

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11324	1009	CYPRESS CREEK IMEDIATELY DOWNSTREAM OF CYPRESSWOOD DRIVE/OLD TETTAR RD EXTENSION	FO	QUARTERLY	Field, Conventional, Bacteria
11328	1009	CYPRESS CREEK BRIDGE ON IH 45 15 MI NORTH OF HOUSTON	HW	BIMONTHLY	Field, Conventional, Bacteria, Flow
11330	1009	CYPRESS CREEK AT STEUBNER-AIRLINE ROAD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
11331	1009	CYPRESS CREEK AT SH 249	HH	BIMONTHLY	Field, Conventional, Bacteria
11332	1009	CYPRESS CREEK IMMEDIATELY DOWNSTREAM OF GRANT ROAD NEAR CYPRESS	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
11333	1009	CYPRESS CREEK IMMEDIATELY DOWNSTREAM OF HOUSE HAHL ROAD NEAR CYPRESS	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
20457	1009	CYPRESS CREEK AT KATY HOCKLEY ROAD 7 KILOMETERS SOUTH OF SH 290 WEST OF CYPRESS	HG	QUARTERLY	Field, Conventional, Bacteria, Flow
17496	1009C	FAULKEY GULLY OF CYPRESS CREEK 105 METERS DOWNSTREAM OF LAKEWOOD FOREST DRIVE NORTHWEST OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
17481	1009D	SPRING GULLY AT SPRING CREEK OAKS DRIVE IN TOMBALL	HH	BIMONTHLY	Field, Conventional, Bacteria
14159	1009E	LITTLE CYPRESS CREEK IMMEDIATELY DOWNSTREAM OF KLUGE ROAD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
20456	1009E	LITTLE CYPRESS CREEK AT MUESCHKE ROAD 4.4 KILOMETERS NORTH OF SH 290 NORTHWEST OF CYPRESS	HG	QUARTERLY	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
HG = Houston-Galveston Area Council
HH = Houston Health & Human Services
HW = Houston Water Quality Control



Cypress Creek - 1009
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
3
6
12
Miles
1009_01
1009A_01
1009B_01
1009C_01
1009D_01
1009E_01
1009_03
1009_04
HG:20456
HG:20457
HH:11333
HH:14159
HH:11332
HH:17496
HH:11331
HH:11330
HH:17481
HW:11328
TCEQ:11324
Todd Mission
Magnolia
Pinehurst
Stagecoach
Tomball
Shenandoah
The Woodlands
Spring
Waller
Cypress
Jersey Village
Katy
Cinco Ranch
Houston
West University Place
CONROE OIL FIELD
WILLOW FLATS
FULSHEAR OIL FIELD

Segment 1009 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0 / 2.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0 / 1.5	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	100		
Sulfate (mg/L as SO_4):	50		
Total Dissolved Solids (mg/L):	600		

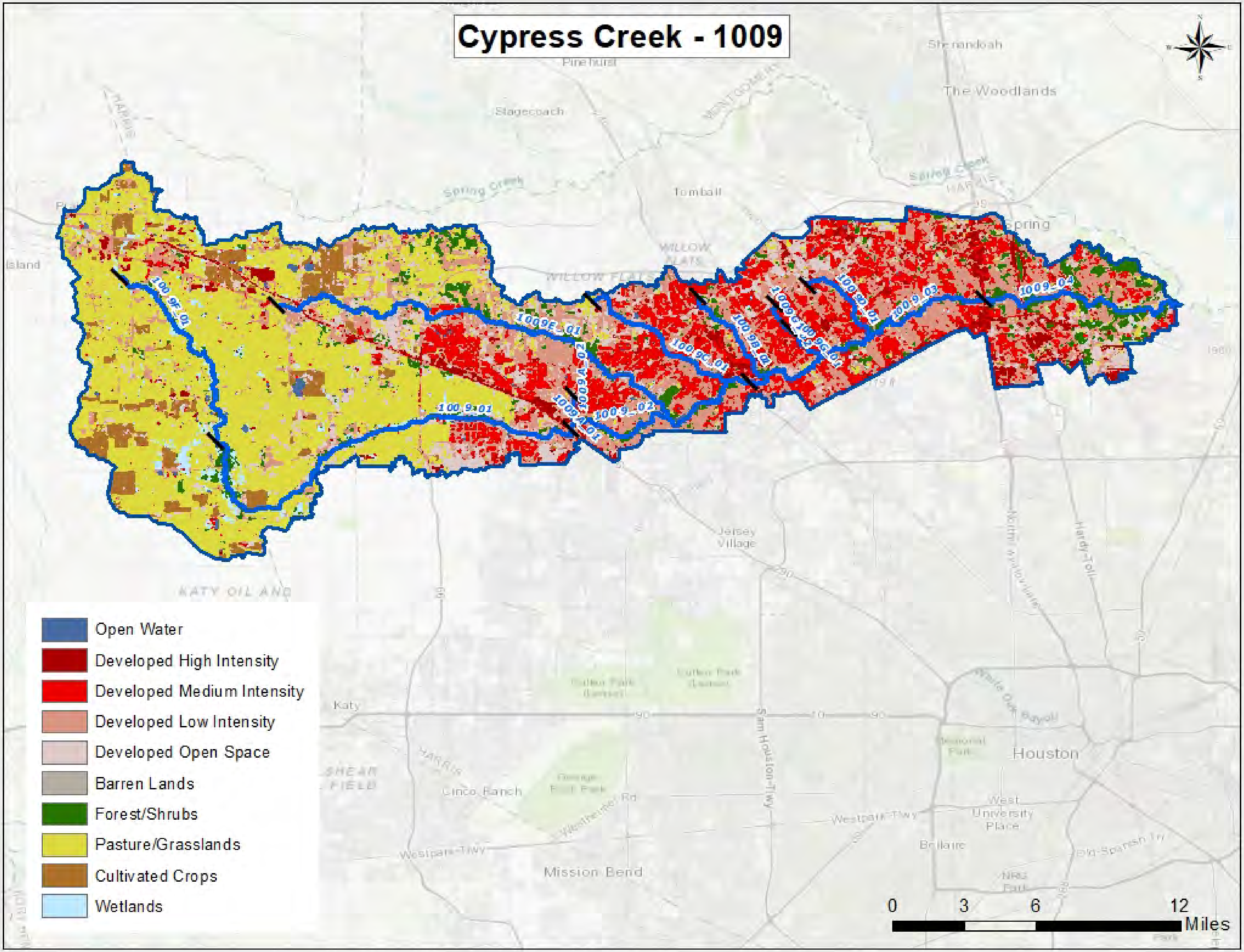
Segment Discussion

Watershed Characteristics and Land Cover: Cypress Creek (1009) stretches from its confluence with Spring Creek in Harris County to the confluence of Snake Creek and Mound Creek in Waller County. Numerous tributaries flow into Cypress Creek, including Dry, Little Cypress, Live Oak, Mound, Pillot, and Seals Creeks, and Dry, Faulkey, Lemm and Spring Gullies.

The eastern portion of Cypress Creek watershed is dominated by dense residential development within forested lands, but the western portion is still dominated by crop lands and grasslands used for cattle grazing. The middle of the watershed has experienced rapid urbanization. Grasslands and cultivated fields were once the primary land cover/land use; however, subdivisions and commercial buildings now dominate the landscape. Between 2008, developed land cover increased by 68.72 percent, from 62,963 acres (30.79 percent) to 106,234 acres (51.96 percent). During the same timeframe, agricultural land cover decreased from 111,151 acres (54.36 percent) to 77,870 acres (38.09 percent). Many larger farms in the area use on-site sewage facilities (OSSFs) as their primary method of waste disposal while developments or commercial operations built off U.S. Hwy 290 are on sanitary sewer.

Segment 1009 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	111,151.41	54.36	77,869.77	38.09	-29.94
Barren Lands	3,603.22	1.76	755.03	0.37	-79.05
Developed	62,962.95	30.79	106,233.84	51.96	68.72
Forest/Shrubs	11,213.97	5.48	13,052.06	6.38	16.39
Open Water	1,547.86	0.76	1,062.37	0.52	-31.37
Wetlands	13,989.89	6.84	5,488.23	2.68	-60.77
TOTAL	**204,469.30**	**100.00**	**204,461.29**	**100.00**	


Cypress Creek - 1009
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 3 6 12
Miles
Shenandoah
The Woodlands
Pinehurst
Stagecoach
Tomball
Spring
Spring Creek
Jersey Village
Katy
Houston
Cinco Ranch
Mission Bend
West University Place
Bellaire
1009_04
1009_03
1009D_01
1009C_01
1009B_01
1009C_02
1009E_01
1009A_02
1009A_01
1009_02
1009_01
1009F_01

Water Quality Issues:

Bacteria Impairments and Concerns

Cypress Creek (1009) is not supporting its contact recreation use designation. The entire segment, along with Faulkey Gully (1009C), Spring Gully (1009D), and Little Cypress Creek (1009E), are listed as impaired for bacteria in the 2020 Integrated Report. In the upper portion of Cypress Creek (AU 1009_01), the bacteria geometric mean was 237.92 MPN/100 mL. As you move downstream, the *E.* coli levels in the stream increased. The geometric mean was 364.05 in AU 1009_02, 464.51 MPN/100 mL in 1009_03, and 781.08 MPN/100 mL in 1009_04.

Dissolved Oxygen Impairments and Concerns

Depressed dissolved oxygen was identified as a concern in AU 1009_01, with 16 percent of grab samples below the screening level during the assessment period.

Nutrient Concerns

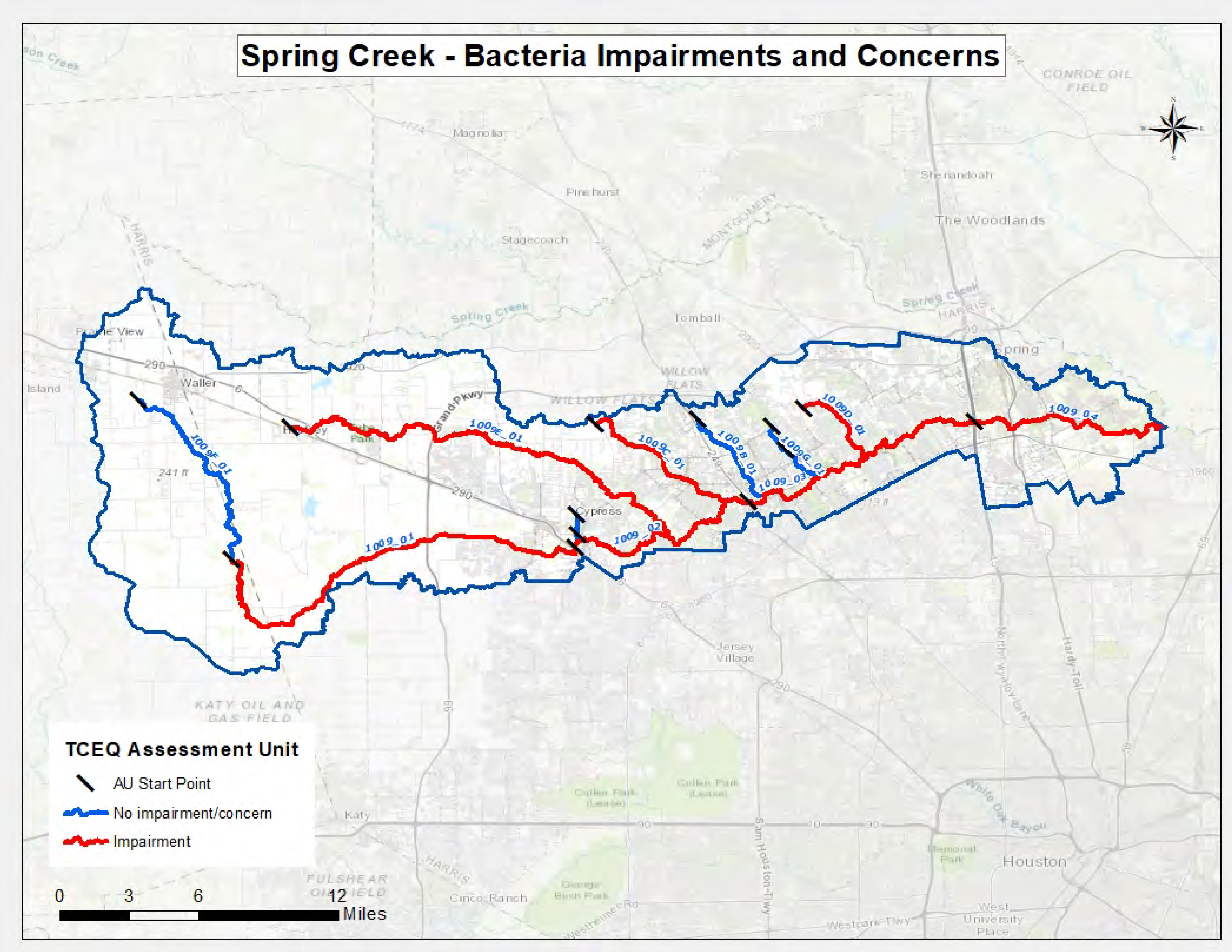
Nutrient concerns for both nitrate-nitrogen and total phosphorus screening levels have been identified in Cypress Creek and its tributaries (Faulkey Creek, Spring Creek, and Little Cypress Creek). Moving downstream, the percentage of samples exceeding the screening level for nitrate-nitrogen increases from 43.8 percent in 1009_01 to 74.2 percent in 1009_02, 74.0 percent in 1009_03, and 81.5 percent in 1009_04. This same pattern is observed with total phosphorus, which increases from 50.6 percent in 1009_01 to 70.3 percent in 1009_02, 76.0 percent in 1009_03, and 82.6 percent in 1009_04.

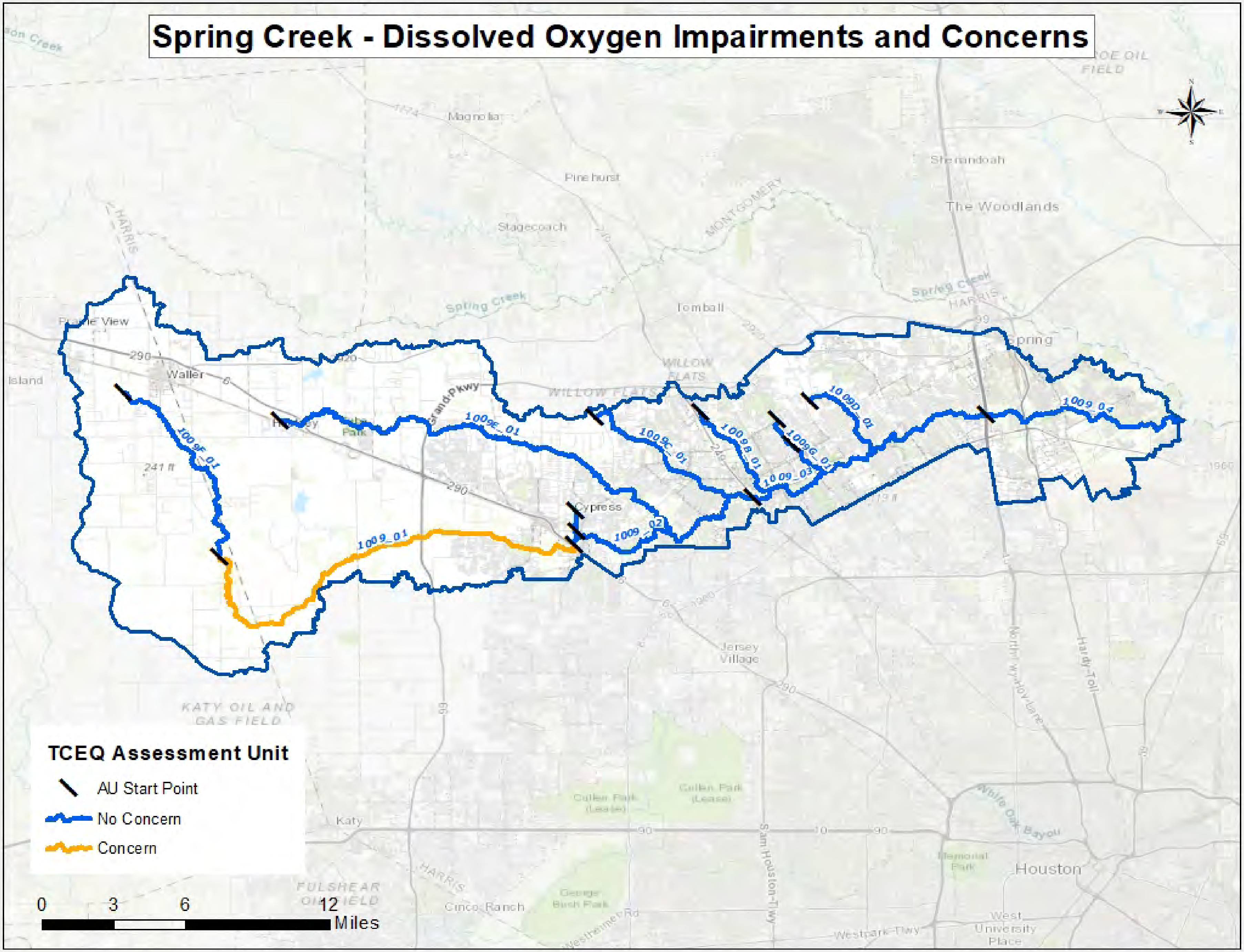
PCBs and Dioxins Impairments

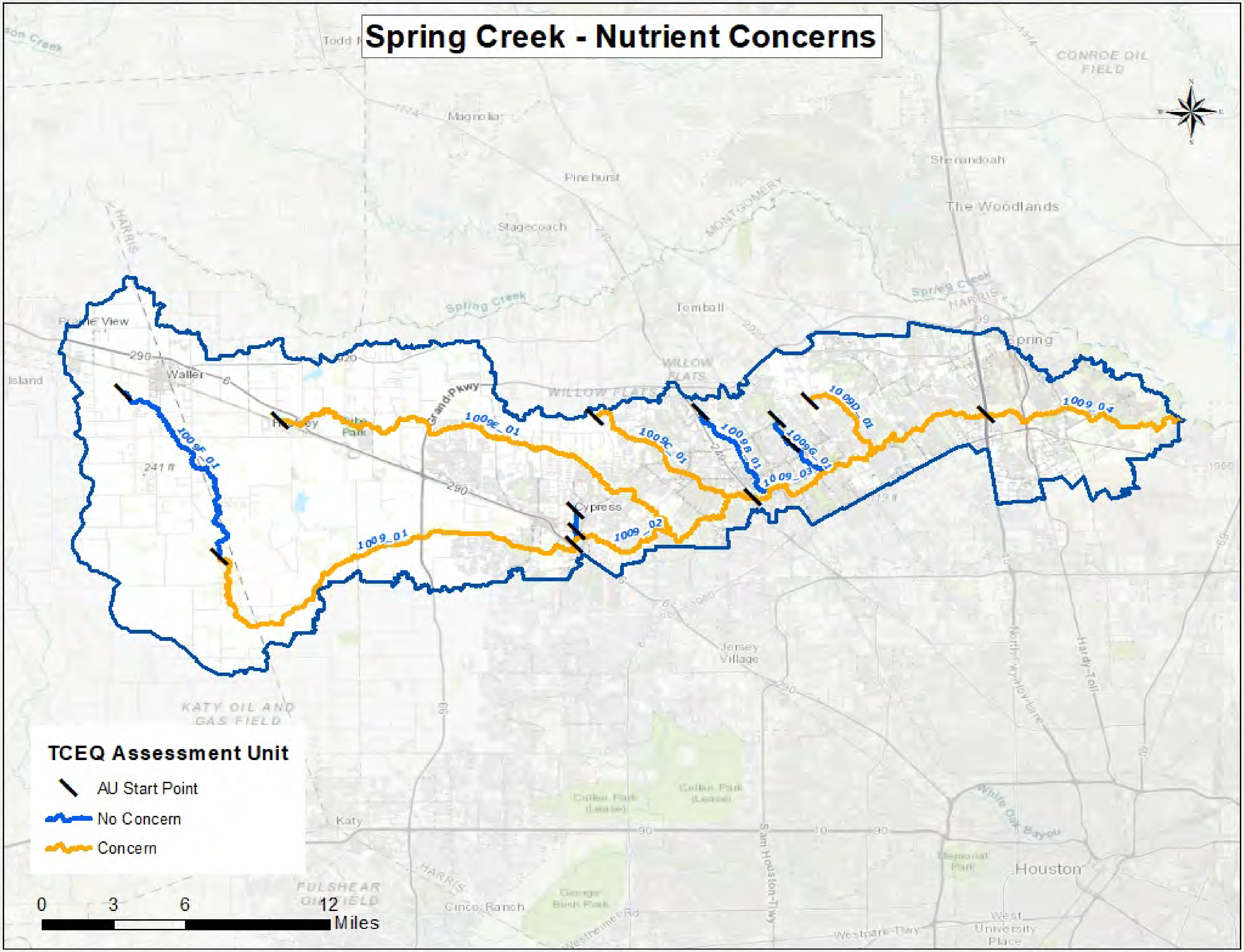
There are no PCBs/Dioxins impairments in this segment.

Habitat

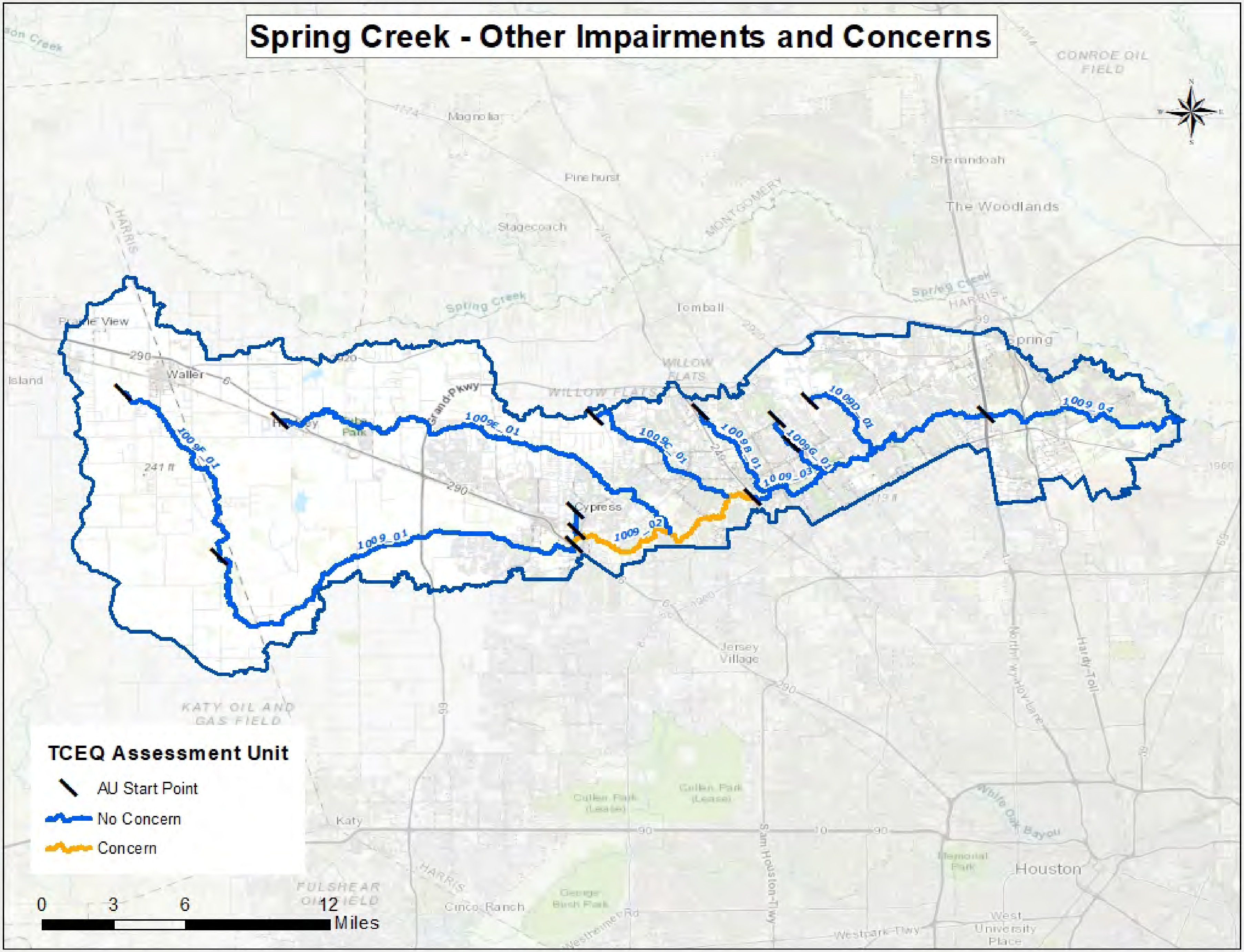
In AU 1009_02, the portion of the stream segment from US 290 to SH 249, a concern for impaired habitat in water has been identified. High quality features of a stream provide diverse shelter and quality food for aquatic organisms. Increased siltation in a stream can decrease the quality of aquatic habitats, leading to less diversity and numbers of aquatic organisms.


Spring Creek - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
3
6
12
Miles
1009_01
1009_02
1009_03
1009_04
1009E_01
1009F_01
1009C_01
1009B_01
1009G_01
1009D_01
Prairie View
Waller
Cypress
Tomball
Magnolia
Pinehurst
Stagecoach
Shenandoah
The Woodlands
Spring
Jersey Village
Katy
Cinco Ranch
Houston
West University Place
CONROE OIL FIELD
KATY OIL AND GAS FIELD
FULSHEAR OIL FIELD
WILLOW FLATS
Spring Creek
Island
MONTGOMERY
HARRIS
Sam Houston Tlwy
Hardy Toll
White Oak Bayou
Memorial Park
George Bush Park
Cullen Park (Lease)
Westpark Tlwy
Westheimer Rd
Grand Pkwy


Spring Creek - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
3
6
12
Miles
1009_01
1009_02
1009_03
1009_04
1009B_01
1009C_01
1009D_01
1009E_01
1009F_01
1009G_01
Waller
Cypress
Tomball
The Woodlands
Houston



Spring Creek - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
1009_01
1009_02
1009_03
1009_04
1009B_01
1009C_01
1009D_01
1009E_01
1009F_01
1009G_01
0
3
6
12
Miles



Spring Creek - Other Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
3
6
12
Miles
1009_01
1009_02
1009_03
1009_04
1009E_01
1009F_01
1009C_01
1009B_01
1009G_01
1009D_01
Prairie View
Waller
Hockley
Cypress
Tomball
Magnolia
Pinehurst
Stagecoach
Shenandoah
The Woodlands
Spring
Jersey Village
Katy
Cinco Ranch
Houston
West University Place
CONROE OIL FIELD
KATY OIL AND GAS FIELD
FULSHEAR OIL FIELD
WILLOW FLATS
Spring Creek
HARRIS
MONTGOMERY
Grand Pkwy
Sam Houston Tlwy
Hardy Toll
White Oak Bayou
Westpark Tlwy
Island

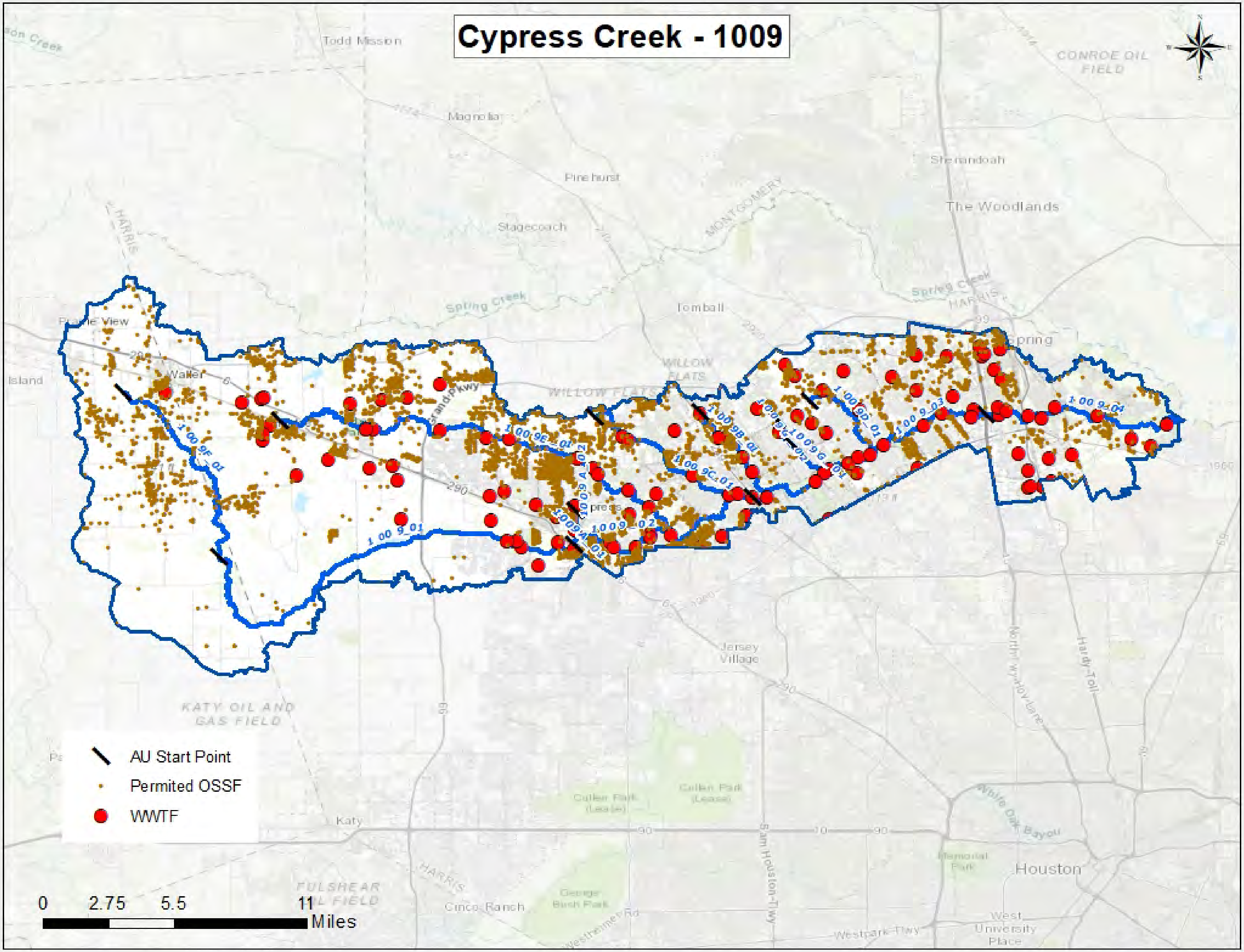
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Cypress Creek watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, feral hogs, and animal waste.

There are 115 permitted wastewater outfalls in the Cypress Creek watershed. In many areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 6,127 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Cypress Creek watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 321 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

A concern for habitat has been identified in a portion of the watershed. Significant development and aggregate mining, as well as hydrologic disruptions in many tributaries in the watershed have appreciably altered the flows, sediment transport and deposition in the waterways and the composition of the riparian corridor in developing areas.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Cypress Creek watershed.



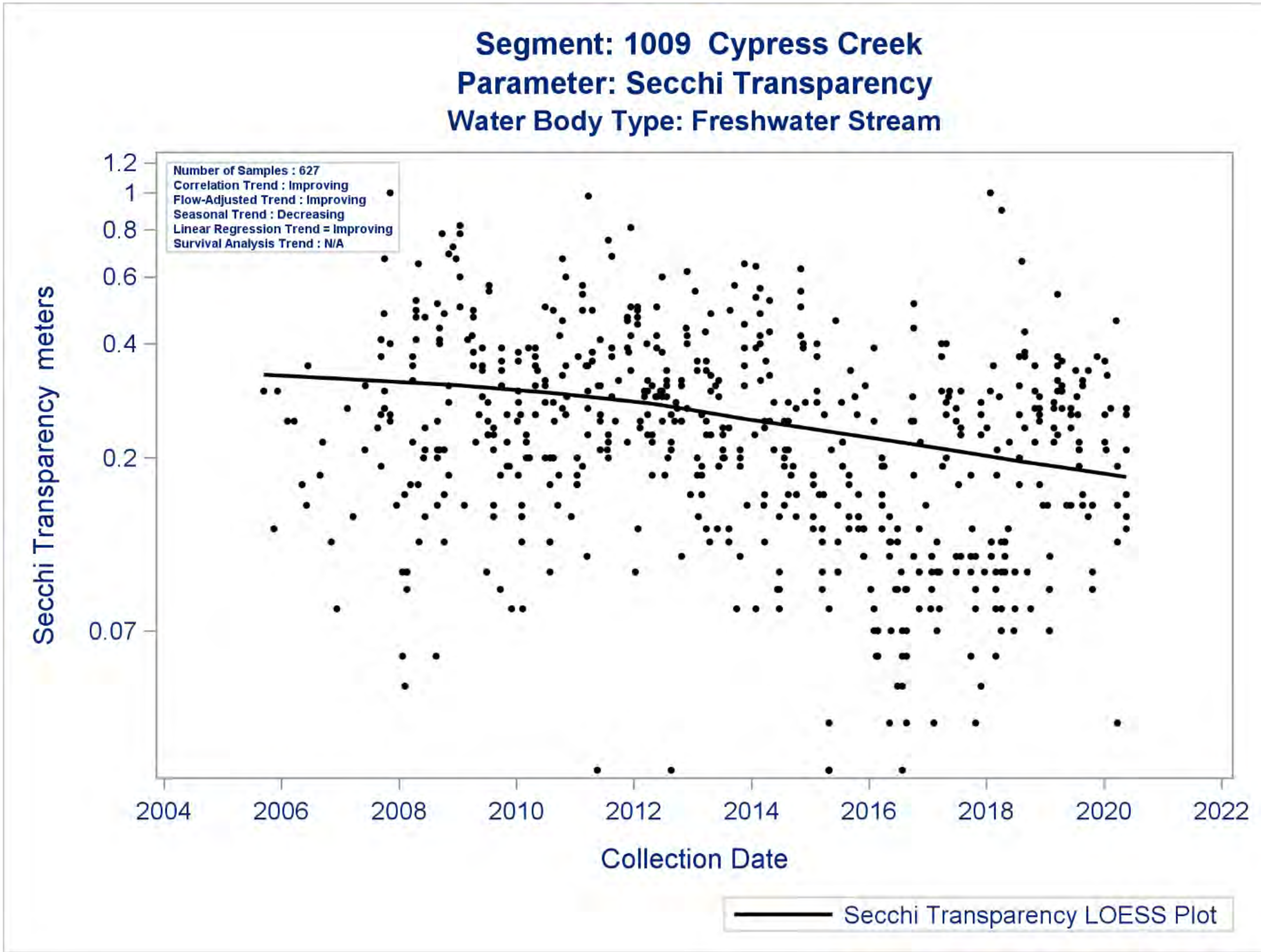
Cypress Creek - 1009
AU Start Point
Permited OSSF
WWTF
0
2.75
5.5
11
Miles
Todd Mission
Magnolia
Pinehurst
Stagecoach
Tomball
Shenandoah
The Woodlands
CONROE OIL FIELD
Spring Creek
Prairie View
Waller
WILLOW FLATS
Jersey Village
KATY OIL AND GAS FIELD
Katy
Cinco Ranch
Houston
West University Place
White Oak Bayou
1009_01
1009_02
1009_03
1009_04
1009F_01
1009E_01
1009A_01
1009B_01
1009C_01
1009D_01

Trend Analysis:

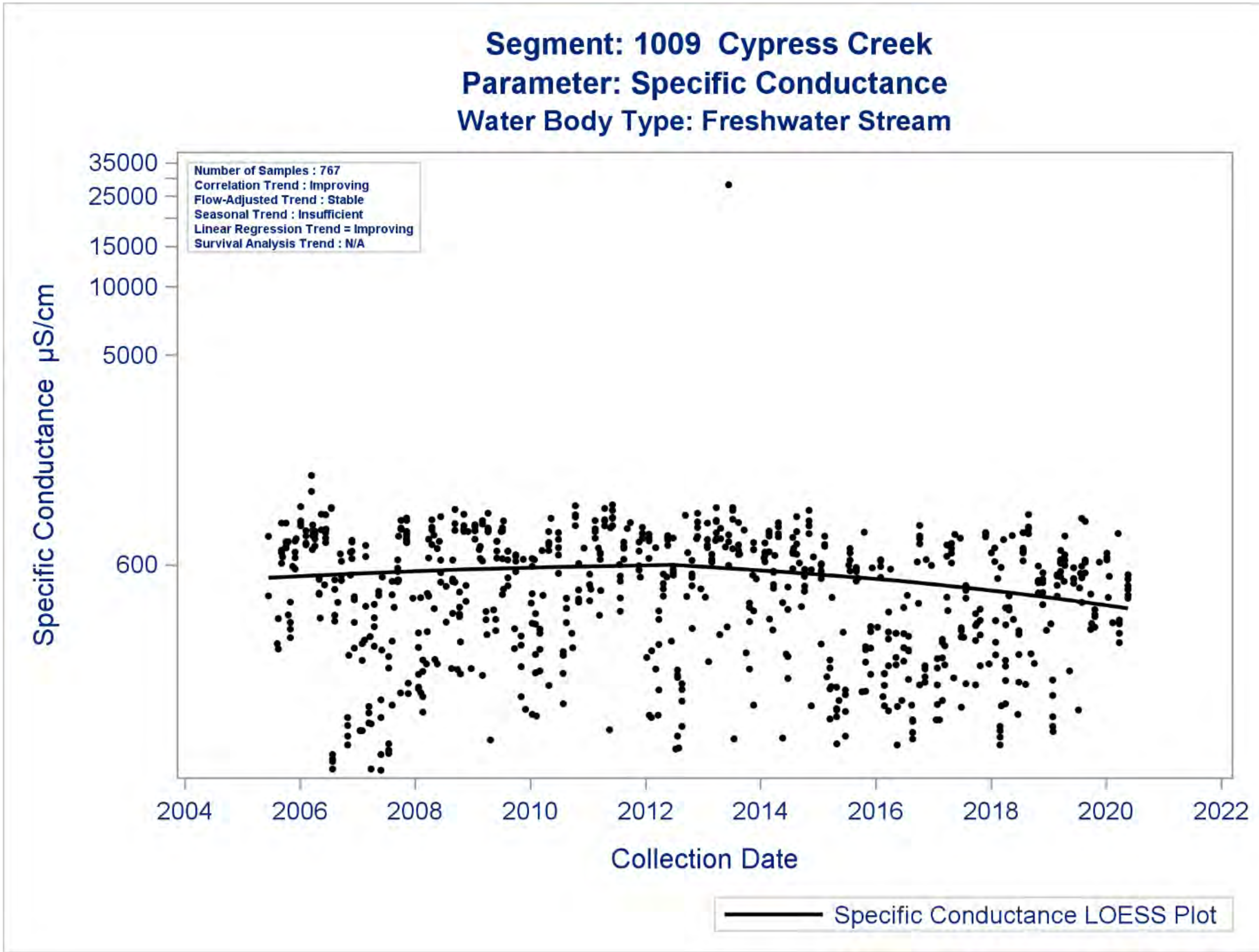
Regression analysis of segment data revealed appreciable trends for 11 parameters – seven parameters exhibited trends in the classified freshwater stream and a total of 11 parameters exhibit trends in one or more of the three unclassified tributaries. Some of the trends identified for the main segment include Secchi transparency, specific conductance, TKN, total phosphorus, and TSS.

Unclassified tributary 1009C (Faulkey Gully) has a total of five parameter trends including increasing concentrations of ammonia, DO, nitrate, and pH standard units. Conversely, Secchi transparency depth values are decreasing due to more turbid water. Unclassified tributary 1009D (Spring Gully) has six trends including decreasing concentrations of, TSS, *E. coli*, TKN, and specific conductance values, increasing DO concentrations and Secchi transparency depth values meaning the water is less turbid. Unclassified segment 1009E (Little Cypress Creek) has five parameter trends including decreasing specific conductance values, TKN, total phosphorus, and Secchi transparency depths, plus increasing TSS values over time.

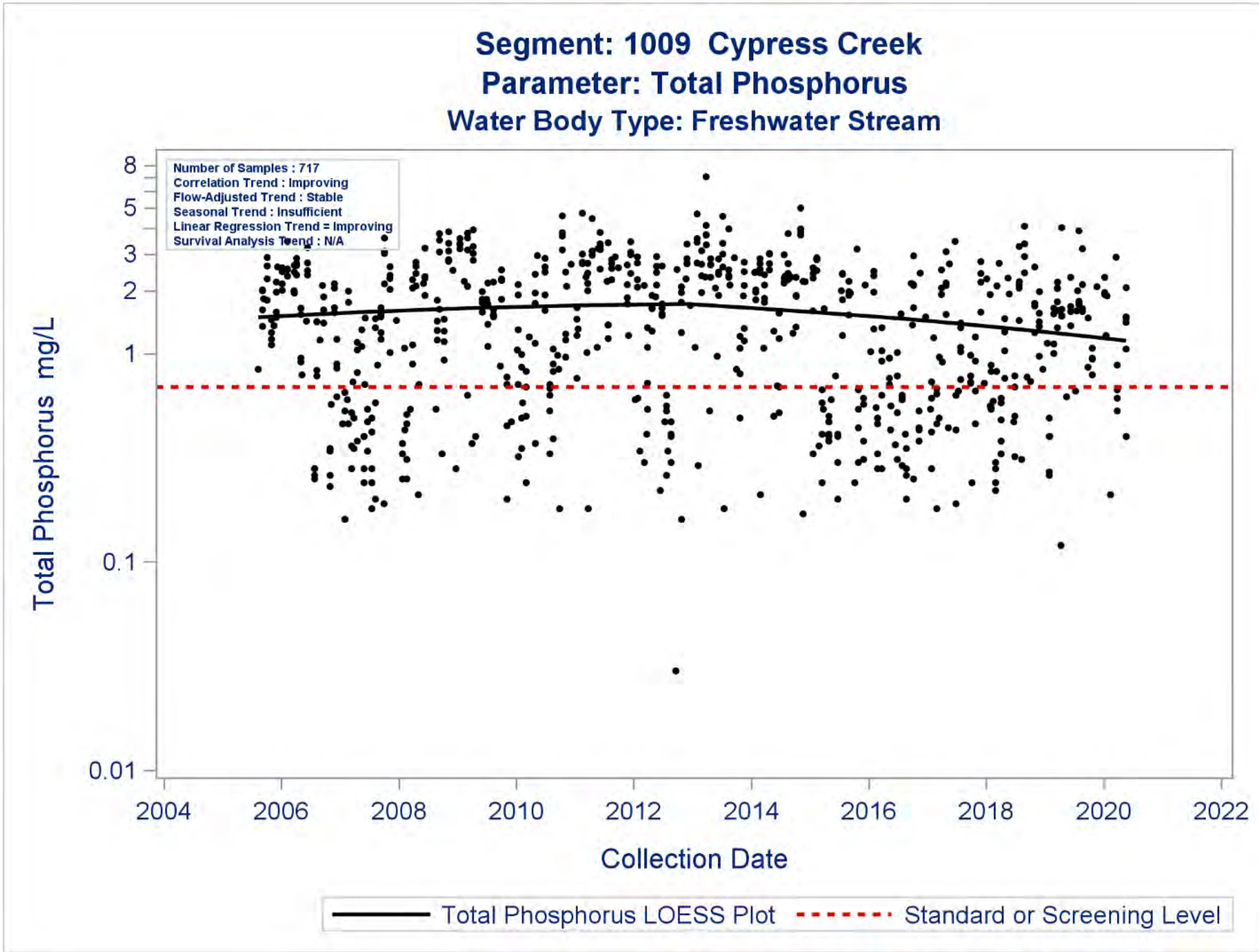
The most common trends throughout this waterway are decreasing TKN concentrations, specific conductance measurements, Secchi transparency depths values, and total phosphorus levels while increasing TSS values are found in two of the fours AUs. Improvements in WWTF operations since the early 2000s have likely played a role in improving phosphorus levels, along with decreases in agricultural activities in the western portions of the waterway. However, reasons for continued increases in TSS and lower values for Secchi disk transparency may include increased sediment transport from development and other activities impacting the hydrology of the system. It is recommended that elements of this segment's watershed protection plan (currently awaiting approval from EPA) be implemented to continue to address nutrient sources and fecal waste. Prior trends toward greater specific conductance have reversed in this data range. While relatively stable other than a positive trend in 1009D, bacteria levels remain consistently higher than the 126 MPN/100 mL standard for the watershed. DO levels continue to improve in Faulkey Gully, even though nitrate levels and temperature are increasing.



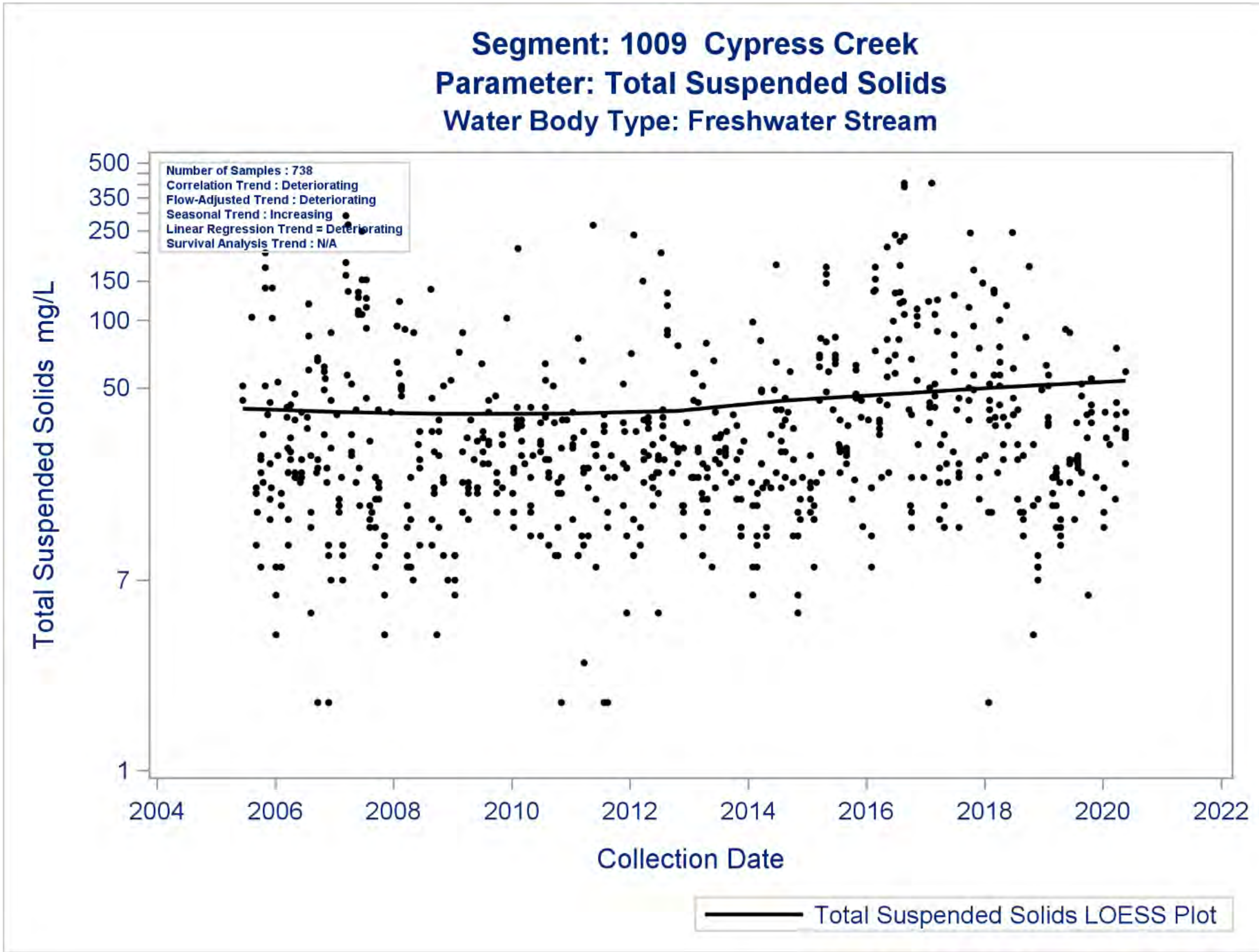
Segment: 1009 Cypress Creek
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 627
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.2
1
0.8
0.6
0.4
0.2
0.07
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot



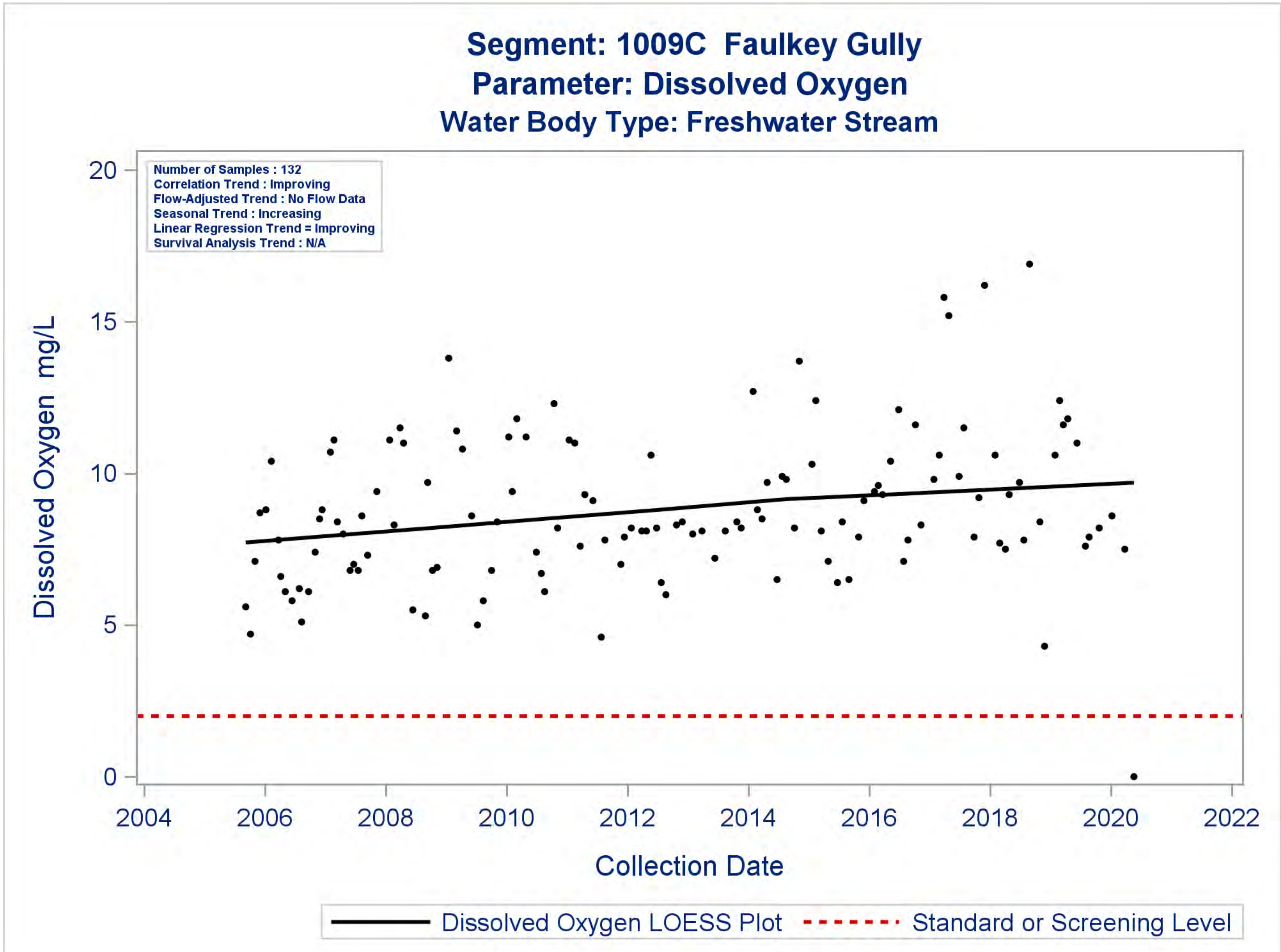
Segment: 1009 Cypress Creek
Parameter: Specific Conductance
Water Body Type: Freshwater Stream
Number of Samples : 767
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
35000
25000
15000
10000
5000
600
Specific Conductance µS/cm
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot

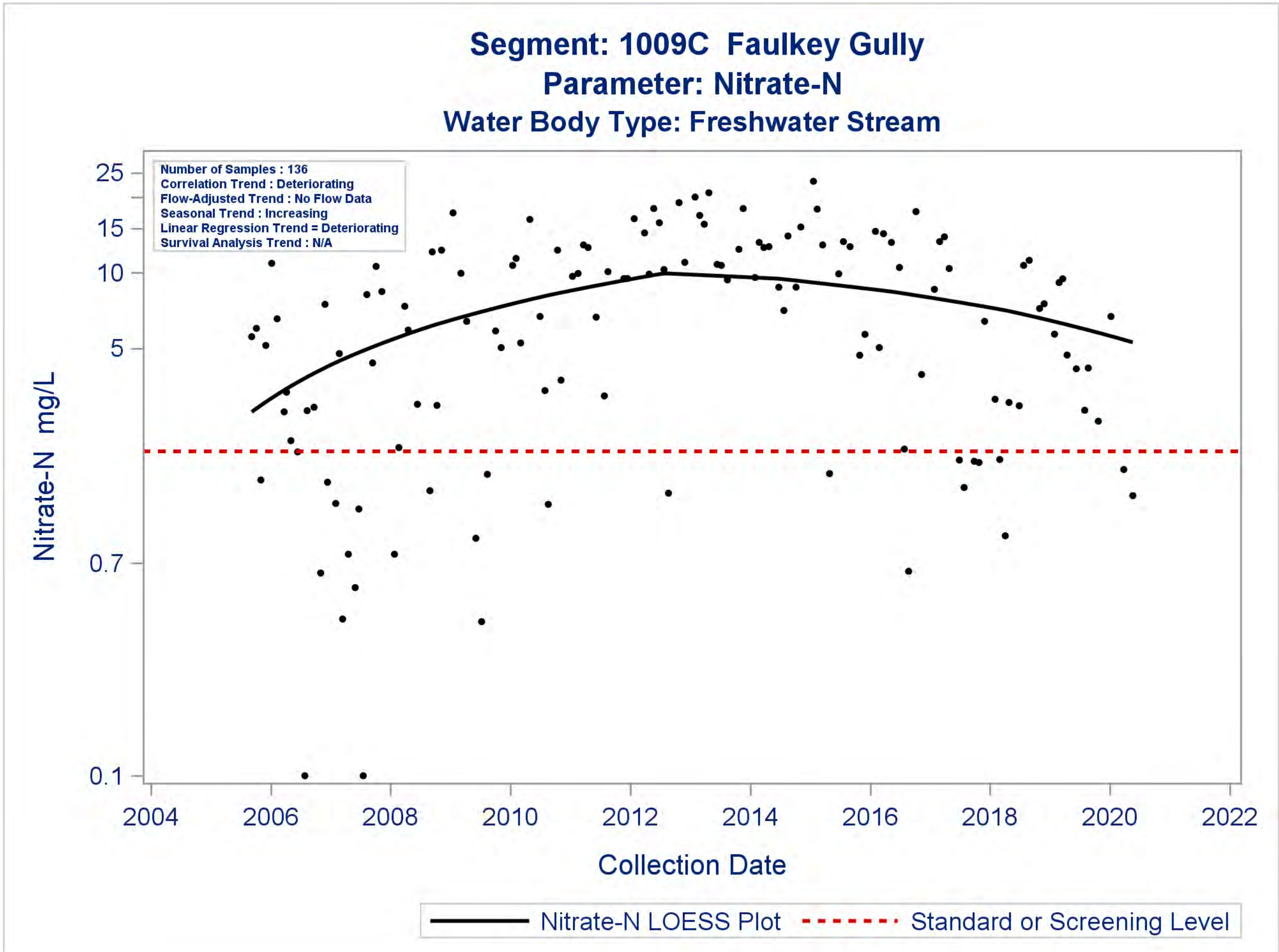


Segment: 1009 Cypress Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 717
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
8
5
3
2
1
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

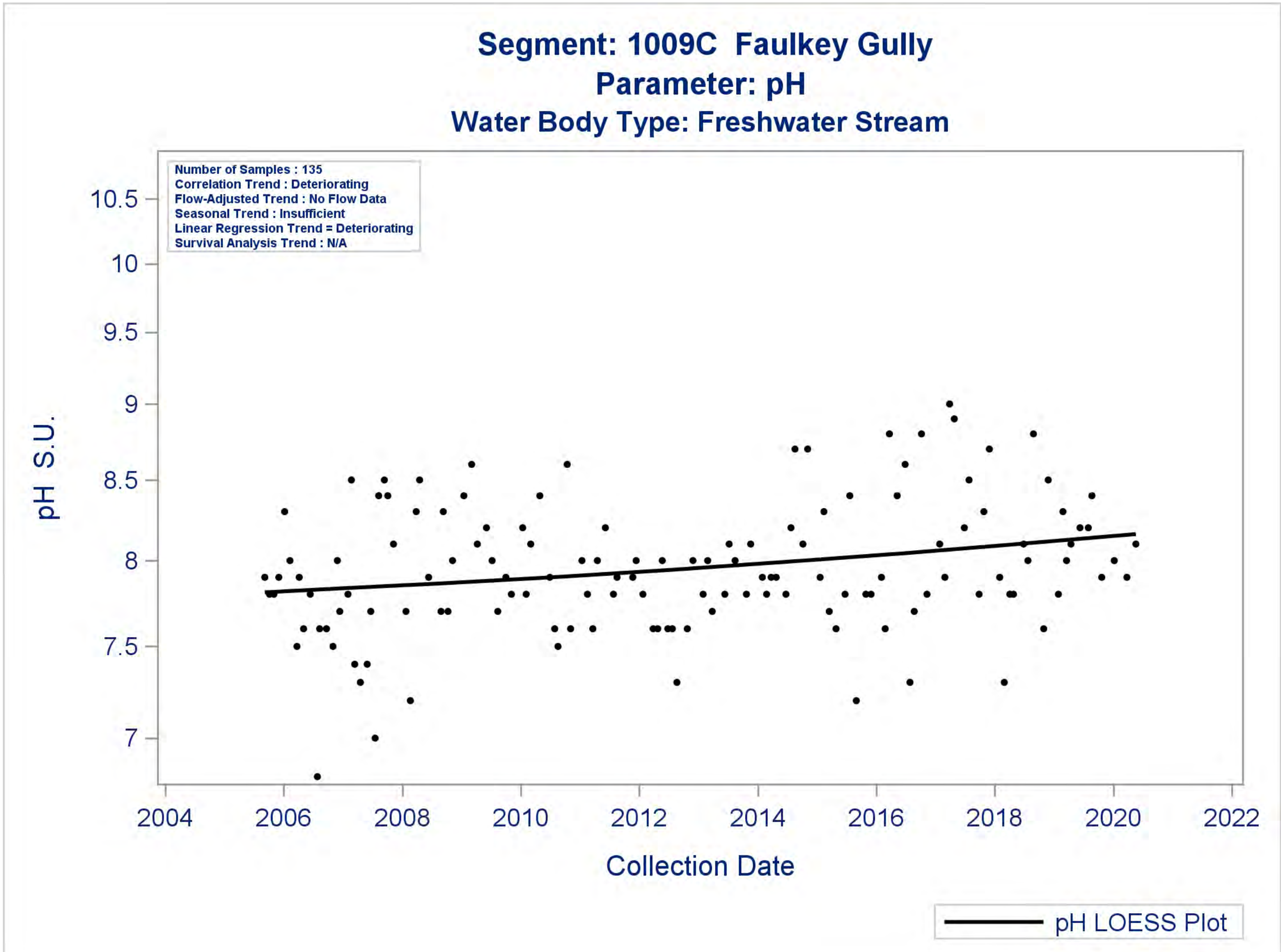


Segment: 1009 Cypress Creek
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 738
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
500
350
250
150
100
50
7
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot

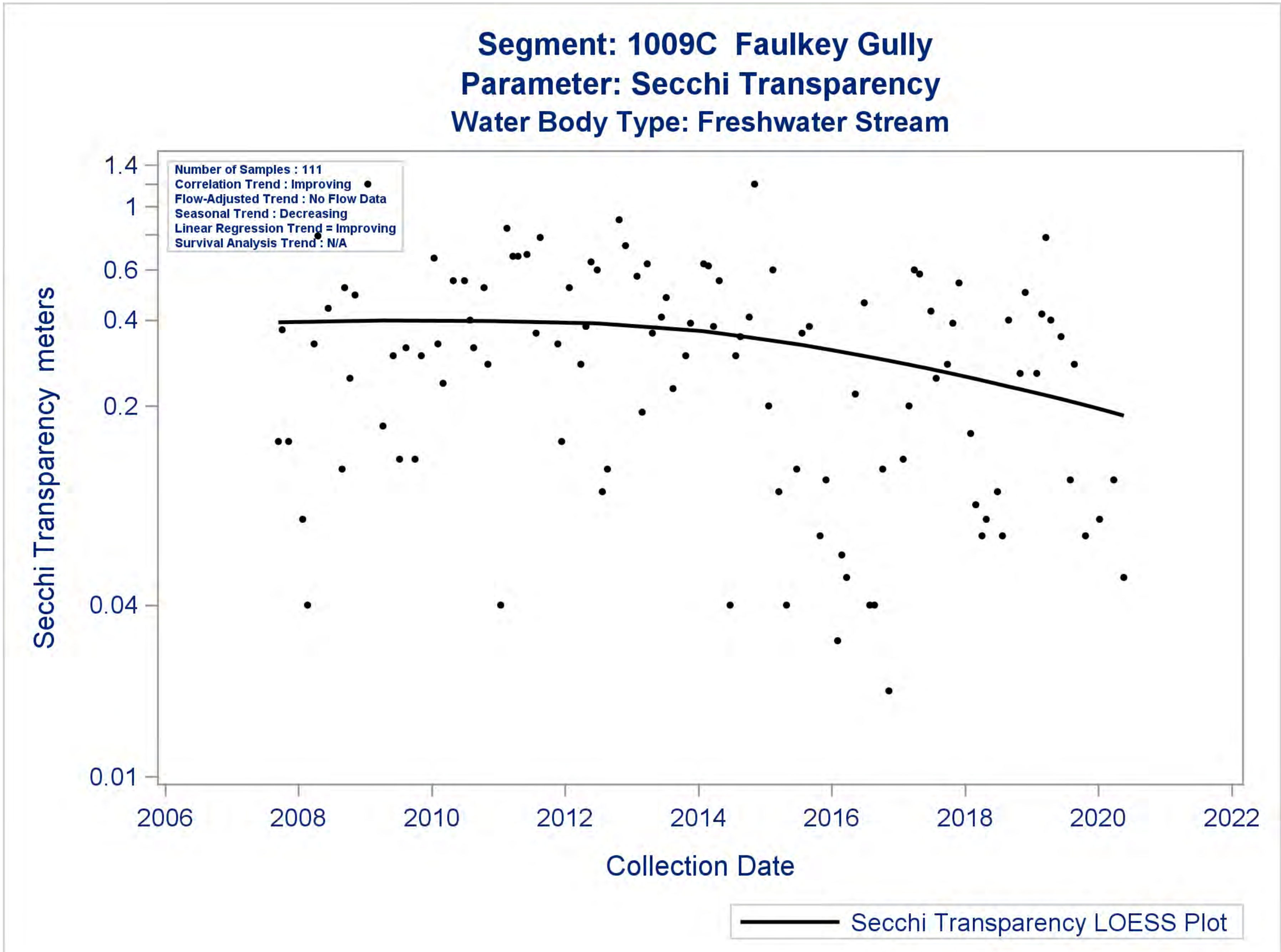

Segment: 1009C Faulkey Gully
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 132
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level



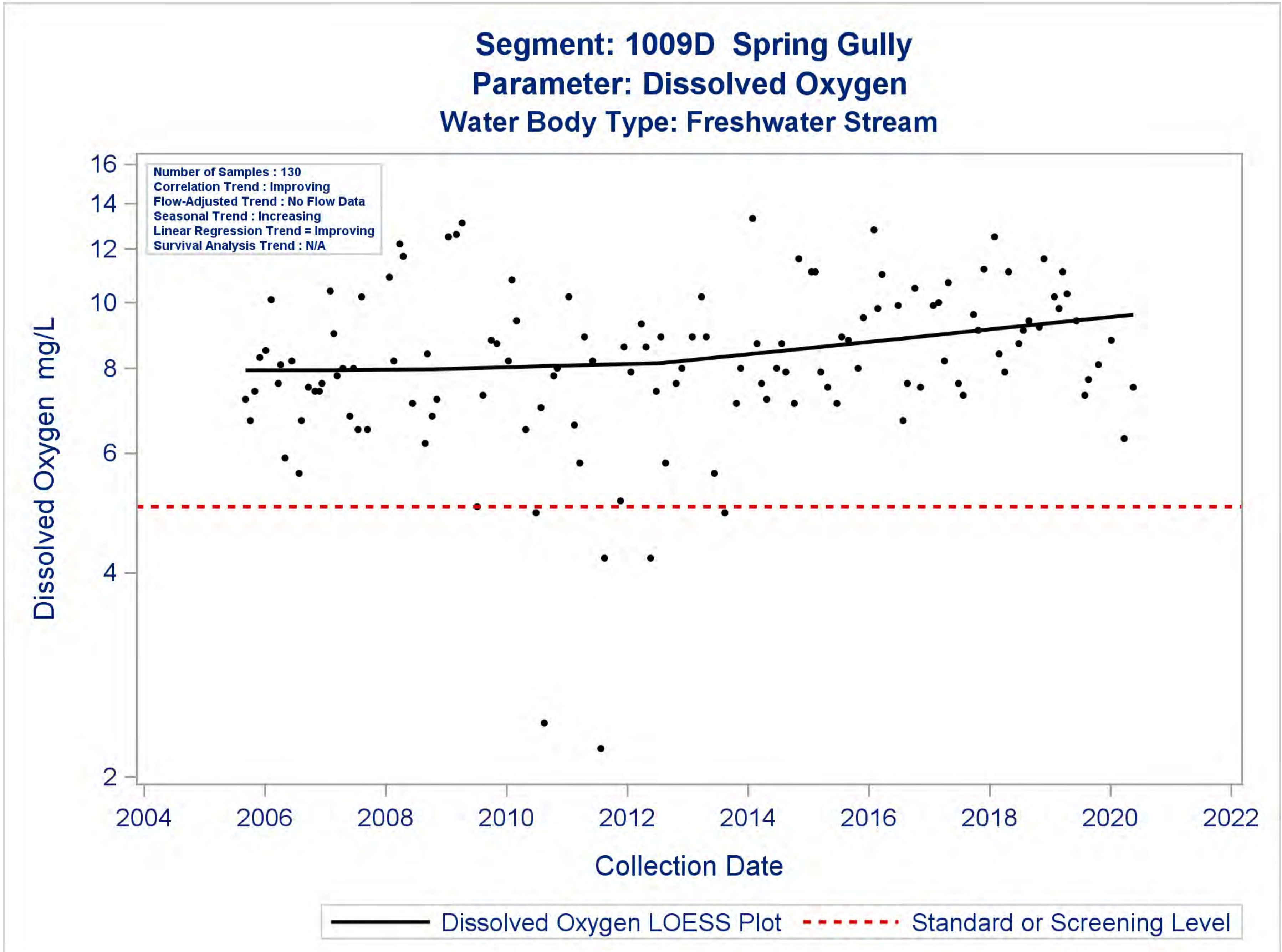
Segment: 1009C Faulkey Gully
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 136
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
25
15
10
5
0.7
0.1
Nitrate-N mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level



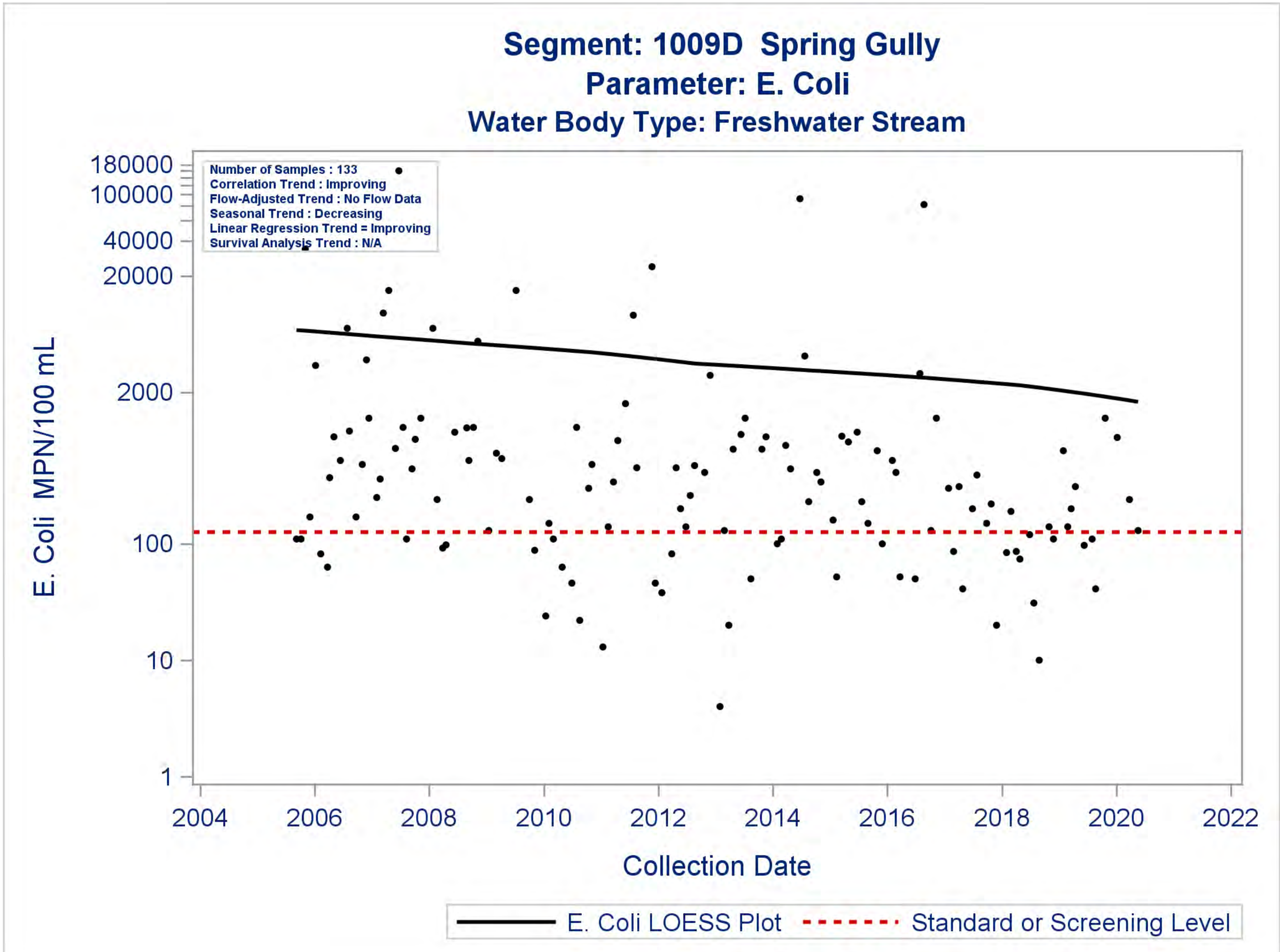
Segment: 1009C Faulkey Gully
Parameter: pH
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
pH S.U.
10.5
10
9.5
9
8.5
8
7.5
7
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
pH LOESS Plot



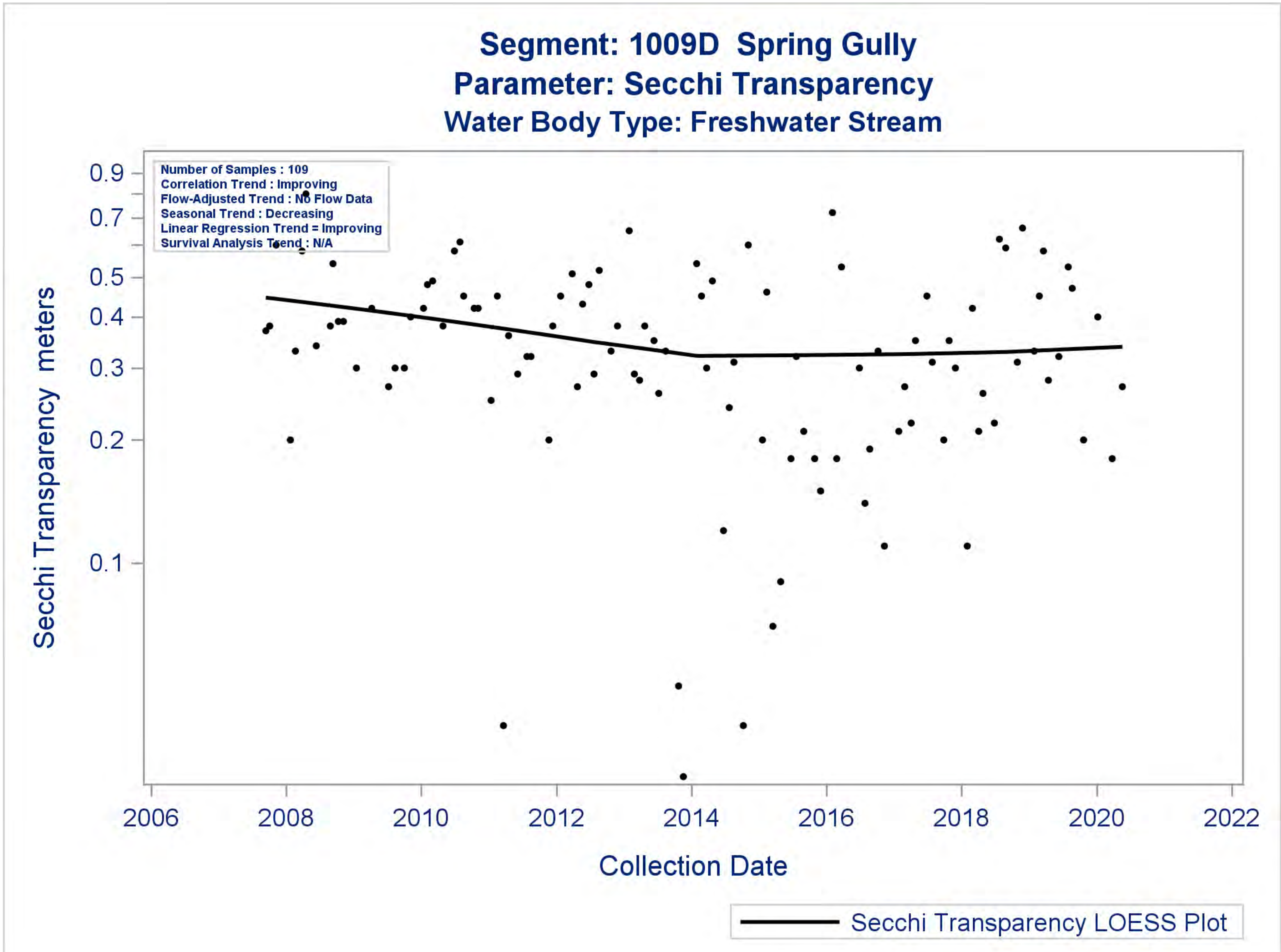
Segment: 1009C Faulkey Gully
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 111
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.4
1
0.6
0.4
0.2
0.04
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot

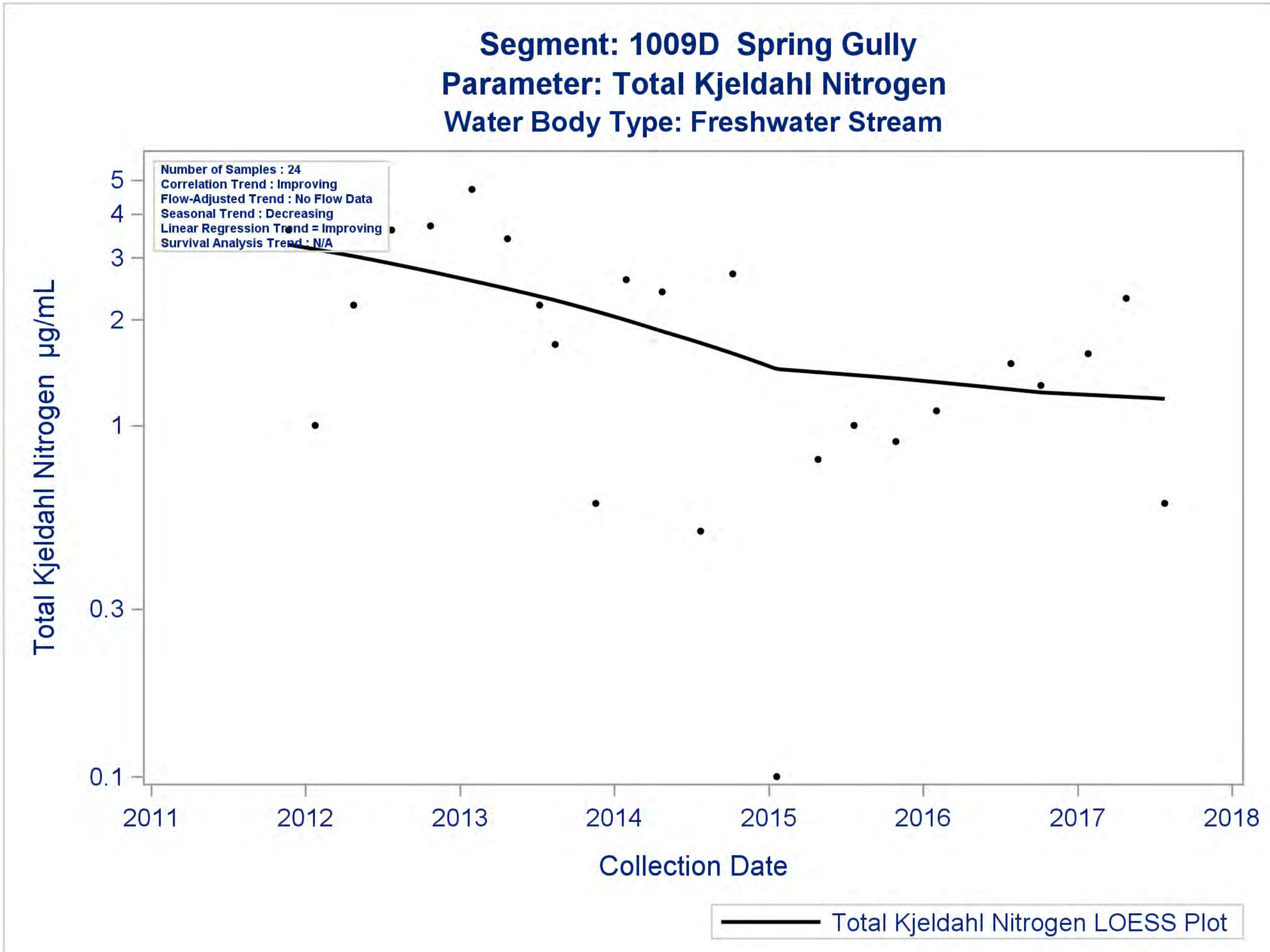


Segment: 1009D Spring Gully
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 130
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
16
14
12
10
8
6
4
2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level

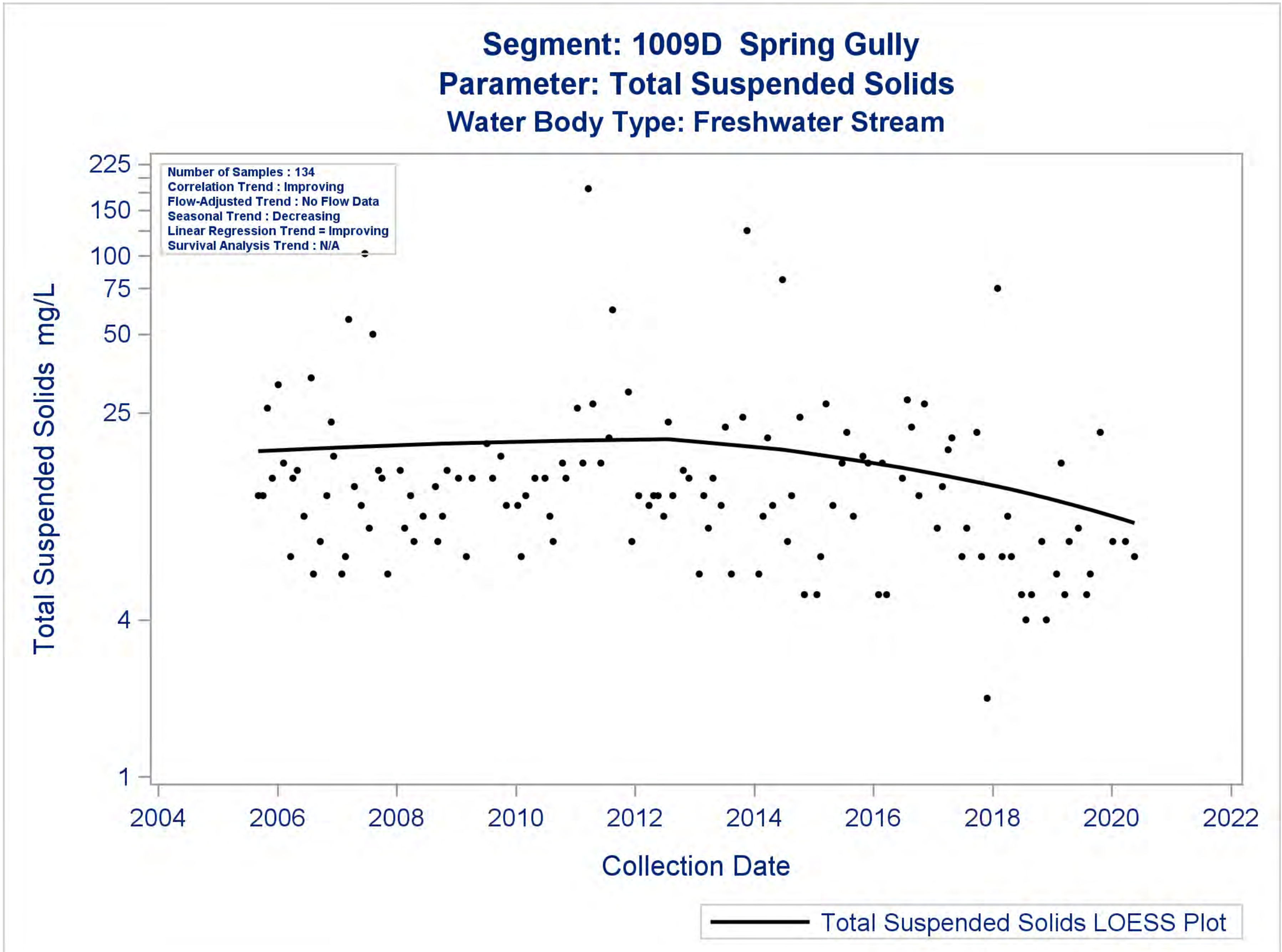


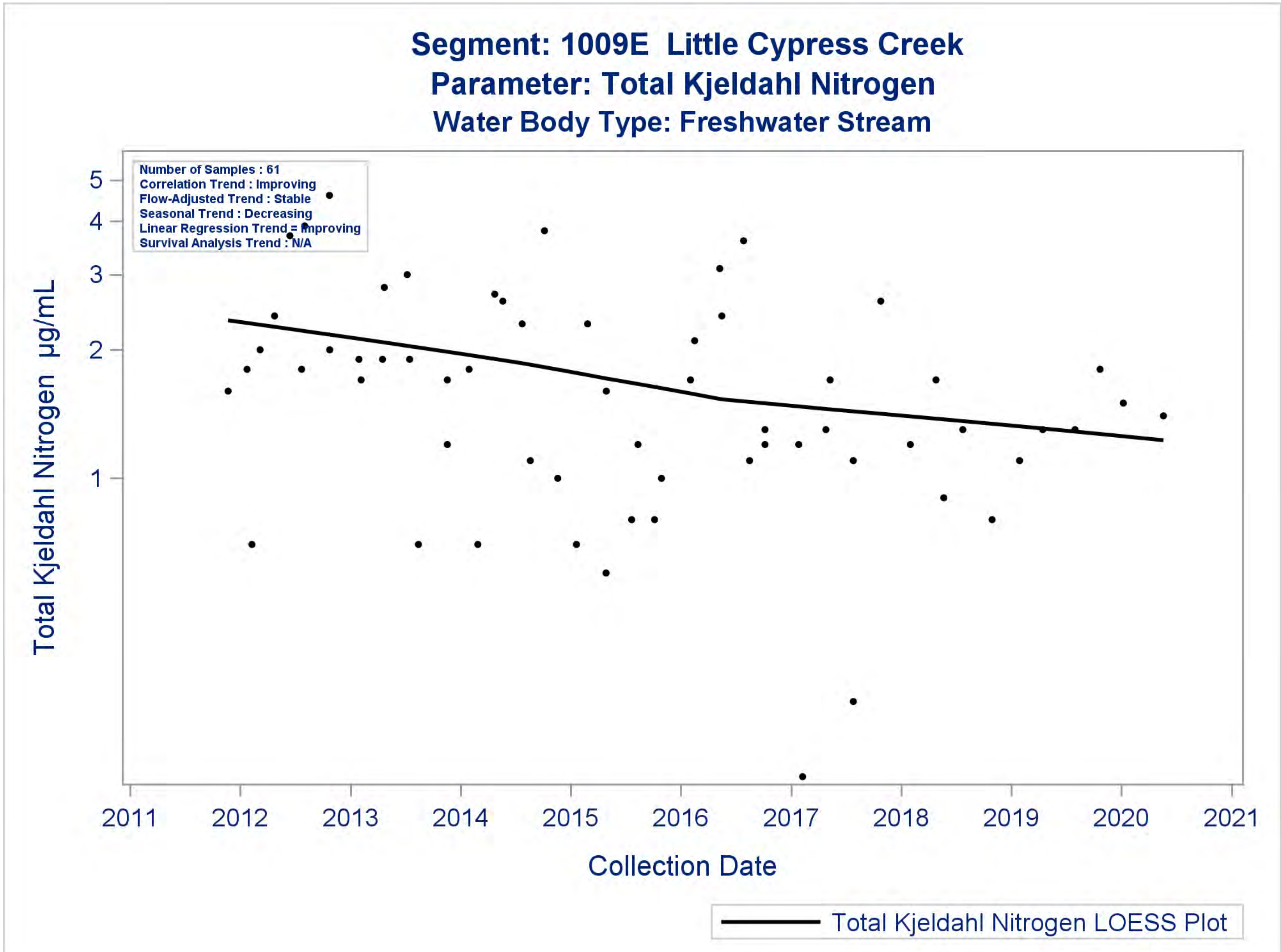
Segment: 1009D Spring Gully
Parameter: E. Coli
Water Body Type: Freshwater Stream
Number of Samples : 133
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
180000
100000
40000
20000
2000
100
10
1
E. Coli MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LOESS Plot
Standard or Screening Level


Segment: 1009D Spring Gully
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 109
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
0.9
0.7
0.5
0.4
0.3
0.2
0.1
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot

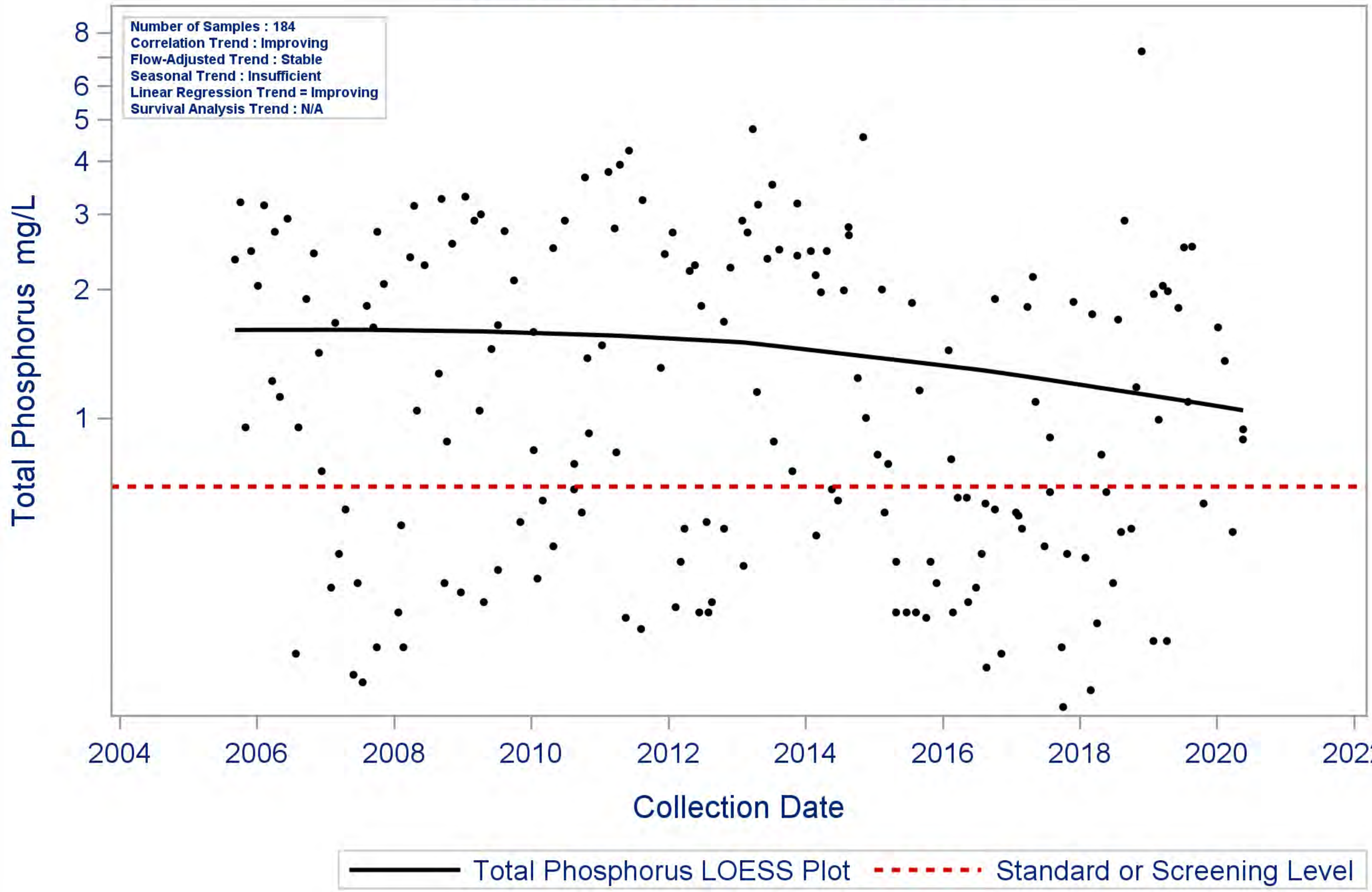


Segment: 1009D Spring Gully
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 24
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
5
4
3
2
1
0.3
0.1
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LOESS Plot


Segment: 1009D Spring Gully
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 134
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
225
150
100
75
50
25
4
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot


Segment: 1009E Little Cypress Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 61
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
5
4
3
2
1
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot

Segment: 1009E Little Cypress Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream



Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1009 (Entire Segment) I 1009C I 1009D I 1009E I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Animal waste from agricultural production and domestic animal facilities • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Improper or no pet waste disposal	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations or provide alternative power supplies during outages • Regionalize chronically non-compliant WWTFs • Ensure proper citing of new or replacement on-site sewage facilities • More public education regarding OSSF operation and maintenance • More public education on pet waste disposal • Improve stormwater controls in new developments by adding bacteria reduction measures • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties
Low Dissolved Oxygen Concentrations	1009_01 C	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural	• Detrimental effect on aquatic biological community	• Improve compliance and enforcement of existing stormwater quality permits • Improve operation and maintenance of existing WWTFs and collection systems • Regionalize chronically non-compliant WWTFs • More public education regarding disposal of household fats, oils, and grease • More public education regarding OSSF operation and maintenance

		production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetative canopy removed		• More public education on pet waste disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating • Conserve or restore trees and habitat along waterways to maintain/create shade to cool water
Elevated Nutrient Concentrations	***Nitrate*** 1009_01 C 1009_02 C 1009_04 C 1009C_01 C 1009D_01 C 1009E_01 C ***Phosphorus*** 1009_01 C 1009_02 C 1009_04 C 1009C_01 C 1009D_01 C 1009E_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Encourage Water Quality Management Plans for individual agricultural properties • Expand use of LID and green infrastructure practices • Install and/or conserve riparian buffer areas along all waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed
Habitat	1009_02 C	• Loss of habitat due to channelization of waterway • Ongoing maintenance of modified channel • Bank erosion and erosion of construction sites	• Detrimental to the aquatic biological community	• Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat • Work with local authorities to minimize sediment runoff from construction sites • Work with drainage districts to install/construct habitat that doesn't interfere with water movement • Re-connect oxbows and lost channels to augment water storage and retention

Special Studies:

A Cypress Creek Watershed Protection Plan is in development. Since beginning work on the project in 2019, the Cypress Creek Watershed Partnership has discussed how water quality issues such as high levels of fecal waste and low dissolved oxygen are impacting the Cypress Creek Watershed. The Partnership reviewed model results describing sources of pollution and reduction targets and has moved forward with selecting the most effective strategies for improving water quality in their communities. The development of the Watershed Protection Plan is nearing completion with approval expected in 2021. More information can be found at cypresspartnership.com.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation and coordination.
- Continue collecting water quality data to evaluate the effectiveness of solutions associated with the watershed protection plan and TMDL.
- Continue to work with the BIG and Cypress Creek Watershed Partnership to implement the I-Plan and WPP recommendations for bacteria reduction and other water quality concerns.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and watershed protection plan
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Promote voluntary conservation and urban forestry projects
- Coordinate efforts with ongoing flood management projects

Segment Number:	**1003**		**Name:**	**East Fork San Jacinto River**	
Length:	81 miles	**Watershed Area:**	404 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	14	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	8

DESCRIPTION

- Segment 1003 (Perennial Stream w/ high ALU): **East Fork San Jacinto River** (classified water body) – From the confluence of Caney Creek in Harris County to US Highway 190 in Walker County

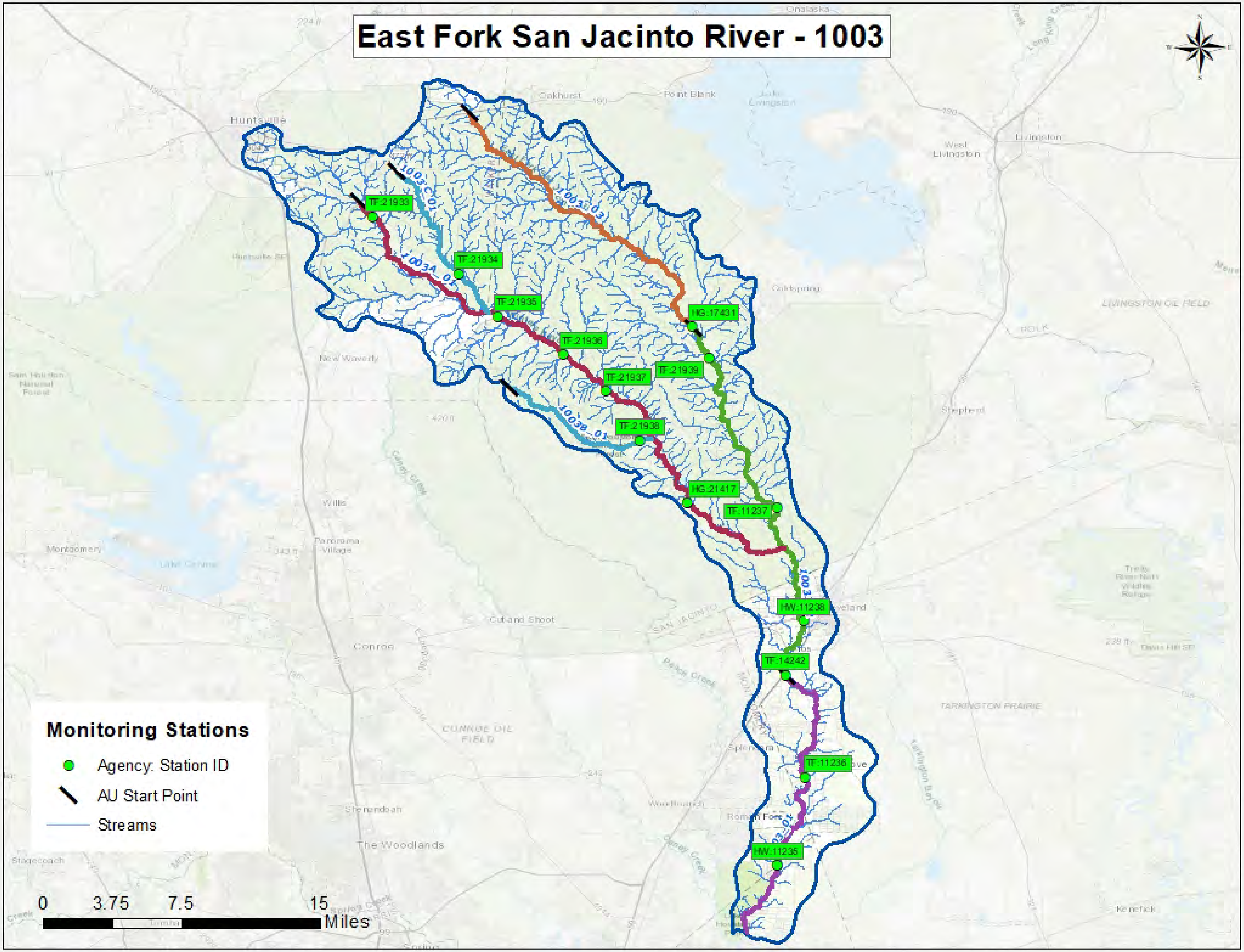
- Segment 1003A (Perennial Stream w/ high ALU): **Winters Bayou** (unclassified water body) – From the confluence with East Fork San Jacinto River to 0.17 mi upstream of Dorrell Road at the confluence of Phelps Creek.

- Segment 1003B (Perennial Stream w/ high ALU): **Nebletts Creek** (unclassified water body) – From the confluence with Winters Bayou near FM 1725 northwest of Cleveland upstream to the headwaters near SH 150 east of New Waverly

- Segment 1003C (Intermittent Stream w/ pools w/ limited ALU): **Boswell Creek** (unclassified water body) - From the confluence with Winters Bayou approximately 11.7 km (7.3 mi) east of New Waverly upstream to the headwaters east of Huntsville

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11235	1003	EAST FORK SAN JACINTO RIVER AT FM 1485	GS	MONTHLY	24-hour DO, Metal, Organic, Field, Conventional, Bacteria, Flow
11235	1003	EAST FORK SAN JACINTO RIVER AT FM 1485	HW	BIMONTHLY	Field, Conventional, Bacteria, Flow
11236	1003	EAST FORK SAN JACINTO RIVER AT FM 2090 IN LIBERTY COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
11237	1003	EAST FORK SAN JACINTO RIVER IMMEDIATELY DOWNSTREAM OF FM 945 5.6 MILES NORTH OF CLEVELAND	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
11238	1003	EAST FORK SAN JACINTO RIVER IMMEDIATELY UPSTREAM OF TX-105 BUSINESS ROUTE / W SOUTHLINE STREET WEST OF CLEVELAND	HW	BIMONTHLY	Field, Conventional, Bacteria, Flow
14242	1003	EAST FORK SAN JACINTO RIVER IMMEDATELY DOWNSTREAM OF US 59 AT RED GULLY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
17431	1003	EAST FORK SAN JACINTO RIVER IMMEDIATELY DOWNSTREAM OF SH 150 WEST OF COLDSPRING	HG	QUARTERLY	Field, Conventional, Bacteria, Flow
21939	1003	EAST FORK SAN JACINTO RIVER AT NORTH BUTCH ARTHUR ROAD IN SAN JACINTO COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
21417	1003A	WINTERS BAYOU AT TONY TAP ROAD NEAR CLEVELAND	HG	QUARTERLY	Field, Conventional, Bacteria, Flow
21933	1003A	WINTERS BAYOU AT FM 2929 / FOUR NOTCH ROAD 4.8 KILOMETERS SOUTH OF PHELPS IN WALKER COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
21935	1003A	WINTERS BAYOU AT FM 2693 IN SAN JACINTO COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
21936	1003A	WINTERS BAYOU AT SH 150 IN SAN JACINTO COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
21937	1003A	WINTERS BAYOU AT DABNEY BOTTOM RD IN SAN JACINTO COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
21938	1003B	NEBLETTS CREEK AT FM 1725 IN SAN JACINTO COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow
21934	1003C	BOSWELL CREEK AT FOUR NOTCH ROAD / BOSWELL ROAD 13 KILOMETERS NORTHEAST OF NEW WAVERLY IN WALKER COUNTY	TF	QUARTERLY	Field, Conventional, Bacteria, Flow

GS = United States Geological Survey
HW = Houston Water Quality Control
TF = Texas Research Institute for Environmental Studies (TRIES) – SHSU



East Fork San Jacinto River - 1003
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0
3.75
7.5
15
Miles
TF:21933
TF:21934
TF:21935
TF:21936
TF:21937
TF:21938
TF:21939
HG:17431
HG:21417
TF:11237
HW:11238
TF:14242
TF:11236
HW:11235
1003C_01
1003A_01
1003B_01
1003_03
Huntsville
Oakhurst
Point Blank
Onalaska
Livingston
West Livingston
Coldspring
New Waverly
Shepherd
Willis
Panorama Village
Montgomery
Lake Conroe
Conroe
Cut and Shoot
Cleveland
Splendora
Shenandoah
The Woodlands
Stagecoach
Kenefick
TARKINGTON PRAIRIE
LIVINGSTON OIL FIELD
CONROE OIL FIELD

Segment 1003 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	33 / 91	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.0-8.5	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	80		
Sulfate (mg/L as SO_4):	50		
Total Dissolved Solids (mg/L):	400		

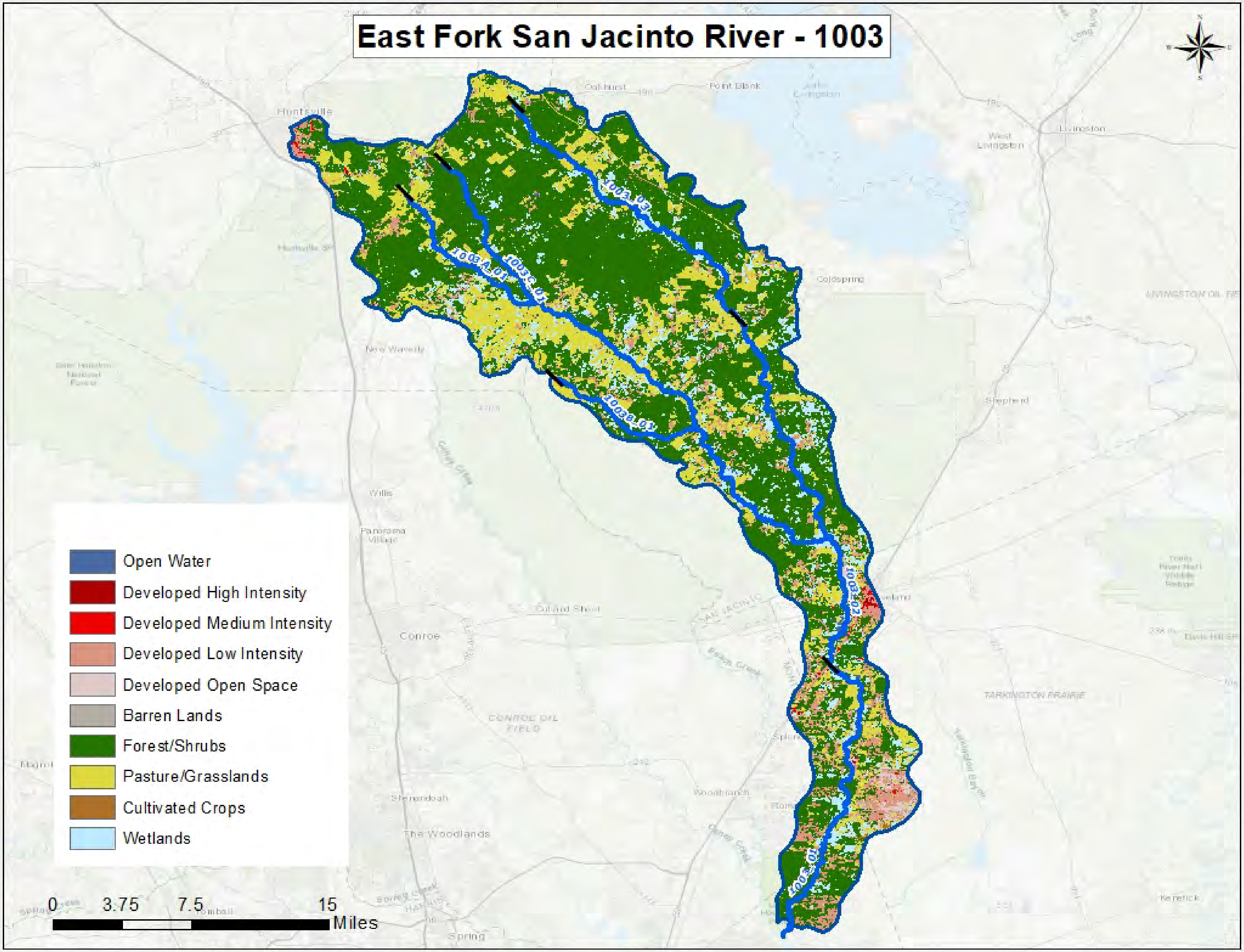
Segment Discussion

Watershed Characteristics and Land Cover: This East Fork San Jacinto segment (1003) extends from the confluence of Caney Creek in Harris County to US Highway 190 in Walker County. Major tributaries include Orange Branch, Miller Creek, Whiskey Branch, and Winters Bayou. The communities of Cleveland, Splendora, Plum Grove, and Roman Forest are located in the southern portion of the watershed. The eastern portion of the City of Huntsville is located at the northwestern edge of the watershed with storm water draining through Winters Bayou, the largest tributary to the East Fork San Jacinto River.

The watershed is predominately forested, with Forest/Shrubs accounting for 55.00 percent of the watershed in 2018. Agricultural use comprises 19.00 percent of the watershed, with grass, hay, and pastureland supporting cattle operations being the dominant agricultural activities. Timber is also harvested from the Sam Houston National Forest located in the upper two-thirds of the watershed. On-site sewage facilities serve as the primary means of waste disposal for residential and commercial properties throughout the watershed.

Segment 1003 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	65,266.28	25.27	49,083.37	19.00	-24.80
Barren Lands	2,510.38	0.97	758.81	0.29	-69.77
Developed	10,772.97	4.17	25,896.62	10.03	140.39
Forest/Shrubs	127,491.56	49.37	142,036.09	55.00	11.41
Open Water	2,146.76	0.83	595.79	0.23	-72.25
Wetlands	50,069.24	19.39	39,895.85	15.45	-20.32
TOTAL	**258,257.18**	**100.00**	**258,266.53**	**100.00**	


East Fork San Jacinto River - 1003
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 3.75 7.5 15
Miles
1003_03
1003A_01
1003C_01
1003B_01
1003_02
1003_01
Huntsville
Coldspring
New Waverly
Willis
Conroe
Shepherd
The Woodlands
Shenandoah
Spring
Livingston

Water Quality Issues:

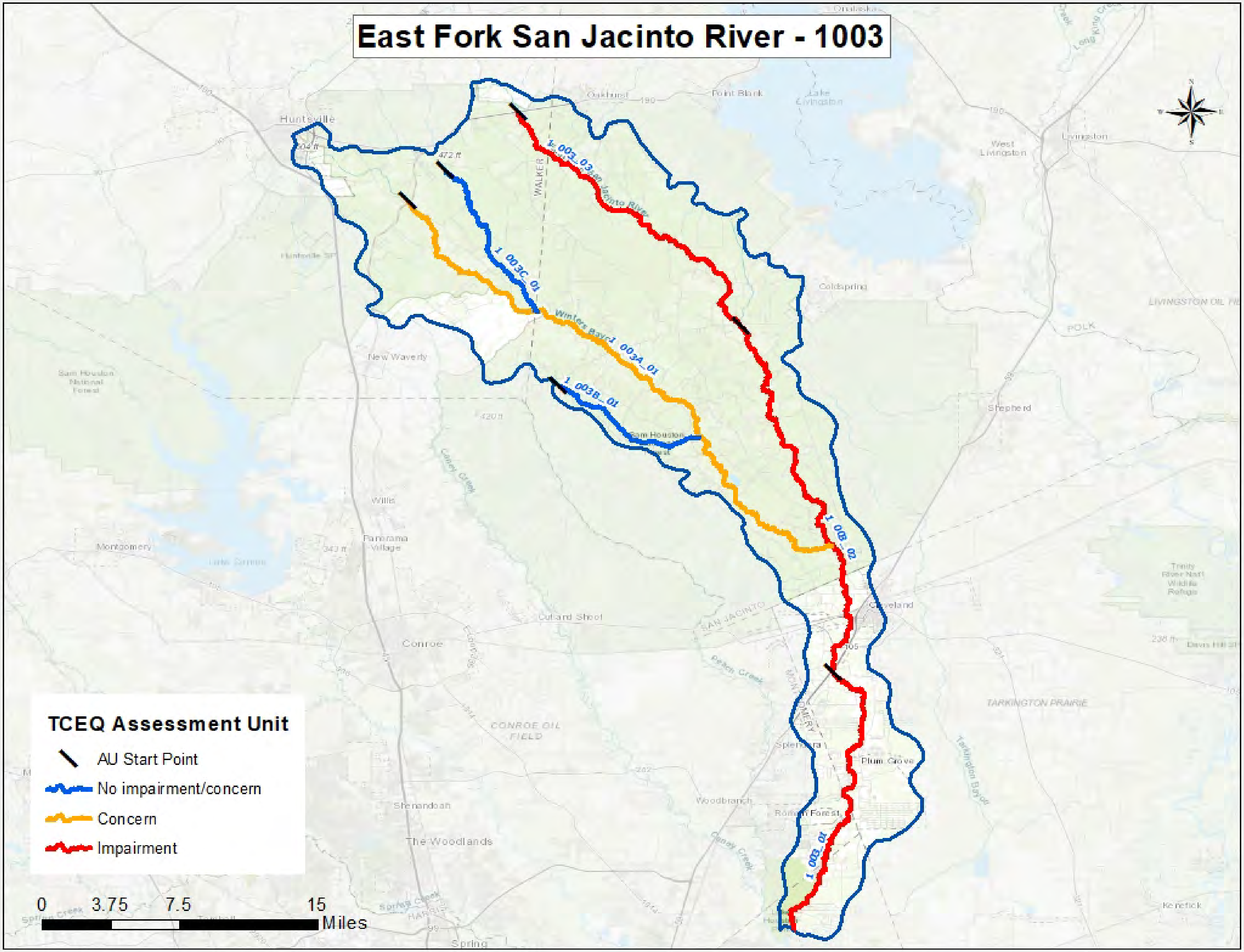
General, aquatic life, and public water supply uses are fully supported.

Bacteria Impairments and Concerns
Recreation use in this segment is not supported. All three assessment units in segment 1003 are impaired for *E. coli*. For the period of 12/01/11 – 11/30/18, the *E. coli* geometric means for this segment were 229.19 MPN/100 mL for AU 1003_01, 166.01 MPN/100 mL for AU 1003_02, and 324.89 MPN/100 mL for AU 1003_03. A concern for bacteria was identified for Winters Bayou (1003A), with a geometric mean of 126.70 MPN/100L.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.



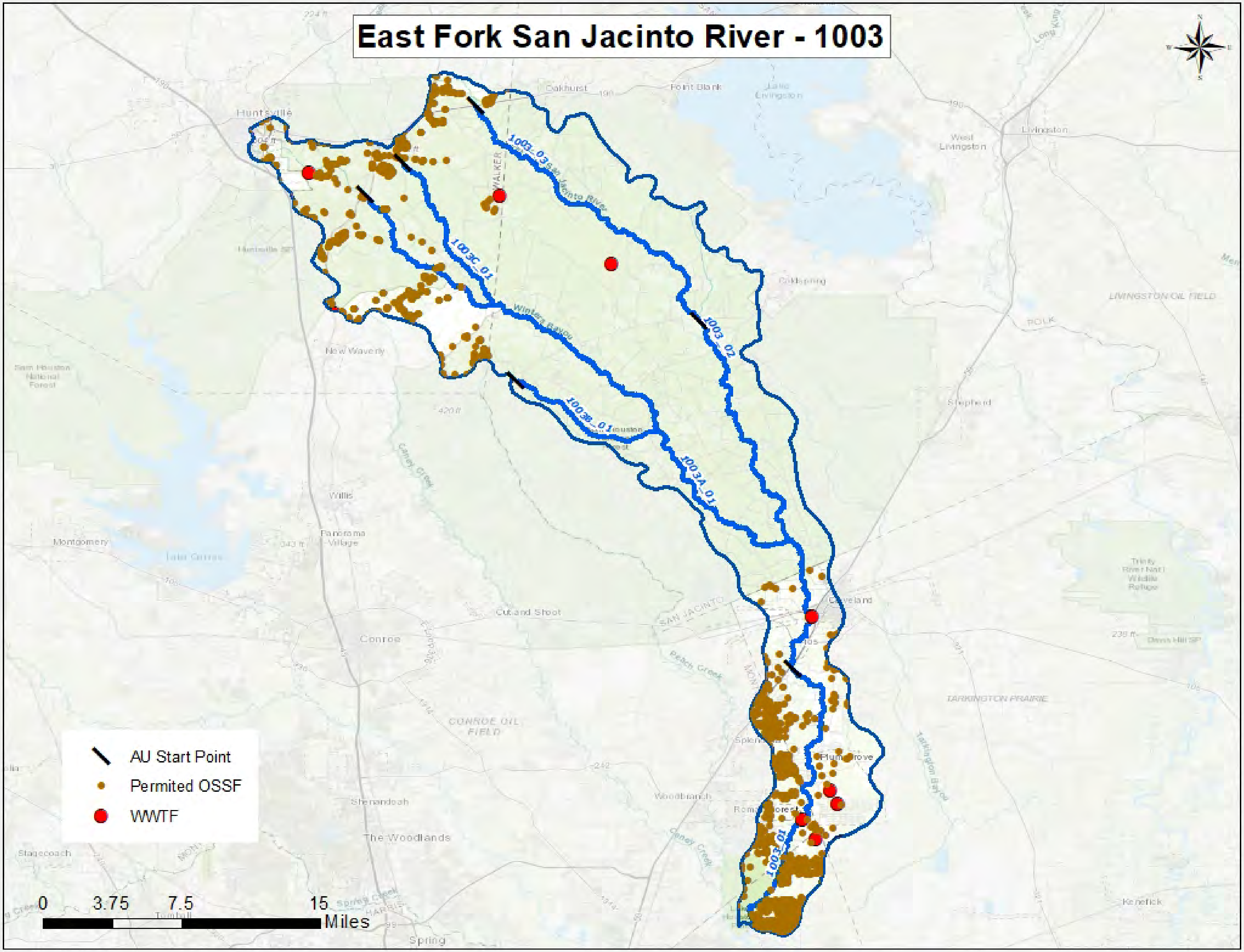
East Fork San Jacinto River - 1003
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0
3.75
7.5
15
Miles
1003_03
1003C_01
1003A_01
1003B_01
1003_02
1003_01
Winters Bay
Huntsville
Oakhurst
Point Blank
Lake Livingston
Livingston
West Livingston
Coldspring
New Waverly
Shepherd
Willis
Panorama Village
Montgomery
Cut and Shoot
Conroe
Cleveland
Splendora
Plum Grove
Roman Forest
Woodbranch
Shenandoah
The Woodlands
Spring
CONROE OIL FIELD
TARKINGTON PRAIRIE
POLK
SAN JACINTO
MONTGOMERY
WALKER
HARRIS
Sam Houston National Forest

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the East Fork San Jacinto River watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, feral hogs, and animal waste.

There are 8 permitted wastewater outfalls in the East Fork San Jacinto River watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 1,826 of these on-site sewage facilities in the watershed area. The wastewater treatment facilities and on-site sewage facilities in the watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 12 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the East Fork San Jacinto River watershed.



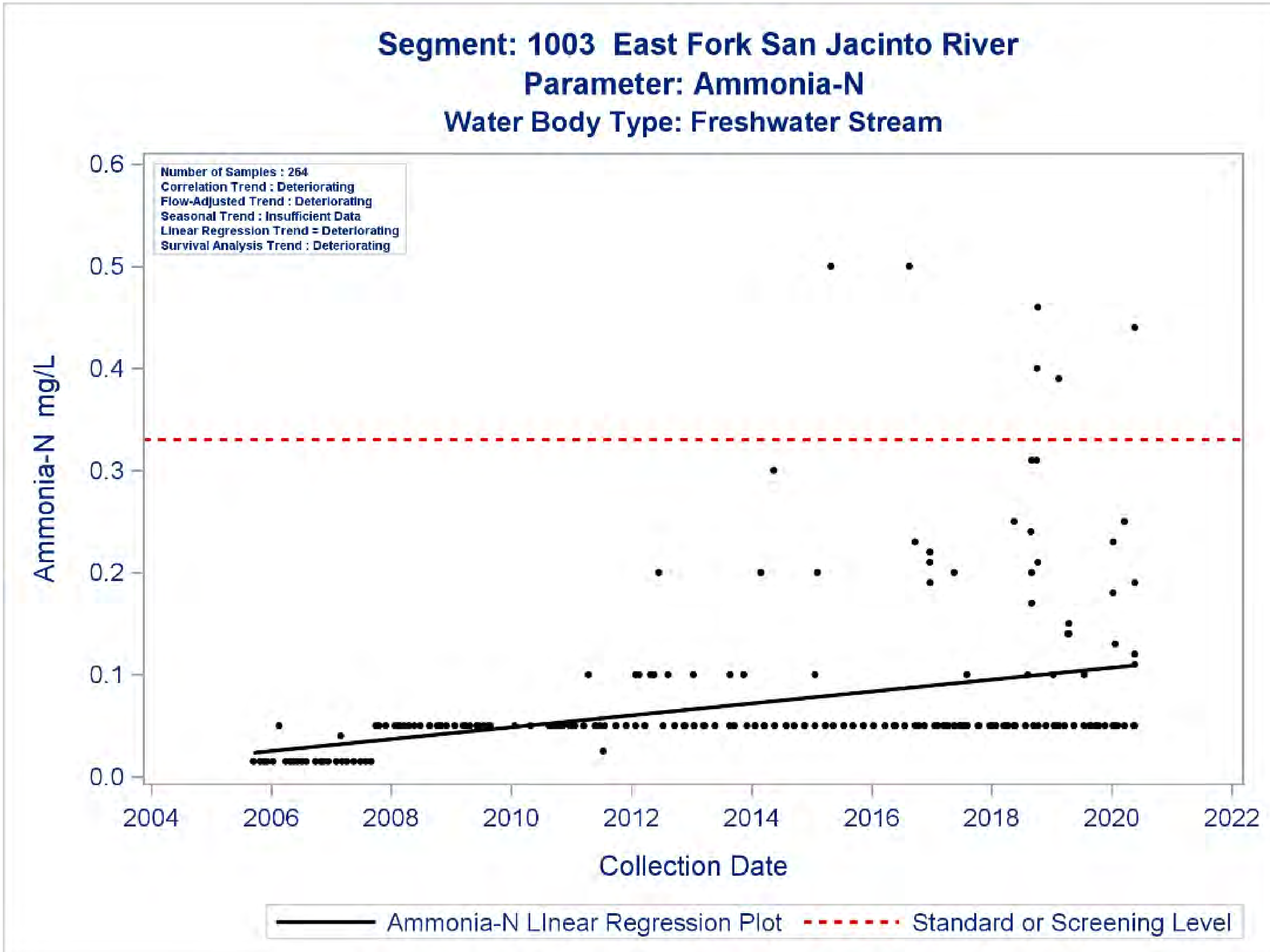
East Fork San Jacinto River - 1003
AU Start Point
Permited OSSF
WWTF
0
3.75
7.5
15
Miles
1003_03 San Jacinto River
1003C_01
Winters Bayou
1003_02
1003B_01
1003A_01
1003_01
Huntsville
Oakhurst
Point Blank
Lake Livingston
West Livingston
Livingston
Coldspring
LIVINGSTON OIL FIELD
POLK
New Waverly
Sam Houston National Forest
Stephens
Willis
Panorama Village
Montgomery
Lake Conroe
Cut and Shoot
Conroe
SAN JACINTO
Cleveland
Peach Creek
TARKINGTON PRAIRIE
CONROE OIL FIELD
Splendora
Plum Grove
Woodbranch
Shenandoah
The Woodlands
Stagecoach
Spring
Kenefick
Trinity River Nat'l Wildlife Refuge
Davis Hill SP

Trend Analysis:

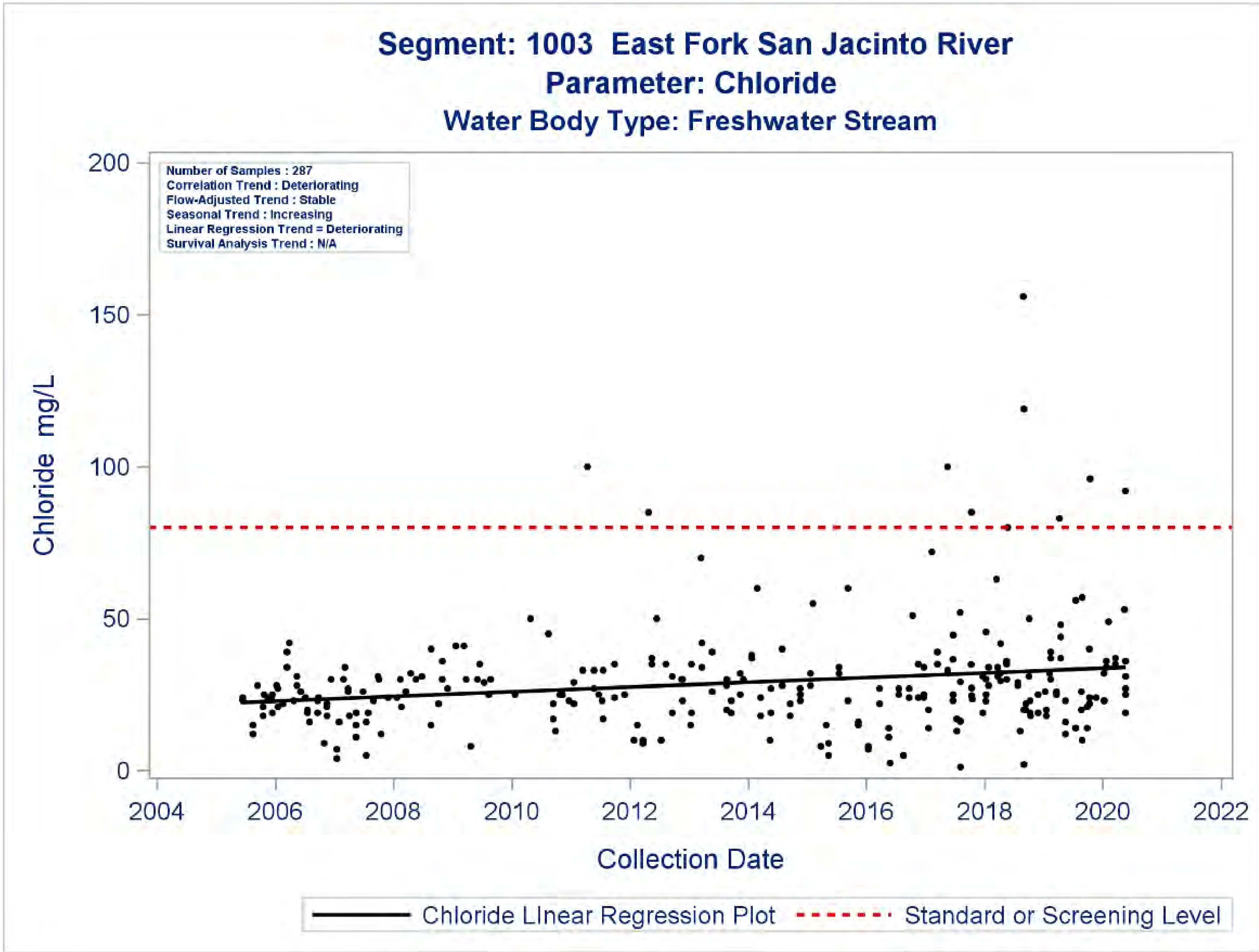
Regression analysis of watershed level data revealed three parameter trends for the East Fork San Jacinto River. Ammonia and chloride levels are increasing while TKN is decreasing in the main river (1003). Total phosphorus is beginning to deteriorate with sample results exceeding the screening criteria beginning in 2015. Winters Bayou (1003A), the largest tributary to the East Fork, shows a decreasing trend for TKN but also shows significant trends with increasing chloride levels and increasing specific conductance concentrations. This is important since the segment flows into Lake Houston, a drinking water source.

The only impairment listed for this segment is for *E. coli*. Regression analysis detected no significant change in *E. coli* concentrations during the period of record. The geometric mean for the East Fork San Jacinto River has remained above the 126 MPN/100 mL standard during the period of record. High bacteria levels in this watershed are likely related to the high density of OSSFs present in the area. Malfunctioning OSSF systems pose the risk of bacteria running off into waterways after a rain event, or potentially leaking into groundwater resources and discharging into surface waters during baseflow conditions. Cattle and other wild animals would also be contributors to the bacteria contamination.

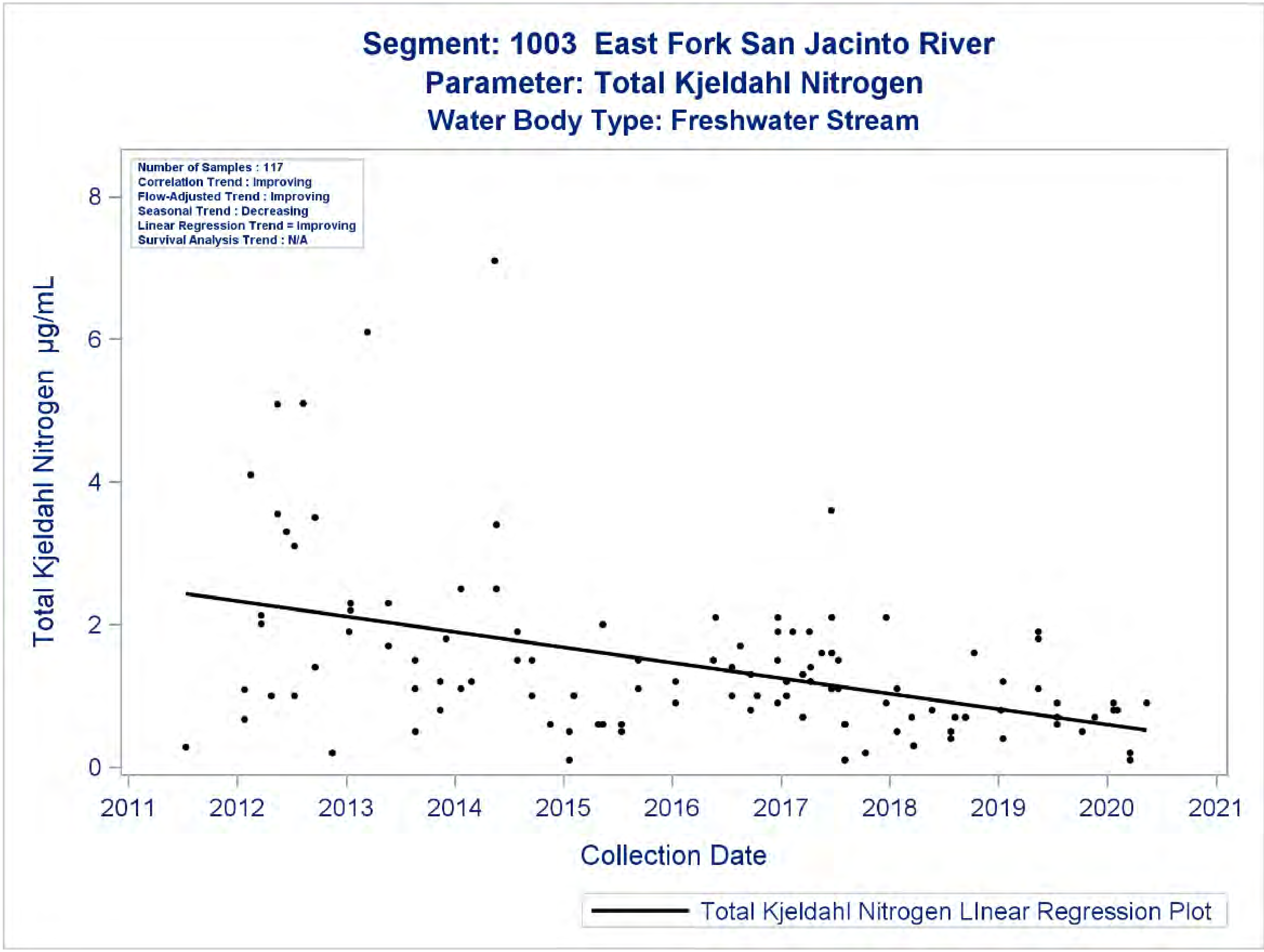
Two smaller tributaries, Nebletts Creek (1003B) and Boswell Creek (1003C), have insufficient data to analyze. Data from another year or two are needed to reveal any trends.



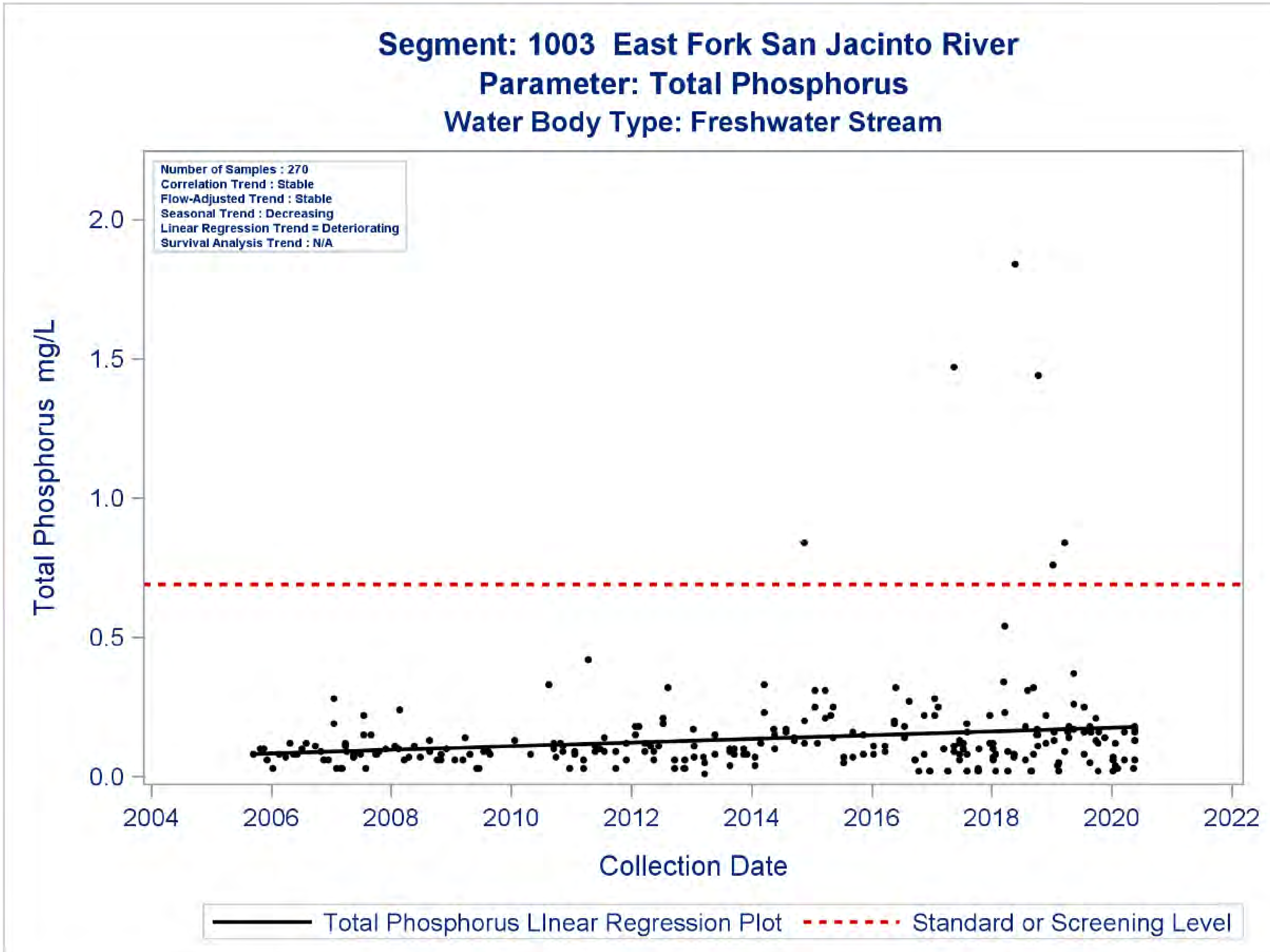
Segment: 1003 East Fork San Jacinto River
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 264
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level



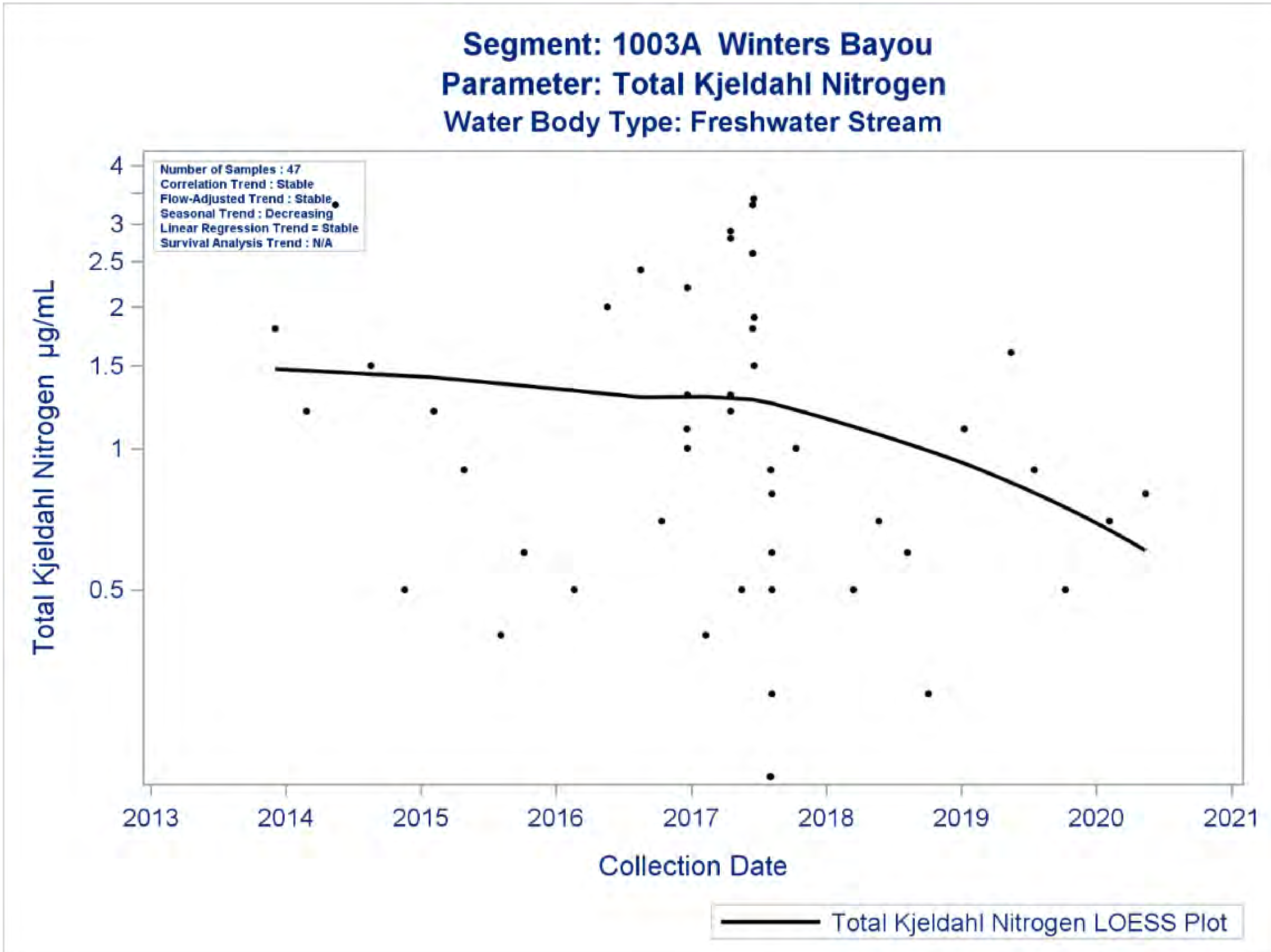
Segment: 1003 East Fork San Jacinto River
Parameter: Chloride
Water Body Type: Freshwater Stream
Number of Samples : 287
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Chloride mg/L
200
150
100
50
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LInear Regression Plot
Standard or Screening Level



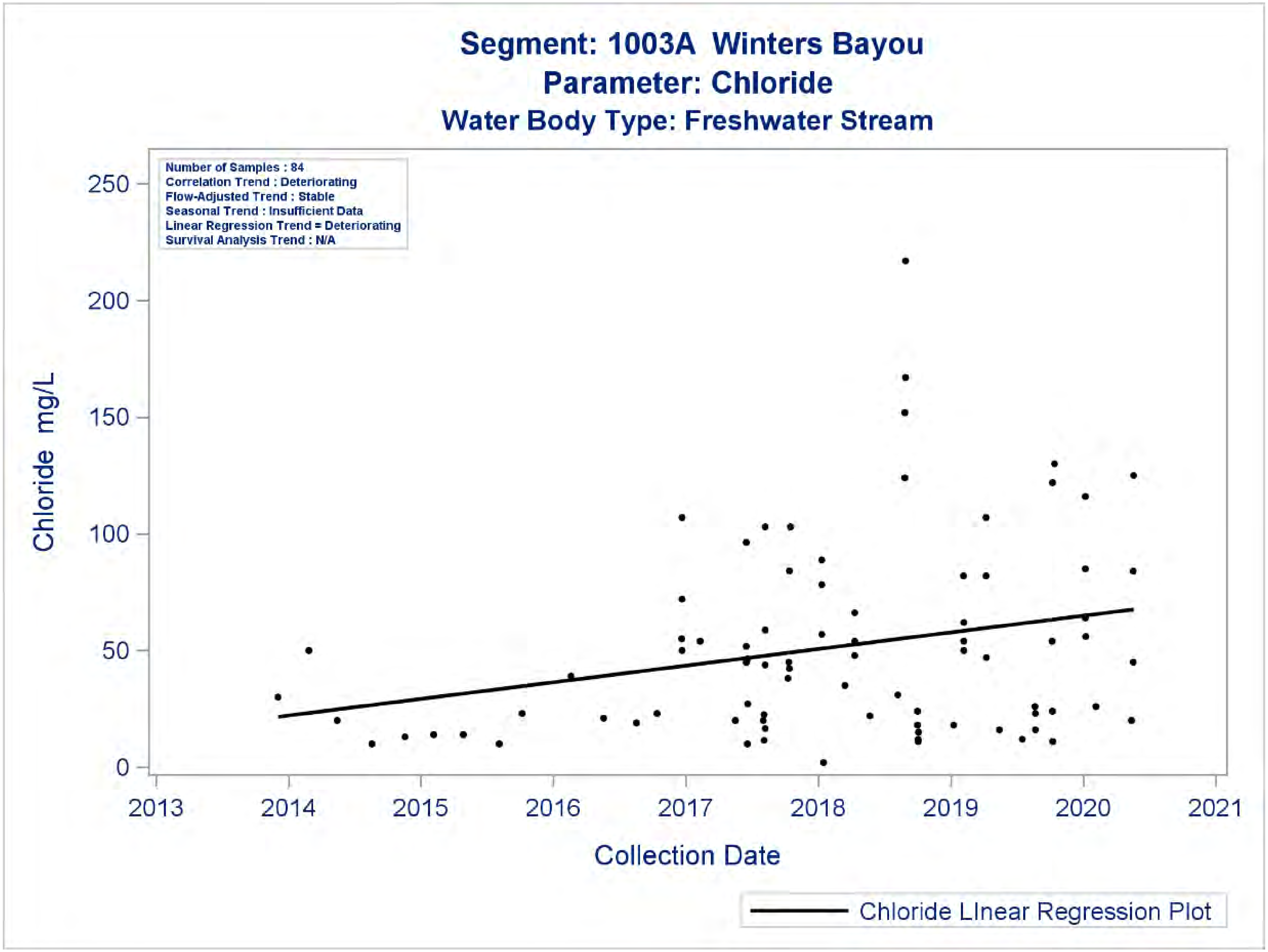
Segment: 1003 East Fork San Jacinto River
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 117
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
2
4
6
8
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot

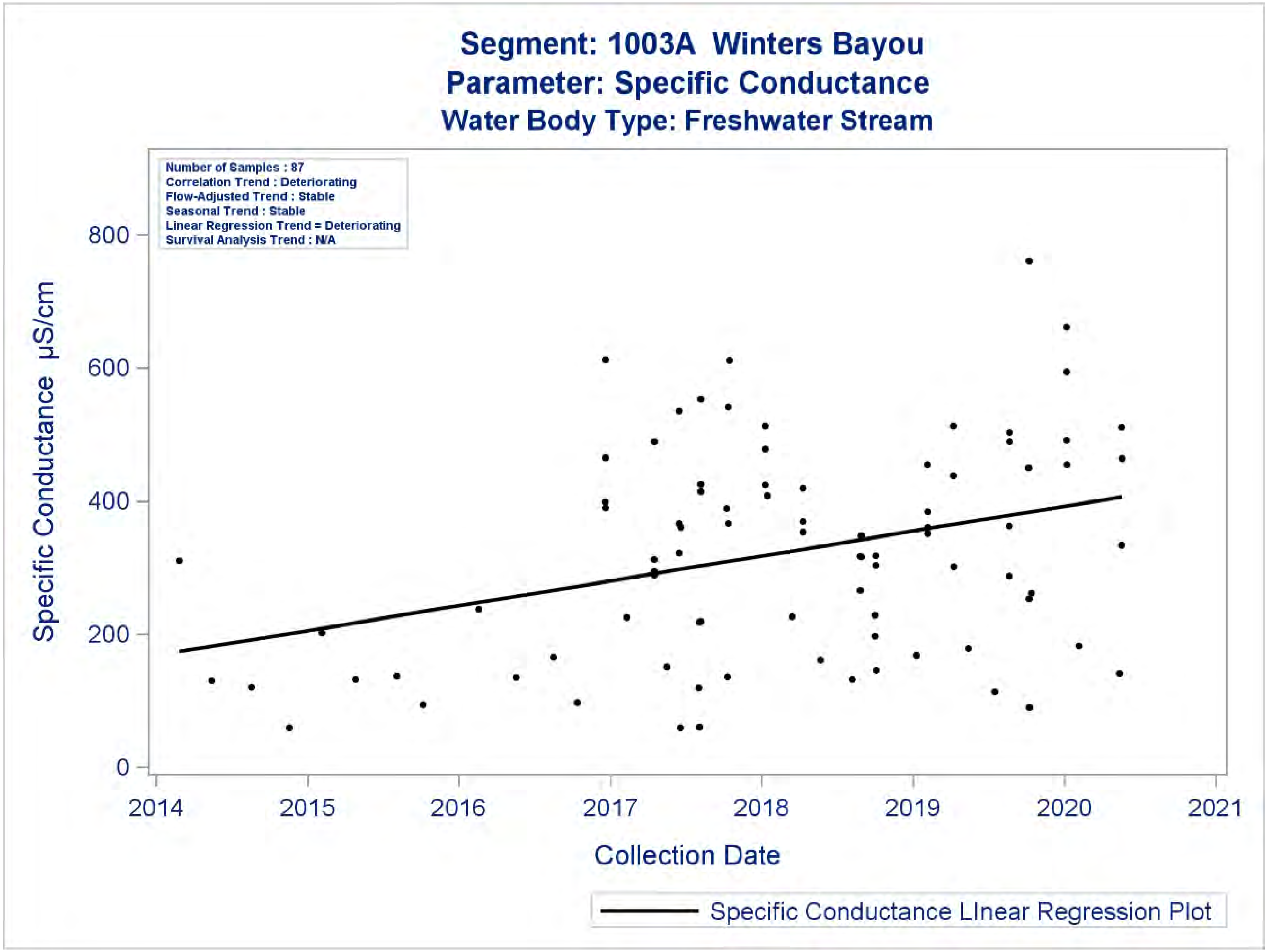


Segment: 1003 East Fork San Jacinto River
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 270
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



Segment: 1003A Winters Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 47
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
4
3
2.5
2
1.5
1
0.5
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot


Segment: 1003A Winters Bayou
Parameter: Chloride
Water Body Type: Freshwater Stream
Number of Samples : 84
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Chloride mg/L
0
50
100
150
200
250
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Chloride LInear Regression Plot



Segment: 1003A Winters Bayou
Parameter: Specific Conductance
Water Body Type: Freshwater Stream
Number of Samples : 87
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Specific Conductance µS/cm
0
200
400
600
800
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Specific Conductance LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1003_01 I 1003_02 I 1003_03 I 1003A_01 C	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Direct and dry weather discharges • Small, privately-run WWTF • Waste haulers illegal discharges/improper disposal • WWTF non-compliance, overflows, and collection system by-passes • Improper or no pet waste disposal	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Improve stormwater controls in new developments by adding bacteria reduction measures • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education on pet waste disposal

Special Studies:

- East Fork San Jacinto River is a part of the Bacteria Implementation Group (BIG)
- A Total Maximum Daily Load Implementation Plan was developed for the East Fork San Jacinto River watershed and surrounding others

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan

- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 1012	Name: Lake Conroe

Length:	45 miles	Watershed Area:	456 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	17	Texas Stream Team Monitoring Stations:	1	Permitted WWTF Outfalls:	49

DESCRIPTION

- Segment 1012 (Reservoir w/ high ALU): **Lake Conroe** (classified water body) – From Conroe Dam in Montgomery County up to the normal pool elevation of 201 feet (impounds West Fork San Jacinto River)

- Segment 1012A (Perennial Stream w/ high ALU): **Town Creek** (unclassified water body) **–** Perennial stream from the confluence with Atkins Creek upstream to the confluence with Carwile Creek

- Segment 1012B (Perennial Stream w/ high ALU): **Robinson Creek** (unclassified water body) **–** Perennial stream from the confluence with the West Fork San Jacinto River upstream to the confluence with an unnamed second order tributary approximately 0.1 km upstream of Bethel Road

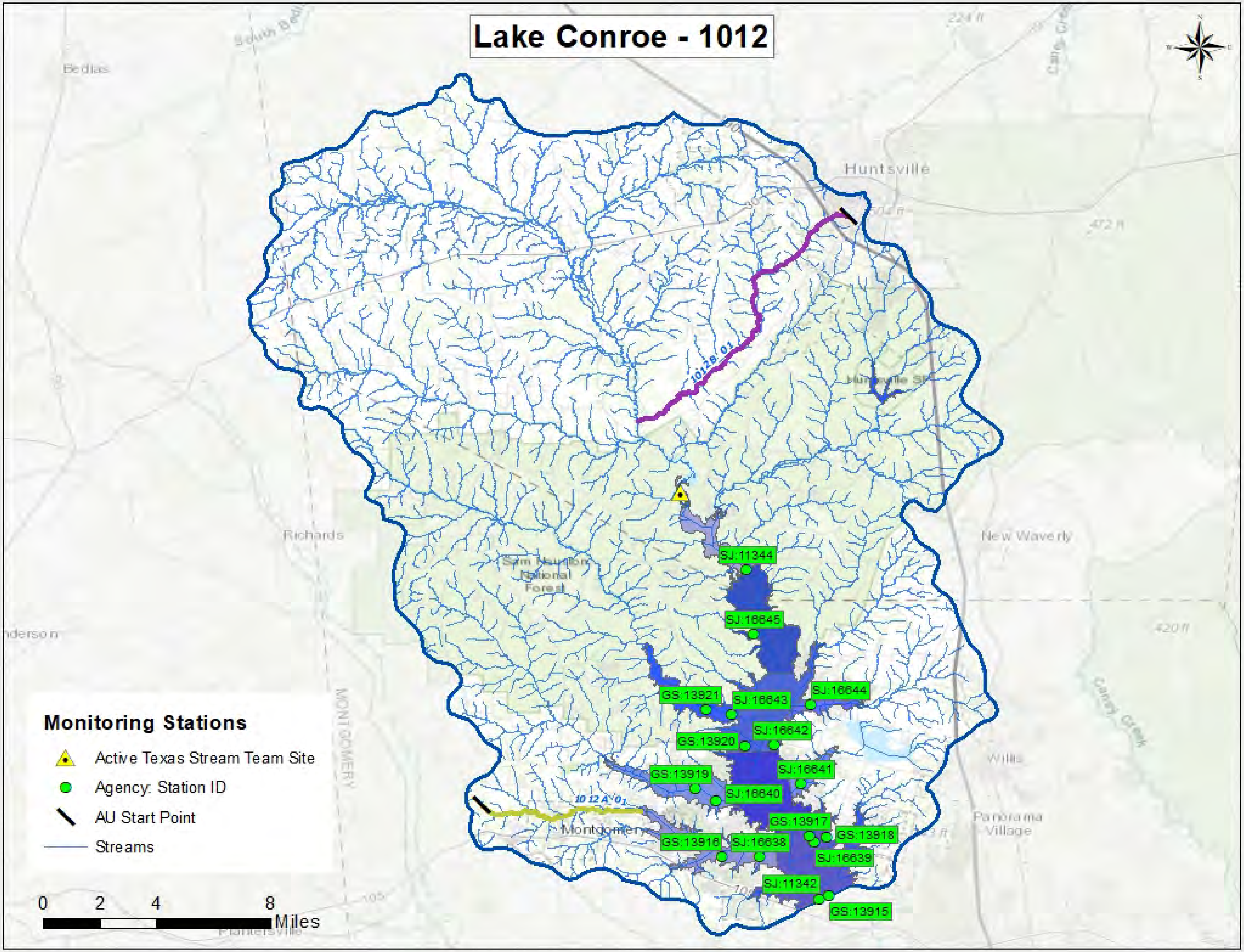
- Segment 1012C (Reservoir w/ high ALU): **Lake Raven** (unclassified water body) **–** Adjacent to Park Road 40 within the boundaries of Huntsville State Park in Walker County

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11342	1012	LAKE CONROE AT DAM MID CHANNEL 85 M OUT FROM MIDDLE TAINTER GATE 922 M N AND 426 M E OF INTERSECTION OF DAM SITE RD AND SH 105	SJ	MONTHLY	Field, Conventional, Bacteria
11344	1012	LAKE CONROE AT FM 1375 IN THE MAIN CHANNEL 4TH PILING FROM THE EAST 541 M SOUTH AND 1.40 KM W OF INTERSECTION OF KAGLE RD AND FM 1375 USGS SITE GC	SJ	MONTHLY	Field, Conventional, Bacteria
13915	1012	LAKE CONROE USGS SITE AL NEAR DAM 774 METERS NORTH AND 904 METERS EAST OF INTERSECTION OF FULTZ ROAD AND DAM SITE ROAD	GS	THREE/YEAR	Field
13916	1012	LAKE CONROE USGS SITE BC NEAR PIPELINE 917 METERS NORTH AND 71 METERS WEST OF LAKEVIEW TERRACE AND APRIL WATERS DRIVE	GS	THREE/YEAR	Field
13917	1012	LAKE CONROE MID LAKE USGS SITE CC 315 METERS SOUTH AND 1.22 KM WEST OF INTERSECTION OF BRUCE ROAD AND CUDE CEMETARY ROAD	GS	THREE/YEAR	Field
13918	1012	LAKE CONROE MID LAKE USGS SITE CL 381 METERS SOUTH AND 367 METERS WEST OF INTERSECTION OF BRUCE ROAD AND CUDE CEMETARY ROAD	GS	THREE/YEAR	Field

13919	1012	LAKE CONROE USGS SITE DC WEST SIDE OF LAKE 546 METERS SOUTH AND 112 METERS EAST OF INTERSECTION OF WATERFORD WAY AND SUNNYVALE EAST	GS	THREE/YEAR	Field
13920	1012	LAKE CONROE USGS SITE EC NEAR FM 1097 149 METERS SOUTH AND 1.47 KM EAST OF INTERSECTION OF FM 1097 AND BENTWATER DRIVE	GS	THREE/YEAR	Field, Conventional
13921	1012	LAKE CONROE KELLY BRANCH ARM USGS SITE FC 986 METERS NORTH AND 328 METERS WEST OF INTERSECTION OF HUNTERS POINT AND TEEL ROAD	GS	THREE/YEAR	Field, Conventional
16638	1012	LAKE CONROE AT APRIL POINT MID CHANNEL 559 M N AND 586 M E OF INTERSECTION OF APRIL POINT PLACE AND APRIL HILL	SJ	MONTHLY	Field, Conventional, Bacteria
16639	1012	LAKE CONROE AT SOUTH END OF LAKE ON EAST SIDE 201 METERS SOUTH AND 732 METERS WEST OF INTERSECTION OF S VALLEY DRIVE AND CREST DRIVE	SJ	MONTHLY	Field, Conventional, Bacteria
16640	1012	LAKE CONROE S OF BENTWATER ISLAND WEST COVE S OF FM 1097 BRIDGE 769 M N AND 89 M E OF INTERSECTION OF WATERFRONT AND SPRINGTIME DR	SJ	MONTHLY	Field, Conventional, Bacteria
16641	1012	LAKE CONROE AT AQUARIUS POINT MID CHANNEL N OF FM 830 BOAT RAMP 437 M N AND 924 M W OF INTERSECT OF FM 830 AND LAKEVIEW MANOR DR	SJ	MONTHLY	Field, Conventional, Bacteria
16642	1012	LAKE CONROE AT LAKE MID POINT MID CHANNEL AT FM 1097 BRIDGE 57 M S AND 520 M W OF INTERSECTION OF FM 1097 AND BLUEBERRY HILL	SJ	MONTHLY	Field, Conventional, Bacteria
16643	1012	LAKE CONROE AT HUNTERS POINT CANEY CREEK ARM E OF SCOTTS RIDGE BOAT RAMP 640 M N AND 558 M E OF INTERSECT OF TEEL RD AND HUNTERS TRL	SJ	MONTHLY	Field, Conventional, Bacteria
16644	1012	LAKE CONROE AT PARADISE POINT MID CHANNEL 396 METERS S AND 309 M WEST INTERSECTION OF PARADISE VIEW DRIVE AND PARADISE POINT DRIVE	SJ	MONTHLY	Field, Conventional, Bacteria
16645	1012	LAKE CONROE AT MOUTH OF SANDY BRANCH COVE 2.63 KM EAST OF INTERSECTION OF HARDY SMITH ROAD AND F S 218 A	SJ	MONTHLY	Field, Conventional, Bacteria

GS = United States Geological Survey
SJ = San Jacinto River Authority



Lake Conroe - 1012
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0 2 4 8 Miles
Huntsville
New Waverly
Richards
Sam Houston National Forest
Willis
Panorama Village
Montgomery
Bedias
1012B_01
1012A_01
SJ:11344
SJ:16645
GS:13921
SJ:16643
SJ:16644
SJ:16642
GS:13920
GS:13919
SJ:16641
SJ:16640
GS:13917
GS:13918
GS:13916
SJ:16638
SJ:16639
SJ:11342
GS:13915

Segment 1012 Water Quality Standards and Screening Levels					
Standards	**Reservoir**	**Perennial Stream**	**Screening Levels**	**Reservoir**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	32 / 90	Ammonia (mg/L):	0.11	0.33
Dissolved Oxygen (24-Hr Average) (mg/L):	5.0	5.0	Nitrate-N (mg/L):	0.37	1.95
Dissolved Oxygen (Absolute Minima) (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.05	0.37
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus (mg/L):	0.20	0.69
E. coli (MPN/100 mL) (grab):	399	399	Chlorophyll a (µg/L):	26.7	14.1
E. coli (MPN/100 mL) (geometric mean):	126	126			
Chloride (mg/L as Cl):	50	50			
Sulfate (mg/L as SO4):	50	50			
Fluoride (mg/L as F):	4				
Total Dissolved Solids (mg/L):	300	300			

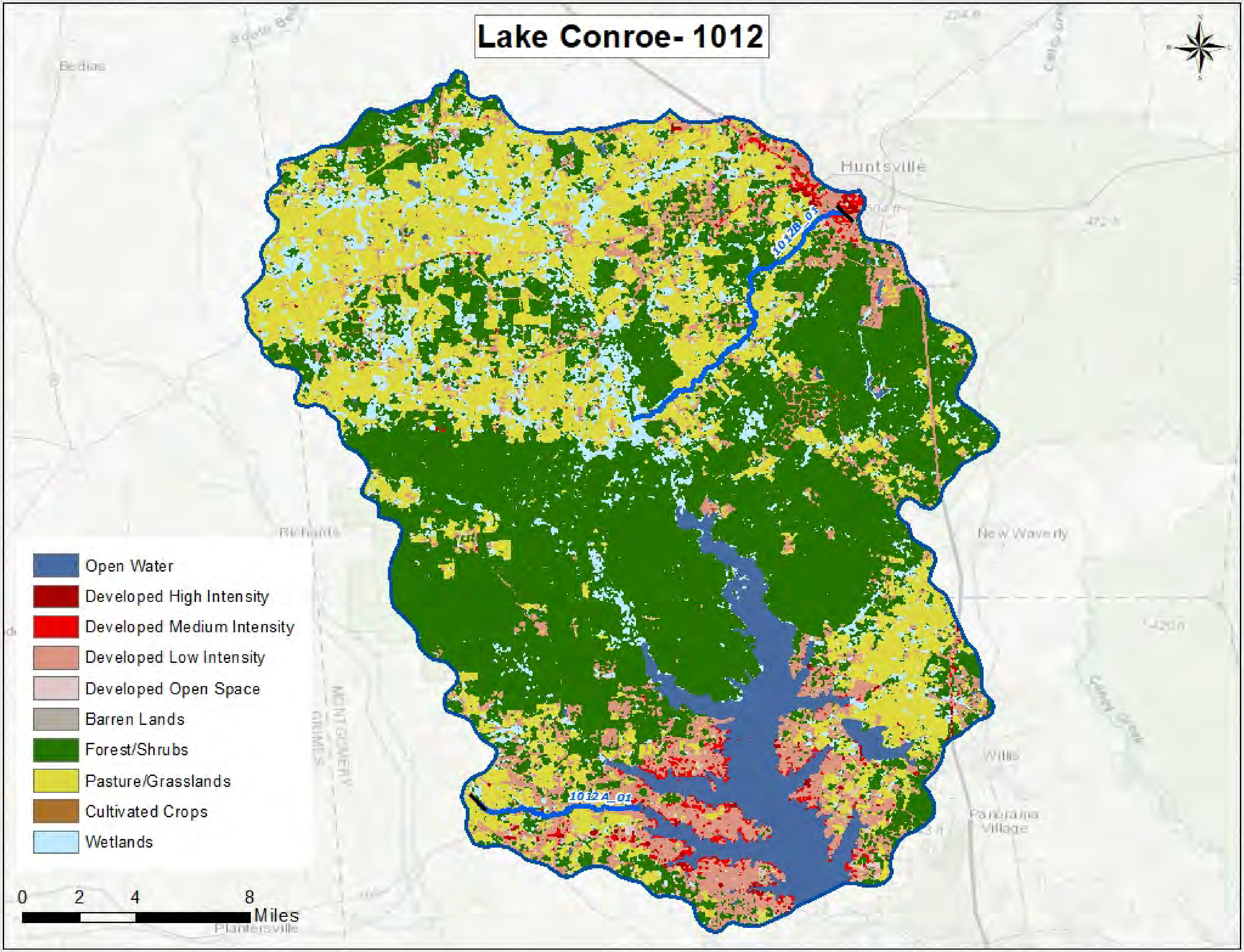
Segment Discussion

Watershed Characteristics and Land Cover: The Lake Conroe (1012) watershed consists of the area draining to Lake Conroe and spans northern Montgomery County and southern Walker County. Lake Conroe is an impoundment of the West Fork of the San Jacinto River and occupies most of the lower one-third of the watershed. In addition to the West Fork of the San Jacinto River, major tributaries include Caney, East Sandy, Lewis, Little Lake, McDonald, McGary, and West Sandy Creeks.

The northern portion of the watershed contains large plots of the Sam Houston National Forest, as well as portions of the City of Huntsville and Huntsville State Park. The majority of the watershed is undeveloped forest lands and grasslands with limited, but dense, urban and suburban development surrounding Lake Conroe and the City of Huntsville. The upper third of the watershed contains large tracts of cultivated land, as well as pastures, pristine forests, and cleared land from timber harvesting. In September of 2015, the San Jacinto River Authority (SJRA) began treating water from Lake Conroe to produce drinking water. The SJRA water treatment plant treats surface waters from Lake Conroe and transmits the treated drinking water to multiple utility districts in Montgomery County. Drinking water from the SJRA plant is blended with groundwater from each utility's existing water wells and is then distributed to area residents.

Segment 1012 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	95,993.51	32.91	68,614.19	23.52	-28.52
Barren Lands	688.53	0.24	678.75	0.23	-1.42
Developed	18,243.61	6.25	40,158.27	13.77	120.12
Forest/Shrubs	117,955.31	40.44	127,578.29	43.74	8.16
Open Water	22,303.85	7.65	20,230.25	6.94	-9.29
Wetlands	36,511.02	12.52	34,436.08	11.81	-5.68
TOTAL	**291,695.83**	**100.00**	**291,695.83**	**100.00**	



Lake Conroe- 1012
Bedias
Huntsville
New Waverly
Richards
Willis
Panorama Village
Plantersville
MONTGOMERY
GRIMES
1012B_01
1012A_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 2 4 8
Miles

Water Quality Issues:

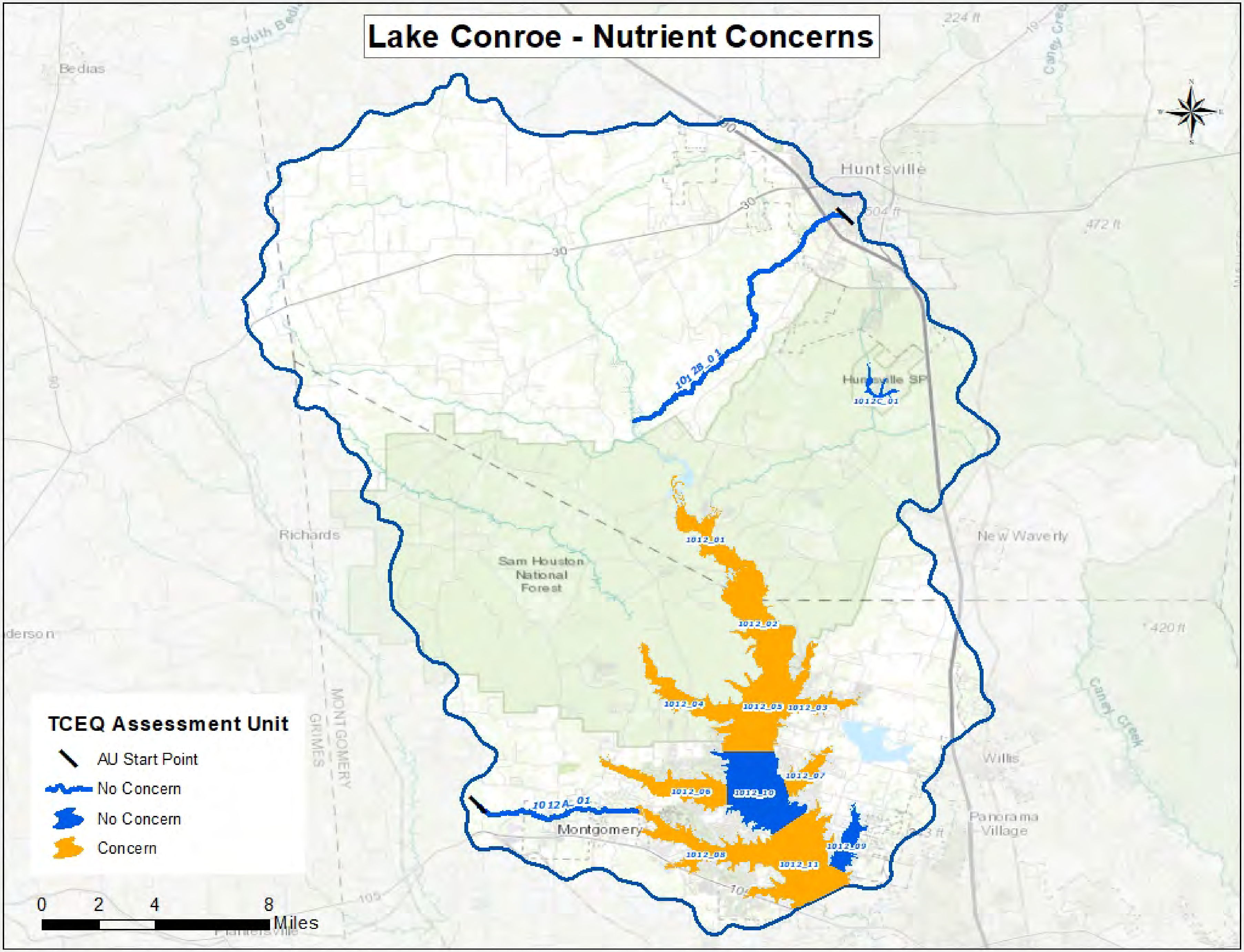
No impairments or concerns were identified for Lake Conroe (1012) in the 2020 Integrated Report. All designated uses are supported in this segment.

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

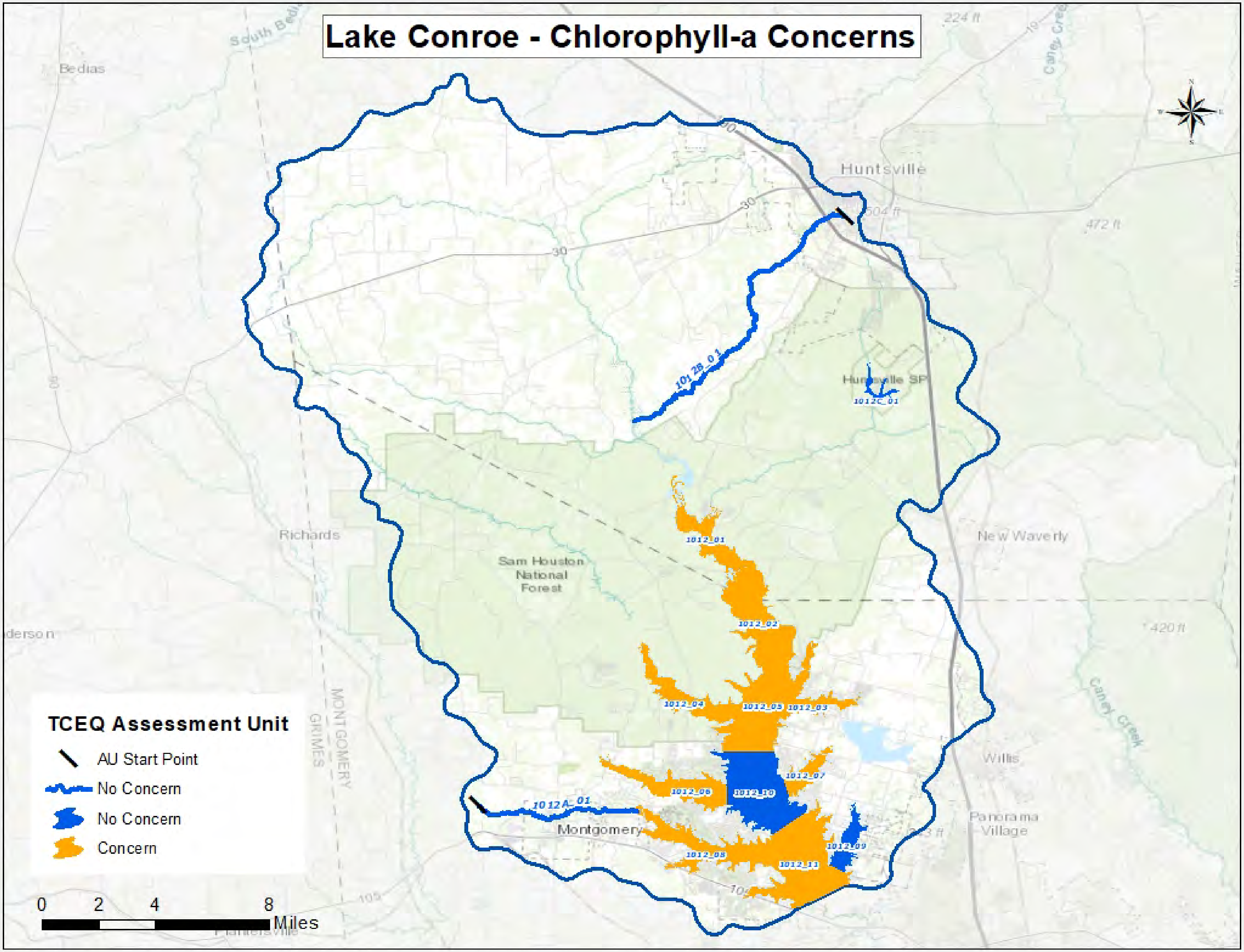
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.


Lake Conroe - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
No Concern
Concern
0
2
4
8
Miles
Huntsville
Huntsville SP
New Waverly
Richards
Sam Houston National Forest
Willis
Panorama Village
Montgomery
Bedias
MONTGOMERY
GRIMES
Caney Creek
1012B_01
1012C_01
1012_01
1012_02
1012_03
1012_04
1012_05
1012_06
1012_07
1012_08
1012_09
1012_10
1012_11
1012A_01

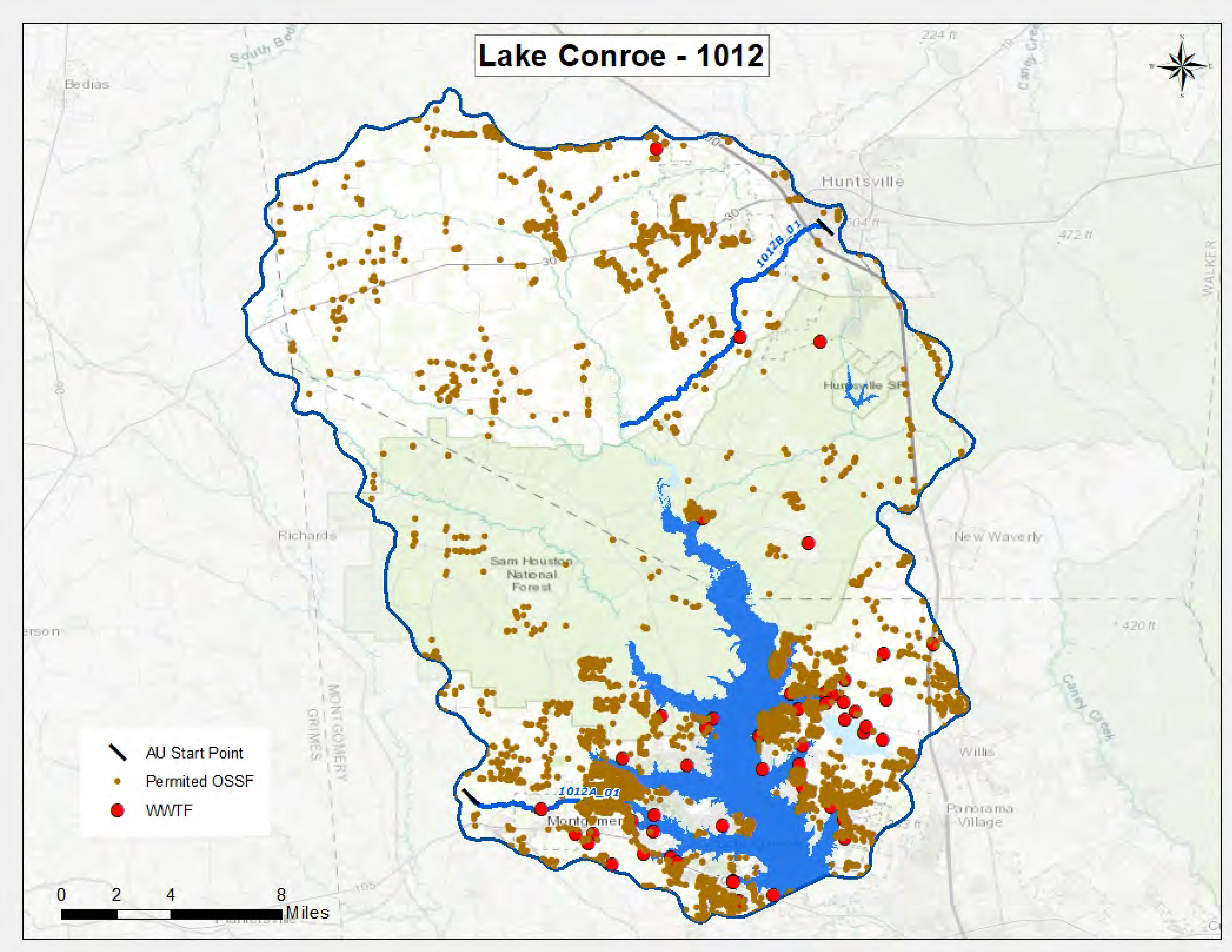
Lake Conroe - Chlorophyll-a Concerns



Potential Sources of Water Quality Issues: There are not bacteria or nutrient concerns in this segment. However, there are both point and non-point sources in the Lake Conroe watershed that could be potential sources of fecal indicator bacteria and nutrients. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste. Although there are no impairments or concerns, these sources still need to be monitored to assure that they do not contribute to bacteria or nutrient levels in the future.

There are 49 permitted wastewater outfalls in the Lake Conroe watershed. In some areas, on-site sewage facilities are the primary source of wastewater disposal, with 6,505 permitted OSSFs in the watershed. These systems are present throughout the area but are concentrated around the reservoir. The wastewater treatment facilities and on-site sewage facilities in the watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 189 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

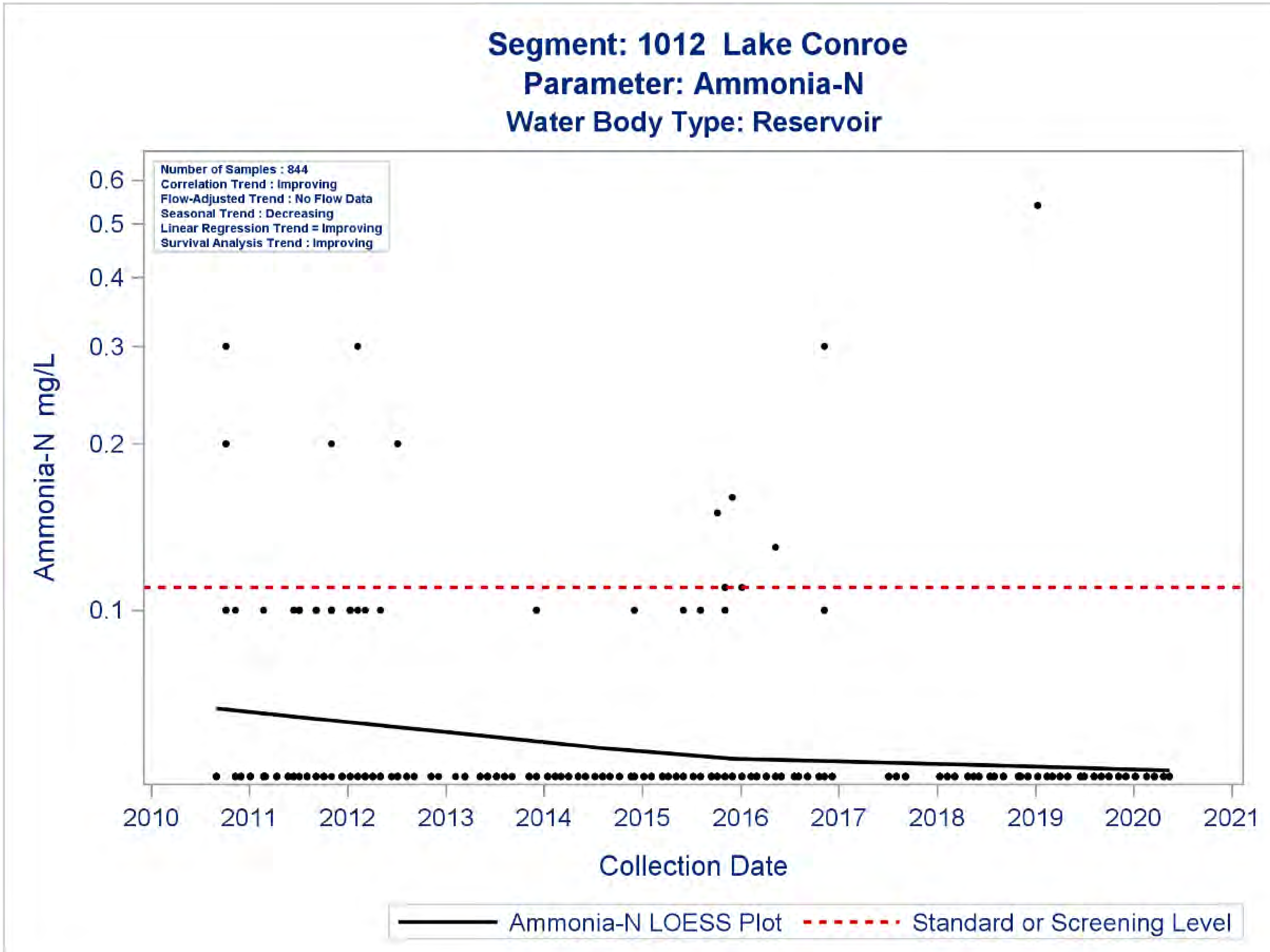


Lake Conroe - 1012
Huntsville
Bedias
Richards
New Waverly
Sam Houston National Forest
Huntsville SP
Willis
Panorama Village
Montgomery
1012B_01
1012A_01
MONTGOMERY
GRIMES
WALKER
Caney Creek
AU Start Point
Permited OSSF
WWTF
0
2
4
8
Miles

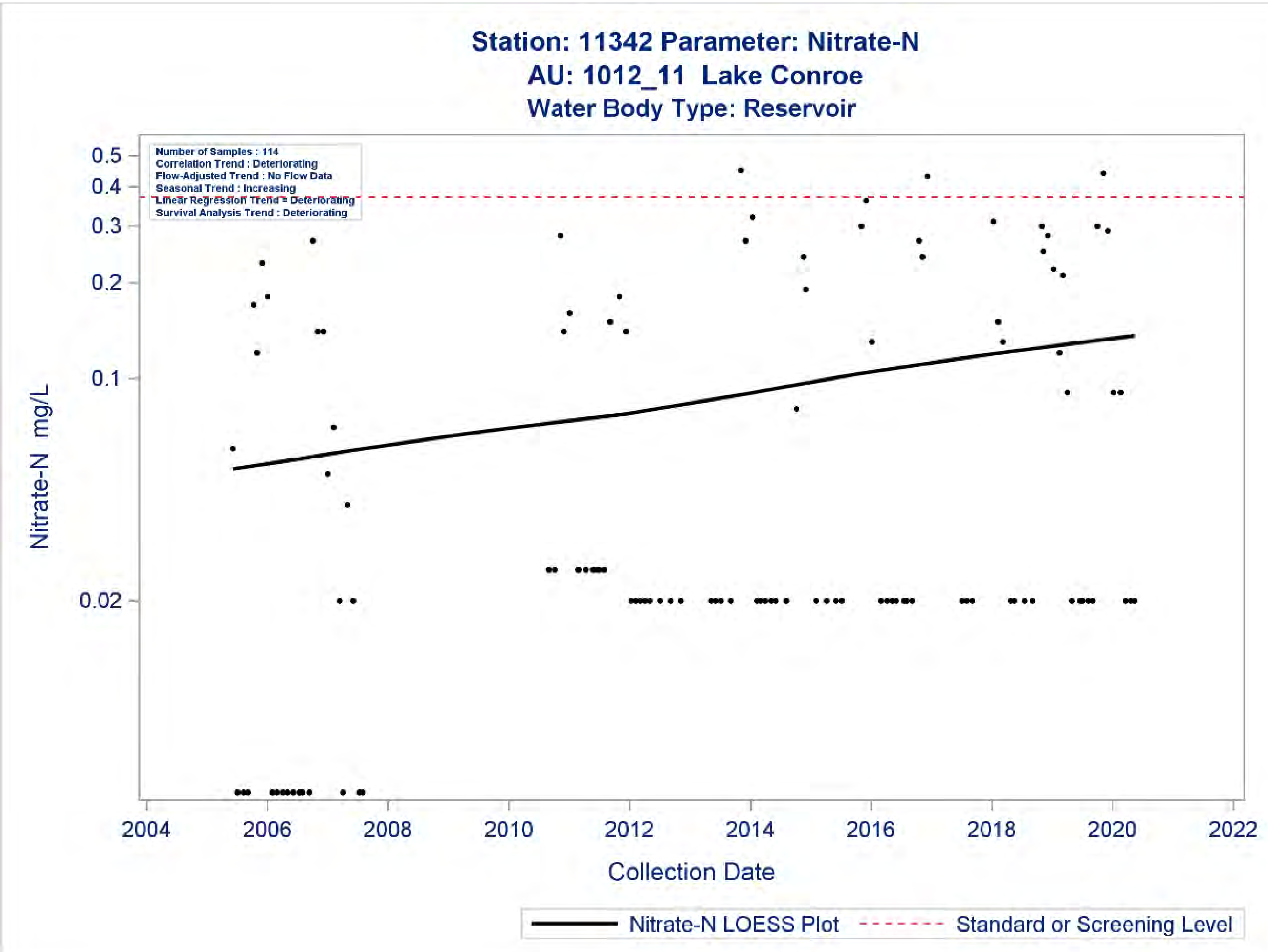
Trend Analysis:

Regression analysis of watershed data revealed 12 parameter trends for this segment including decreasing ammonia, TKN, sulfate, chloride, and DO concentrations. Lake Conroe also has increasing trends for nitrate, total phosphorus, chlorophyll *a*, and TSS in some or nearly all of the 11 AUs which make up segment 1012 (Lake Conroe). Bacteria concentrations appear to be decreasing however, the reporting limit was lowered from 10 MPN to 1 MPN in 2012. This drop produces a false downward trend. Both Secchi transparency and concentrations of chlorophyll *a* are decreasing over time but the chlorophyll *a* samples that exceeded the criteria after 2014 were much higher than the result measured before 2012.

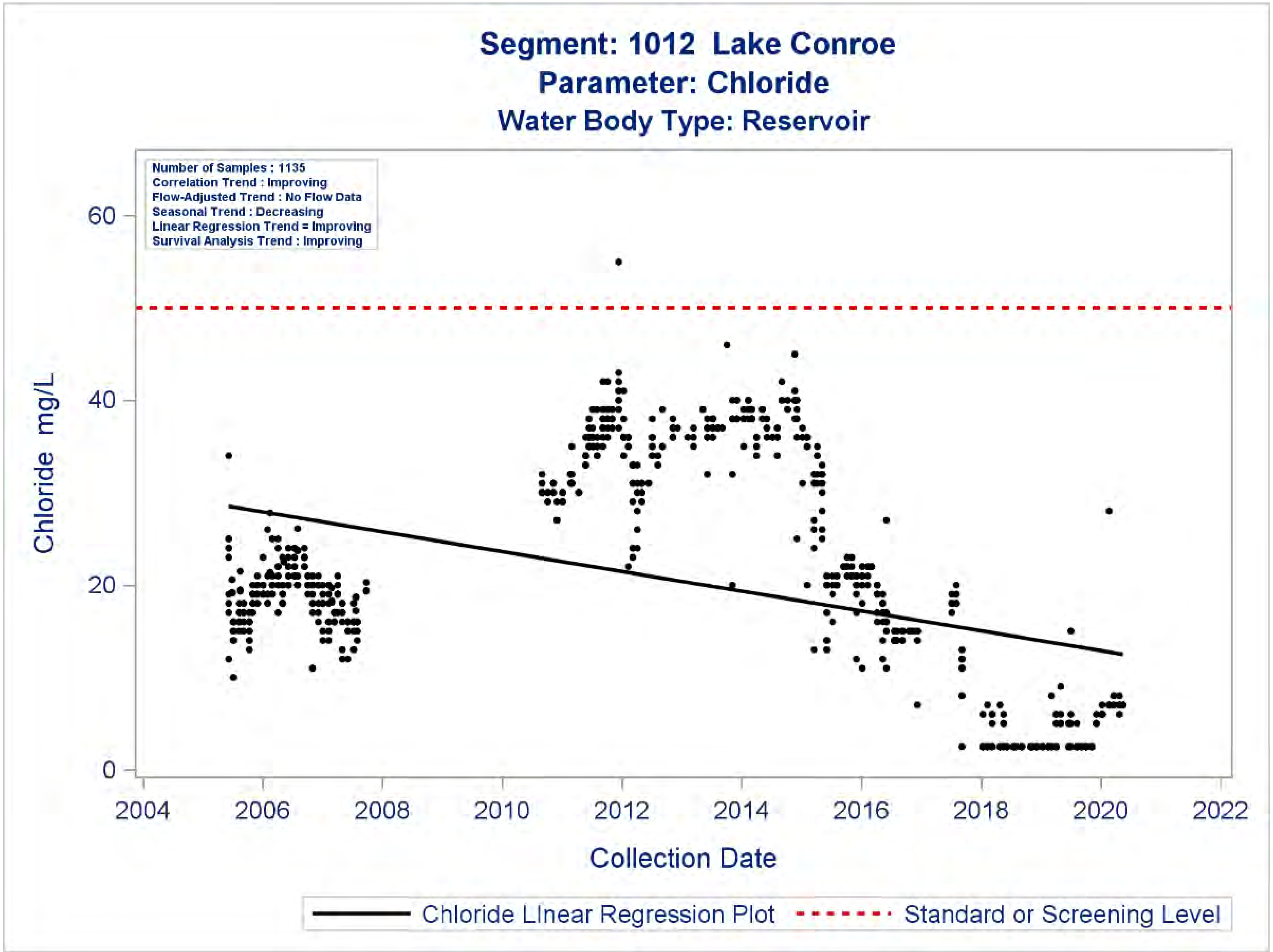
Trends of note include a gradual improvement in DO levels throughout the watershed. The graph of monitoring station 16645 shows all DO measurements above the grab standard beginning after 2011-2012 time period. The increasing concentrations of DO are found in all AUs except for 1012_11 where DO is stable. Numerous individual monitoring stations show similar trends after the 2011-2012 time period. Additionally, a decrease in specific conductance is evident for this segment starting after 2015. This decrease may be due to the drought that affected the lake from about 2010 through early 2015. Following the drought, rainfall throughout this watershed was still limited for a couple of years allowing the specific conductance to remain higher than usual.



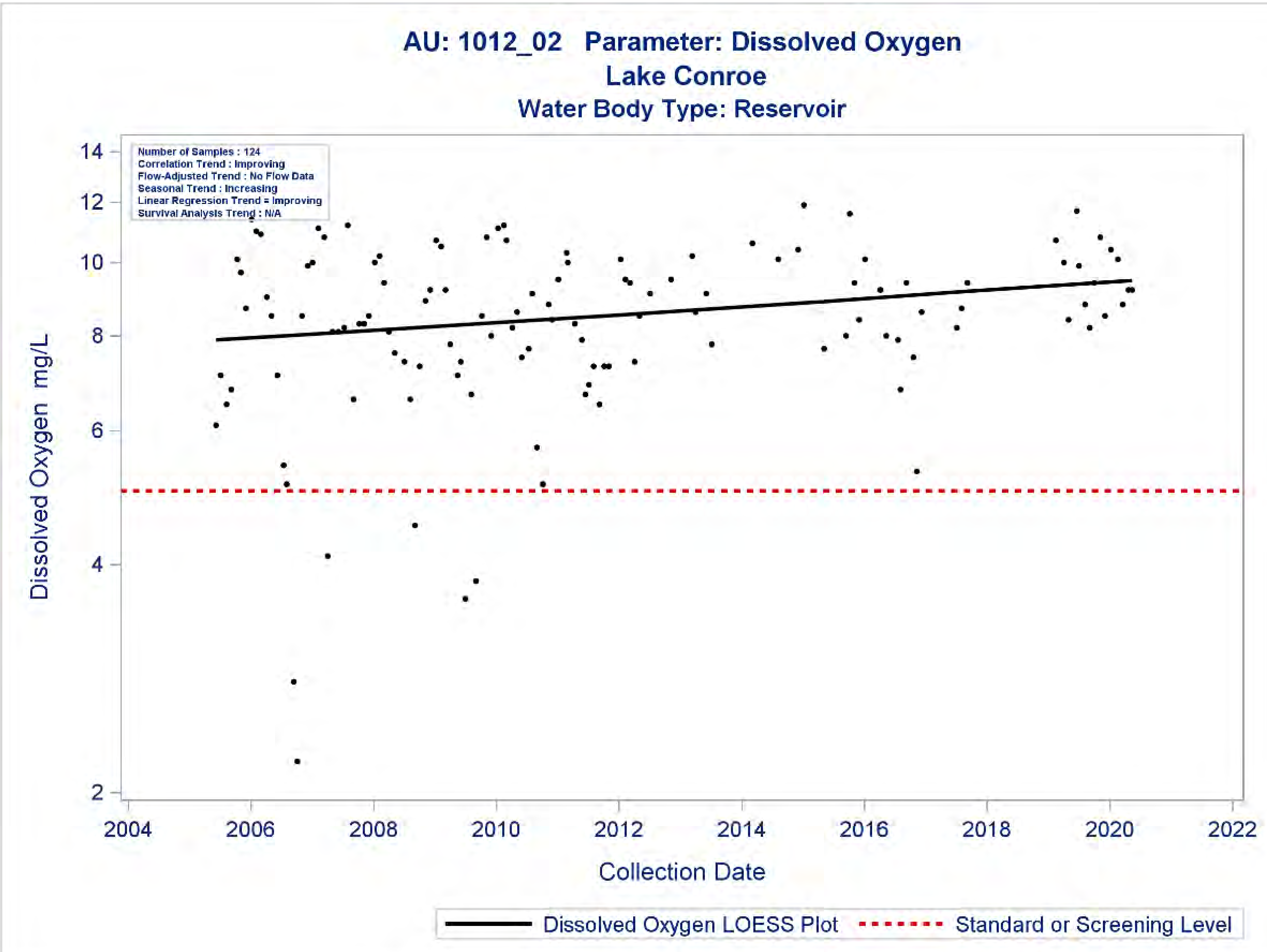
Segment: 1012 Lake Conroe
Parameter: Ammonia-N
Water Body Type: Reservoir
Number of Samples : 844
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
0.6
0.5
0.4
0.3
0.2
0.1
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level

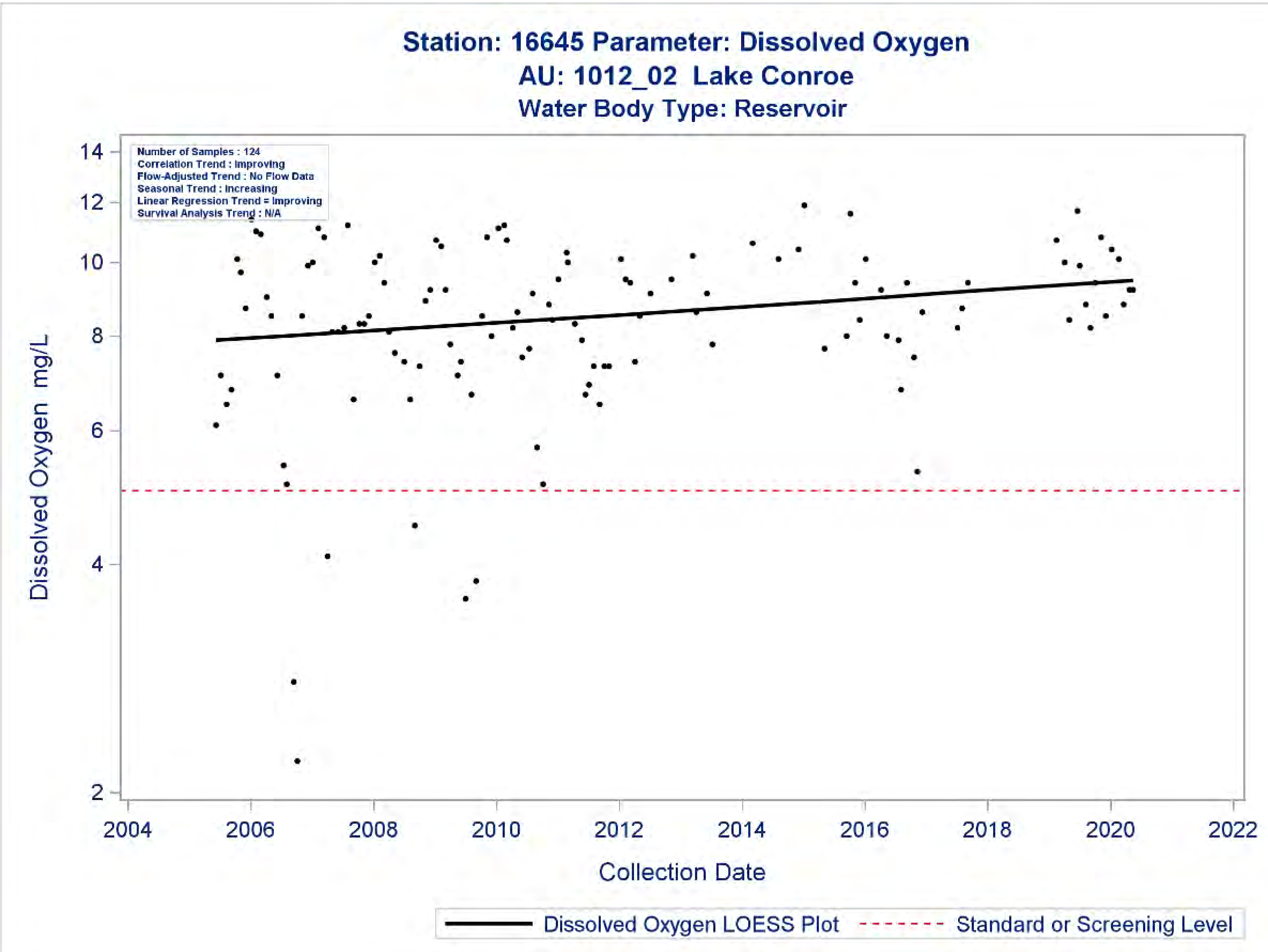


Station: 11342 Parameter: Nitrate-N
AU: 1012_11 Lake Conroe
Water Body Type: Reservoir
Number of Samples : 114
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend : Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0.5
0.4
0.3
0.2
0.1
0.02
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

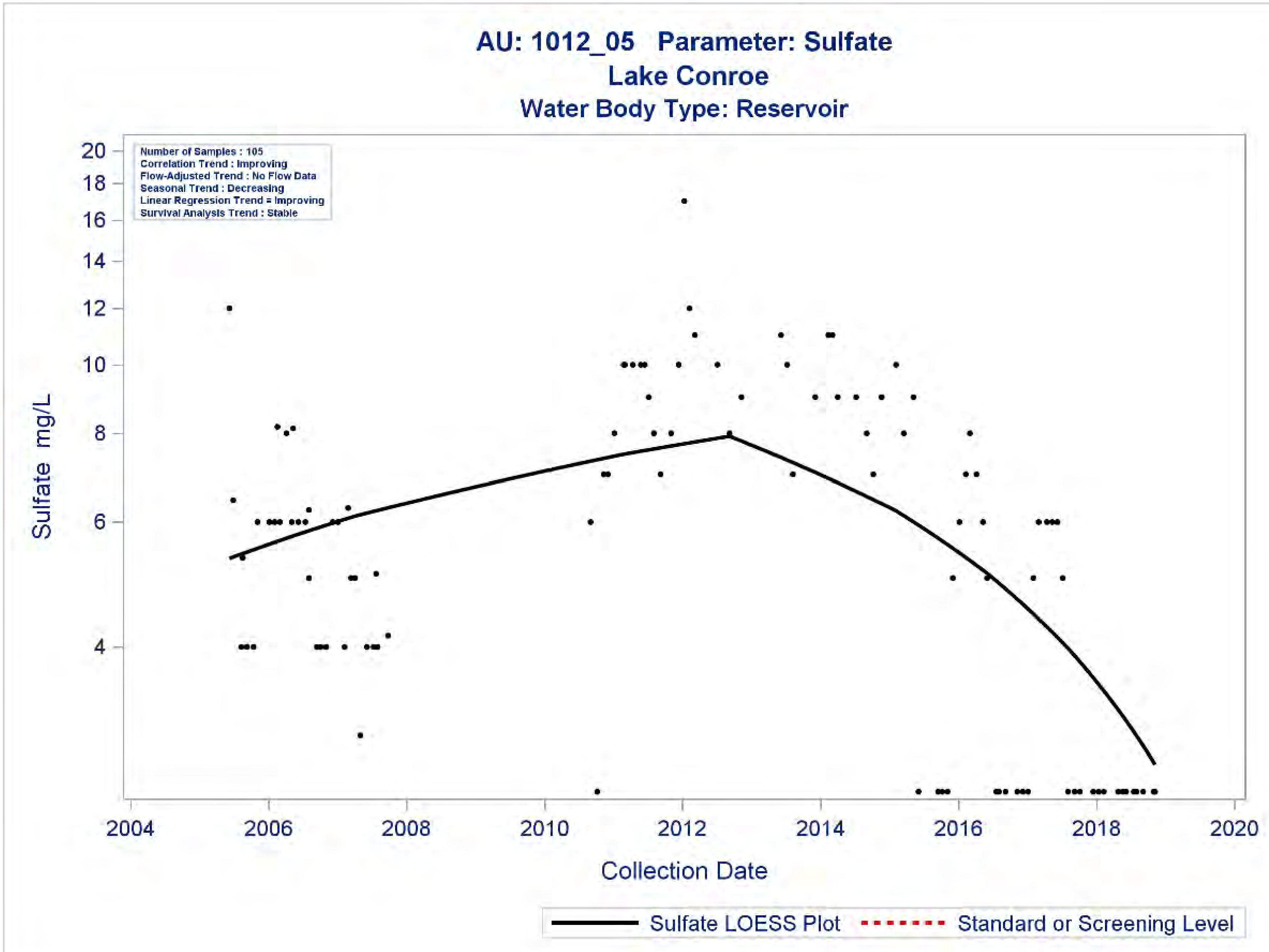


Segment: 1012 Lake Conroe
Parameter: Chloride
Water Body Type: Reservoir
Number of Samples : 1135
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Chloride mg/L
0
20
40
60
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride Linear Regression Plot
Standard or Screening Level

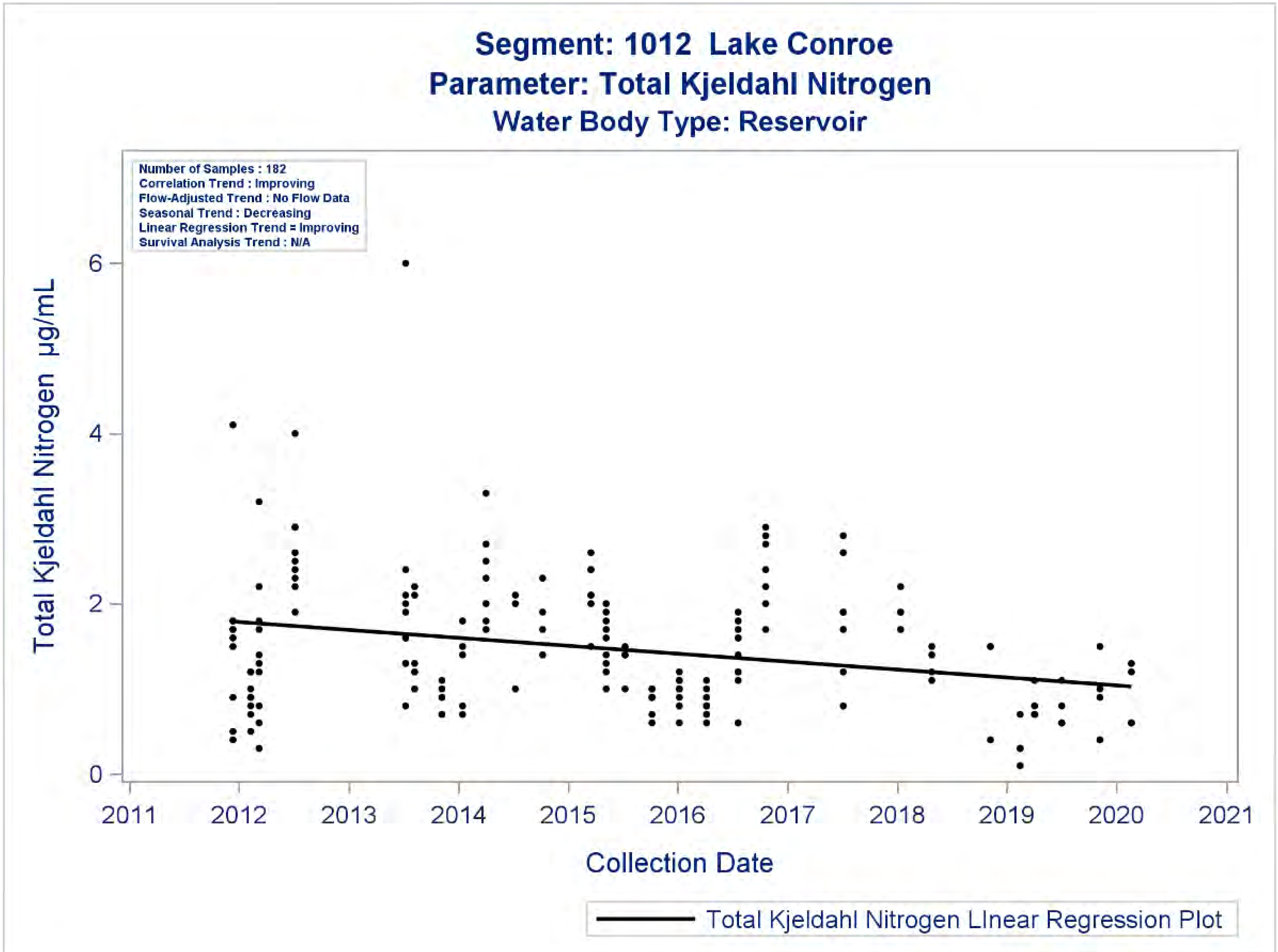

AU: 1012_02 Parameter: Dissolved Oxygen
Lake Conroe
Water Body Type: Reservoir
Number of Samples : 124
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
14
12
10
8
6
4
2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level



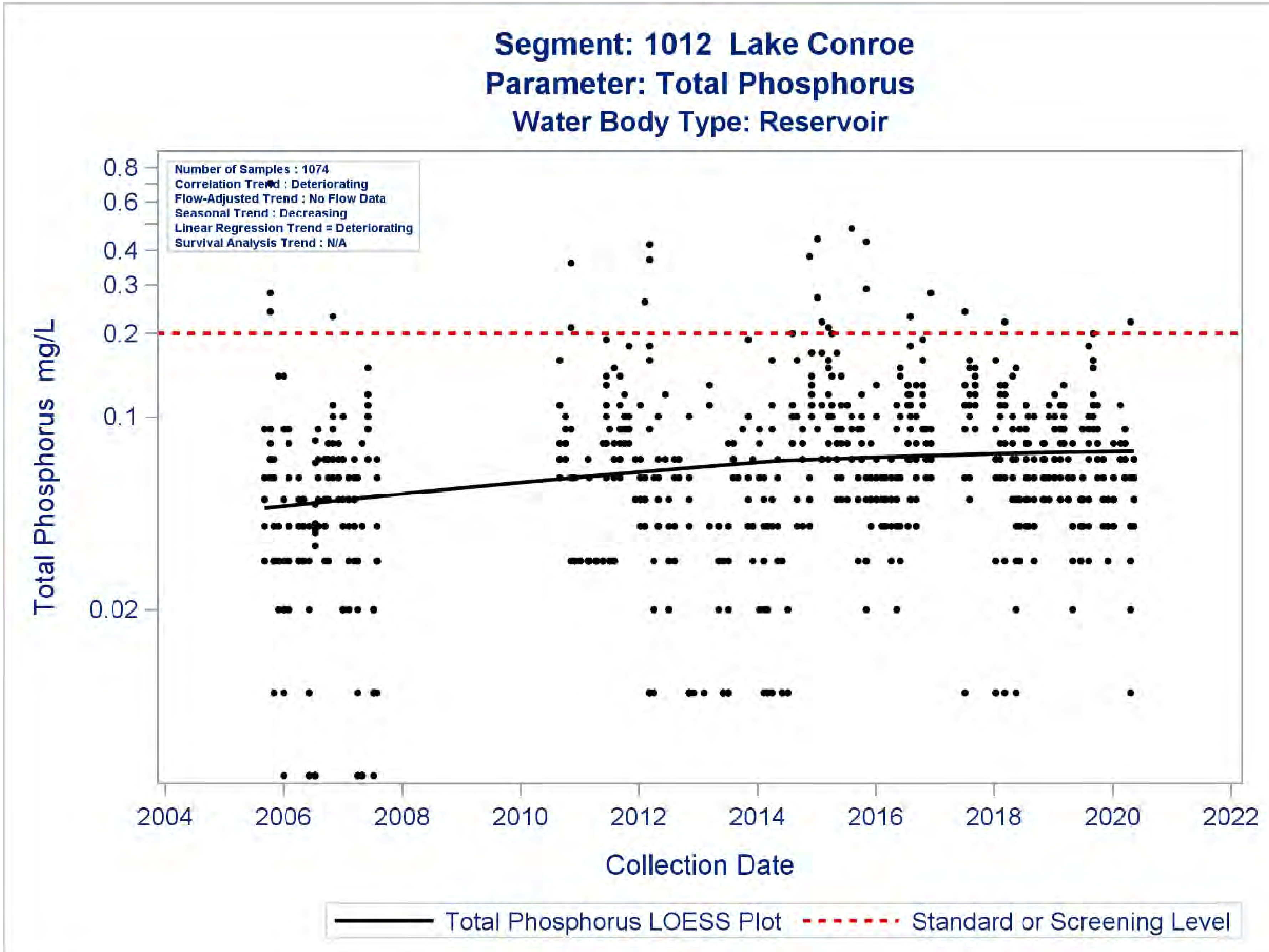
Station: 16645 Parameter: Dissolved Oxygen
AU: 1012_02 Lake Conroe
Water Body Type: Reservoir
Number of Samples : 124
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
14
12
10
8
6
4
2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level



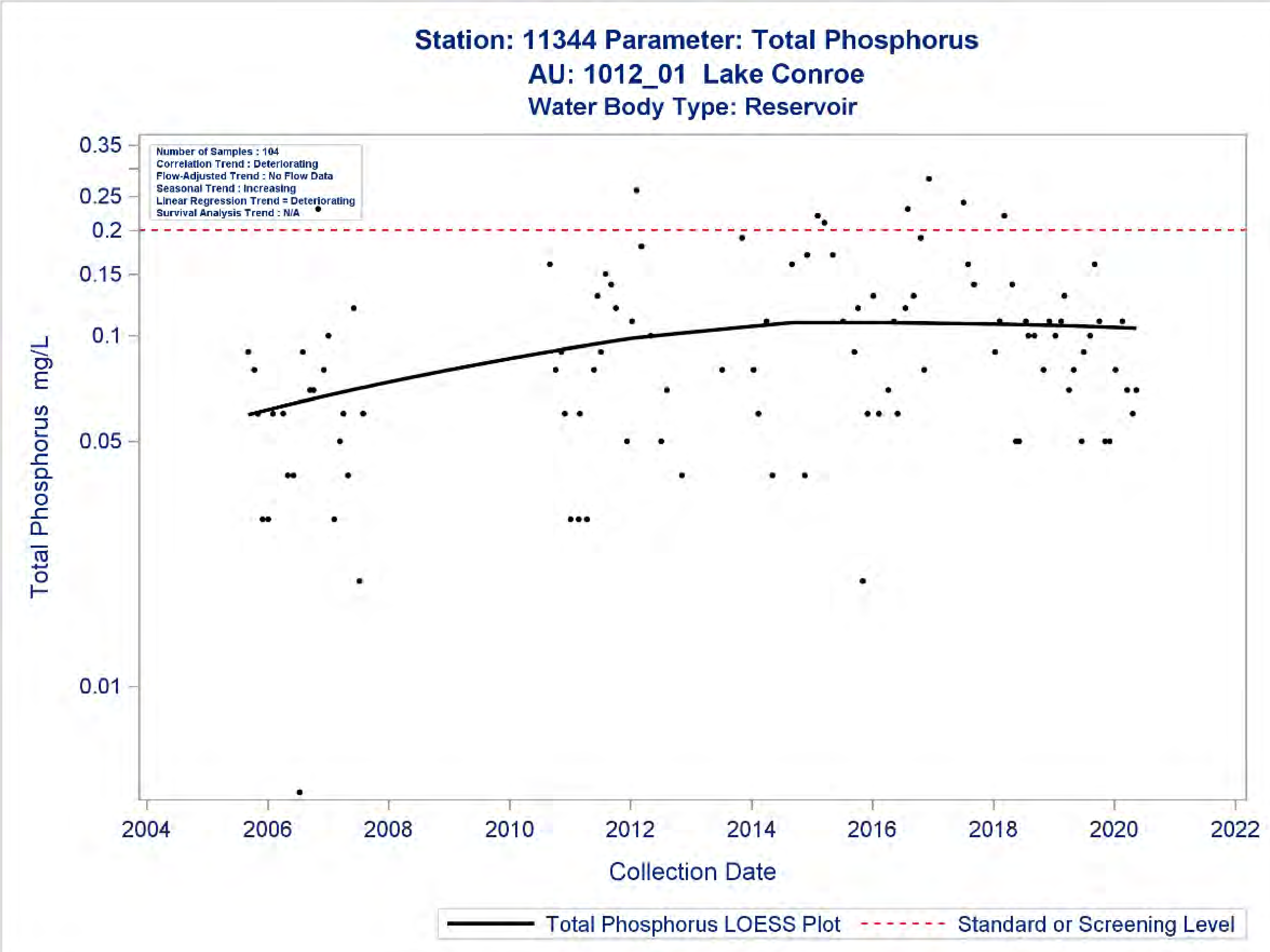
AU: 1012_05 Parameter: Sulfate
Lake Conroe
Water Body Type: Reservoir
Number of Samples : 105
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Stable
Sulfate mg/L
20
18
16
14
12
10
8
6
4
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Sulfate LOESS Plot
Standard or Screening Level



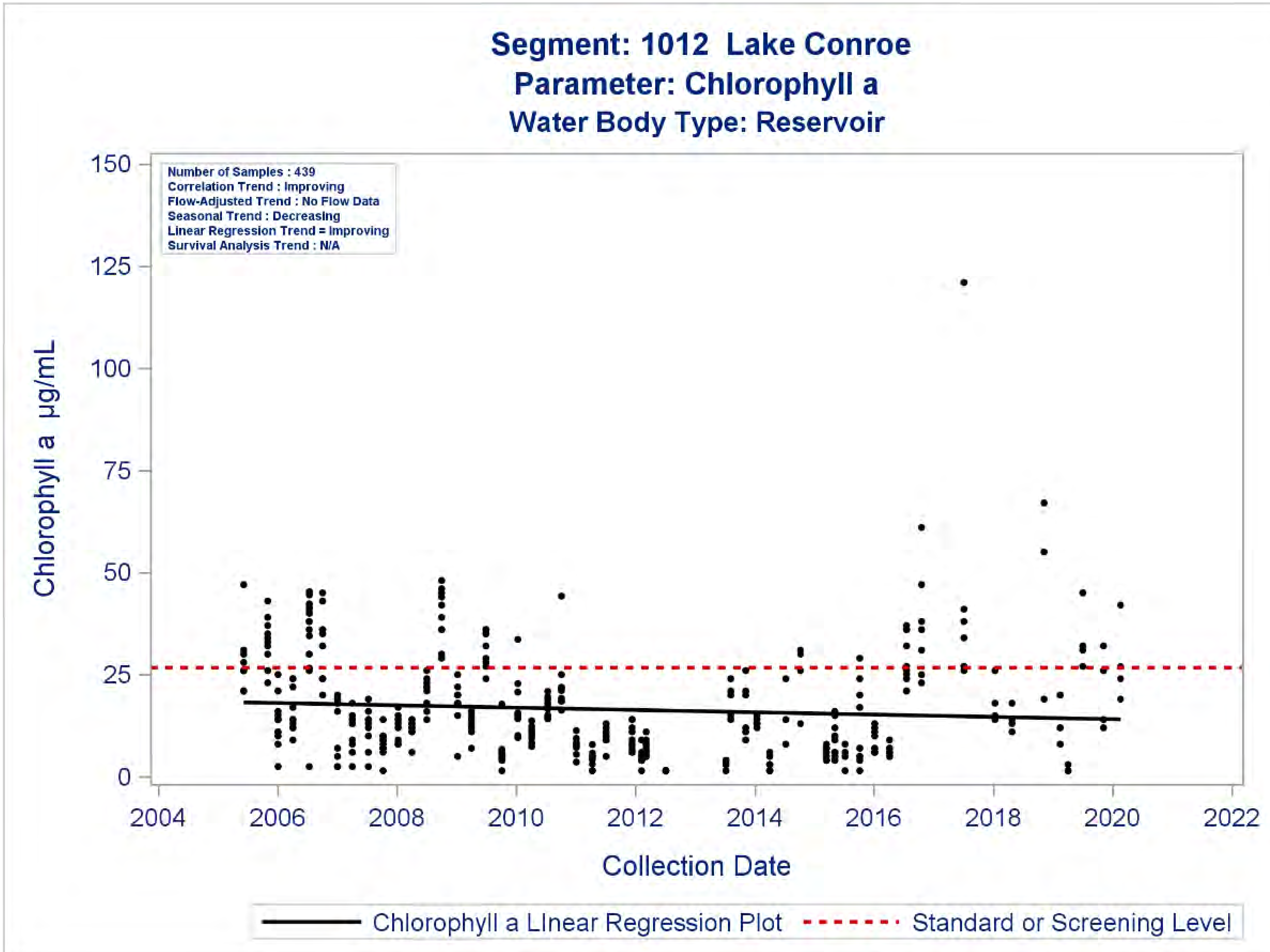
Segment: 1012 Lake Conroe
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Reservoir
Number of Samples : 182
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
2
4
6
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



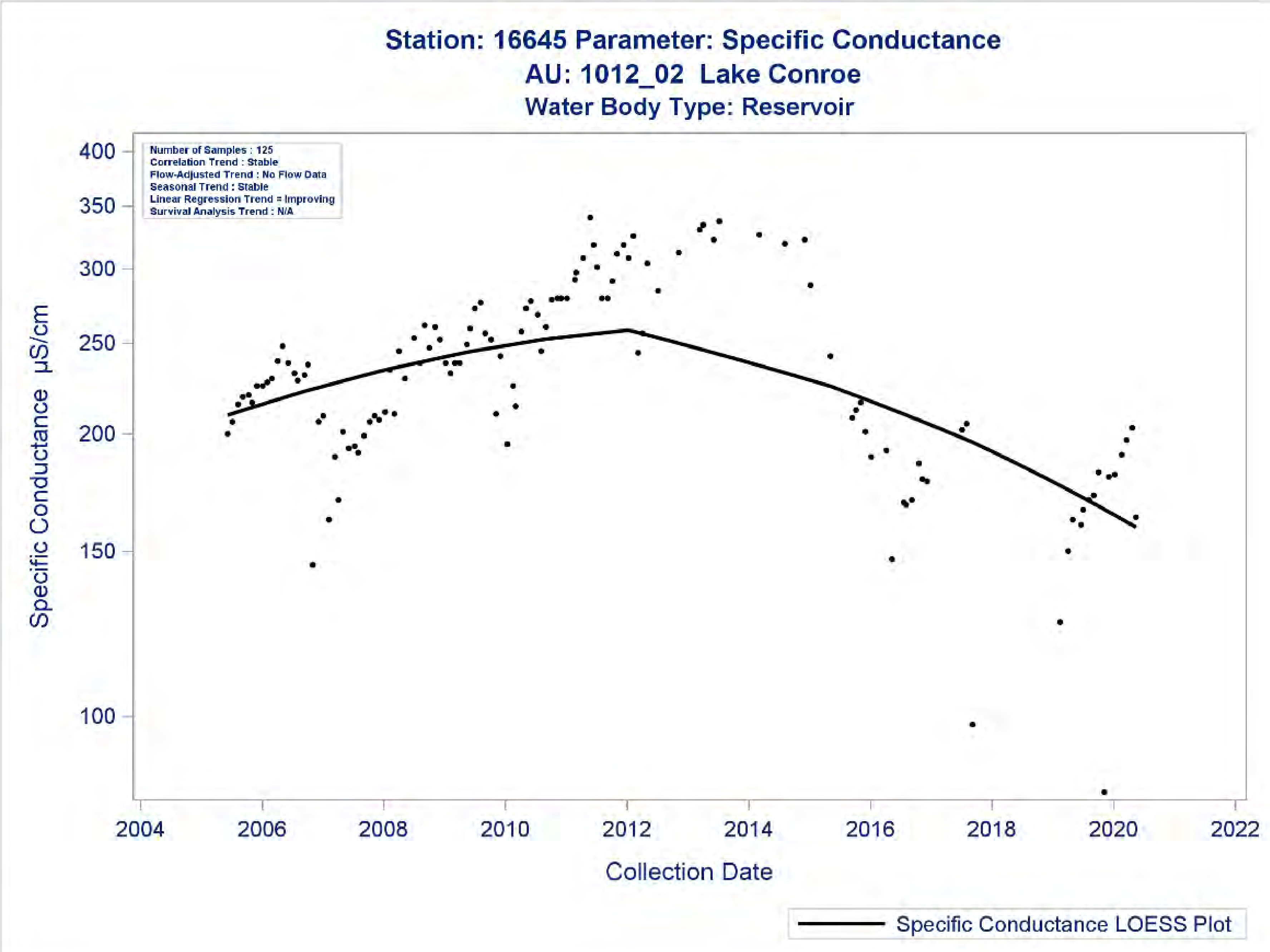
Segment: 1012 Lake Conroe
Parameter: Total Phosphorus
Water Body Type: Reservoir
Number of Samples : 1074
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.8
0.6
0.4
0.3
0.2
0.1
0.02
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



Station: 11344 Parameter: Total Phosphorus
AU: 1012_01 Lake Conroe
Water Body Type: Reservoir
Number of Samples : 104
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.35
0.25
0.2
0.15
0.1
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



Segment: 1012 Lake Conroe
Parameter: Chlorophyll a
Water Body Type: Reservoir
Number of Samples : 439
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Chlorophyll a µg/mL
150
125
100
75
50
25
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chlorophyll a Linear Regression Plot
Standard or Screening Level


Station: 16645 Parameter: Specific Conductance
AU: 1012_02 Lake Conroe
Water Body Type: Reservoir
Number of Samples : 125
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Specific Conductance µS/cm
400
350
300
250
200
150
100
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
There were no impairments or concerns identified for Lake Conroe in the 2020 Integrated Report.				

Special Studies:

No plans currently exist for the Lake Conroe watershed.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 1015		Name: Lake Creek			
Length:	63 miles	**Watershed Area:**	328 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	3	**Texas Stream Team Monitoring Stations:**	1	**Permitted WWTF Outfalls:**	17

DESCRIPTION

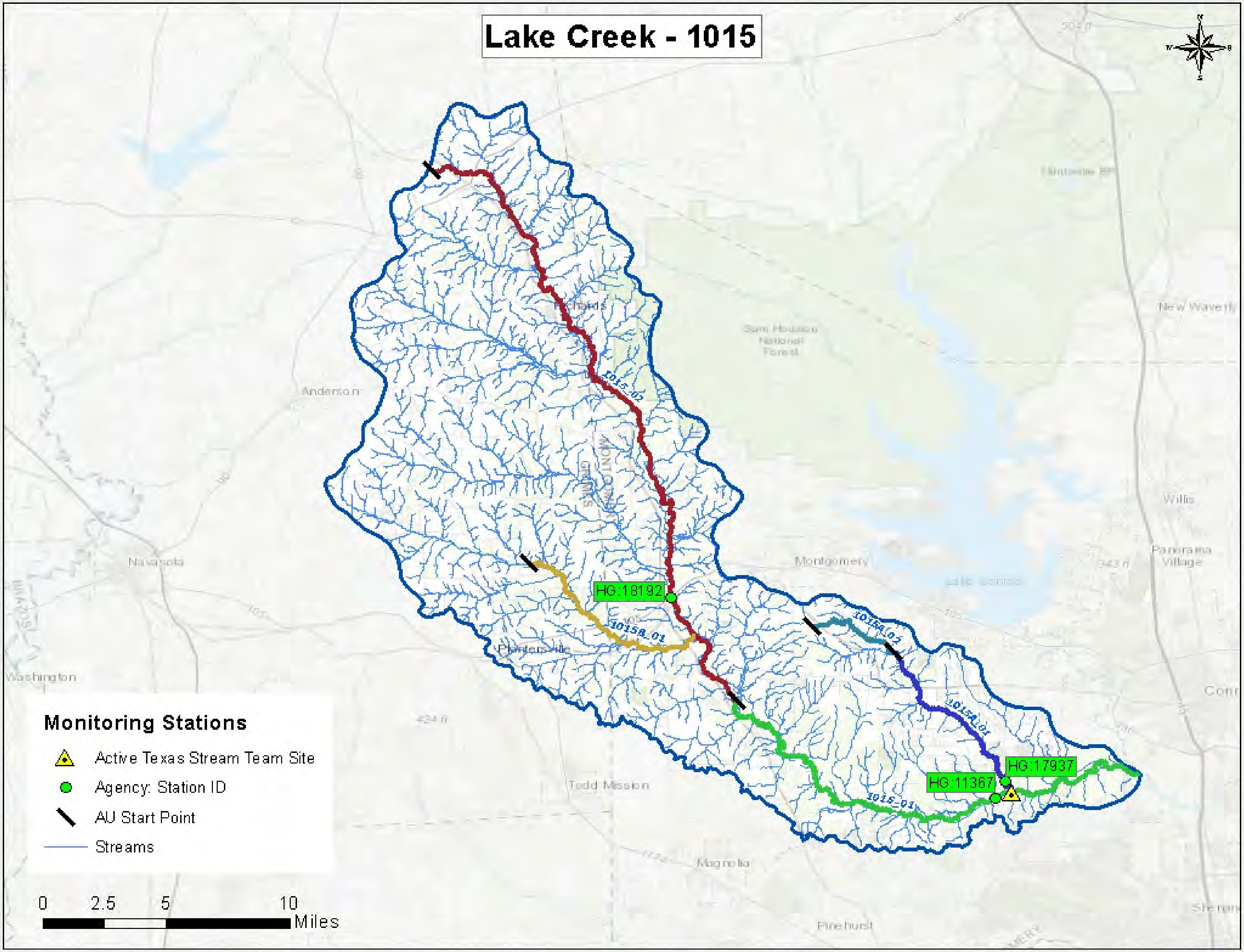
- Segment 1015 (Perennial Stream w/ high ALU): **Lake Creek** (classified water body) – From the confluence with the West Fork San Jacinto River in Montgomery County to a point 4.0 km (2.5 mi) upstream of SH 30 in Grimes County

- Segment 1015A (Perennial Stream w/ high ALU): **Mound Creek** (unclassified water body) – From the Lake Creek confluence upstream to a point 1.1 km (0.69 mi) east of FM 149

- Segment 1015B (Perennial Stream w/ high ALU): **Caney Creek** (unclassified water body) – From the Lake Creek confluence upstream to a point 2.4 km (1.5 mi) south of FM 1774

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11367	1015	LAKE CREEK AT EGYPT COMMUNITY ROAD 8.3 MILES SOUTHWEST OF CONROE	HG	QUARTERLY	Field, Conventional, Bacteria, Flow
18192	1015	LAKE CREEK AT SH 105 NR DOBBIN	HG	QUARTERLY	Field, Conventional, Bacteria, Flow
17937	1015A	MOUND CREEK 167 METERS DOWNSTREAM OF MULLIGAN ROAD 1.35 KM UPSTREAM OF CONFLUENCE WITH LAKE CREEK	HG	QUARTERLY	Field, Conventional, Bacteria, Flow

HG = Houston-Galveston Area Council



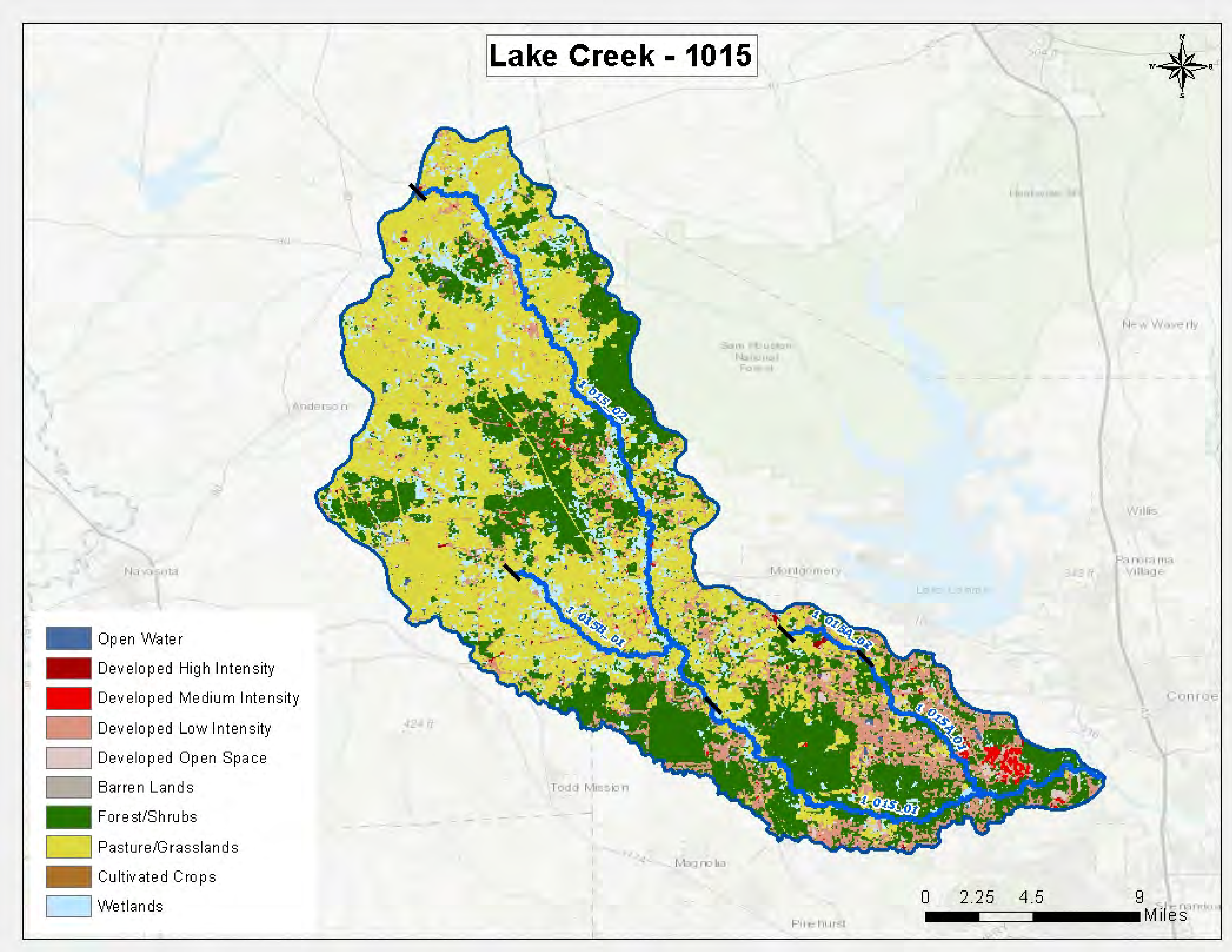
Lake Creek - 1015
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
2.5
5
10
Miles
HG:18192
HG:17937
HG:11367
1015_02
1015_01
1015B_01
1015A_02
1015A_01
Anderson
Navasota
Washington
Plantersville
Todd Mission
Magnolia
Pinehurst
Montgomery
Willis
Panorama Village
New Waverly
Sam Houston National Forest

Segment 1015 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	80		
Sulfate (mg/L as SO_4):	50		
Total Dissolved Solids (mg/L):	300		

Segment Discussion

Watershed Characteristics and Land Cover: Lake Creek (1015) is defined as the confluence with the West Fork San Jacinto River in Montgomery County to a point 4.0 km (2.5 mi) upstream of SH 30 in Grimes County. Major tributaries include Caney, Fish, Garretts, Landrum, Little Caney, and Mound Creeks. The majority of the Lake Creek watershed is rural in nature, dominated by forested lands and grasslands. Agricultural land uses such as pastureland for hay are common throughout the watershed. Between 2008 and 2018, developed land cover has increased from 3.22 percent to 14.84 percent of the watershed. Mixed residential and commercial developments in the form of subdivisions, strip centers, and ranchettes or hobby farms are scattered throughout, particularly in the southern portion of the watershed west of the City of Conroe and I-45 between Hwy 2854 and Hwy 1488. There are a few other pockets of development in the center of the watershed outside of the City of Montgomery, but no major population centers are present in the area. Much of the area utilizes on-site sewage facilities for wastewater treatment.

Segment 1015 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	116,911.18	55.66	84,242.24	40.10	-27.94
Barren Lands	840.65	0.40	256.42	0.12	-69.50
Developed	6,768.55	3.22	31,156.00	14.83	360.31
Forest/Shrubs	52,585.63	25.03	66,669.81	31.74	26.78
Open Water	1,180.24	0.56	1,179.58	0.56	-0.06
Wetlands	31,768.70	15.12	26,551.12	12.64	-16.42
TOTAL	**210,054.94**	**100.00**	**210,055.16**	**100.00**	


Lake Creek - 1015
1015_02
1015B_01
1015A_02
1015A_01
1015_01
Anderson
Navasota
Montgomery
Sam Houston National Forest
New Waverly
Willis
Panorama Village
Conroe
Todd Mission
Magnolia
Pinehurst
Lake Conroe
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
2.25
4.5
9
Miles

Water Quality Issues:

Bacteria Impairments and Concerns
Lake Creek (1015) supports its designated primary contact recreation use. However, Mound Creek (1015A_01) is impaired due to high levels of *E. coli* bacteria.

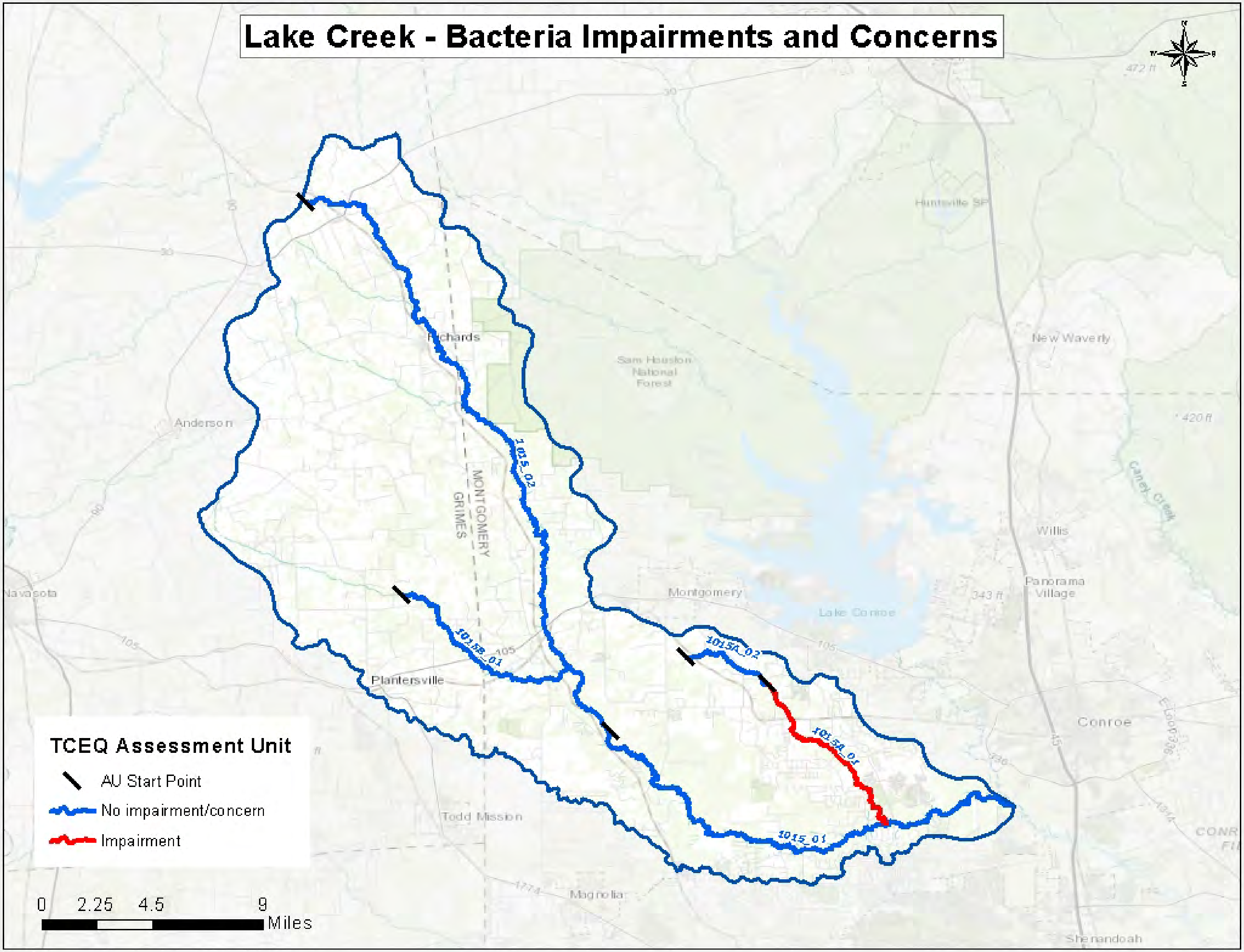
Dissolved Oxygen Impairments and Concerns
In the 2020 Integrated Report, assessment unit 1015_02 was identified as of concern for aquatic life use due to low levels of dissolved oxygen in grab samples. This concern is a carry-forward from a previous assessment.

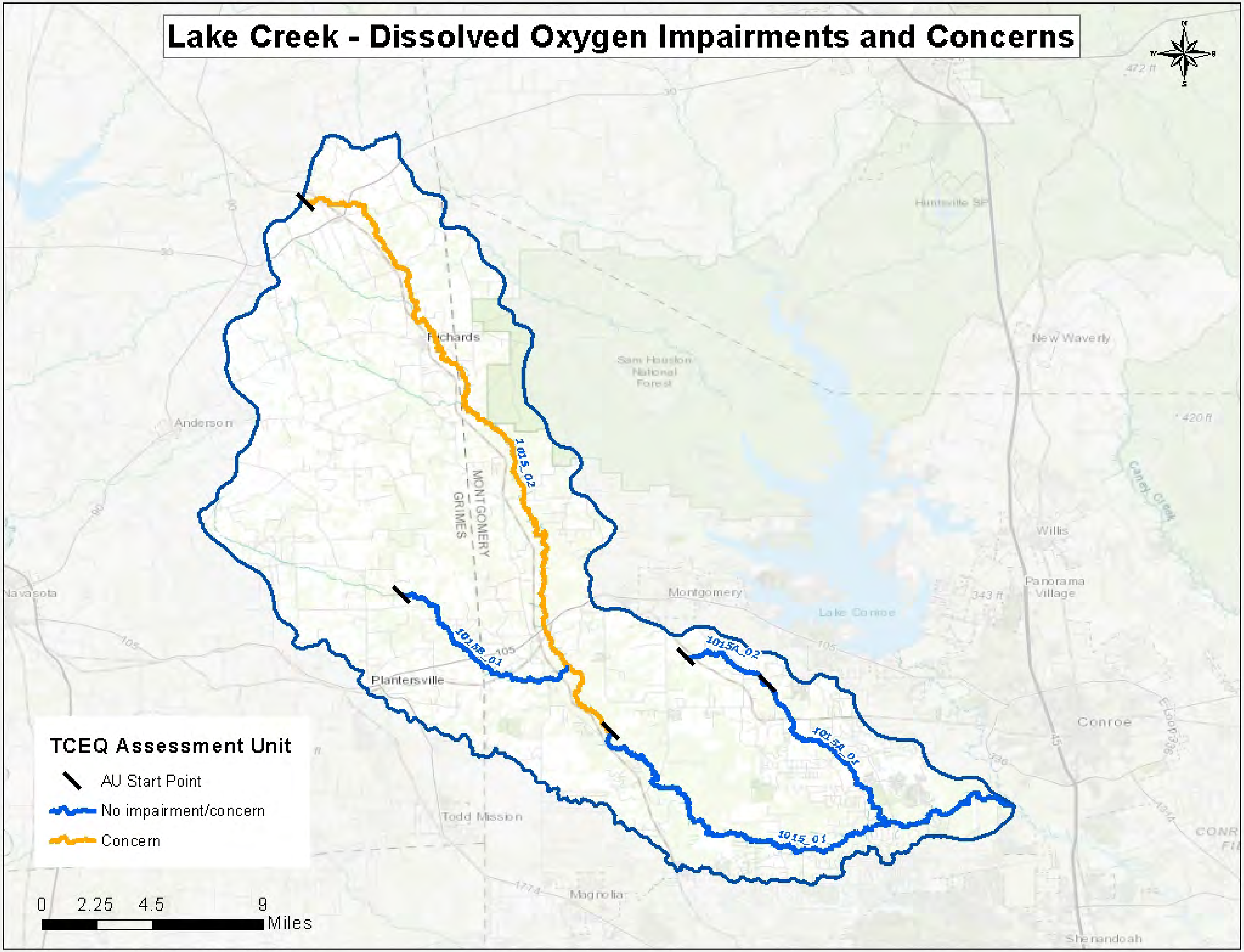
Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Macrobenthic Community Concerns
A concern exists for the macrobenthic community in AU 1015_01.

Lake Creek - Bacteria Impairments and Concerns



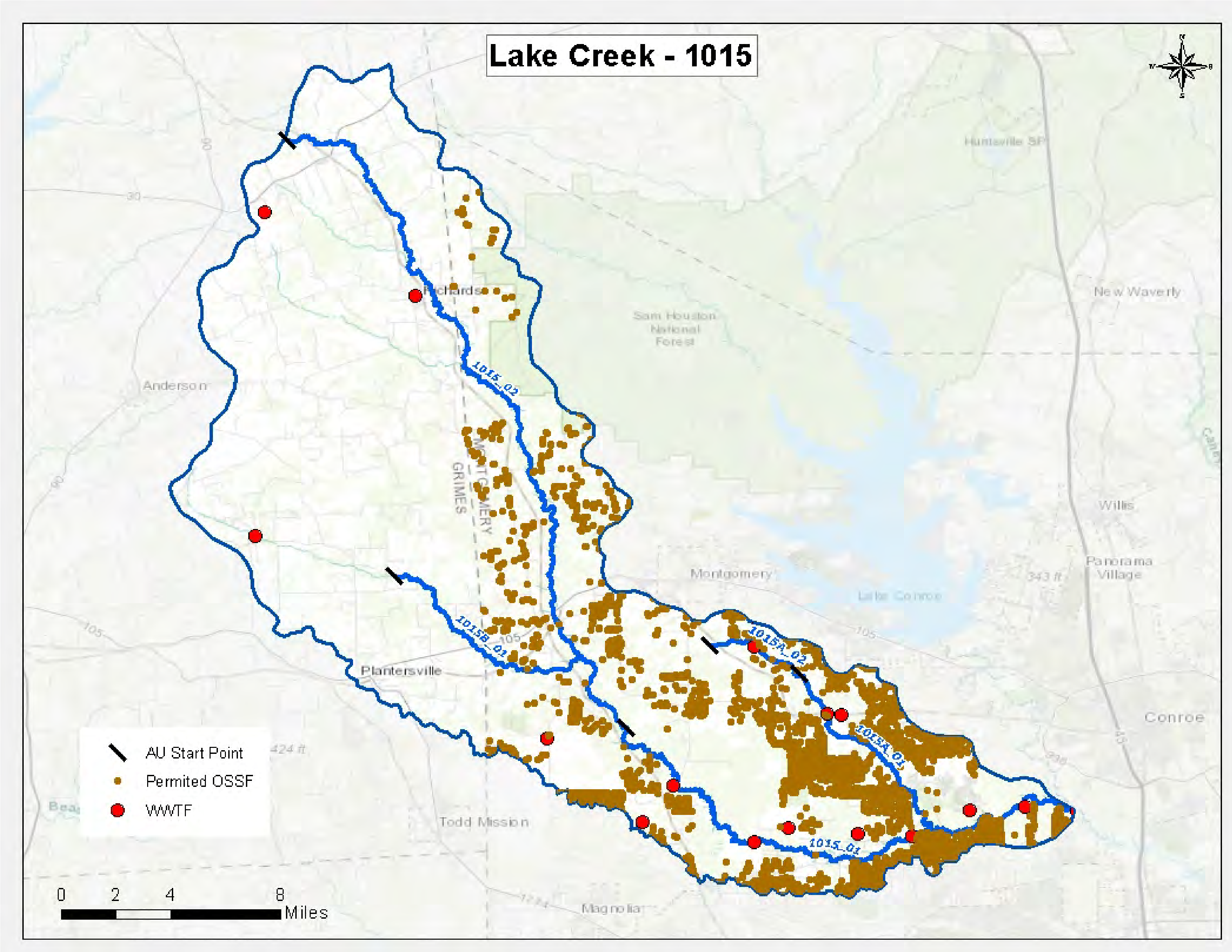

Lake Creek - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
0 2.25 4.5 9 Miles
1015_02
1015B_01
1015A_02
1015A_01
1015_01
Richards
Anderson
Navasota
Plantersville
Todd Mission
Magnolia
Montgomery
Lake Conroe
Sam Houston National Forest
Huntsville SP
New Waverly
Willis
Panorama Village
Conroe
Shenandoah
MONTGOMERY
GRIMES
Caney Creek

Potential Sources of Water Quality Issues: Lake Creek is a rural water body and rural sources of fecal bacteria, such as agriculture and failing on-site sewage systems, are the key sources.

There are 17 permitted wastewater outfalls in the Lake Creek watershed. In most areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 3,863 permitted on-site sewage facilities located within the watershed. The wastewater treatment facilities and on-site sewage facilities in the Lake watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 18 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Lake Creek watershed.



Lake Creek - 1015
AU Start Point
Permited OSSF
WWTF
0 2 4 8
Miles
1015_02
1015B_01
1015A_02
1015A_01
1015_01
Richards
Anderson
Plantersville
Todd Mission
Magnolia
Montgomery
Lake Conroe
Sam Houston National Forest
Huntsville SP
New Waverly
Willis
Panorama Village
Conroe
GRIMES
MONTGOMERY

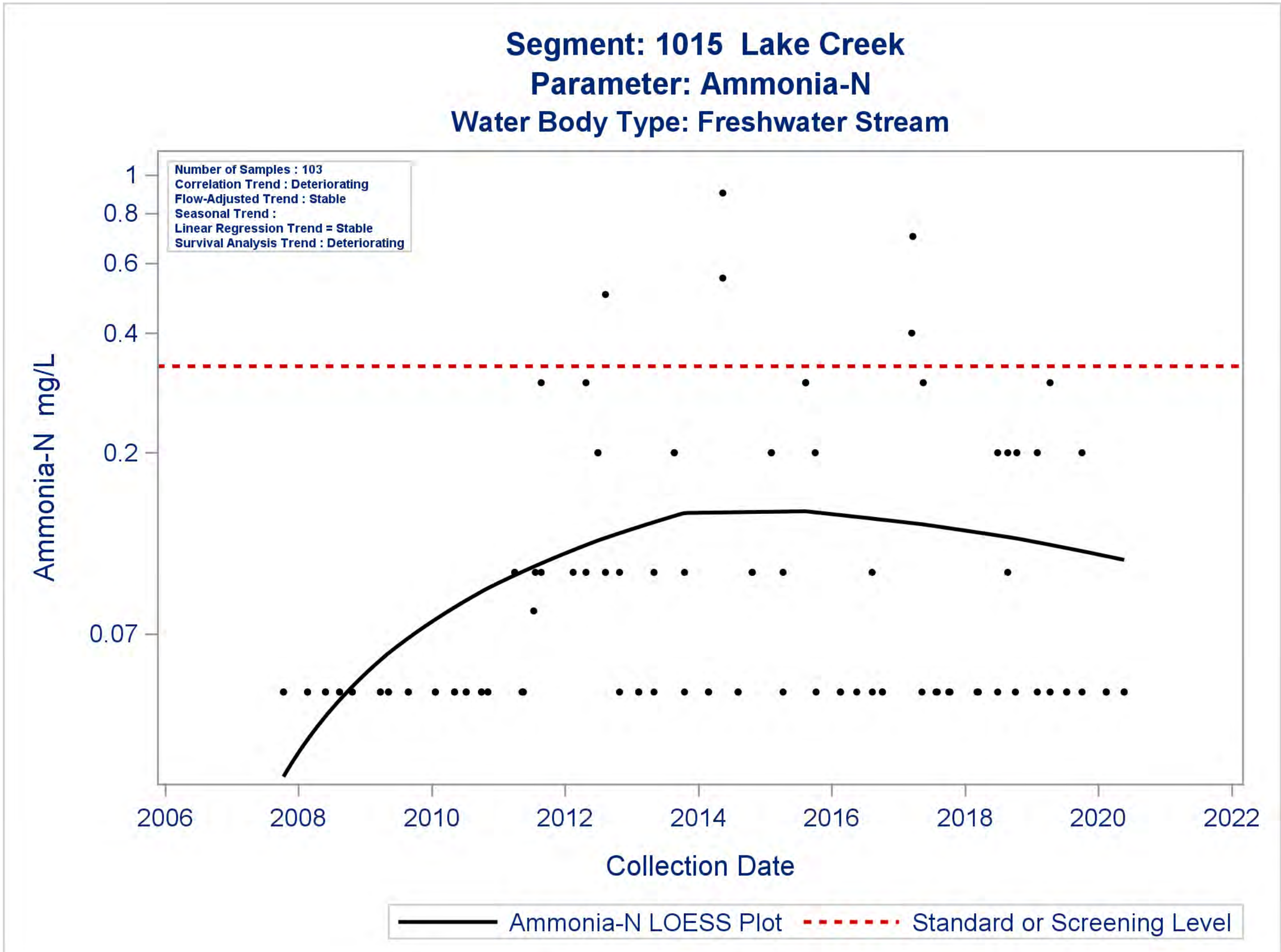
Trend Analysis:

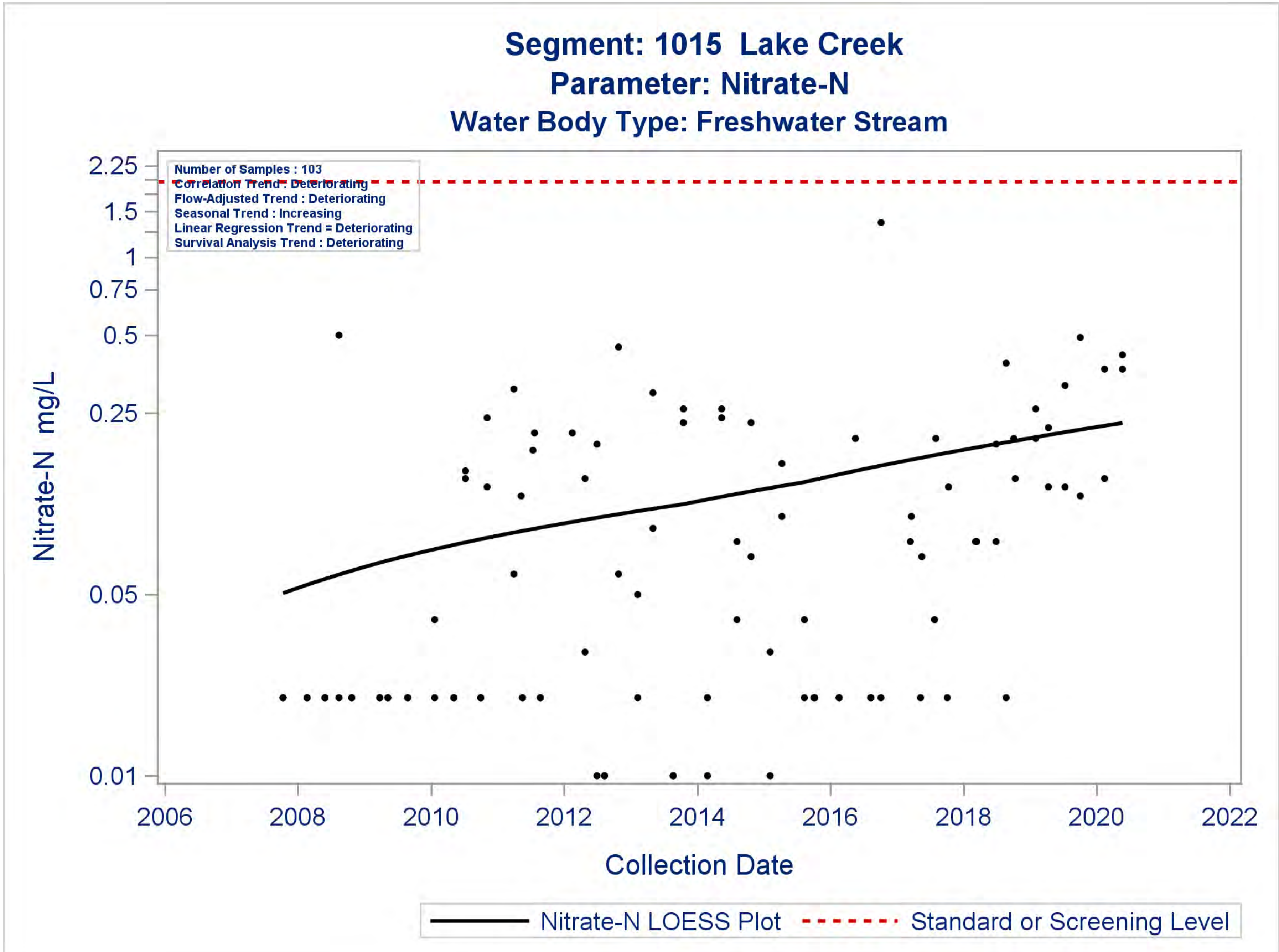
Regression analysis on existing data for the main segment revealed eight significant parameter trends in the system, with six on the main stem and four on 1015A (Mound Creek). On 1015, notable trends include a slight increase in ammonia overall, increases in nitrate and TSS, and decreases in sulfate, TKN and Secchi depth. *E. coli* trends were generally stable in the system, which is part of an approved watershed protection plan in conjunction with segment 1004 (West Fork San Jacinto River).

Notable trends in 1015A include increasing flow, nitrate and specific conductance values, and decreasing TKN.

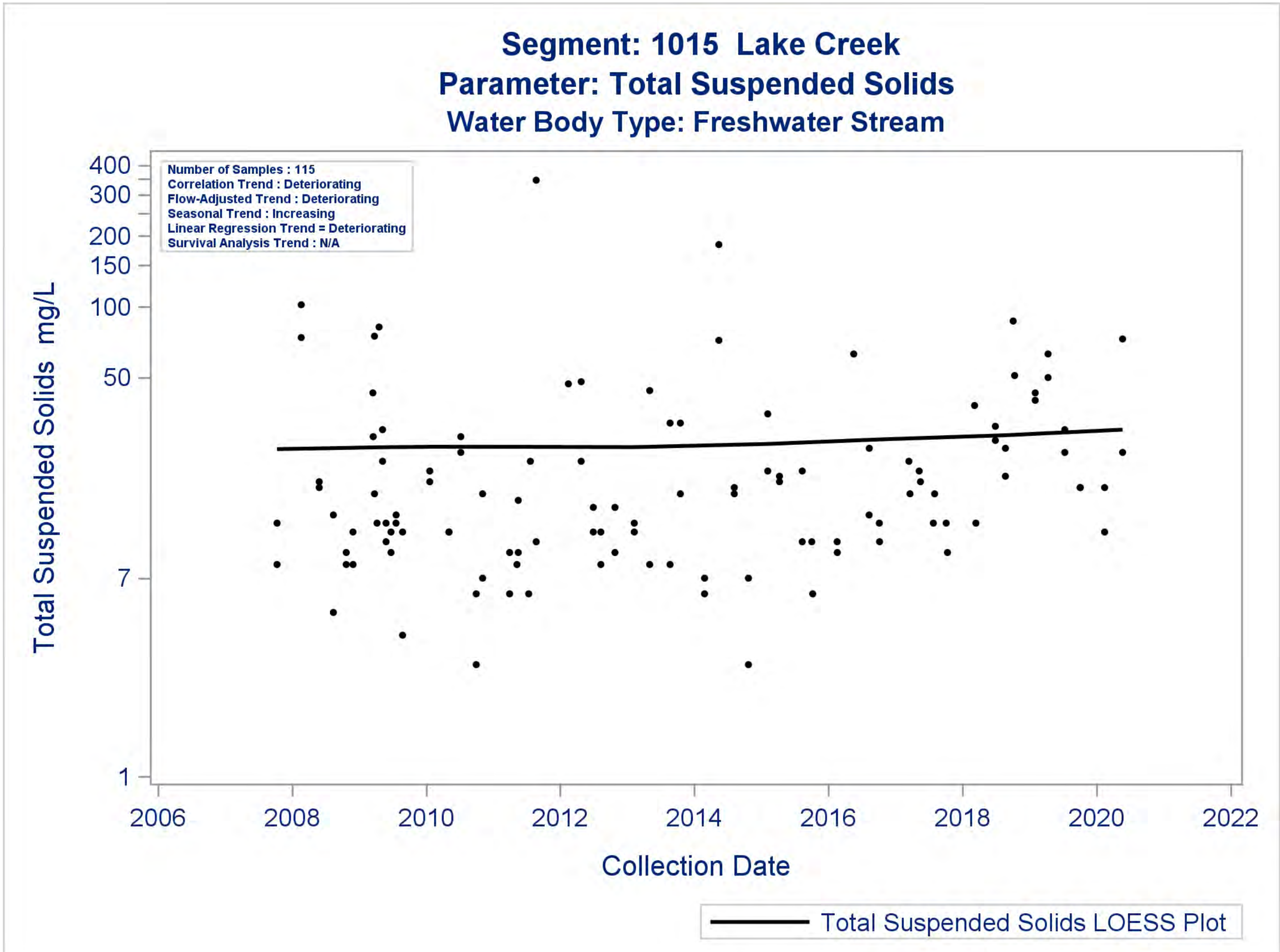
While DO and *E. coli* are statistically stable overall throughout the system, the former has variability across stations, and the latter still has regular instances in which measurements exceed the surface water quality standard, sometimes by significant amounts.

Runoff from agricultural land uses in the upper portion of the watershed as well as upstream WWTF discharges are likely factors contributing to variations in DO and nutrients in area waterways. Increasing development moving west from existing urban centers and along transportation corridors is likely an exacerbating factor in conditions, especially in downstream stations.

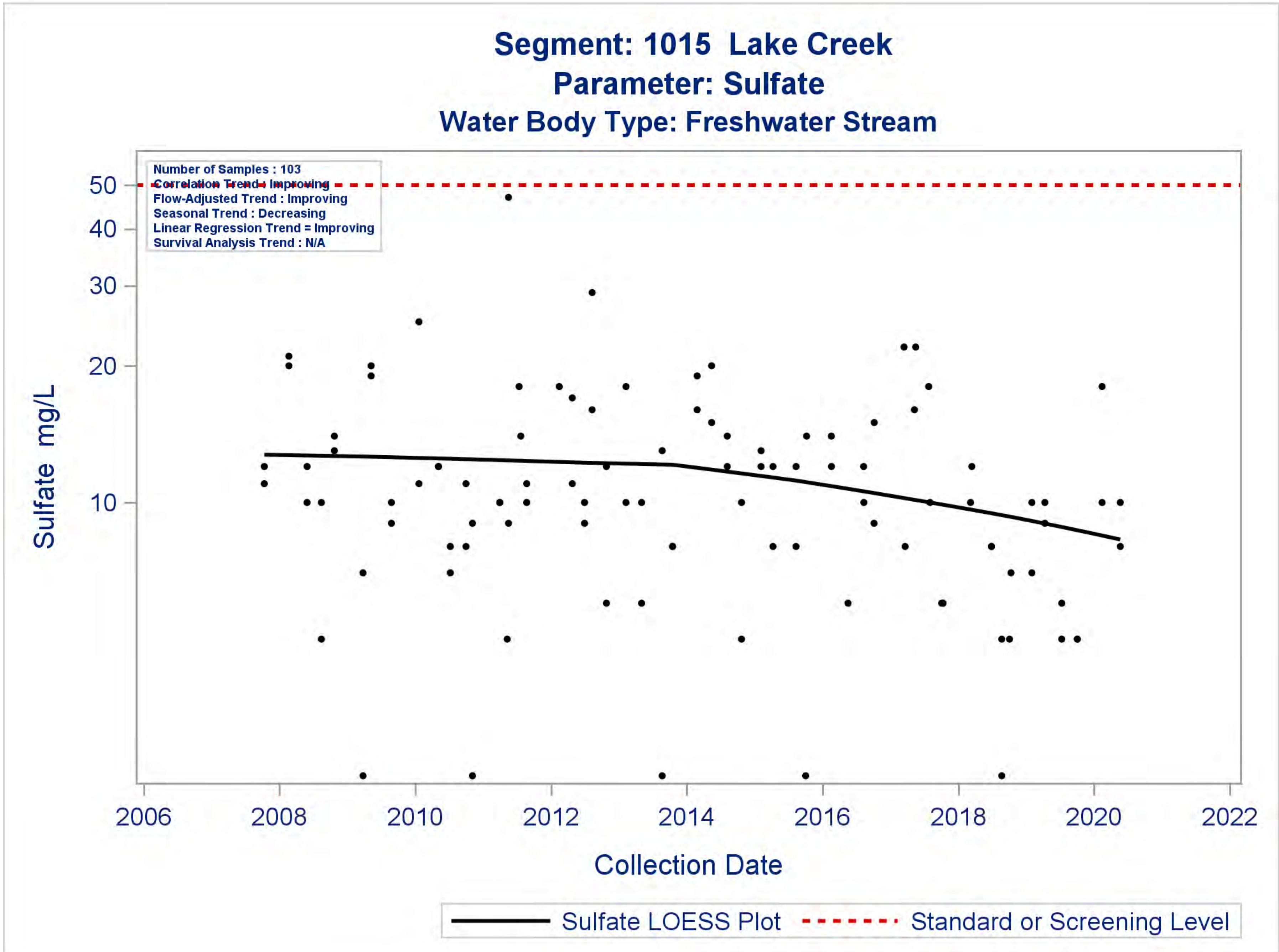

Segment: 1015 Lake Creek
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 103
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend :
Linear Regression Trend = Stable
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
1
0.8
0.6
0.4
0.2
0.07
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level



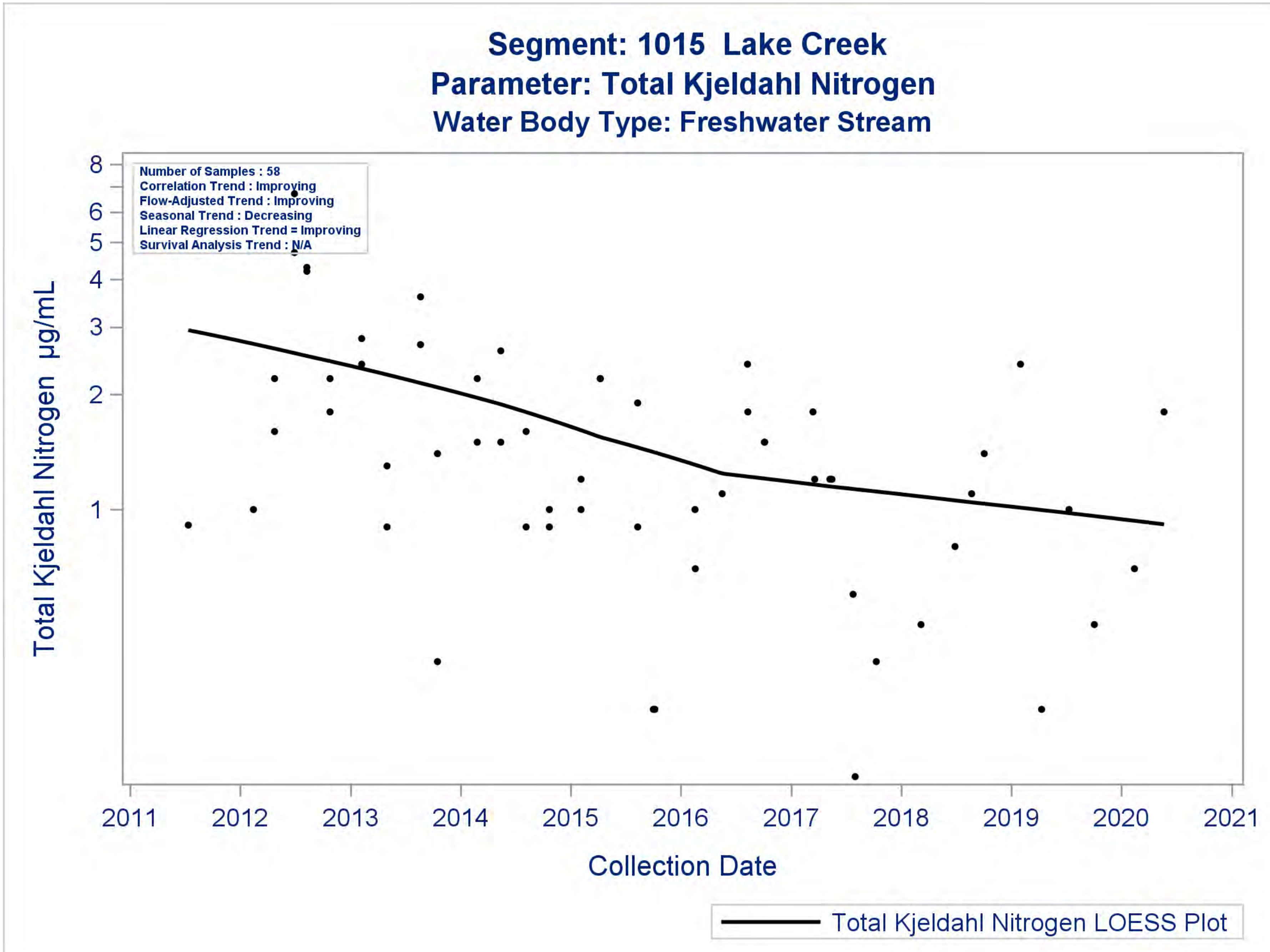
Segment: 1015 Lake Creek
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 103
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
2.25
1.5
1
0.75
0.5
0.25
0.05
0.01
Nitrate-N mg/L
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

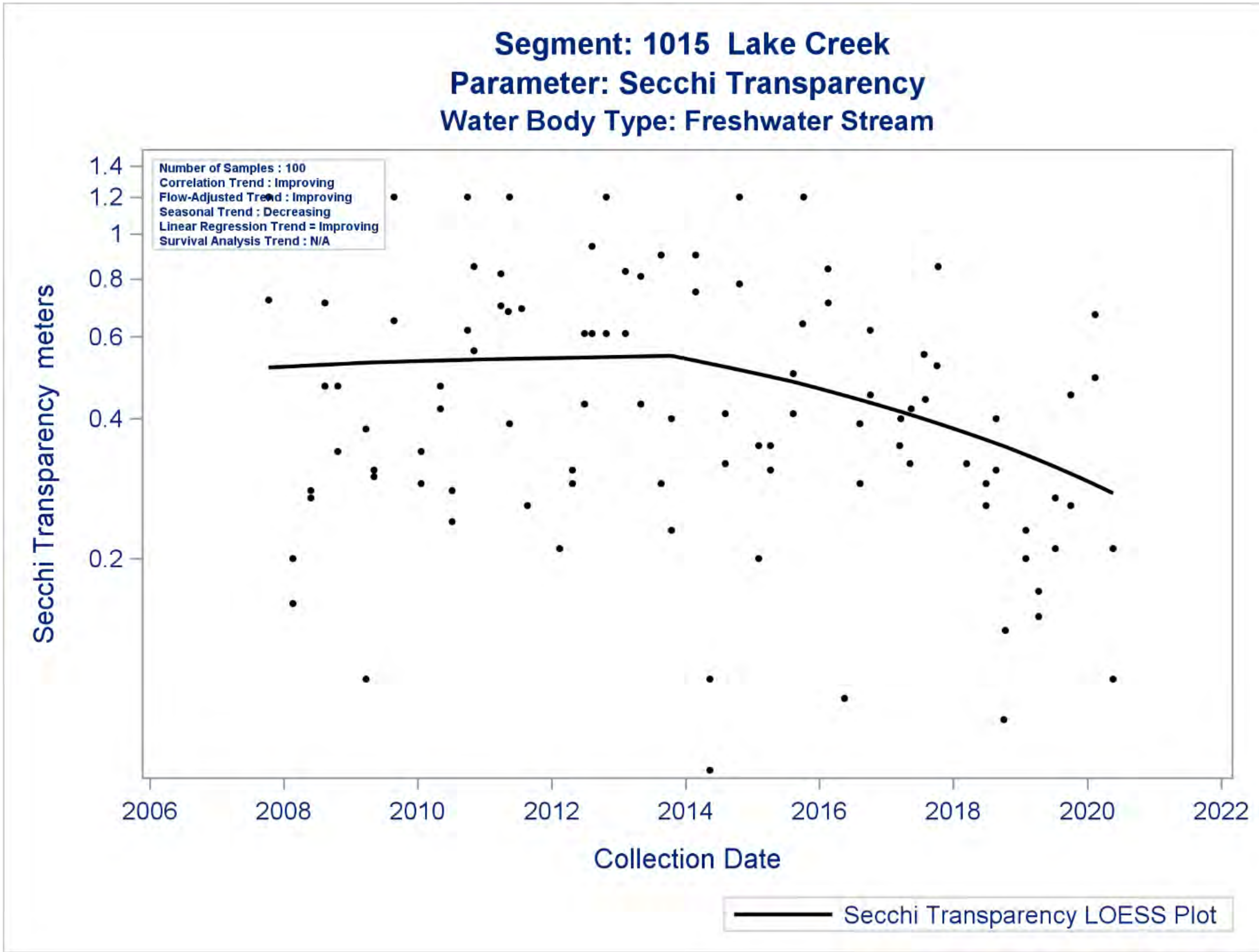


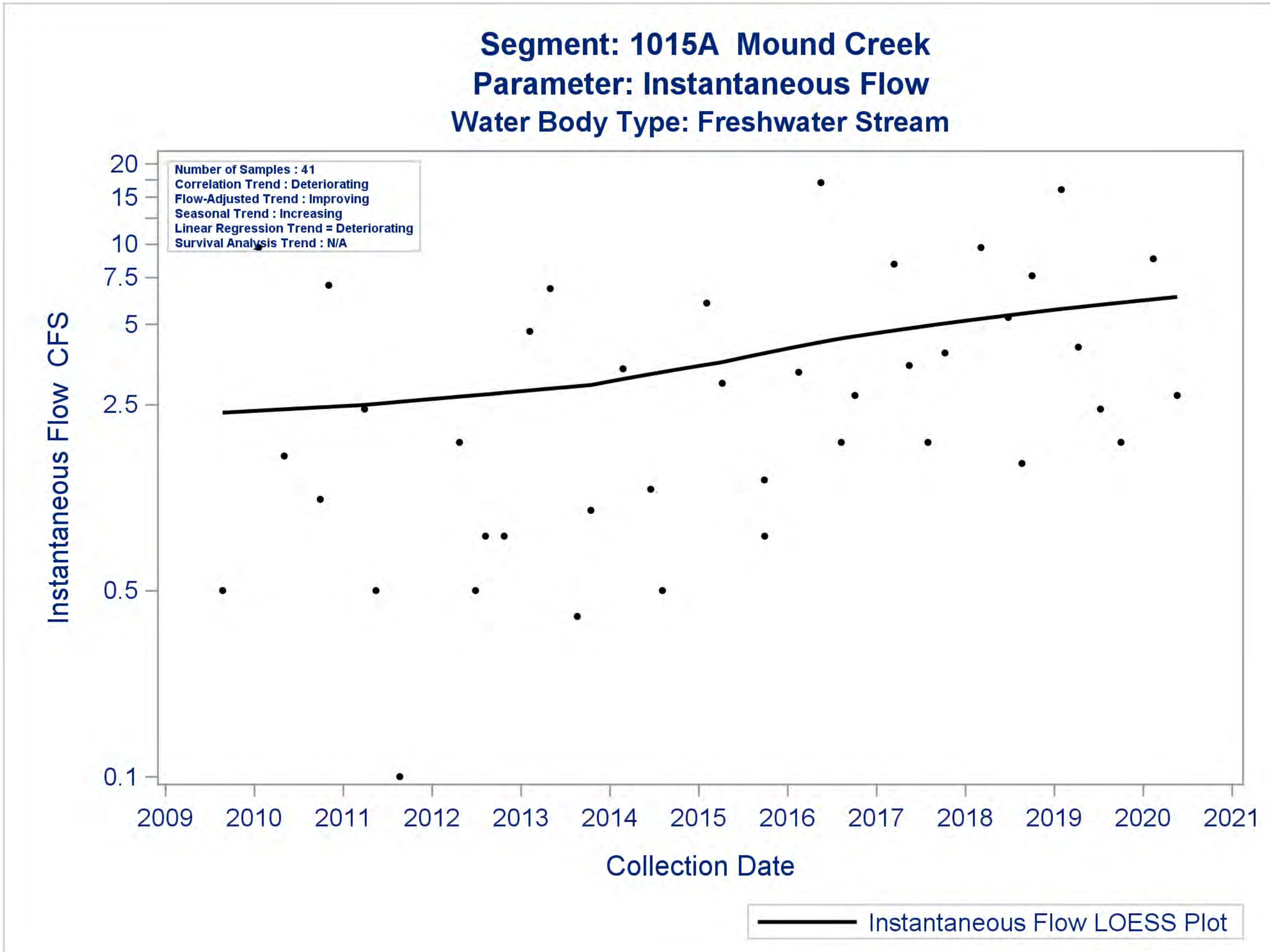
Segment: 1015 Lake Creek
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 115
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
400
300
200
150
100
50
7
1
Total Suspended Solids mg/L
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot



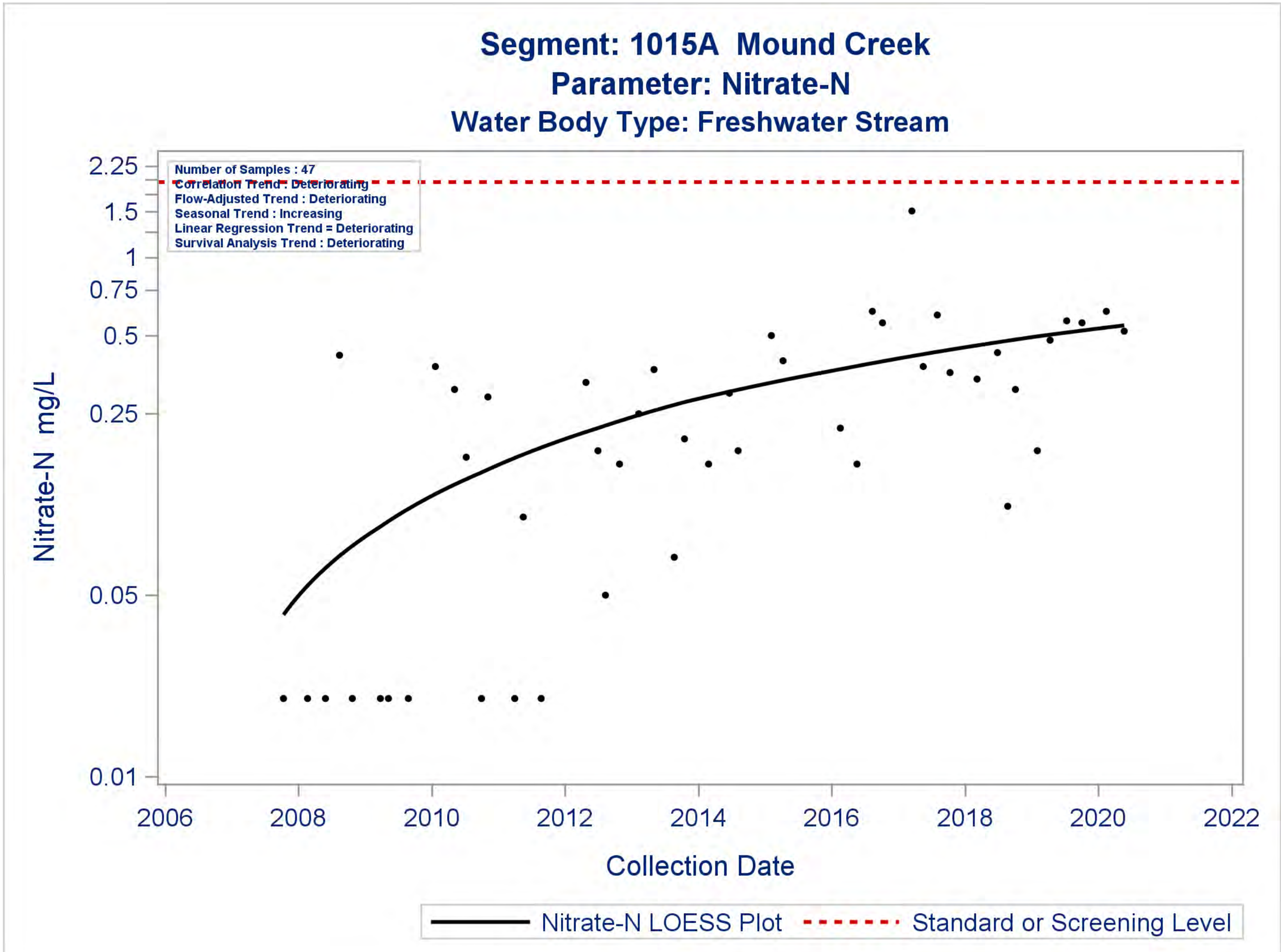
Segment: 1015 Lake Creek
Parameter: Sulfate
Water Body Type: Freshwater Stream
Number of Samples : 103
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
50
40
30
20
10
Sulfate mg/L
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Sulfate LOESS Plot
Standard or Screening Level

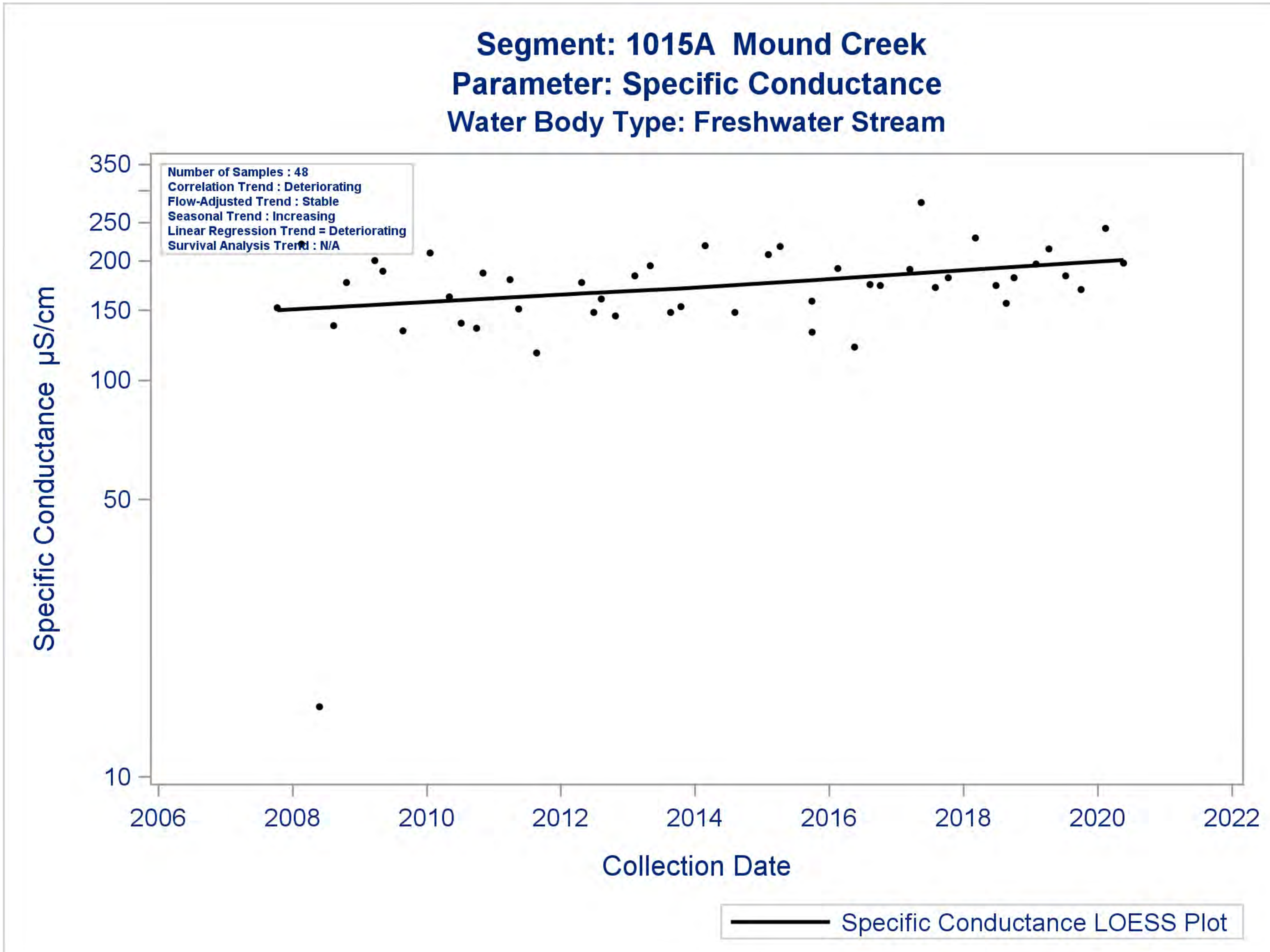

Segment: 1015 Lake Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 58
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
8
6
5
4
3
2
1
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot

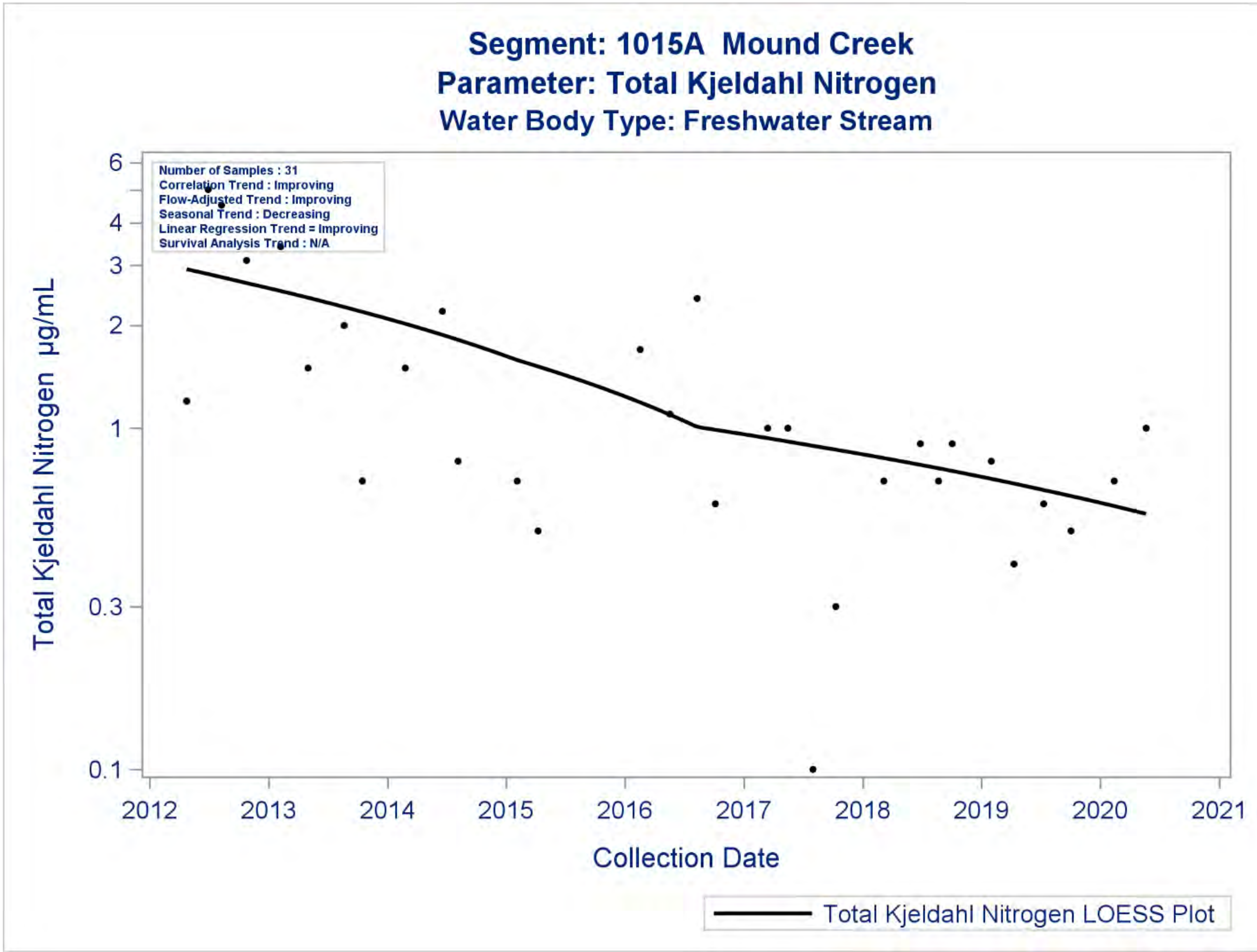

Segment: 1015 Lake Creek
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 100
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.4
1.2
1
0.8
0.6
0.4
0.2
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot



Segment: 1015A Mound Creek
Parameter: Instantaneous Flow
Water Body Type: Freshwater Stream
Number of Samples : 41
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Improving
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Instantaneous Flow CFS
20
15
10
7.5
5
2.5
0.5
0.1
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Instantaneous Flow LOESS Plot


Segment: 1015A Mound Creek
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 47
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
2.25
1.5
1
0.75
0.5
0.25
0.05
0.01
Nitrate-N mg/L
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level


Segment: 1015A Mound Creek
Parameter: Specific Conductance
Water Body Type: Freshwater Stream
Number of Samples : 48
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Specific Conductance µS/cm
350
250
200
150
100
50
10
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot


Segment: 1015A Mound Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 31
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
6
4
3
2
1
0.3
0.1
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1015A I	• Improper or no pet waste disposal • WWTF non-compliance, overflows, and collection system by-passes • Runoff from agricultural areas in the upper portion of the watershed • Malfunctioning OSSFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, and grease disposal; and OSSF maintenance • Regionalize wastewater treatment to minimize number of small package plants and reduce OSSF dependency • Work with farmers to optimize fertilization practices and reduce runoff
Low Dissolved Oxygen Concentrations	1015_02 C	▪ Eutrophication of streams due to agricultural activities, especially in the upper portion of the watershed ▪ Excessive nutrients and organic matter from WWTF effluent, sanitary sewer overflows, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste, such as grass clippings and pet waste ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water • Improve compliance and enforcement of existing stormwater quality permits • Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste, household fats, oils, and grease disposal, and OSSF maintenance • Regionalize wastewater treatment to minimize number of small package plants and reduce OSSF dependency • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating • Work with farmers to optimize fertilization practices and avoid nutrients runoff
Macrobenthic Community	1015C_01 I	• Bank erosion causing increased suspended sediment • Erosion from agricultural properties	• Detrimental to the aquatic biological community	• Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat • Install and maintain silt fencing and other BMPs to minimize sediment laden runoff

Special Studies:

The Lake Creek watershed is a part of the Bacteria Implementation Group (BIG**).** Lake Creek is also included in the West Fork San Jacinto River and Lake Creek Watershed Protection Plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation and coordination.
- Continue collecting water quality data to evaluate the effectiveness of solutions associated with the watershed protection plan and TMDL.
- Continue to work with the BIG and West Fork Watersheds Partnership to implement the I-Plan and WPP recommendations for bacteria reduction and other water quality concerns.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and watershed protection plan
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Promote voluntary conservation and urban forestry projects
- Coordinate efforts with ongoing flood management projects

Segment Number: 1002		Name: Lake Houston			
Length:	23 miles	**Watershed Area:**	279 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	13	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	12

DESCRIPTION

- Segment 1002 (Reservoir): **Lake Houston** (classified water body) – From Lake Houston Dam in Harris County to the confluence of Spring Creek on the West Fork San Jacinto arm in Harris/Montgomery County and to the confluence of Caney Creek on the East Fork San Jacinto arm in Harris County, up to the normal pool elevation of 44.5 feet (impounds San Jacinto River)

- Segment 1002A (Perennial Stream w/ intermediate ALU): **Tarkington Bayou** (unclassified water body) – From the Luce Bayou confluence upstream to a point just upstream of FM 2025 in Liberty County

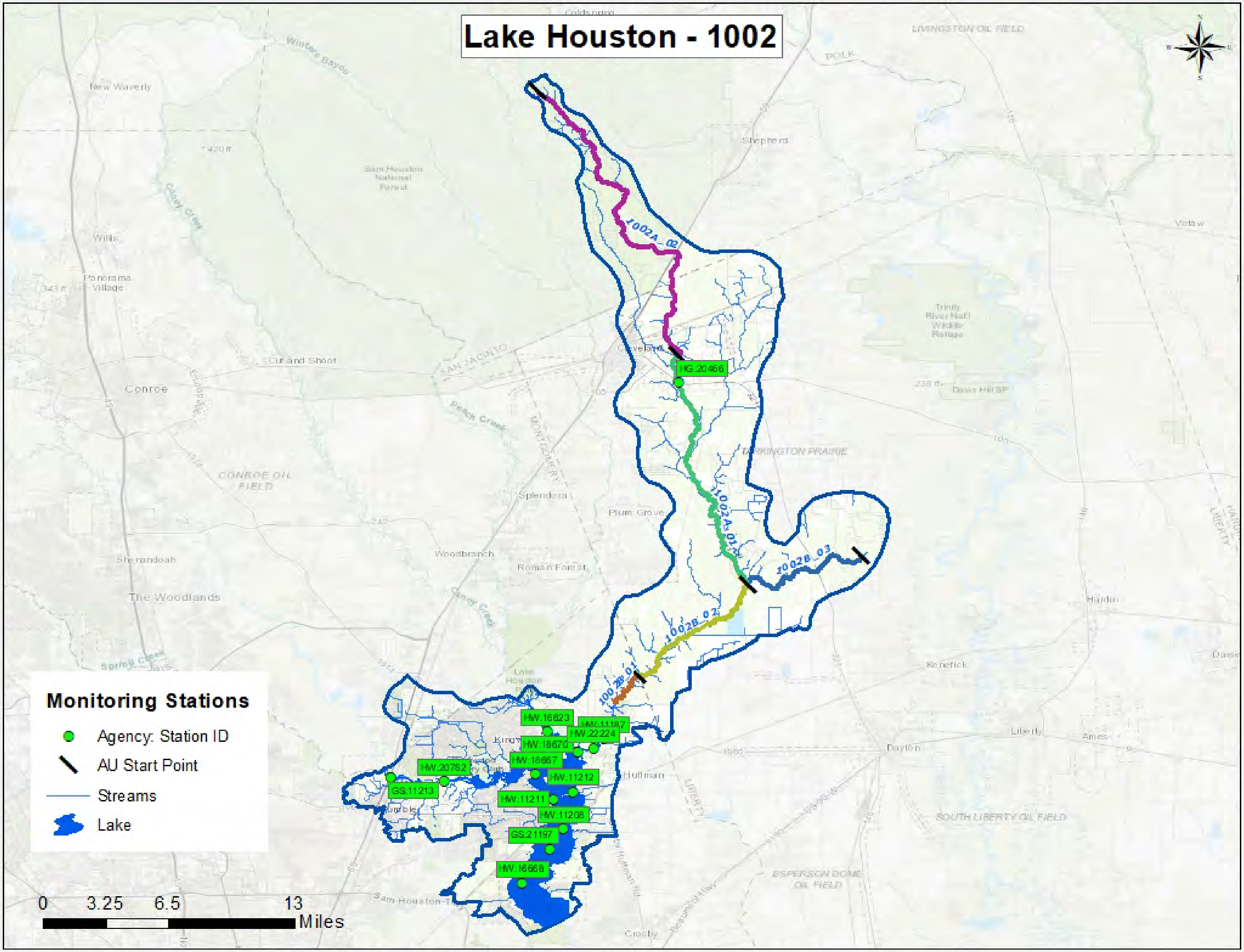
- Segment 1002B (Perennial Stream w/ minimal ALU): **Luce Bayou** (unclassified water body) – From confluence with Lake Houston (Harris County) to FM 1008 (Liberty County)

- Segment 1002C (Reservoir): **Lake Isabell** (unclassified water body) – Small lake located at the southern end of Lake Houston Park northeast of the Caney Creek (segment 1010) and East Fork of the San Jacinto River (segment 1003) confluence in Harris County

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11204	1002	LAKE HOUSTON NEAR DAM 652 METERS NORTH AND 226 METERS WEST OF INTERSECTION OF RIVER TRAIL AND EISENHOWER PARK	FO	ONE/YEAR TWO/YEAR QUARTERLY	Metals in Water Metals in Sediment, Organics in Sediment Field, Conventional, Bacteria
11208	1002	LAKE HOUSTON NORTH SIDE OF MISSOURI PACIFIC RAILROAD BRIDGE 137 METERS SOUTH AND 1.36 KM WEST OF INTERSECTION OF PINO LN AND SUNOCO RD	HW	MONTHLY	Field, Conventional, Bacteria
11211	1002	LAKE HOUSTON AT FM 1960 WEST END PASS BRIDGE 269 M N AND 731 M E OF INTERSECTION OF ATASCOCITA SHORES AND FM 1960/CITY HO SITE 9	HW	MONTHLY	Field, Conventional, Bacteria
11212	1002	LAKE HOUSTON AT FM 1960 EAST END PASS BRIDGE 235 M S AND 950 M WEST OF INTERSECTION OF FM 1960 AND FAIRLAKE LANE/CITY HO SITE 13	HW	MONTHLY	Field, Conventional, Bacteria
11213	1002	LAKE HOUSTON WEST FORK SAN JACINTO ARM AT US 59 525 METERS SOUTH AND 150 METERS WEST OF INTERSECTION OF HAMBLEN ROAD AND US 59	FO	QUARTERLY	Field, Conventional, Bacteria, Flow
16623	1002	LAKE HOUSTON 90 M S AND 349 M W OF INTERSECTION OF MAGNOLIA PT DR AND DIAMOND WAY CANEY CREEK ARM IN HOUSTON	HW	MONTHLY	Field, Conventional, Bacteria
16668	1002	LK HOUSTON W OF LK SHADOWS SUBDIVISION MID LAKE NW OF HOUSTON 2.09 KM N AND 1.38 KM E OF INTERSECT OF LK HOUSTON PKWY AND DITE CAYLIN	HW	MONTHLY	Field, Conventional, Bacteria
16668	1002	LK HOUSTON W OF LK SHADOWS SUBDIVISION MID LAKE NW OF HOUSTON 2.09 KM N AND 1.38 KM E OF INTERSECT OF LK HOUSTON PKWY AND DITE CAYLIN	FO	QUARTERLY	Field, Conventional, Bacteria
18667	1002	LAKE HOUSTON IN THE WEST FORK SAN JACINTO RIVER CHANNEL 270 M EAST AND 60 M NORTH OF MISTY COVE AT ATASCOCITA PLACE DR	HW	MONTHLY	Field, Conventional, Bacteria
18670	1002	LAKE HOUSTON/LUCE BAYOU 123 M NORTH AND 188 M WEST OF LAKEWATER DR AT WATERWOOD DR IN WATER WONDERLAND SUBDIVISION IN HARRIS COUNTY	HW	MONTHLY	Field, Conventional, Bacteria
20782	1002	LAKE HOUSTON WEST FORK SAN JACINTO RIVER ARM UNDER POWER LINES 567 METERS EAST AND 538 METERS	HW	MONTHLY	Field, Conventional, Bacteria

		NORTH FROM THE INTERSECTION OF BELLEAU WOOD DRIVE AND SOUTHSHORE DRIVE IN HOUSTON			
22224	1002	LUCE BAYOU 224 METERS NORTHWEST OF END OF CRY BABY LANE IN HUFFMAN	HW	BIMONTHLY	Field, Conventional, Bacteria
20466	1002A	TARKINGTON BAYOU AT SH 105/SH 321 SOUTHEAST OF CLEVELAND	HG	QUARTERLY	Field, Conventional, Bacteria, Flow
11187	1002B	LUCE BAYOU/SAN JACINTO RIVER EAST FORK AT HUFFMAN-NEW CANEY ROAD	HW	BIMONTHLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HG = Houston-Galveston Area Council
HW = Houston Water Quality Control



Lake Houston - 1002
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
Lake
1002A_02
1002A_01
1002B_03
1002B_02
1002B_01
HG:20466
HW:16623
HW:11187
HW:22224
HW:18670
HW:18667
HW:20782
GS:11213
HW:11212
HW:11211
HW:11208
GS:21197
HW:16668
0
3.25
6.5
13
Miles

Segment 1002 Water Quality Standards and Screening Levels					
Standards	**Reservoir**	**Perennial Stream**	**Screening Levels**	**Reservoir**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	32 / 90	Ammonia (mg/L):	0.11	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	4.0 / 2.0	Nitrate-N (mg/L):	0.37	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0 / 1.5	Orthophosphate Phosphorus (mg/L):	0.05	0.37
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus (mg/L):	0.20	0.69
E. coli (MPN/100 mL) (grab):	399	399	Chlorophyll *a* (µg/L):	26.7	14.1
E. coli (MPN/100 mL) (geometric mean):	126	126			
Chloride (mg/L as Cl):	100	100			
Sulfate (mg/L as SO_4):	50	50			
Total Dissolved Solids (mg/L):	400	400			

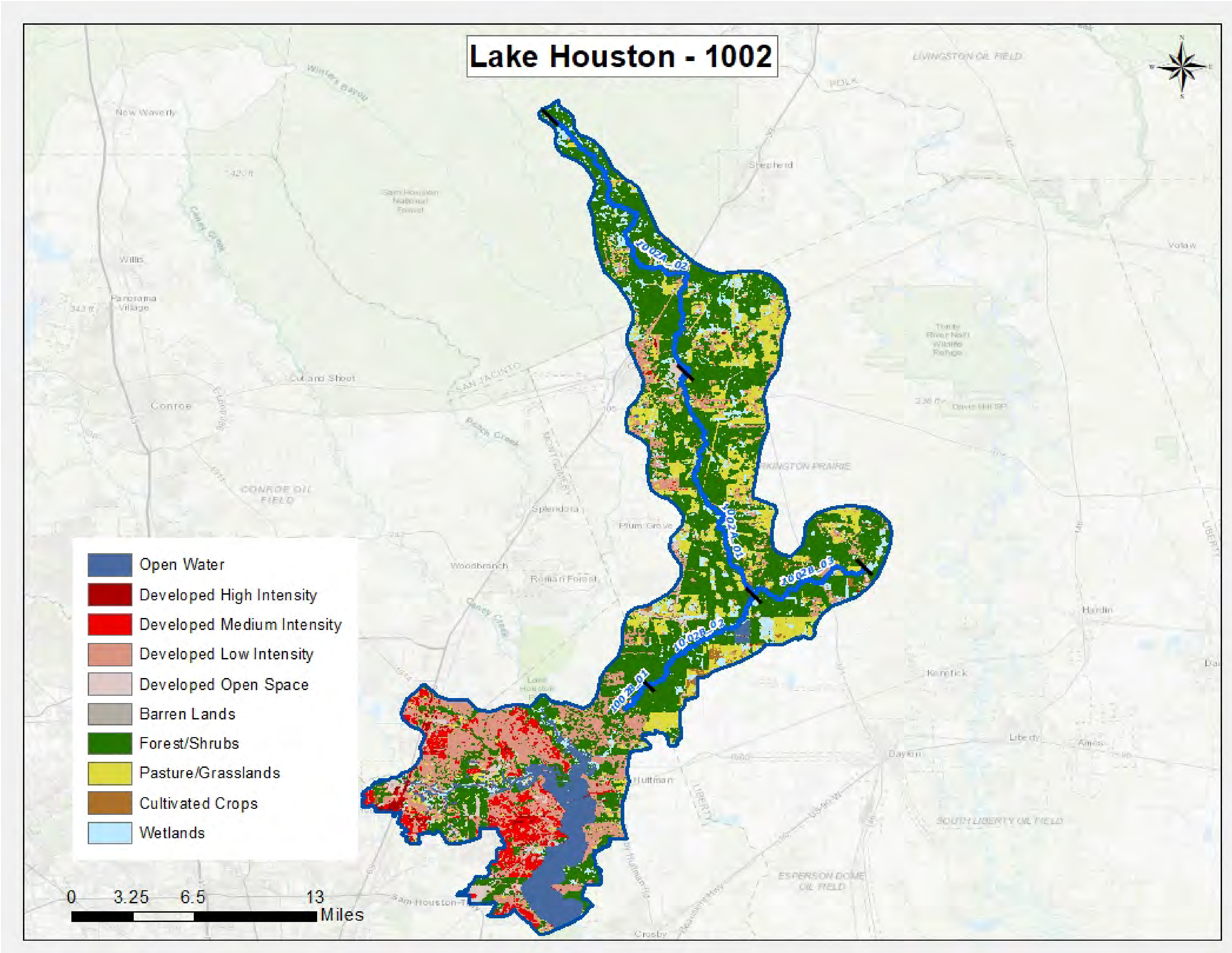
Segment Discussion

Watershed Characteristics and Land Cover: Lake Houston (1002) is a large reservoir located in northeast Harris County. It is the primary source of drinking water for the City of Houston and surrounding communities. The lake receives in-flow from the East Fork and West Fork San Jacinto River as well as their numerous tributaries. Luce Bayou, which receives flow from Tarkington Bayou, is the third major tributary of the lake.

The watershed area for Lake Houston covers approximately 178,400 acres, with Forest/Shrubs being the predominant land cover type (81,109 acres, or 45.46 percent, in 2018). Approximately a quarter of the area is developed. The west fork of Lake Houston is highly urbanized with the communities of Humble, Kingwood, and Atascocita covering most of the western portion of the watershed. Smaller developments are located on the southwest and eastern shores primarily near FM1960 with smaller subdivisions scattered throughout the area surrounding Lake Houston. The City of Cleveland lies in the upper Tarkington Bayou watershed. Luce and Tarkington Bayous flow primarily through undeveloped forested lands and discharge into Lake Houston from the north. Agricultural operations are slowly encroaching on Luce and Tarkington Bayous as the forest is cleared. Grass, hay, and low-density cattle ranching are the most common agricultural operations.

Segment 1002 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	30,545.53	17.12	25,495.20	14.29	-16.53
Barren Lands	874.67	0.49	1,001.88	0.56	14.54
Developed	29,287.45	16.42	42,736.04	23.95	45.92
Forest/Shrubs	67,241.81	37.69	81,108.71	45.46	20.62
Open Water	12,764.28	7.15	11,076.98	6.21	-13.22
Wetlands	37,690.59	21.13	16,990.20	9.52	-54.92
TOTAL	**178,404.33**	**100.00**	**178,409.00**	**100.00**	



Lake Houston - 1002
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
3.25
6.5
13
Miles
1002A_02
1002A_01
1002B_03
1002B_02
1002B_01
New Waverly
Willis
Panorama Village
Conroe
Cut and Shoot
CONROE OIL FIELD
Splendora
Plum Grove
Woodbranch
Roman Forest
Shepherd
LIVINGSTON OIL FIELD
Votaw
Hardin
Kenefick
Liberty
Ames
Dayton
Huffman
Crosby
SOUTH LIBERTY OIL FIELD
ESPERSON DOME OIL FIELD
SAN JACINTO
MONTGOMERY
LIBERTY
POLK
Winters Bayou
Peach Creek
Caney Creek

Water Quality Issues:

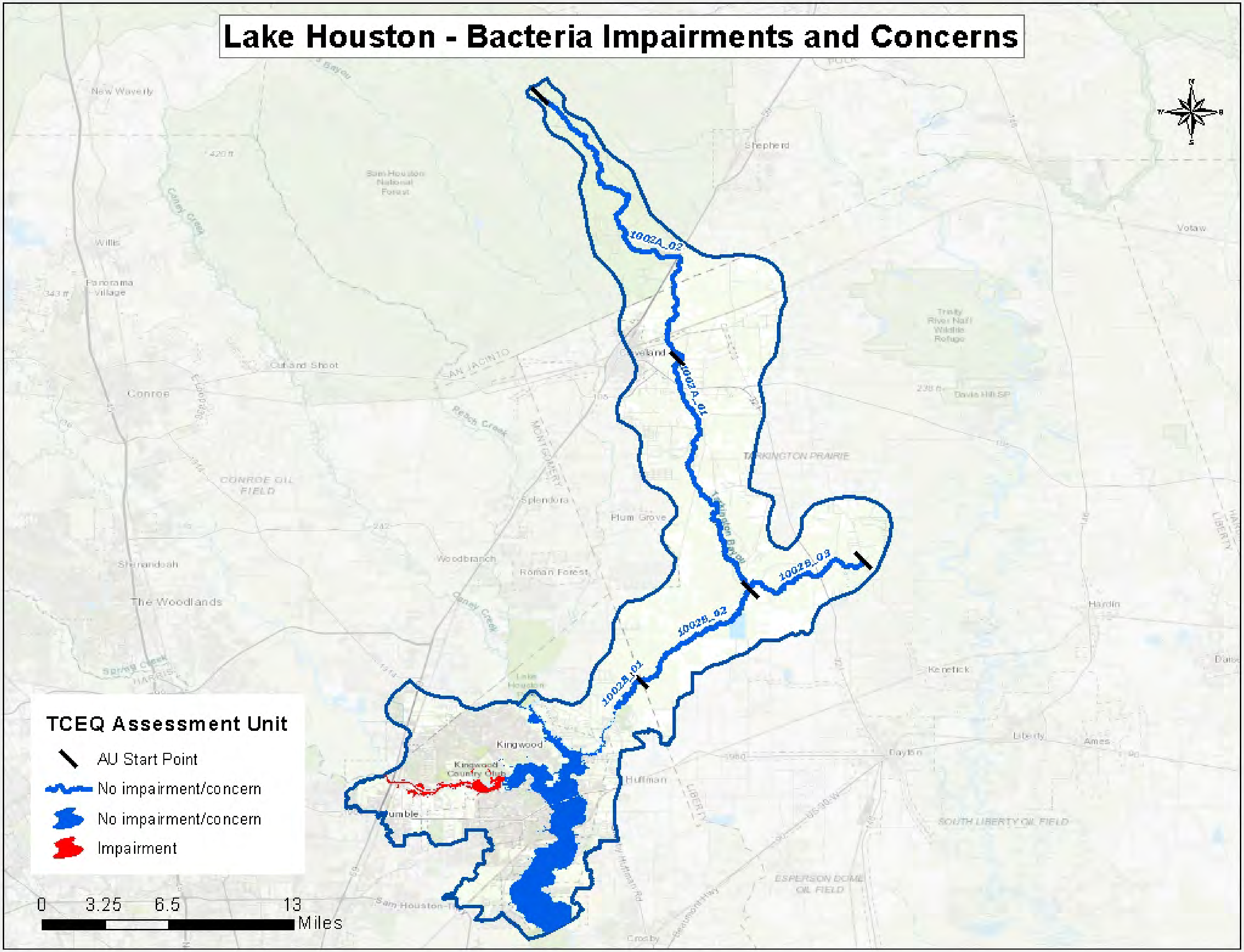
Bacteria Impairments and Concerns
Recreation use is not supported in AU 1002_06, which is the portion of the segment from the confluence with Spring Creek downstream to the West Lake Houston Parkway. The 2020 assessment found a geometric mean of 151.20 MPN/100 mL based on 106 results from the period 12/01/11 – 11/30/18. There were no other bacteria impairments or concerns in this watershed.

Dissolved Oxygen Impairments and Concerns
A concern for dissolved oxygen was identified in Tarkington Bayou (1002A_01). Depressed dissolved oxygen levels were identified in 7 of 26 grab samples (26.9 percent) collected between 12/01/11 and 11/30/18.

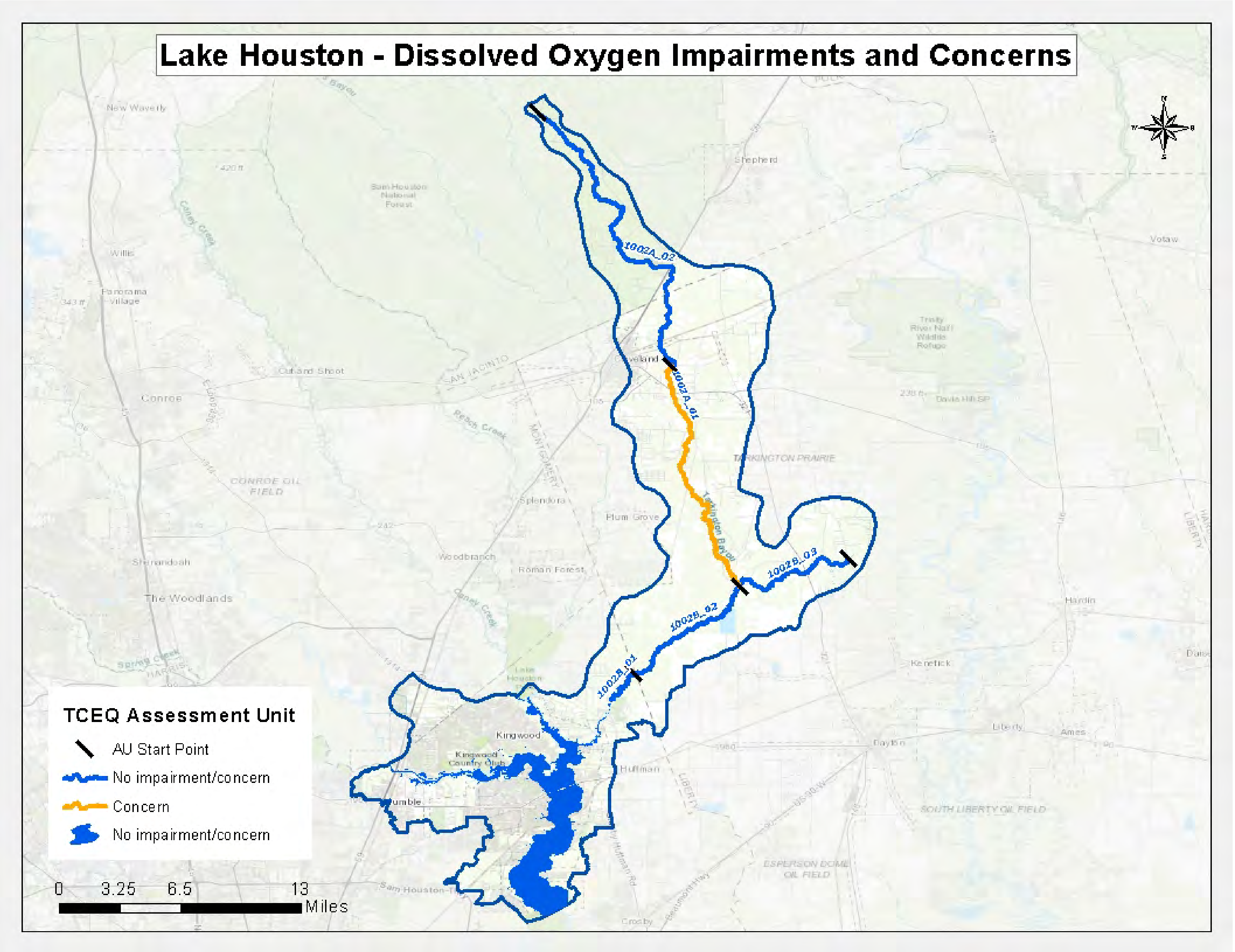
Nutrient Concerns
Concerns for nutrient screening levels were identified for both nitrate and total phosphorus in Tarkington Bayou (1002A_01) in the 2020 Integrated Report. For nitrate, 17 of 28 samples (60.7 percent) exceeded the 1.95 mg/L screening level. The assessment of total phosphorus results showed 18 of 28 samples (62.8 percent) exceeding the screening level of 0.69 mg/L.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

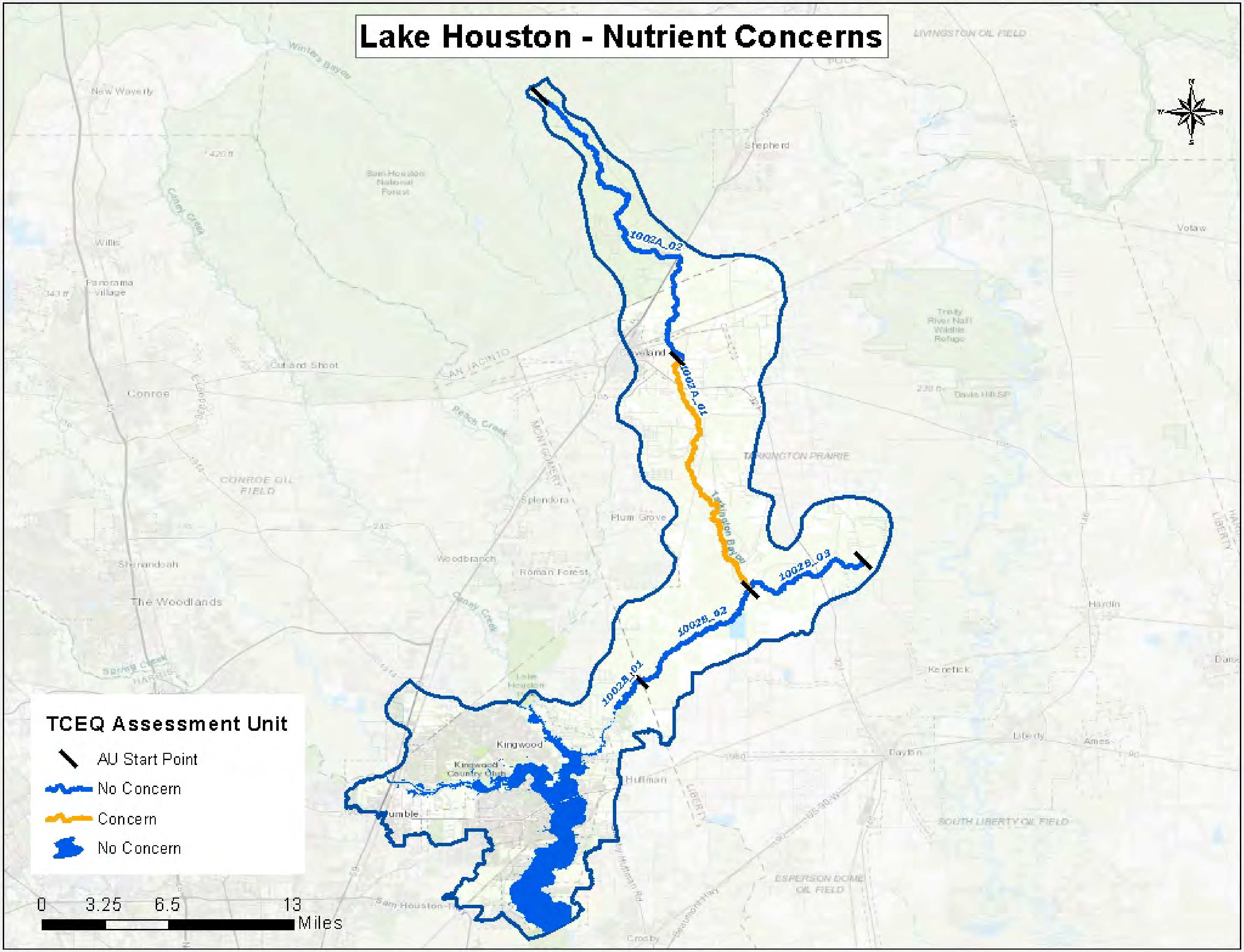
Mercury Impairments
A fish consumption advisory has been issued for Lake Isabell (1002C) due to the presence of mercury in edible fish tissue.



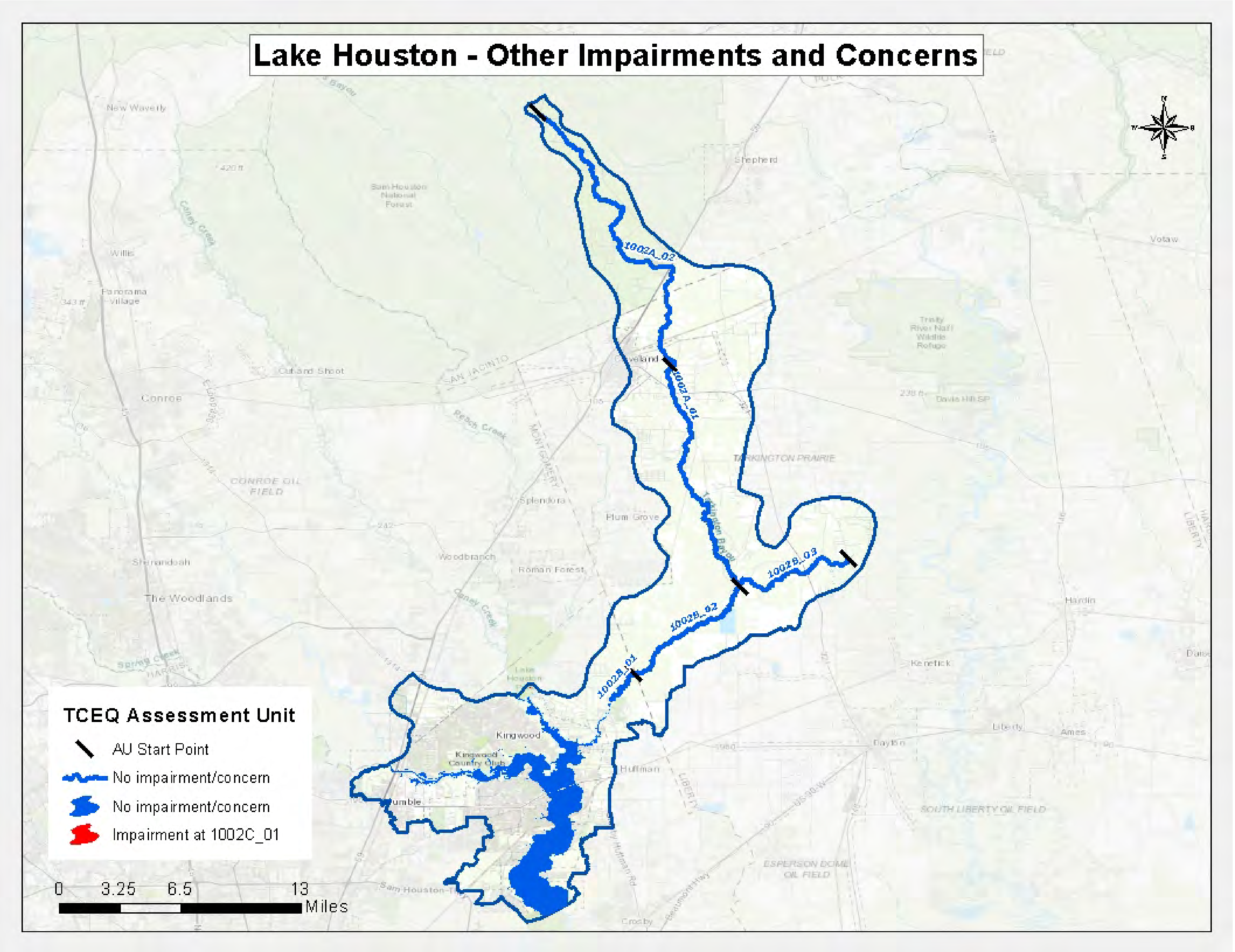
Lake Houston - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
No impairment/concern
Impairment
0 3.25 6.5 13 Miles
1002A_02
1002A_01
1002B_03
1002B_02
1002B_01
Kingwood
Humble
Cleveland
Shepherd
Conroe
The Woodlands
Splendora
Plum Grove
Huffman
Dayton
Liberty
Crosby



Lake Houston - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
No impairment/concern
0
3.25
6.5
13
Miles
1002A_02
1002A_01
1002B_01
1002B_02
1002B_03
Tarkington Bayou
New Waverly
Shepherd
Willis
Panorama Village
Cut and Shoot
Conroe
Cleveland
Tarkington Prairie
Splendora
Plum Grove
Woodbranch
Roman Forest
Shenandoah
The Woodlands
Kingwood
Humble
Huffman
Dayton
Liberty
Ames
Kenefick
Hardin
Votaw
Crosby
Conroe Oil Field
South Liberty Oil Field
Esperson Dome Oil Field
Trinity River Nat'l Wildlife Refuge
Davis Hill SP
Sam Houston National Forest
Peach Creek
Caney Creek
Spring Creek
Lake Houston



Lake Houston - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
No Concern
0
3.25
6.5
13
Miles
1002A_02
1002A_01
1002B_03
1002B_02
1002B_01
Tarkington Bayou
Cleveland
Shepherd
Conroe
Willis
New Waverly
Panorama Village
Cut and Shoot
Splendora
Plum Grove
Woodbranch
Roman Forest
Shenandoah
The Woodlands
Kingwood
Kingwood Country Club
Humble
Huffman
Crosby
Dayton
Liberty
Ames
Hardin
Kenefick
Votaw
TARKINGTON PRAIRIE
CONROE OIL FIELD
SOUTH LIBERTY OIL FIELD
ESPERSON DOME OIL FIELD
LIVINGSTON OIL FIELD
Sam Houston National Forest
Trinity River Nat'l Wildlife Refuge
Davis Hill SP
Peach Creek
Caney Creek
Winters Bayou
Spring Creek
Lake Houston


Lake Houston - Other Impairments and Concerns
1002A_02
1002A_01
1002B_03
1002B_02
1002B_01
TCEQ Assessment Unit
AU Start Point
No impairment/concern
No impairment/concern
Impairment at 1002C_01
0 3.25 6.5 13 Miles

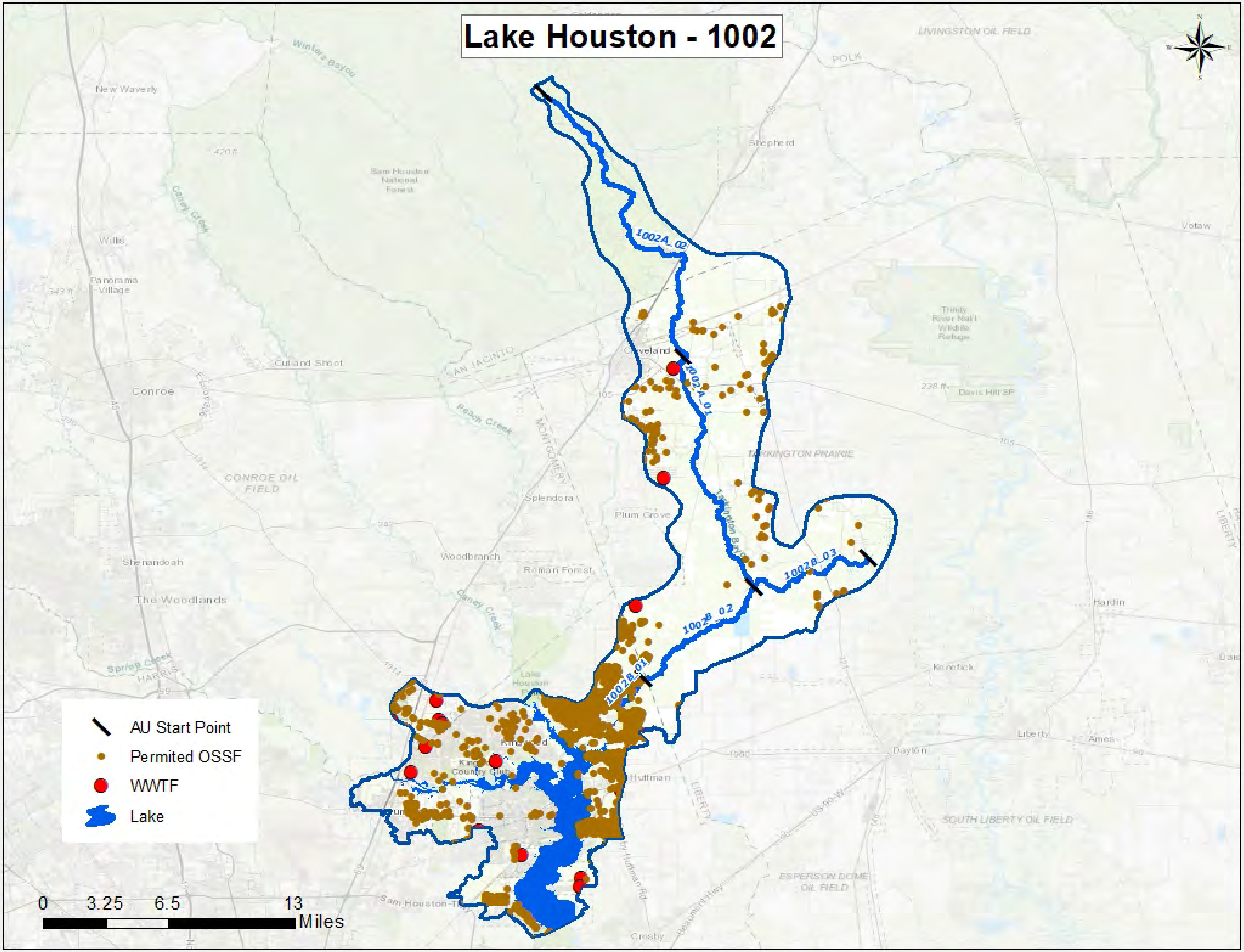
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Lake Houston watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 12 permitted wastewater outfalls in the Lake Houston watershed. In some areas, on-site sewage facilities are the primary source of wastewater disposal, with 2,395 permitted systems in the watershed. These systems are found throughout the area but are most heavily concentrated in the areas north and east of Lake Houston. The wastewater treatment facilities and on-site sewage facilities in the Lake Houston watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 121 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

The source of mercury in Lake Isabel (1002C) is currently unknown. The main source of mercury to most water bodies is from atmospheric deposition. Some water bodies may also receive mercury through point sources, such as a direct discharge of wastes containing mercury.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Lake Houston watershed.



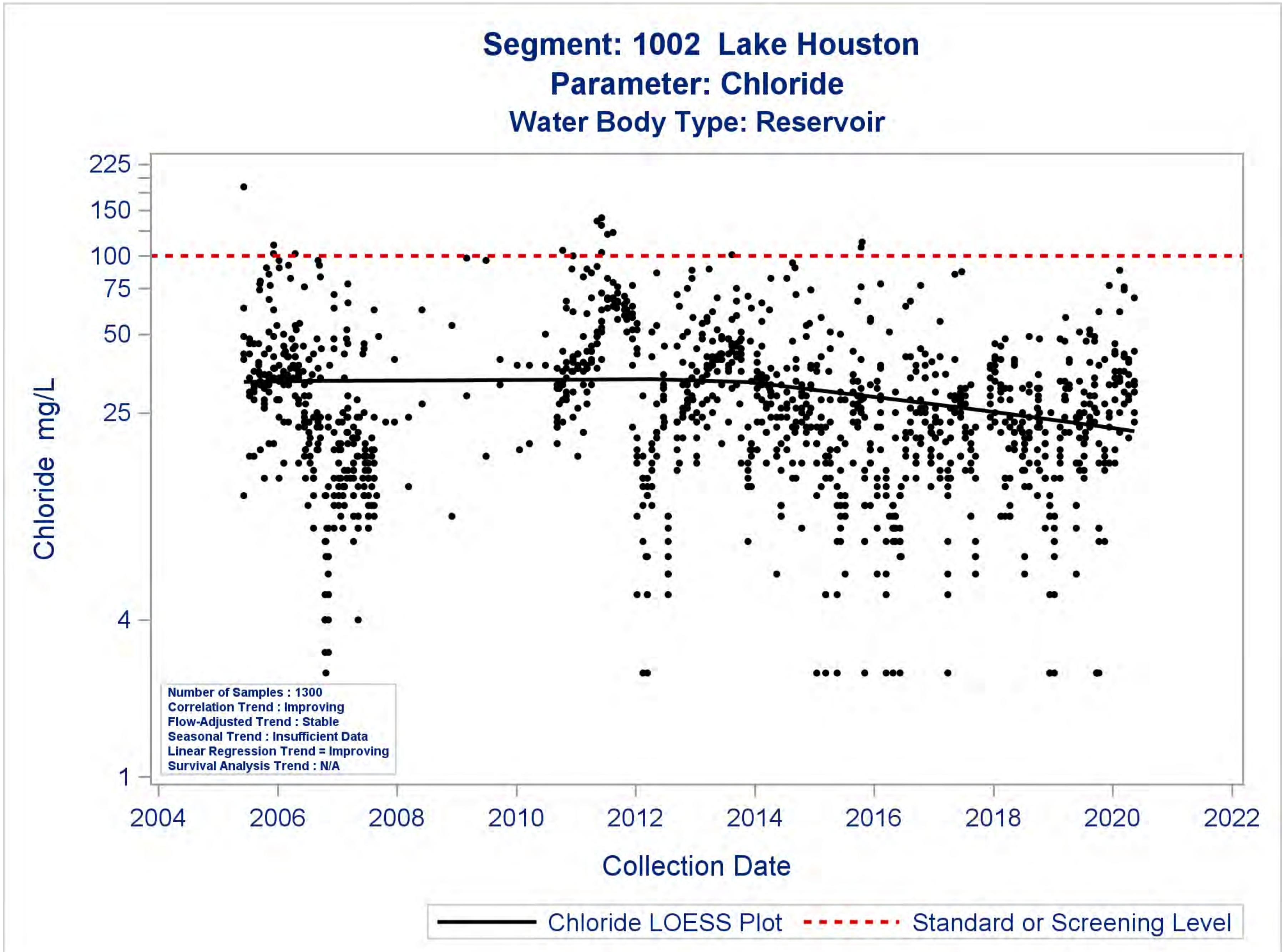
Lake Houston - 1002
AU Start Point
Permited OSSF
WWTF
Lake
0
3.25
6.5
13
Miles
1002A_02
1002A_01
1002B_03
1002B_02
1002B_01
Cleveland
Conroe
Shepherd
Plum Grove
Splendora
Woodbranch
Roman Forest
Shenandoah
The Woodlands
Huffman
Dayton
Liberty
Hardin
Kenefick
Crosby

Trend Analysis:

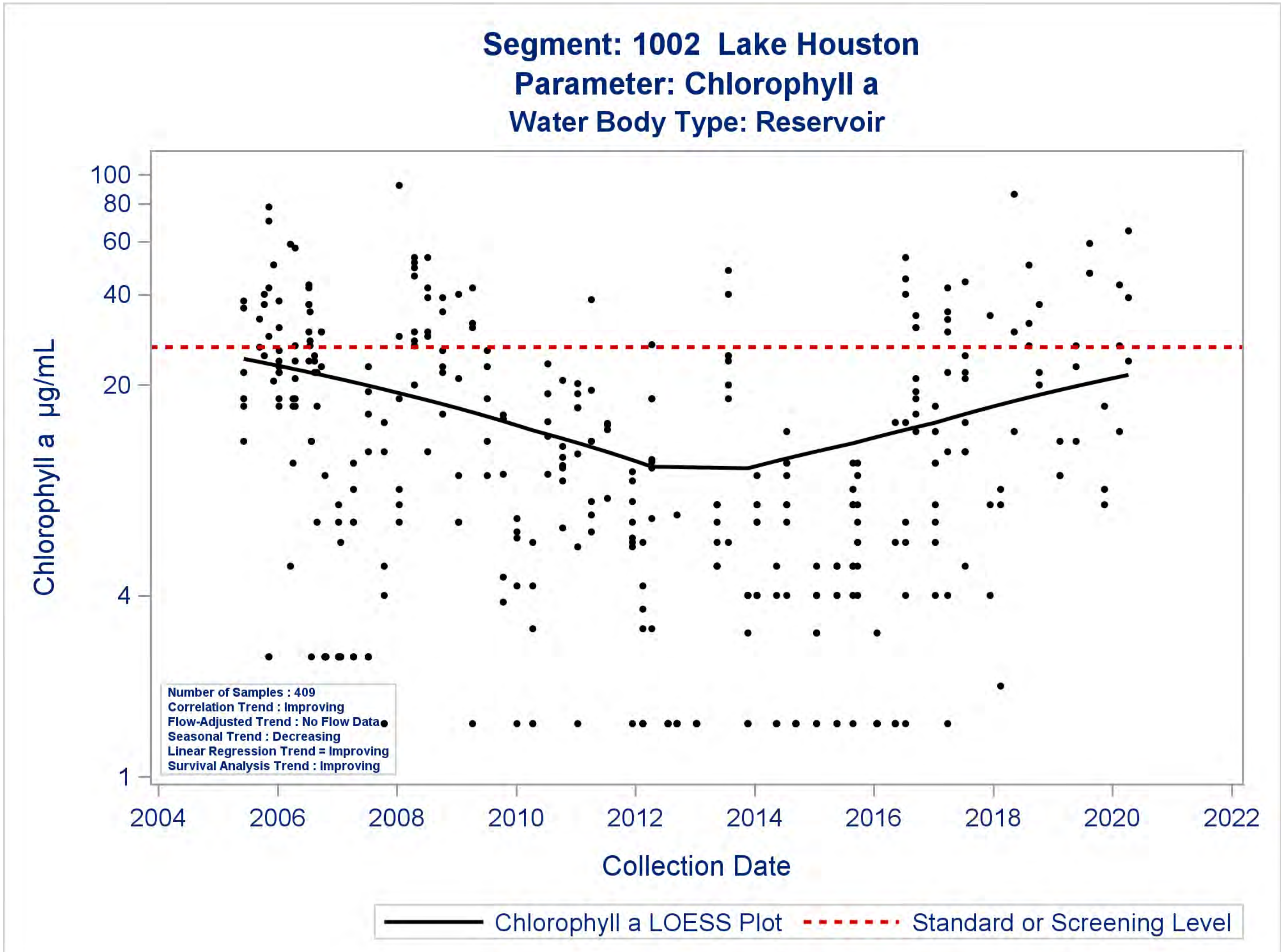
Regression analysis of watershed-level data revealed trends for thirteen water quality parameters. There were eight trends in Lake Houston proper and a total of eight trending constituents on two unclassified tributaries (1002A – Tarkington Bayou, and 1002B – Luce Bayou). In Lake Houston, TSS was increasing creating more turbid water, while concentrations of chloride, sulfate, TKN, and total phosphorus, as well as specific conductance measurements were decreasing. Conversely, Secchi transparency depths are decreasing due to a heavier sediment load in the water column. Chlorophyll *a* levels were statistically in decline over the entire dataset but have been increasing since a low point in 2014, pointing to a shorter-term degradation trend beginning in early 2018 when sample results were measured above the state standard for lakes and reservoirs.

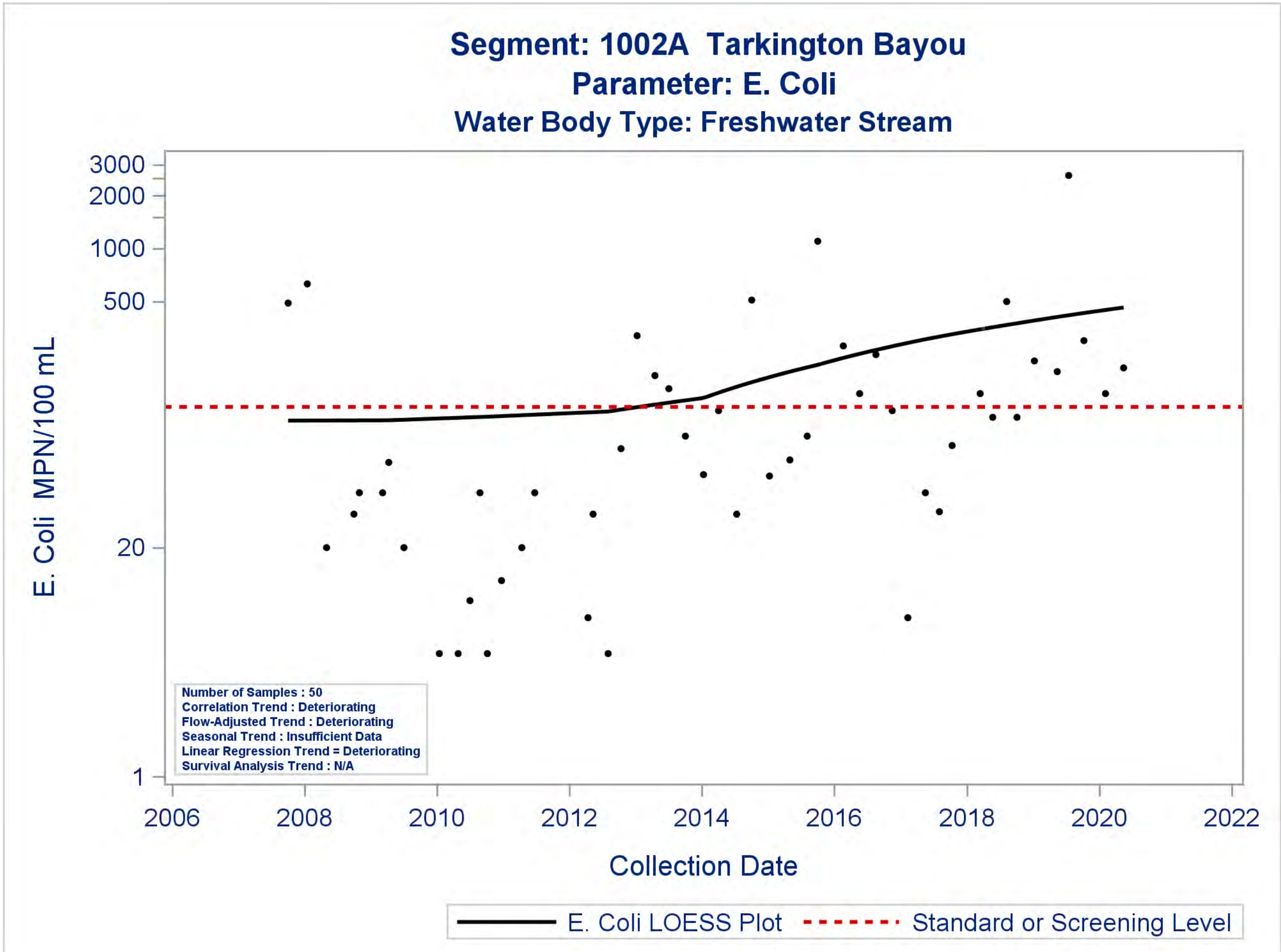
1002A (Tarkington Bayou) is experiencing a mix of trends, with *E. coli*, flow, nitrate, and TSS levels increasing, while Secchi transparency depth is decreasing as TSS concentrations increase. TKN levels are decreasing and pH standard units are increasing over time but are still well within an acceptable range. 1002B (Luce Bayou) shows mostly stable or negative trends, with ammonia and TSS levels increasing, and Secchi depth decreasing.

Degradation of TSS levels throughout the system may be exacerbated by ongoing development and increasing impervious cover in the watershed, large amounts of sediment transport during and after Hurricane Harvey and other flooding events, and active dredging and hydrologic modification efforts in the system and its tributary segments. The location of the sampling station for 1002A on a highway corridor adjacent to the expanding Cleveland area may not reflect conditions in the rest of that tributary, which is primarily rural and undeveloped in nature. Similarly, the end of segment station for 1002B is located within a more developed area with a broader channel adjacent to the confluence with the lake and may not well reflect the primarily rural and undeveloped nature of the majority of its length. While Luce Bayou is sampled in the lowest reach and most upper reach, the middle reach is difficult to access due to lack of road crossings over most of the water body.

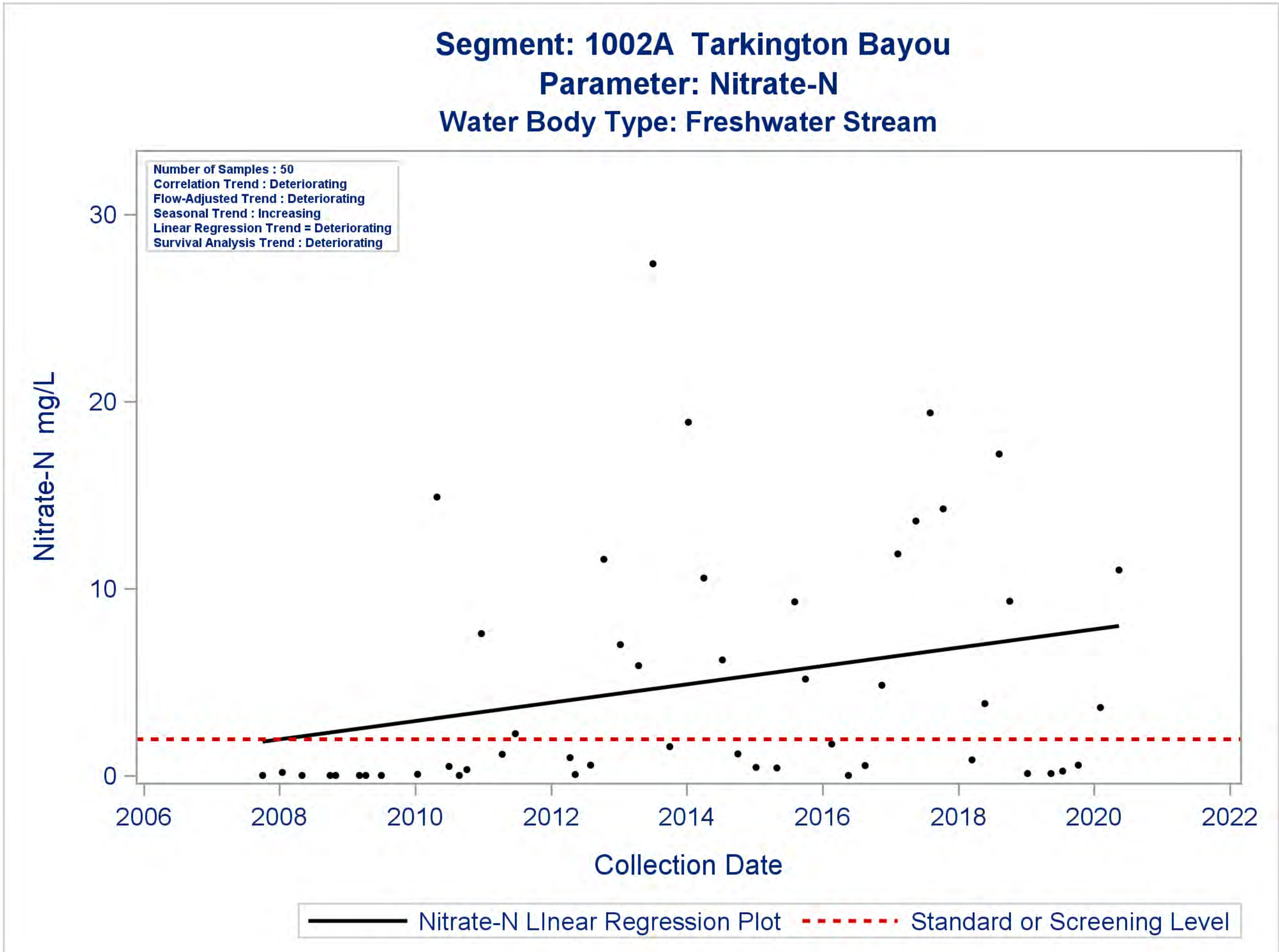


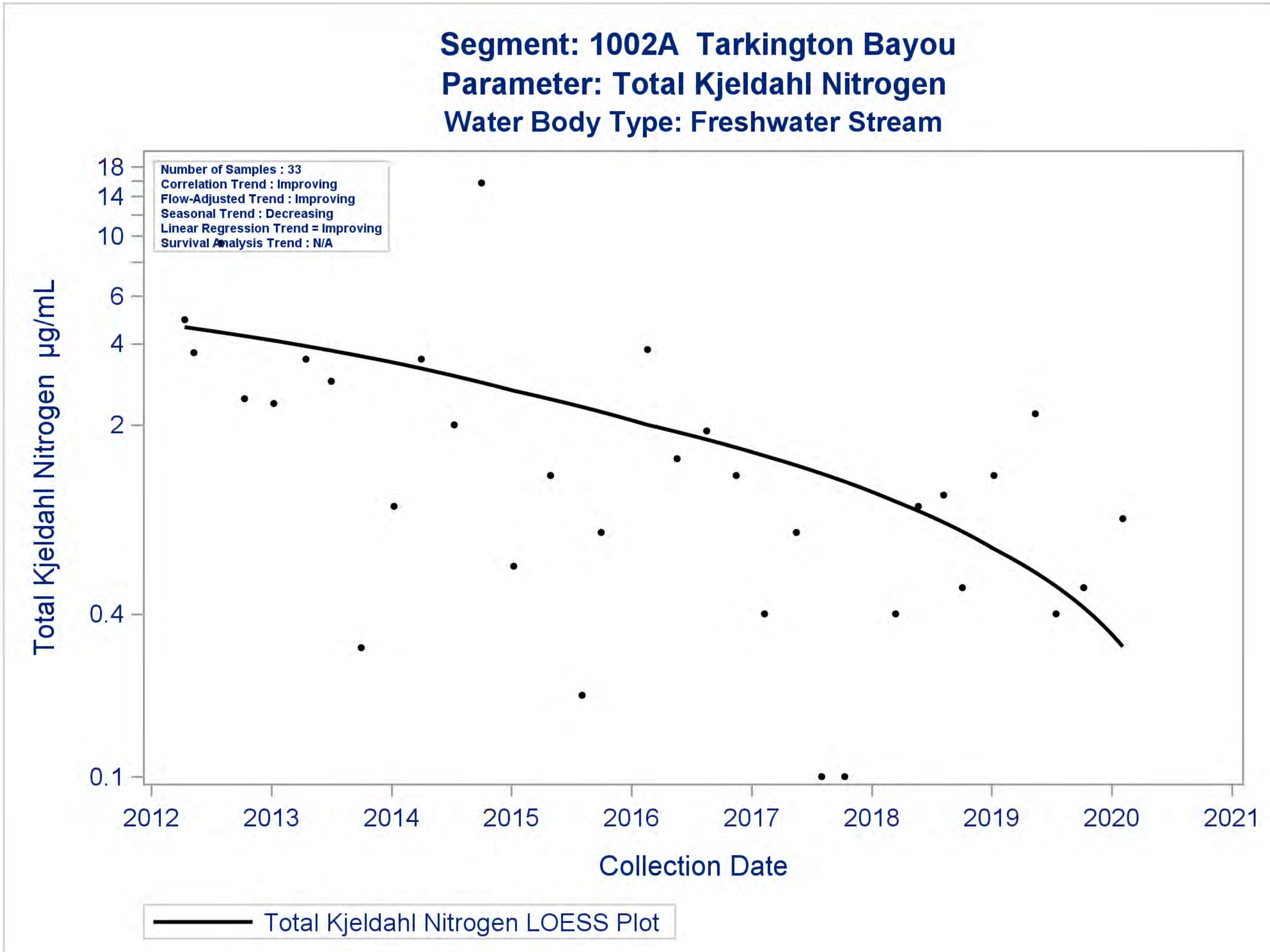
Segment: 1002 Lake Houston
Parameter: Chloride
Water Body Type: Reservoir
Chloride mg/L
225
150
100
75
50
25
4
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Number of Samples : 1300
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Chloride LOESS Plot
Standard or Screening Level

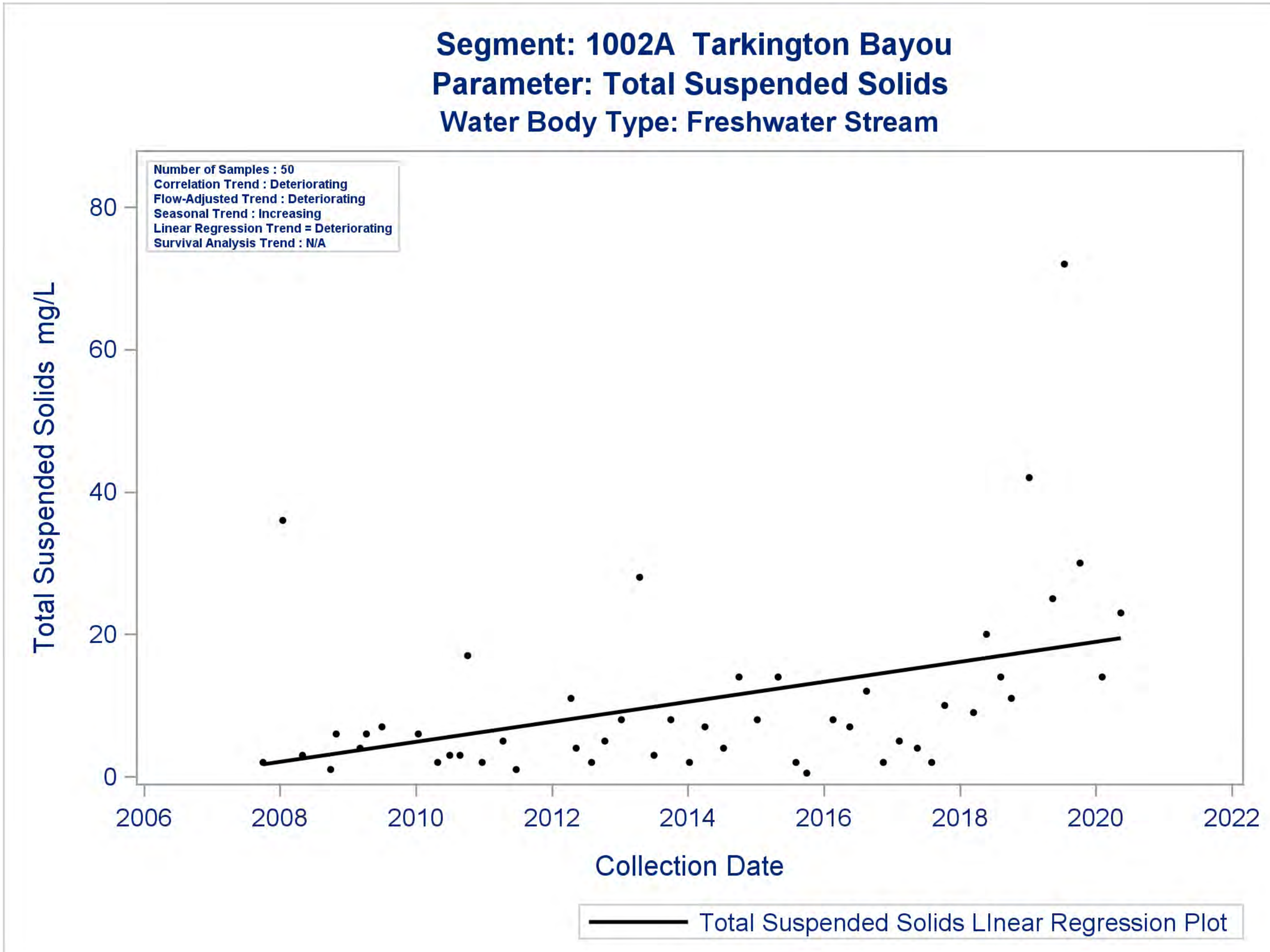

Segment: 1002 Lake Houston
Parameter: Chlorophyll a
Water Body Type: Reservoir
100
80
60
40
20
4
1
Chlorophyll a µg/mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Number of Samples : 409
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Chlorophyll a LOESS Plot
Standard or Screening Level



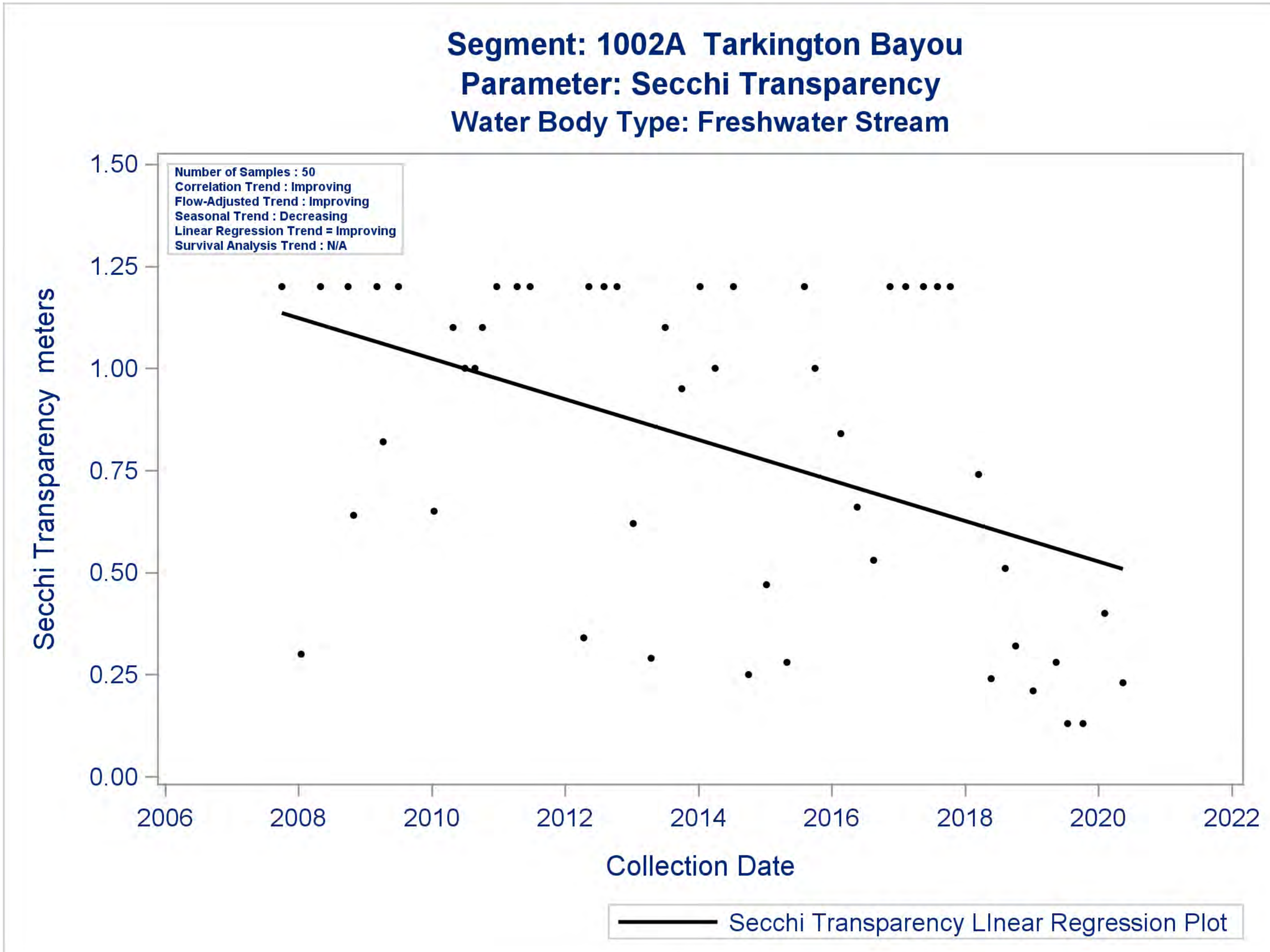
Segment: 1002A Tarkington Bayou
Parameter: E. Coli
Water Body Type: Freshwater Stream
E. Coli MPN/100 mL
3000
2000
1000
500
20
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Number of Samples : 50
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
E. Coli LOESS Plot
Standard or Screening Level


Segment: 1002A Tarkington Bayou
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 50
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
30
20
10
0
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

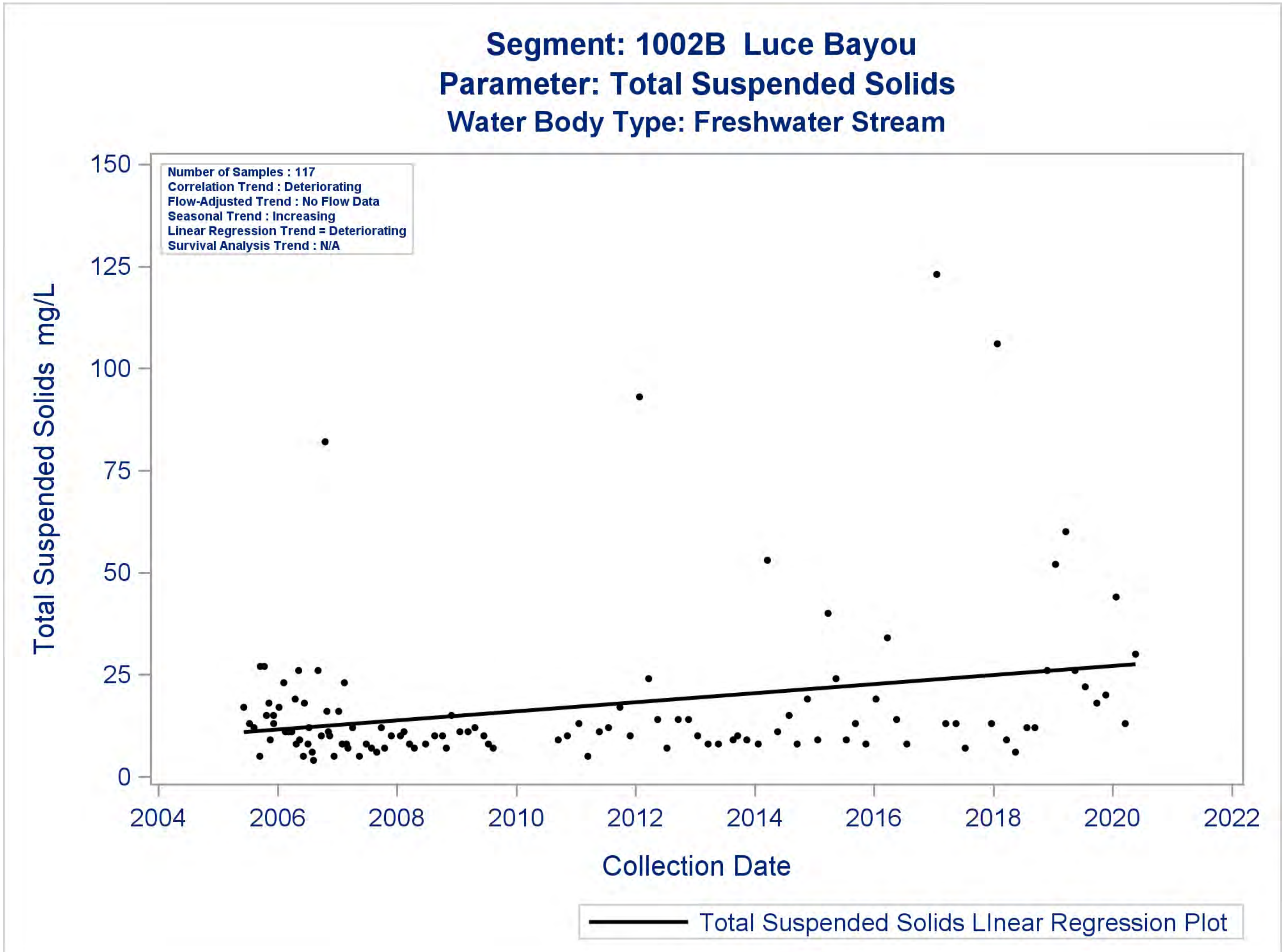

Segment: 1002A Tarkington Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 33
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
18
14
10
6
4
2
0.4
0.1
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



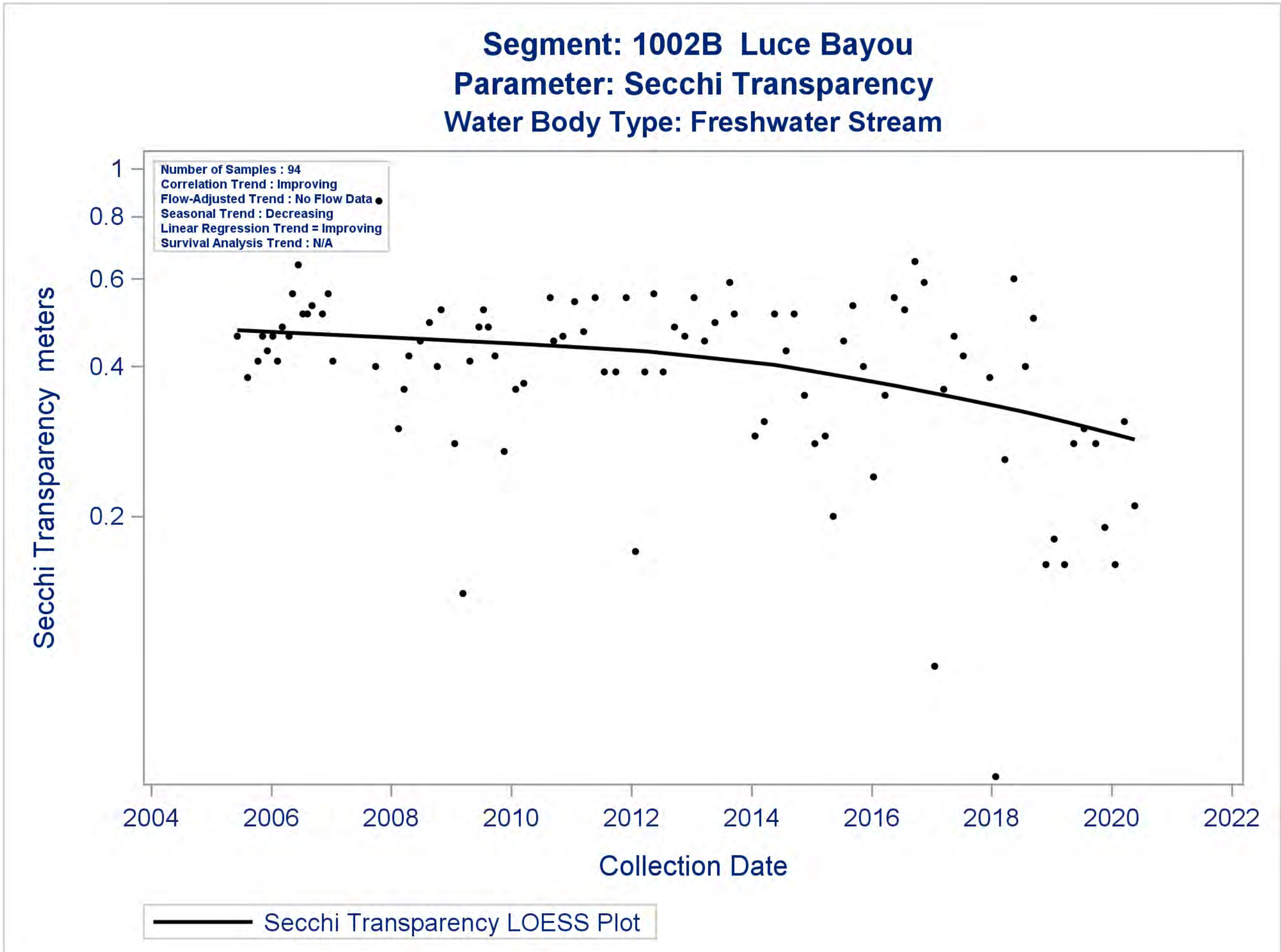
Segment: 1002A Tarkington Bayou
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 50
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
20
40
60
80
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot



Segment: 1002A Tarkington Bayou
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 50
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot



Segment: 1002B Luce Bayou
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 117
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
150
125
100
75
50
25
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot



Segment: 1002B Luce Bayou
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 94
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1
0.8
0.6
0.4
0.2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1002_06 I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Improper or no pet waste disposal • Developments with malfunctioning OSSFs • Animal waste from agricultural production	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Regionalize chronically non-compliant WWTFs • Improve stormwater controls in new developments by adding bacteria reduction measures • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • Ensure proper citing of new or replacement OSSFs • Increase monitoring and enforcement efforts to identify and repair failing OSSFs • More public education regarding OSSF operations and maintenance • Require larger partials of land in developments platted to use OSSFs • More public education on pet waste disposal • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties
Low Dissolved Oxygen Concentrations (Grab)	1002A_01 C	▪ Excessive nutrients and organic matter from agricultural production ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and	• Detrimental effect on aquatic biological community	• Install and/or maintain riparian buffer areas between agricultural fields and waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties

		biodegradable solid waste (e.g., grass clippings and pet waste)		• Improve compliance and enforcement of existing stormwater quality permits • Regionalize chronically non-compliant WWTFs • Improve operation and maintenance of existing WWTF and collection systems • More public education regarding disposal of household fats, oils, and grease • More public education on pet waste disposal • More public education regarding OSSF operations and maintenance
Elevated Nitrate-Nitrogen and Phosphorus Concentrations	*Nitrate-N* 1002A_01 C *Phosphorus* 1002A_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Mercury in Edible Fish Tissue	1002C I	• Atmospheric deposition • Point sources (direct discharges) • Illegal dumping	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health https://www.dshs.texas.gov/seafood/PDF2/FishConsumptionAdvisoryBaNNews/ADV-38_LakeIsabell_signed.pdf	• Additional testing of other smaller impoundments in the area should be undertaken to determine potential sources • Continue monitoring fish populations and publicizing advisories

Special Studies:

- The Lake Houston watershed is a part of the Bacteria Implementation Group (BIG)
- Lake Houston is included in the Total Maximum Daily Load Implementation Plan for the East and West Fork of the San Jacinto River project

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to evaluate fish tissue samples for the presence of mercury.

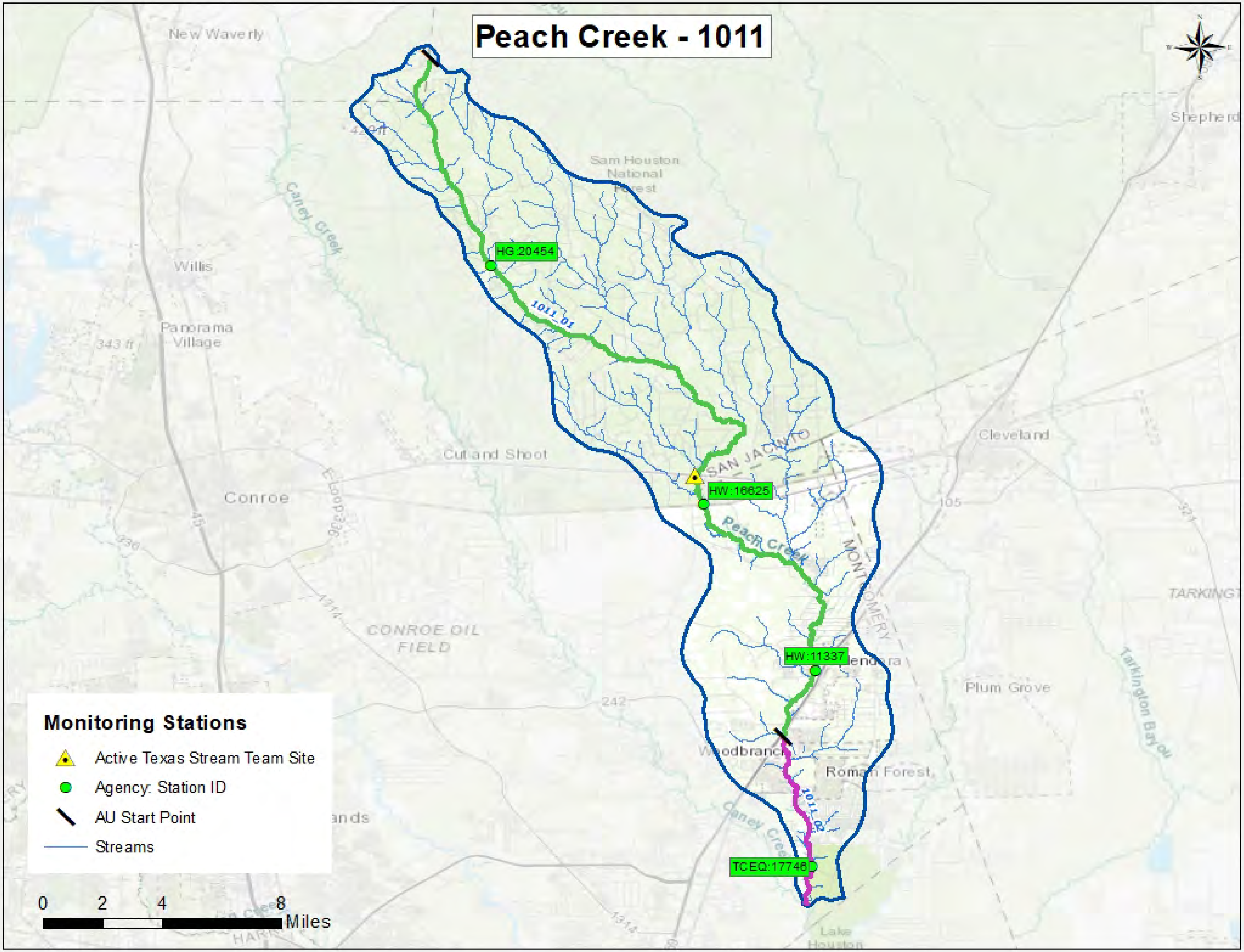
Segment Number:	1011		Name:	Peach Creek	
Length:	43 miles	**Watershed Area:**	151 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	4	**Texas Stream Team Monitoring Stations:**	1	**Permitted WWTF Outfalls:**	13

DESCRIPTION

- Segment 1011 (Perennial Stream w/ high ALU): **Peach Creek** (classified water body) – From the confluence with Caney Creek in Montgomery County to SH 150 in Walker County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11337	1011	PEACH CREEK BRIDGE AT FM 2090 IN SPLENDORA	HW	BIMONTHLY	Field, Conventional, Bacteria
16625	1011	PEACH CREEK IMMEDIATELY UPSTREAM OF OLD HWY 105	HW	BIMONTHLY	Field, Conventional, Bacteria
17746	1011	PEACH CREEK AT LAKE HOUSTON STATE PARK FOOTBRIDGE 1.09 KM DOWNSTREAM OF FM 1485	FO	QUARTERLY	Field, Conventional, Bacteria, Flow
20454	1011	PEACH CREEK AT COUNTY LINE ROAD-FM 3081 NORTHEAST OF CONROE IN MONTGOMERY COUNTY	HG	QUARTERLY	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
HG = Houston-Galveston Area Council
HW = Houston Water Quality Control

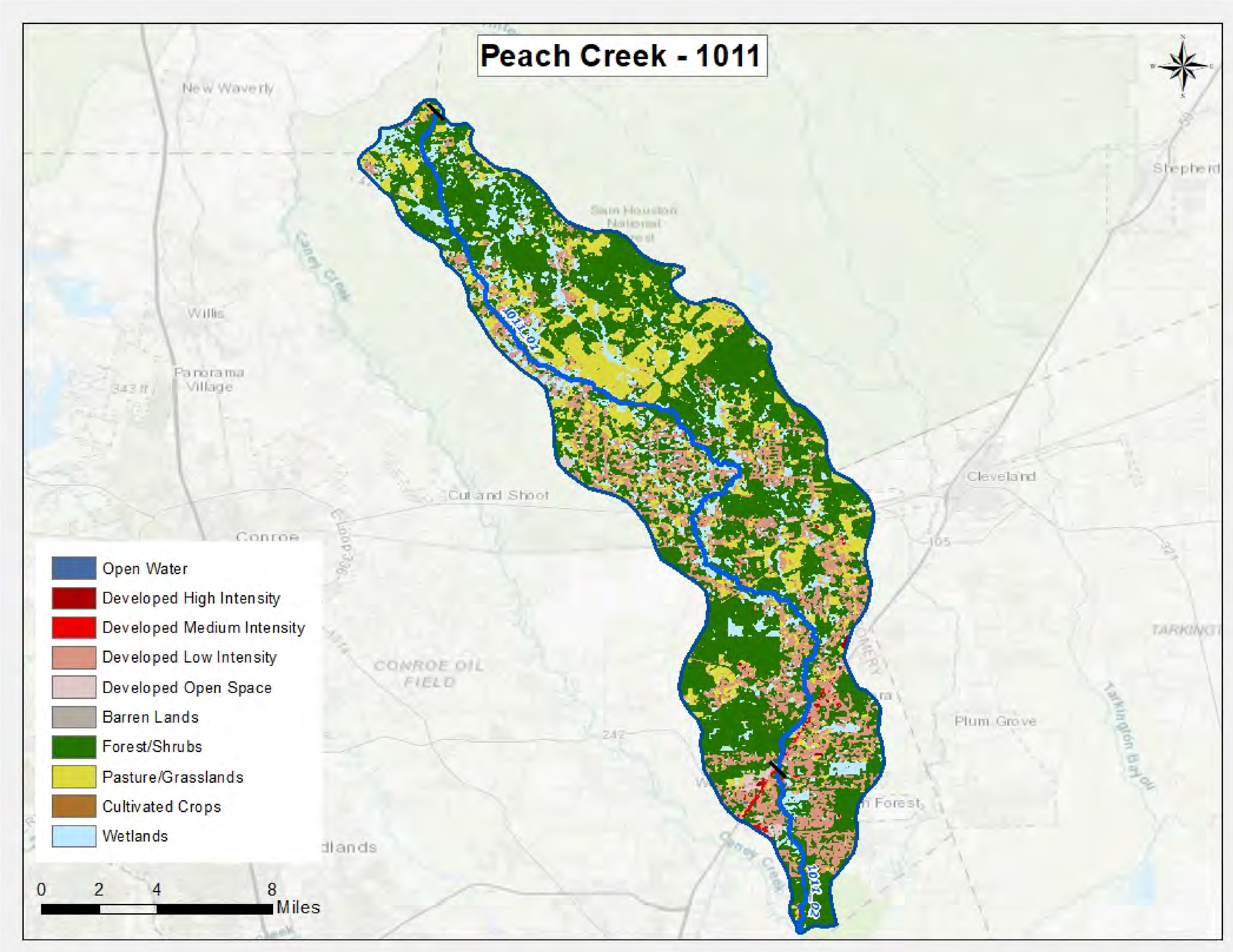

Peach Creek - 1011
New Waverly
Sam Houston National Forest
Shepherd
Caney Creek
Willis
Panorama Village
343 ft
HG:20454
1011_01
Cut and Shoot
SAN JACINTO
Cleveland
Conroe
HW:16625
Peach Creek
MONTGOMERY
105
CONROE OIL FIELD
TARKINGT
HW:11337
Plum Grove
Tarkington Bayou
242
Woodbranch
Roman Forest
1011_02
Caney Creek
TCEQ:17746
Lake Houston
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
2
4
8
Miles

Segment 1011 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C / °F):	32 / 90	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-8.5	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	50		
Sulfate (mg/L as SO_4):	50		
Total Dissolved Solids (mg/L):	300		

Segment Discussion

Watershed Characteristics and Land Cover: The Peach Creek (1011) watershed is dominated by forested land with the Sam Houston National Forest in the upper reach. Peach Creek flows into the East Fork San Jacinto River approximately two miles upstream from Lake Houston, the major drinking water supply for the region. Several small communities including Splendora, Patton Village, Roman Forest, and Woodbranch are located in the lower reach of the watershed. These residential communities are growing quickly, especially along the U.S. Highway 59 corridor.

Segment 1011 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	23,053.54	23.89	15,817.96	16.40	-31.39
Barren Lands	1,494.71	1.55	192.82	0.20	-87.10
Developed	6,809.02	7.06	17,162.11	17.79	152.05
Forest/Shrubs	51,176.76	53.04	47,470.13	49.20	-7.24
Open Water	310.46	0.32	62.49	0.06	-79.87
Wetlands	13,636.73	14.13	15,769.26	16.35	15.64
TOTAL	**96,481.22**	**100.00**	**96,474.77**	**100.00**	



Peach Creek - 1011
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 2 4 8
Miles
1011_01
1011_02
New Waverly
Willis
Panorama Village
Conroe
Cut and Shoot
Sam Houston National Forest
Shepherd
Cleveland
Plum Grove
CONROE OIL FIELD
Caney Creek
Tarkington Bayou

Water Quality Issues:

Bacteria Impairments and Concerns

Recreation use is not supported in Peach Creek (1011). As listed in the 2020 Integrated Report, the *E. coli* geometric mean was 169.22 MPN/100 mL in AU 1011_01. In AU 1011_02, the geometric mean was 169.92 MPN/100 mL.

Dissolved Oxygen Impairments or Concerns

There are no dissolved oxygen impairments in this segment.

Nutrient Concerns

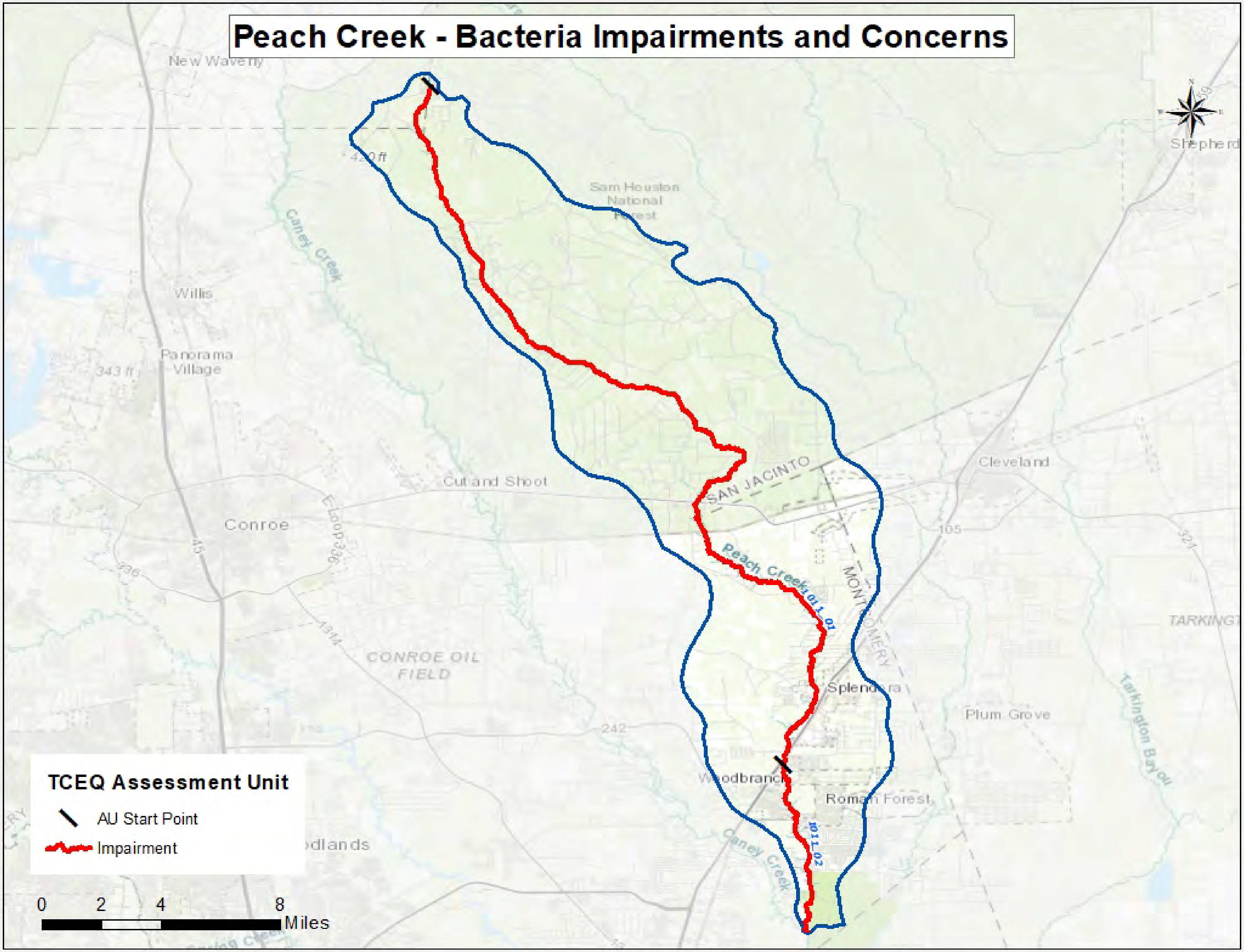
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments

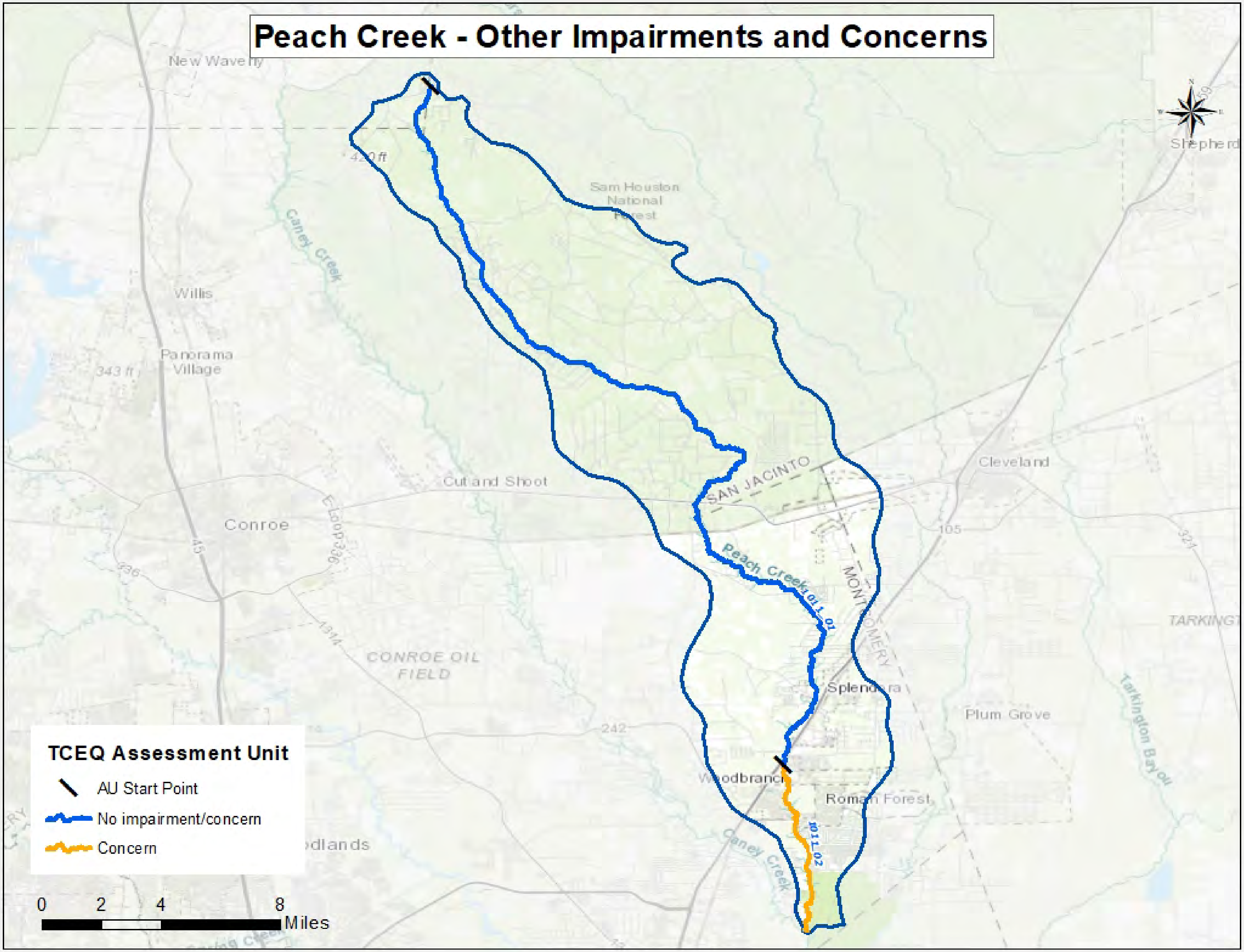
There are no PCBs/Dioxins impairments in this segment.

Habitat

A concern for impaired habitat was identified in AU 1011_02 in the 2020 Integrated Report.



Peach Creek - Bacteria Impairments and Concerns
New Waverly
Sam Houston National Forest
Shepherd
Caney Creek
Willis
Panorama Village
343 ft
Cut and Shoot
SAN JACINTO
Cleveland
Conroe
Loop 336
45
336
105
Peach Creek
1011_01
MONTGOMERY
TARKINGTON
1314
CONROE OIL FIELD
Splendora
Plum Grove
Tarkington Bayou
321
242
Woodbranch
Roman Forest
1011_02
Caney Creek
TCEQ Assessment Unit
AU Start Point
Impairment
0
2
4
8
Miles


Peach Creek - Other Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
0
2
4
8
Miles
Peach Creek
1011_01
1011_02
New Waverly
Sam Houston National Forest
Willis
Panorama Village
Conroe
Cut and Shoot
CONROE OIL FIELD
SAN JACINTO
MONTGOMERY
Cleveland
Splendora
Plum Grove
Roman Forest
Caney Creek
Tarkington Bayou
Shepherd

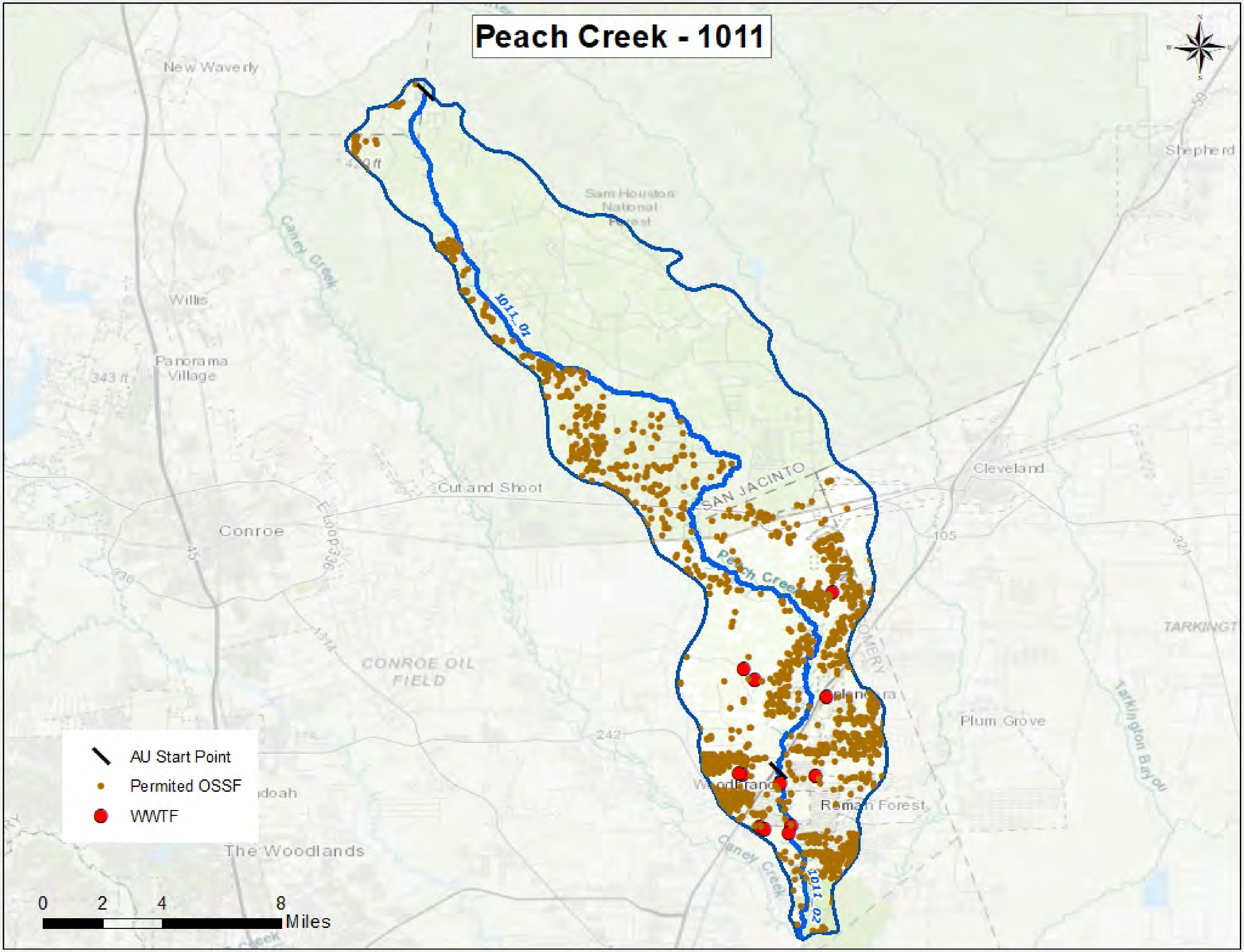
Potential Sources of Water Quality Issues: Peach Creek is a rural water body and rural sources of fecal bacteria, such as agriculture and failing on-site sewage systems, are the key sources.

There are 13 permitted wastewater outfalls in the Peach Creek watershed. In the majority of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 1,594 permitted on-site sewage facilities in the area. The wastewater treatment facilities and on-site sewage facilities in the Peach Creek watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 20 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

The likely source of the habitat impairment is channelization of the water body, which causes loss of habitat.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Peach Creek watershed.

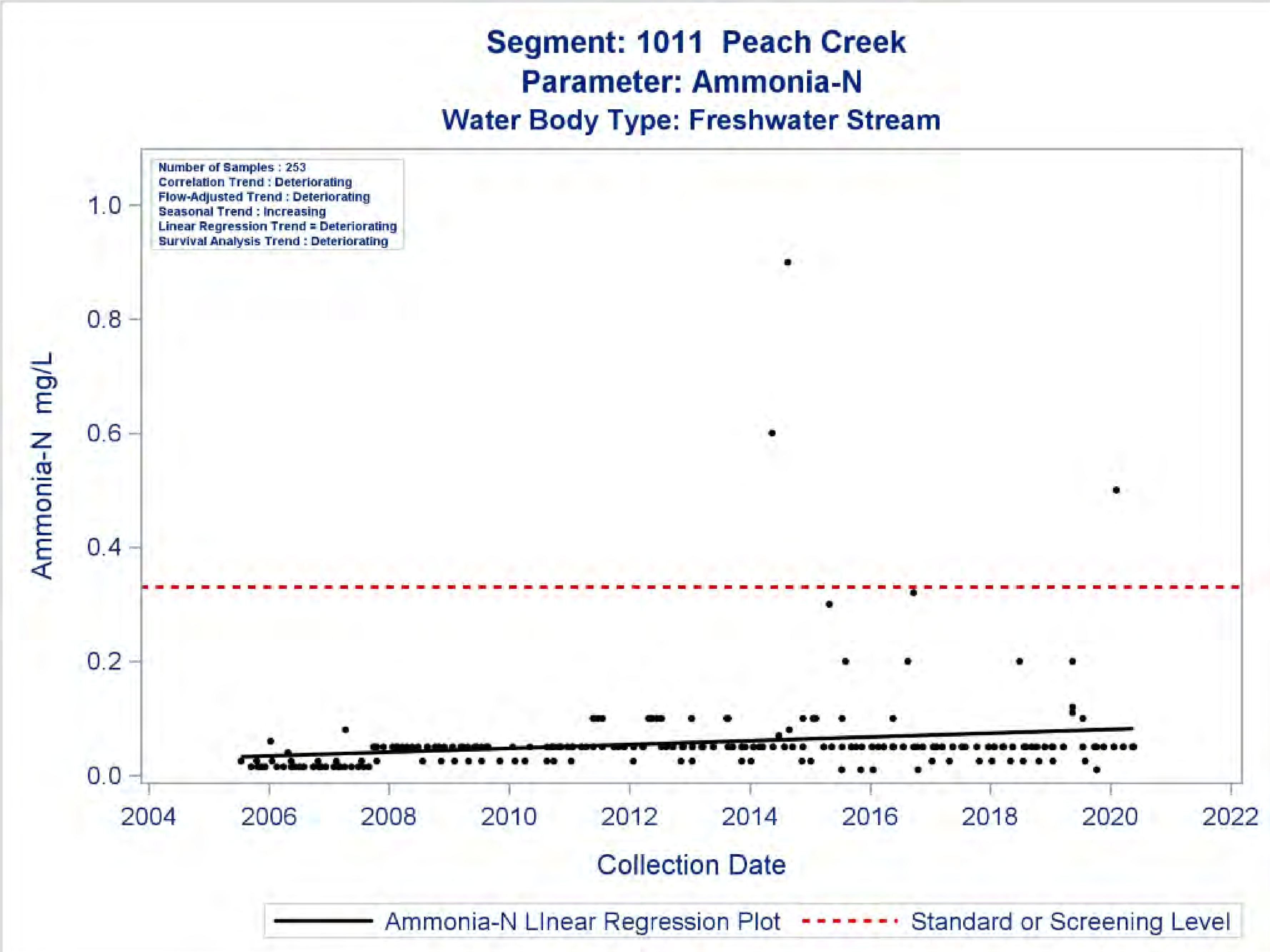


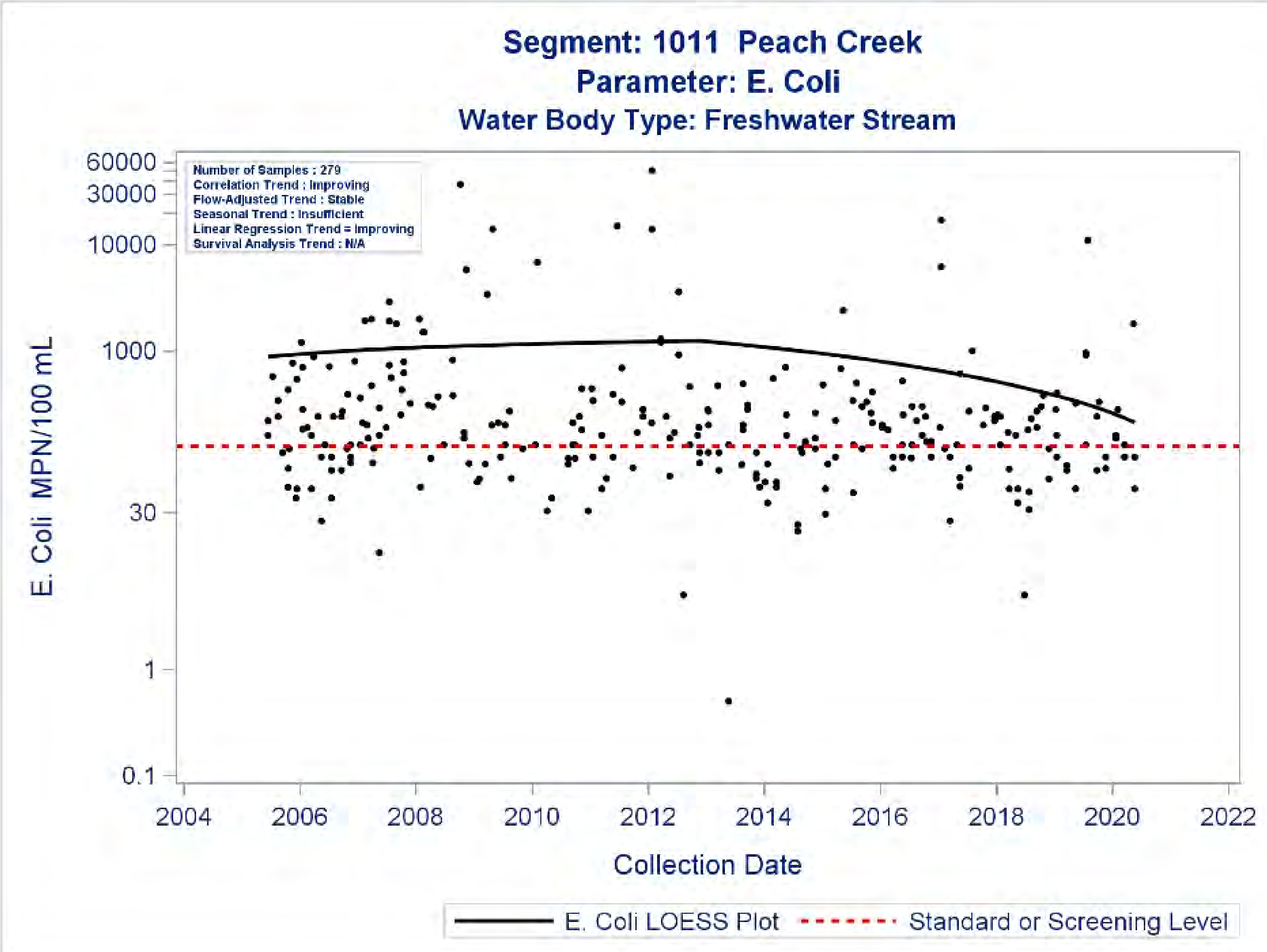
Peach Creek - 1011
New Waverly
Sam Houston National Forest
Shepherd
Willis
Panorama Village
343 ft
Caney Creek
1011_01
SAN JACINTO
Cut and Shoot
Cleveland
Conroe
Peach Creek
CONROE OIL FIELD
TARKINGT
Plum Grove
Tarkington Bayou
Roman Forest
The Woodlands
1011_02
AU Start Point
Permited OSSF
WWTF
0
2
4
8
Miles

Trend Analysis:

Regression analysis of watershed data revealed a significant increasing trend in ammonia. Although ammonia concentrations are increasing throughout the watershed, levels are still well below the set screening criteria. Other nutrients show a stable trend below set screening criteria, so no concern for nutrients is present at this time.

The 2020 Integrated Report lists this entire segment as impaired for bacteria. Regression analysis of *E. coli* data detected a slight decreasing trend for bacteria concentrations in Peach Creek during the period of record; however, levels remain well above the 126 MPN/100 mL standard. Potential sources of bacterial contamination in this watershed include surface runoff from agricultural areas and hobby farms, as well as from malfunctioning OSSFs in the Peach Creek watershed.


Segment: 1011 Peach Creek
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 253
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



Segment: 1011 Peach Creek
Parameter: E. Coli
Water Body Type: Freshwater Stream
Number of Samples : 279
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
E. Coli MPN/100 mL
60000
30000
10000
1000
30
1
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1011 (Entire Segment) I	• Animal waste from agricultural production, hobby farms, and riding stables • Urbanization and increased impervious cover, especially in the lower portion of the watershed • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Create and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Improve stormwater controls in new developments by adding bacteria reduction measures • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs
Habitat	1011_02 C	• Loss of habitat due to channelization of waterway • Ongoing maintenance of modified channel • Bank erosion and erosion of construction sites	• Detrimental to the aquatic biological community	• Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat • Work with local authorities to minimize sediment runoff from construction sites • Work with drainage districts to install/construct habitat that doesn't interfere with water movement • Re-connect oxbows and lost channels to augment water storage and retention

Special Studies:

- The Peach Creek watershed is part of the Bacteria Implementation Group (BIG).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 1008				Name: Spring Creek	
Length: 57 miles	**Watershed Area:** 441 square miles		**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply	
Number of Active Monitoring Stations:	20	**Texas Stream Team Monitoring Stations:**	5	**Permitted WWTF Outfalls:**	80

DESCRIPTION

- Segment 1008 (Perennial Stream w/ high ALU) **Spring Creek** (classified water body) – From the confluence with the West Fork San Jacinto River in Harris/Montgomery County to the most upstream crossing of FM 1736 in Waller County

- Segment 1008A (Perennial Stream w/ intermediate ALU): **Mill Creek** (unclassified water body) – Perennial stream from the normal pool elevation of Neidigk Lake upstream to the confluence of Hurricane Creek and Kickapoo Creek

- Segment 1008B (Intermittent with Pools w/ limited ALU): **Upper Panther Branch** (unclassified water body) – From the normal pool elevation of 125 feet of Lake Woodlands upstream to Old Conroe Road confluence

- Segment 1008C (Perennial Stream w/ intermediate ALU): **Lower Panther Branch** (unclassified water body) – From the Spring Creek confluence upstream to the dam impounding Lake Woodlands in Montgomery County

- Segment 1008D (Intermittent with Pools): Intermittent stream with perennial pools (unclassified water body) – From the confluence of Cannon Gully up to 0.1 mi below Kuykendahl Road

- Segment 1008E (Intermittent with Pools w/ limited ALU): **Bear Branch** (unclassified water body) – From the Upper Panther Branch confluence to south of FM 1488 in Montgomery County

- Segment 1008F (Reservoir w/ high ALU): **Lake Woodlands** (unclassified water body) – From Lake Woodlands Dam to confluence with Upper Panther Branch Creek in Montgomery County (impounds Upper Panther Branch)

- Segment 1008G: Retired segment description

- Segment 1008H (Perennial Stream w/ high ALU): **Willow Creek** (unclassified water body) – From the Spring Creek confluence to a point 0.3 mi north of Juergen Road

- Segment 1008I (Perennial Stream w/ high ALU): **Walnut Creek** (unclassified water body) – From the Spring Creek confluence to a point 25.5 mi upstream

- Segment 1008J (Perennial Stream w/ high ALU): **Brushy Creek** (unclassified water body) – From the Spring Creek confluence to a point 3.5 mi upstream of FM 1488

- Segment 1008K (Intermittent Stream with perennial pools): **Arnold Branch** (unclassified water body) – Intermittent stream with perennial pools from the confluence with Mink Branch upstream to the headwaters just upstream of FM 1774

- Segment 1008L (Perennial Stream): **Mink Branch** (unclassified water body) – Perennial stream from the confluence with Walnut Creek upstream to the confluence with an unnamed tributary approximately 1.0 km (0.6 mi) upstream of Nichols-Sawmill Road

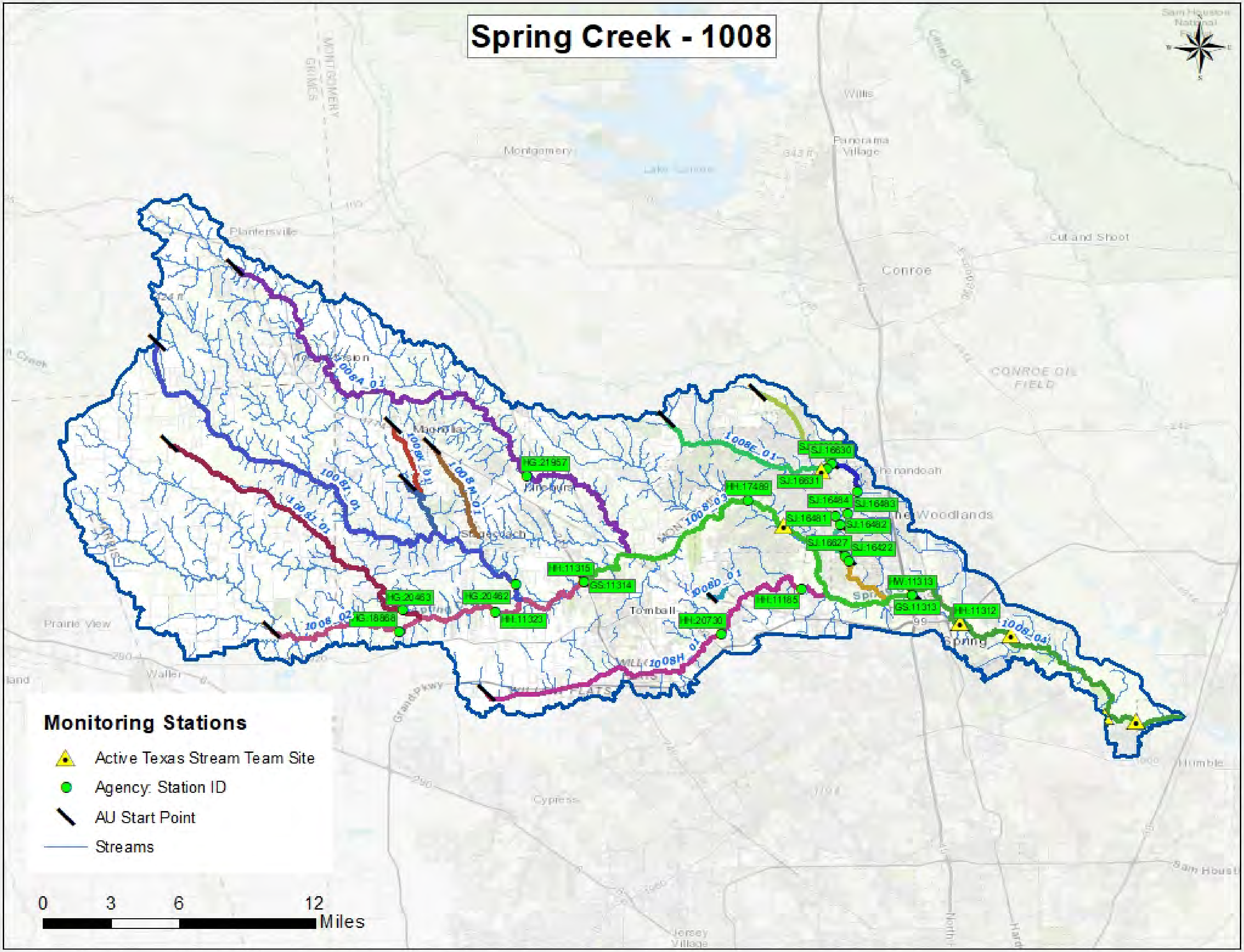
- Segment 1008M (Intermittent Stream with perennial pools): **Sulphur Branch** (unclassified water body) – Intermittent stream with perennial pools from an unnamed reservoir, known locally as Lake Apache, upstream to FM 1774. The unnamed reservoir impounds Sulphur Branch approximately 0.8 km (0.5 mi) upstream of the confluence with Walnut Creek

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11312	1008	SPRING CREEK IMMEDIATELY DOWNSTREAM OF RILEY FUZZEL ROAD	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
11313	1008	SPRING CREEK BRIDGE AT IH 45 20 MILES NORTH OF HOUSTON	HW GS	BIMONTHLY MONTHLY	Field, Conventional, Bacteria, Flow Field, Conventional, Bacteria, Flow, 24-hr DO, Metals in Water, Organics in Water
11315	1008	SPRING CREEK 1.13 KM UPSTREAM OF SH 249 NEAR DRAGONFLY RD IN SPRING CREEK PARK	HH	BIMONTHLY	Field, Conventional, Bacteria
11323	1008	SPRING CREEK IMMEDIATELY UPSTREAM OF DECKER PRAIRIE ROSEHILL ROAD	HH	BIMONTHLY	Field, Conventional, Bacteria
17489	1008	SPRING CREEK IMMEDIATELY DOWNSTREAM OF KUYKENDAHL ROAD NORTHEAST OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
18868	1008	SPRING CREEK AT ROBERTS CEMETERY ROAD WEST-NORTHWEST OF TOMBALL	HG	QUARTERLY	Field, Conventional, Bacteria
21957	1008A	MILL CREEK AT FM 149 NORTH OF TOMBALL	HG	QUARTERLY	Field, Conventional, Bacteria, Flow
16629	1008B	UPPER PANTHER BRANCH APPROX 80 M UPSTREAM OF PERMIT WQ0012597-001 LOCATED AT 5402 RESEARCH FOREST DR	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
16630	1008B	UPPER PANTHER BRANCH APPROX 170 METERS DOWNSTREAM OF PERMIT WQ0012597-001 LOCATED AT 5402 RESEARCH FOREST DR	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
16422	1008C	PANTHER BRANCH 295 METERS DOWNSTREAM OF SAWDUST ROAD IN THE WOODLANDS	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
16627	1008C	LOWER PANTHER BRANCH AT FOOTBRIDGE 265 M UPSTREAM OF SAWDUST RD APPROX 200 M UPSTREAM OF PERMIT WQ0011401-001 LOCATED AT 2436 SAWDUST ROAD	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
16631	1008E	BEAR BRANCH 20 METERS DOWNSTREAM OF RESEARCH FOREST DRIVE	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria, Flow

16481	1008F	LAKE WOODLANDS AT WESTERN REACH 110 METERS NORTH AND 100 METERS EAST OF INTERSECTION OF MEADOW COVE DR AND PLEASURE COVE DR IN THE WOODLANDS	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
16482	1008F	LAKE WOODLANDS AT SOUTH END 23 METERS NORTH AND 50 METERS EAST OF THE WEST EDGE OF DAM IN THE WOODLANDS	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
16483	1008F	LAKE WOODLANDS AT MID POINT 130 METERS NORTH AND 30 METERS EAST OF THE NORTHERN INTERSECTION OF E SHORE DR AND CAPE HARBOR PL IN THE WOODLANDS	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
16484	1008F	LAKE WOODLANDS AT NORTH END 111 METERS DOWNSTREAM OF RESEARCH FOREST DRIVE IN THE WOODLANDS	SJ	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
11185	1008H	WILLOW CREEK IMMEDIATELY UPSTREAM OF GOSLING ROAD	HH	MONTHLY/ QUARTERLY	Field, Conventional, Bacteria
20730	1008H	WILLOW CREEK AT TUWA ROAD APPROXIMATELY 859 METERS DOWNSTREAM OF FM 2920 ROAD IN NORTHERN HARRIS COUNTY	HH	BIMONTHLY	Field, Conventional, Bacteria
20462	1008I	WALNUT CREEK AT DECKER PRAIRIE ROSEHL ROAD NORTHWEST OF TOMBALL	HG	BIMONTHLY	Field, Conventional, Bacteria, Flow
20463	1008J	BRUSHY CREEK AT GLENMONT ESTATES BOULEVARD 265 METERS NORTH AND 35 METERS WEST TO THE INTERSECTION OF ARNDT LANE AND ANN CIRCLE WEST OF TOMBALL	HG	QUARTERLY	Field, Conventional, Bacteria, Flow

GS = United States Geological Survey
HG = Houston-Galveston Area Council
HH = Houston Health & Human Services
HW = Houston Water Quality Control
SJ = San Jacinto River Authority


Spring Creek - 1008
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
3
6
12
Miles

Segment 1008 Water Quality Standards and Screening Levels

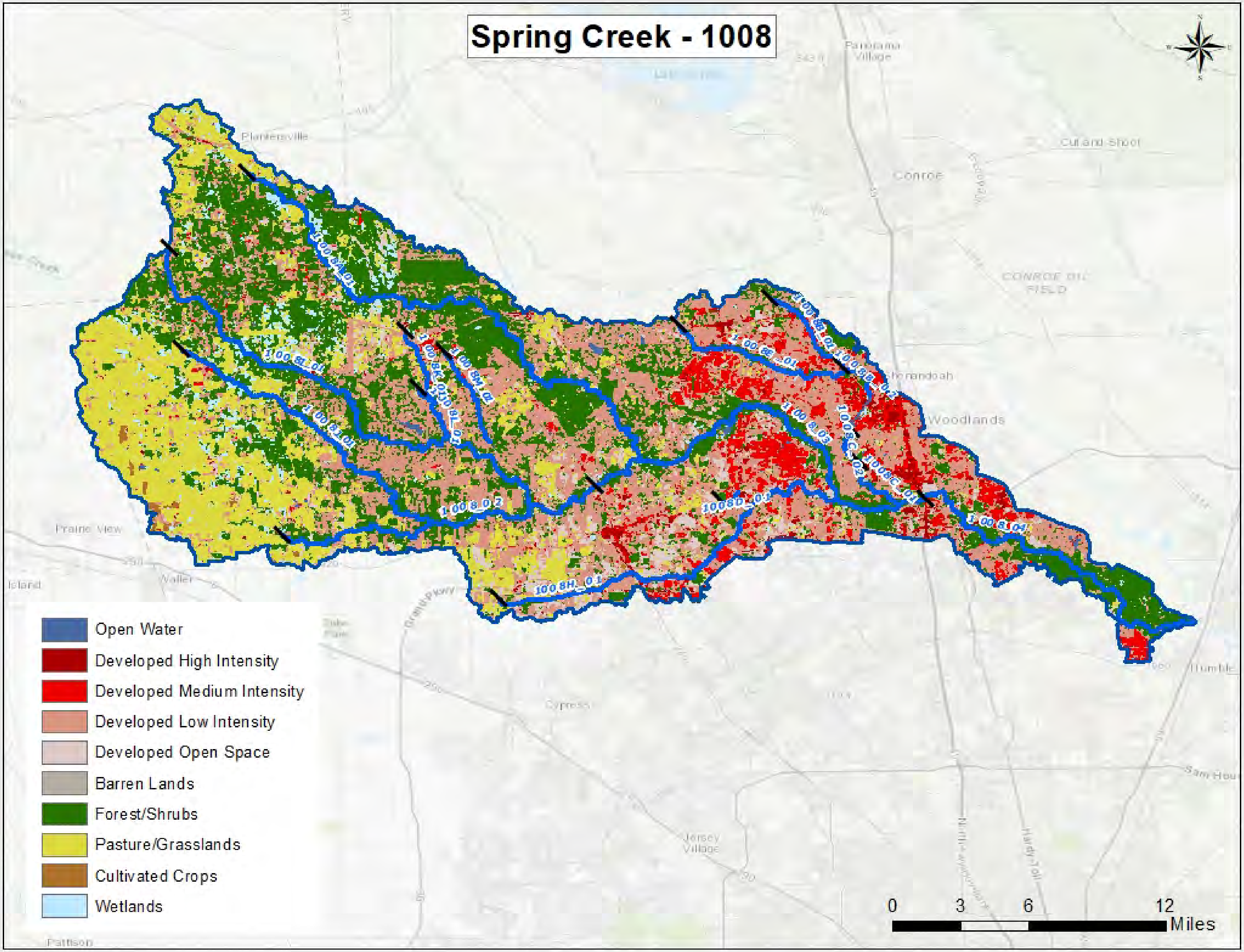
Standards	Perennial Stream	Reservoir	Intermittent w/ Pools	Screening Levels	Perennial Stream	Reservoir	Intermittent w/ Pools
Temperature (°C/°F):	32 / 90	32 / 90	32 / 90	Ammonia (mg/L):	0.33	0.11	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0 / 4.0 / 3.0	5.0	3.0	Nitrate-N (mg/L):	1.95	0.37	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	2.0	Orthophosphate Phosphorus (mg/L):	0.37	0.05	0.37
pH (standard units):	6.5-9.0	6.5-9.0	6.5-9.0	Total Phosphorus (mg/L):	0.69	0.2	0.69
E. coli (MPN/100 mL) (grab):	399	-	-	Chlorophyll *a* (µg/L):	14.1	26.7	14.1
E. coli (MPN/100 mL) (geometric mean):	126	126	126				
Chloride (mg/L as Cl):	100	100	100				
Sulfate (mg/L as SO_4):	50	50	50				
Total Dissolved Solids (mg/L):	450	450	450				
Drinking Water Human Health - Fluoride (mg/L)	4.0	4.0	-				
Drinking Water Human Health - Nitrate (mg/L)	10.0	10.0	-				

Segment Discussion

Watershed Characteristics and Land Cover: The Spring Creek (1008) segment is from the confluence with the West Fork San Jacinto River in Harris/Montgomery County to the most upstream crossing of FM 1736 in Waller County. This watershed area continues to experience rapid urban growth and development, especially around the cities of Tomball and The Woodlands, as well as the I-45 and SH 249 corridors. Between 2008 and 2018, the amount of developed land increased from 56,344 acres (19.94 percent) to 118,706 acres (42.02 percent). The areas around Spring, The Woodlands, Shenandoah, and Oak Ridge North have been growing for quite some time and continue to expand. Development around the cities of Tomball and Magnolia, located in the middle of the watershed, has escalated over recent years. Texas State Highway 249 is the major connector between these communities, which are changing from rural to more suburban landscapes. Farm-to-Market Roads 2920 in the south and 1488 in the north were widened to accommodate increased vehicular traffic in the area. Between I-45 at the west end and U.S. Highway 59 to the east, most of Spring Creek has been preserved as a greenbelt to help minimize flooding. The primary land cover west of Tomball is agricultural and cultivated lands. Grass, hay, and pasture production related to cattle and horse ranches are common. The forested areas in the middle and northwest portion of the watershed are interspersed by subdivisions platted with lots ranging from 0.5 to 5 acres in size. Ranchettes and hobby ranches are also common in that portion of the watershed. On-site sewage facilities (OSSFs) are the primary means of waste disposal in those areas.

Segment 1008 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	108,707.75	38.48	57,768.50	20.45	-46.86
Barren Lands	2,013.11	0.71	1,105.52	0.39	-45.08
Developed	56,344.29	19.94	118,706.34	42.02	110.68
Forest/Shrubs	83,593.96	29.59	91,025.46	32.22	8.89
Open Water	2,358.93	0.83	1,169.12	0.41	-50.44
Wetlands	29,499.39	10.44	12,755.60	4.51	-56.76
TOTAL	**282,517.43**	**100.00**	**282,530.55**	**100.00**	


Spring Creek - 1008
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
3
6
12
Miles

Water Quality Issues:

Public Water Supply Use
Public Water Supply use is fully supported in this segment.

Bacteria Impairments and Concerns
Recreation use is not supported in Spring Creek, with elevated levels of *E. coli* present in AUs 1008_02 (204.06 MPN/100 mL), 1008_03 (226.74 MPN/100 mL), and 1008_04 (234.61). AU 1008_01 was not assessed.

A concern has been identified in Mill Creek (1008A), but there were only 8 samples available for assessment during the 12/01/11 – 11/30/18 timeframe assessed for the 2020 Integrated Report. Impairments were found in Lower Panther Branch (1008C), with *E. coli* geometric means of 180.50 MPN/100 mL in AU 1008C_01 and 131.50 MPN/100 mL in AU 1008C_02.

Impairments were identified in Willow Creek (1008H), Walnut Creek (1008I), and Brushy Creek (1008J), with *E. coli* geometric means of 233.39, 171.12, and 184.34 MPN/100 mL respectively.

A watershed protection plan is being developed to address bacteria impairments in this watershed.

Dissolved Oxygen Impairments and Concerns
A concern due to dissolved oxygen screening levels has been identified in AU 1008F_01. In the 2020 Integrated Report, 10 of 64 samples (15.6 percent) were below the criteria of 5 mg/L.

Nutrient Concerns
Nutrient concerns for both nitrate-nitrogen and total phosphorus screening levels have been identified in portions of Spring Creek (1008_04), Upper Panther Branch (1008B_01), and Lower Panther Branch (1008C_01), as well as Willow Creek (1008I). A concern for total phosphorus is present in AU 1008C_02 of Lower Panther Branch.

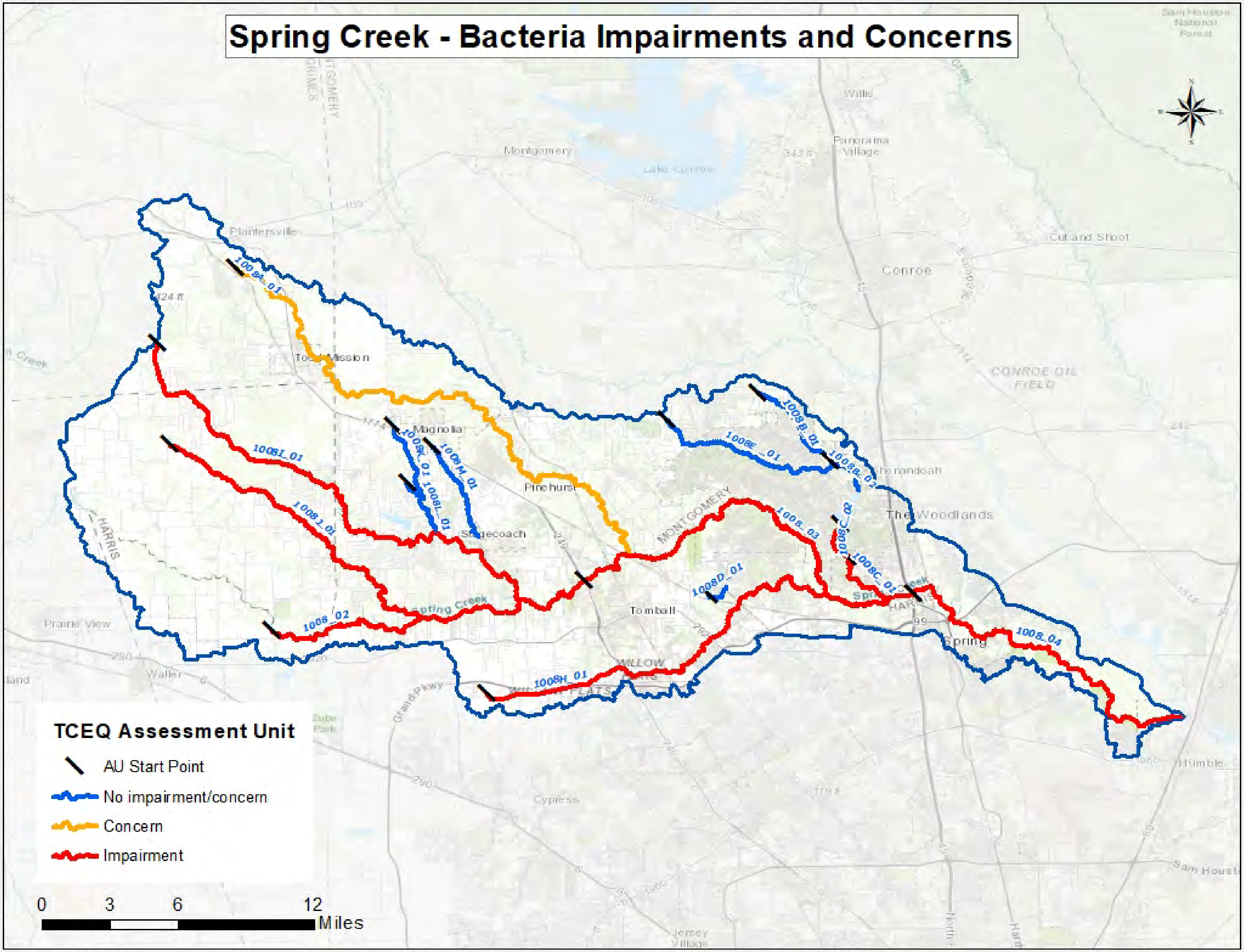
In AU 1008_04 (IH 45 to the confluence with Lake Houston), 51 of 64 nitrate-nitrogen samples (79.7 percent) exceeded the 1.95 mg/L screening level. In that same assessment unit, 41 of 64 total phosphorus samples (64.1 percent) exceeded the 0.69 mg/L screening level. In Upper Panther Branch, 18 of 21 (85.7 percent) nitrate-nitrogen and 20 of 21 (95.2 percent) total phosphorus samples exceeded the nutrient screening levels. In Lower Panther Branch (1008C_01), 16 of 21 nitrate-nitrogen samples (76.2 percent) and 18 of 21 total phosphorus samples (85.7 percent) exceeded the nutrient screening levels. In 1008C_02, 11 of 21 total phosphorus samples exceeded the screening level. For Willow Creek (1008H), 116 of 128 nitrate-nitrogen samples (90.6 percent) and 113 of 128 total phosphorus samples (88.3 percent) exceeded the nutrient screening levels.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

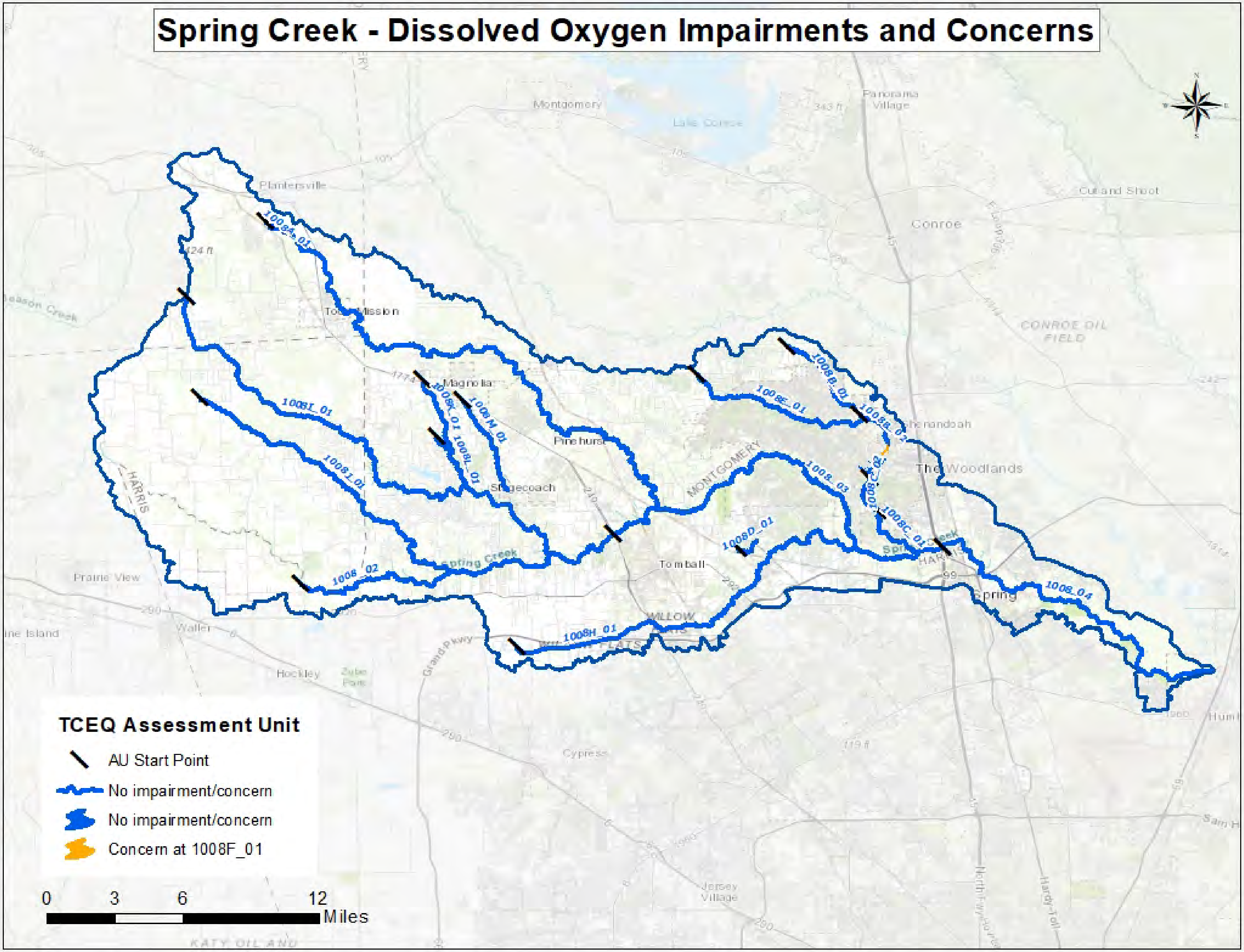
Chronic Toxic Substances in Water
A concern for chronic toxic substances in water (cadmium) has been identified in AU 1008B_01 of Upper Panther Branch.

Fish Community

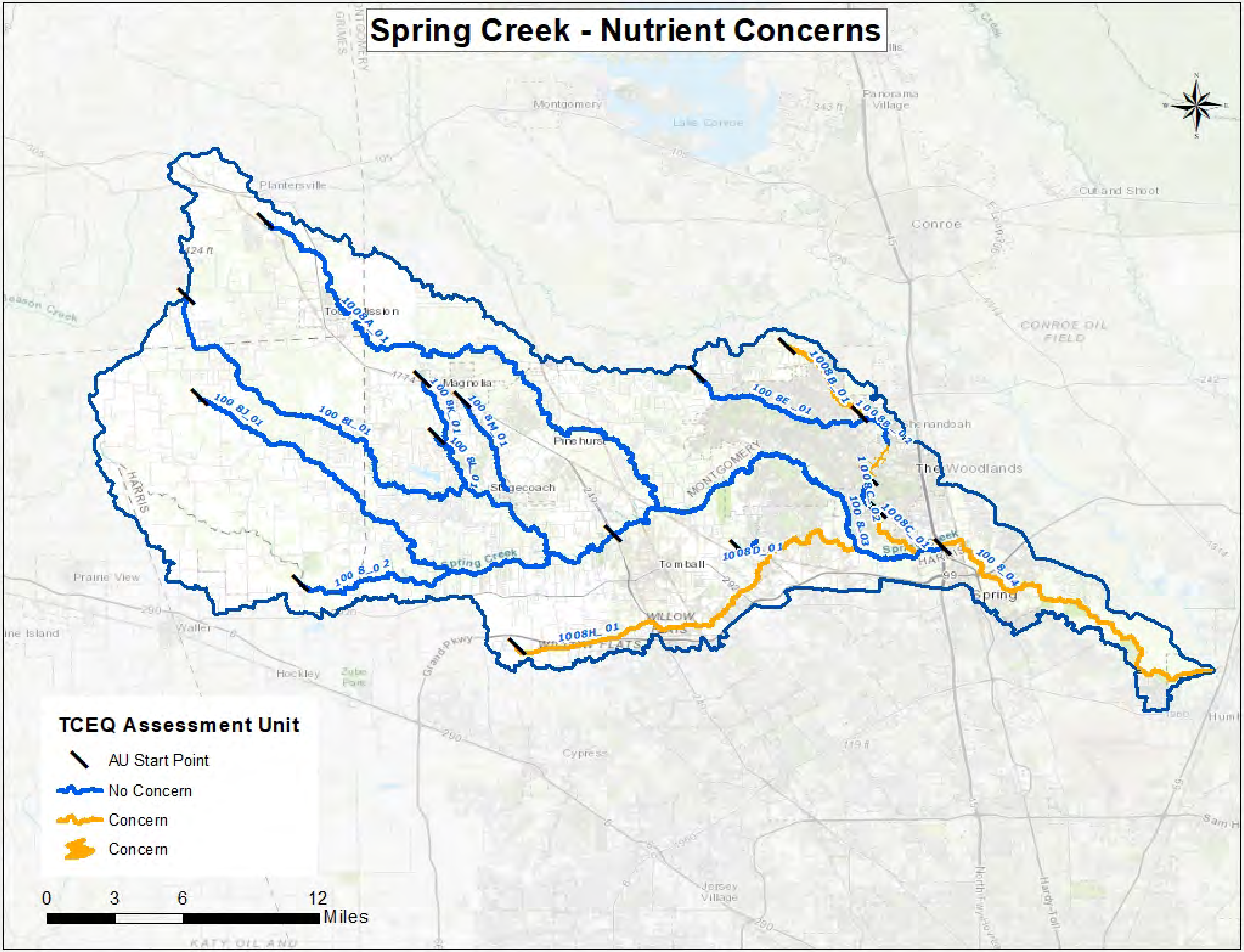
A concern for impaired fish community has been identified in a portion of Spring Creek. This concern is in assessment unit 1008_02, which is the portion of the segment from the Kickapoo Creek confluence to SH 249.

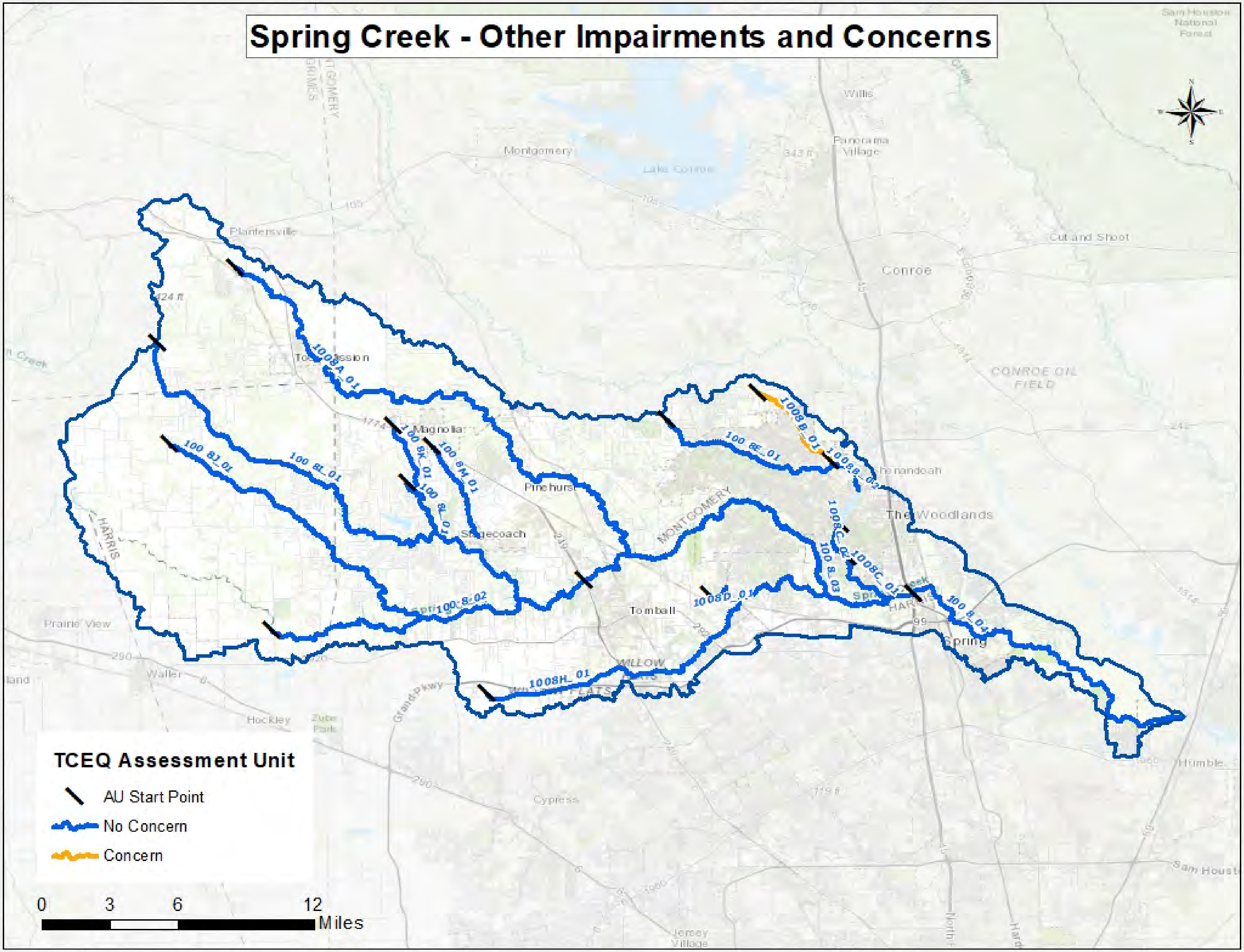


Spring Creek - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0
3
6
12
Miles
1008_04
1008_03
1008_02
1008H_01
1008I_01
1008J_01
1008E_01
1008B_01
1008C_01
1008D_01
1008M_01
Tomball
Spring
The Woodlands
Conroe
Magnolia
Pinehurst
Stagecoach
Cypress
Humble
Waller
Prairie View
Plantersville
Montgomery
Lake Conroe
Willis
Cut and Shoot
CONROE OIL FIELD


Spring Creek - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
No impairment/concern
Concern at 1008F_01
0
3
6
12
Miles
1008A_01
1008I_01
1008J_01
1008K_01
1008L_01
1008M_01
1008E_01
1008B_01
1008_03
1008D_01
1008C_01
1008_02
1008H_01
1008_04
Spring Creek
Plantersville
Todd Mission
Magnolia
Pinehurst
Stagecoach
Tomball
Conroe
The Woodlands
Spring
Montgomery
Lake Conroe
Panorama Village
Cut and Shoot
CONROE OIL FIELD
Prairie View
Waller
Hockley
Cypress
Jersey Village
MONTGOMERY
HARRIS

Spring Creek - Nutrient Concerns





Spring Creek - Other Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
3
6
12
Miles
1008A_01
1008J_01
1008L_01
1008K_01
1008M_01
1008I_01
1008_02
1008E_01
1008B_01
1008B_02
1008C_02
1008C_01
1008_03
1008D_01
1008_04
1008H_01
Plantersville
Magnolia
Pinehurst
Stagecoach
Tomball
Spring
The Woodlands
Conroe
Montgomery
Lake Conroe
Willis
Panorama Village
Cut and Shoot
CONROE OIL FIELD
Prairie View
Waller
Hockley
Cypress
Jersey Village
Humble
Shenandoah
Sam Houston National Forest

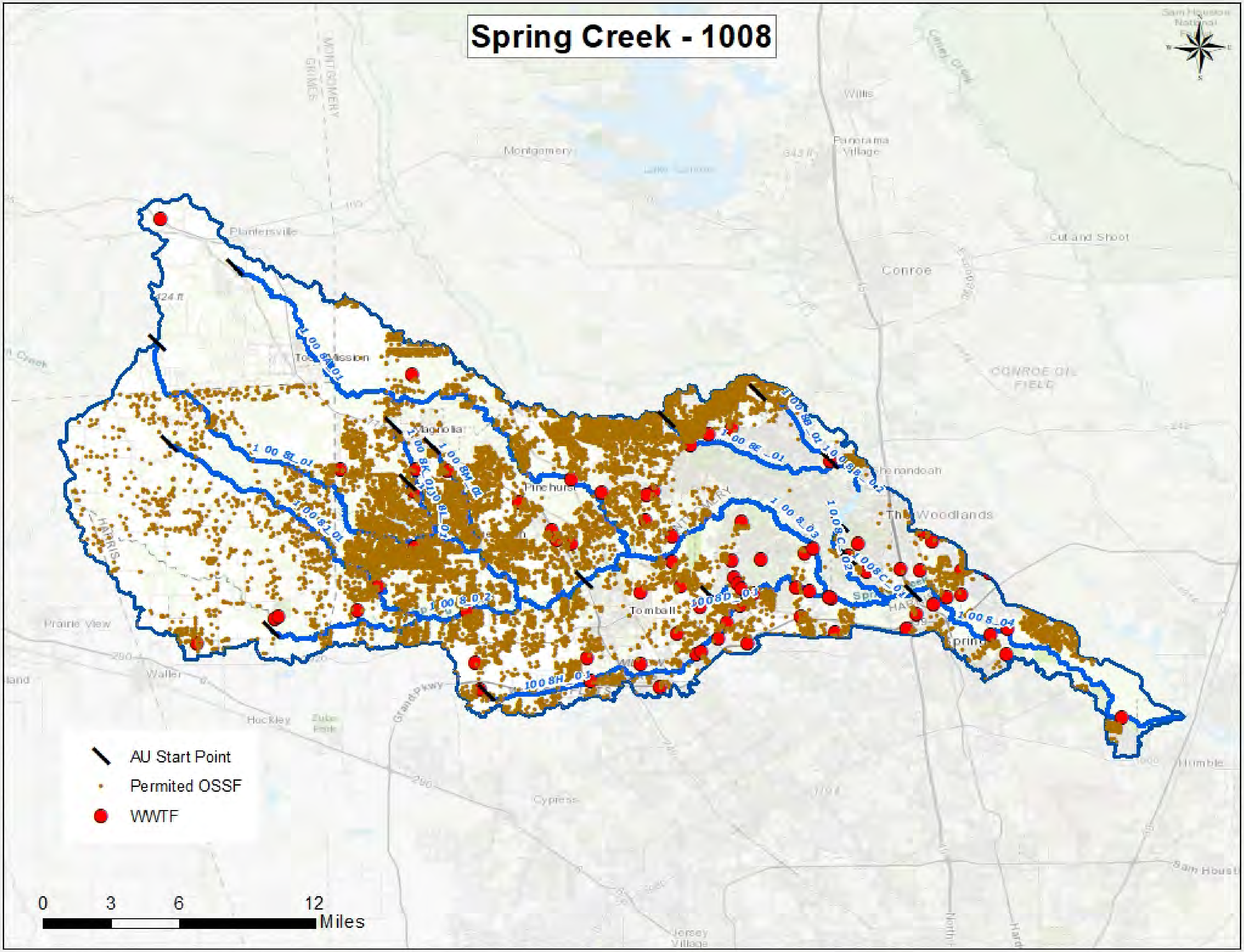
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Spring Creek watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, feral hogs, and animal waste.

There are 80 permitted wastewater outfalls in the Spring Creek watershed. In a large portion of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 15,969 permitted on-site sewage facilities in this watershed, the most of any segment in the Houston-Galveston region. The wastewater treatment facilities and on-site sewage facilities in the Spring Creek watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 176 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Upper Panther Branch (1008B_01) has a concern for chronic toxic substances in water due to the presence of dissolved cadmium. The most likely sources of cadmium are urban runoff and stormwater, leaching from fertilizers, spills or point source discharges, or other unknown industrial or urban sources.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Spring Creek watershed.



Spring Creek - 1008
AU Start Point
Permited OSSF
WWTF
0
3
6
12
Miles
Montgomery
Plantersville
Magnolia
Pinehurst
Tomball
Conroe
Willis
Panorama Village
Shenandoah
The Woodlands
Cut and Shoot
CONROE OIL FIELD
Prairie View
Waller
Hockley
Cypress
Humble
Jersey Village

Trend Analysis:

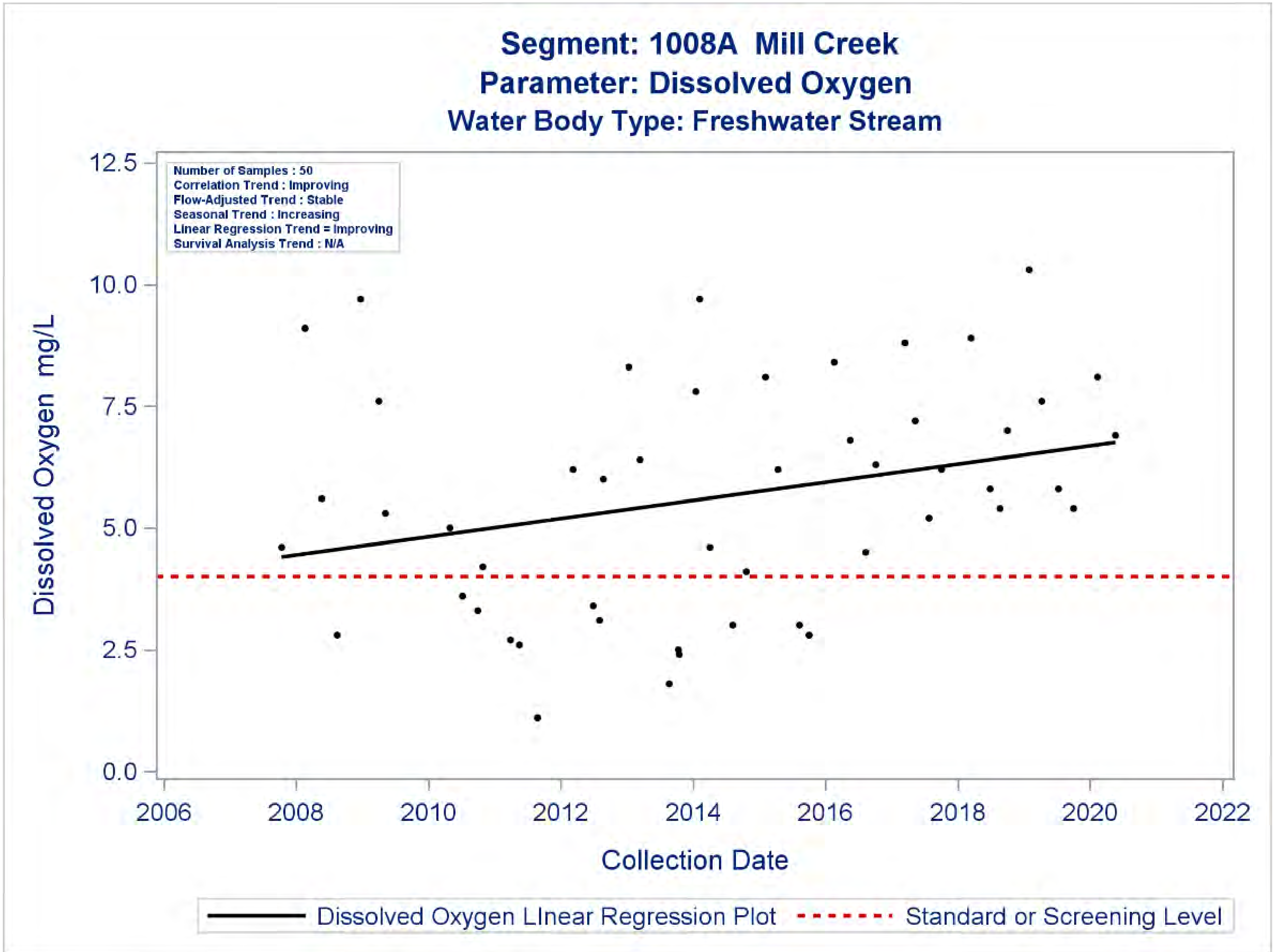
Regression analyses of Spring Creek watershed data from 2005 to 2020 identified appreciable trends in six parameters for the classified segment and a total of 13 parameters for the unclassified tributaries. Ammonia and total suspended solids (TSS) in the classified segment 1008 are increasing while chloride, Secchi transparency, TKN, and total phosphorous show decreasing trends. While Mill Creek (1008A) data shows increasing trends in DO instantaneous flow, and TSS as well as decreases in nitrate, Secchi transparency, sulfate, and TKN, it should be noted that the monitoring site on Mill Creek was moved in 2016. The old site was determined to be too close to a downstream man-made pond. The new site is further upstream and has a continuous flow that is more representative of the tributary. Trends on Upper Panther Branch (1008B) included increases in ammonia, DO, as well as decreases in *E. coli*, Secchi transparency, specific conductance, and pH. Lower Panther Branch (1008C) data shows an increase in ammonia and decreases in Secchi transparency, specific conductance, TKN and pH. Trends on Bear Branch (1008E) include increases in ammonia, DO, and total phosphorus as well as decreases in Secchi transparency depths, TKN, and pH. Lake Woodlands (1008F) data shows increasing trends in ammonia, DO, and Secchi transparency, as well as decreases in *E. coli*, specific conductance, TKN, TSS, and pH. Trends on Willow Creek (1008H) include decreases in Secchi transparency and pH. Walnut Creek (1008I) data shows increasing trends in nitrate and decreasing trends in sulfate and TKN. Trends on Brushy Creek (1008J) include increases in ammonia and pH as well as a decrease in TKN.

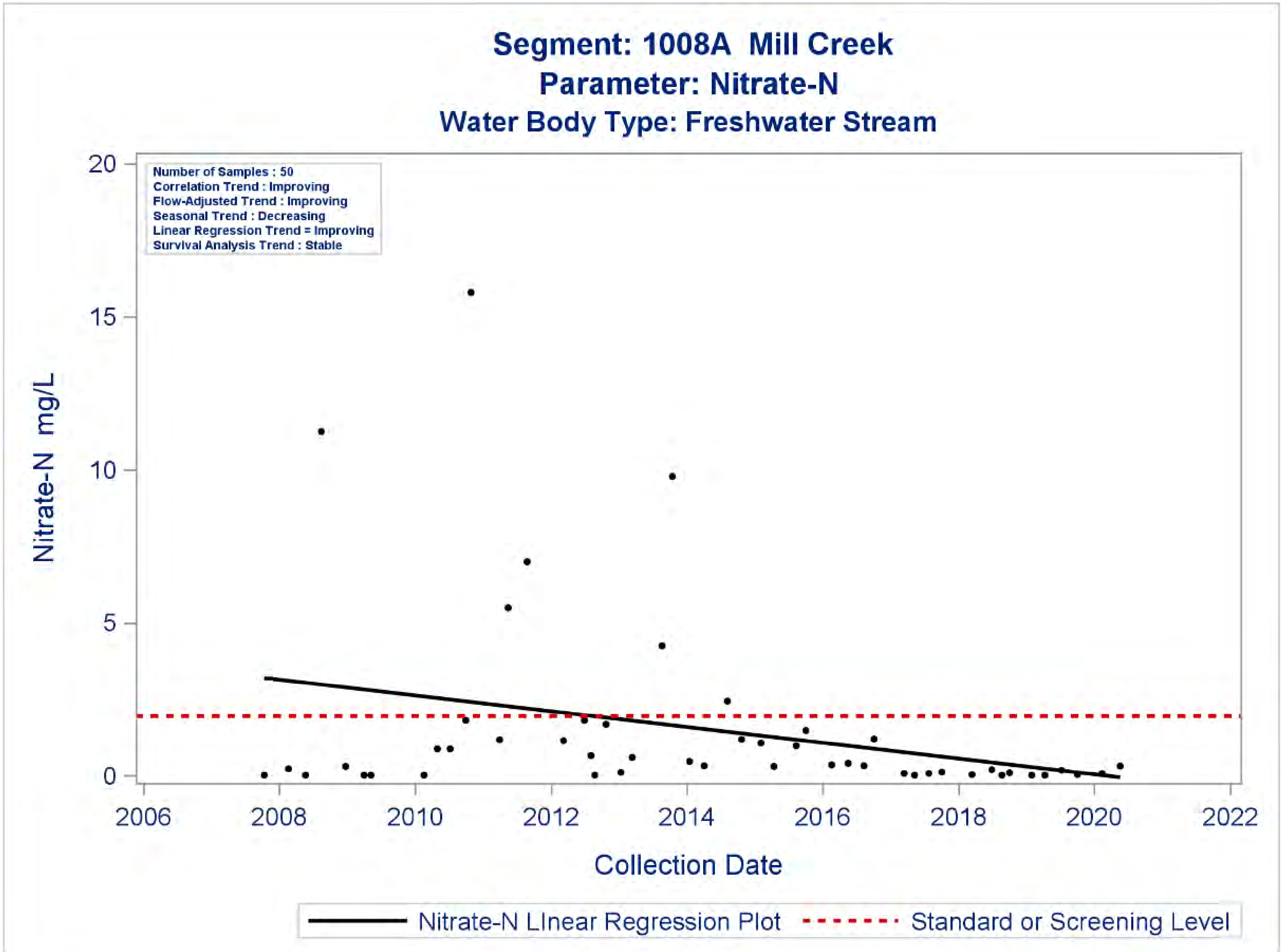
A common trend seen between the classified segment and most unclassified tributaries is a gradual decrease in Secchi transparency over the past 15 years. Exceptions include 1008I and 1008J where measurements have remained stable, and 1008F where Secchi transparency has increased and the water is less turbid on a regular basis. The main segment as well as unclassified tributary 1008A also show appreciable increases in TSS which further indicates poor water clarity. This may be partially due to sediment runoff from nearby construction sites, in addition to stormwater runoff and bank erosion.

Impairments for contact recreation use due to exceedances of the state water quality standard for *E. coli* geomean concentrations are present throughout the classified segment as well as the majority of unclassified tributaries. Though unclassified tributary 1008B and the Lake Woodlands Reservoir (1008F) have shown decreasing *E. coli* concentrations since 2005, the majority of samples continue to exceed the geometric mean standard of 126 MPN/100mL. These elevated levels of bacteria are likely related to rain events which cause collection systems overflow, WWTF and OSSF malfunctions, and waste from pets, livestock, and wildlife that enter area waterways via stormwater.

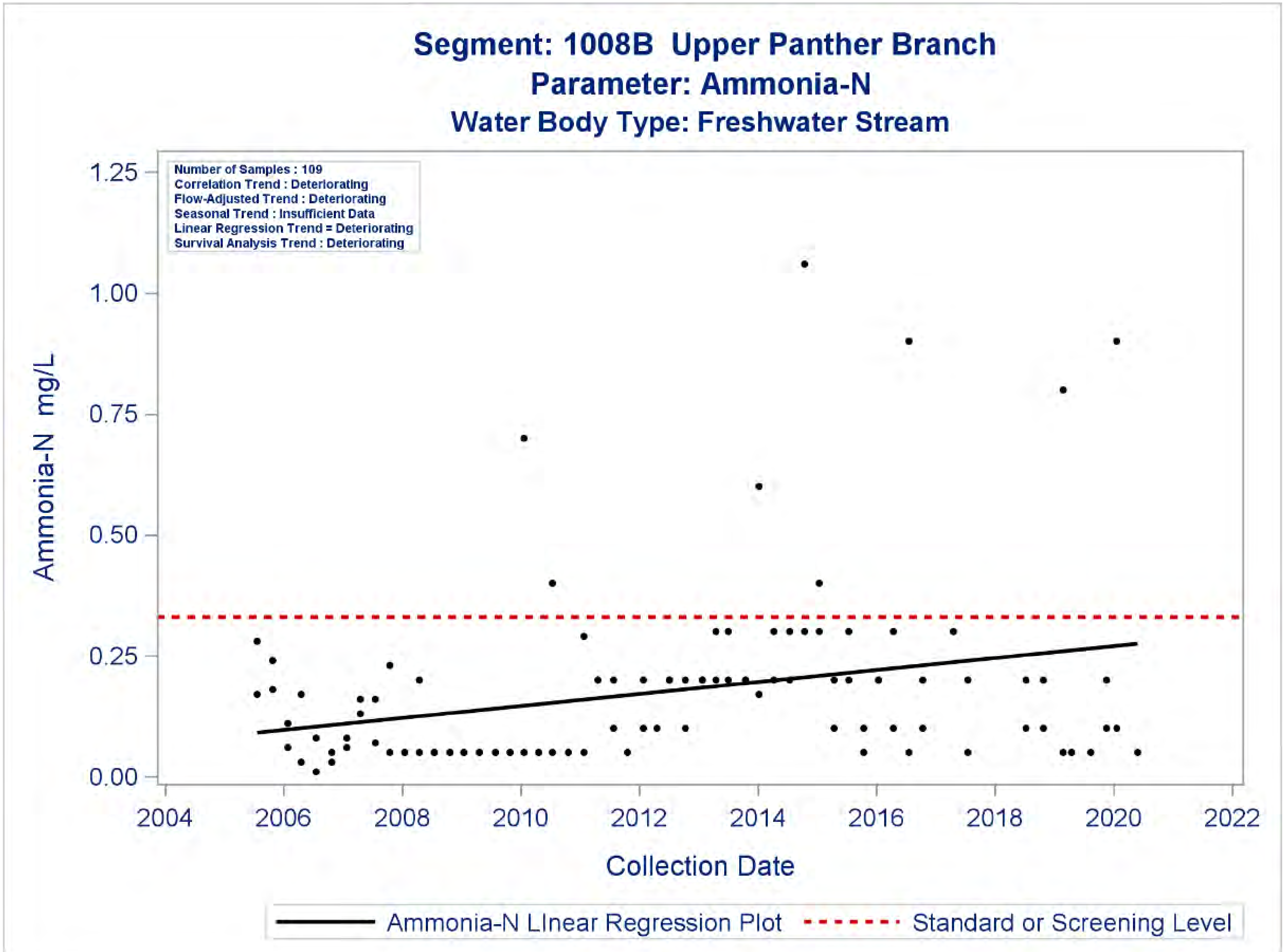
Nutrient concerns for nitrate and total phosphorus are present throughout the downstream AU (1008_04) of the classified segment, as well as the two unclassified tributaries that form a confluence with the downstream (1008B, 1008C, and 1008H). Data show nitrate and TP levels consistently above the designated screening criteria with generally stable trends seen throughout the watershed. Exceedances of the screening criteria are especially evident in Spring Creek (1008), Upper and Lower Panther Branch (1008B, 1008C), Lake Woodlands (1008F), and Willow Creek (1008H). Additionally, increasing trends in ammonia concentrations are pervasive throughout the classified segment and many of the unclassified tributaries. Among these, ammonia measurements at 1008F (Lake Woodlands) most frequently exceed the screening criteria of 0.11 mg/L. As Lake Woodlands is a drinking water supply source, it is notable that ammonia concentrations are increasing at monitoring stations located on segment 1008F. Increasing nutrients, and to a lesser extent, increasing ammonia, could be attributed to runoff from over-fertilized yards and landscaping, agricultural runoff, and WWTF effluent.

Waterbodies in the Spring Creek watershed have shown concerns for DO in recent years. However, grab sample DO levels show appreciable improvement in unclassified tributaries 1008A, 1008B, 1008E, and 1008F, and measurements well above the screening level throughout the watershed overall. Refer to the appendix section of this report to review all water quality graphs and trend analyses for segment 1008 that are not included in this summary.

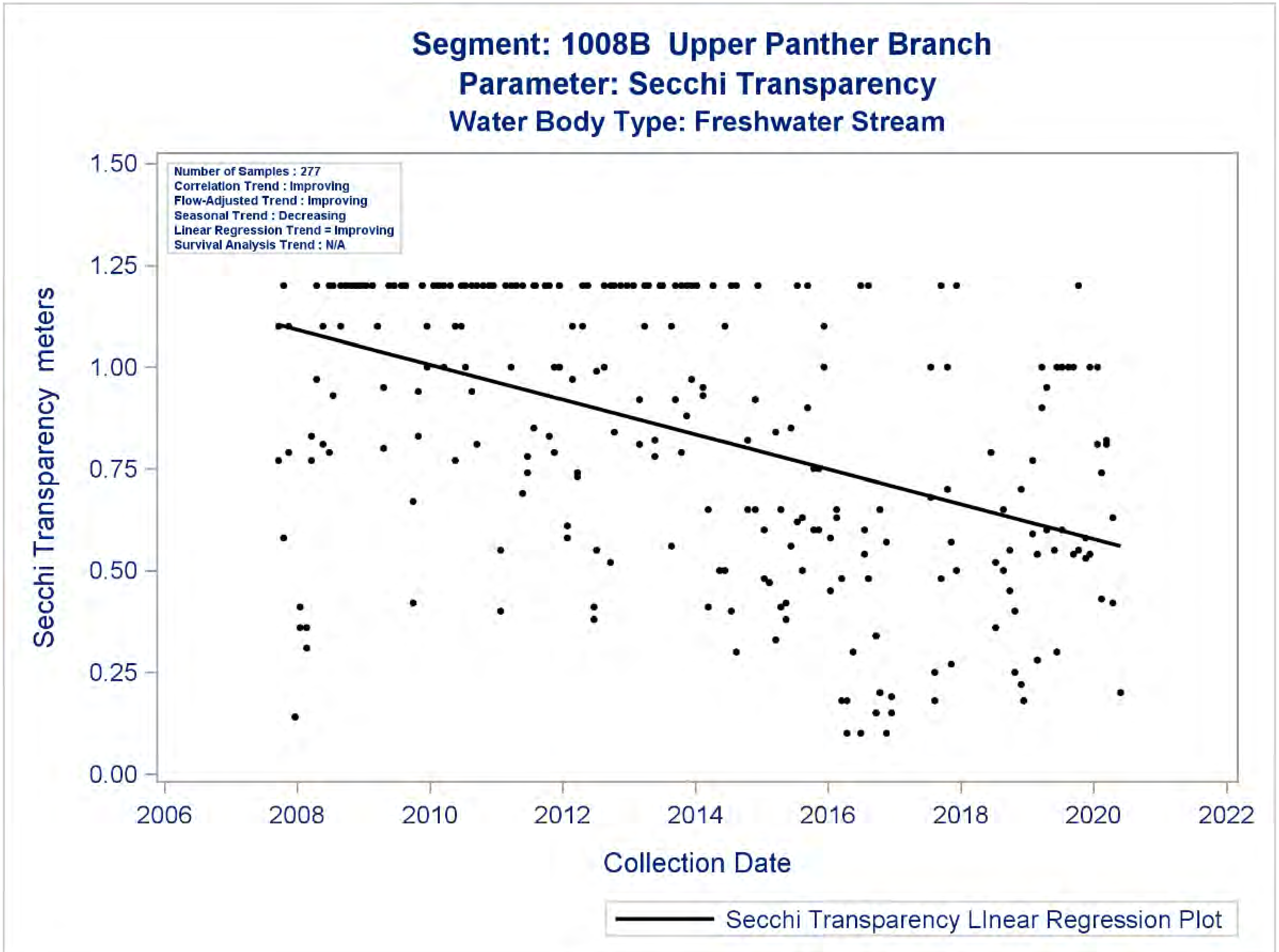

Segment: 1008A Mill Creek
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 50
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
12.5
10.0
7.5
5.0
2.5
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level

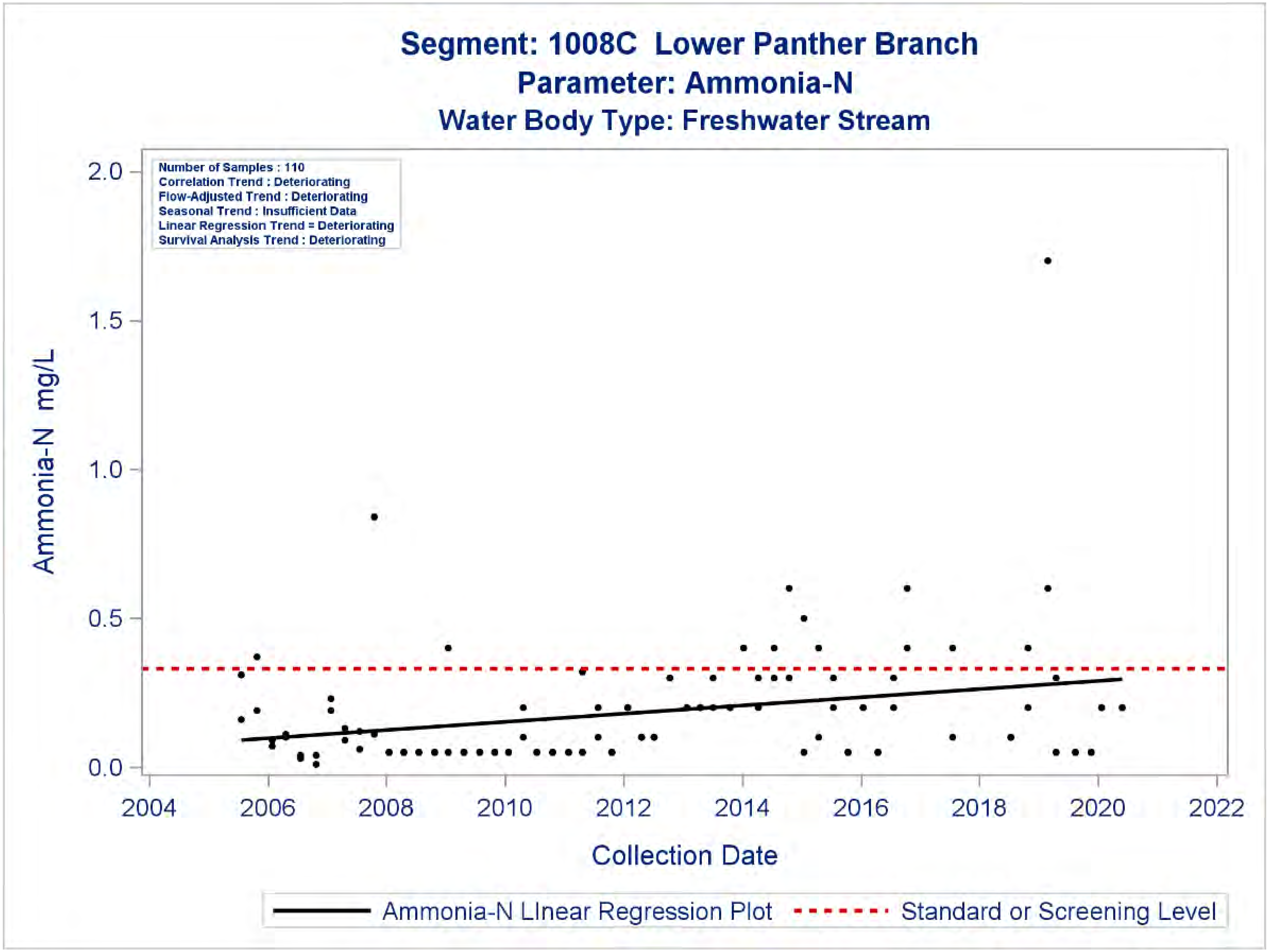


Segment: 1008A Mill Creek
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 50
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Stable
Nitrate-N mg/L
0
5
10
15
20
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

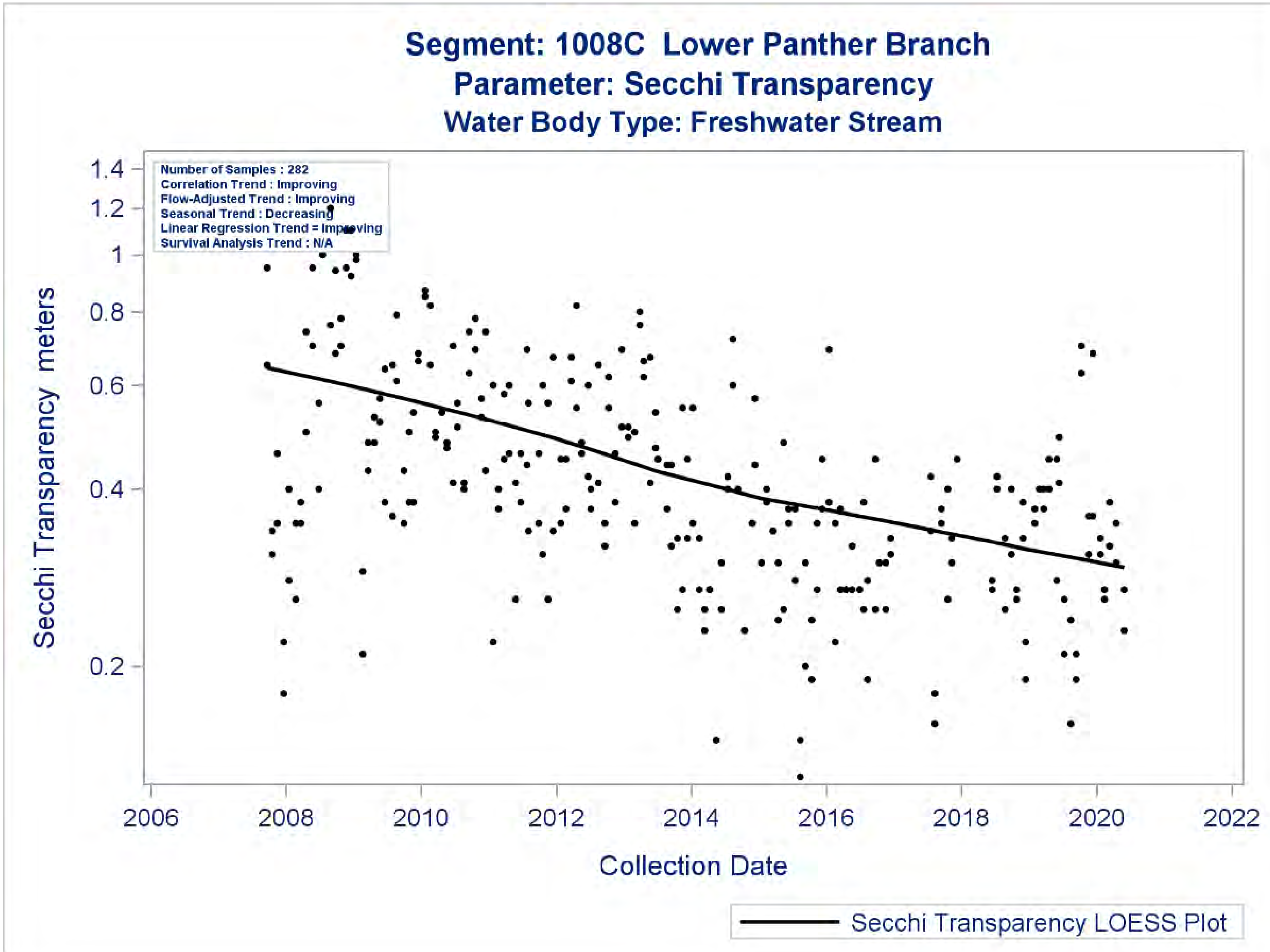


Segment: 1008B Upper Panther Branch
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 109
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

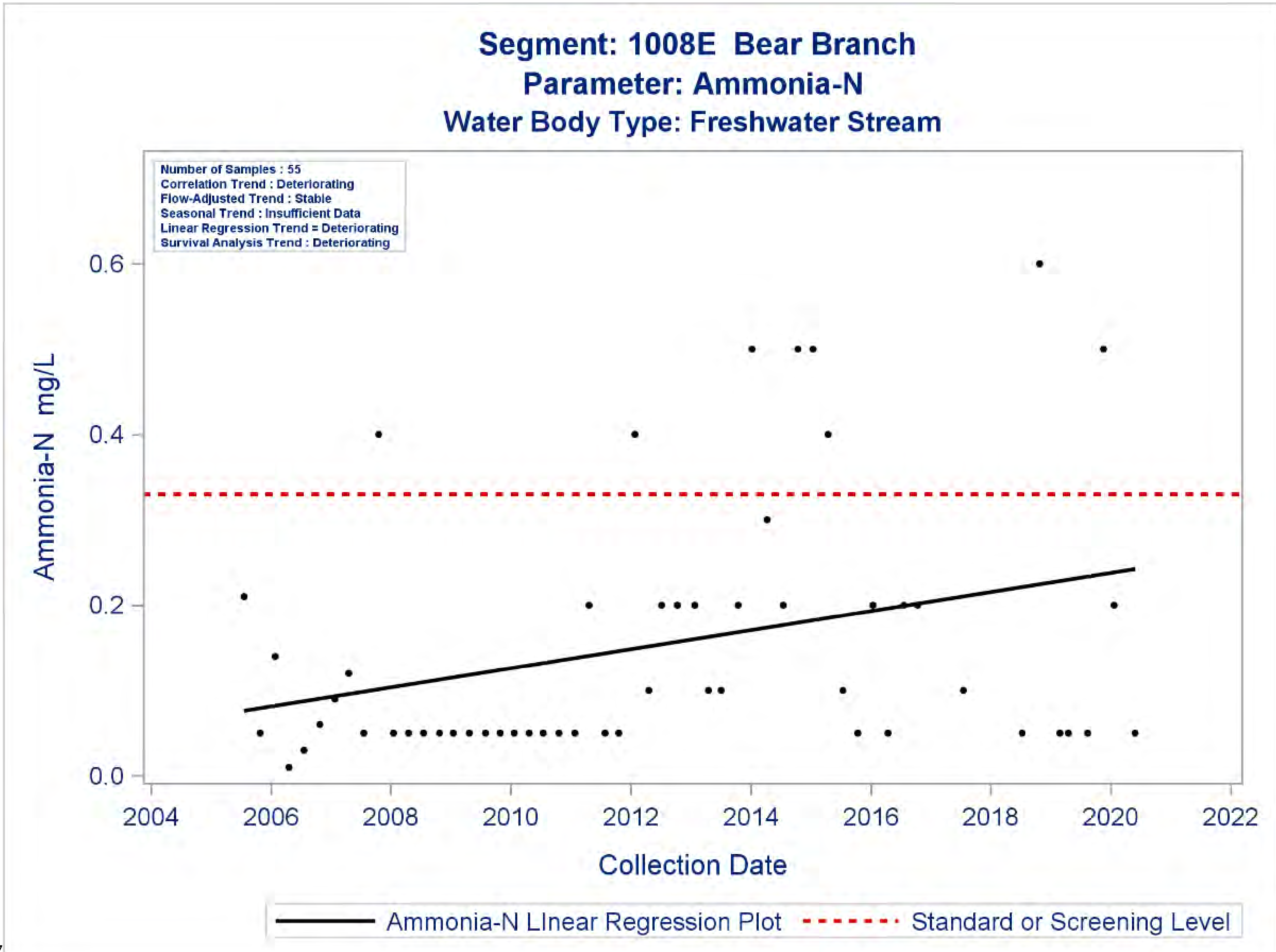

Segment: 1008B Upper Panther Branch
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 277
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot



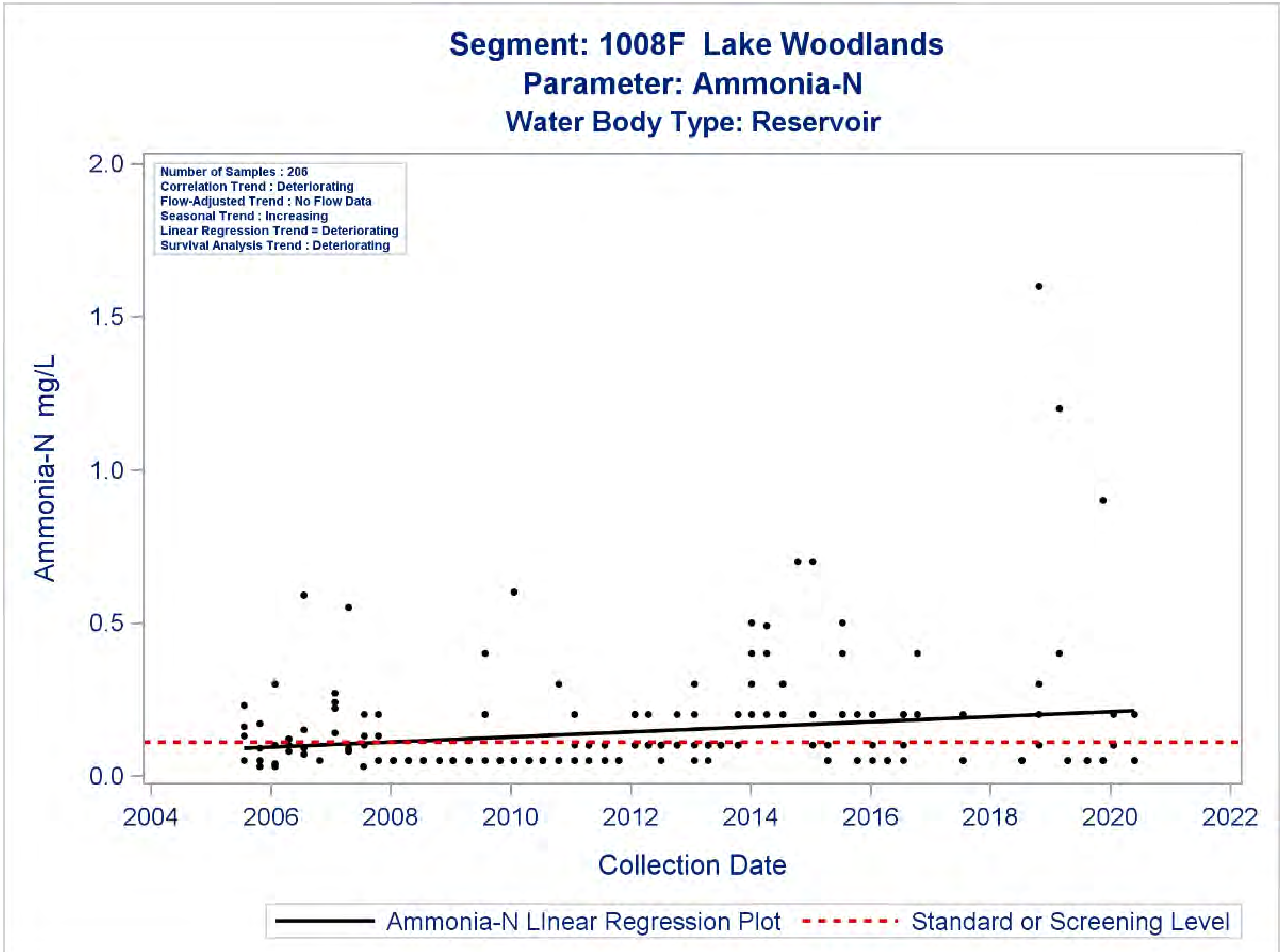
Segment: 1008C Lower Panther Branch
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 110
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level



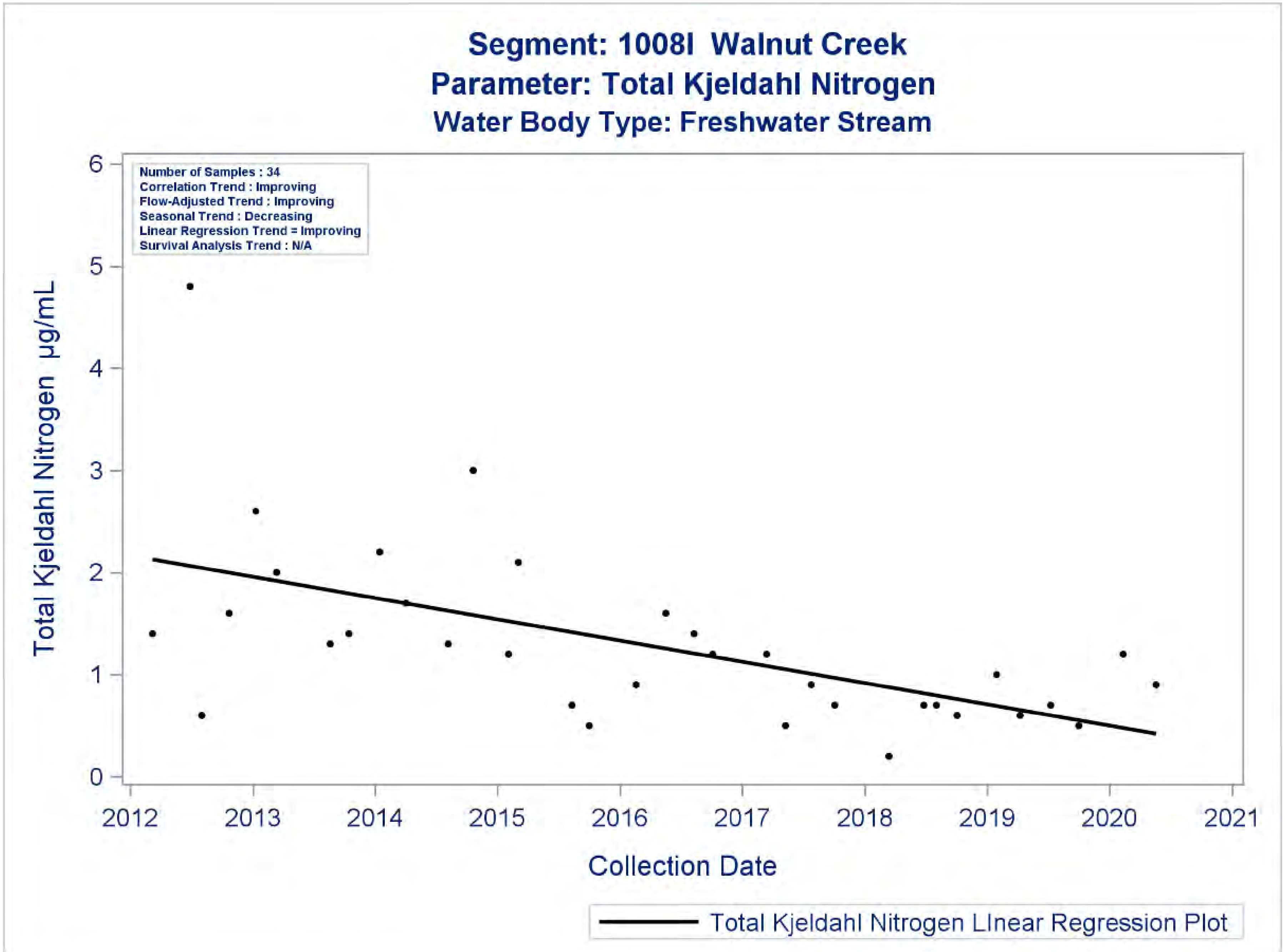
Segment: 1008C Lower Panther Branch
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 282
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.4
1.2
1
0.8
0.6
0.4
0.2
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot

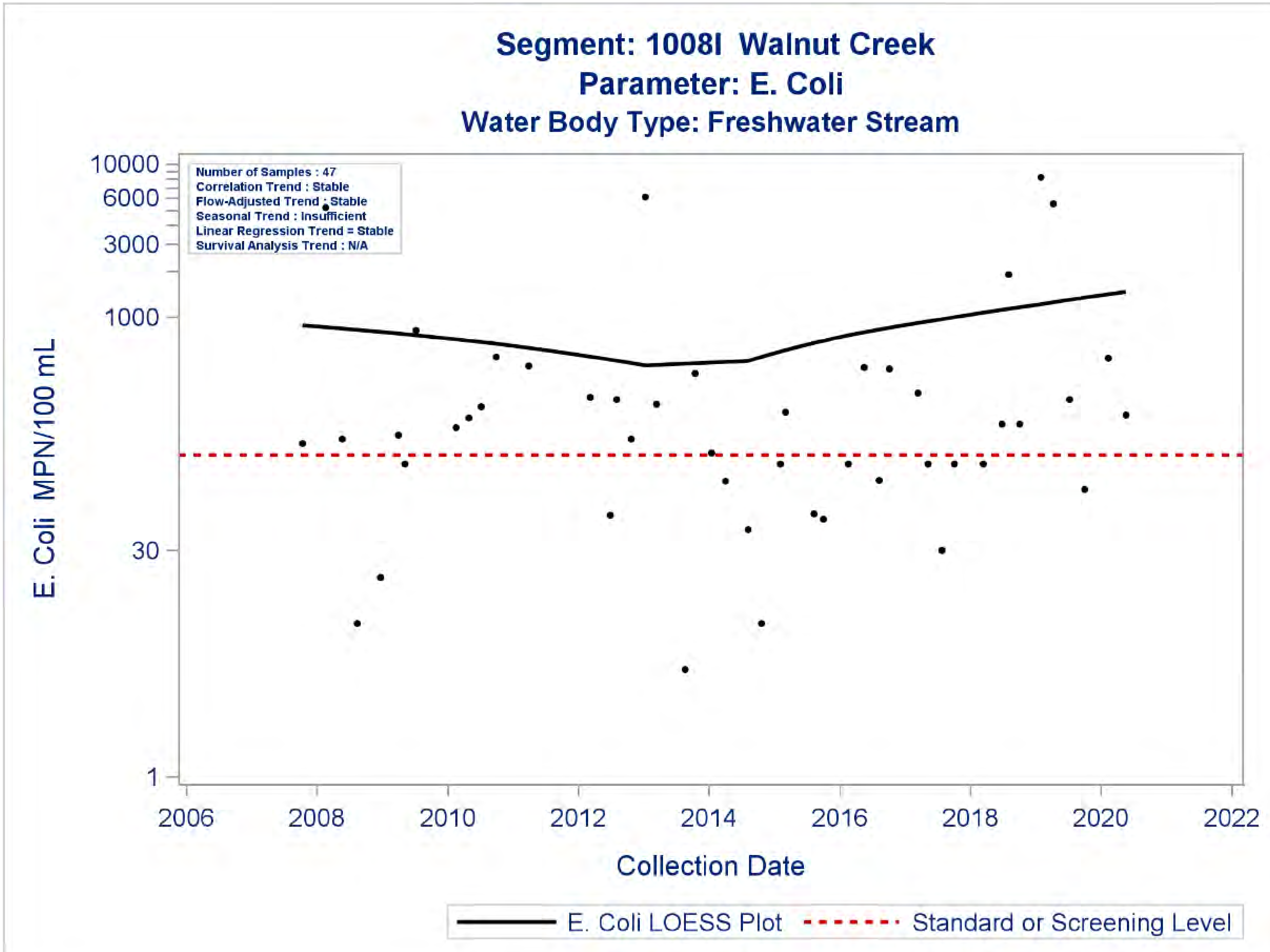


Segment: 1008E Bear Branch
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 55
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
0.0
0.2
0.4
0.6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



Segment: 1008F Lake Woodlands
Parameter: Ammonia-N
Water Body Type: Reservoir
Number of Samples : 206
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level


Segment: 1008I Walnut Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 34
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
6
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot


Segment: 1008I Walnut Creek
Parameter: E. Coli
Water Body Type: Freshwater Stream
Number of Samples : 47
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
E. Coli MPN/100 mL
10000
6000
3000
1000
30
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1008_02 I 1008_03 I 1008_04 I 1008A_01 C 1008C_01 I 1008C_02 I 1008H_01 I 1008I_01 I 1008J_01 I	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Urbanization and increased impervious cover • Constructed stormwater controls failing • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Improper pet waste disposal • Animal waste from agricultural production	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations or provide alternative power supplies during outages • Regionalize chronically non-compliant WWTFs • Ensure proper citing of new or replacement on-site sewage facilities • More public education regarding OSSF operation and maintenance • More public education on pet waste disposal • Improve stormwater controls in new developments by adding bacteria reduction measures • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties
Low Dissolved Oxygen Concentrations	1008F_01 C	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste)	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, and grease disposal; and OSSF maintenance • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices

		▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Vegetative canopy removed		• Create and implement Water Quality Management Plans for individual agricultural properties • Work with drainage districts and agencies to change practices of clear-cutting and channelizing waterways to protect from solar heating • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water.
Elevated Nutrient Concentrations	***Nitrate*** 1008_04 C 1008B_01 C 1008C_01 C 1008H_01 C ***Phosphorus*** 1008_04 C 1008B_01 C 1008C C 1008H_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Can increase algal production • Algal growth can affect dissolved oxygen concentrations • Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Chronic Toxic Substances in Water (Cadmium)	1008B_01 C	• Unknown industrial or urban sources • Waste disposal and spills • Leaching from fertilizers • Urban runoff and urban stormwater	• Detrimental to the aquatic biological community • Cadmium is a known carcinogen and targets the body's cardiovascular, renal, gastrointestinal, neurological, reproductive, and respiratory systems	• Improve compliance and enforcement of existing stormwater quality permits • Industrial pretreatment of wastewater
Fish Community	1008_02 C	• Loss of habitat due to channelization of waterway • Ongoing maintenance of modified channel	• Detrimental to the aquatic biological community	• Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat • Work with local authorities to minimize sediment runoff from construction sites

Special Studies:

A Spring Creek Watershed Protection Plan is scheduled for development. Planning for this project began in 2019, and the Spring Creek Watershed Partnership first convened in the summer of 2020. Pollutant sources and reduction targets for the watershed have been modeled, and the Partnership is now focusing on approving the model results before selecting the most appropriate water quality improvement strategies. Once these are decided, the development of the Watershed Protection Plan document is expected to continue well into 2021. More information can be found at springcreekpartnership.com.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number:	1004	Name:	West Fork San Jacinto River

Length:	40 miles	Watershed Area:	216 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	6	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	37

DESCRIPTION

- Segment 1004 (Perennial Stream): **West Fork San Jacinto** (classified water body) – From the confluence of Spring Creek in Harris/Montgomery County to Conroe Dam in Montgomery County

- Segment 1004A (Perennial Stream w/ intermediate ALU): **East Fork White Oak Creek** (unclassified water body) – Perennial stream from the confluence with White Oak Creek upstream to the confluence of an unnamed tributary approximately 0.4 km upstream of League Line Road in the City of Panorama Village

- Segment 1004B (Perennial Stream w/ intermediate ALU): **West Fork White Oak Creek** (unclassified water body) – Perennial stream from the confluence with White Oak Creek and West Fork San Jacinto River upstream to an on-channel impoundment of West Fork White Oak Creek 1.2 km upstream of League Line Road

- Segment 1004C (Perennial Stream w/ intermediate ALU): **Unnamed Tributary** (unclassified water body) – Perennial stream from the confluence of the West Fork San Jacinto River upstream to the Missouri-Pacific Railroad bridge crossing located east of IH 45 north of Needham Road approximately 10 km south of the City of Conroe

- Segment 1004D (Perennial Stream w/ high ALU): **Crystal Creek** (unclassified water body) — From the West Fork of the San Jacinto River confluence to the confluence of the east and west forks of Crystal Creek

- Segment 1004E (Perennial Stream w/ high ALU): **Stewarts Creek** (unclassified water body) — From the West Fork of the San Jacinto River to the headwaters northwest of Old Montgomery Road

- Segment 1004F (Perennial Stream w/ high ALU): **Woodsons Gully** (unclassified water body) — Perennial stream from the confluence with West Fork San Jacinto River upstream to the confluence with an unnamed tributary approximately 1.9 km upstream from Riley-Fussel Road

- Segment 1004G (Perennial Stream w/ high ALU): **West Fork of Crystal Creek** (unclassified water body) – From the Crystal Creek confluence upstream of a point 0.30 km (0.19 mi) northeast of the FM 3083 and Loop 336 intersection

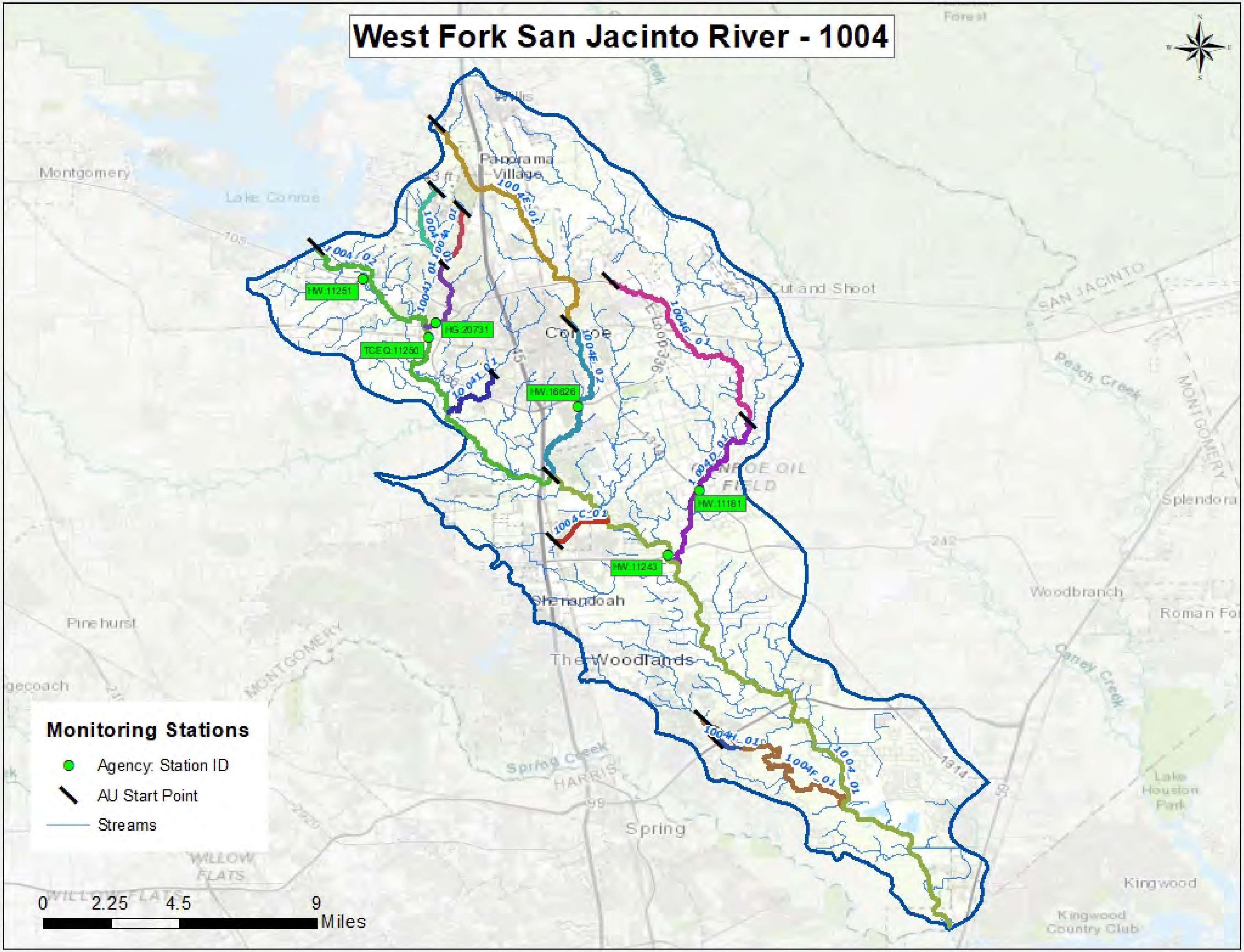
- Segment 1004H (Perennial Stream w/ high ALU): **Unnamed Tributary of Woodsons Gully** (unclassified water body) – Perennial stream from the confluence with Woodsons Gully upstream to the headwaters

- Segment 1004I (Perennial Stream w/ high ALU): **Alligator Creek** (unclassified water body) – From the confluence of the West Fork of the San Jacinto River to 0.43 mi upstream of where the water body crosses Sgt Ed Holcomb Blvd.

- Segment 1004J (Perennial Stream w/ high ALU): **White Oak Creek** (unclassified water body) – Perennial stream from the confluence with West Fork San Jacinto River upstream to the confluence with East Fork White Oak Creek and West Fork White Oak Creek in Conroe

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11243	1004	WEST FORK SAN JACINTO RIVER IMMEDIATELY UPSTREAM OF SH 242	HW	BIMONTHLY	Field, Conventional, Bacteria
11250	1004	WEST FORK SAN JACINTO RIVER AT FM 2854 WEST OF CONROE	FO	QUARTERLY	Field, Conventional, Bacteria, Flow
11251	1004	WEST FORK SAN JACINTO RIVER IMMEDIATELY DOWNSTREAM OF SH 105 NW OF CONROE CAMS772	HW	BIMONTHLY	Field, Conventional, Bacteria, Flow
11181	1004D	CRYSTAL CREEK AT FM 1314 SOUTHEAST OF CONROE	HW	BIMONTHLY TEN/YEAR	Field, Conventional, Bacteria Field, Flow
16626	1004E	STEWARTS CREEK 175 METERS DOWNSTREAM OF SH LOOP 336 SOUTHEAST OF CONROE	HW	BIMONTHLY	Field, Conventional, Bacteria
20731	1004J	WHITE OAK CREEK AT MEMORIAL DRIVE IN CONROE	HG	QUARTERLY	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
HG = Houston-Galveston Area Council
HW = Houston Water Quality Control



West Fork San Jacinto River - 1004
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0
2.25
4.5
9
Miles
HW:11251
HG:20731
TCEQ:11250
HW:16626
HW:11181
HW:11243
1004A_02
1004E_01
1004G_01
1004E_02
1004I_01
1004D_01
1004C_01
1004H_01
1004F_01
1004_01
Montgomery
Lake Conroe
Panorama Village
Willis
Conroe
Cut and Shoot
Shenandoah
The Woodlands
Spring
Pinehurst
Woodbranch
Splendora
Kingwood
Kingwood Country Club
Lake Houston Park
Spring Creek
Peach Creek
Caney Creek
Conroe Oil Field
Willow Flats

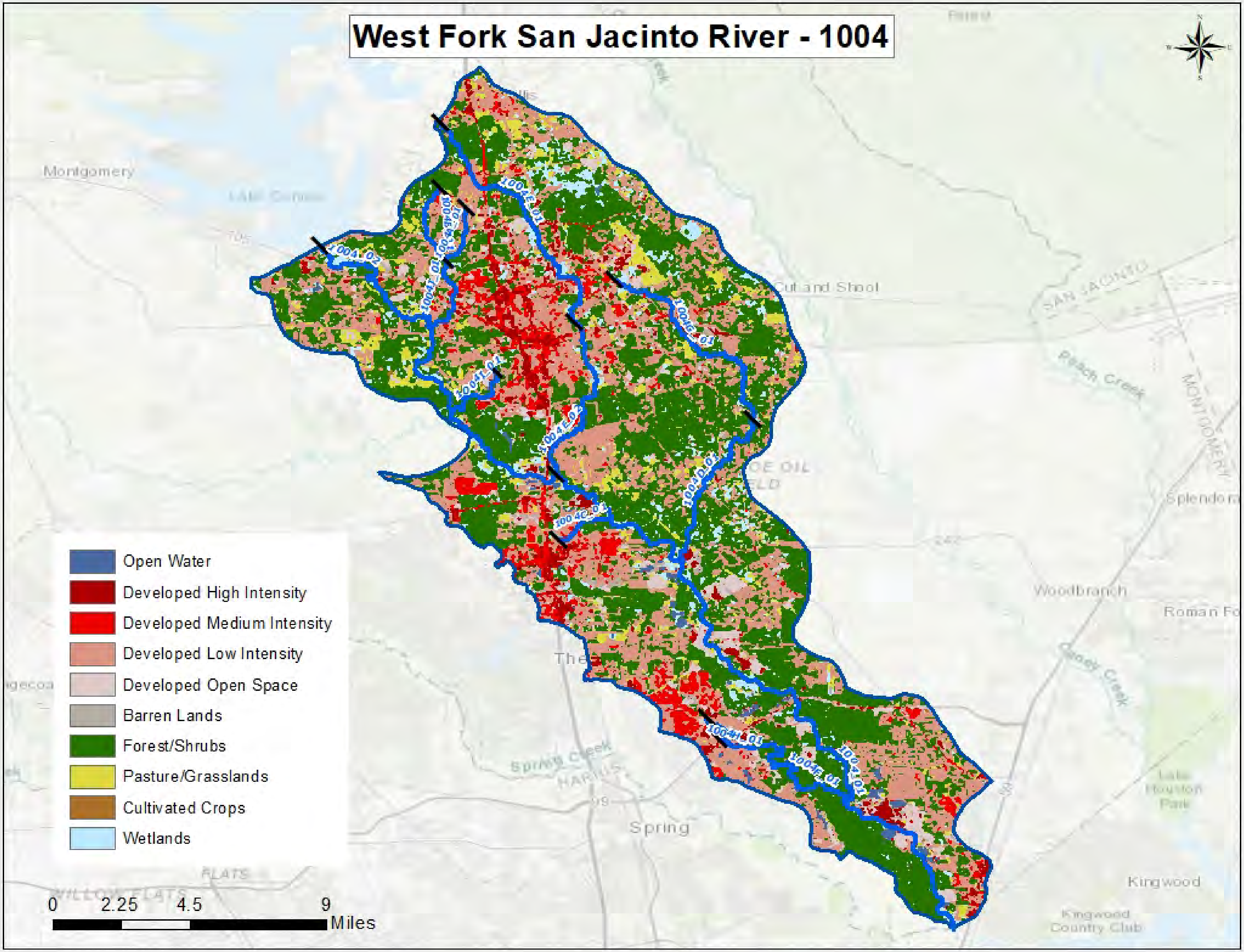
Segment 1004 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	Ammonia (mg/L):	0.33
Dissolved Oxygen (24-Hr Average) (mg/L):	5.0 / 4.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen (Absolute Minima) (mg/L):	3.0 / 3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	100		
Sulfate (mg/L as SO4):	50		
Total Dissolved Solids (mg/L):	400		

Segment Discussion

Watershed Characteristics and Land Cover: The West Fork San Jacinto River segment (1004) lies between U.S. Hwy 59 on the west fork of Lake Houston to the south and Lake Conroe to the north and covers approximately 138,450 acres. Forests/Shrubs (42.51 percent) and Developed (41.46 percent) are the primary land cover types. Several concentrated urban areas lie within the watershed boundaries including The City of Conroe and Willis to the north, Shenandoah and surrounding Woodlands and Oak Ridge North developments in the center, and Porter, Kingwood, and the City of Houston to the south. The majority of river segments are lined with wooded riparian buffers from north to south. Primary urban development is residential and commercial with smaller subdivisions and hobby farms present throughout the watershed. There is little industrial activity in the area with pockets of agricultural land uses dispersed throughout the northern portion of the watershed. The Sam Houston National Forest is located in the northern portion of the watershed. Commercial logging occurs intermittently throughout the area.

Segment 1004 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	28,785.06	20.79	10,348.86	7.47	-64.05
Barren Lands	2,972.51	2.15	2,052.25	1.48	-30.96
Developed	34,136.74	24.66	57,401.33	41.46	68.15
Forest/Shrubs	41,905.84	30.27	58,854.90	42.51	40.45
Open Water	3,359.03	2.43	1,043.47	0.75	-68.94
Wetlands	27,296.36	19.71	8,746.52	6.32	-67.96
TOTAL	**138,455.56**	**100.00**	**138,447.33**	**100.00**	



West Fork San Jacinto River - 1004
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
2.25
4.5
9
Miles
Montgomery
Cut and Shoot
Peach Creek
Woodbranch
Spring
Kingwood
Spring Creek
Caney Creek
1004_02
1004E_01
1004I_01
1004G_01
1004D_01
1004E_02
1004C_01
1004H_01
1004F_01
1004J_01

Water Quality Issues:

Public water supply, aquatic life, and fish consumption uses are fully supported in West Fork San Jacinto River (1004). The water body is impaired for recreational use.

Bacteria Impairments and Concerns

The 2020 Texas Integrated Report lists both assessment units of this segment and two of its tributaries, Stewarts Creek (1004E_02) and White Oak Creek (1004J_01), as impaired for recreational use due to elevated levels of bacteria. For the main classified segment, the *E. coli* geometric mean was 161.95 MPN/100 mL in AU 1004_01 and 191.72 MPN/100 mL in AU 1004_02. For Stewarts Creek, the *E. coli* geometric mean was 149.25 MPN/100 mL, and in White Oak Creek, which is heavily influenced by stormwater runoff from the Conroe area, the geometric mean was 3,324.90 MPN/100 mL.

Dissolved Oxygen Impairments or Concerns

There are no dissolved oxygen impairments in this segment.

Nutrient Concerns

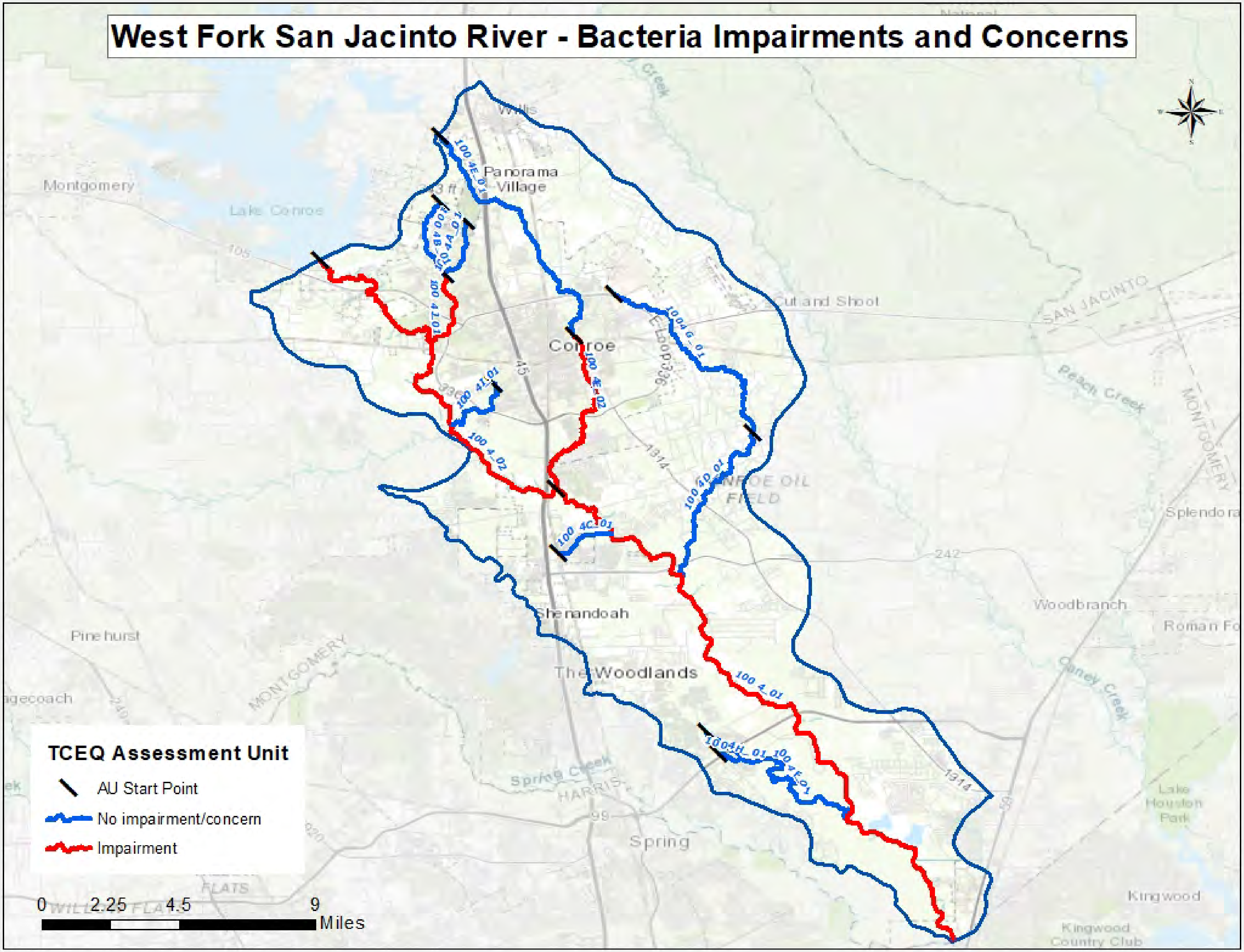
A screening level concern for nitrate is present in AU 1004_01, in the lower portion of the watershed. For this parameter, 15 of 39 results (38.5 percent) exceeded the screening level criteria of 1.95 mg/L.

PCBs and Dioxins Impairments

There are no PCBs/Dioxins impairments in this segment.

Other Impairments and Concerns

In AU 1004_02, a concern for impaired macrobenthic community in water was identified in the 2020 Texas Integrated Report.



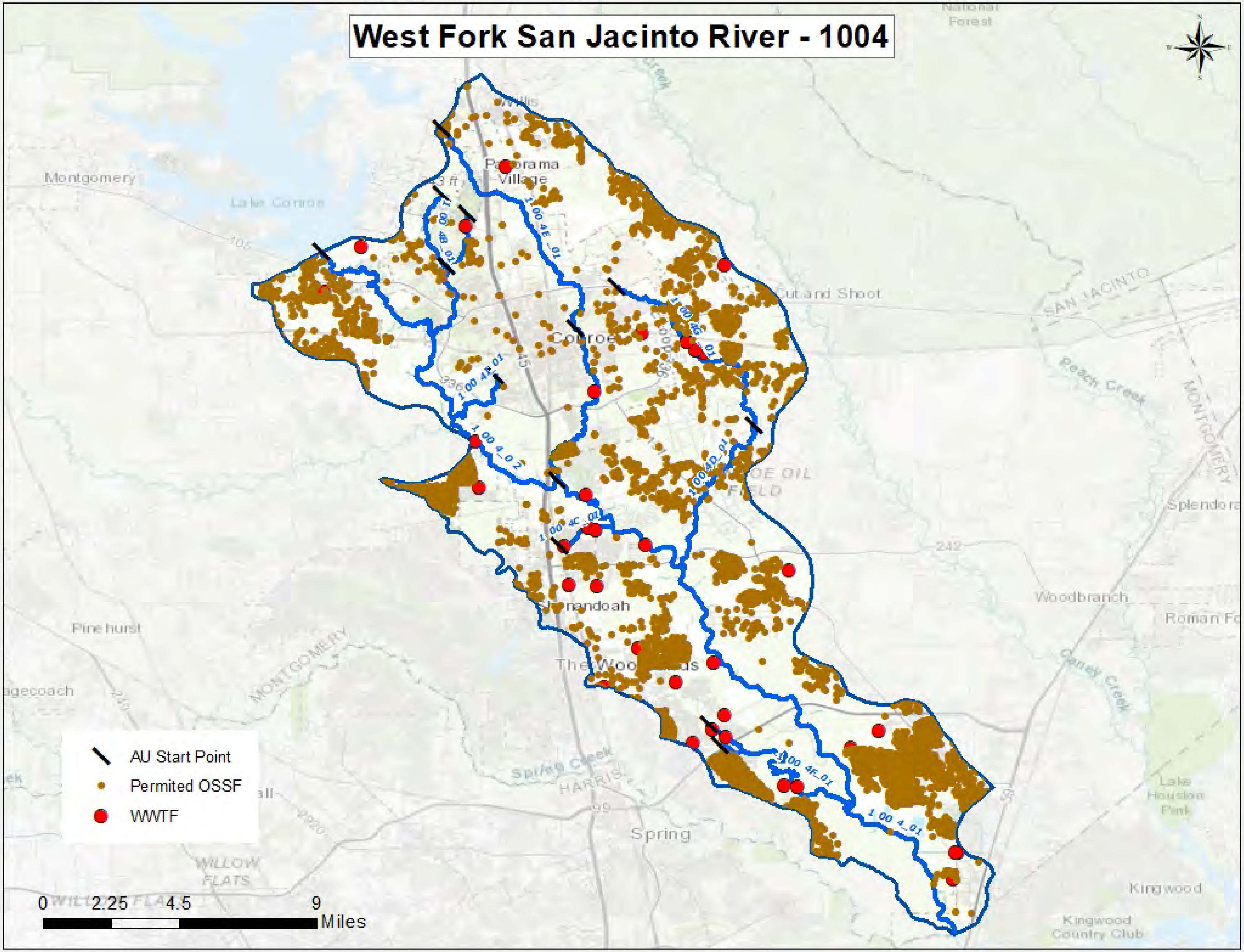
West Fork San Jacinto River - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
2.25
4.5
9
Miles
Willis
Panorama Village
Montgomery
Lake Conroe
Conroe
Cut and Shoot
Shenandoah
The Woodlands
Spring
Pinehurst
Woodbranch
Splendora
Kingwood
Kingwood Country Club
Lake Houston Park
Peach Creek
Caney Creek
Spring Creek
HARRIS
MONTGOMERY
SAN JACINTO
CONROE OIL FIELD
1004E_01
1004A_01
1004B_01
1004I_01
1004J_01
1004E_02
1004G_01
1004_02
1004D_01
1004C_01
1004_01
1004H_01
1004F_01

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the West Fork San Jacinto River watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, feral hogs, and animal waste. Areas of the watershed, including White Oak Creek, are heavily impacted by stormwater and accompanying nonpoint source pollution from the Conroe urban area and surrounding development.

There are 37 permitted wastewater outfalls in the West Fork San Jacinto River watershed. In any areas, on-site sewage facilities are the primary source of wastewater disposal. There are 5,462 permitted on-site sewage facilities in the watershed, one of the highest concentrations in the region. The wastewater treatment facilities and on-site sewage facilities in the West Fork San Jacinto River watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 125 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the West Fork San Jacinto River watershed.

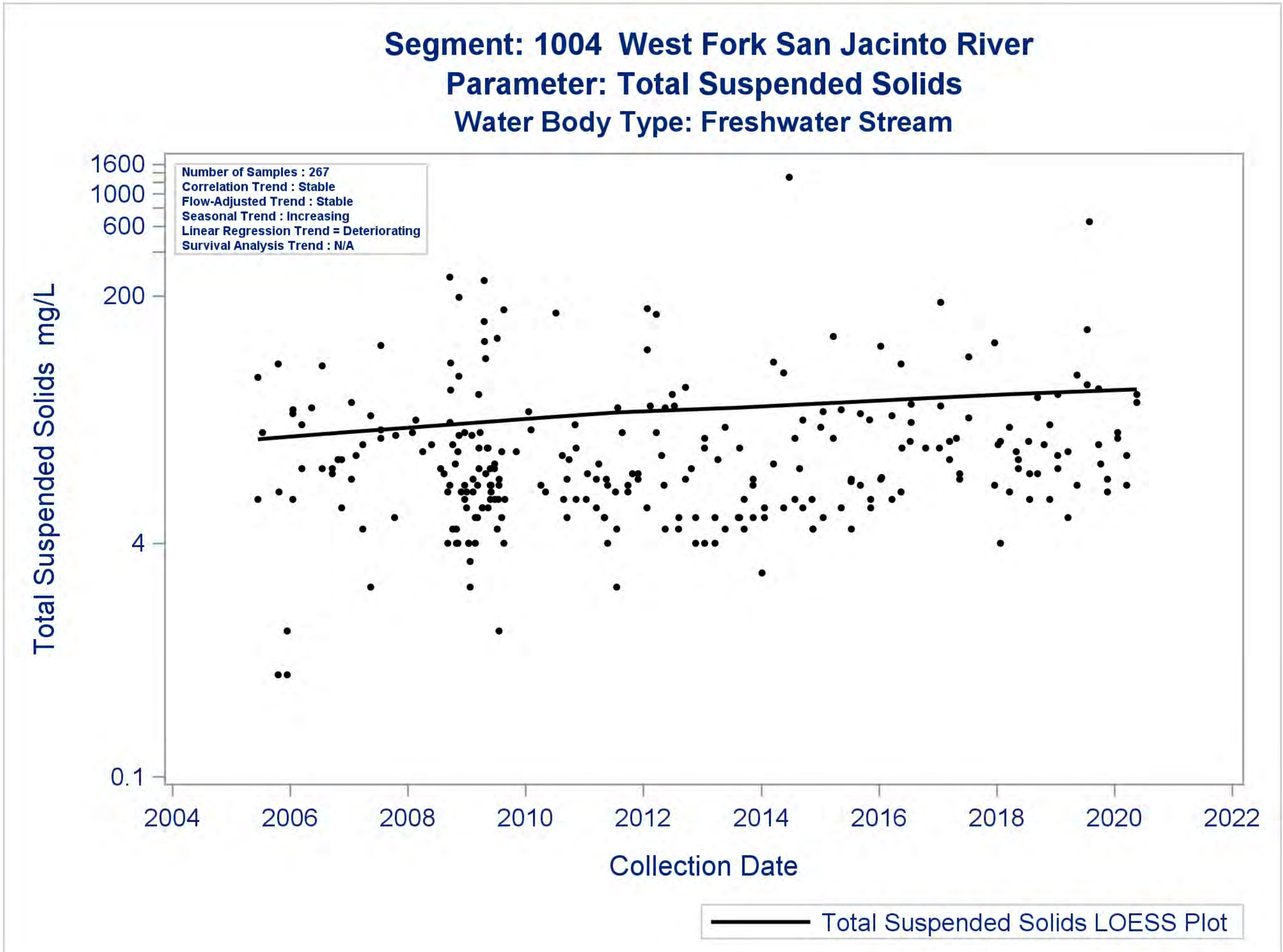


West Fork San Jacinto River - 1004
AU Start Point
Permited OSSF
WWTF
0
2.25
4.5
9
Miles
Montgomery
Lake Conroe
Panorama Village
Willis
Conroe
Cut and Shoot
Shenandoah
The Woodlands
Spring
Pinehurst
Woodbranch
Kingwood
Kingwood Country Club
Splendora
1 00 4E_01
1 00 4B_01
1 00 4G_01
1 00 4F_01
1 00 4_02
1 00 4D_01
1 00 4C_01
1 00 4F_01
1 00 4_01

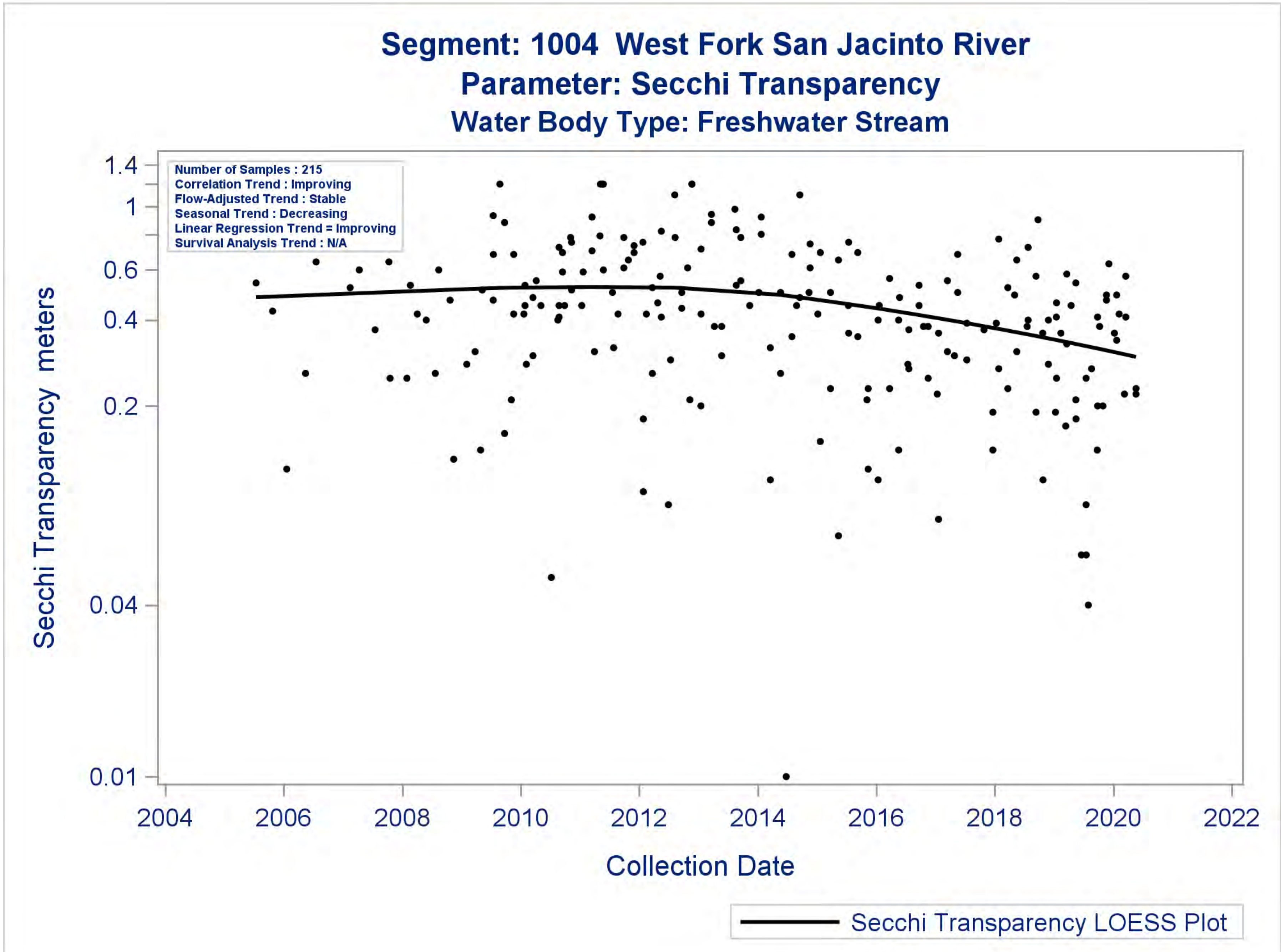
Trend Analysis:

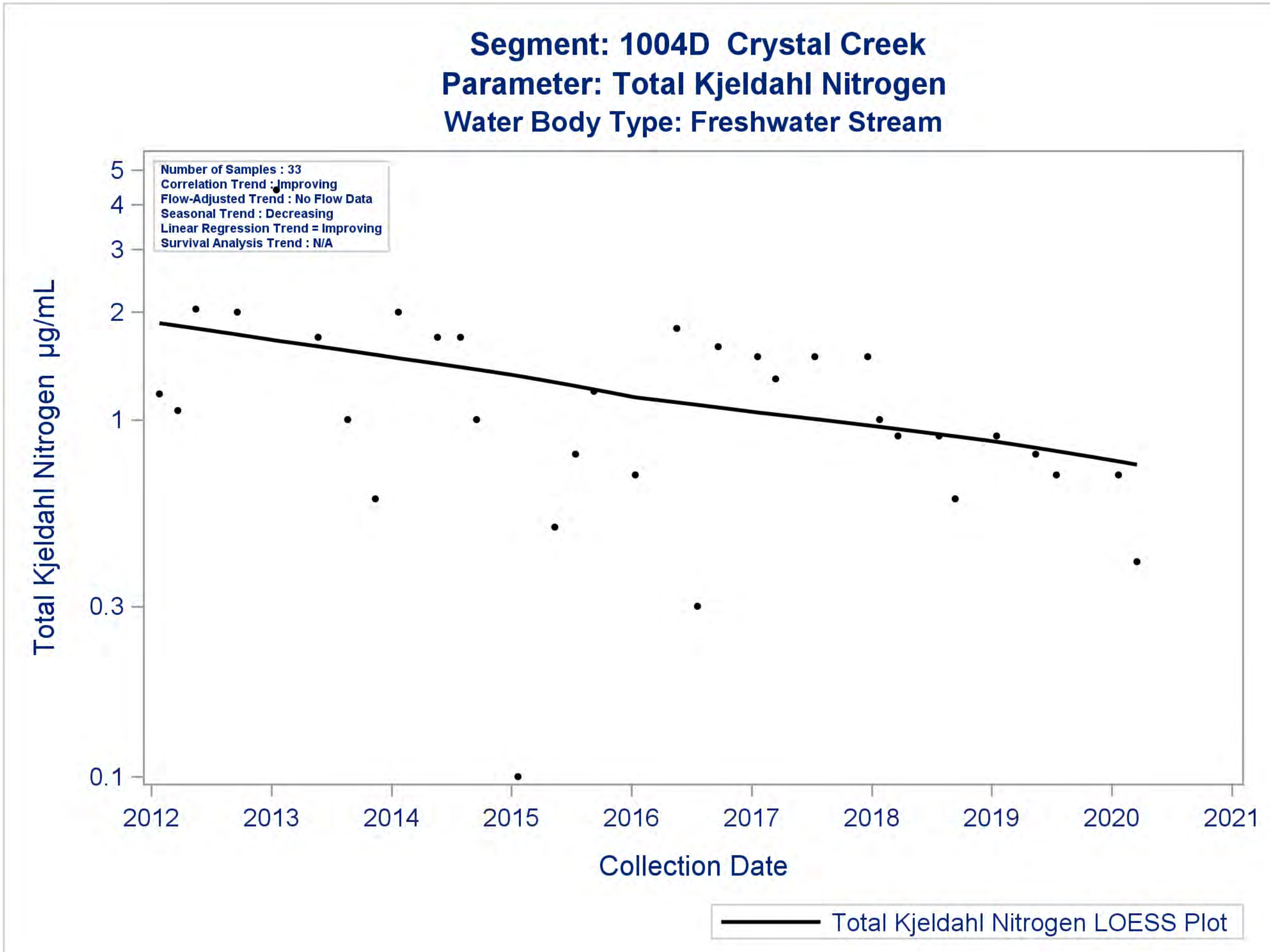
Regression analysis of watershed-level data revealed trends for six water quality parameters. There were two trends on the classified segment and a total of five trending constituents on three unclassified tributaries (1004D, 1004E, and 1004J). On the classified stream, TSS is increasing and Secchi transparency depths are decreasing. 1004D (Crystal Creek) shows improvement in specific conductance and TKN. 1004E (Stewarts Creek) shows improvement in TKN. 1004J (White Oak Creek) shows increasing pH and specific conductance and decreasing Secchi depth. *E. coli* concentrations had been increasing in the main segment in recent years, but current trends are stable for 1004, 1004D, 1004E, and 1004J. However, *E. coli* levels are still well above the surface water quality standards, in some instances by orders of magnitude. These spikes in bacteria are likely related to sanitary sewer overflows, WWTF and OSSF malfunction, and accumulated pet, wildlife, and livestock waste washing into waterways during rain events leading to higher bacteria levels in stormwater. These sources are exacerbated by increasing impervious cover in the watershed.

With the exception of positive movement of TKN levels, most other nutrient parameters are statistically stable in all tributaries and have not shown marked deterioration in recent years. Dissolved oxygen levels have also been stable in 1004 and 1004D.

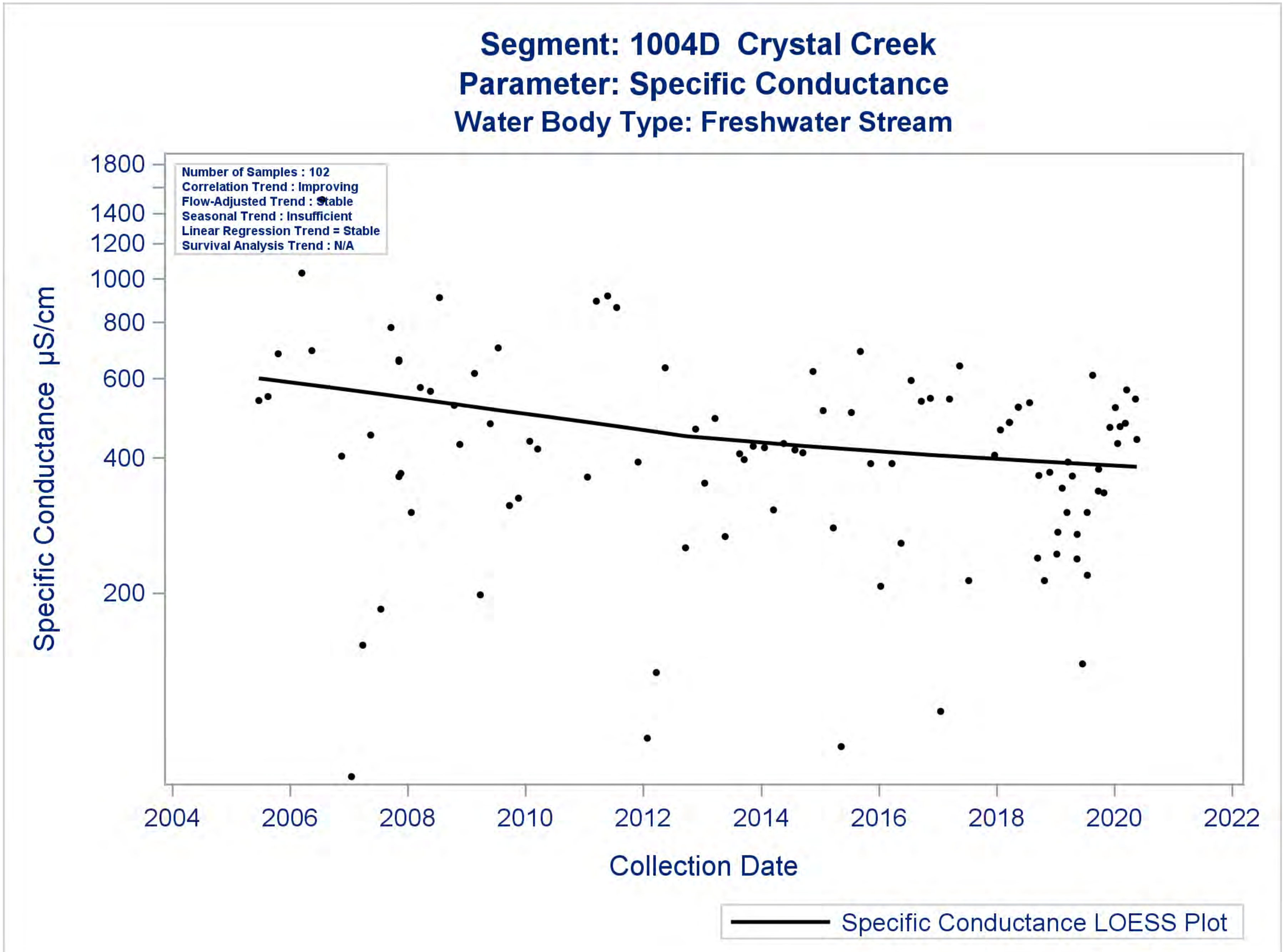


Segment: 1004 West Fork San Jacinto River
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 267
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
1600
1000
600
200
4
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot

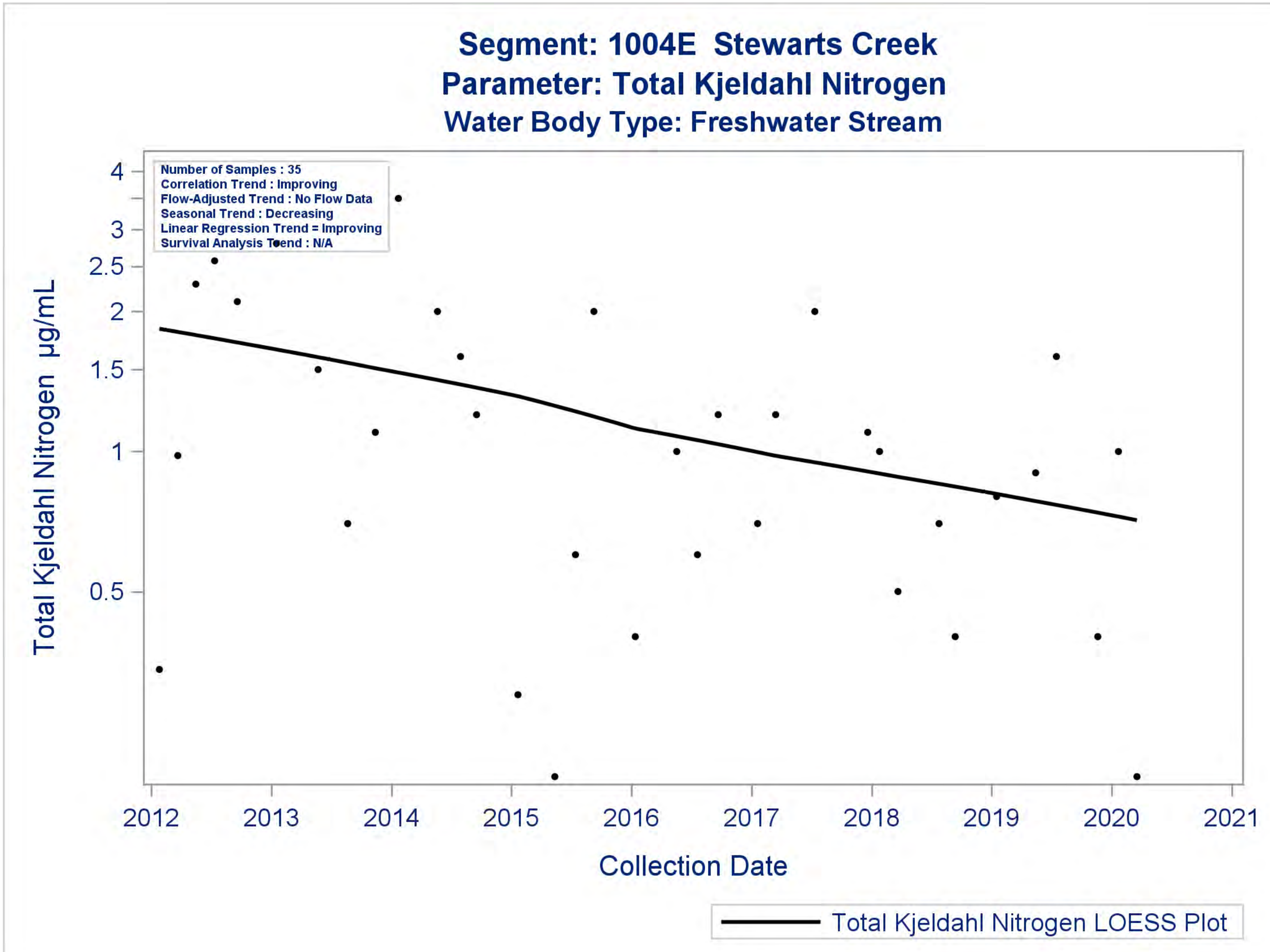

Segment: 1004 West Fork San Jacinto River
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 215
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.4
1
0.6
0.4
0.2
0.04
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot



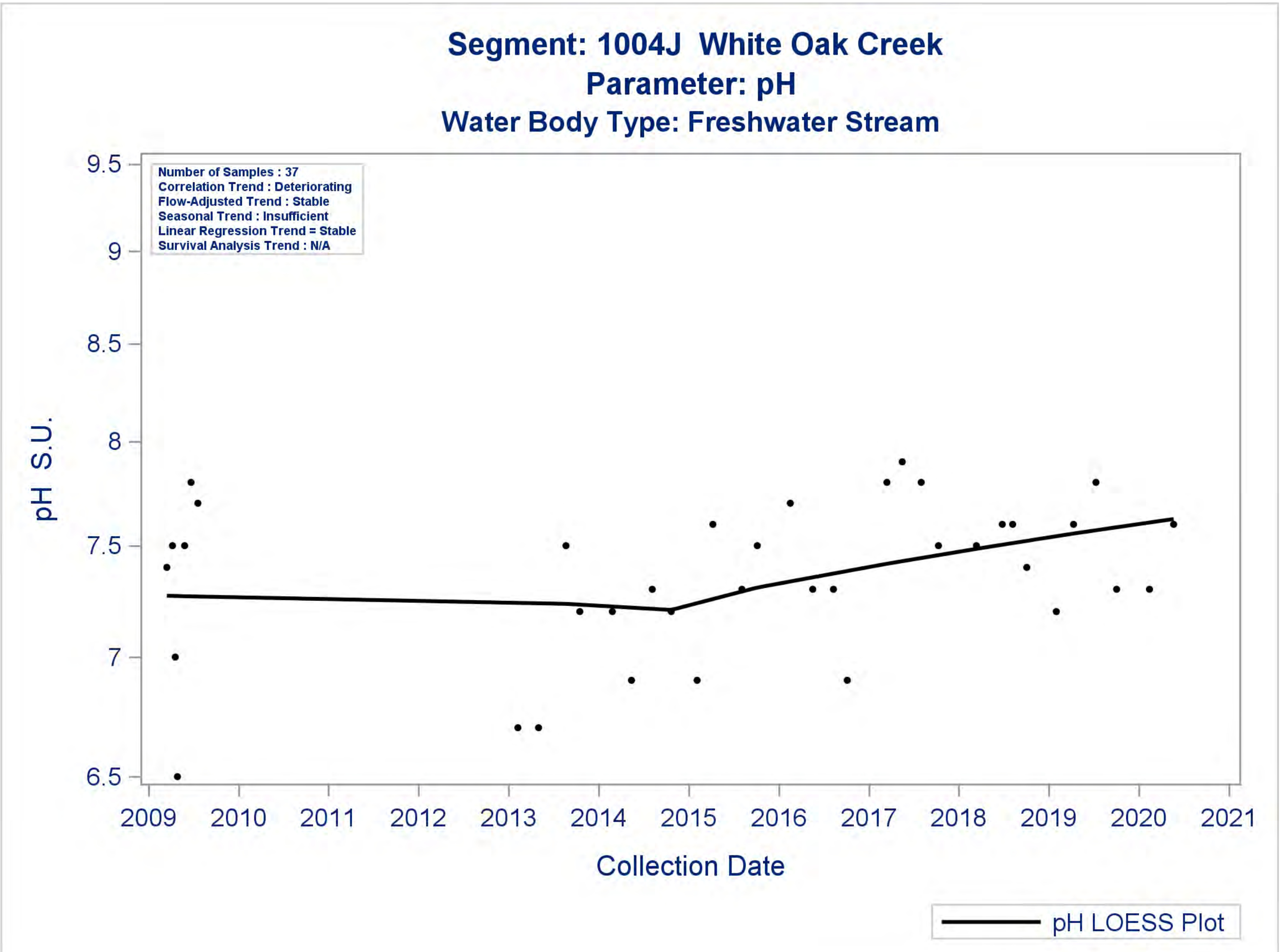
Segment: 1004D Crystal Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 33
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
5
4
3
2
1
0.3
0.1
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



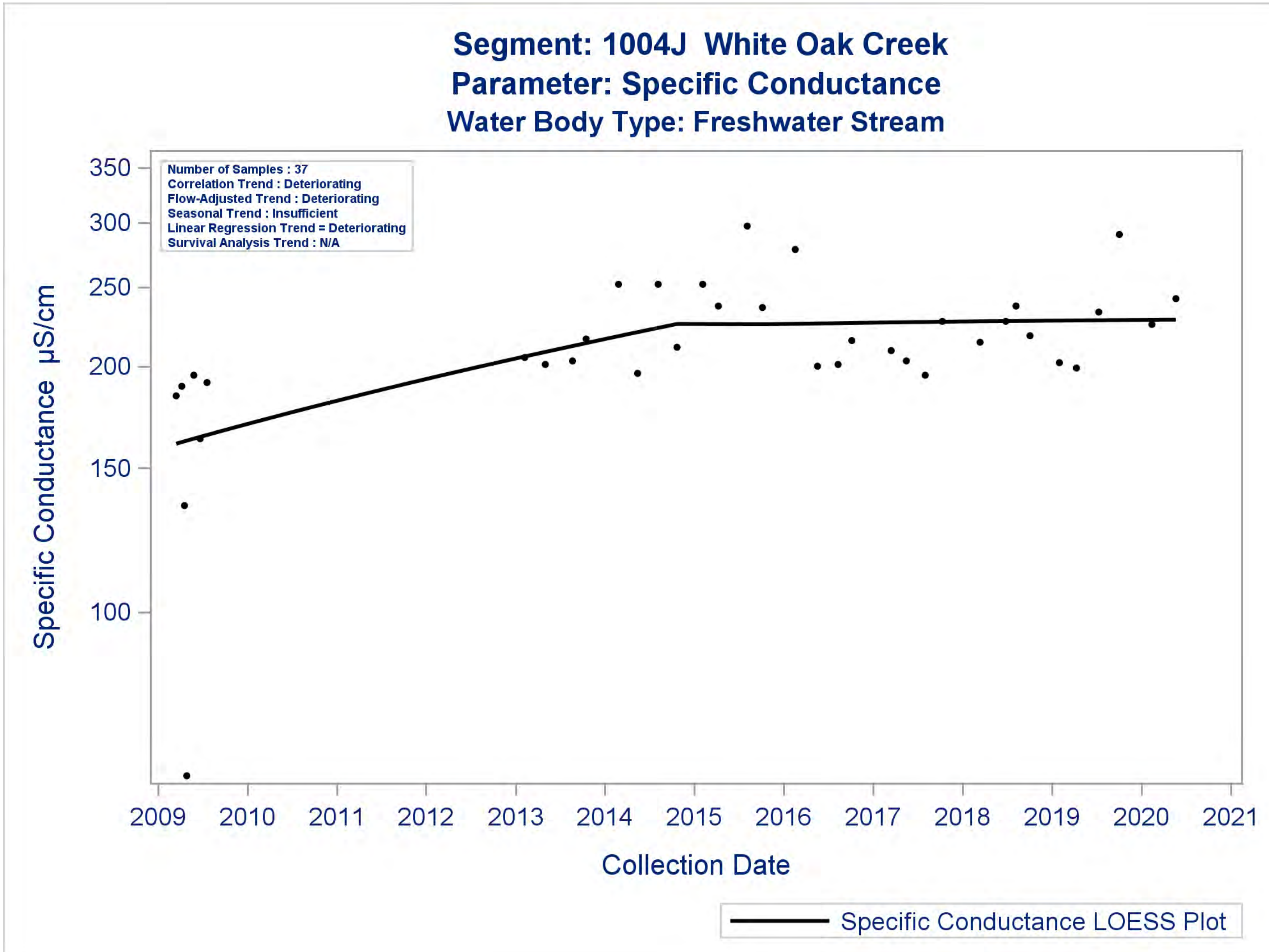
Segment: 1004D Crystal Creek
Parameter: Specific Conductance
Water Body Type: Freshwater Stream
Number of Samples : 102
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Specific Conductance µS/cm
1800
1400
1200
1000
800
600
400
200
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot



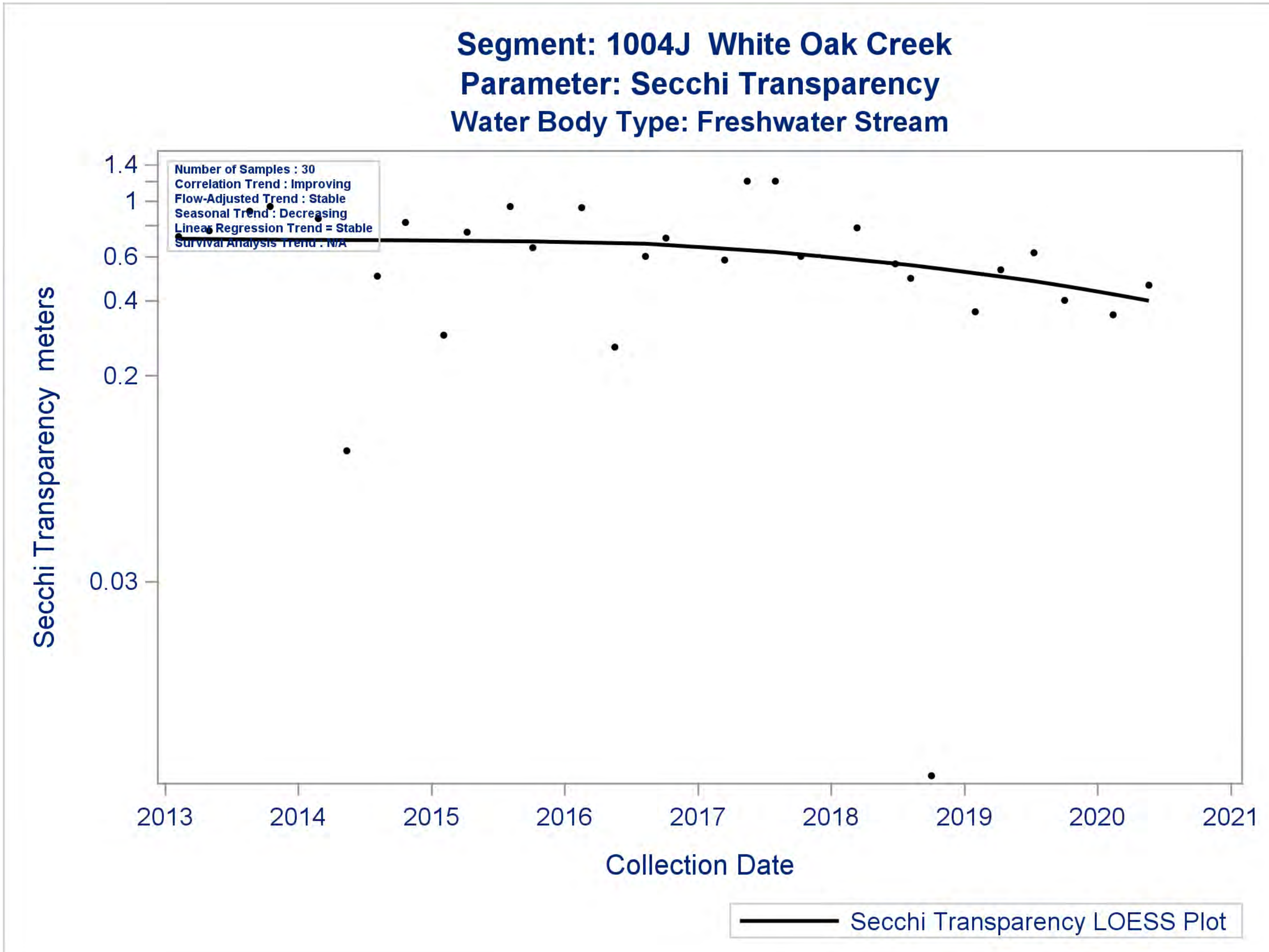
Segment: 1004E Stewarts Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 35
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
4
3
2.5
2
1.5
1
0.5
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



Segment: 1004J White Oak Creek
Parameter: pH
Water Body Type: Freshwater Stream
Number of Samples : 37
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
pH S.U.
9.5
9
8.5
8
7.5
7
6.5
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
pH LOESS Plot



Segment: 1004J White Oak Creek
Parameter: Specific Conductance
Water Body Type: Freshwater Stream
Number of Samples : 37
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Specific Conductance µS/cm
350
300
250
200
150
100
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Specific Conductance LOESS Plot


Segment: 1004J White Oak Creek
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 30
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Secchi Transparency meters
1.4
1
0.6
0.4
0.2
0.03
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Secchi Transparency LOESS Plot

Water Quality Issues Summary					
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*		**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1004 (Entire Segment) 104E_02 1004J_01	I I I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Improper or no pet waste disposal • Developments with malfunctioning OSSFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Improve stormwater controls in new developments by adding bacteria reduction measures • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education on pet waste disposal • Ensure proper citing of new or replacement OSSFs • More public education regarding OSSF operation and maintenance
Elevated Nitrate-Nitrogen Concentrations	1004_01	C	• Agricultural runoff from row crops, fallow fields pastures, and animal operations • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Impaired Macrobenthic Community in Water	1004_02	C	• Construction stormwater controls failing • Urbanization and increased impervious cover	• Detrimental effect on aquatic biological community	• Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices

		• Agricultural runoff from row crops, fallow fields pastures, and animal operation		• Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways

Special Studies:

A Total Maximum Daily Load Implementation Plan was developed for the West Fork San Jacinto River watershed and surrounding areas. The watershed is included in the West Fork San Jacinto River and Lake Creek Watershed Protection Plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation and coordination.
- Continue collecting water quality data to evaluate the effectiveness of solutions associated with the watershed protection plan and TMDL.
- Continue to work with the BIG and West Fork Watersheds Partnership to implement the I-Plan and WPP recommendations for bacteria reduction and other water quality concerns.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and watershed protection plan
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Promote voluntary conservation and urban forestry projects
- Coordinate efforts with ongoing flood management projects

BASIN 10 (Lower Portion)

Lower San Jacinto Coastal Basin

1014 – Buffalo Bayou Above Tidal

1013 – Buffalo Bayou Tidal

1016 – Greens Bayou Above Tidal

1006 – Houston Ship Channel Tidal

1007 – Houston Ship Channel/Buffalo Bayou Tidal

1005 – Houston Ship Channel/San Jacinto River Tidal

1001 – San Jacinto River Tidal

1017 – White Oak Bayou Above Tidal

Segment Number: 1014				Name: Buffalo Bayou Above Tidal	
Length:	23 miles	**Watershed Area:**	351 square miles	**Designated Uses:**	Primary Contact Recreation 1; Limited Aquatic Life
Number of Active Monitoring Stations:	23	**Texas Stream Team Monitoring Stations:**	3	**Permitted WWTF Outfalls:**	124

DESCRIPTION

- Segment 1014 (Perennial Stream w/ limited ALU): **Buffalo Bayou Above Tidal** (classified water body) – From a point 400 meters (440 yards) upstream of Shepherd Drive in Harris county to SH 6 in Harris County
- Segment 1014A (perennial Stream w/ intermediate ALU): **Bear Creek** (unclassified water body) — From the South Mayde Creek confluence to a point upstream of an unnamed tributary 1.24 km (0.77 mi) north of Langenbaugh Road in Harris County
- Segment 1014B (Perennial Stream w/ intermediate ALU): **Buffalo Bayou/Barker Reservoir** (unclassified water body) — From Barker Dam (Harris County) upstream to the Willow Fork Buffalo Bayou confluence (Fort Bend County)
- Segment 1014C (Perennial Stream w/ intermediate ALU): **Horsepen Creek** (Unclassified water body) – From the Langham Creek confluence upstream to a point 0.1 km (0.06 mi) west of Barker Cypress Road
- Segment 1014D: Retired segment description
- Segment 1014E (Perennial Stream w/ intermediate ALU): **Langham Creek** (unclassified water body) — From the Dinner Creek confluence upstream to FM 529
- Segment 1014F: Retired segment description
- Segment 1014G: Retired segment description
- Segment 1014H (Perennial Stream w/ intermediate ALU): **South Mayde Creek** (unclassified water body) — From the Buffalo Bayou confluence upstream to an unnamed tributary 1.05 km (0.65 mi) south of Clay Road
- Segment 1014I (Intermittent Stream): **Willow Fork Buffalo Bayou** (unclassified water body) – Intermittent stream with perennial pools from the confluence with Buffalo Bayou in Fort Bend County up to 1.0 km above US 90 in Waller County
- Segment 1014J (Perennial stream): **Dinner Creek** (unclassified water body) – From the confluence with Langham Creek upstream to Frey Road
- Segment 1014K (Perennial w/ intermediate ALU): **Turkey Creek** (unclassified water body) — From the South Mayde Creek confluence upstream to 1.1 km (0.68 mi) directly east of FM 529 in Harris County
- Segment 1014L (Perennial w/ intermediate ALU): **Mason Creek** (unclassified water body) — From the Buffalo Bayou confluence upstream to Mason Road upstream to 0.32 km (0.2 mi) east of Katyland Drive
- Segment 1014M Perennial Stream w/ intermediate ALU): **Newman Branch** (Neimans Bayou) (unclassified water body) — From the Buffalo Bayou Above Tidal confluence to 0.1 km (0.06 mi) upstream of Hammerly Blvd in Harris County

- Segment 1014N (Perennial w/ intermediate ALU): **Rummel Creek** (unclassified water body) — From the Buffalo Bayou Tidal confluence to 1.2 km (0.75 mi) upstream to IH-10 in Harris County

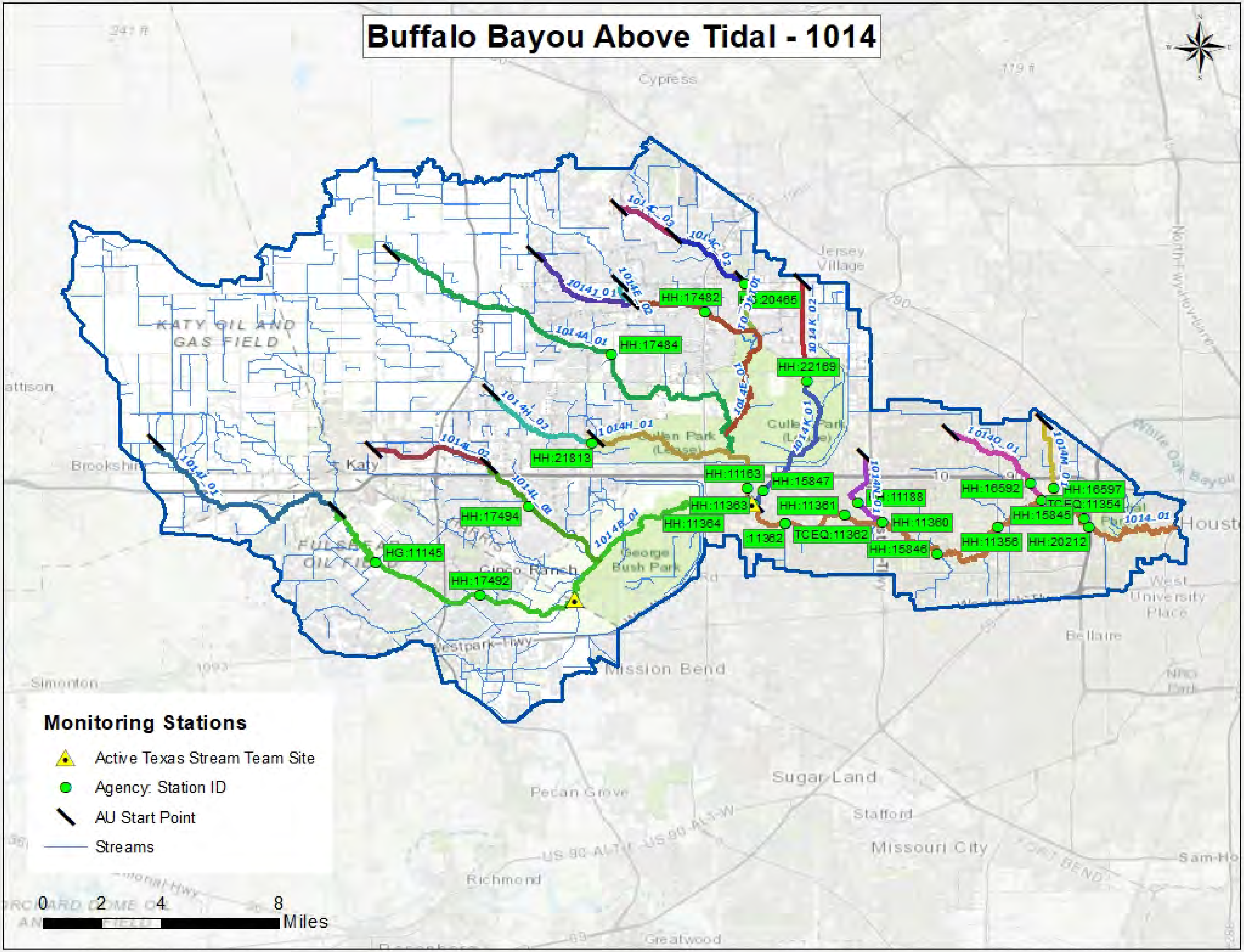
- Segment 1014O (Perennial w/ intermediate ALU): **Spring Branch** (unclassified water body) — From the Buffalo Bayou Tidal confluence to 1.4 km (0.87 mi) upstream of Long Point Road in Harris County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11354	1014	BUFFALO BAYOU AT WOODWAY DRIVE	FO	Quarterly	Field, Conventional, Bacteria
11356	1014	BUFFALO BAYOU AT VOSS ROAD	HH	Bimonthly	Field, Conventional, Bacteria
11360	1014	BUFFALO BAYOU IMMEDIATELY DOWNSTREAM OF WEST BELTWAY 8 IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria, Flow
11361	1014	BUFFALO BAYOU AT WILCREST DRIVE IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
11362	1014	BUFFALO BAYOU IMMEDIATELY DOWNSTREAM OF DAIRY ASHFORD ROAD WEST OF HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria, Flow
11362	1014	BUFFALO BAYOU IMMEDIATELY DOWNSTREAM OF DAIRY ASHFORD ROAD WEST OF HOUSTON	FO	Quarterly	Field, Conventional, Bacteria, Flow
11363	1014	BUFFALO BAYOU AT ELDRIDGE ROAD IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
11364	1014	BUFFALO BAYOU AT SH 6	HH	Bimonthly	Field, Conventional, Bacteria, Flow
15845	1014	BUFFALO BAYOU AT CHIMNEY ROCK ROAD IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
15846	1014	BUFFALO BAYOU IMMEDIATELY DOWNSTREAM OF BRIAR FOREST DRIVE IN WEST HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
20212	1014	BUFFALO BAYOU NORTH SHORE IMMEDIATELY UNDERNEATH THE SOUTHBOUND FEEDER ROAD BRIDGE OF IH 610 WEST IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
17484	1014A	BEAR CREEK AT OLD GREENHOUSE ROAD WEST OF HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
11145	1014B	BUFFALO BAYOU IMMEDIATELY DOWNSTREAM OF GREEN BUSH ROAD 3.1 MILES SOUTHEAST OF KATY	HG	Quarterly	Field, Conventional, Bacteria, Flow
17492	1014B	BUFFALO BAYOU AT SOUTH MASON ROAD WEST OF HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
20465	1014C	HORSEPEN CREEK AT FM 529 1.9 KILOMETERS EAST OF SH 6 NORTHWEST OF HOUSTON	HG	Quarterly	Field, Conventional, Bacteria, Flow
17482	1014E	LANGHAM CREEK AT SH 6 IN NORTHWEST HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria, Flow

11163	1014H	SOUTH MAYDE CREEK IMMEDIATELY DOWNSTREAM OF MEMORIAL DRIVE	HH	Bimonthly	Field, Conventional, Bacteria
21813	1014H	SOUTH MAYDE CREEK AT SOUTH PARK VIEW DRIVE WEST OF HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
15847	1014K	TURKEY CREEK 200 M UPSTREAM OF MEMORIAL DRIVE AT BRIDGE IN MEMORIAL OAKS CEMETERY	HH	Bimonthly	Field, Conventional, Bacteria
22169	1014K	TURKEY CREEK AT CLAY ROAD IN NORTHWEST HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
17494	1014L	MASON CREEK 151 METERS DOWNSTREAM OF PARK PINE DRIVE WEST OF HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
16597	1014M	NEWMAN BRANCH / NEIMANS BAYOU AT MEMORIAL DRIVE IN WEST HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
11188	1014N	RUMMEL CREEK IMMEDIATELY DOWNSTREAM OF MEMORIAL DRIVE IN WEST HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
16592	1014O	SPRING BRANCH CREEK IMMEDIATELY UPSTREAM OF WIRT ROAD 331 METERS DOWNSTREAM OF IH 10 IN WEST HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HG = Houston-Galveston Area Council
HH = Houston Health & Human Services

Buffalo Bayou Above Tidal - 1014



Segment 1014 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	33.3 / 92	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0 / 3.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0 / 2.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	110		
Sulfate (mg/L as SO_4):	65		
Total Dissolved Solids (mg/L):	600		

Segment Discussion

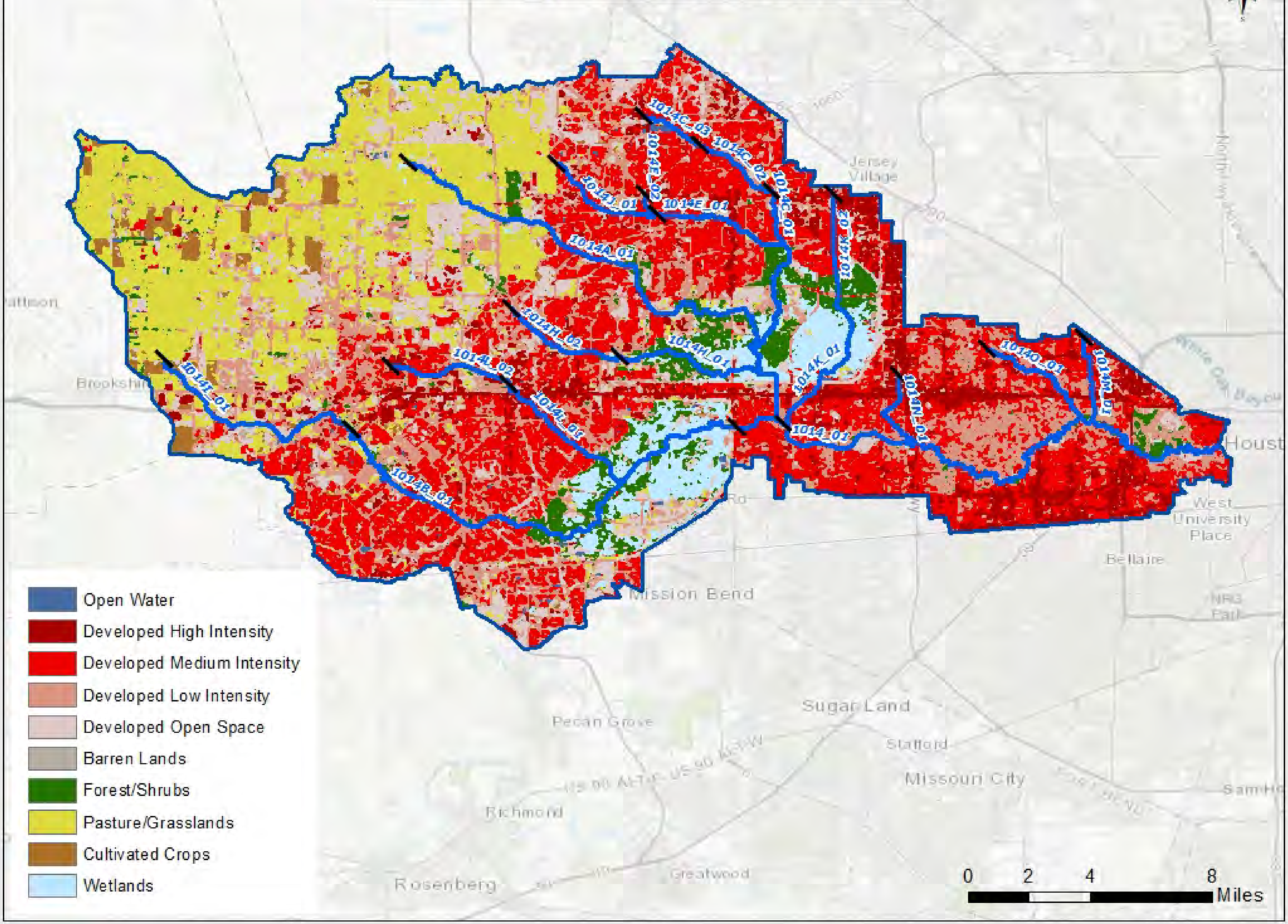
Watershed Characteristics and Land Cover: The Buffalo Bayou Above Tidal (1014) segment extends from the heavily developed areas of Houston's urban core, through dense residential areas, and into the primarily rural and agricultural areas of western Harris County. Buffalo Bayou Above Tidal drains into Buffalo Bayou Tidal and then into the Houston Ship Channel and the Galveston Bay system. It drains an area that includes both Barker and Addicks Reservoirs in its western portion and thus is affected greatly by the amount of water being released at any given time from their dams. Major tributaries include Bear, Langham, Mason, Rummel, South Mayde, and Turkey Creeks, Spring Branch, and Neimans Bayou.

The majority of the watershed is developed (68.42 percent of the watershed). Large tracts of land in the northwest areas of the segment are dedicated to cultivated crops or ranch activities. East of State Highway 6, the Bayou is primarily a wooded waterway immediately adjacent to parkland (Terry Hershey Park) or primarily affluent urban residential areas and golf courses. There are not an appreciable number of industrial facilities in this segment. Because of the narrow and deep profile of the Bayou, recreational activity consists primarily of canoeing and kayaking and limited swimming in some areas.

Segment 1014 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	80,288.52	35.70	46,617.02	20.73	-41.94
Barren Lands	4,497.91	2.00	1,131.76	0.50	-74.84
Developed	111,610.43	49.63	153,867.20	68.42	37.86
Forest/Shrubs	6,534.59	2.91	10,629.52	4.73	62.67
Open Water	1,535.63	0.68	654.06	0.29	-57.41
Wetlands	20,403.27	9.07	11,974.56	5.33	-41.31
TOTAL	**224,870.35**	**100.00**	**224,874.13**	**100.00**	

Buffalo Bayou Above Tidal - 1014



Water Quality Issues:

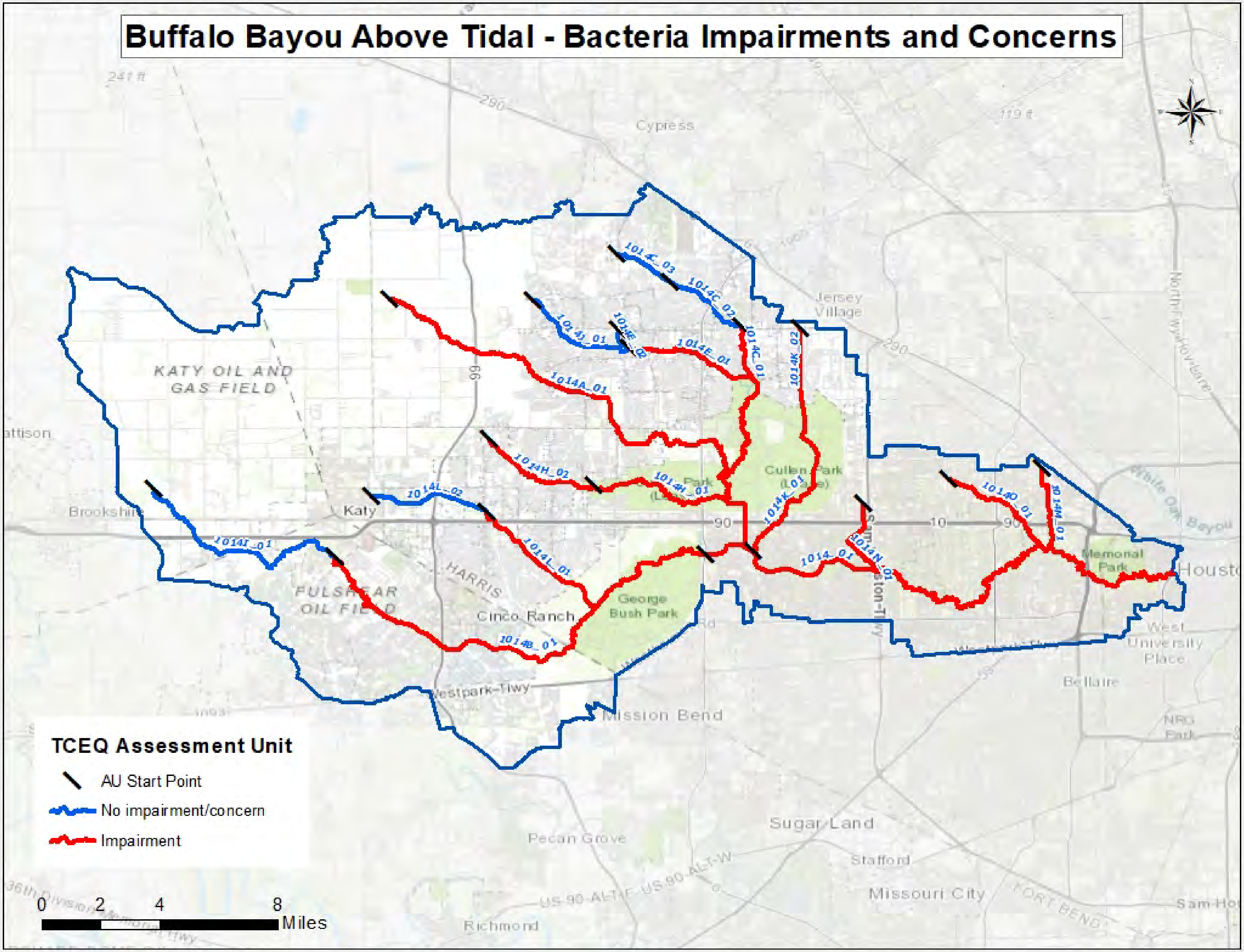
Bacteria Impairments and Concerns
Each of the stream segments (a total of 13 assessment units) in this watershed assessed in 2020 were listed as impaired for contact recreation use due to elevated levels of *E. coli* bacteria.

Dissolved Oxygen Impairments and Concerns
Aquatic life uses are not fully supported throughout the watershed. Neimans Bayou (Newman Branch) (1014M_01) is listed as impaired for depressed dissolved oxygen, fish community, and macrobenthic community. A dissolved oxygen concern was identified in South Mayde Creek (1014H_01), Rummel Creek (1014N_01), and Spring Branch (1014O) due to grab sample results below the dissolved oxygen screening level.

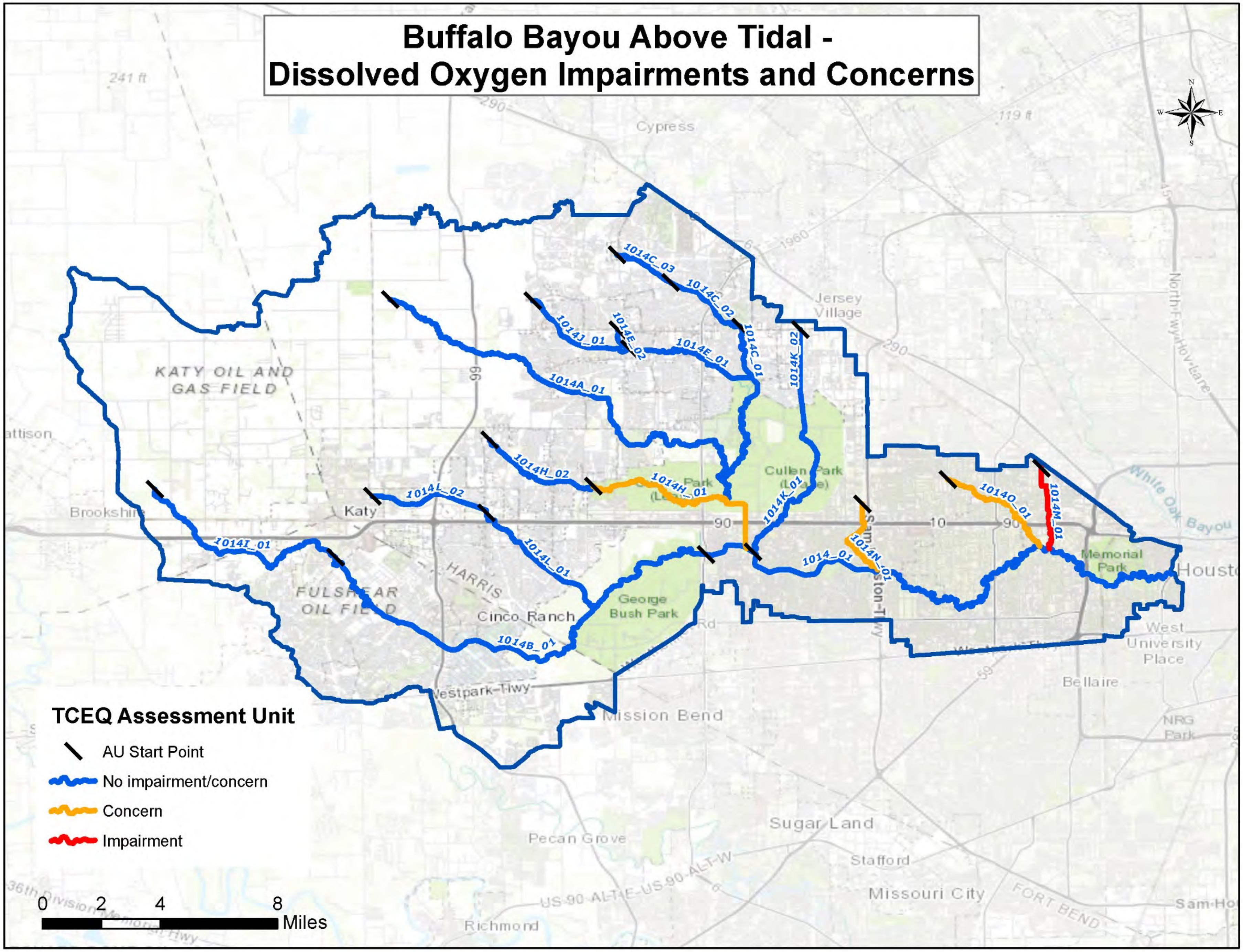
Nutrient Concerns
Nutrient concerns exist in a large portion of the watershed. Of the 13 AUs assessed, 4 have concerns for ammonia-nitrogen, 9 have concerns for nitrate-nitrogen, and 8 have concerns for total phosphorus as identified in the 2020 Integrated Report.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

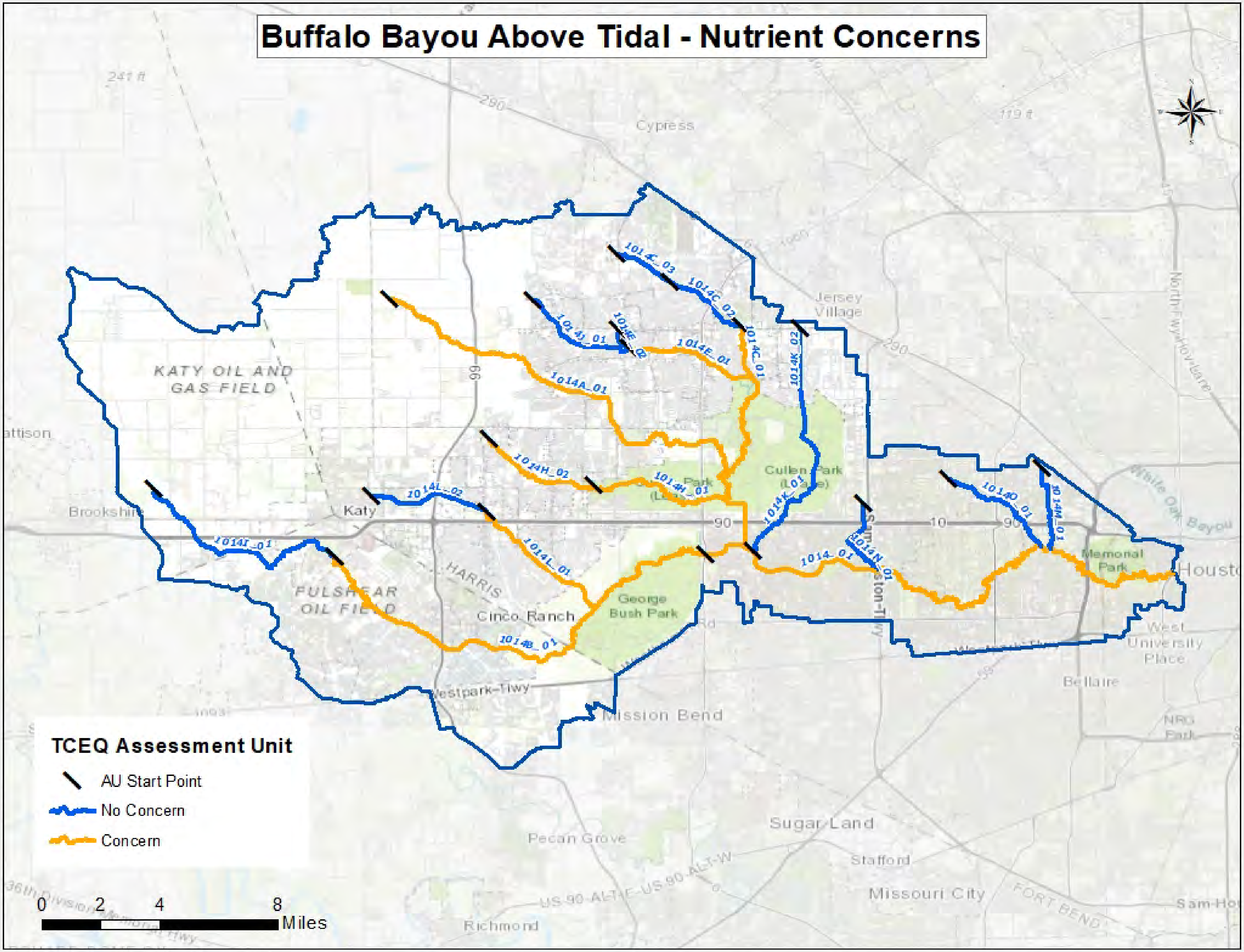
Fish and Macrobenthic Community
Neimans Bayou (Newman Branch) (1014M_01) is listed as impaired for fish community and for macrobenthic community.



Buffalo Bayou Above Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
2
4
8
Miles
KATY OIL AND GAS FIELD
FULSHEAR OIL FIELD
Cypress
Jersey Village
Katy
Cinco Ranch
George Bush Park
Cullen Park
Memorial Park
Mission Bend
Sugar Land
Stafford
Missouri City
Pecan Grove
Richmond
Bellaire
West University Place
1014_01
1014A_01
1014B_01
1014C_01
1014C_02
1014C_03
1014E_01
1014E_02
1014H_01
1014H_02
1014I_01
1014J_01
1014K_01
1014K_02
1014L_01
1014L_02
1014M_01
1014N_01
1014O_01



Buffalo Bayou Above Tidal -
Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0 2 4 8 Miles
1014C_03
1014C_02
1014C_01
1014J_01
1014E_02
1014E_01
1014K_02
1014K_01
1014A_01
1014H_02
1014H_01
1014L_02
1014L_01
1014I_01
1014B_01
1014_01
1014N_01
1014O_01
1014M_01
Cypress
Jersey Village
KATY OIL AND GAS FIELD
Katy
Brookshire
FULSHEAR OIL FIELD
Cinco Ranch
George Bush Park
Cullen Park
Memorial Park
Houston
West University Place
Bellaire
Mission Bend
Sugar Land
Pecan Grove
Stafford
Missouri City
Richmond
White Oak Bayou
Westpark Tlwy



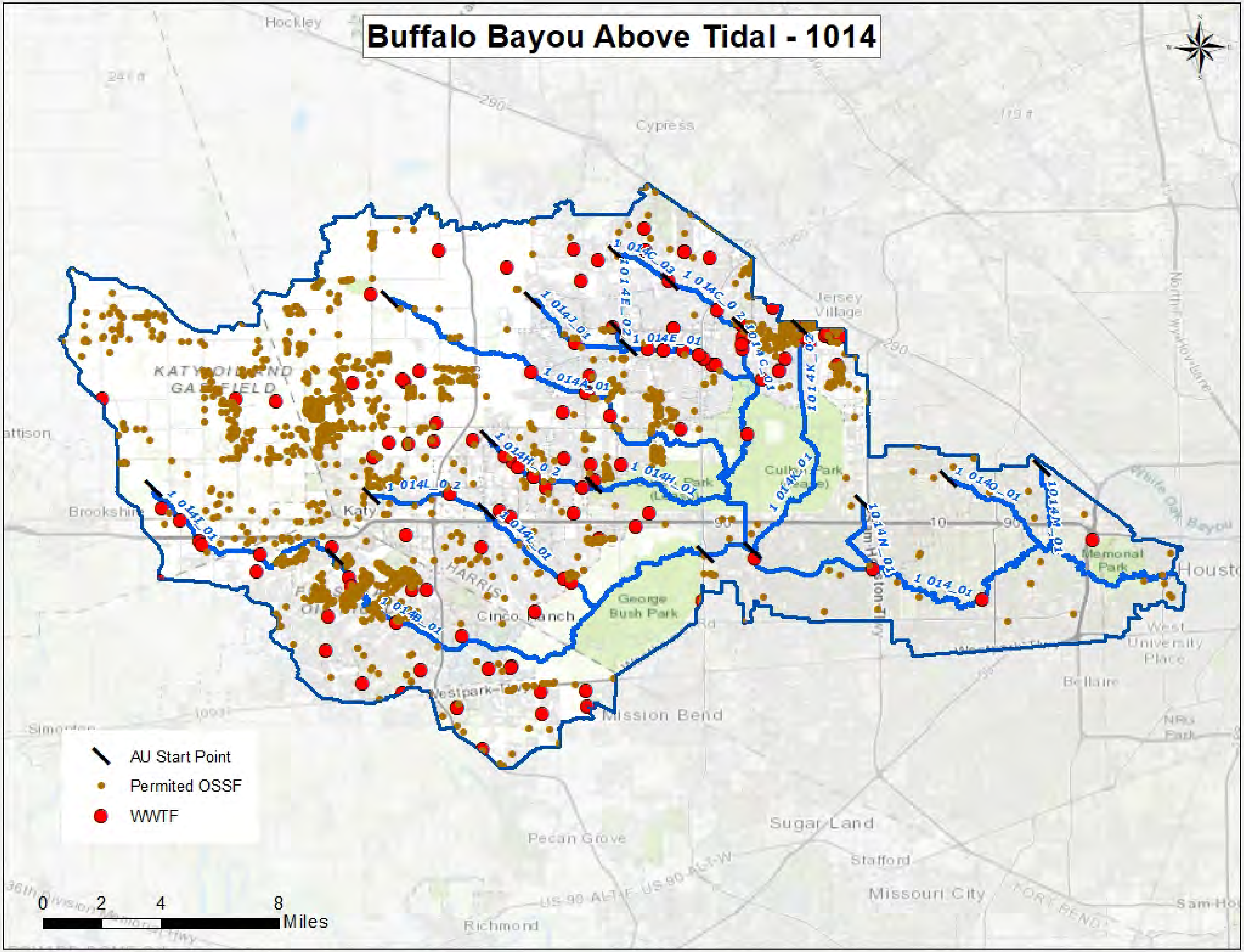
Buffalo Bayou Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0 2 4 8
Miles
KATY OIL AND GAS FIELD
FULSHEAR OIL FIELD
Katy
Cinco Ranch
Mission Bend
Cypress
Jersey Village
Cullen Park
George Bush Park
Memorial Park
Houston
West University Place
Bellaire
Sugar Land
Stafford
Missouri City
Pecan Grove
Richmond
1014_01
1014A_01
1014B_01
1014C_01
1014C_02
1014C_03
1014E_01
1014E_02
1014H_01
1014H_02
1014I_01
1014J_01
1014K_01
1014K_02
1014L_01
1014L_02
1014M_01
1014N_01
1014O_01

Potential Sources of Water Quality Issues: Potential sources fecal indicator bacteria and nutrients in the Buffalo Bayou Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 124 permitted wastewater outfalls in the Buffalo Bayou Above Tidal watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 1,844 permitted systems. These systems are found throughout the watershed but are most heavily concentrated in the more rural western portion of the watershed. The wastewater treatment facilities and on-site sewage facilities in the Buffalo Bayou Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 978 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Buffalo Bayou Above Tidal watershed.

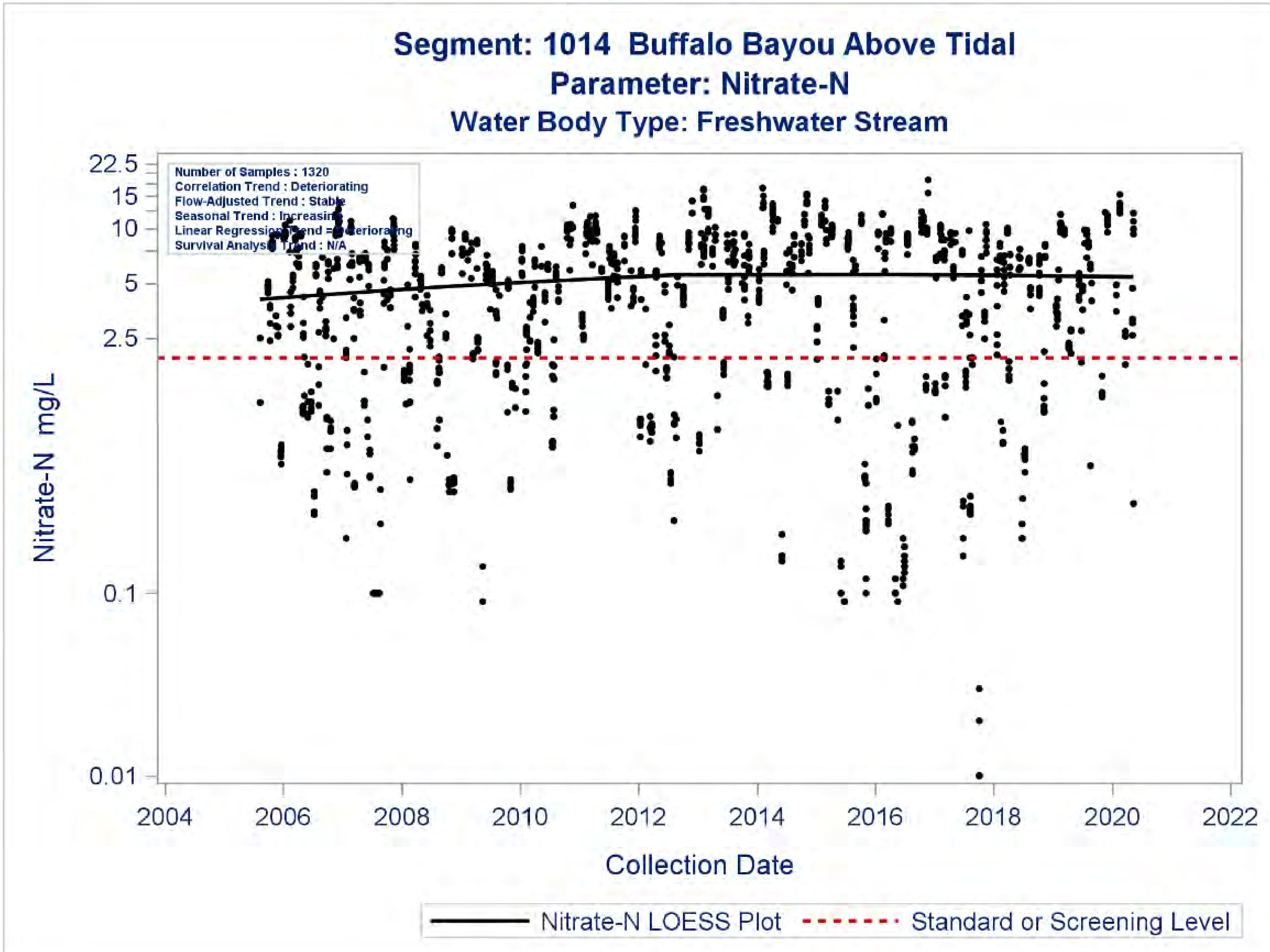

Buffalo Bayou Above Tidal - 1014
AU Start Point
Permited OSSF
WWTF
0 2 4 8
Miles

Trend Analysis:

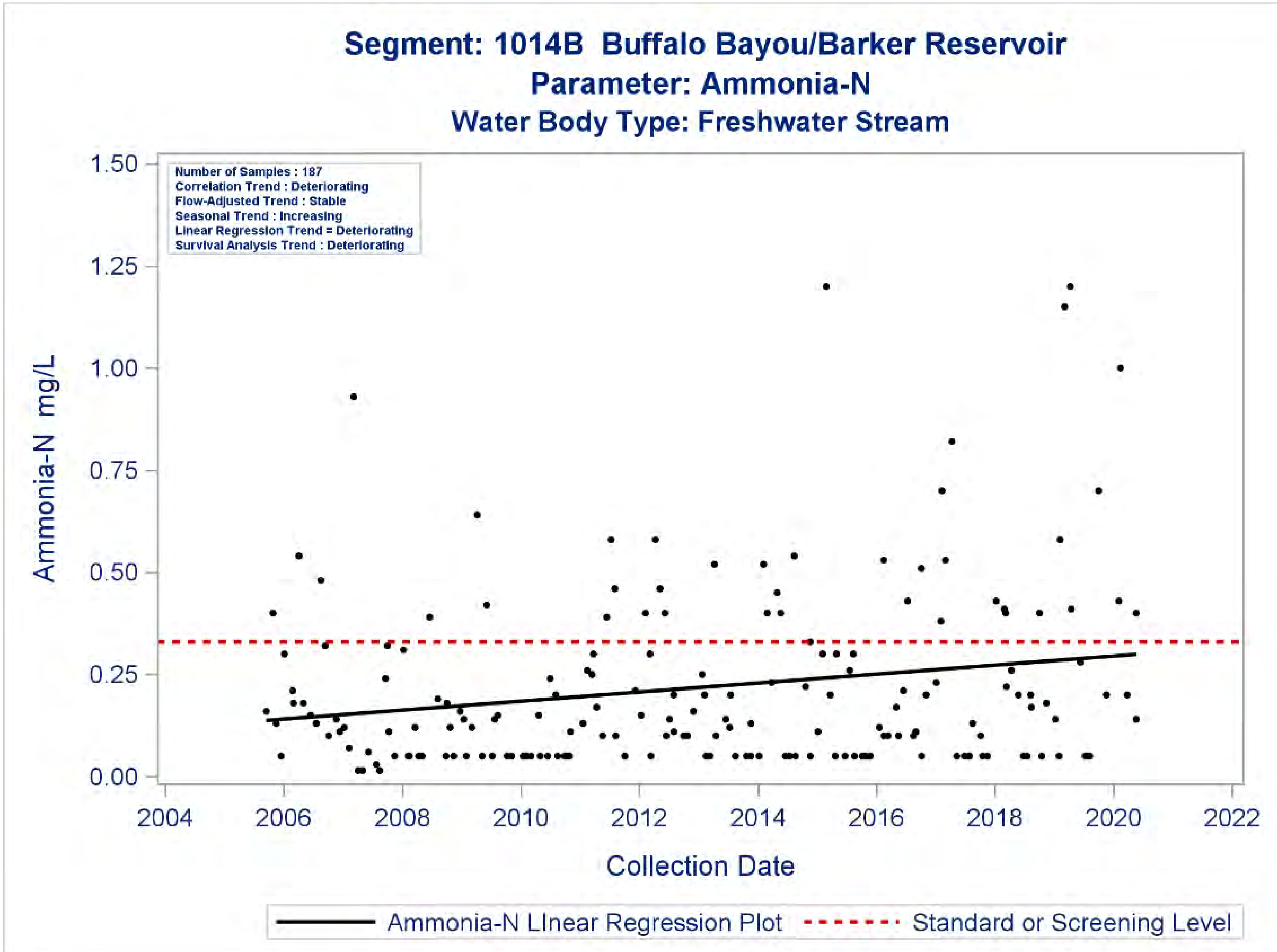
Fourteen water quality parameter trends were detected in the 11 assessment units (AUs) located in the Buffalo Bayou Above Tidal (segment 1014) watershed. The most common trends seen throughout all classified and unclassified segments involve nutrients and suspended solids in the water column. Nitrate concentrations are increasing in 1014 (the classified segment) and 1014M (Newman Branch or Neimans Bayou) while ammonia is decreasing in 1014N (Rummel Creek) but increasing in in 1014B (Buffalo Bayou / Barker Reservoir) and 1014K (Turkey Creek). Nutrients TKN and total phosphorus as well as sulfate concentrations are either stable or decreasing in all segment AUs. During the period of record, the majority of nitrate and total phosphorus samples have exceeded the 1.95 mg/L and 0.69 mg/L screening criteria, respectively. However, increasing sediment loading to the water column and high bacteria concentrations continue to be the greatest water quality concerns for this watershed. TSS concentrations are increasing in six of thirteen AUs and decreasing in only two AUs. In the other five AUs, TSS concentrations show neither improving or deteriorating trends. They are stable. In most AUs, if there is a trend with the TSS data, there is an inverse relationship to the Secchi transparency data. Where sediment loads are increasing the Secchi transparency depth is decreasing. Decreasing trends are typically categorized as ‘improving’ trends, as seen in the graph legend, but the water is actually getting more turbid. This sediment is most likely from development and bank erosion.

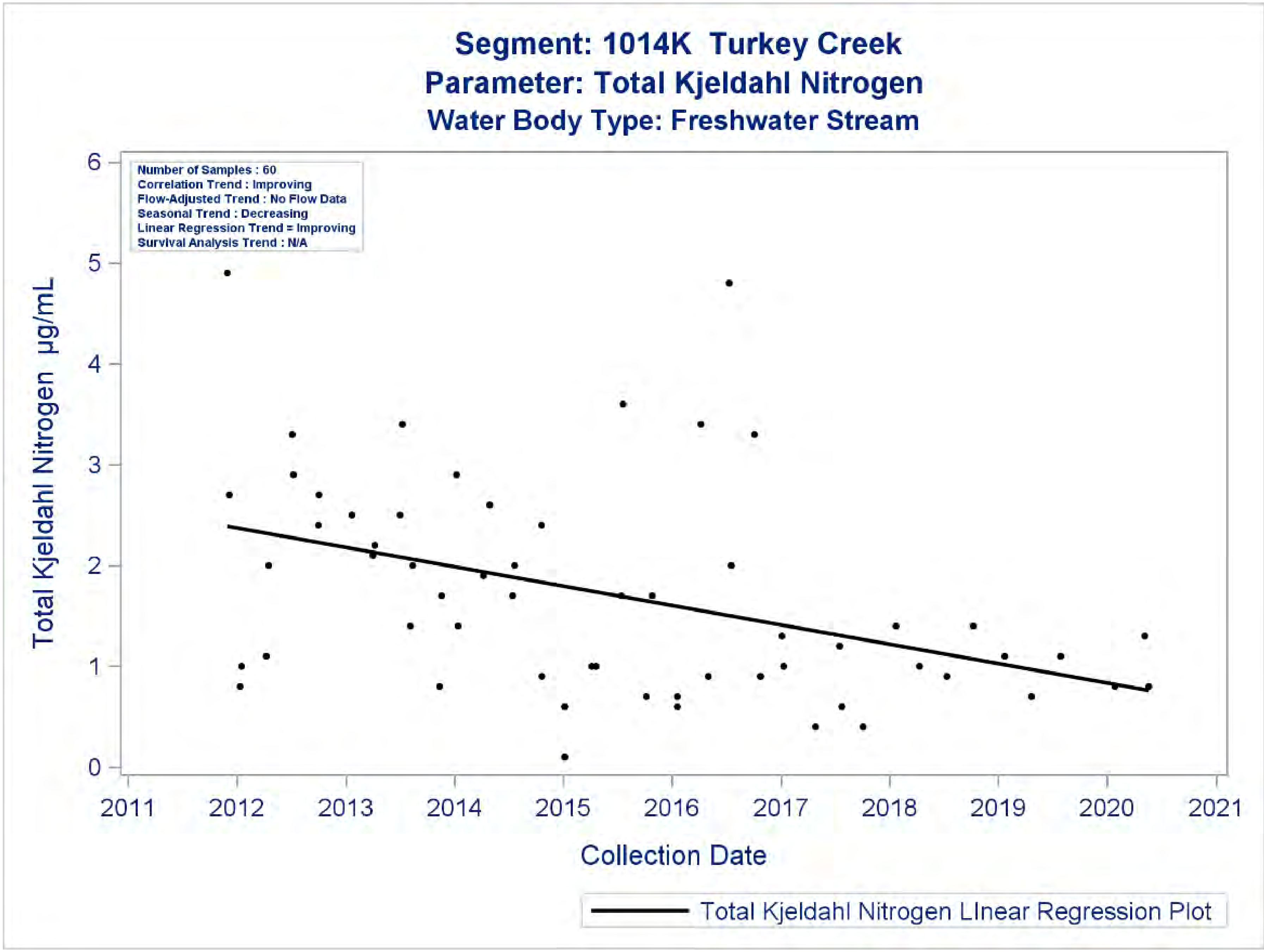
Regression analysis of bacteria data revealed that *E. coli* concentrations are improving in segments 1014E (Langham Creek), 1014L (Mason Creek) and 1014N (Rummel Creek). Bacteria concentrations remain stable for all remaining AUs; however, majority of bacteria samples remain significantly higher than the 126 MPN/100 mL water quality standard.

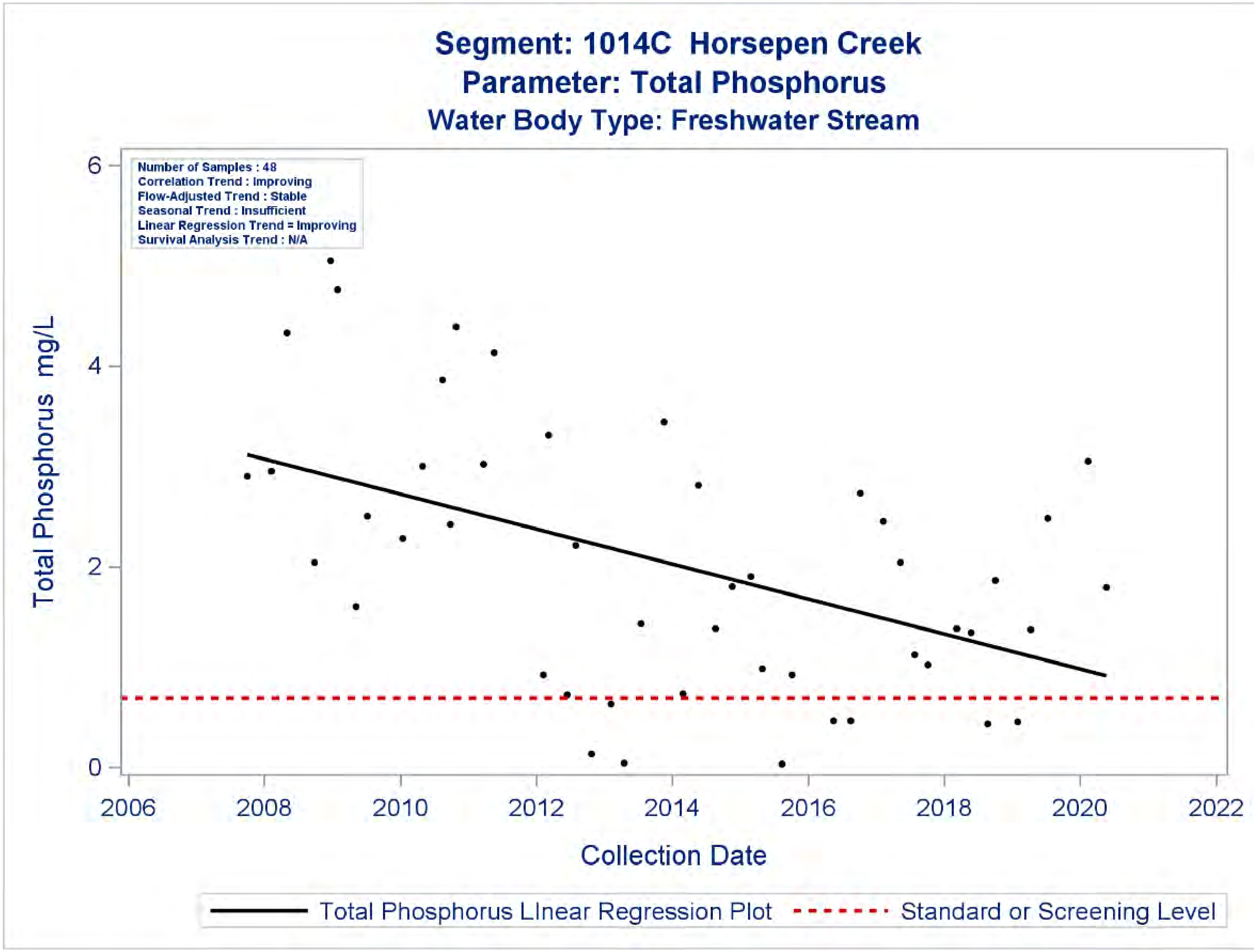
South Mayde Creek (1014H) is the only AU to show a trend in dissolved oxygen. Since 2015 there have been only two grab measurements found to be less than the minimum grab criteria of 3.0 mg/L.



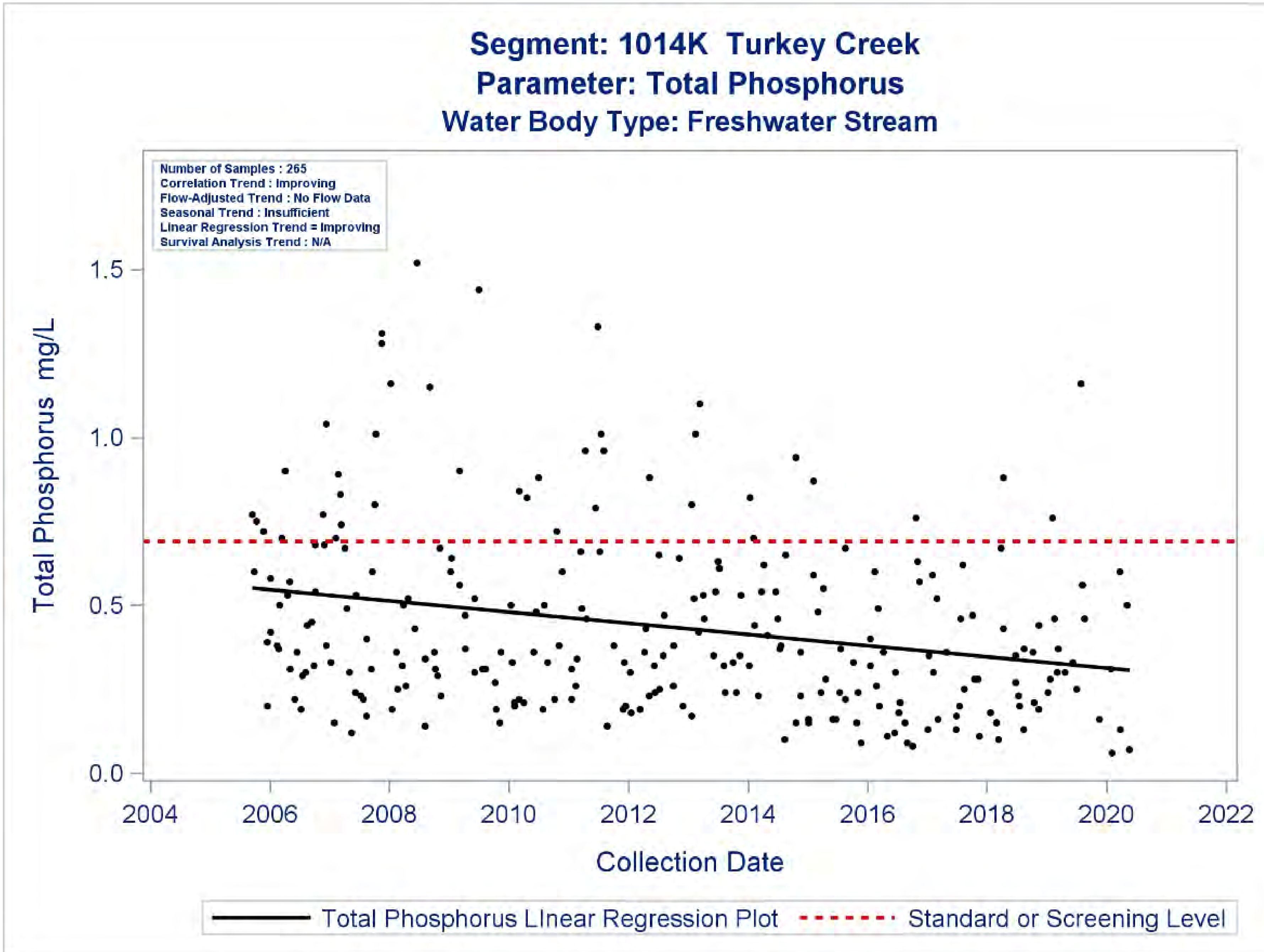
Segment: 1014 Buffalo Bayou Above Tidal
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 1320
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
22.5
15
10
5
2.5
0.1
0.01
Nitrate-N mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level


Segment: 1014B Buffalo Bayou/Barker Reservoir
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 187
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

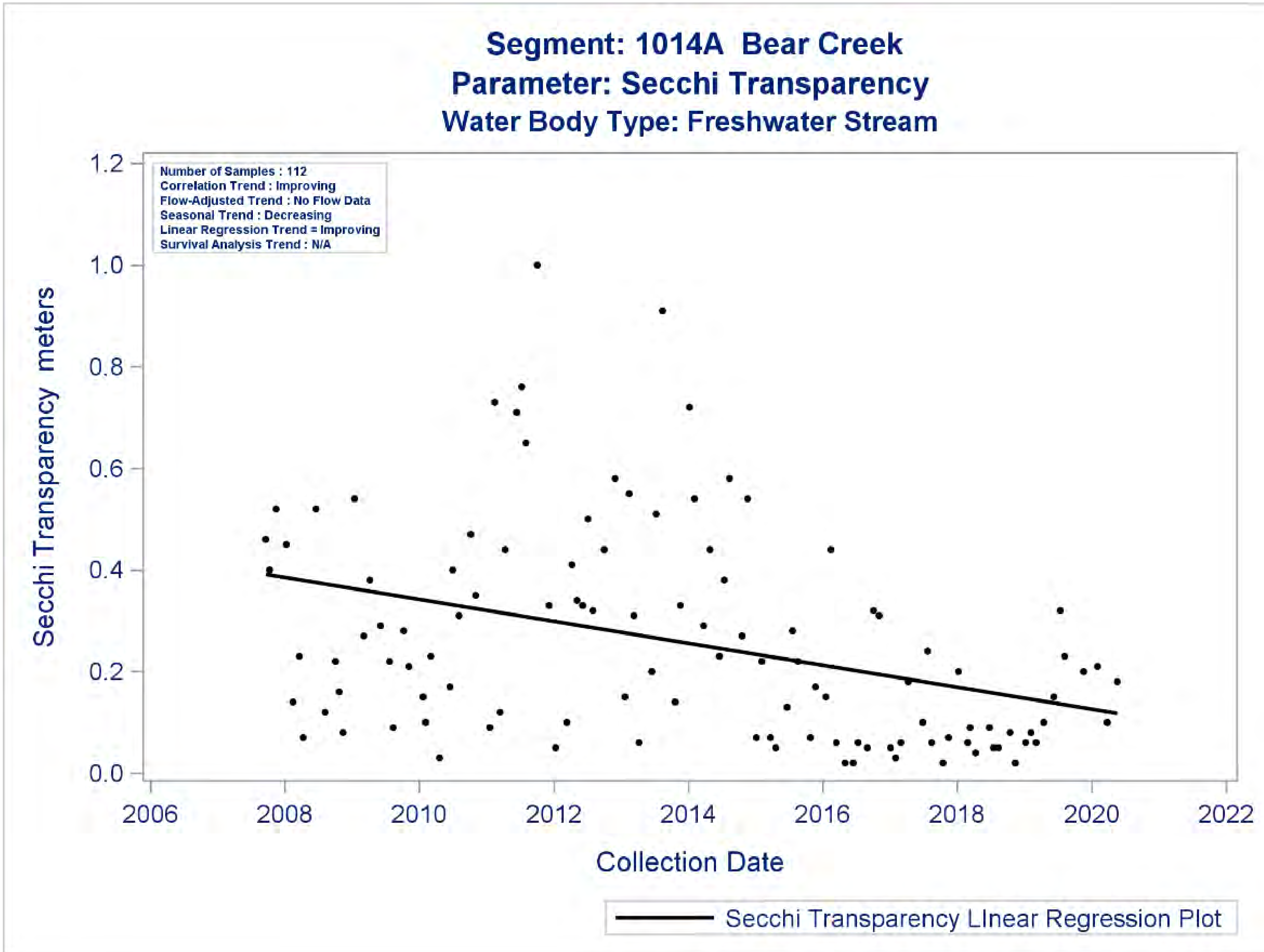

Segment: 1014K Turkey Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 60
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
6
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



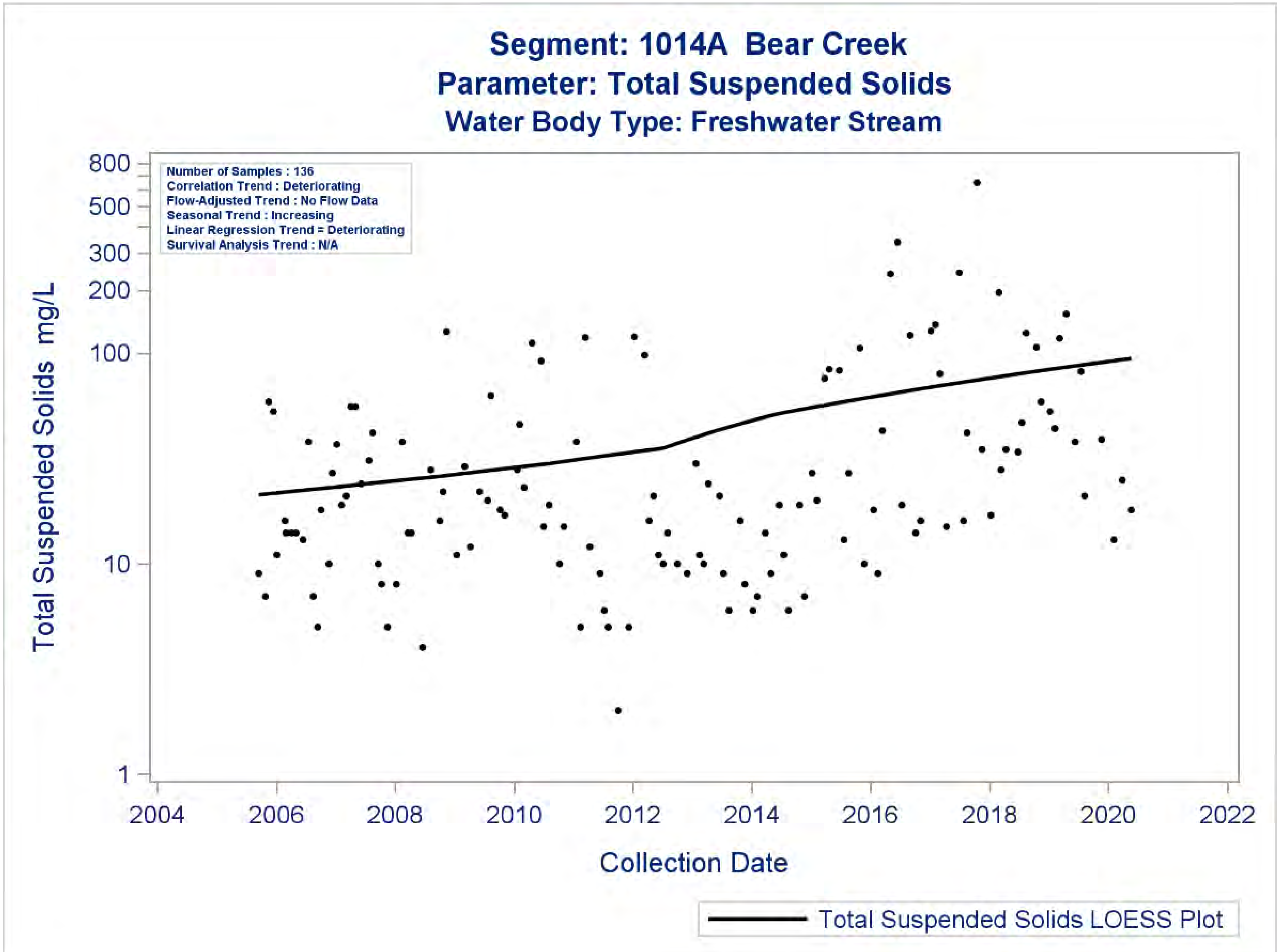
Segment: 1014C Horsepen Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 48
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
2
4
6
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



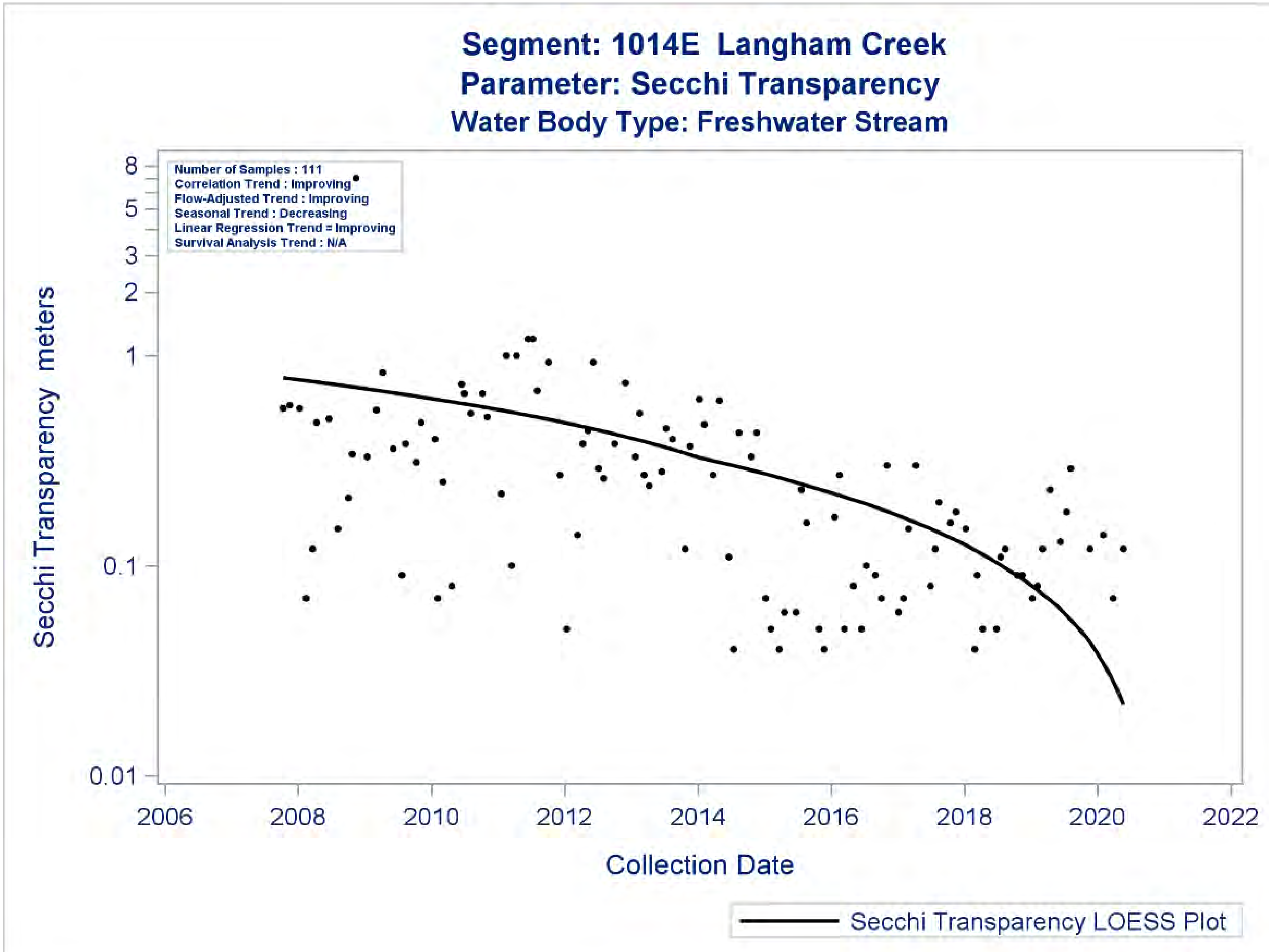
Segment: 1014K Turkey Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 265
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.5
1.0
1.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



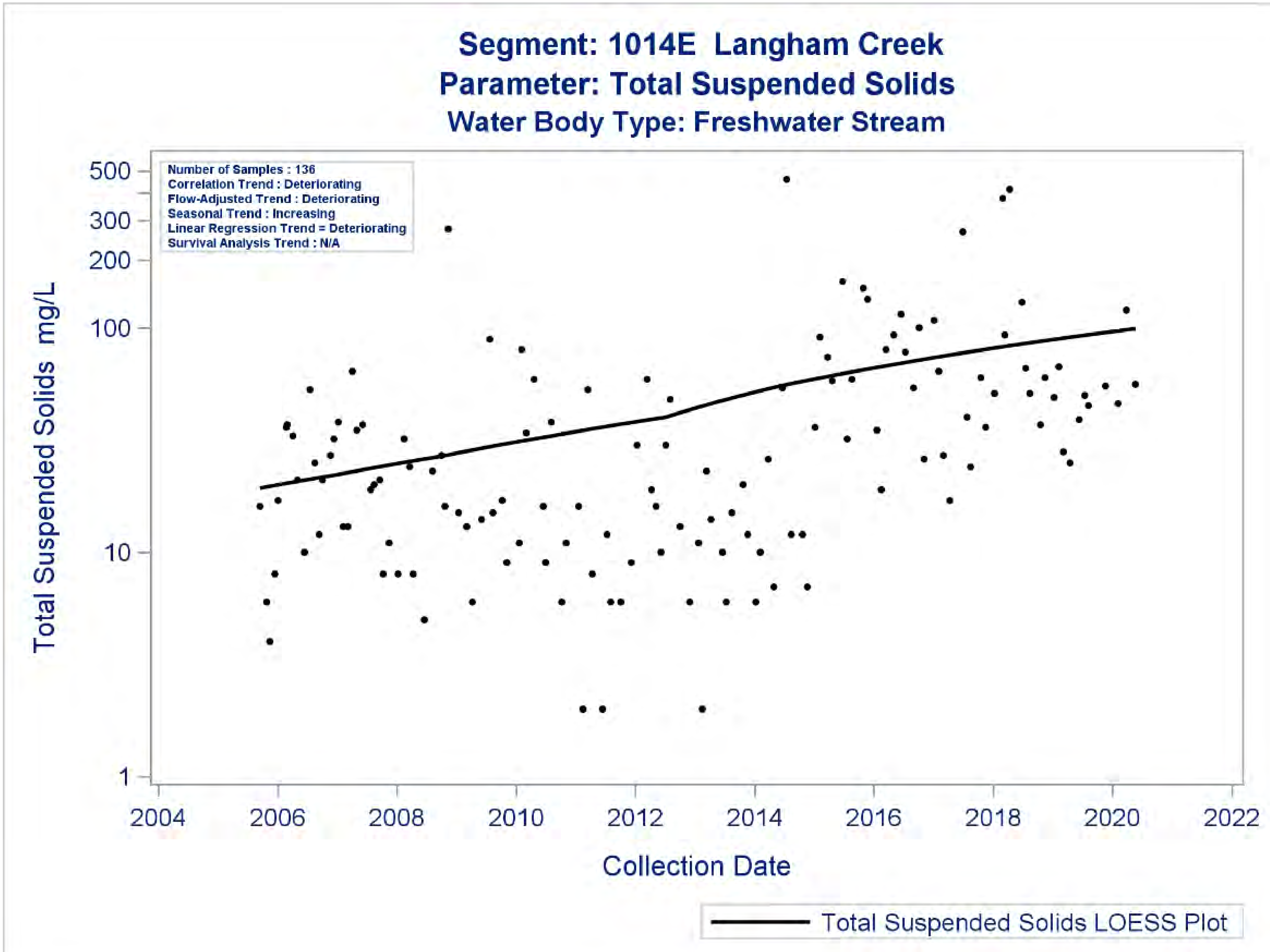
Segment: 1014A Bear Creek
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 112
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot



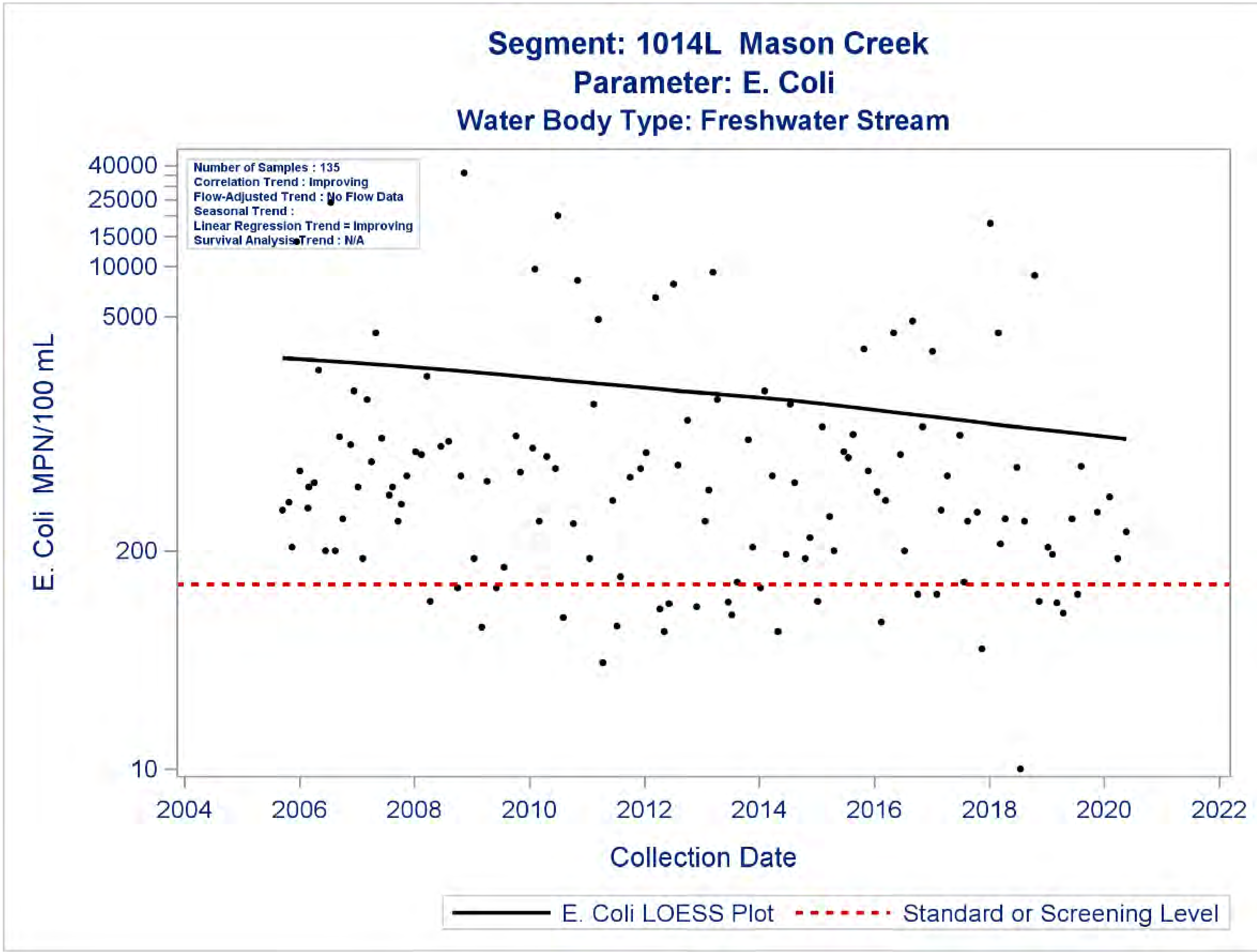
Segment: 1014A Bear Creek
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 136
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
800
500
300
200
100
10
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot

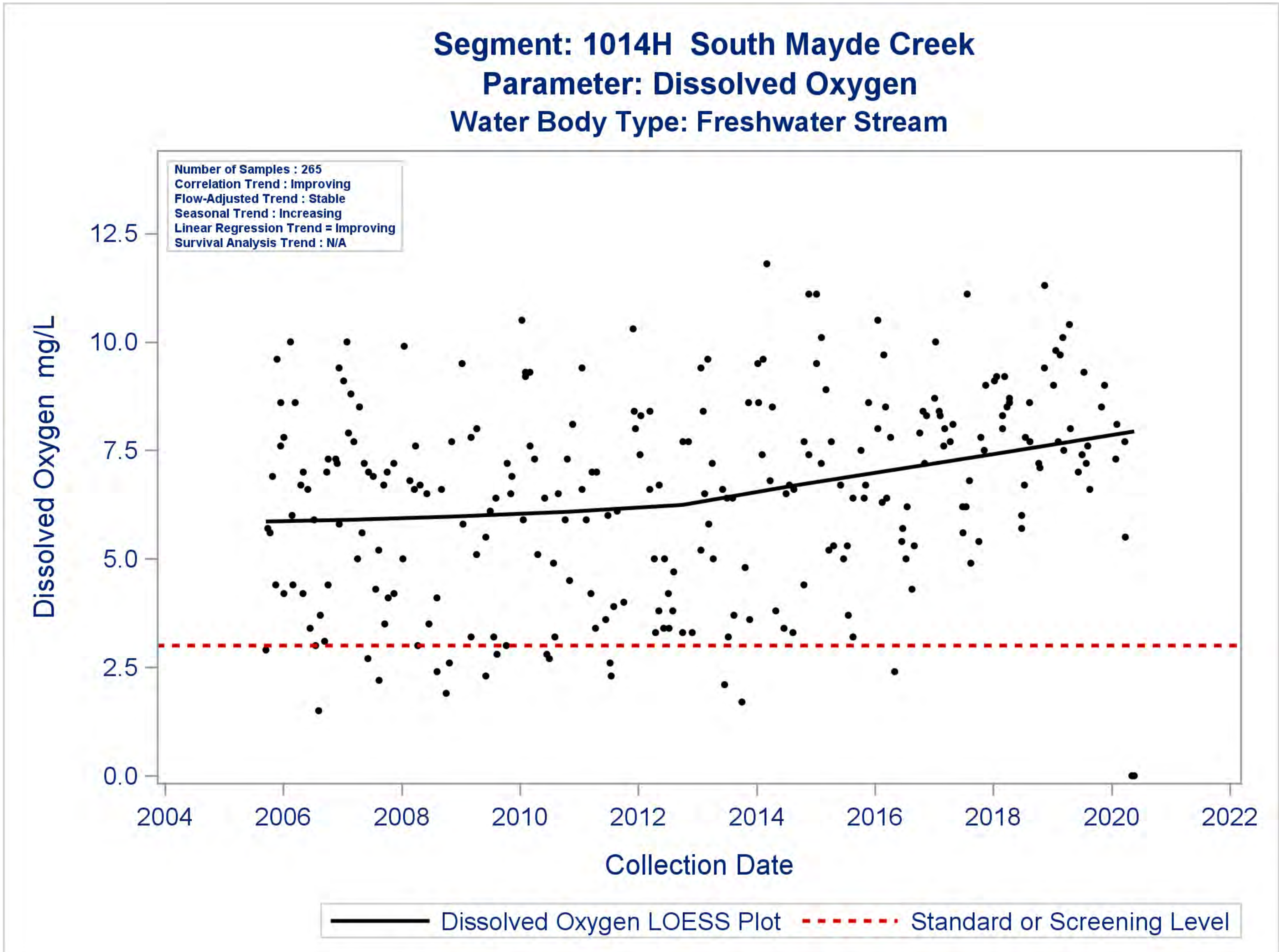


Segment: 1014E Langham Creek
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 111
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
8
5
3
2
1
0.1
0.01
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot



Segment: 1014E Langham Creek
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 136
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
500
300
200
100
10
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot


Segment: 1014L Mason Creek
Parameter: E. Coli
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend :
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
40000
25000
15000
10000
5000
200
10
E. Coli MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LOESS Plot
Standard or Screening Level


Segment: 1014H South Mayde Creek
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 265
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0.0
2.5
5.0
7.5
10.0
12.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1014_01 I 1014A_01 I 1014B_01 I 1014C_01 I 1014E_01 I 1014H_01 I 1014H_02 I 1014K_01 I 1014K_02 I 1014L I 1014M I 1014N 1014O	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Constructed stormwater controls failing • Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Direct and dry weather discharges • Improper or no pet waste disposal • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Improve compliance and enforcement of existing stormwater quality permits • Improve storm water controls in new developments by adding bacteria reduction measures • Improve construction oversight to minimize TSS discharges to waterways • More public education on pet waste disposal • Promote and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing and alternative water supplies to keep livestock out of or away from waterways
Low Dissolved Oxygen Concentrations	1014H_01 C 1014M_01 I	▪ Excessive nutrients and organic matter from agricultural production ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve riparian buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Regionalize chronically non-compliant WWTFs • Improve operation and maintenance of existing WWTF and collection systems • More public education about OSSF maintenance • More public education regarding disposal of household fats, oils, and grease

				• More public education on pet waste disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating • Conserve or restore trees and habitat along waterways to maintain/create shade to cool water
Elevated Nutrient Concentrations	***Ammonia*** 1014A_01 C 1014C_01 C 1014E_01 C 1014H_01 C ***Nitrate*** 1014_01 C 1014A_01 C 1014B_01 C 1014C_01 C 1014E_01 C 1014H_01 C 1014H_02 C 1014K_01 C 1014L_01 C ***Phosphorus*** 1014_01 C 1014A_01 C 1014B_01 C 1014C_01 C 1014E_01 C 1014H_01 C 1014H_02 C 1014L_01 C	• Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Impaired Macrobenthic and Fish Communities	1014M_01 I	• Loss of habitat due to channelization of waterway • Erosion from construction sites including roads, and commercial and residential developments • Erosion from agricultural properties	• Detrimental to the aquatic biological community	• Work with drainage districts to install/construct habitat that doesn't interfere with water movement • Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat

Special Studies:

This segment is part of a larger geographic area covered under several TMDLs, collectively known as the Bacteria Implementation Group (BIG) I-Plan. Refer to the Public Involvement and Outreach section of the 2021 Basin Summary Report for more information about the BIG.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number:	1013			Name:	Buffalo Bayou Tidal		
Length:	5 miles	Watershed Area:	9 square miles	Designated Uses:	Primary Contact Recreation 1; Intermediate Aquatic Life		
Number of Active Monitoring Stations:	7	Texas Stream Team Monitoring Stations:	2	Permitted WWTF Outfalls:	0		

DESCRIPTION

- Segment 1013 (Tidal Stream w/ intermediate ALU): **Buffalo Bayou Tidal** (classified water body) – From a point 100 meters (110 yards) upstream of US 59 in Harris County to a point 400 meters (440 yards) upstream of Shepherd Drive in Harris County including the tidal portions of tributaries

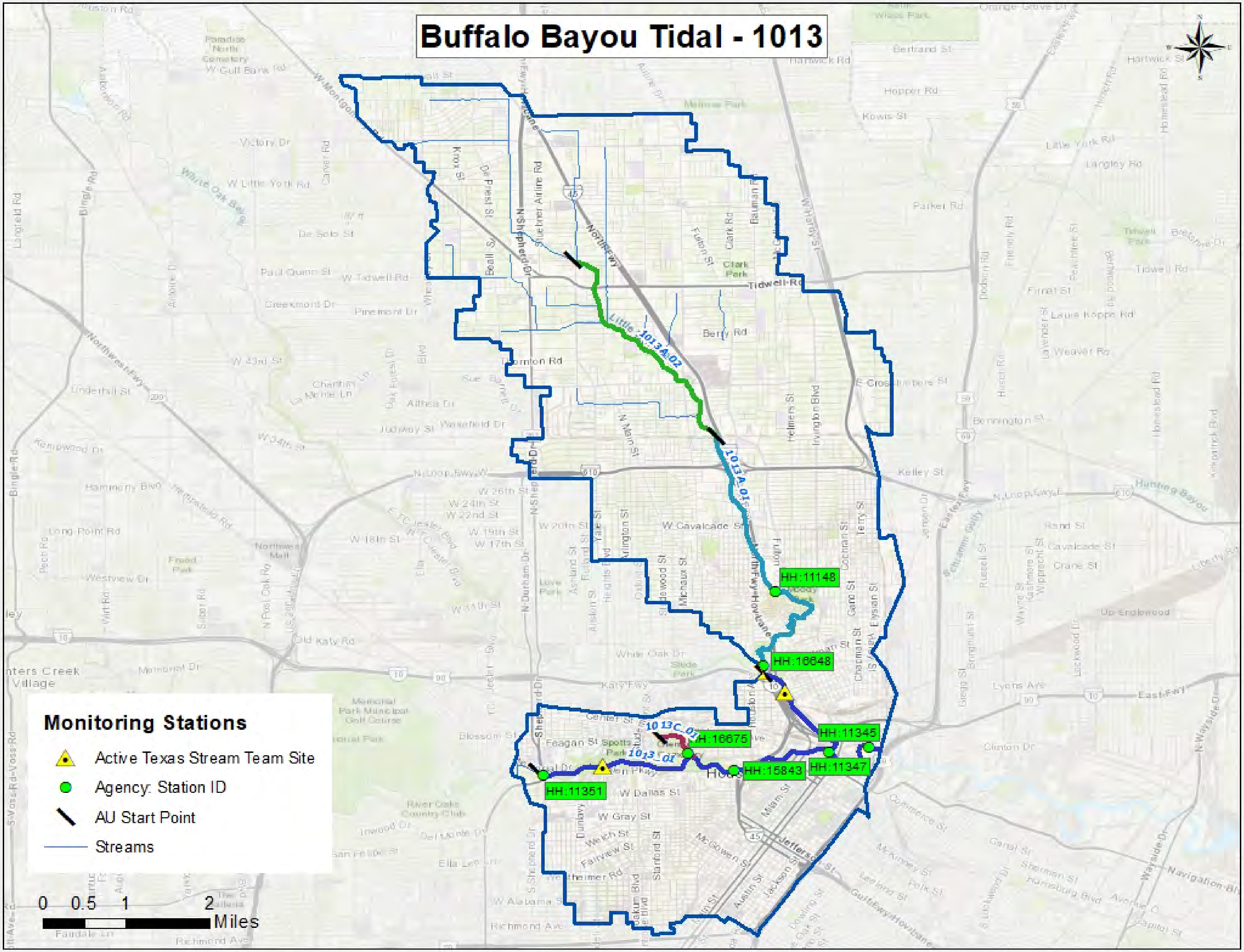
- Segment 1013A Perennial Stream w/ intermediate ALU): **Little White Oak Bayou** (unclassified water body) – From the confluence of White Oak Bayou to Yale Street in Harris County

- Segment 1013B: Retired segment description

- Segment 1013C (Perennial Stream w/ high ALU): **Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal** (unclassified water body) – From the Buffalo Bayou confluence upstream to a point 0.34 km (0.21 mi) east of Studemont Street

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11345	1013	BUFFALO BAYOU TIDAL AT MCKEE ST IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
11345	1013	BUFFALO BAYOU TIDAL AT MCKEE ST IN HOUSTON	FO	Quarterly	Field, Conventional, Bacteria
11347	1013	BUFFALO BAYOU TIDAL IMMEDIATELY DOWNSTREAM OF MAIN STREET IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria, Flow
11351	1013	BUFFALO BAYOU TIDAL AT SHEPHERD DRIVE IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria, Flow
15843	1013	BUFFALO BAYOU TIDAL AT SABINE STREET NORTH OF ALLEN PARKWAY IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
11148	1013A	LITTLE WHITE OAK BAYOU AT TRIMBLE STREET/NORTH EDGE OF HOLLYWOOD CEMETERY IN HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria, Flow
16648	1013A	LITTLE WHITE OAK BAYOU AT WHITE OAK DRIVE IN NORTH HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria
16675	1013C	UNNAMED TRIB OF BUFFALO BAYOU AT GLENWOOD CEMETARY RD 160 M W OF INTERSECT OF LUBBOCK ST AND SAWYER ST IN CENTRAL HOUSTON	HH	Bimonthly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HH = Houston Health & Human Services


Buffalo Bayou Tidal - 1013
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0 0.5 1 2
Miles
1013A_02
1013A_01
1013C_01
1013_01
HH:11148
HH:16648
HH:11345
HH:16675
HH:15843
HH:11347
HH:11351

Segment 1013 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F):	33 / 92	33 / 92	Ammonia (mg/L):	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	3.0	5.0 / 4.0	Nitrate-N (mg/L):	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	2.0	3.0 / 3.0	Orthophosphate Phosphorus (mg/L):	0.46	0.37
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus (mg/L):	0.66	0.69
Enterococci (MPN/100mL) (grab):	89		Chlorophyll *a* (µg/L):	21	14.1
Enterococci (MPN/100mL) (geometric mean):	35				
E. coli (MPN/100 mL) (grab):		399			
E. coli (MPN/100 mL) (geometric mean):		126			

Segment Discussion

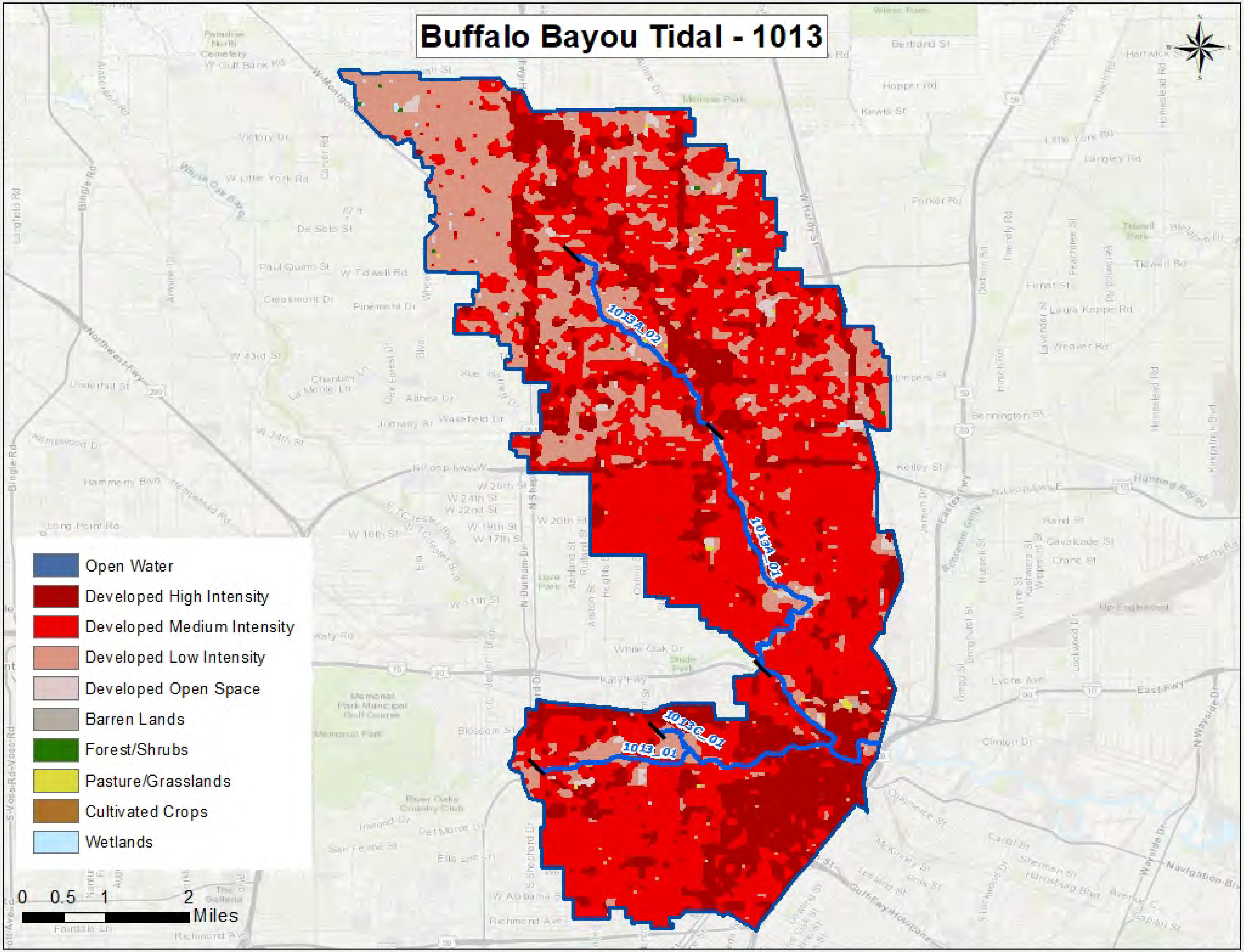
Watershed Characteristics and Land Cover: The Buffalo Bayou Tidal (1013) segment is defined as from a point 100 meters (110 yards) upstream of US 59 in Harris County to a point 400 meters (440 yards) upstream of Shepherd Drive in Harris County, including the tidal and non-tidal portions of tributaries. Major tributaries include the tidal and non-tidal portions of White Oak and Little White Oak Bayous. A major portion of the Houston metropolitan area is drained by Buffalo Bayou. In addition to a large number of municipal and industrial wastewater discharges, Buffalo Bayou Tidal receives significant amounts of urban storm water runoff.

The Buffalo Bayou Tidal watershed is completely urbanized, with 99.35 percent of the watershed area being developed. This watershed encompasses downtown Houston, the theater and entertainment districts, residential developments, high volume mixed-commercial developments, and light industry. Several parks and natural areas are located along the banks of Buffalo and White Oak Bayous. Programs like the Houston Downtown Living Initiative have rapidly increased residential development and redevelopment throughout central Houston resulting in an increased population density within the Buffalo Bayou watersheds. Interstate-45, Interstate-10, and US Highway 59 are major thoroughfares that converge around downtown Houston.

Segment 1013 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	46.04	0.23	43.37	0.22	-5.80
Barren Lands	0.89	0.00	28.02	0.14	3,048.31
Developed	19,617.34	98.70	19,749.21	99.35	0.67
Forest/Shrubs	124.76	0.63	22.02	0.11	-82.35
Open Water	40.92	0.21	2.00	0.01	-95.11
Wetlands	46.48	0.23	34.03	0.17	-26.79
TOTAL	**19,876.43**	**100.00**	**19,878.65**	**100.00**	

Buffalo Bayou Tidal - 1013



Water Quality Issues:

Bacteria Impairments and Concerns

Contact recreation uses are not currently supported in this watershed. For the period of 12/01/11 – 11/30/18 assessed for the 2020 Integrated Report, the bacteria geometric mean for enterococci in Buffalo Bayou Tidal (1013_01) was 201.82 MPN/100 mL. The water quality standard for enterococcus is 35 MPN/100 mL. For the tributaries, the *E. coli* geometric mean was 1,749.02 MPN/100 mL for Little White Oak Creek (1013A_01) and 2,191.56 MPN/100 mL of an unnamed tributary (1013C). These values greatly exceed the water quality standard of 126 MPN/100 mL.

Dissolved Oxygen Impairments and Concerns

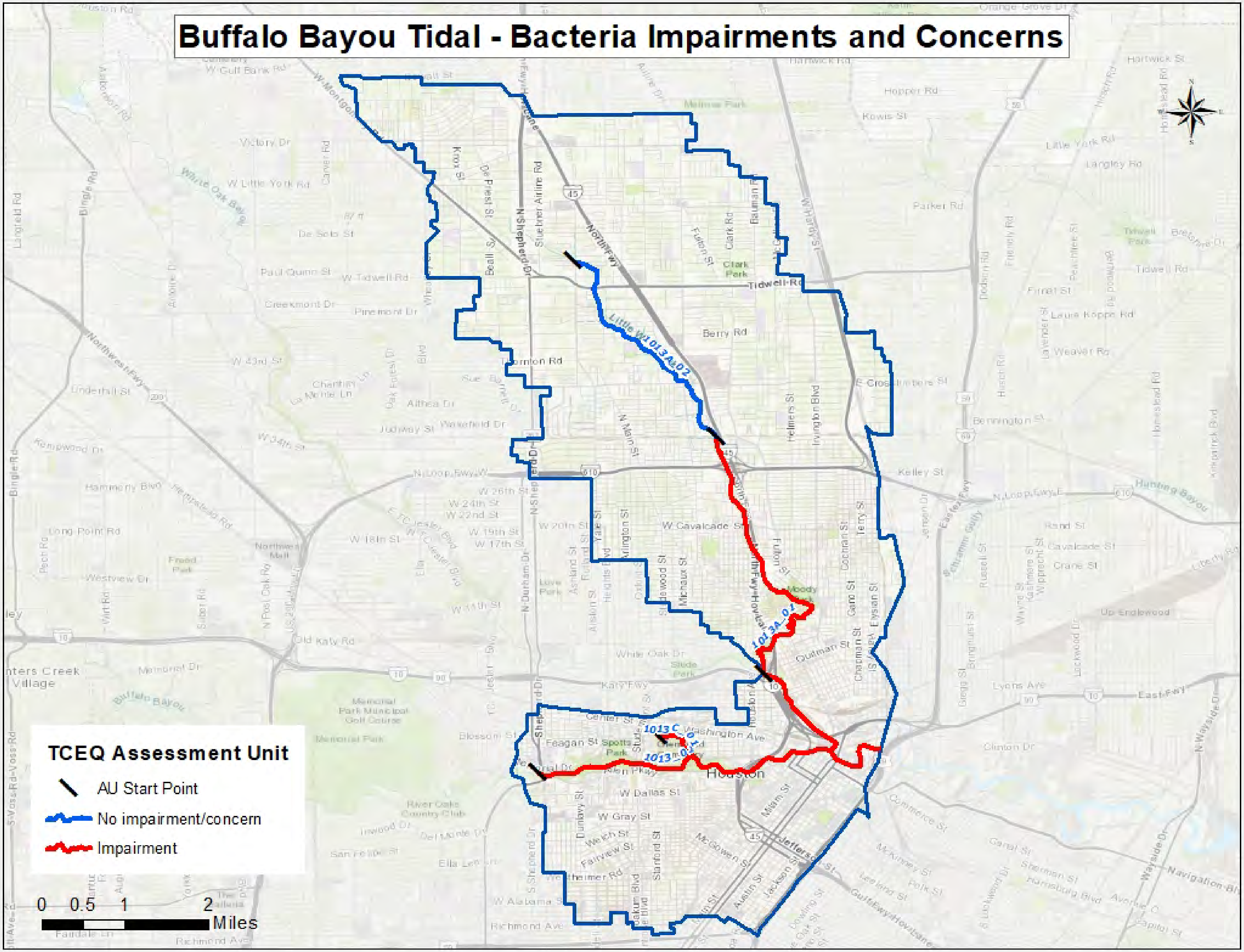
Aquatic life use is supported in Buffalo Bayou Tidal, with only 3 of 249 dissolved oxygen results (1.2 percent) below the criteria of 3.0 mg/L. Little White Oak Bayou does not support its aquatic life designated use, as it is not supporting based upon dissolved oxygen 24-hour average and minimum measurements. For the unnamed tributary of Buffalo Bayou (1013C), the segment does not support its designated use, with a concern for dissolved oxygen grab screening level criteria and an impairment for grab minimum levels.

Nutrient Concerns

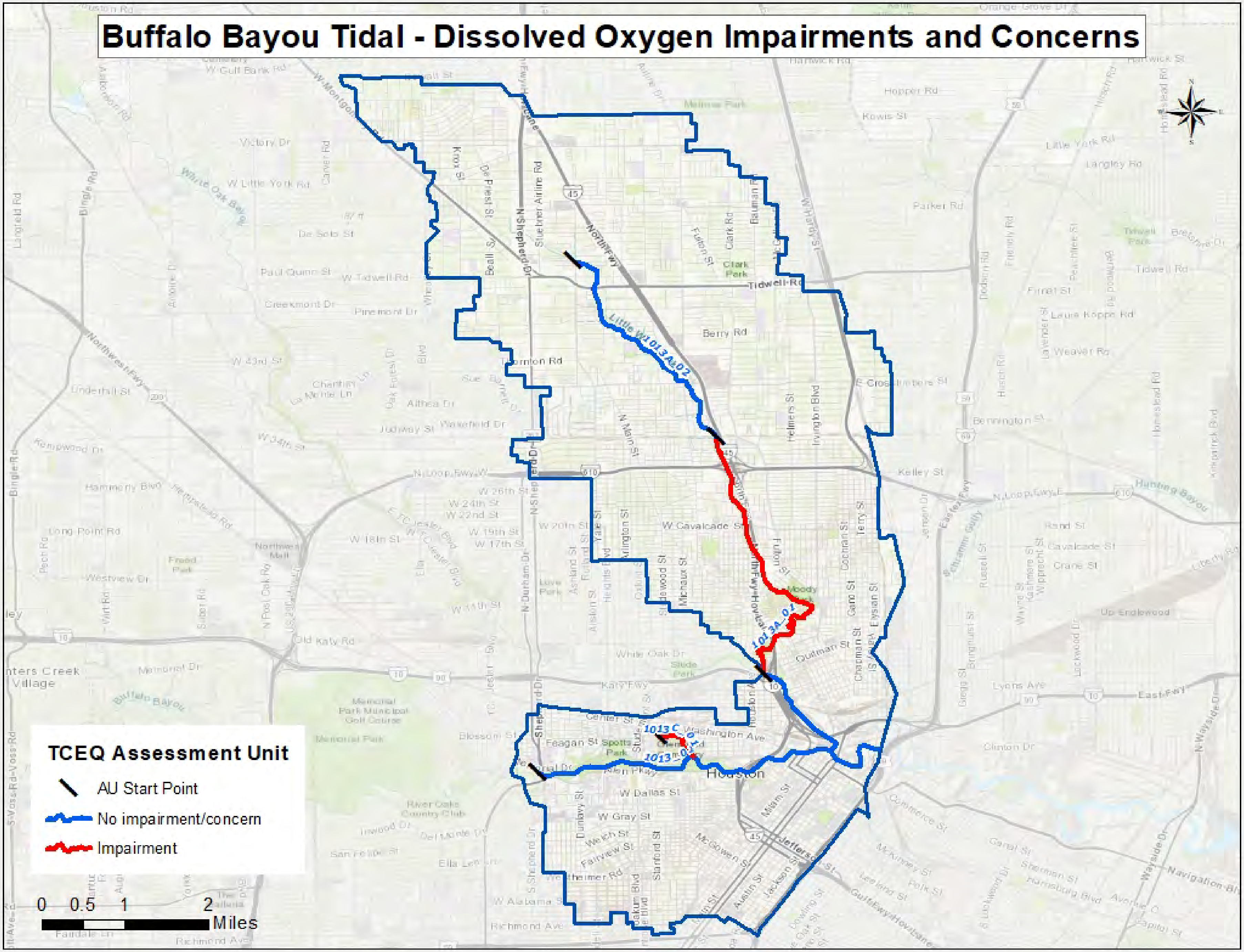
There are concerns for nutrient screening levels in the Buffalo Bayou Tidal segment. Concerns were identified for both nitrate-nitrogen and total phosphorus in the 2020 Integrated Report. 194 of 261 nitrate-nitrogen samples (74.3 percent) exceeded the 1.10 mg/L screening level. For total phosphorus, 151 of 261 samples (57.8 percent) exceeded the 0.66 mg/L screening level.

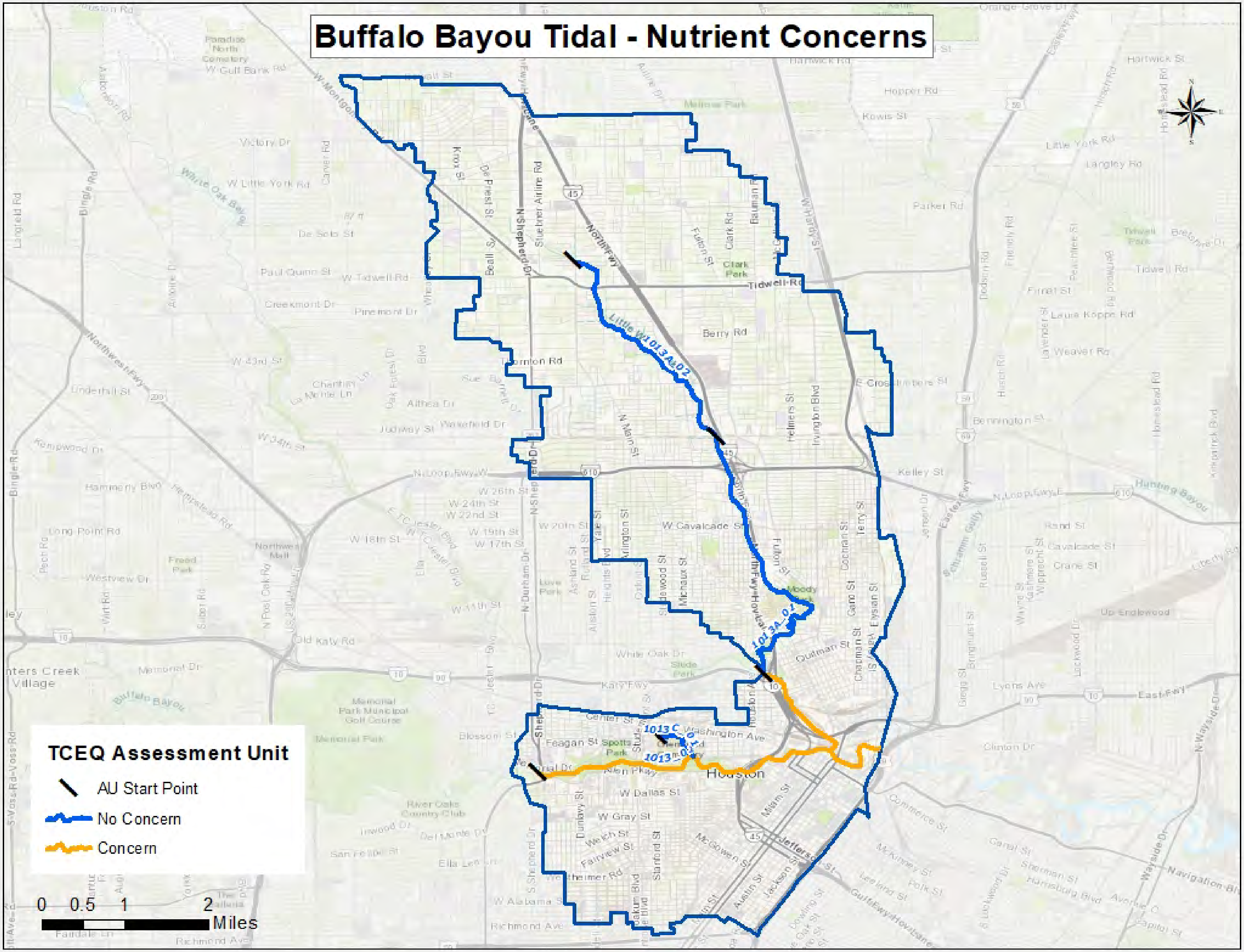
Macrobenthic Community

In the 2020 Integrated Report, a concern for the macrobenthic community was identified in Little White Oak Bayou (1013A). Little White Oak Bayou is susceptible to frequent ‘flash’ flows which will scour the stream bottom, plus the waterway’s aquatic life use is not fully supported due to depressed dissolved oxygen. Not only is the 24-hour average below the stream standard, the lowest measurement collected during the 24-hour period was below the minimum standard for the stream. Additionally, the dissolved oxygen grab screening level repeatedly is below the screening criteria when local partners are collecting grab samples during routine monitoring. All this together means the waterway’s low dissolved oxygen levels fail to provide a diverse and healthy populations of benthic insects.



Buffalo Bayou Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0 0.5 1 2
Miles
1013A_02
1013A_01
1013C_01
1013_01


Buffalo Bayou Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
1013A_02
1013A_01
1013C_01
1013_01
0 0.5 1 2
Miles

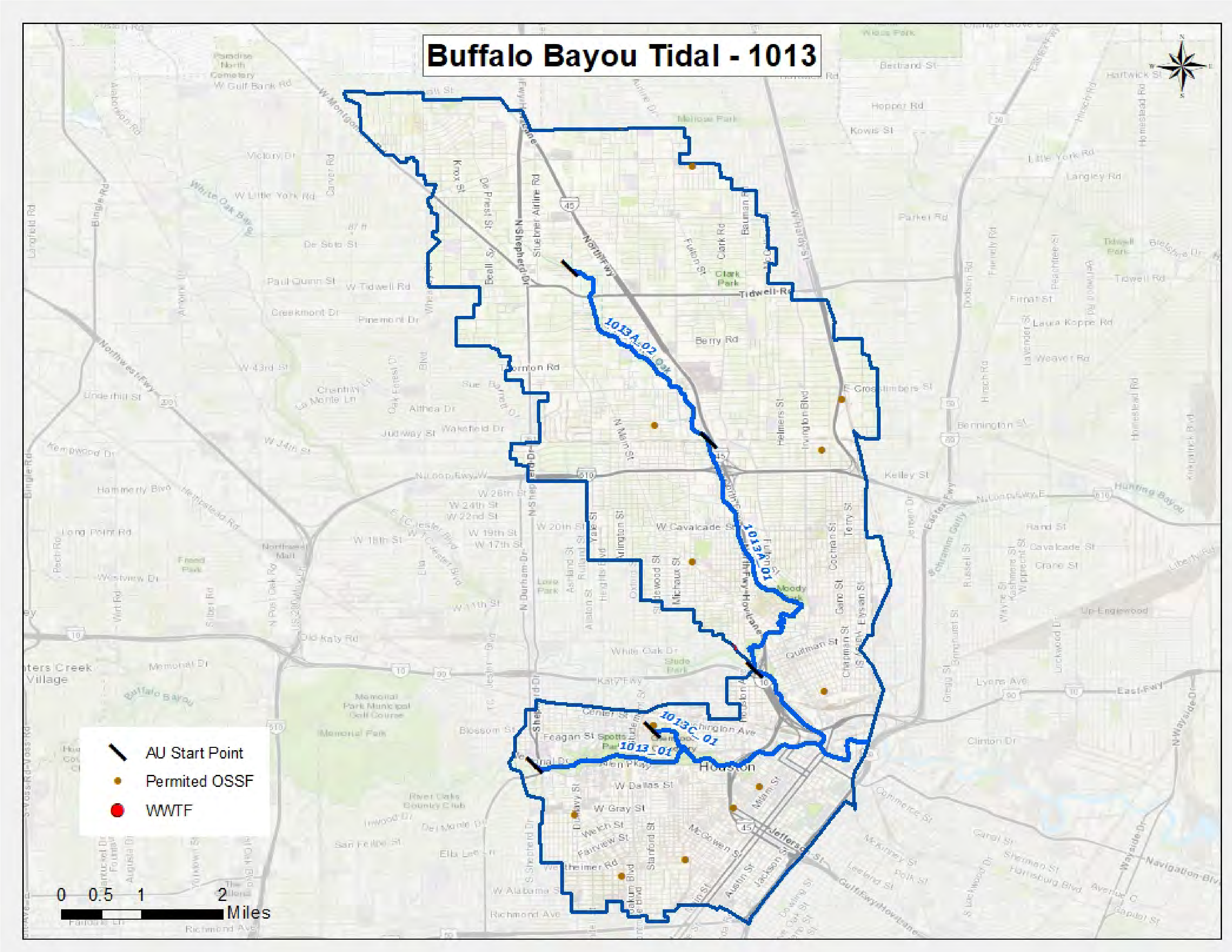

Buffalo Bayou Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
0.5
1
2
Miles
1013A_02
1013A_01
1013C_01
1013_01
Houston

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Buffalo Bayou Tidal watershed include both point source and nonpoint sources. These sources include sanitary sewer overflows, stormwater runoff, and pet waste.

There are no permitted wastewater outfalls and only 13 ‘permitted’ on-site sewage facilities in the Buffalo Bayou Tidal watershed. The wastewater treatment facilities and on-site sewage facilities in the Buffalo Bayou Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 2,105 sanitary sewer overflows reported in the sewer collection systems. These sanitary sewer overflows likely contribute to chronically high bacteria within this waterway, and discrete events may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

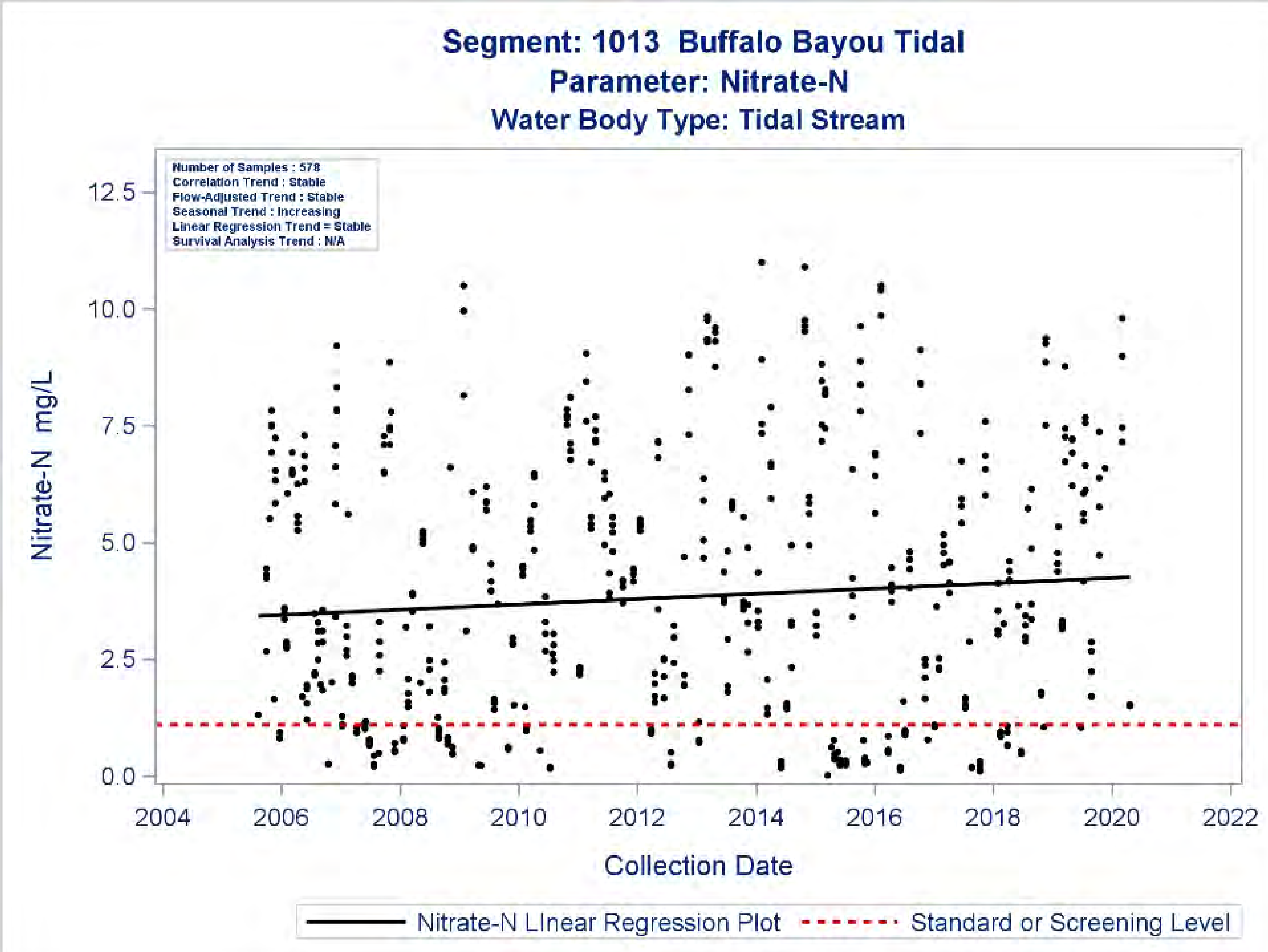
For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Buffalo Bayou Tidal watershed.


Buffalo Bayou Tidal - 1013
1013A_02
1013A_01
1013C_01
1013_01
AU Start Point
Permited OSSF
WWTF
0 0.5 1 2
Miles

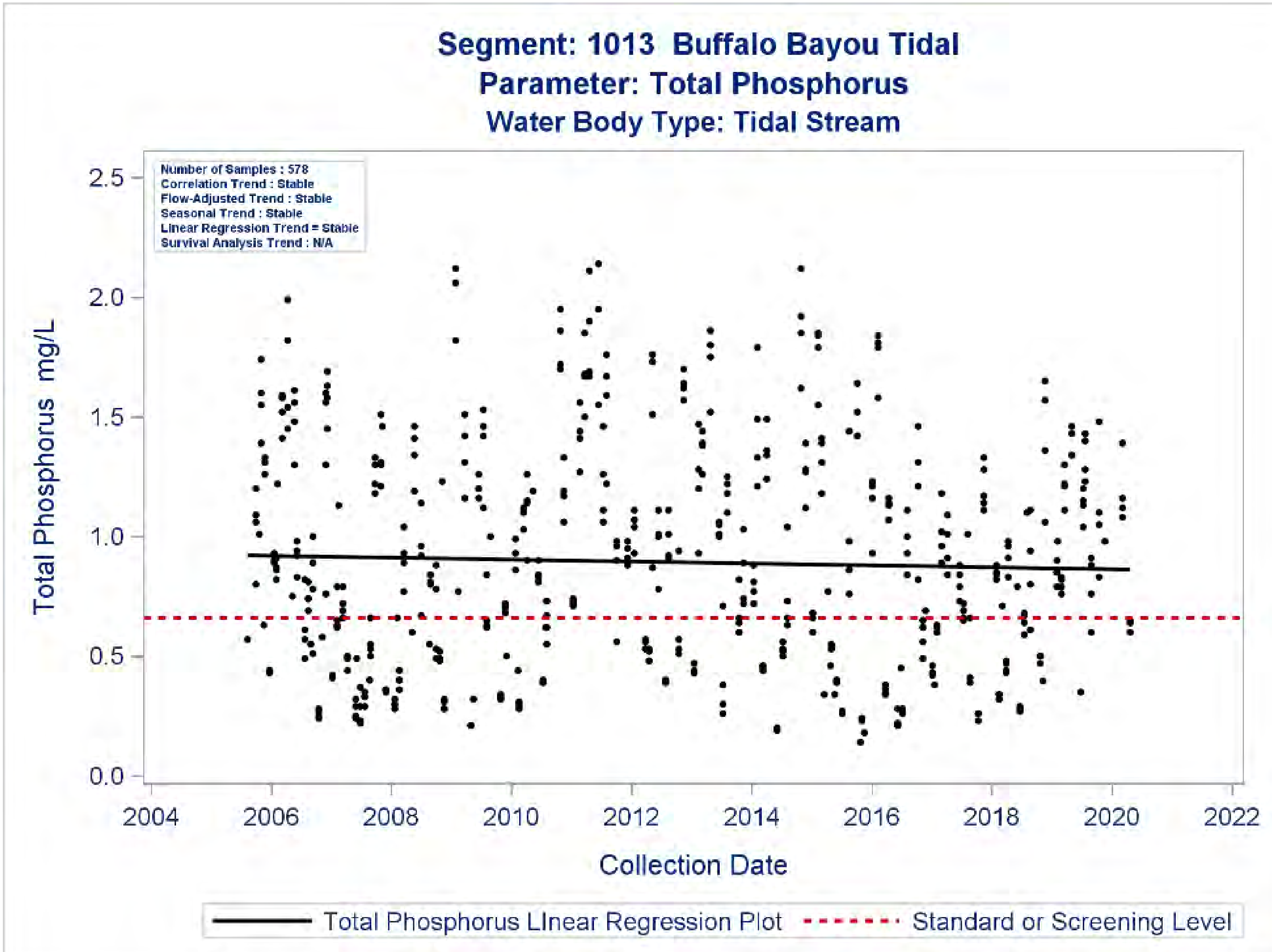
Trend Analysis:

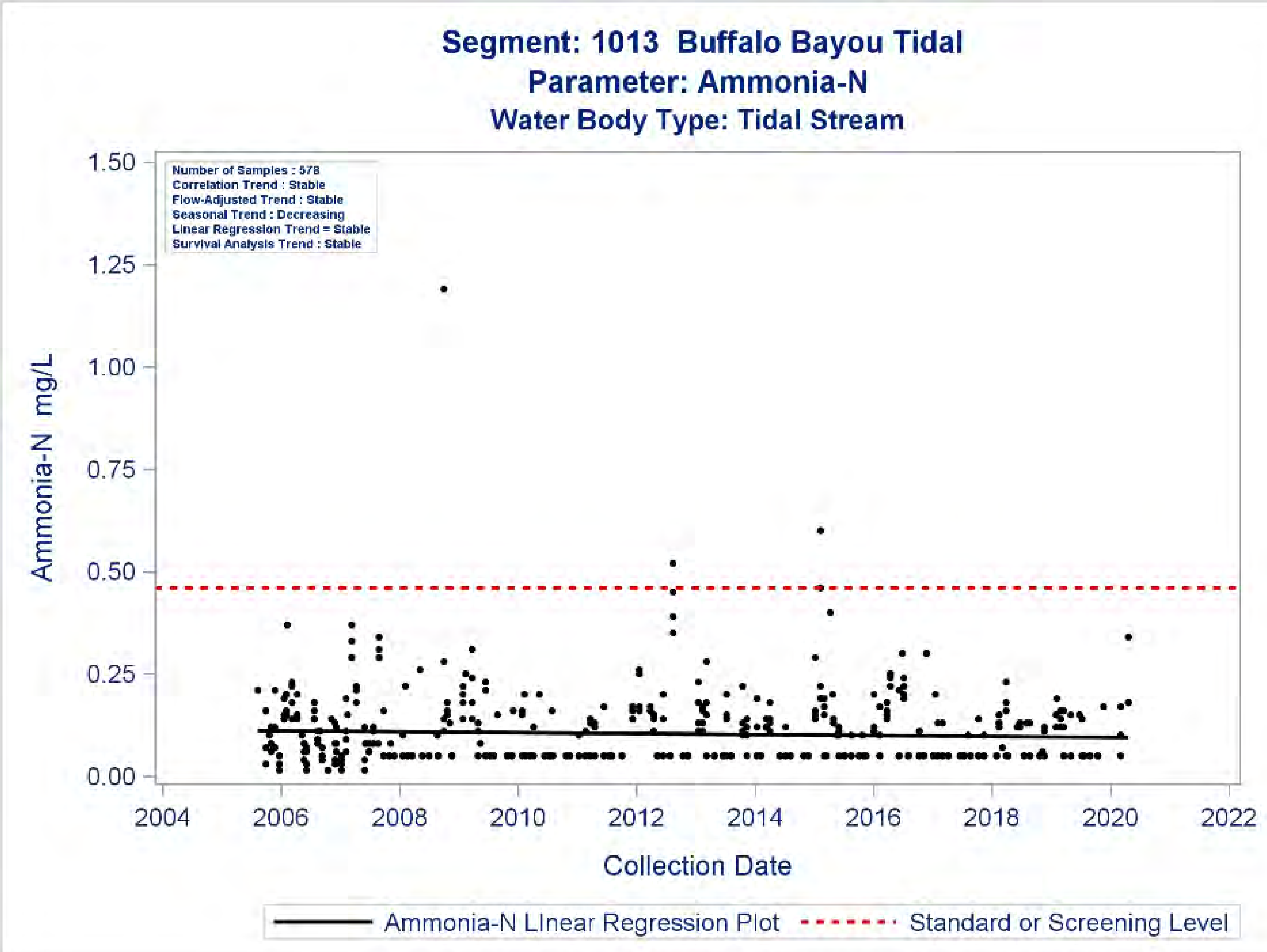
Regression analysis of watershed data revealed that nutrient trends vary depending on the location in the watershed. Trends in the main segment of Buffalo Bayou Tidal appear to be mostly stable, with a majority of nitrate and total phosphorus (TP) samples above the screening criteria and ammonia samples well below the screening criteria. Ammonia levels appear to be improving in both Little White Oak Bayou (1013A) and an unnamed tributary to Buffalo Bayou Tidal (1013C); However, if not for the one outlier measured back in 2006, the concentrations of ammonia would be stable. Nitrate levels in both tributaries are increasing, but while levels on 1013A remain well below screening criteria, samples from 1013C in recent years have risen above screening criteria. The 1013C tributary also has an increasing TP trend with several samples exceeding the screening criteria since 2016. In addition, 1013C is seeing an increasing trend in water temperature, none of which are at sustained levels to affect aquatic life.

Both tributaries have impairments for low dissolved oxygen (DO) levels. However, it is worth noting that 24-hour DO samples for 1013A stopped in 2011 and there are insufficient data to determine a trend. DO grab samples show a stable trend with only a few samples below the standard since 2016. A significant increasing trend is shown for DO on 1013C, again with only a few samples below the standard since 2015. In tributary 1013C, the secchi depth has been decreasing which means the water is getting more turbid. This is probably associated with dirt work within the Glenwood Cemetery where the stream was channelized and run through underground culverts. Overall, bacteria levels in the Buffalo Bayou Tidal watershed have remained stable during the period of record with most samples still measuring well above the set water quality standards.

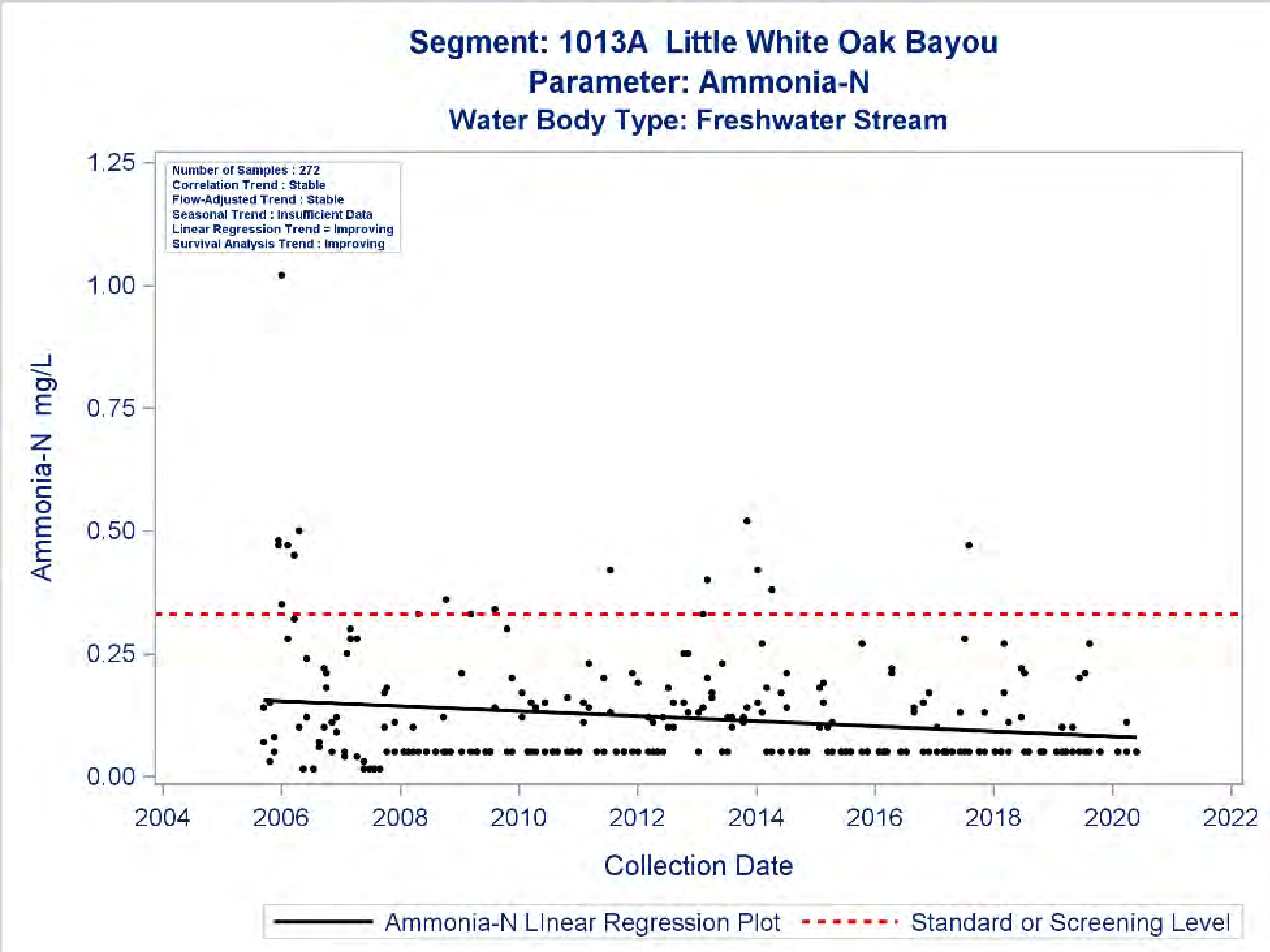


Segment: 1013 Buffalo Bayou Tidal
Parameter: Nitrate-N
Water Body Type: Tidal Stream
Number of Samples : 578
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Nitrate-N mg/L
0.0
2.5
5.0
7.5
10.0
12.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

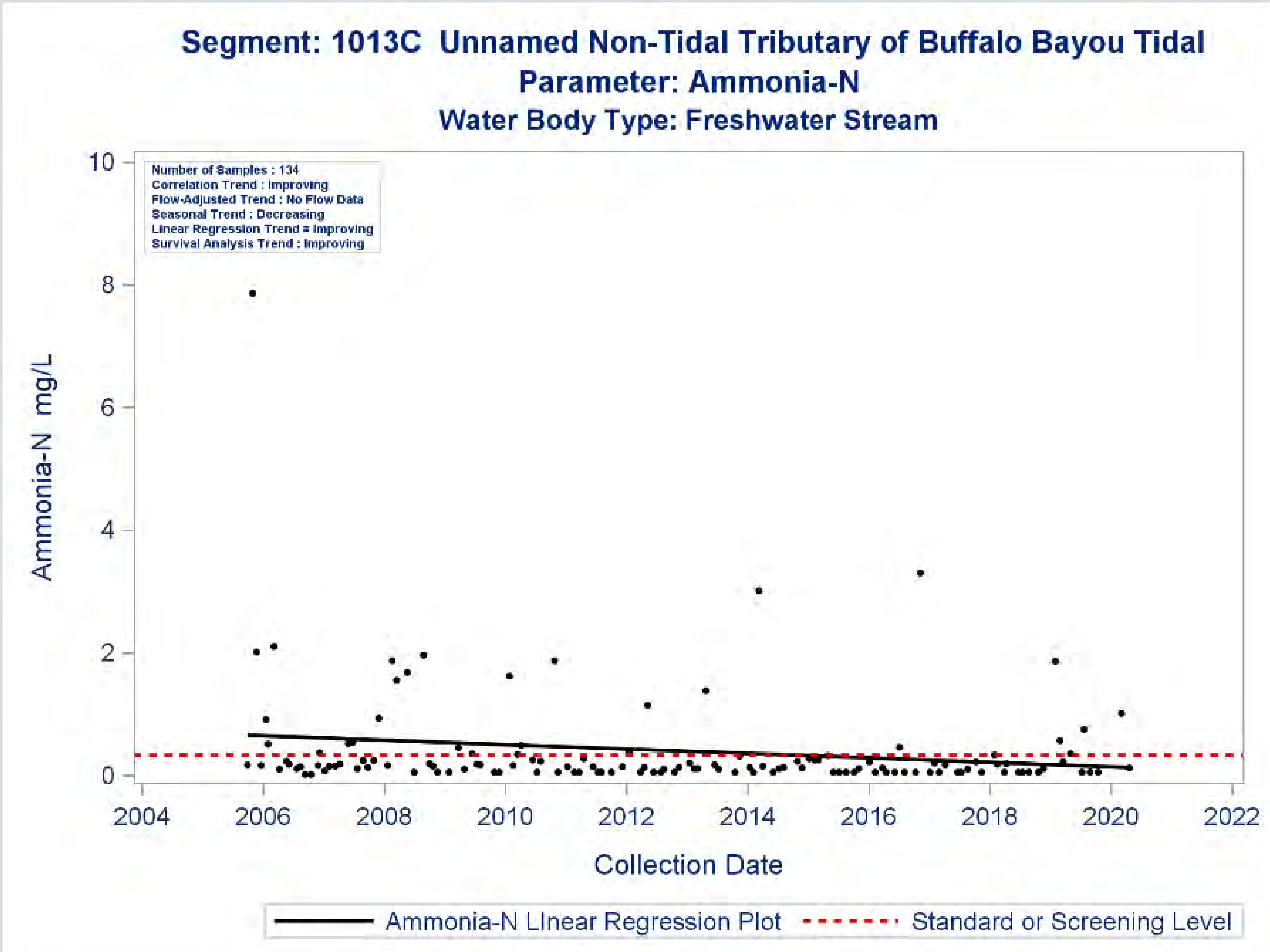

Segment: 1013 Buffalo Bayou Tidal
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 578
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.5
1.0
1.5
2.0
2.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



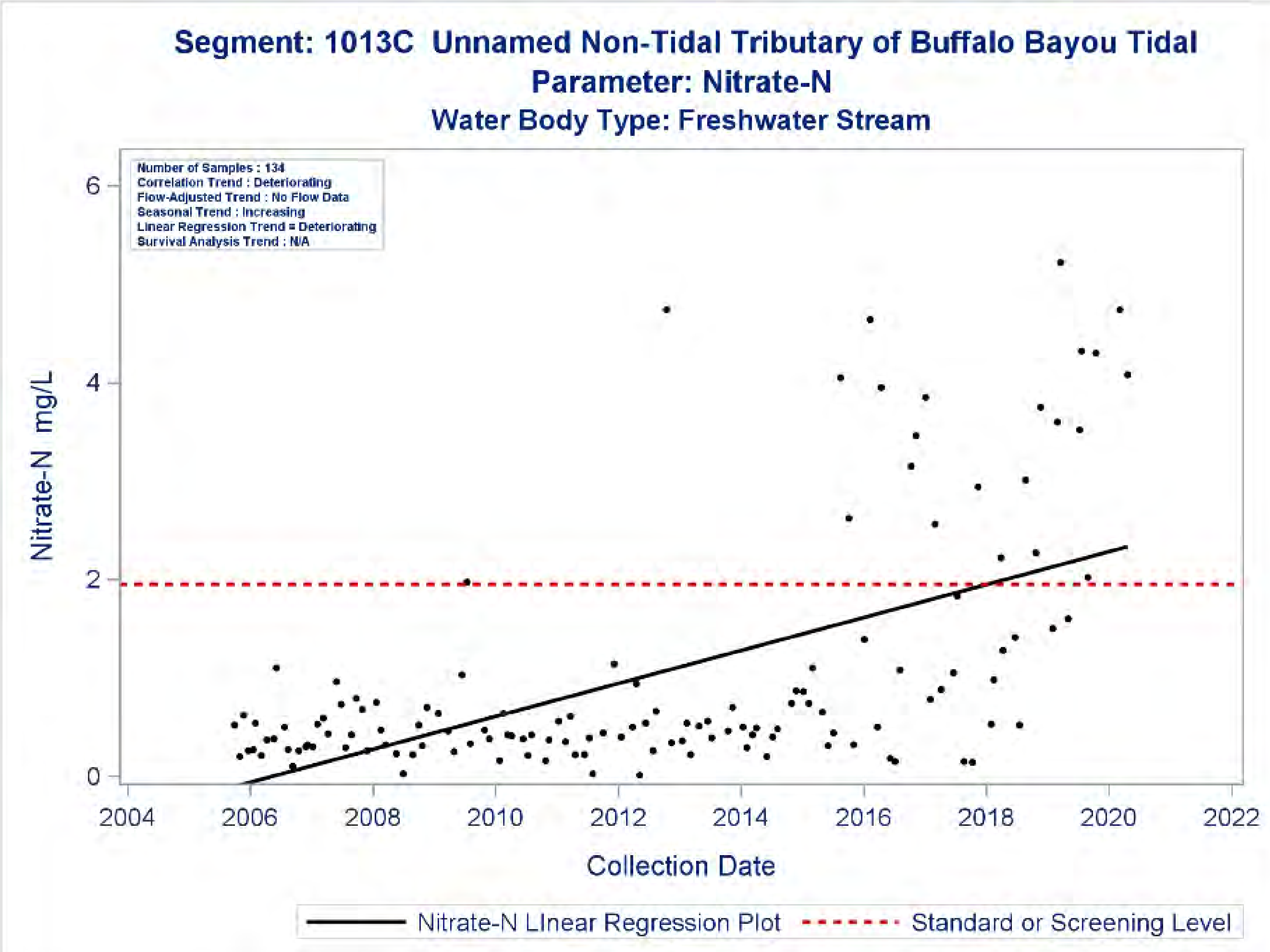
Segment: 1013 Buffalo Bayou Tidal
Parameter: Ammonia-N
Water Body Type: Tidal Stream
Number of Samples : 578
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Ammonia-N mg/L
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level

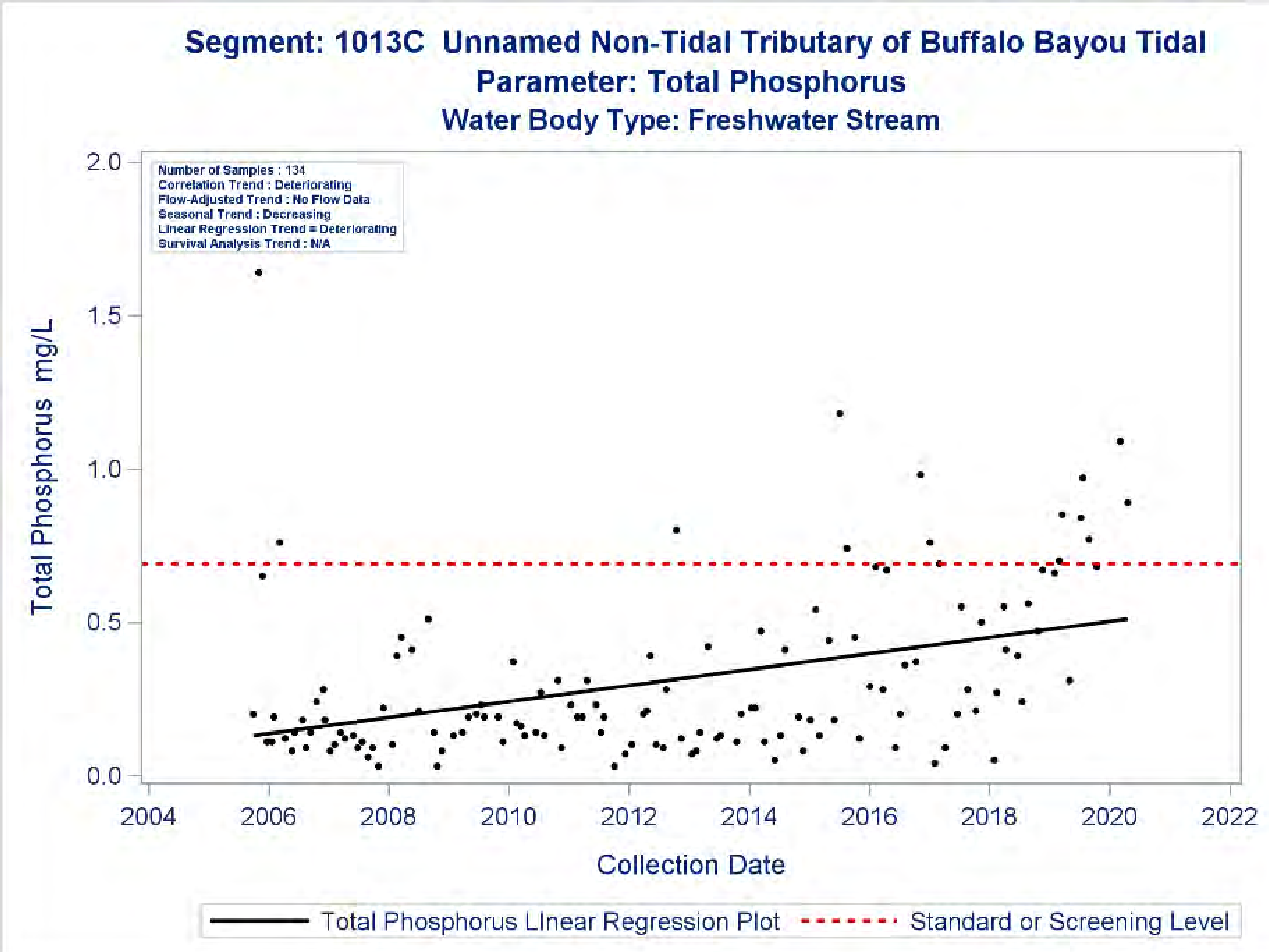


Segment: 1013A Little White Oak Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 272
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level

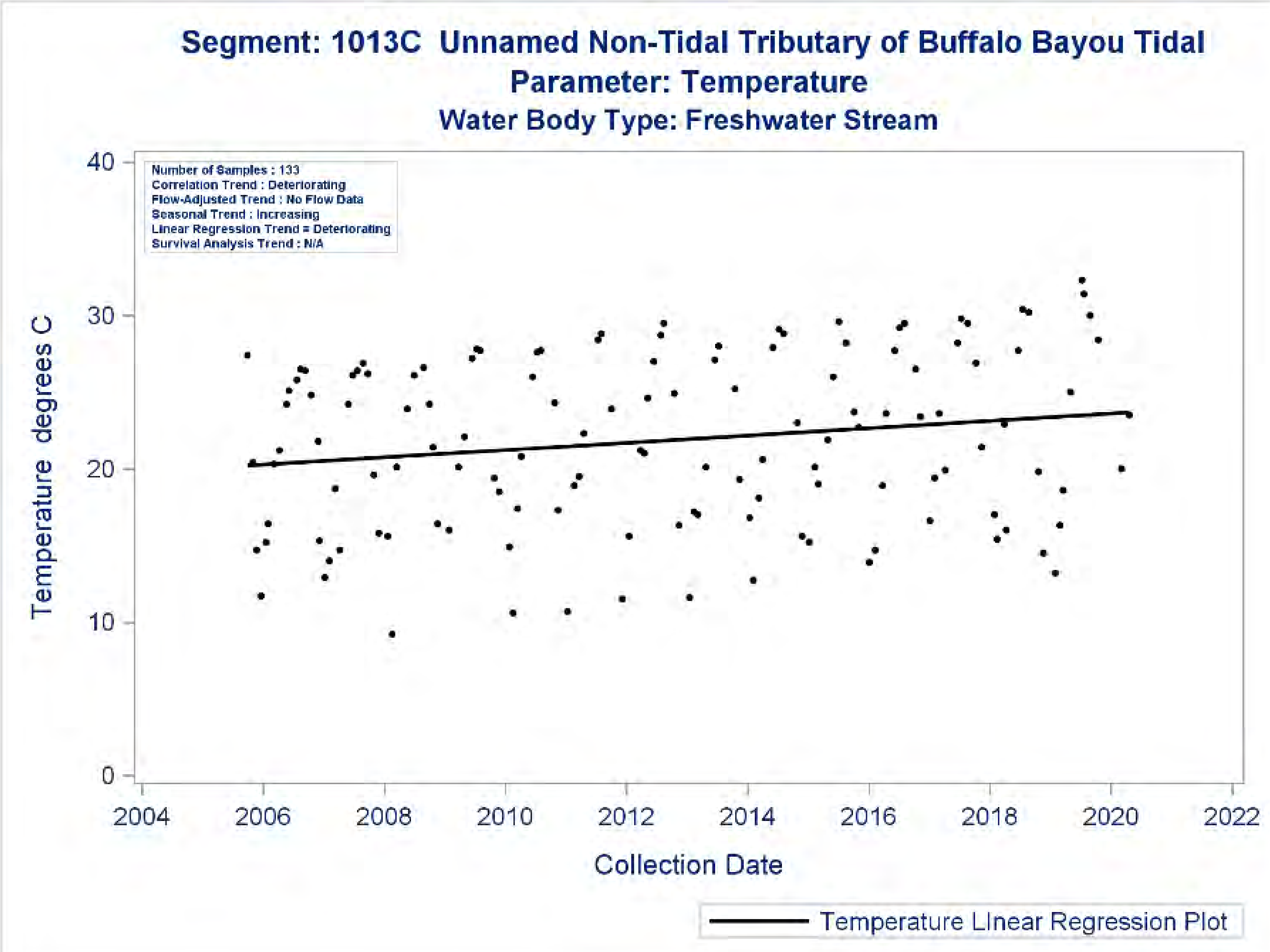


Segment: 1013C Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 134
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
10
8
6
4
2
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level

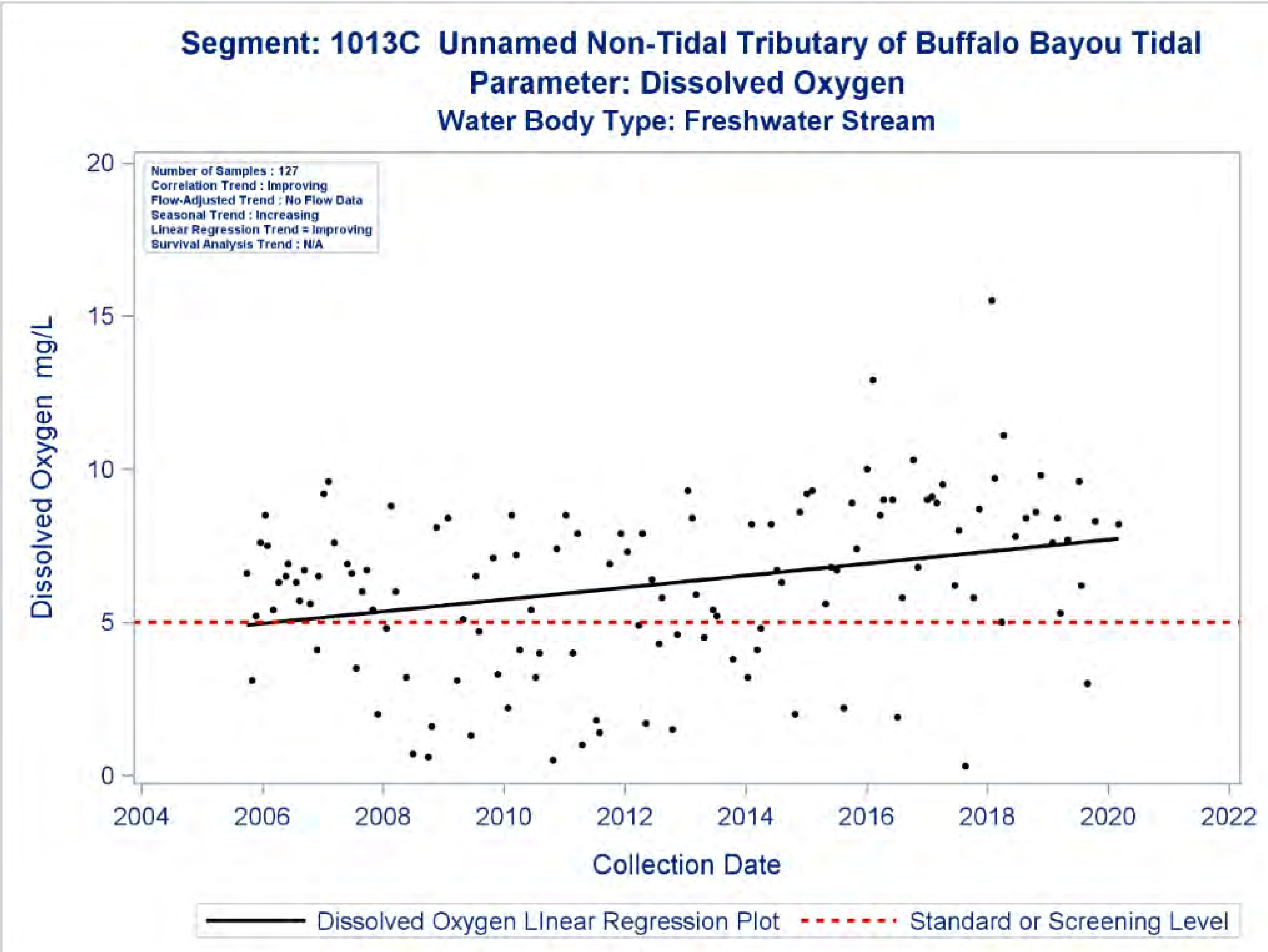

Segment: 1013C Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 134
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
0
2
4
6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level



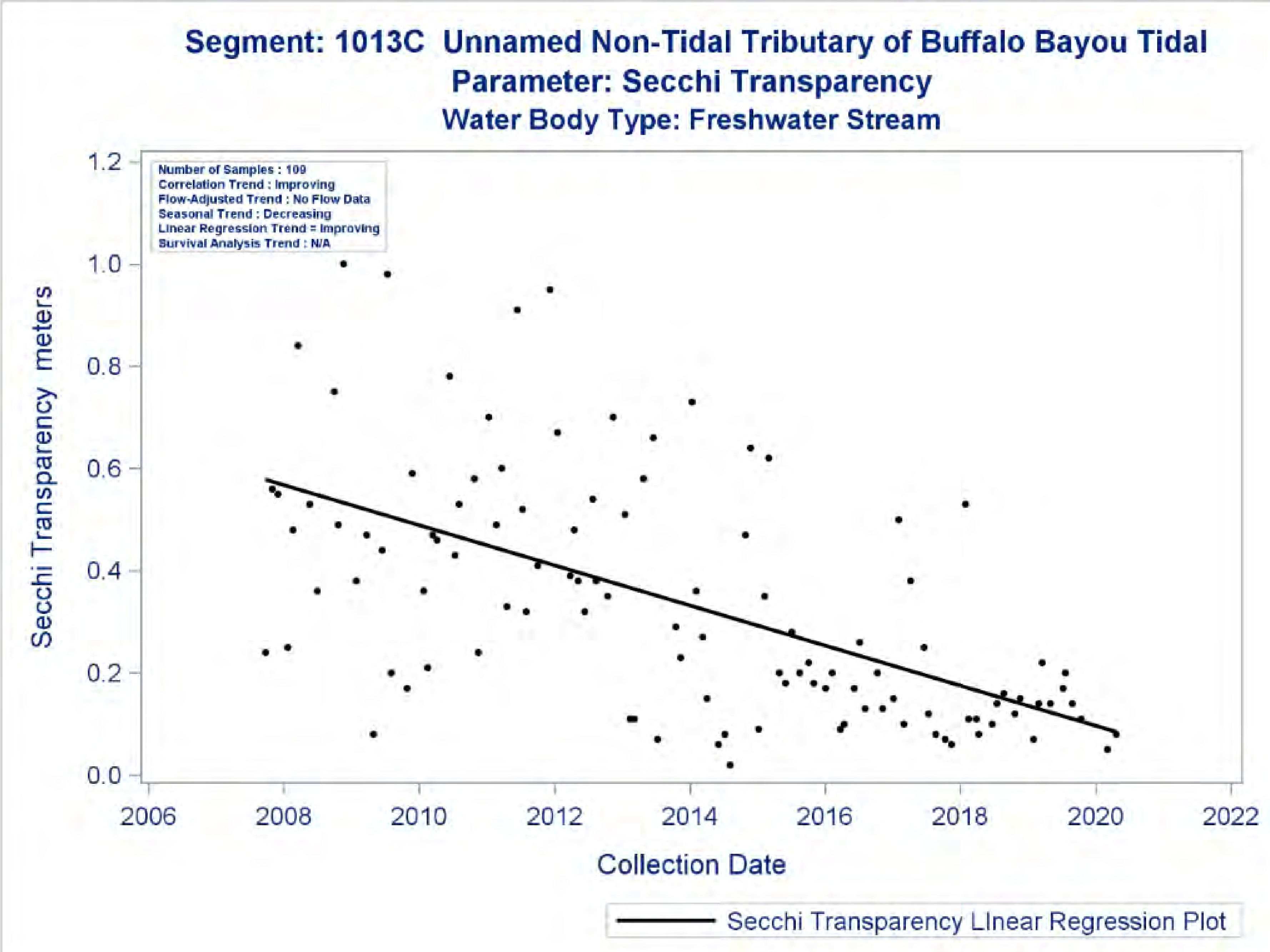
Segment: 1013C Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 134
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.5
1.0
1.5
2.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level



Segment: 1013C Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal
Parameter: Temperature
Water Body Type: Freshwater Stream
Number of Samples : 133
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Temperature degrees C
40
30
20
10
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Temperature Linear Regression Plot



Segment: 1013C Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 127
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level



Segment: 1013C Unnamed Non-Tidal Tributary of Buffalo Bayou Tidal
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 109
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1013 I 1013A_01 I 1013C I	• Constructed stormwater controls failing • Collection system overflows and by-passes • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Improper or no pet waste disposal	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education on pet waste disposal
Low Dissolved Oxygen Concentrations	***DO 24-hour Average*** 1013A_01 I ***DO 24-hour Minimum*** 1013A_01 I ***DO Grab Min*** 1013C I ***DO Grab Screening Level*** 1013C C	▪ Excessive nutrients and organic matter from SSOs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Improve compliance and enforcement of existing stormwater quality permits • Improve operation and maintenance of existing WWTF and collection systems • More public education regarding pet waste and household fats, oils, and grease disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating • Conserve or restore trees and habitat along waterways to maintain/create shade to cool water
Elevated Nutrient Concentrations	***Nitrate-N*** 1013 C ***Phosphorus*** 1013 C	• Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Sanitary sewer overflows	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Expand use of LID and green infrastructure practices • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Macrobenthic Community	1013A C	• Bank erosion and erosion at construction sites • Loss of habitat due to channelization of waterway	• Detrimental to the aquatic biological community	• Re-connect oxbows and lost channels to augment water storage and retention • Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat

		• Ongoing maintenance of modified channel		• Work with drainage districts to install/construct habitat that doesn't interfere with water movement

Special Studies:

This segment is part of a larger geographic area covered under several TMDLs, collectively known as the Bacteria Implementation Group (BIG) I-Plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Continue collecting water quality data and expand monitoring efforts to support actions associated with the Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Support public education on pet waste disposal

Segment Number: 1016				Name: Greens Bayou Above Tidal			
Length:	29 miles	Watershed Area:	143 square miles	Designated Uses:	Primary Contact Recreation 1; Limited Aquatic Life		
Number of Active Monitoring Stations:	11	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	87		

DESCRIPTION

- Segment 1016 (Perennial Stream w/ limited ALU): **Greens Bayou Above Tidal** (classified water body) – From a point 0.7 km (0.4 miles) above the confluence of Halls Bayou in Harris County to a point 100 meters (110 yards) above FM 1960 in Harris County

- Segment 1016A (Perennial Stream w/ high ALU): **Garners Bayou** (unclassified water body) – From the Greens Bayou confluence to a point 1.5 km (0.93 mi) upstream of Will Clayton Pkwy in Harris County

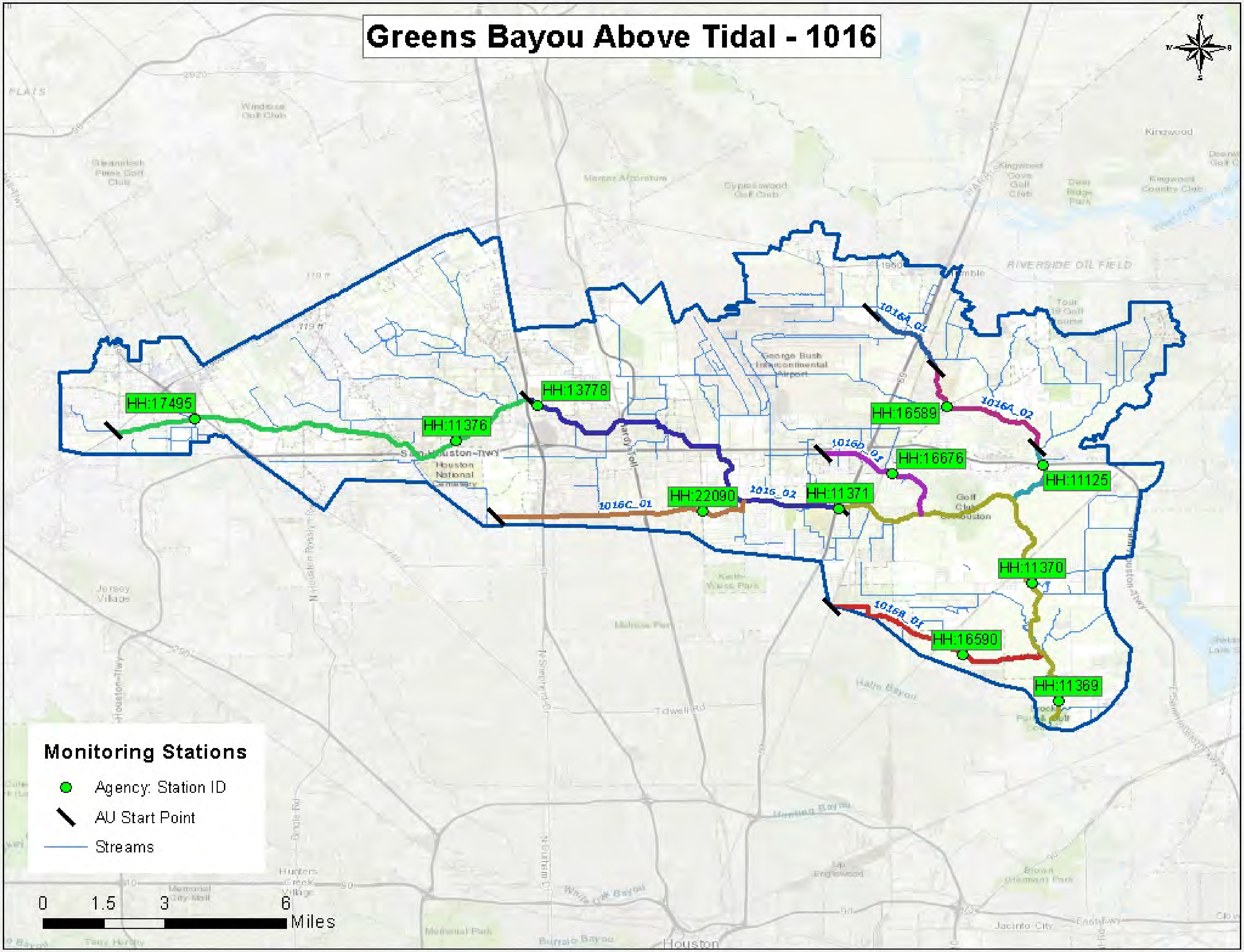
- Segment 1016B (Perennial Stream w/ limited ALU): **Unnamed Tributary of Greens Bayou** (unclassified water body) – From the Greens Bayou Above Tidal confluence to Hirsch Road in Harris County

- Segment 1016C (Perennial Stream w/ limited ALU): **Unnamed Tributary of Greens Bayou** (unclassified water body) – From the Greens Bayou Above Tidal confluence to 1.6 km (0.99 mi) west of IH-45 in Harris County

- Segment 1016D (Perennial Stream w/ high ALU): **Unnamed Tributary of Greens Bayou** (unclassified water body) – From the Greens Bayou Above Tidal confluence to 0.19 km (0.12 mi) west of JFK Blvd in Harris County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11369	1016	GREENS BAYOU AT TIDWELL ROAD IN HARRIS CO	HH	BIMONTHLY	Field, Conventional, Bacteria
11369	1016	GREENS BAYOU AT TIDWELL ROAD IN HARRIS CO	FO	QUARTERLY	Field, Conventional, Bacteria, Flow
11370	1016	GREENS BAYOU IMMEDIATELY DOWNSTREAM OF MT HOUSTON PARKWAY	HH	BIMONTHLY	Field, Conventional, Bacteria
11371	1016	GREENS BAYOU AT US 59 NORTH OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11376	1016	GREENS BAYOU AT WEST GREENS PARKWAY	HH	BIMONTHLY	Field, Conventional, Bacteria
13778	1016	GREENS BAYOU 184 METERS DOWNSTREAM OF KNOBCREST DRIVE	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
17495	1016	GREENS BAYOU IMMEDIATELY UPSTREAM OF MILLS ROAD WEST OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11125	1016A	GARNERS BAYOU AT NORTH SAM HOUSTON PARKWAY/SH LOOP 8 NE OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
16589	1016A	GARNERS BAYOU IMMEDIATELY UPSTREAM OF OLD HUMBLE ROAD AT CONFLUENCE WITH RIENHARDT BAYOU IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16590	1016B	UNNAMED TRIBUTARY OF GREENS BAYOU AT MESA DR/E. HOUSTON-DYERSDALE ROAD IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
22090	1016C	UNNAMED TRIBUTARY OF GREENS BAYOU AT ALDINE-WESTFIELD RD	HH	BIMONTHLY	Field, Conventional, Bacteria
16676	1016D	UNNAMED TRIBUTARY OF GREENS BAYOU AT SMITH RD IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HH = Houston Health & Human Services



Greens Bayou Above Tidal - 1016
HH:17495
HH:11376
HH:13778
HH:22090
HH:11371
HH:16676
HH:16589
HH:11125
HH:11370
HH:16590
HH:11369
1016A_01
1016A_02
1016D_01
1016_02
1016C_01
1016B_01
George Bush Intercontinental Airport
Houston National Cemetery
RIVERSIDE OIL FIELD
Kingwood
Humble
Houston
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0
1.5
3
6
Miles

Segment 1016 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	33 / 92	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0 / 3.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0 / 2.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	150		
Sulfate (mg/L as SO_4):	150		
Total Dissolved Solids (mg/L):	1,000		

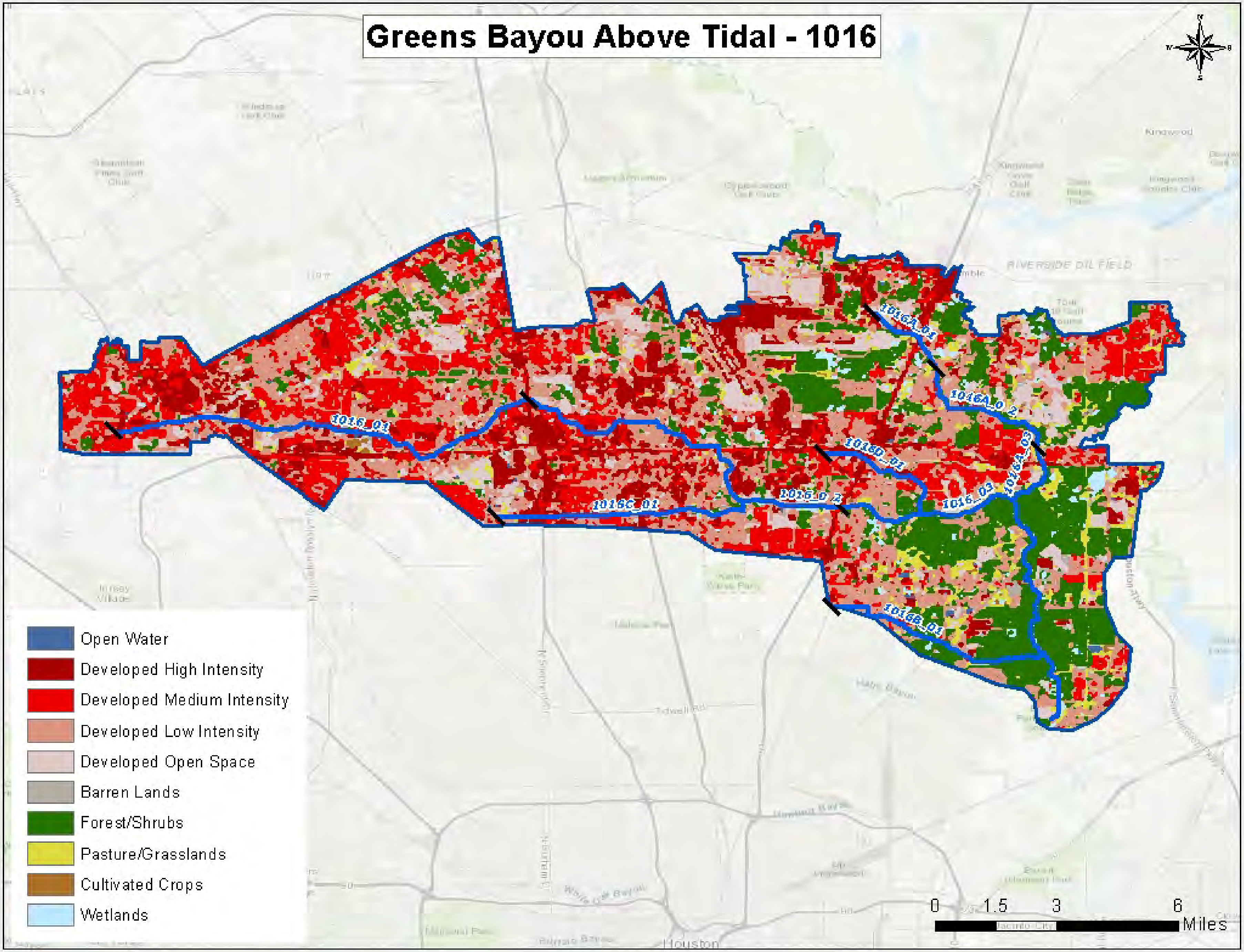
Segment Discussion

Watershed Characteristics and Land Cover: The Greens Bayou Above Tidal (1016) segment is defined as from a point 0.7 km (0.4 miles) above the confluence of Halls Bayou in Harris County to a point 100 meters (110 yards) above FM 1960 in Harris County. Garners Bayou and Williams Gully are major tributaries. The T.H. Wharton power plant cooling water discharges provide year-round flow to Greens Bayou from its headwaters.

This urban watershed is heavily developed (72.89 percent of the watershed) with residential and mixed commercial developments as the dominant land uses. Beltway 8 runs through the middle of the watershed with large, high intensity developments and business districts found adjacent to, and at the intersections with, I-45, U.S. Highway 59 and Texas Highway 249. Development has continued to expand along the U.S. Hwy 59 and Beltway 8 corridors in recent years where high intensity residential development has replaced single family homes. Bush Intercontinental Airport is located in the north central section of the watershed. The eastern most portion of the watershed is mostly undeveloped with mixed residential and commercial developments scattered throughout. The majority of the area is served by wastewater treatment facilities, but on-site sewage facilities are still used in some parts of the watershed.

Segment 1016 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	11,098.11	12.10	5,402.61	5.89	-51.32
Barren Lands	1,382.62	1.51	810.40	0.88	-41.39
Developed	57,579.91	62.77	66,865.74	72.89	16.13
Forest/Shrubs	11,304.71	12.32	16,581.44	18.07	46.68
Open Water	433.00	0.47	170.13	0.19	-60.71
Wetlands	9,939.88	10.84	1,909.47	2.08	-80.79
TOTAL	**91,738.23**	**100.00**	**91,739.79**	**100.00**	



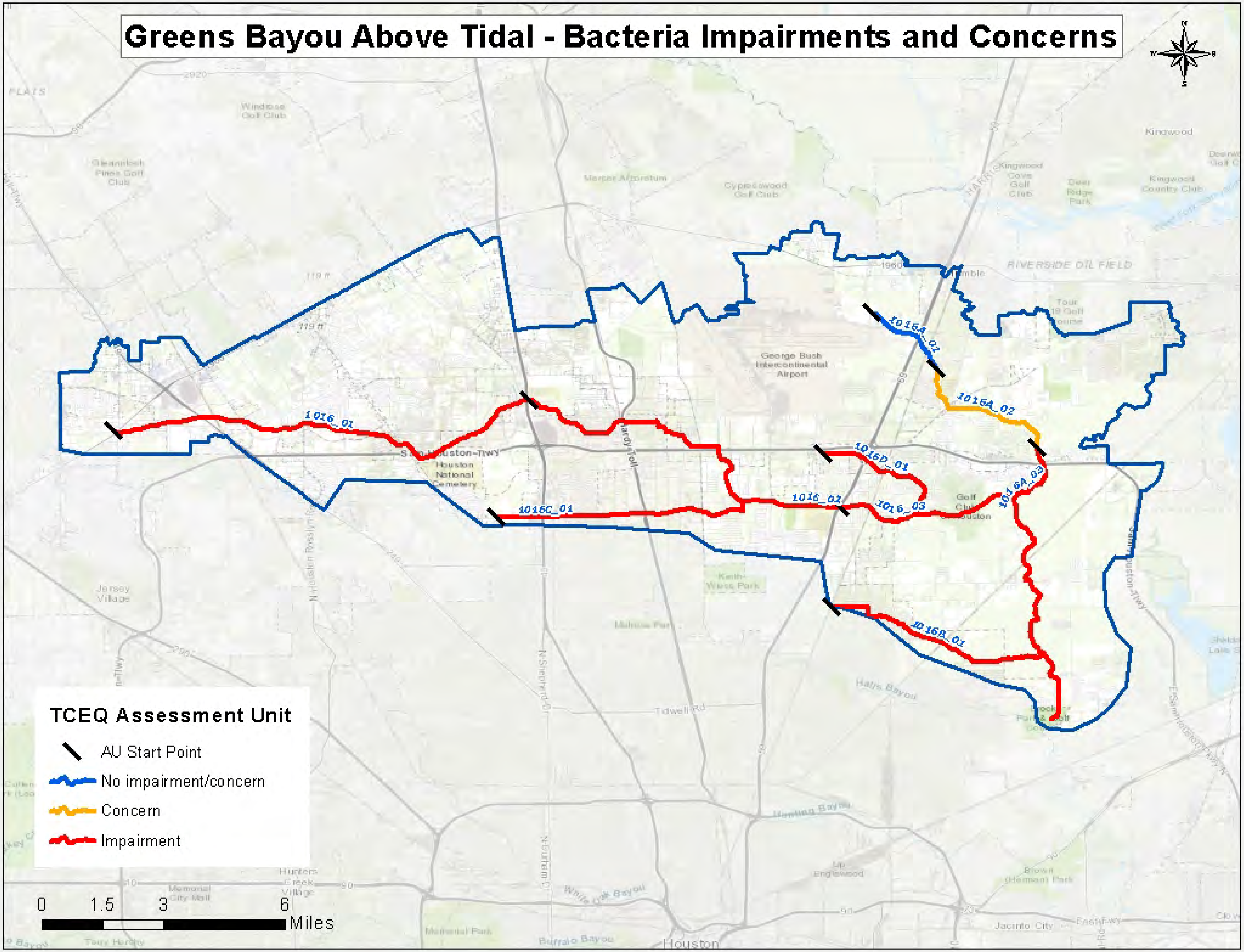
Greens Bayou Above Tidal - 1016
1016_01
1016C_01
1016_0_2
1016D_01
1016_03
1016A_01
1016A_0_2
1016A_03
1016B_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1.5 3 6
Miles
RIVERSIDE OIL FIELD
Houston

Water Quality Issues:

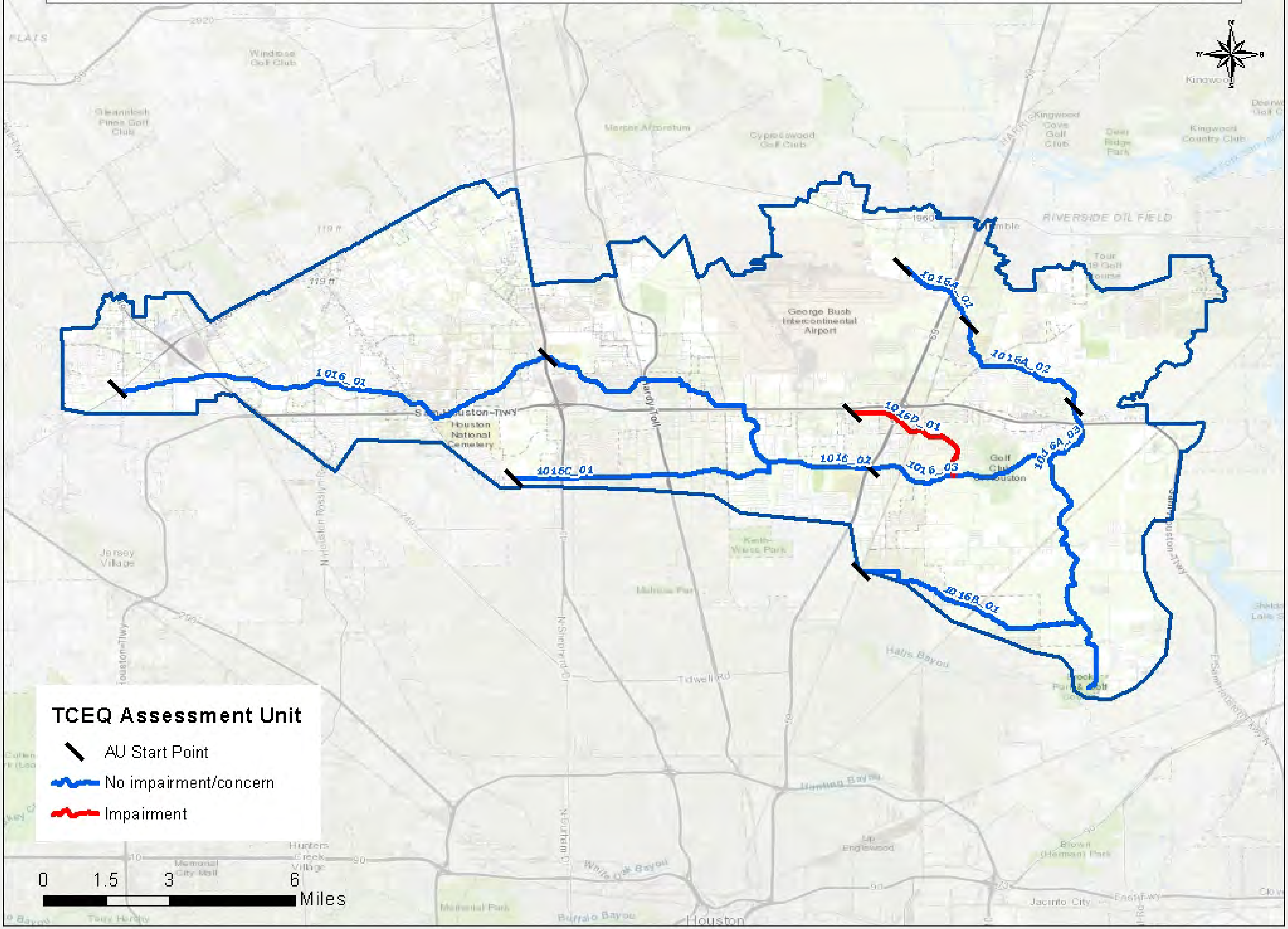
Bacteria Impairments and Concerns
Due to elevated *E. coli* levels, recreation use is not supported in this watershed. In the 2020 Integrated Report, the entire segment is listed as impaired. Bacteria impairments are also present in three of the unnamed tributaries of Greens Bayou.

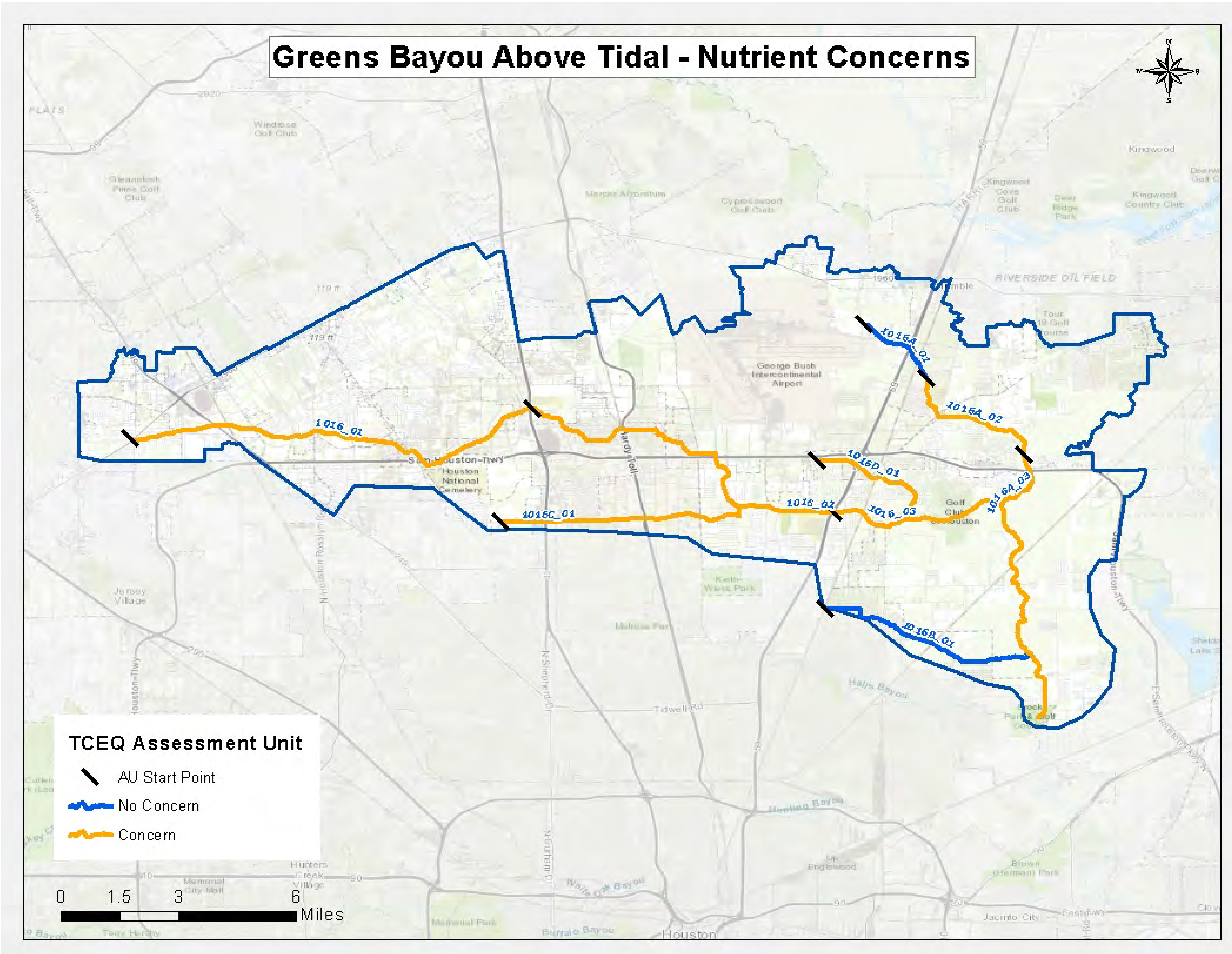
Dissolved Oxygen Impairments and Concerns
A dissolved oxygen concern is present for 1016D. Other segments are supporting their designated aquatic life use.

Nutrient Concerns
Nutrient screening level concerns are listed in the 2020 Integrated Report for all segments in this watershed except 1016B. Ammonia-nitrogen concerns are present for AU 1016_02 of Greens Bayou Above Tidal and 1016D. Nitrate-nitrogen concerns are present for all assessment units of 1016, 1016A, and 1016C. Total phosphorus concerns are present for all assessment units of 1016, 1016A, 1016C, and 1016D.


Greens Bayou Above Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
1016_01
1016_02
1016_03
1016A_01
1016A_02
1016A_03
1016B_01
1016C_01
1016D_01
George Bush Intercontinental Airport
Houston National Cemetery
0 1.5 3 6
Miles

Greens Bayou Above Tidal - Dissolved Oxygen Impairments and Concerns



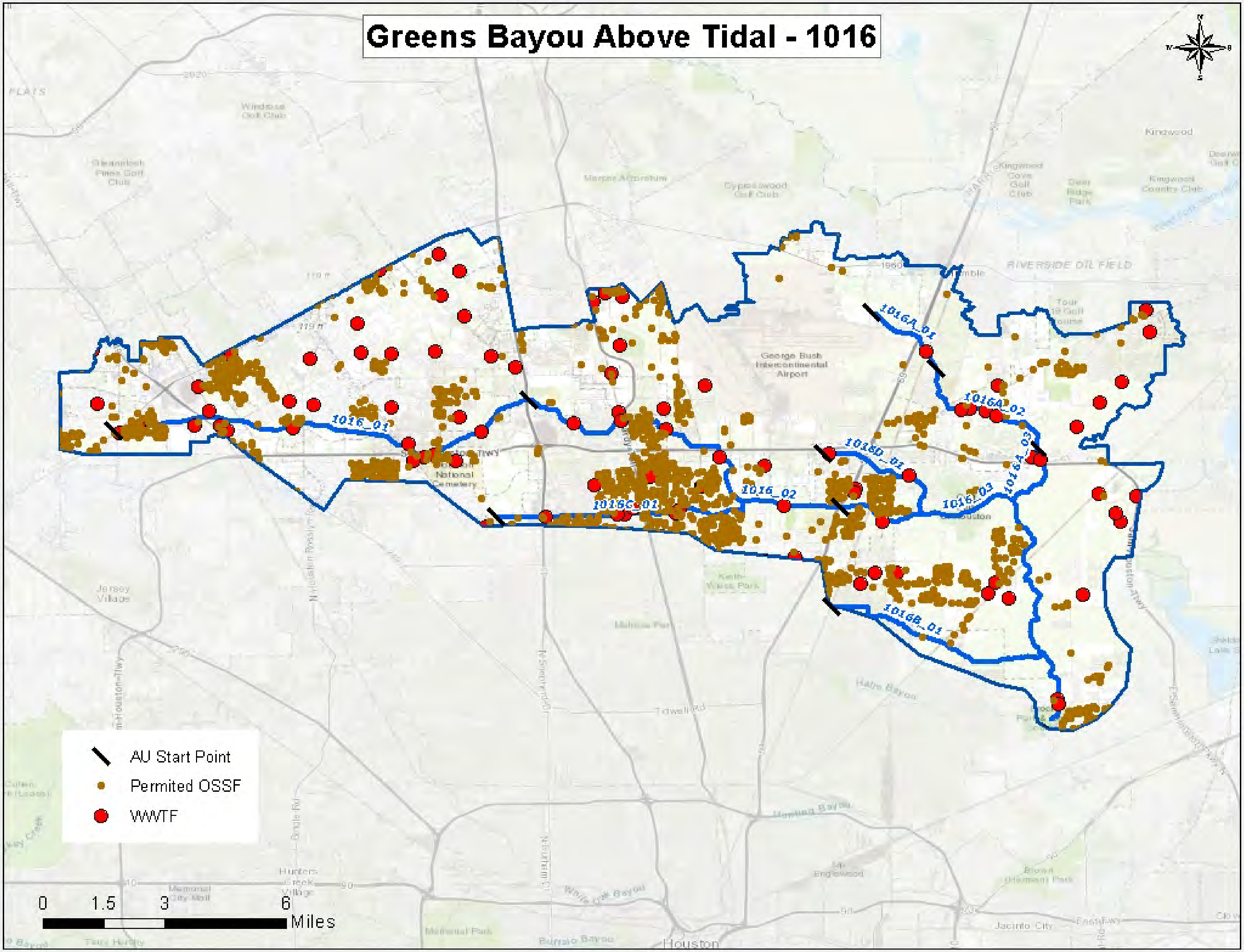

Greens Bayou Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
1016_01
1016_02
1016_03
1016A_01
1016A_02
1016A_03
1016B_01
1016C_01
1016D_01
George Bush Intercontinental Airport
0
1.5
3
6
Miles

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Greens Bayou Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 87 permitted wastewater outfalls in the Greens Bayou Above Tidal watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 2,006 permitted systems. The wastewater treatment facilities and on-site sewage facilities in the Greens Bayou Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 531 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Greens Bayou Above Tidal watershed.



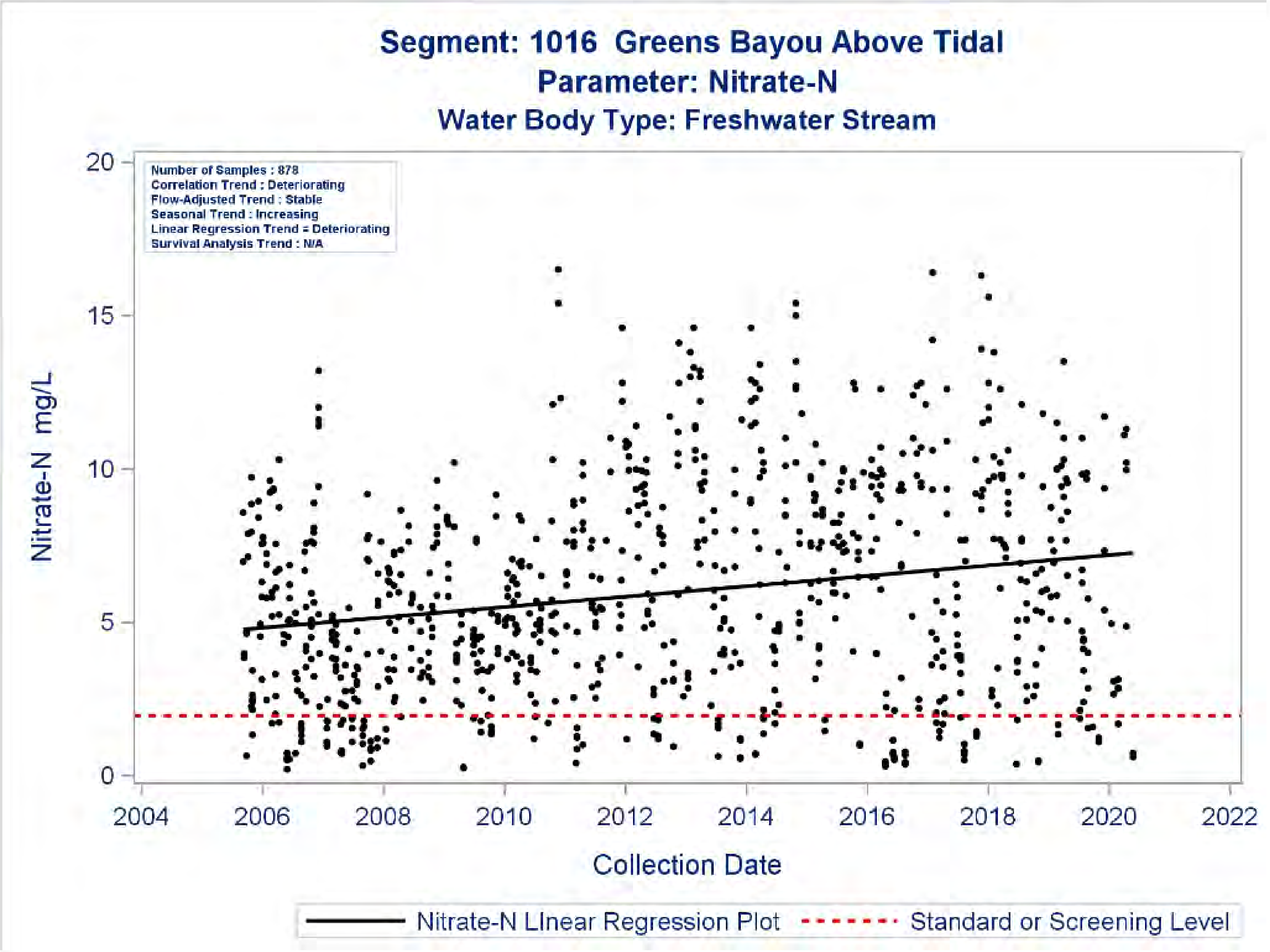
Greens Bayou Above Tidal - 1016
1016_01
1016_02
1016_03
1016A_01
1016A_02
1016A_03
1016B_01
1016C_01
1016D_01
George Bush Intercontinental Airport
AU Start Point
Permited OSSF
WWTF
0
1.5
3
6
Miles

Trend Analysis:

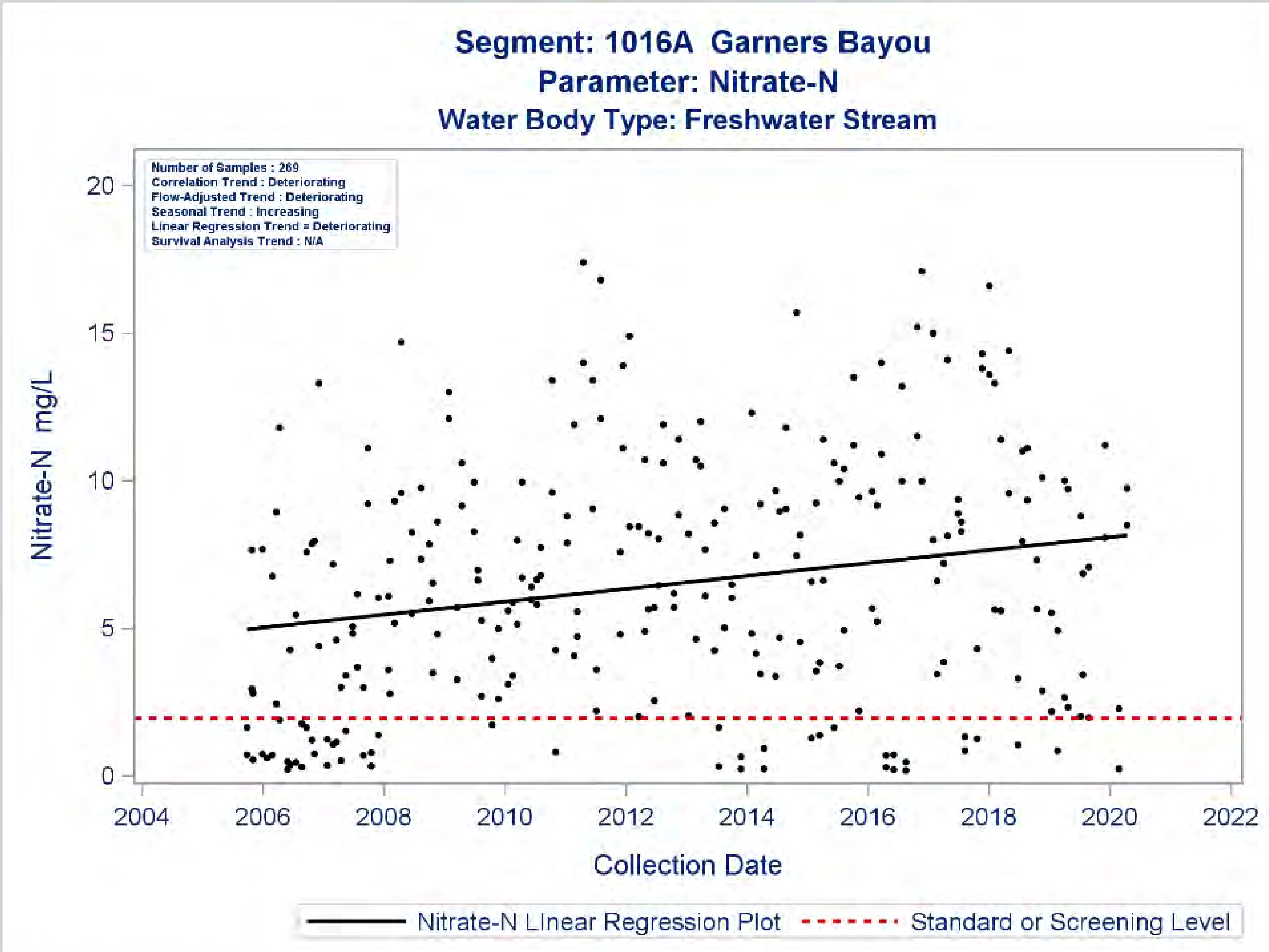
Regression analysis of water quality data detected two or more significant nutrient trends on Greens Bayou Above Tidal and each of its four tributaries with the nutrient of concern varying depending on the location within the watershed. Nitrate and total phosphorus concentrations for segments 1016A (Garners Bayou) and 1016 (main segment of Greens Bayou) frequently reached levels more than four times the set screening criteria during the period of record, with nitrate data showing an increasing trend. Unnamed tributary of Greens Bayou (1016B) shows an increasing nitrate trend but all the results are still below the screening criteria. Unnamed tributary 1016C shows nitrates remaining mostly above screening criteria while total phosphorus levels are decreasing and trending closer to the screening criteria. Conversely, unnamed tributary 1016D shows total phosphorus levels increasing with more samples exceeding the screening criteria in recent years. Ammonia levels are decreasing on Garners Bayou (1016A) but increasing on 1016C, an unnamed tributary of Greens Bayou. Ammonia concentrations have also increased on 1016D, another unnamed tributary of Greens Bayou, where all but a few samples since 2014 have exceeded the set screening criteria. Unnamed tributary 1016C shows TKN having a downward trend since 2013. Unnamed tributary 1016B is the only segment where all nutrients are consistently below the screening criteria.

A concern for DO is listed in the 2020 Integrated Report for tributary 1016D. Most of the watershed shows DO concentrations relatively stable and higher than the standard. However, although regression analysis of DO data from monitoring station 16676, located on segment 1016D, revealed no significant change in DO concentrations over time, sample concentrations have frequently been lower than the 3.0 mg/L DO minimum.

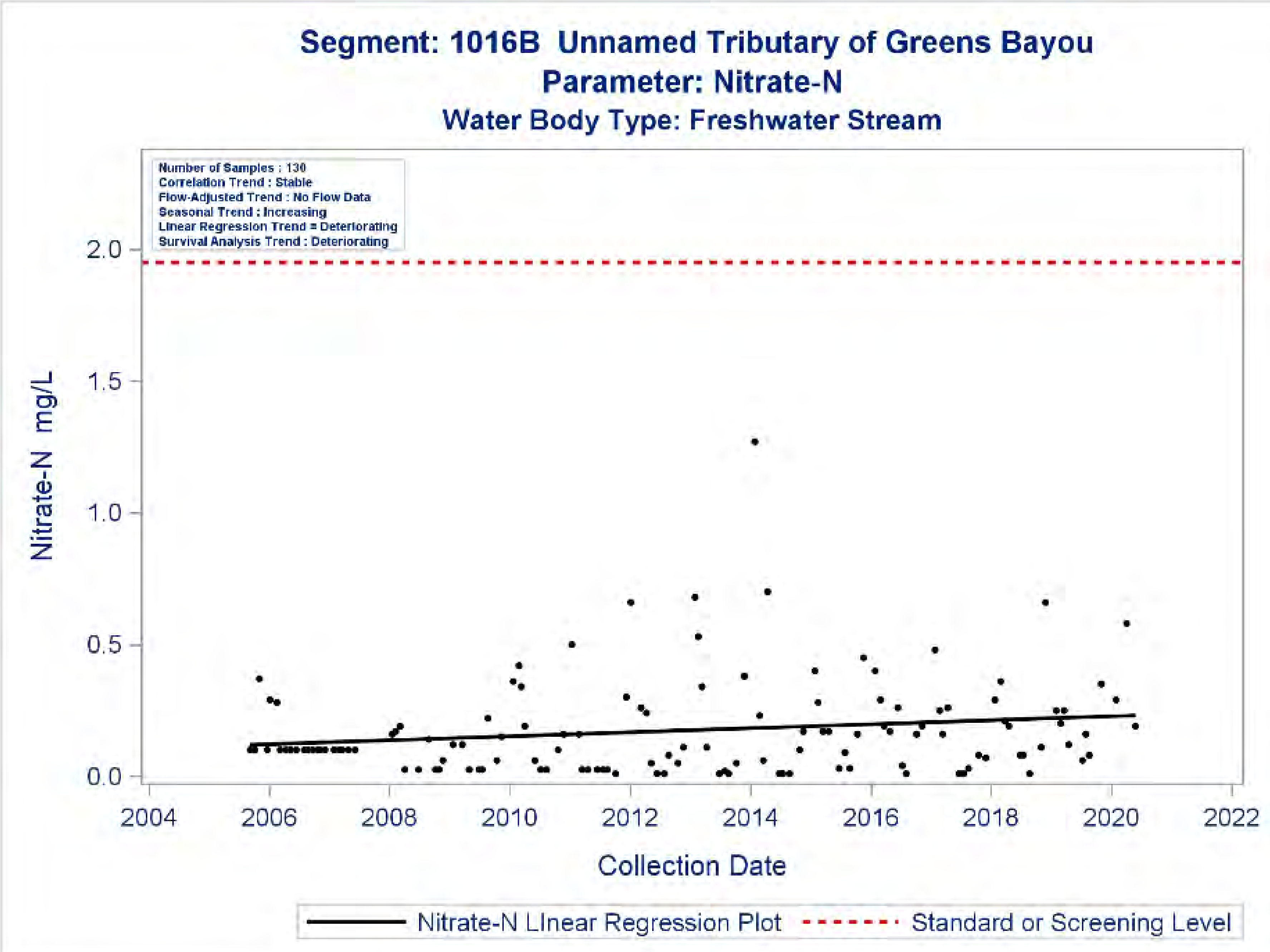
Impairments or concerns for elevated *E. coli* levels are present on the main segment of Greens Bayou Above Tidal and all four tributaries. While many of the AUs were showing a slight decreasing trend for part of the period of record, most of them have stabilized well above the standard 126 MPN/100mL. Only tributary 1016B still shows a slight decreasing trend towards the standard during the current reporting period.



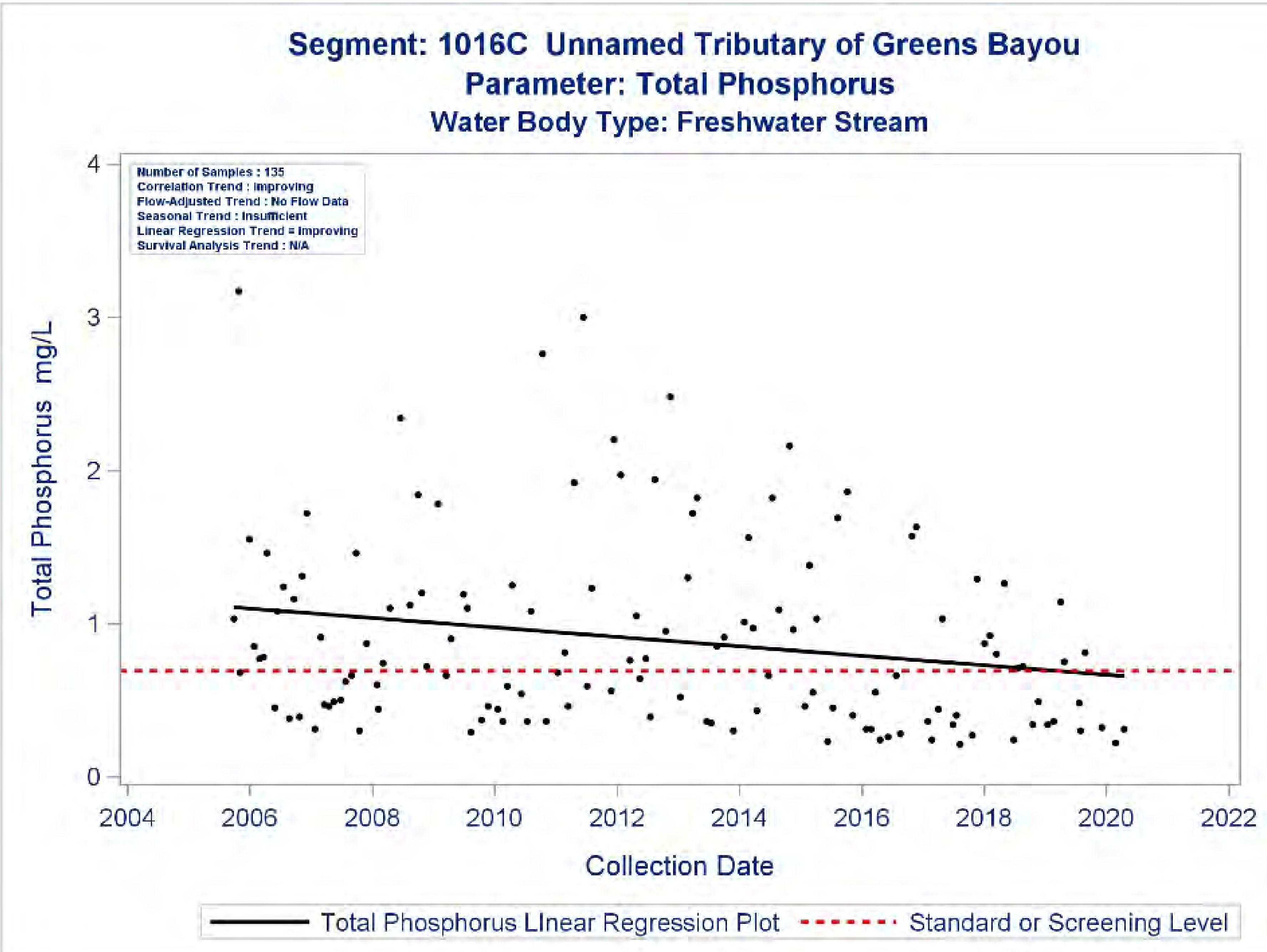
Segment: 1016 Greens Bayou Above Tidal
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 878
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
20
15
10
5
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

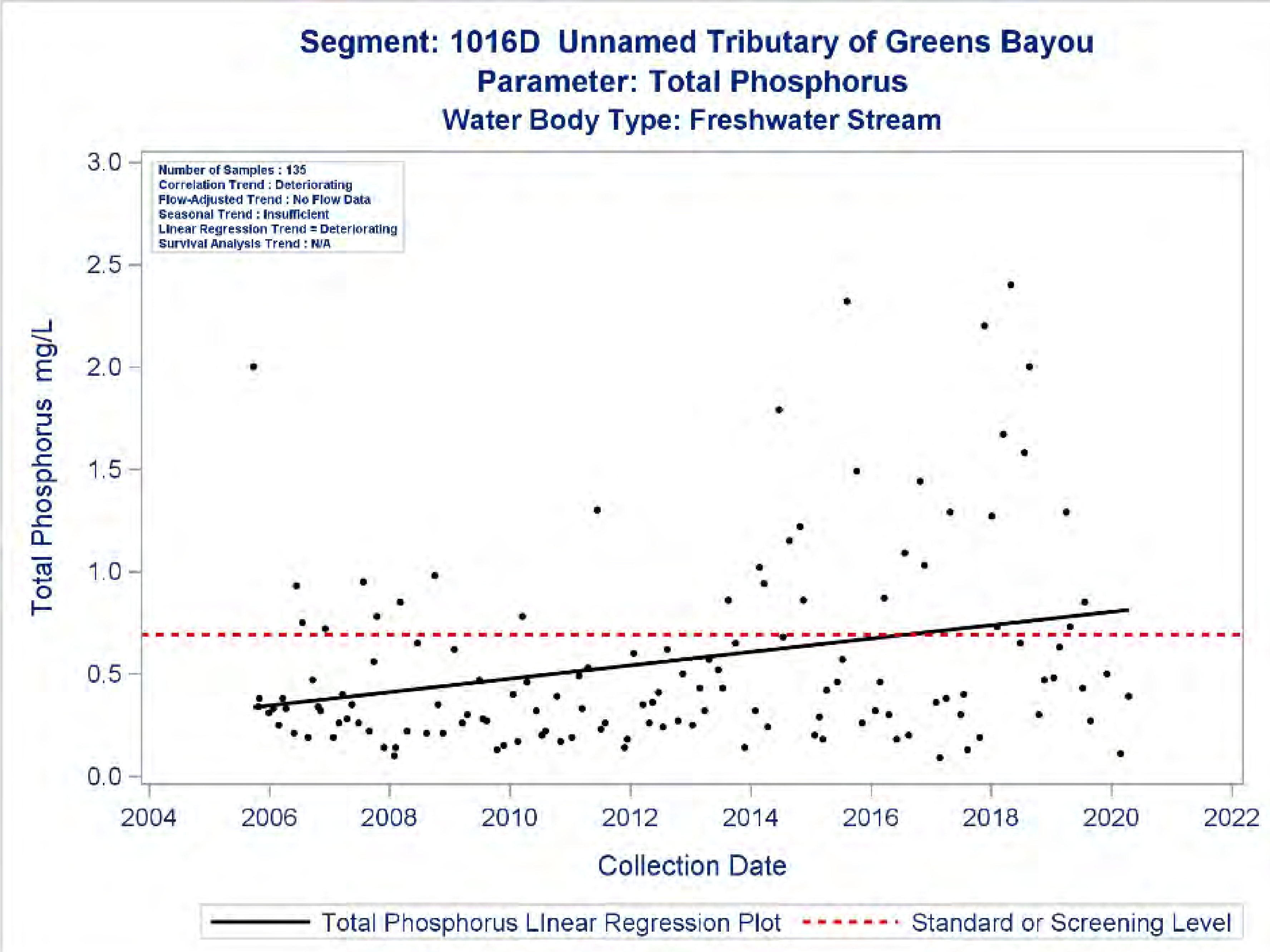


Segment: 1016A Garners Bayou
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 269
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
0
5
10
15
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N Linear Regression Plot
Standard or Screening Level

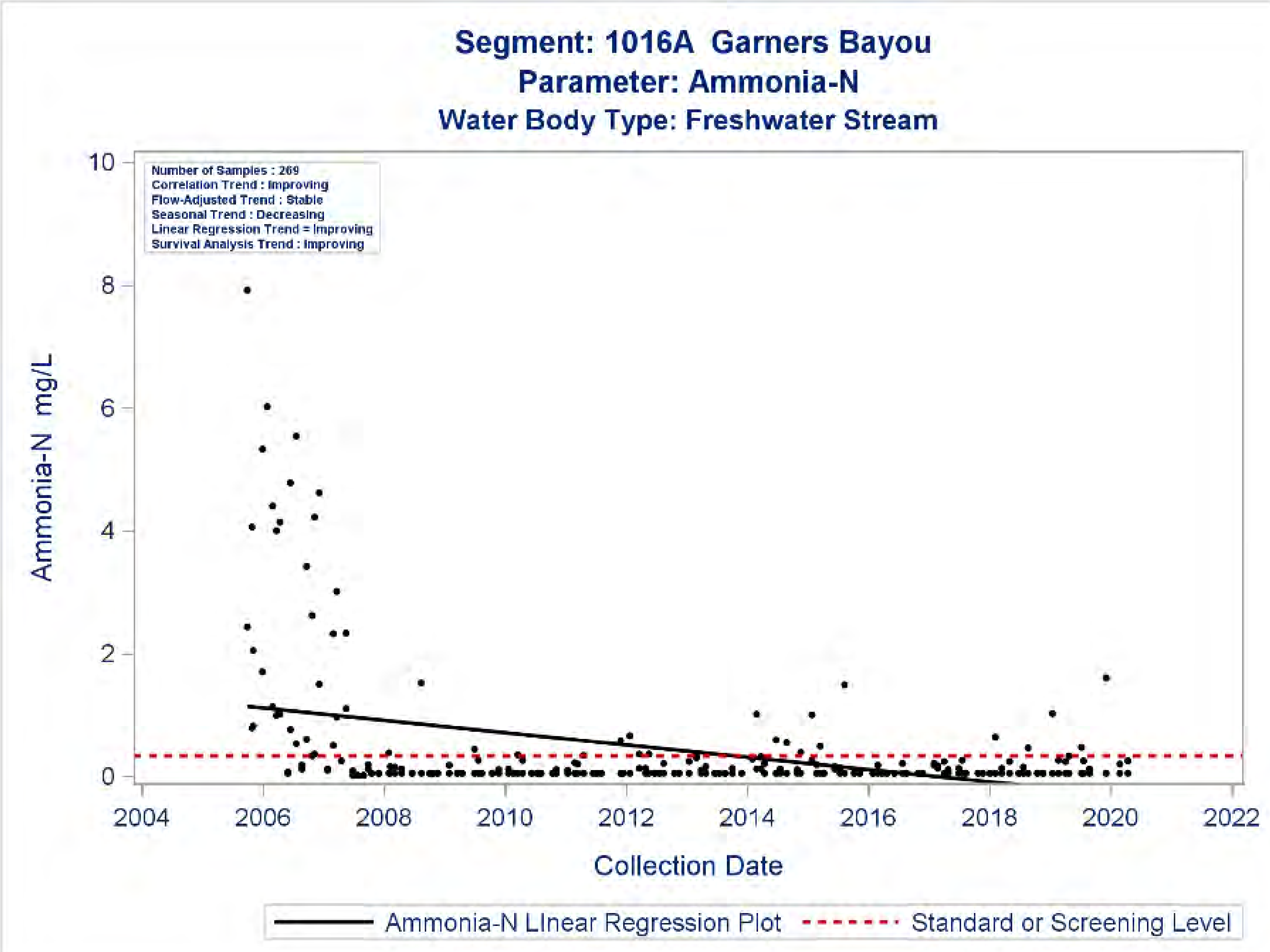


Segment: 1016B Unnamed Tributary of Greens Bayou
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 130
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0.0
0.5
1.0
1.5
2.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

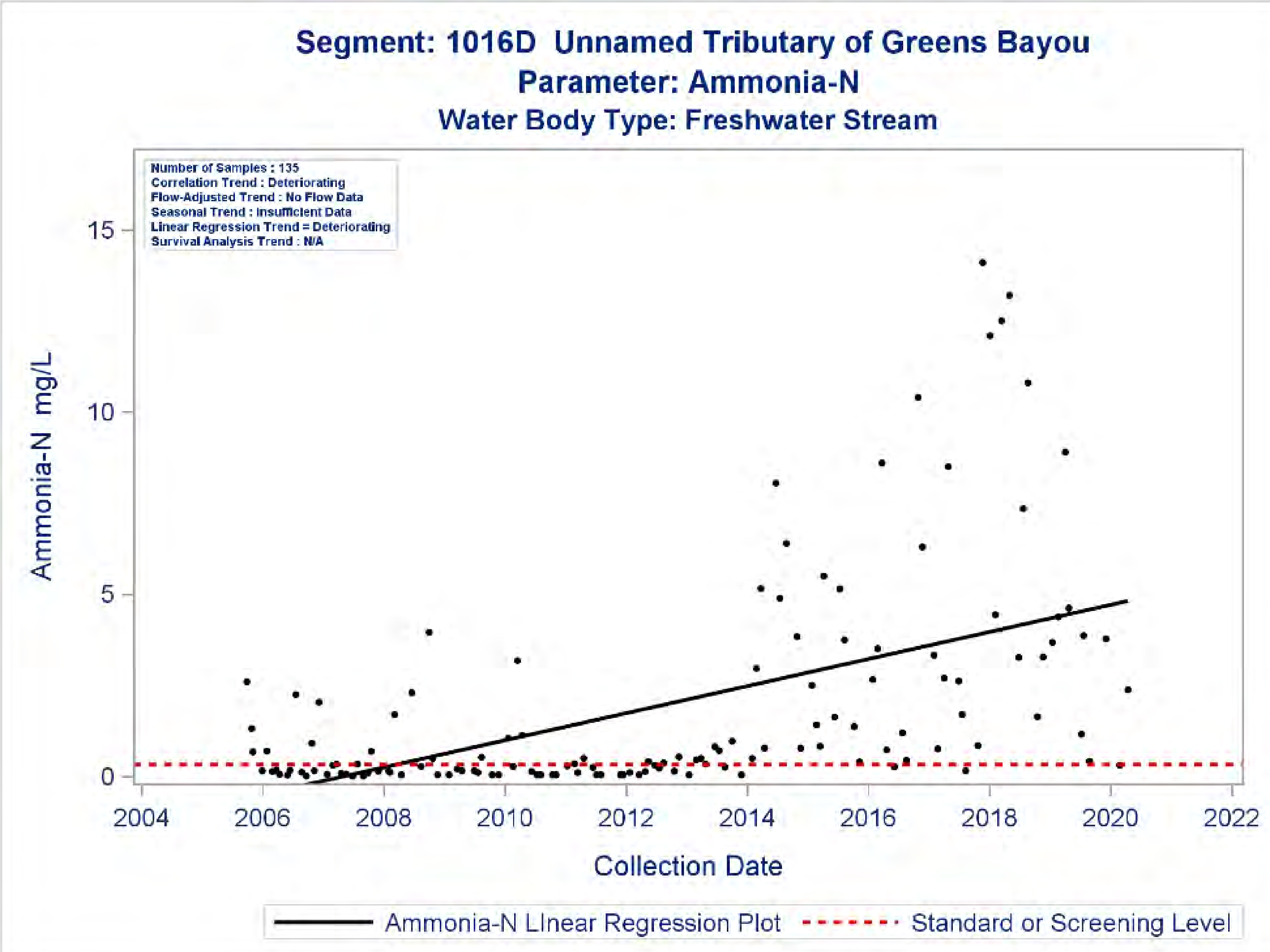

Segment: 1016C Unnamed Tributary of Greens Bayou
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
1
2
3
4
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level

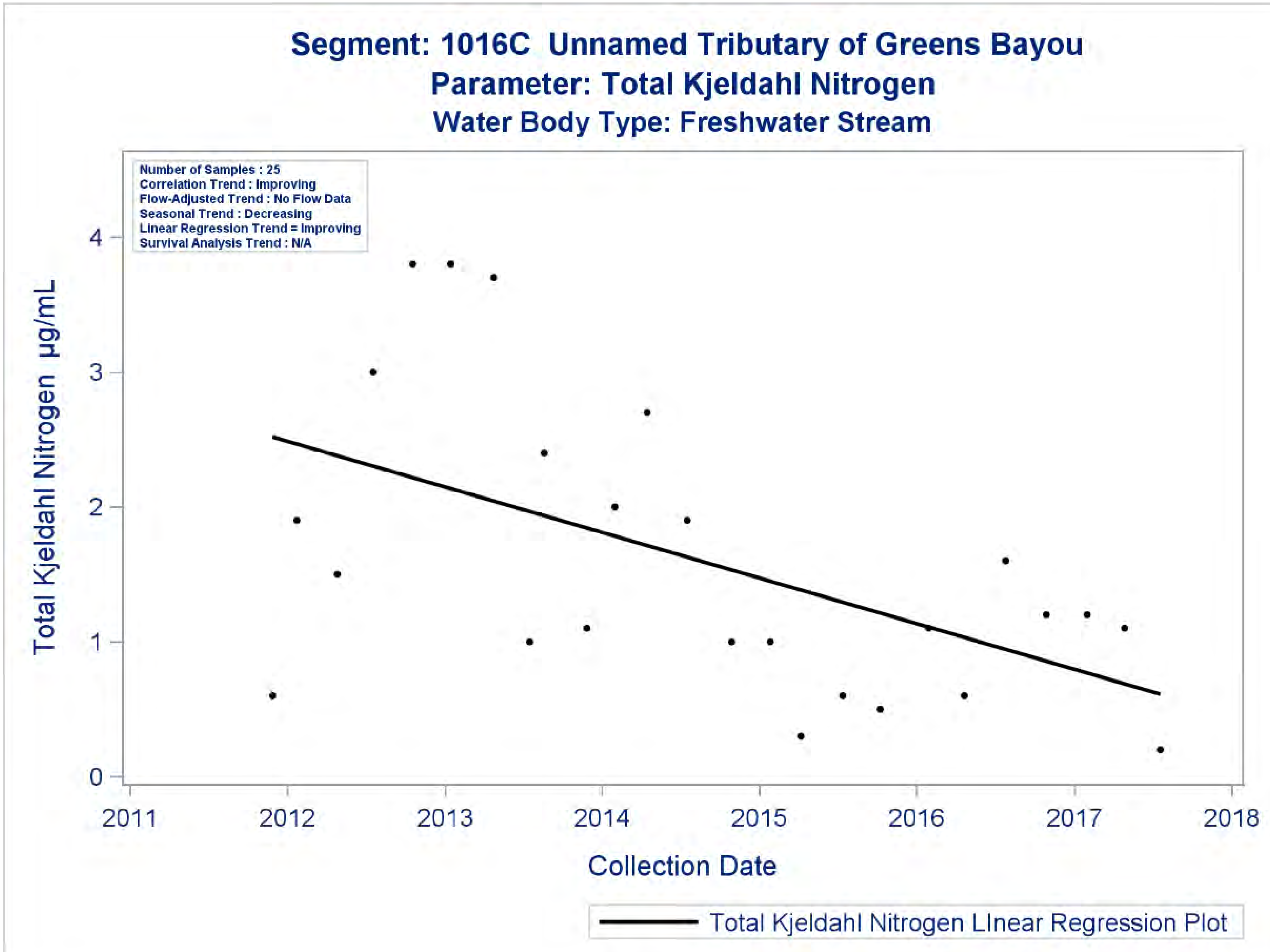


Segment: 1016D Unnamed Tributary of Greens Bayou
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.5
1.0
1.5
2.0
2.5
3.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level

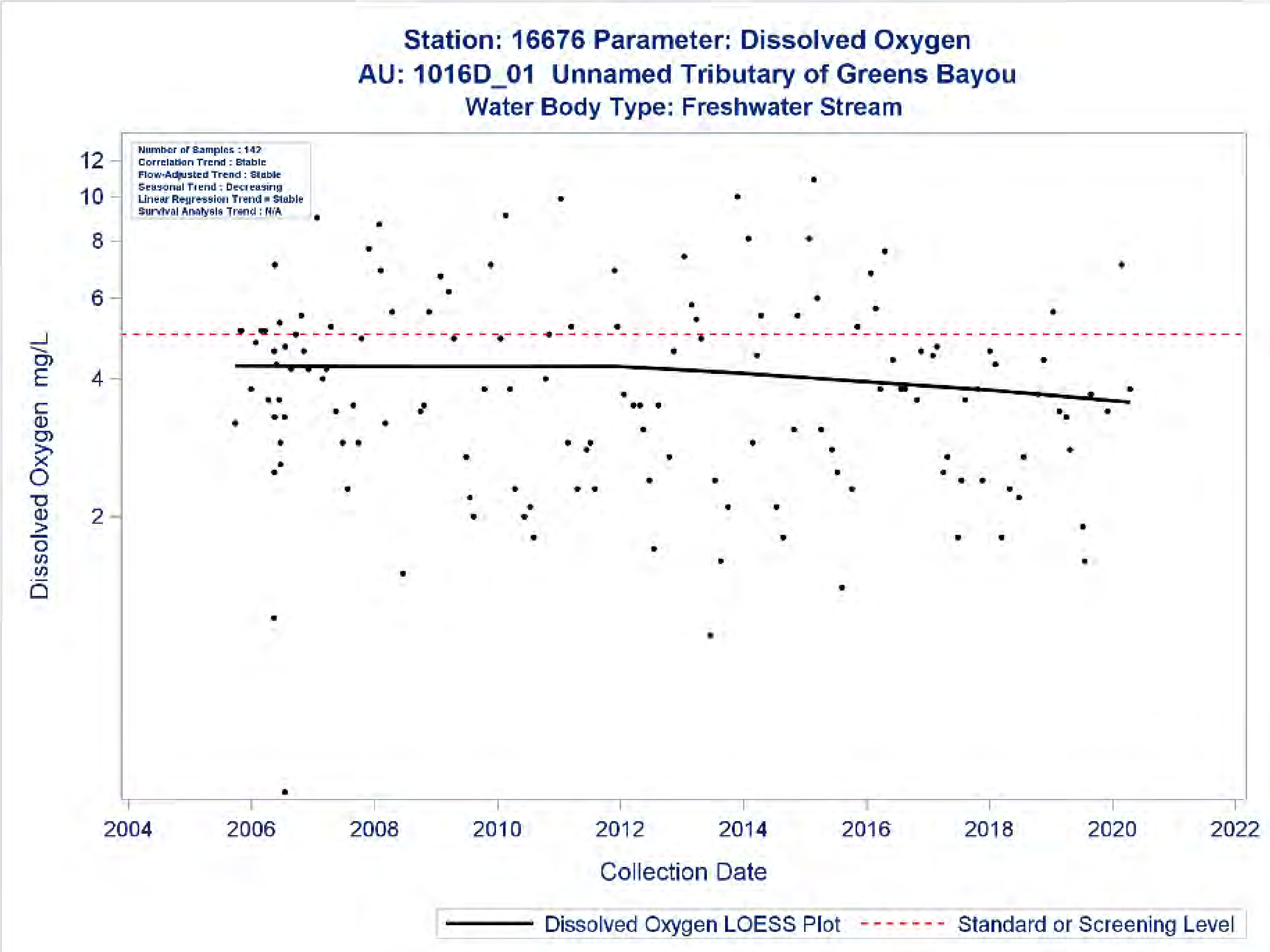


Segment: 1016A Garners Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 269
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
10
8
6
4
2
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level

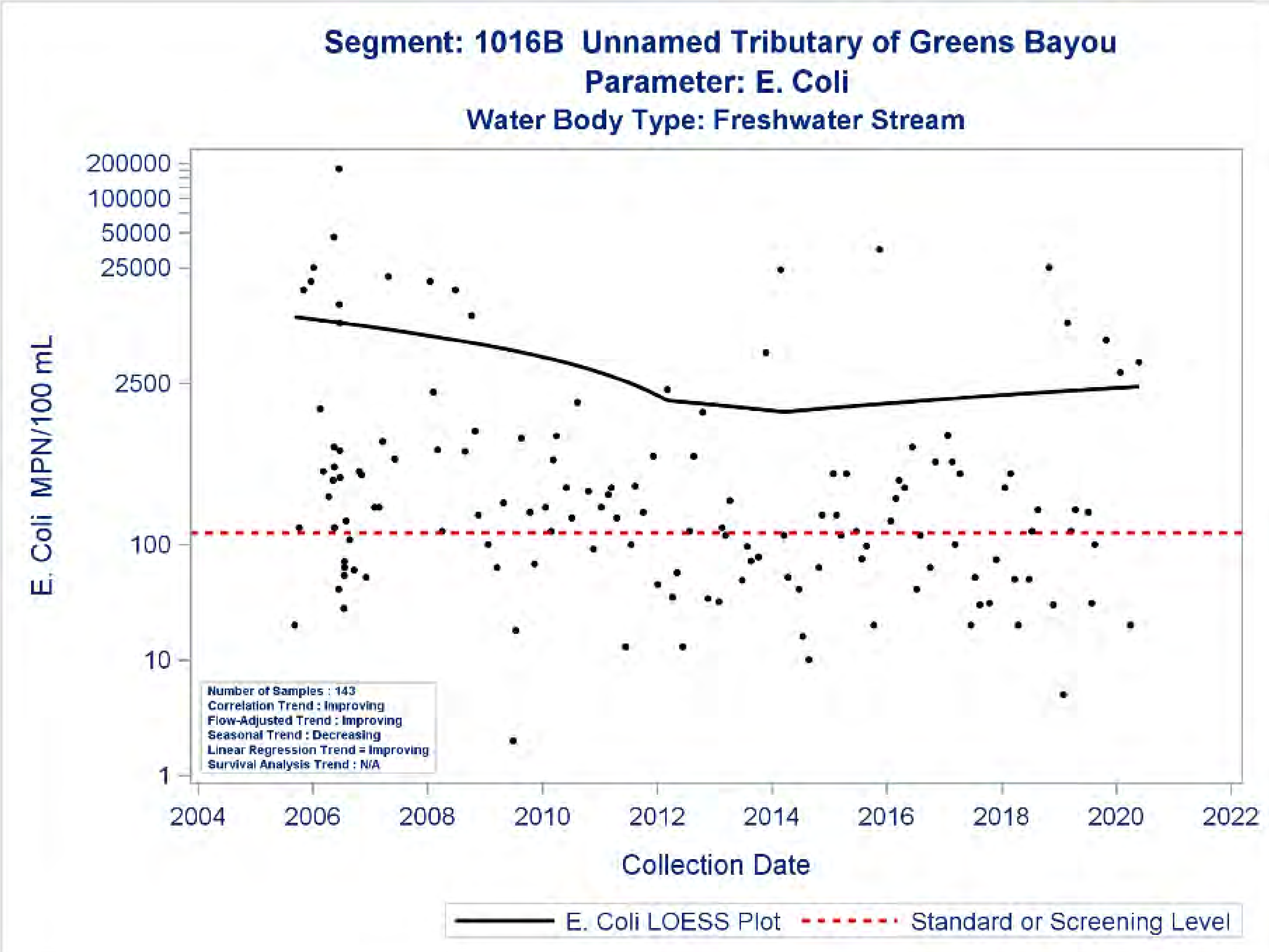

Segment: 1016D Unnamed Tributary of Greens Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Ammonia-N mg/L
0
5
10
15
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



Segment: 1016C Unnamed Tributary of Greens Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 25
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Station: 16676 Parameter: Dissolved Oxygen
AU: 1016D_01 Unnamed Tributary of Greens Bayou
Water Body Type: Freshwater Stream
Number of Samples : 142
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
12
10
8
6
4
2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level


Segment: 1016B Unnamed Tributary of Greens Bayou
Parameter: E. Coli
Water Body Type: Freshwater Stream
E. Coli MPN/100 mL
200000
100000
50000
25000
2500
100
10
1
Number of Samples : 143
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1016_01 I 1016_02 I 1016_03 I 1016A_02 C 1016A_03 I 1016B I 1016C I 1016D I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Improper or no pet waste disposal • Developments with malfunctioning OSSFs • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education on pet waste disposal • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties
Low Dissolved Oxygen Concentrations	1016D_01 C	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste, such as grass clippings and pet waste	• Detrimental effect on aquatic biological community	• Install and/or maintain riparian buffer areas between agricultural fields and waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Improve compliance and enforcement of existing stormwater quality permits • Improve operation and maintenance of existing WWTF and collection systems

		▪ High temperature discharges from industrial WWTFs		• Regionalize chronically non-compliant WWTFs • More public education regarding disposal of household fats, oils, and grease • More public education regarding OSSF operation and maintenance • More public education on pet waste disposal
Elevated Nutrient Concentrations	***Ammonia*** 1016_02 C 1016D_01 C ***Nitrate*** 1016_01 C 1016_02 C 1016_03 C 1016A_02 C 1016A_03 C 1016C_01 C ***Phosphorus*** 1016_01 C 1016_02 C 1016_03 C 1016A_02 C 1016A_03 C 1016C_01 C 1016D_01 C	• Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Nutrient loading from WWTF effluent, SSOs, and malfunctioning OSSFs • Fertilizer runoff from agricultural properties.	• Detrimental effect on aquatic biological community	• Expand use of LID and green infrastructure practices • Install and/or conserve riparian buffer areas along all waterways • More public education regarding nutrients and consequences • Improve compliance and enforcement of existing stormwater quality permits • Improve stormwater controls in new developments • Reduce or manage fertilizer runoff from agricultural areas • Create and implement Water Quality Management Plans for individual agricultural properties

Special Studies:

This segment is part of a larger geographic area covered under several TMDLs, collectively known as the Bacteria Implementation Group (BIG) I-Plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number:	1006	Name:	Houston Ship Channel Tidal

Length:	28 miles	Watershed Area:	122 square miles	Designated Uses:	Navigation; Industrial Water Supply
Number of Active Monitoring Stations:	25	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	188

DESCRIPTION

- Segment 1006 (Tidal Stream): **Houston Ship Channel Tidal** (classified water body) – From the confluence with the San Jacinto River in Harris County to a point immediately upstream of Greens Bayou in Harris County, including tidal portions of tributaries

- Segment 1006A: Retired segment description

- Segment 1006B (Perennial Stream w/ intermediate ALU): **Carpenters Bayou** (unclassified water body) – Perennial stream from 9.0 k upstream of Houston Ship Channel up to 0.km upstream of Wallisville Rd

- Segment 1006C: **Patrick Bayou** (unclassified water body) – Retired segment description

- Segment 1006D (Perennial Stream w/ intermediate ALU): **Halls Bayou** (unclassified water body) – From the confluence with Greens Bayou upstream to Frick Road in Harris County

- Segment 1006E: **Halls Bayou Above US 59** (unclassified water body) – Retired segment description

- Segment 1006F (Perennial Stream w/ intermediate ALU): **Big Gulch Above Tidal** (unclassified water body) – From the confluence with Greens Bayou Tidal to Wallisville Road in Harris County

- Segment 1006G: Retired segment description.

- Segment 1006H (Perennial Stream w/ intermediate ALU): **Spring Gully Above Tidal** (unclassified water body) – From confluence with Greens Bayou to US 90 in Harris County

- Segment 1006I (Perennial Stream w/ limited ALU): **Unnamed Tributary of Halls Bayou** (unclassified water body) – From the confluence with Halls Bayou to a point 0.13 miles upstream of Richland Drive in Harris County

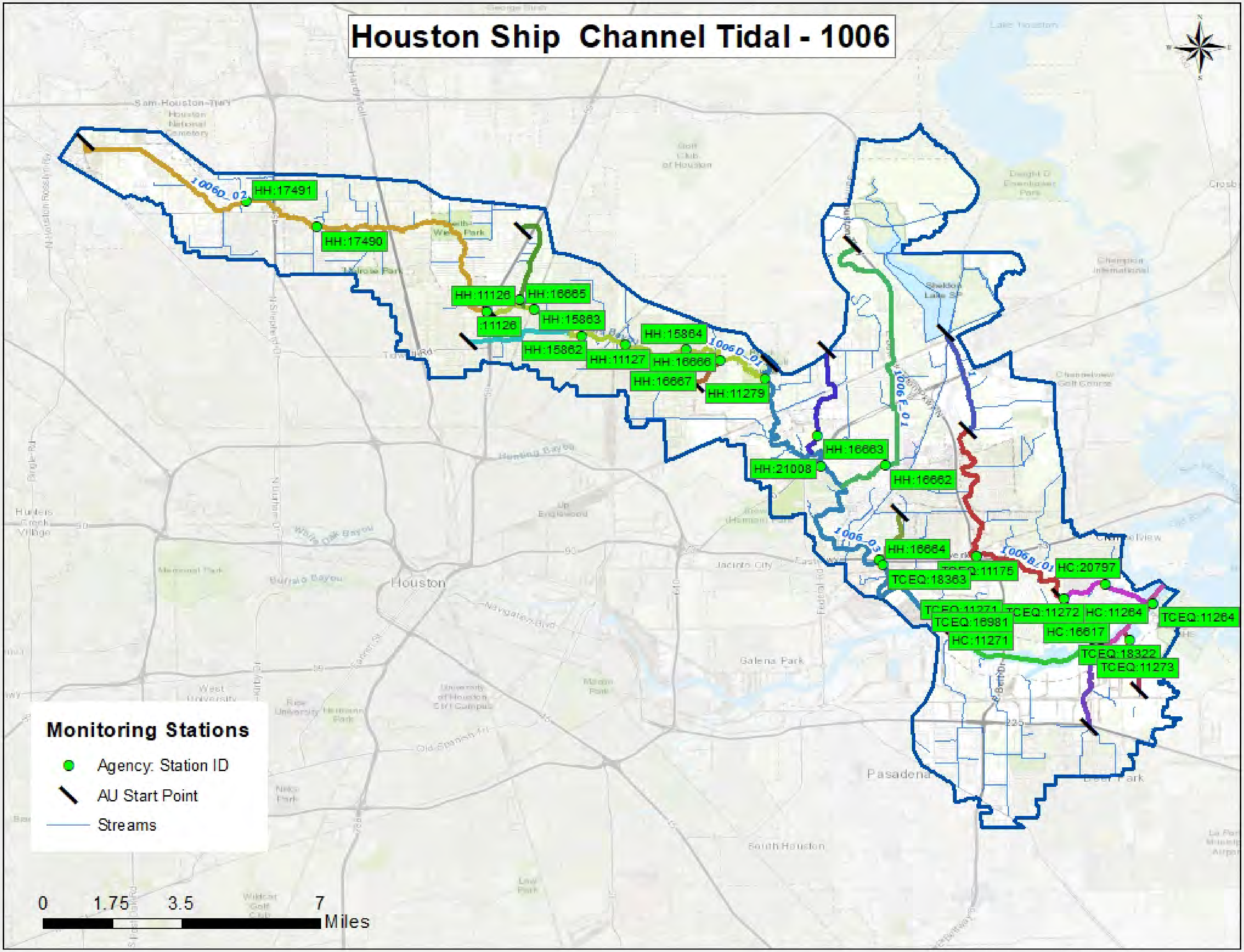
- Segment 1006J (Perennial Stream w/ limited ALU): **Unnamed Tributary of Halls Bayou** (unclassified water body) – From the confluence of Halls Bayou (east of US 59 and south of Langley Road) to Mount Houston Road in Harris County

- Segment 1006K (Perennial Stream w/ intermediate ALU): **Unnamed Tributary of Halls Bayou** (unclassified water body) – From the confluence of Halls Bayou (in Tidwell Park east of Allwood St.) to Jensen west of Hwy 59

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11264	1006	HOUSTON SHIP CHANNEL AT SAN JACINTO PK WEST OF THE BATTLESHIP TX 317 M N AND 303 M W OF INTERSECTION OF BATTLEGROUND RD AND MARKER DR	HC	MONTHLY	Field, Conventional, Bacteria
11264	1006	HOUSTON SHIP CHANNEL AT SAN JACINTO PK WEST OF THE BATTLESHIP TX 317 M N AND 303 M W OF INTERSECTION OF BATTLEGROUND RD AND MARKER DR	FO	QUARTERLY ONE/YEAR	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment
11271	1006	HOUSTON SHIP CHANNEL AT CONFLUENCE WITH GREENS BAYOU/CM 152	HC	MONTHLY	Field, Conventional, Bacteria
11271	1006	HOUSTON SHIP CHANNEL AT CONFLUENCE WITH GREENS BAYOU/CM 152	FO	QUARTERLY	Field, Conventional, Bacteria
11272	1006	CARPENTER BAYOU TIDAL AT SOUTH SHELDON RD IN CHANNELVIEW	FO	QUARTERLY	Field, Conventional, Bacteria
11723	1006	PATRICK BAYOU TIDAL IMMEDIATELY UPSTREAM OF TIDAL RD BRIDGE LEADING TO OCCIDENTAL CHEMICAL INTAKE STATION ON HOUSTON SHIP CHANNEL	FO	QUARTERLY ONE/YEAR TWO/YEAR	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment Metals in Water
11279	1006	GREENS BAYOU IMMEDIATELY DOWNSTREAM OF GREEN RIVER ROAD/LEY ROAD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
16617	1006	HOUSTON SHIP CHANNEL AT CARGILL TERMINAL NORTH OF TIDAL ROAD	HC	MONTHLY	Field, Conventional, Bacteria
16664	1006	GOODYEAR CREEK TIDAL IMMEDIATELY UPSTREAM OF IH 10 IN EAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16981	1006	GREENS BAYOU TIDAL AT MOUTH OF ISK BIOSCIENCES DITCH 1.57 KM UPSTREAM OF CONFLUENCE WITH HOUSTON SHIP CHANNEL IN HOUSTON	FO	QUARTERLY ONE/YEAR	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment
18322	1006	TUCKER BAYOU MID CHANNEL AT FIRST BEND 300 M UPSTREAM OF CONFLUENCE WITH HOUSTON SHIP CHANNEL	FO	QUARTERLY ONE/YEAR TWO/YEAR	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment Metals in Water
18363	1006	GREENS BAYOU MID CHANNEL IMMEDIATELY UPSTREAM OF MARKET STREET	FO	QUARTERLY	Field, Conventional, Bacteria
20797	1006	CARPENTERS BAYOU AT MOUTH OF BARGE CANAL 32 METERS WEST AND 666 METERS SOUTH FROM THE INTERSECTION OF DE ZAVALLA ROAD AND HARDING ROAD/HARDING STREET IN HARRIS COUNTY	HC	MONTHLY	Field, Conventional, Bacteria

21008	1006	GREENS BAYOU AT WALLISVILLE ROAD APPROX 150 METERS NORTHEAST OF THE INTERSECTION OF DATTNER ROAD AND WALLISVILLE ROAD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11126	1006D	HALLS BAYOU AT JENSEN DRIVE IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
11175	1006B	CARPENTERS BAYOU IMMEDIATELY UPSTREAM OF ST LOOP 8 NEAR OF IH 10 EAST OF CLOVERLEAF	FO	QUARTERLY	Field, Conventional, Bacteria
11127	1006D	HALLS BAYOU 87 METERS UPSTREAM OF TIDWELL ROAD IN SETTEGAST	HH	BIMONTHLY	Field, Conventional, Bacteria
15862	1006D	HALLS BAYOU AT HOMESTEAD ROAD IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15863	1006D	HALLS BAYOU AT HIRSCH RD IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15864	1006D	HALLS BAYOU AT MESA DR IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
17490	1006D	HALLS BAYOU AT AIRLINE ROAD IN NORTH HOUSTON	HH	9 TIMES/YEAR	Field, Conventional, Bacteria
17491	1006D	HALLS BAYOU AT DEER TRAIL DRIVE IN NORTH HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
16662	1006F	BIG GULCH AT WALLISVILLE ROAD IN EAST HOUSTON	HH	BIMONTHLY	Field and Bacteria
16663	1006H	SPRING GULLY AT WEST TERMINUS OF BARNESWORTH DRIVE IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16666	1006I	UNNAMED TRIBUTARY OF HALLS BAYOU AT TALTON STREET IN NORTH EAST HOUSTON	HH	BIMONTHLY	Field and Bacteria
16667	1006I	UNNAMED TRIBUTARY OF HALLS BAYOU AT WOODLYN ROAD IN NORTH EAST HOUSTON	HH	BIMONTHLY	Field and Bacteria
16665	1006J	UNNAMED TRIBUTARY OF HALLS BAYOU IMMEDIATELY DOWNSTREAM OF LANGLEY ROAD IN NORTH HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HC = Harris County Pollution Control
HH = Houston Health & Human Services

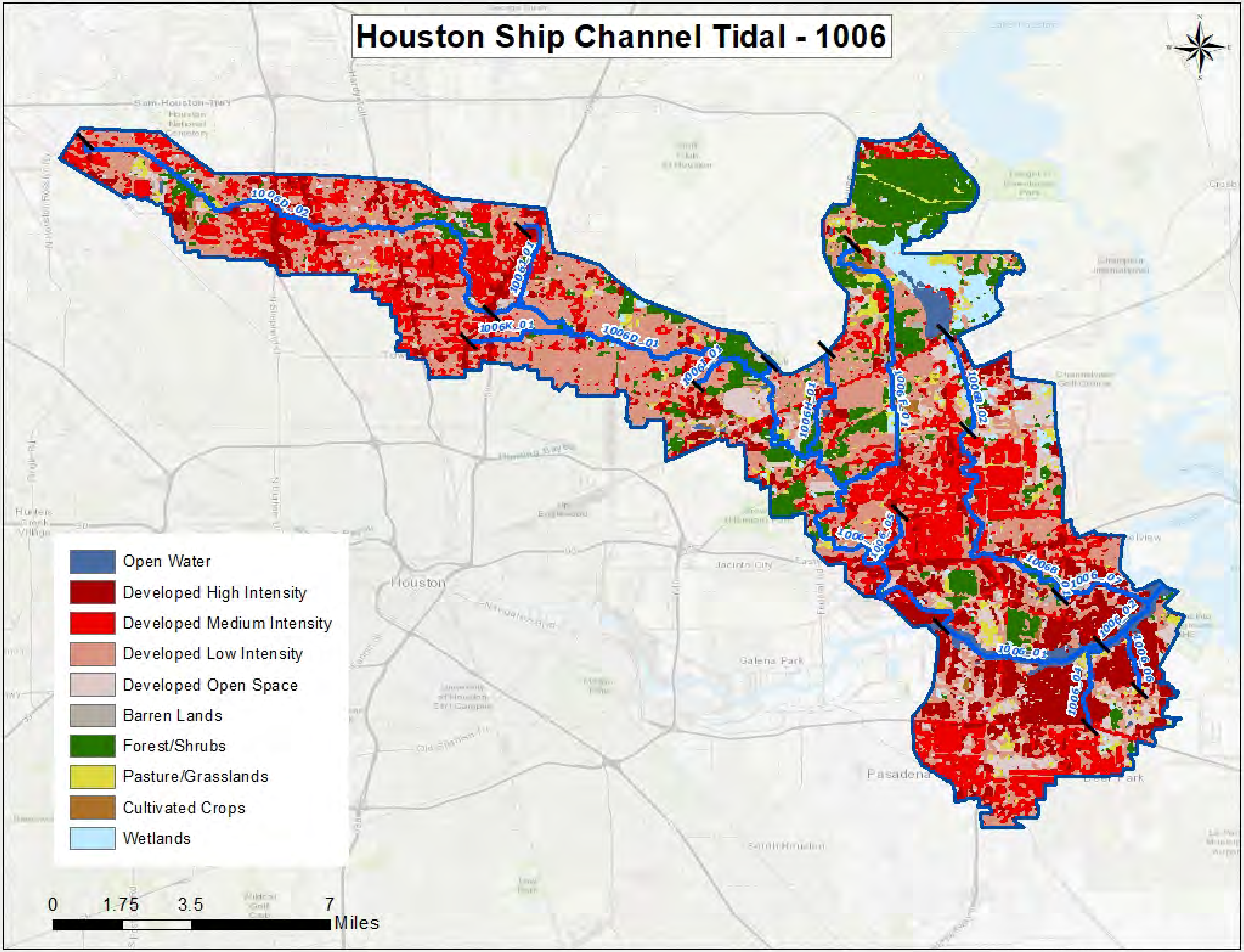

Houston Ship Channel Tidal - 1006
1006D_02
HH:17491
HH:17490
HH:11126
HH:16665
11126
HH:15863
HH:15864
HH:15862
HH:11127
HH:16666
1006D_01
HH:16667
HH:11279
1006F_01
HH:16663
HH:21008
HH:16662
1006_03
HH:16664
TCEQ:11175
TCEQ:18363
1006B_01
HC:20797
TCEQ:11271
TCEQ:11272
HC:11264
TCEQ:11264
TCEQ:16981
HC:16617
HC:11271
TCEQ:18322
TCEQ:11273
Houston
Jacinto City
Galena Park
Pasadena
South Houston
Deer Park
Channelview
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0
1.75
3.5
7
Miles

Segment 1006 Water Quality Standards and Screening Levels					
Standards	Tidal Stream	Perennial Stream	Screening Levels	Tidal Stream	Perennial Stream
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia (mg/L):	0.46	0.33
Dissolved Oxygen (24-Hr Average) (mg/L):	2.0	4.0 / 3.0	Nitrate-N (mg/L):	1.10	1.95
Dissolved Oxygen (Absolute Minima) (mg/L):	2.0	3.0 / 2.0	Orthophosphate Phosphorus (mg/L):	0.46	0.37
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus (mg/L):	0.66	0.69
Enterococci (MPN/100mL) (30-day geometric mean> 10 samples):	168	168	Chlorophyll a (µg/L):	21	14.1
E. coli (MPN/100 mL) (grab):		399			
E. coli (MPN/100 mL) (geometric mean):		126			

Segment Discussion

Watershed Characteristics and Land Cover: The Houston Ship Channel Tidal (1006) segment includes the portion of the Houston Ship Channel from the confluence with the San Jacinto River in Harris County to a point immediately upstream of Greens Bayou in Harris County, including tidal and non-tidal portions of tributaries. The tidal portion of the Houston Ship Channel is heavily developed, with 76.37 percent of the land cover being developed. The lower portion of the watershed includes the cities of Deer Park, Channelview, Houston, Pasadena, and parts of unincorporated Harris County. Heavy industrial complexes line both sides of the channel in the lower part of the watershed. The eastern end of this segment is Carpenters Bayou, which has four tributaries: Tucker Bayou, Patrick Bayou, Boggy Bayou, and Glenmore Ditch. On the south shore of the western end of the watershed is the confluence with Greens Bayou which also receives heavy barge traffic. Tributaries to Greens Bayou include Goodyear Creek, Jordan Gully, Big Gulch, Spring Gully, Halls Bayou, and an unnamed tributary. The Halls Bayou area is predominantly residential and commercial with some light industry. The majority of the area is serviced by sanitary sewer. However, there are on-site sewer facilities scattered throughout the watershed.

Segment 1006 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	8,148.50	10.42	3,759.56	4.81	-53.86
Barren Lands	352.49	0.45	783.49	1.00	122.27
Developed	53,504.34	68.41	59,733.13	76.37	11.64
Forest/Shrubs	5,103.93	6.53	9,062.98	11.59	77.57
Open Water	2,312.23	2.96	1,842.09	2.36	-20.33
Wetlands	8,785.44	11.23	3,030.11	3.87	-65.51
TOTAL	**78,206.92**	**100.00**	**78,211.37**	**100.00**	



Houston Ship Channel Tidal - 1006
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1.75
3.5
7
Miles
1006D_02
1006J_01
1006K_01
1006D_01
1006A_01
1006H_01
1006F_01
1006B_02
1006B_01
1006_01
1006_02
1006_03
1006_05
1006_06
Houston
Galena Park
Pasadena
Deer Park

Water Quality Issues:

Bacteria Impairments and Concerns
Recreation use is prohibited in the classified portion of the watershed (the main channel, segment 1006), but all of the unclassified tributaries to 1006 have designated recreational uses. Segment 1006B was not assessed for bacteria, while none of the other unclassified segments support recreation use due to elevated levels of *E. coli* bacteria. One AU of the main classified segment (1006_05) is also impaired for enterococci.

Dissolved Oxygen Impairments and Concerns
In the 2020 Integrated Report, no impairments or concerns for dissolved oxygen were identified in this watershed.

Nutrient Concerns
There are numerous nutrient concerns identified in this watershed in the 2020 Integrated Report. In the main Houston Ship Channel Tidal (1006) segment, there are screening level concerns for nitrate-nitrogen in all assessment units. This segment also has screening level concerns for total phosphorus in three assessment units (1006_03, 1006_04, and 1006_05).

For Carpenter's Bayou (1006B_01), concerns for nutrient screening levels were identified for ammonia-nitrogen, nitrate-nitrogen, and total phosphorus.

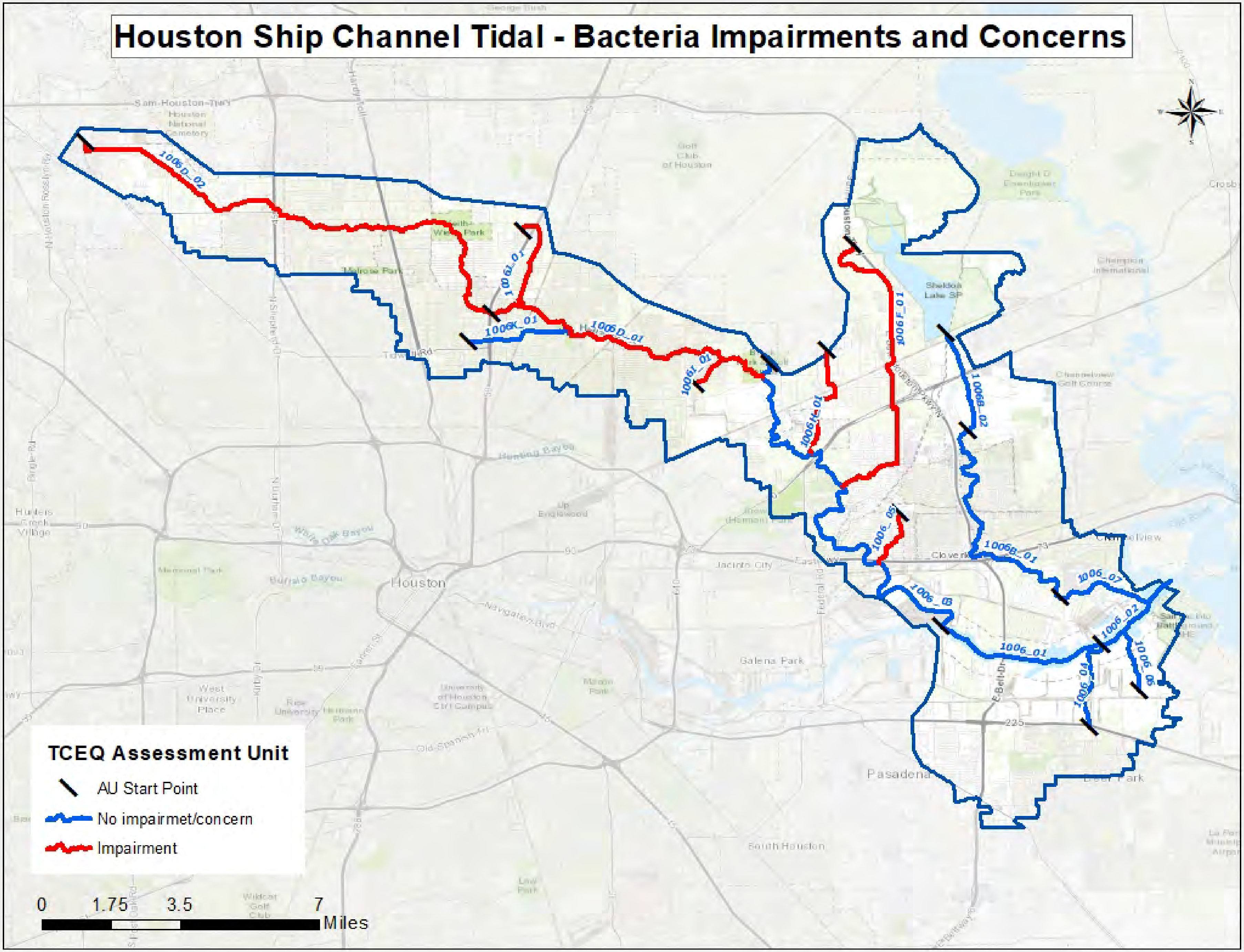
Nutrient concerns were also identified in the 2020 Integrated Report for Halls Bayou (1006D). AU 1006D_01 has screening level concerns for nitrate-nitrogen and total phosphorus, while 1006D_02 had concerns for ammonia-nitrogen, nitrate-nitrogen, and total phosphorus.

The Big Gulch Above Tidal (1006F) segment has screening level concerns for nitrate-nitrogen.

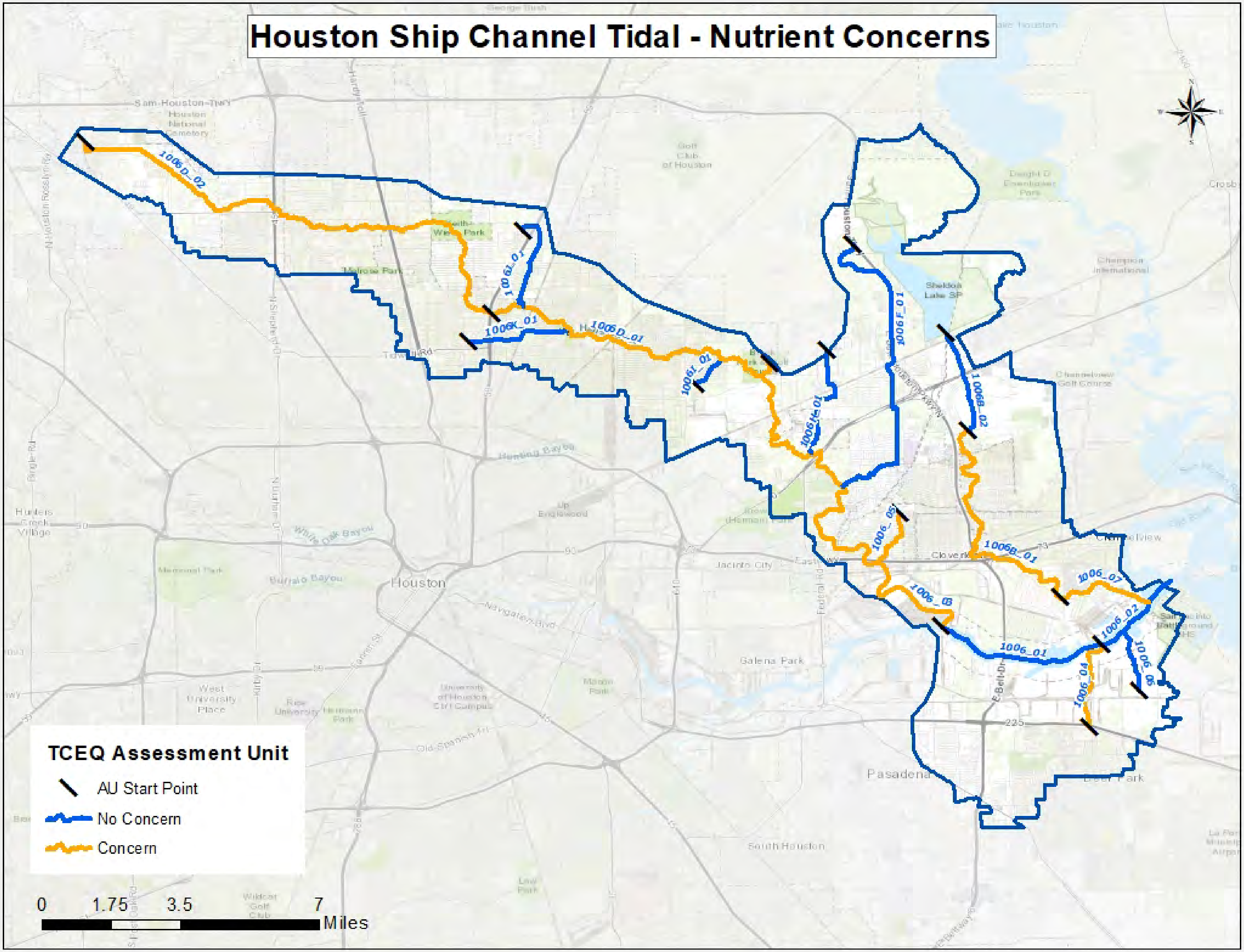
Chlorophyll-a
Chlorophyll-a screening levels have been exceeded for two AUs (1006_04 and 1004_07) in the Houston Ship Channel Tidal segment.

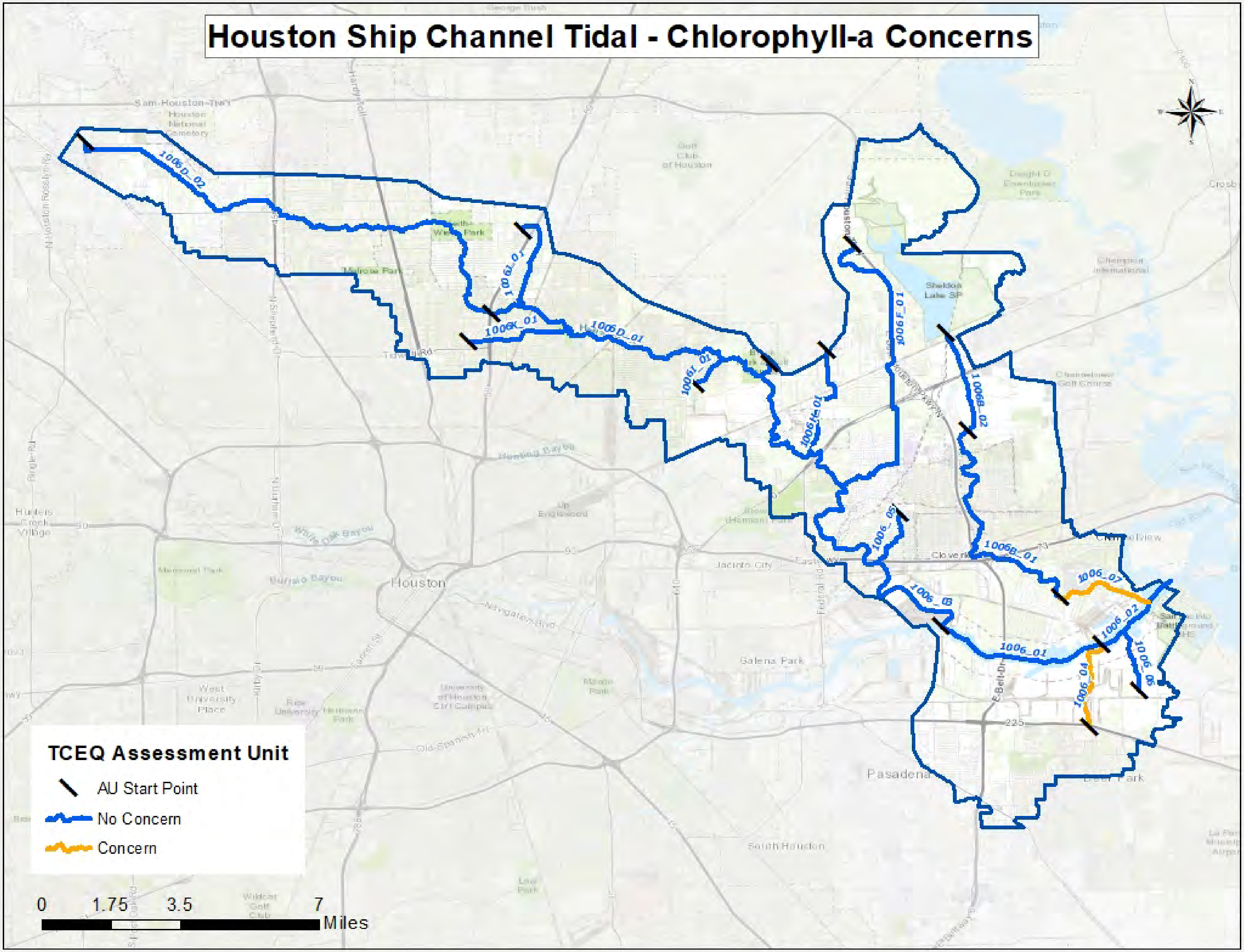
PCBs and Dioxin Impairments
Segment 1006 was deemed to not support the fish consumption use in the 2020 Integrated Report due to elevated levels of PCBs and Dioxin for all species of finfish and blue crab.

Toxicity in Sediment
Toxic substances in sediment were identified in two assessment units (1006_03 and 1006_04) of the Houston Ship Channel Tidal segment. AU 1006_03 had screening level concerns for DDD and DDT in sediment. AU 1006_04 had screening level concerns for hexachlorobutadiene and mercury in sediment.

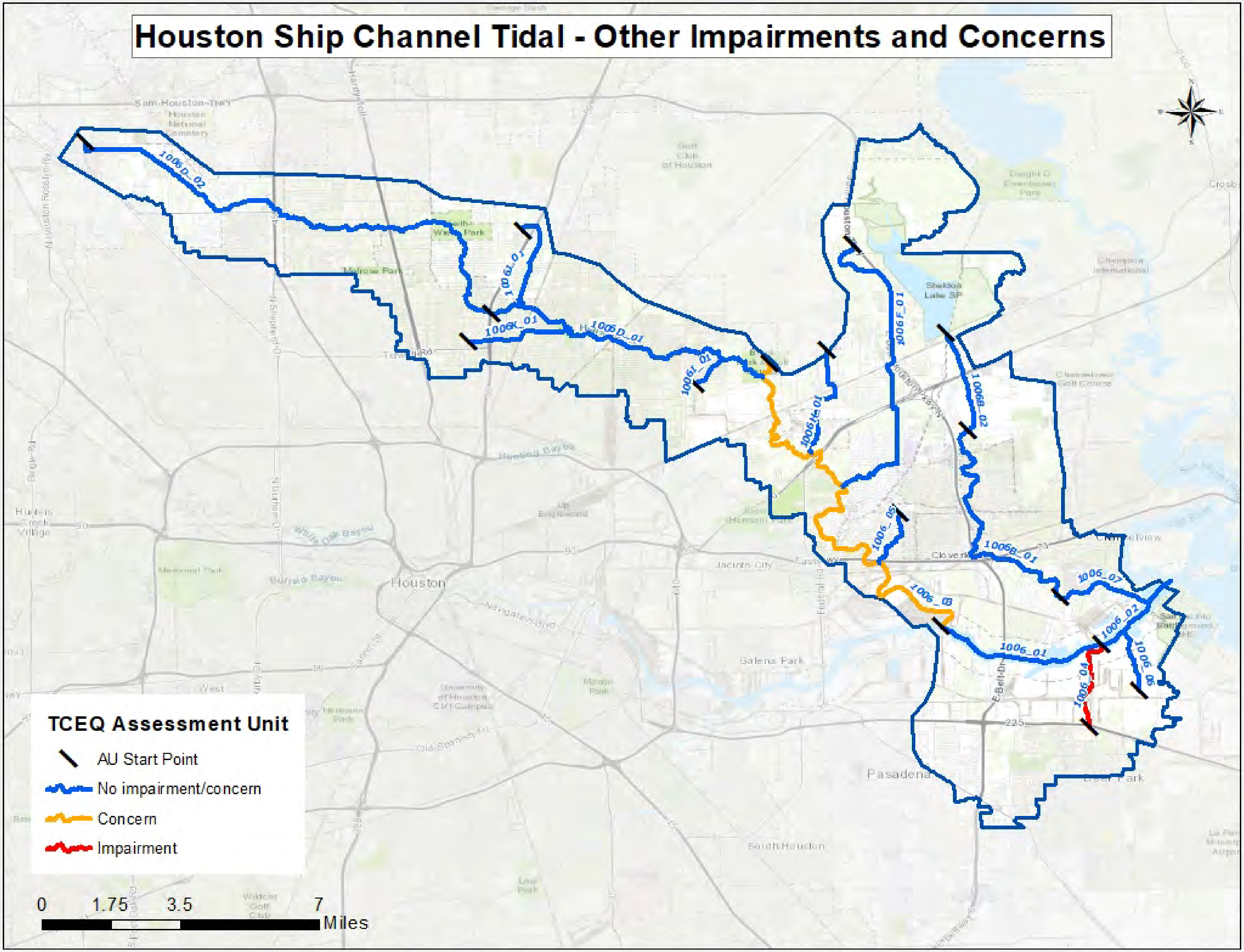

Houston Ship Channel Tidal - Bacteria Impairments and Concerns
1006D_02
1006J_01
1006K_01
1006D_01
1006I_01
1006H_01
1006F_01
1006B_02
1006_05
1006B_01
1006_07
1006_03
1006_02
1006_01
1006_06
1006_04
TCEQ Assessment Unit
AU Start Point
No impairmet/concern
Impairment
0
1.75
3.5
7
Miles

Houston Ship Channel Tidal - Nutrient Concerns

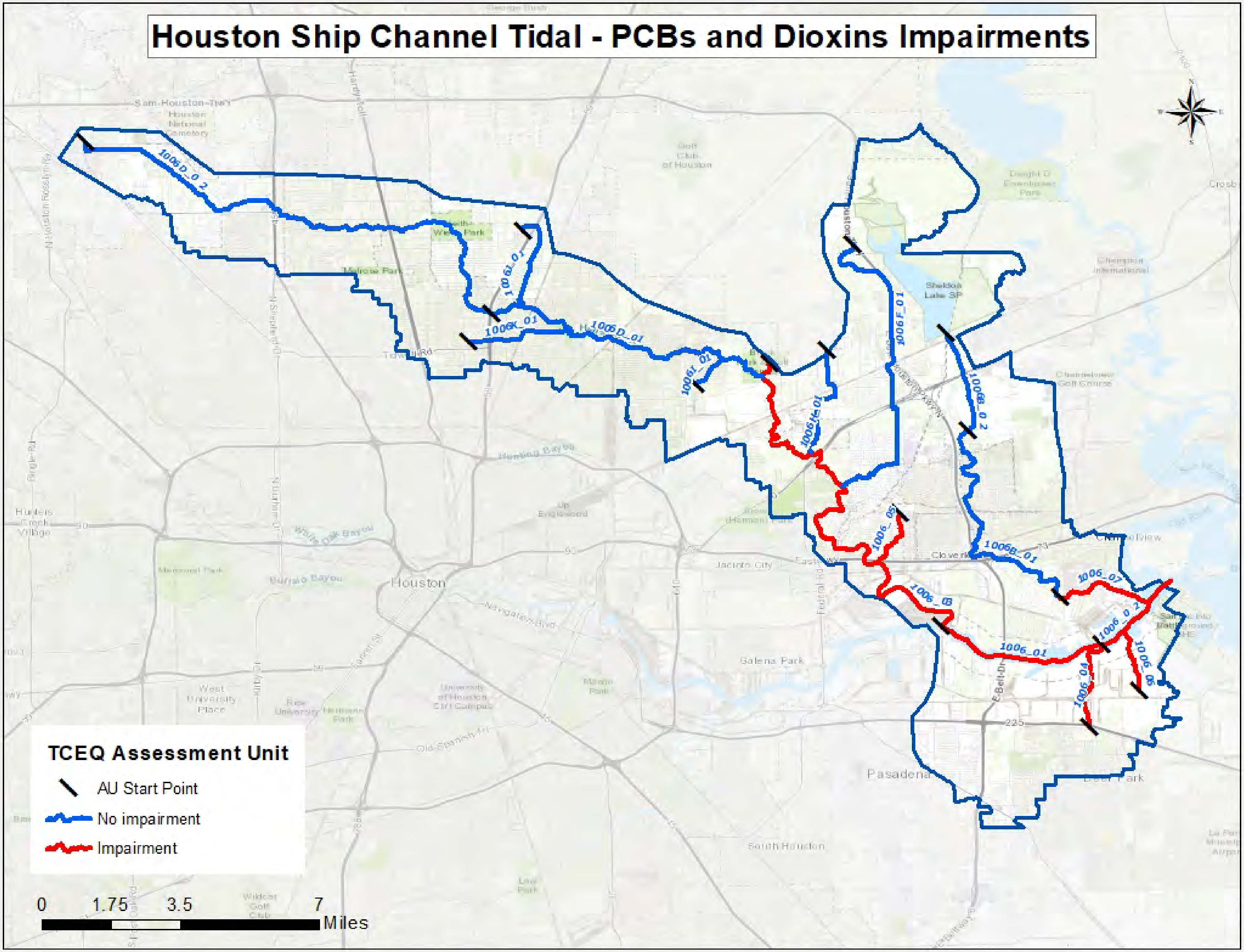




Houston Ship Channel Tidal - Chlorophyll-a Concerns
1006D_02
1006L_01
1006K_01
1006D_01
1006I_01
1006J_01
1006F_01
1006B_02
1006B_01
1006_05
1006_03
1006_07
1006_02
1006_01
1006_04
1006_06
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
1.75
3.5
7
Miles


Houston Ship Channel Tidal - Other Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0
1.75
3.5
7
Miles
1006D_02
1006L_01
1006K_01
1006D_01
1006I_01
1006H_01
1006F_01
1006B_02
1006B_01
1006_05
1006_03
1006_07
1006_02
1006_01
1006_04
1006_06
Houston
Pasadena
Galena Park
Jacinto City
Sheldon Lake SP
Channelview
Deer Park
South Houston
Hunters Creek Village

Houston Ship Channel Tidal - PCBs and Dioxins Impairments



Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Houston Ship Channel Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, and stormwater runoff.

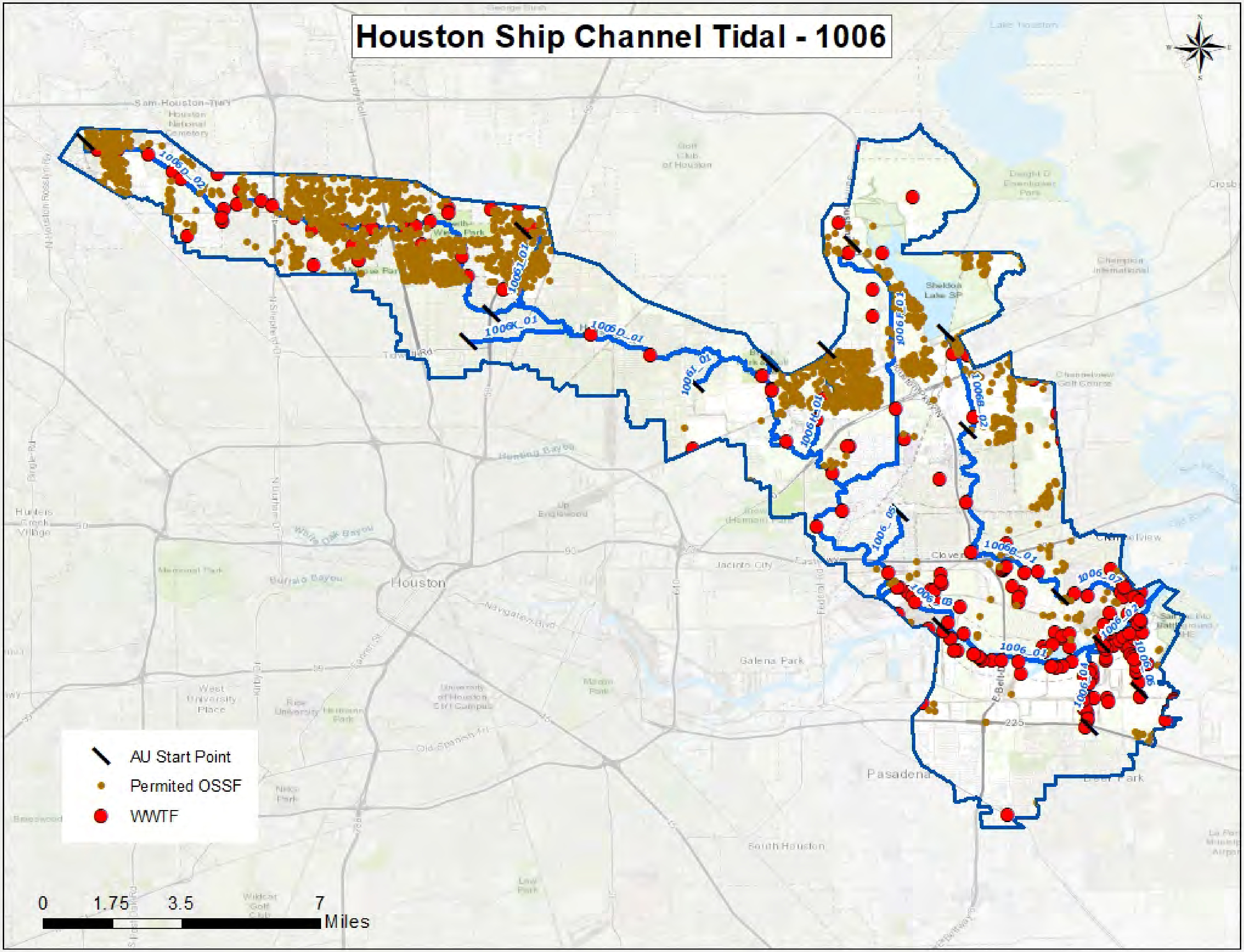
There are 188 permitted wastewater outfalls in the Houston Ship Channel Tidal watershed. In some areas, on-site sewage facilities are the primary source of wastewater disposal, with 2,343 permitted on-site sewage facilities in the watershed. These systems are most heavily concentrated in the northern portions of the watershed. The wastewater treatment facilities and on-site sewage facilities in the Houston Ship Channel Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 1,061 sanitary sewer overflows reported in the sewer collection systems. These sanitary sewer overflows may be a contributing factor to chronically high bacteria within this waterway. Discrete events may also cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

Toxicity in sediment due to the presences of pesticides (DDD and DDT) and other toxic substances (hexachlorobutadiene and mercury) is likely the result of unknown industrial or urban sources. These are legacy pollutants that persist in the environment, particularly in soils and sediments.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Houston Ship Channel Tidal watershed.



Houston Ship Channel Tidal - 1006
AU Start Point
Permited OSSF
WWTF
0
1.75
3.5
7
Miles

Trend Analysis:

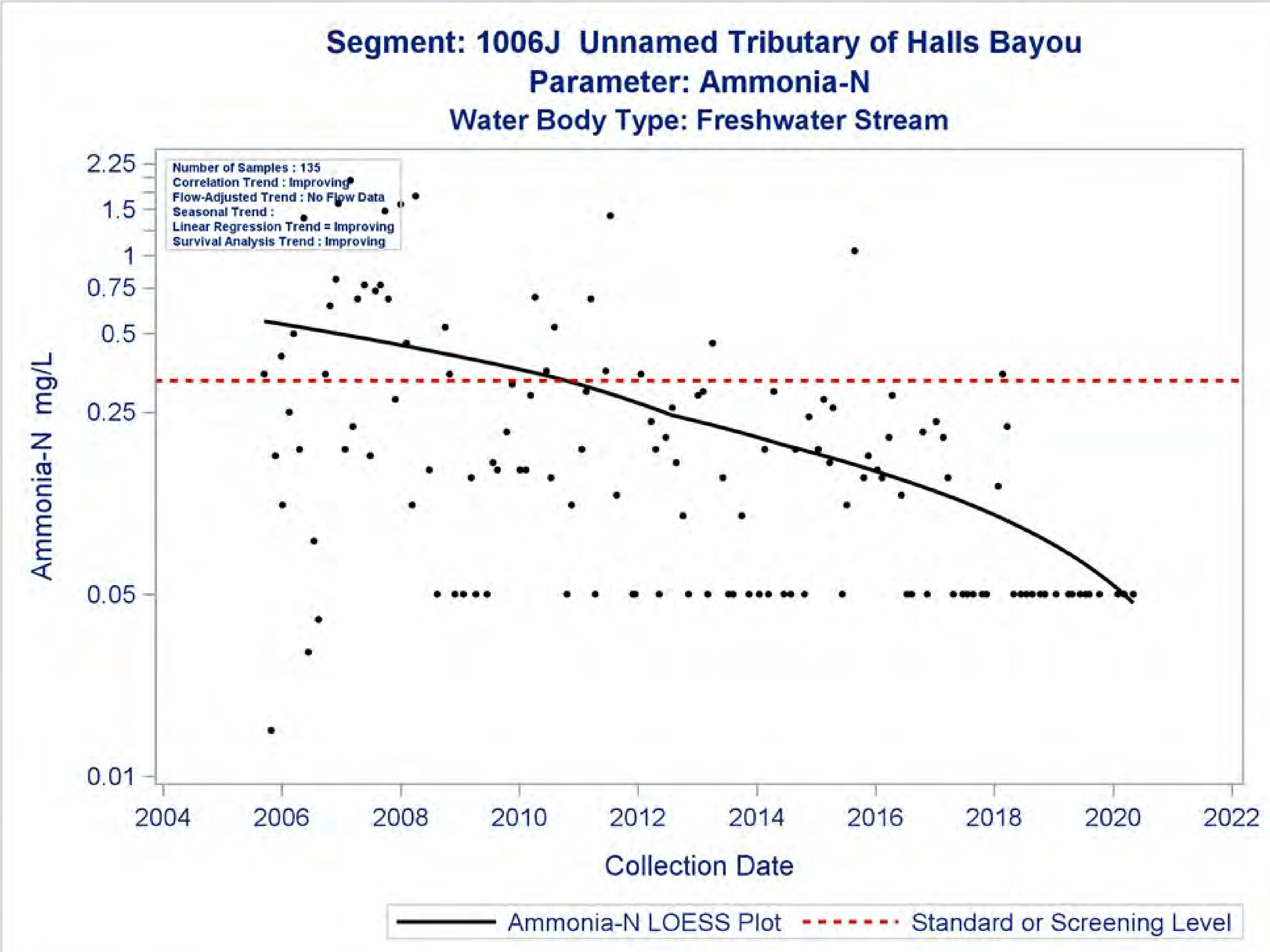
Sixteen parameters were collected throughout the period of record to allow for a regression analysis. However, chlorophyll *a*, 24-hour dissolved oxygen (24-hour DO), and instantaneous flow were sporadically collected during the period and have insufficient data for a trends analysis. The trend examination presented were therefore carried out on those parameters that were consistently collected for the classified and unclassified segments found within 1006.
The trends that stands out the most are ones of general decreases in most nutrient parameters: ammonia, nitrate, TKN, and total phosphorus. In most cases, the nutrient parameters were either showing no trend – stable or saw a decreasing trend. The exceptions can be found in graphs for Halls Bayou (unclassified segment 1006D) where nitrate and total phosphorus concentrations are increasing or getting worse.

Examples of decreasing nutrient trends are seen in figures for total phosphorus in classified segment 1006_04, ammonia and TKN in unclassified segment Halls Bayou (1006D), TKN in unclassified segment Spring Gully (1006H), and ammonia and total phosphorus in Unnamed Tributary to Halls Bayou (unclassified segment 1006J).

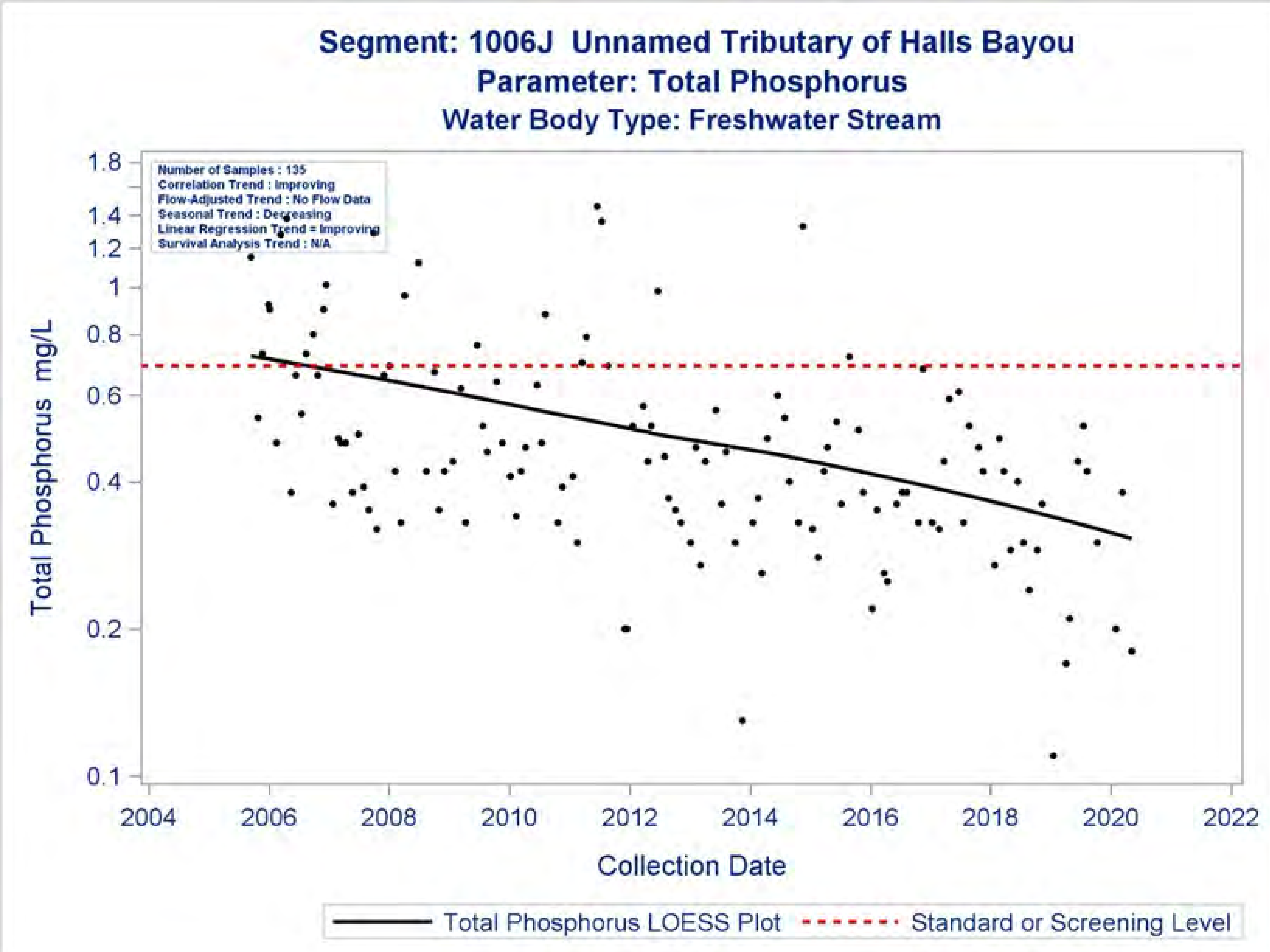
Most water bodies had stable DO without a trend, however, a few sites showed a trend with slight increases in dissolved oxygen levels beginning between 2012 - 2014, e.g. 1006 F – Big Gulch and 1006 I – Unnamed Tributary to Halls Bayou, respectively. These slight trends were due to fewer grab samples being measured below the minimum concentrations. There was also a couple of instances where decreasing trends in pH were found within the segment, i.e. 1006H – Spring Gully and 1006I – Unnamed Tributary to Halls Bayou. However, all pH values were still generally measured between 7.0 and 8.5 standard units.

Bacteria trends for the most part were stable. However, the concentrations of bacteria were consistently elevated above the water quality standards for contract recreation. Notable exceptions were 1006B – Carpenters Bayou, with a slight decrease in enterococci bacteria and 1006H – Spring Gully with a slight increase in *E. coli* bacteria concentrations.

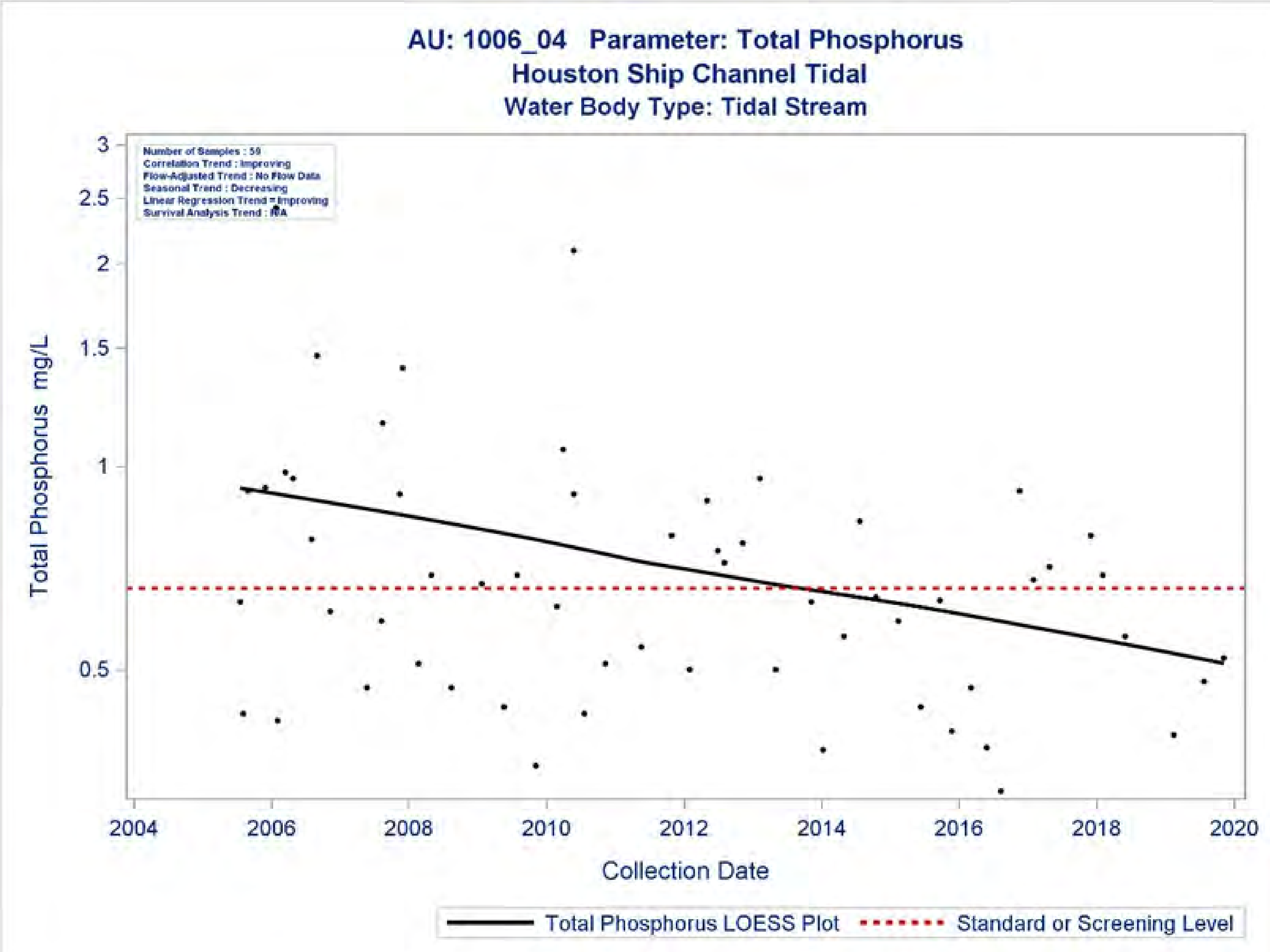
Finally, TSS results and Secchi transparency measurements seemed to inversely related as TSS increased or remained the same for most segments, the corresponding segment saw a decrease in water clarity with lower observations of Secchi transparency depths, e.g. 1006_07 – Houston Ship Channel Tidal and 1006D_02 – Halls Bayou. The exception was for 1006I – Unnamed Tributary to Halls Bayou which saw a slight increase in Secchi transparency depth results while seeing a decrease in TSS concentrations.



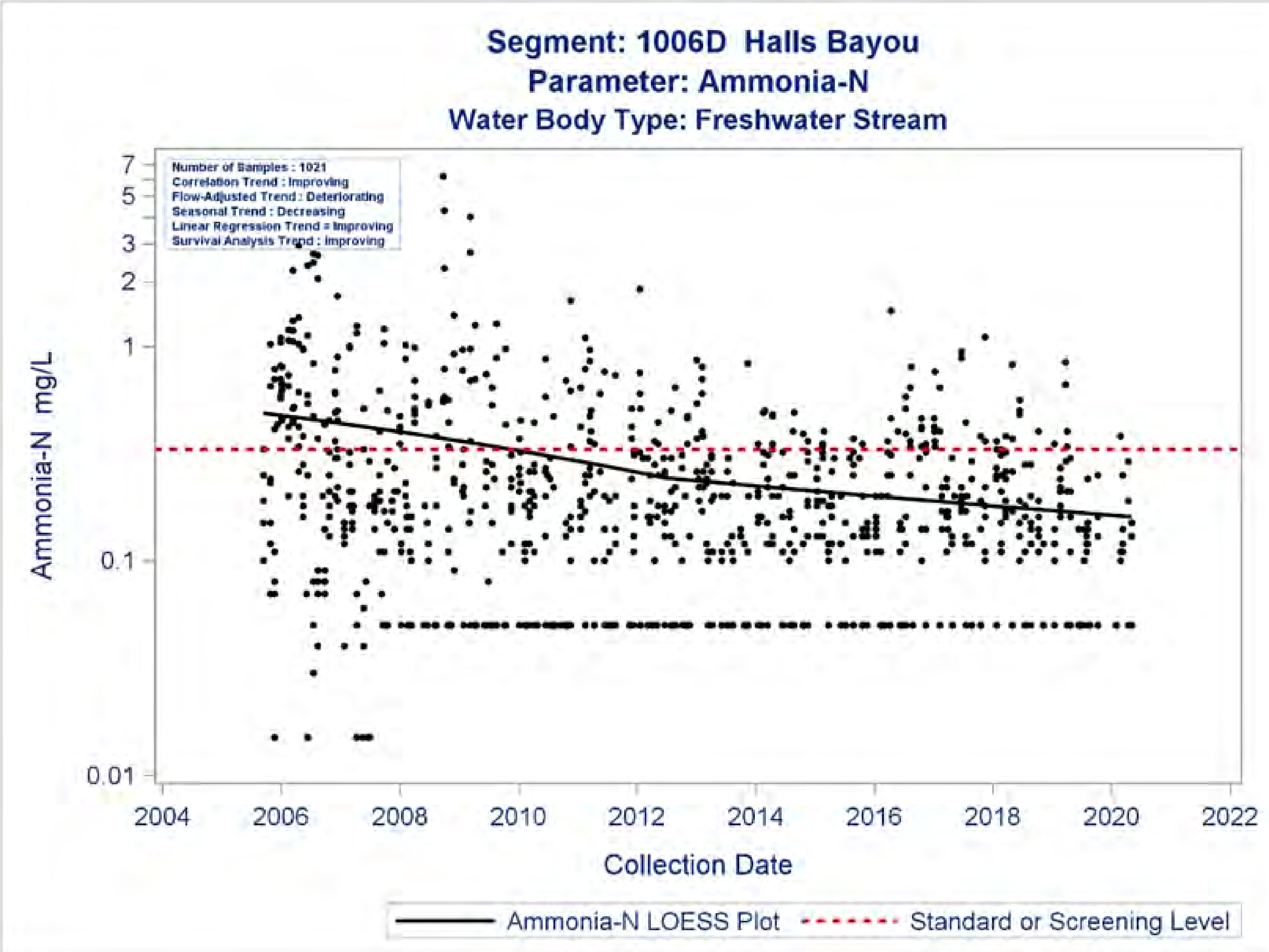
Segment: 1006J Unnamed Tributary of Halls Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend :
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
2.25
1.5
1
0.75
0.5
0.25
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level



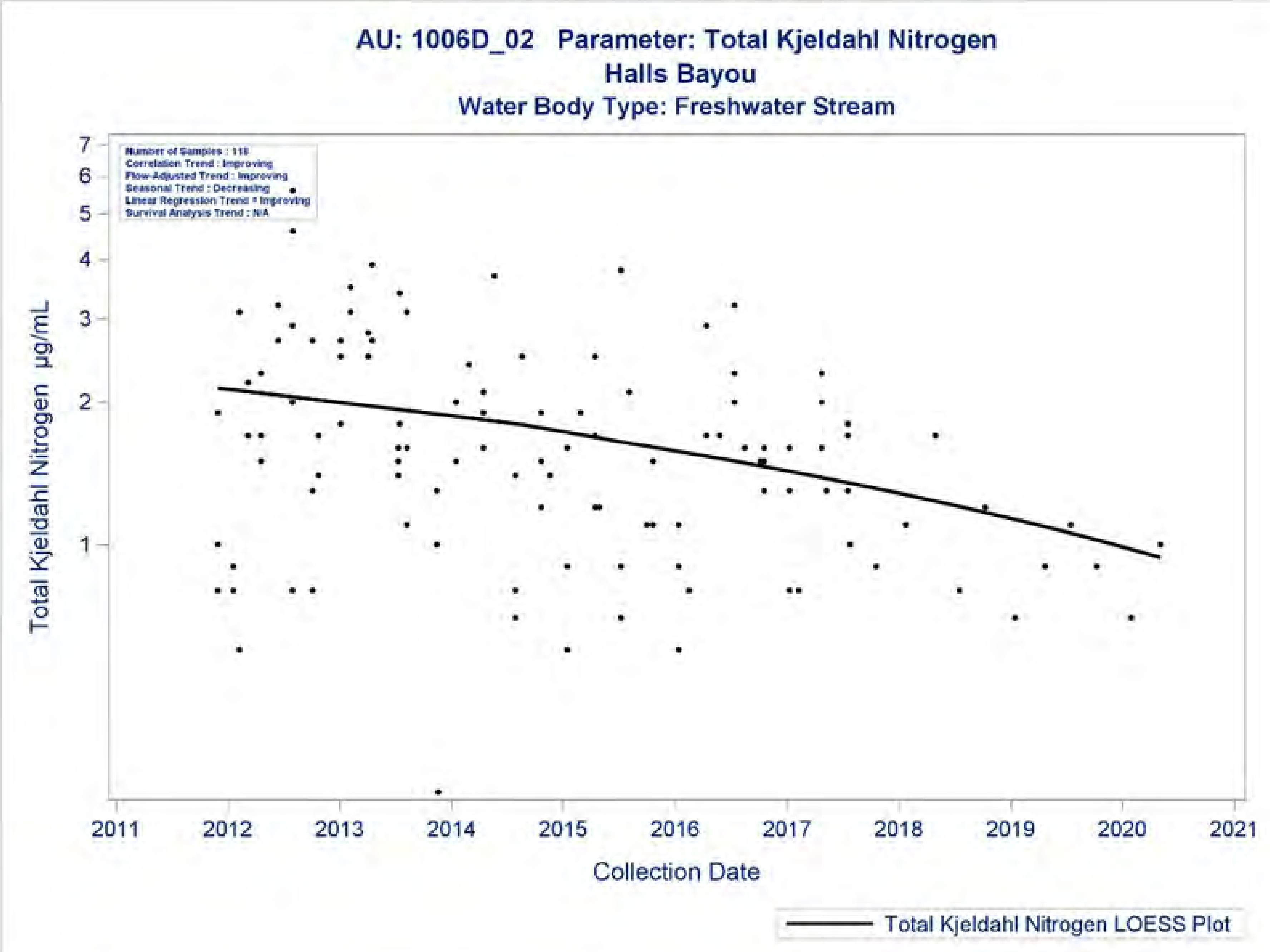
Segment: 1006J Unnamed Tributary of Halls Bayou
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1.8
1.4
1.2
1
0.8
0.6
0.4
0.2
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



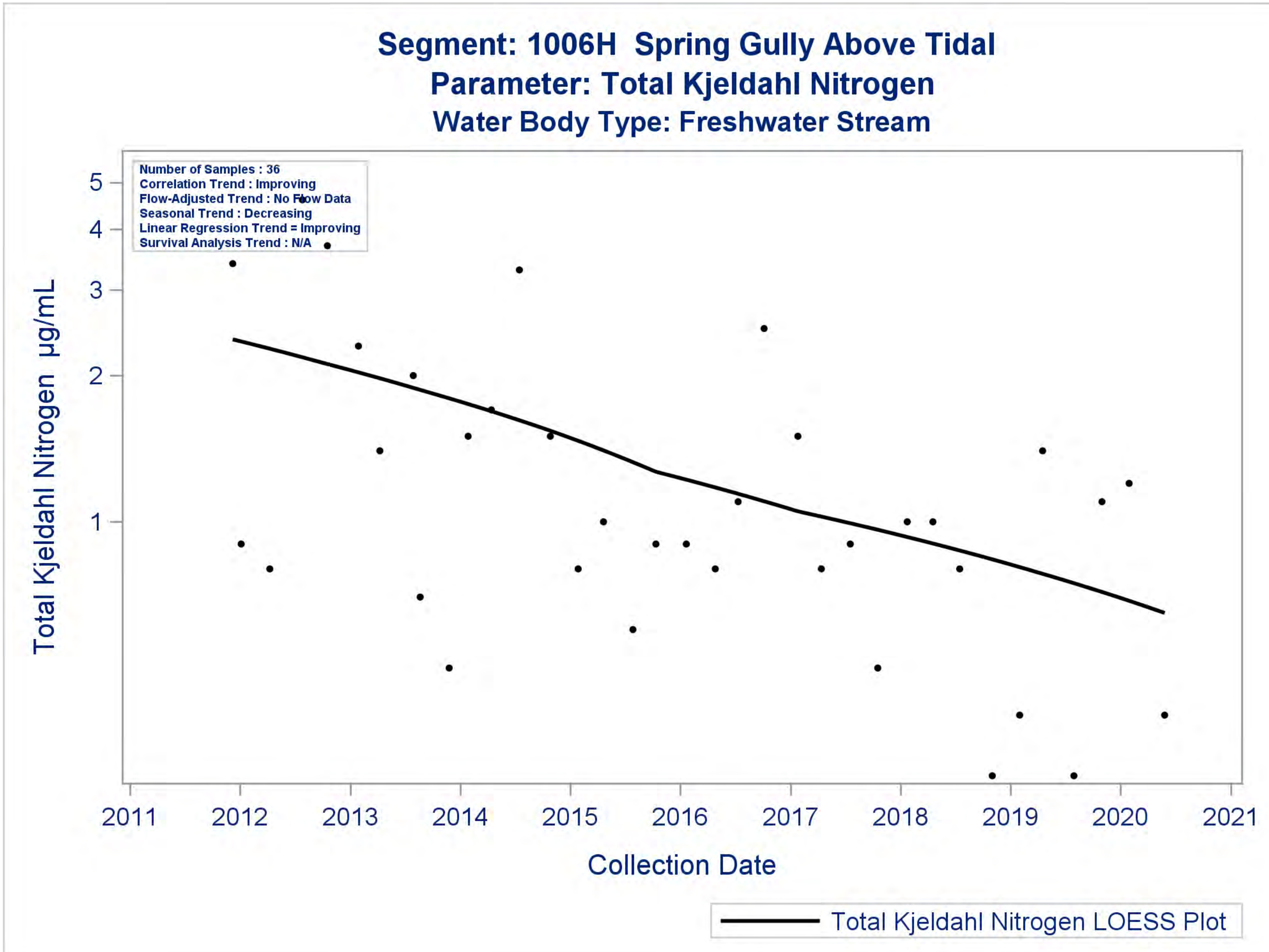
AU: 1006_04 Parameter: Total Phosphorus
Houston Ship Channel Tidal
Water Body Type: Tidal Stream
Number of Samples : 59
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : NA
Total Phosphorus mg/L
3
2.5
2
1.5
1
0.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



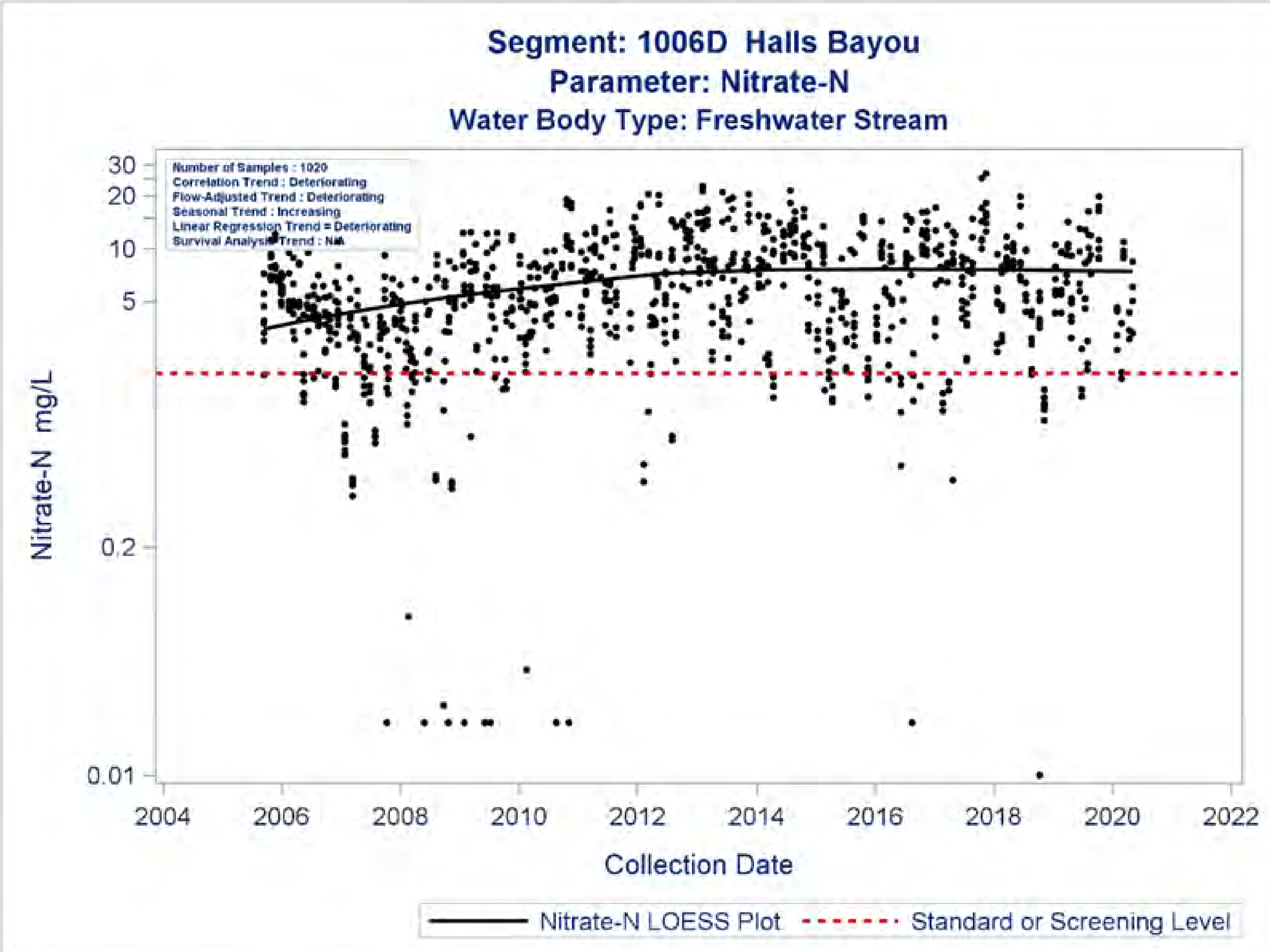
Segment: 1006D Halls Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 1021
Correlation Trend : Improving
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
7
5
3
2
1
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level

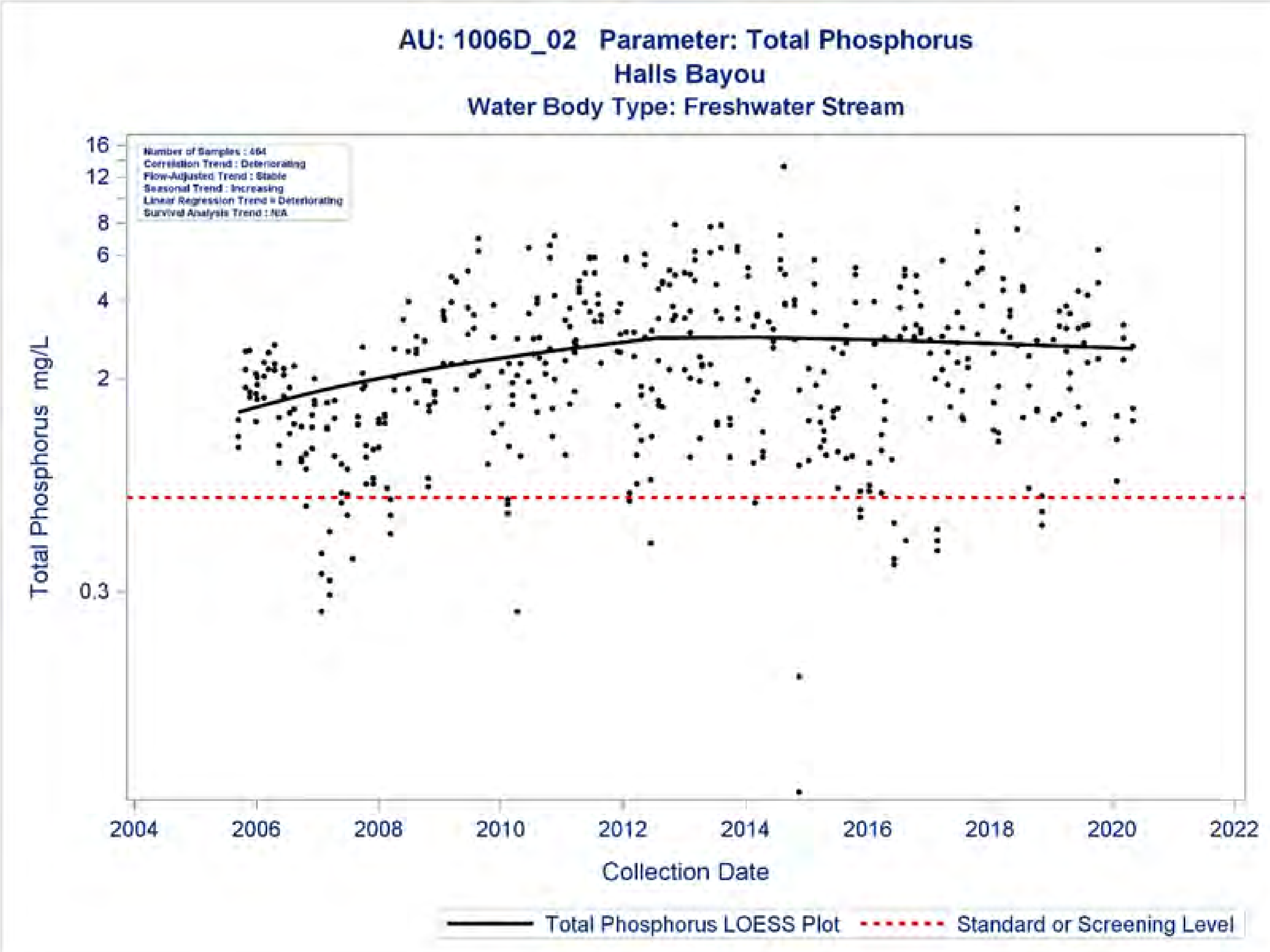


AU: 1006D_02 Parameter: Total Kjeldahl Nitrogen
Halls Bayou
Water Body Type: Freshwater Stream
Number of Samples : 118
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
7
6
5
4
3
2
1
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot

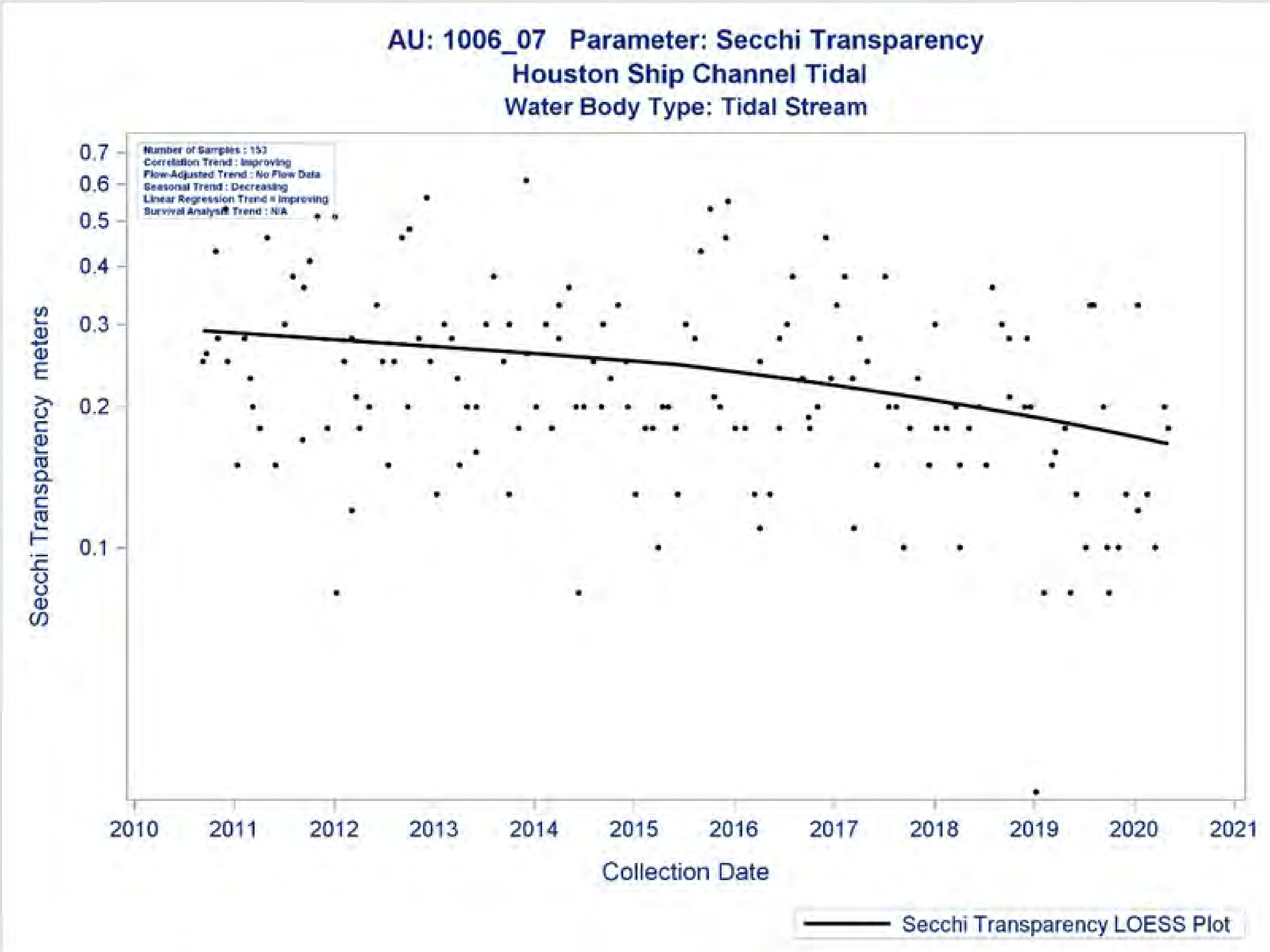


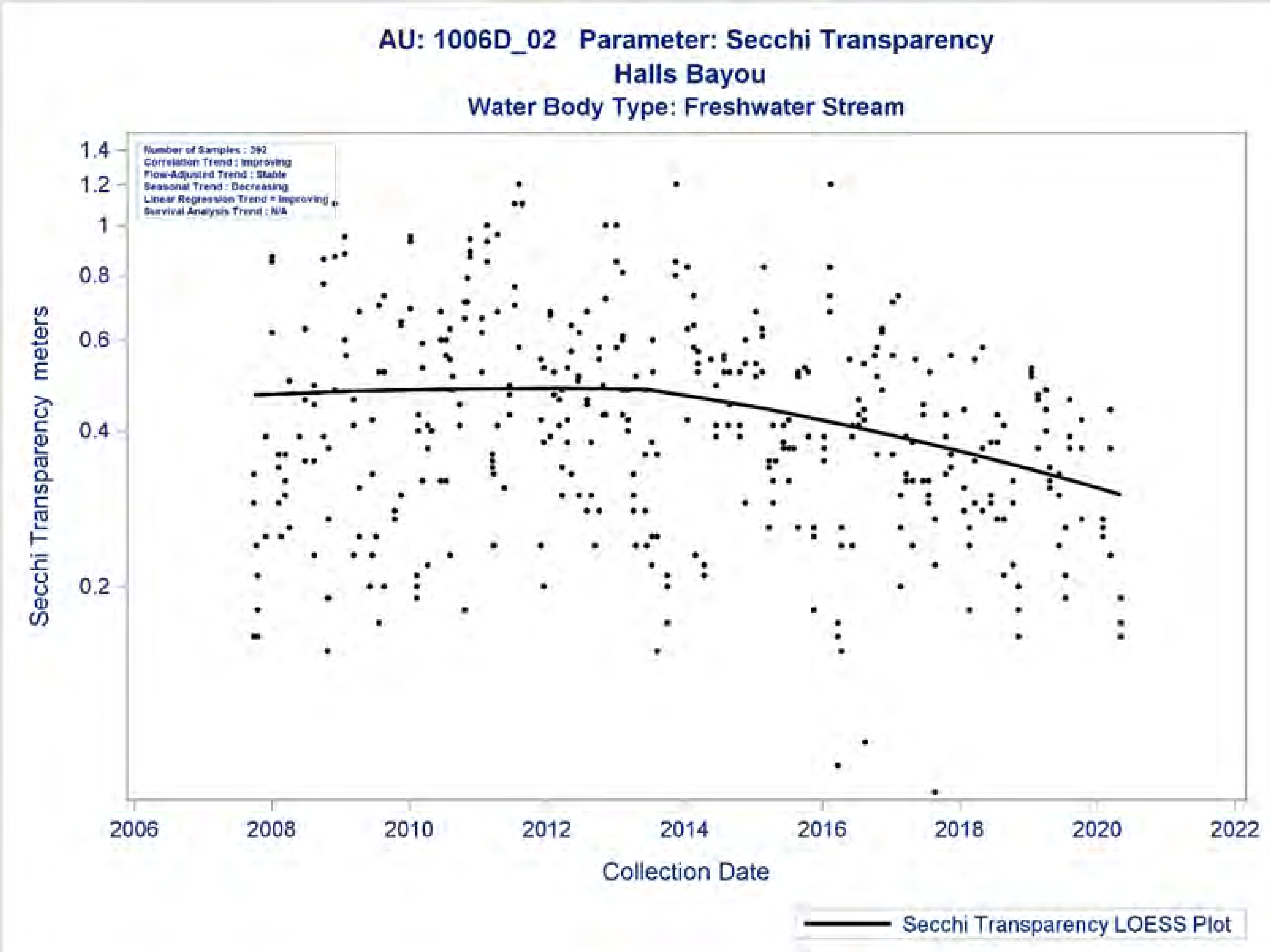
Segment: 1006H Spring Gully Above Tidal
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 36
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
5
4
3
2
1
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot


Segment: 1006D Halls Bayou
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 1020
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : NA
Nitrate-N mg/L
30
20
10
5
0.2
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level



AU: 1006D_02 Parameter: Total Phosphorus
Halls Bayou
Water Body Type: Freshwater Stream
Number of Samples : 464
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
16
12
8
6
4
2
0.3
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


AU: 1006_07 Parameter: Secchi Transparency
Houston Ship Channel Tidal
Water Body Type: Tidal Stream
Number of Samples : 153
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
0.7
0.6
0.5
0.4
0.3
0.2
0.1
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Secchi Transparency LOESS Plot


AU: 1006D_02 Parameter: Secchi Transparency
Halls Bayou
Water Body Type: Freshwater Stream
Number of Samples :
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.4
1.2
1
0.8
0.6
0.4
0.2
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1006_05 I 1006D I 1006F I 1006H I 1006I I 1006J I	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Constructed stormwater controls failing • Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Direct and dry weather discharges • Improper or no pet waste disposal • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Improve compliance and enforcement of existing stormwater quality permits • Improve storm water controls in new developments by adding bacteria reduction measures • Improve construction oversight to minimize TSS discharges to waterways • More public education on pet waste disposal • Promote and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing and alternative water supplies to keep livestock out of or away from waterways
Elevated Nutrient Concentrations	***Ammonia-N*** 1006B_01 C 1006D_02 C ***Nitrate-N*** 1006 (Entire Segment) C 1006B_01 C 1006D C 1006F C ***Phosphorus*** 1006_03 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Can increase algal production • Algal growth can affect dissolved oxygen concentrations • Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways

	1006_04 1006_05 1006B_01 1006D	C C C C			• Monitor phosphorus levels at WWTFs to determine if controls are needed.
Elevated Chlorophyll -*a* Concentrations	1006_04 1006_07	C C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	1006 (Entire Segment)	I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue monitoring and assessments of fish tissue to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits
Toxicity in Sediment	1006_03 1006_04	C I	• Legacy pollutant in sediment • Industrial point source discharges • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields	• Detrimental to the aquatic biological community	• Continue to contain, remove, and monitor known contaminated sites

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan

- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 1007		Name: Houston Ship Channel / Buffalo Bayou Tidal	
Length: 37 miles	**Watershed Area:** 296 square miles	**Designated Uses:**	Navigation; Industrial Water Supply
Number of Active Monitoring Stations: 59	**Texas Stream Team Monitoring Stations:** 6	**Permitted WWTF Outfalls:** 117	

DESCRIPTION

- Segment 1007 (Tidal Stream): **Houston Ship Channel / Buffalo Bayou Tidal** (classified water body) – From a point immediately upstream of the confluence with Greens Bayou in Harris County to a point 100 meters (110 yards) upstream of US 59 in Harris County, including tidal portion of tributaries

- Segment 1007A (Perennial Stream w/ limited ALU): **Canal C-147 Tributary of Sims Bayou Above Tidal** (unclassified water body)—From the Sims Bayou confluence upstream to a point 0.71 km (0.44 mi) east of Beltway 8.

- Segment 1007B (Perennial Stream w/ limited ALU): **Brays Bayou Above Tidal** (unclassified water body) – From a point 11.5 km (7.1 mi) upstream of confluence with Houston Ship Channel up to SH 6

- Segment 1007C (Perennial Stream w/ limited ALU): **Keegans Bayou Above Tidal** (unclassified water body) – From the Brays Bayou confluence to the Harris County line

- Segment 1007D Perennial Stream w/ limited ALU): **Sims Bayou Above Tidal** (unclassified water body) – From 11.0 km (6.8 mi) upstream of the Houston Ship Channel confluence to Hiram Clark Drive

- Segment 1007E (Perennial Stream w/ limited ALU): **Willow Waterhole Bayou Above Tidal** (unclassified water body) – From the Brays Bayou confluence upstream to South Garden Street (in Missouri City)

- Segment 1007F (Perennial Stream w/ limited ALU): **Berry Bayou Above Tidal** (unclassified water body) – From a point 2.4 km (1.5 mi) upstream of the Sims Bayou confluence to the southern city limits of South Houston

- Segment 1007G (Perennial Stream w/ high ALU): **Kuhlman Gully Above Tidal** (unclassified water body) – From Brays Bayou confluence to Atchison, Topeka and Santa Fe Railroad tracks in Harris County

- Segment 1007H (Perennial Stream w/ intermediate ALU): **Pine Gully Above Tidal** (unclassified water body) – From the Sims Bayou confluence to 0.11 km (0.07 mi) east of Broadway Street in Harris County

- Segment 1007I (Perennial Stream w/ intermediate ALU): **Plum Creek Above Tidal** (unclassified water body) – From the Sims Bayou confluence to Telephone Road in Harris County

- Segment 1007J: Retired segment description

- Segment 1007K (Perennial Stream w/ intermediate ALU): **Country Club Bayou Above Tidal** (unclassified water body) – From the Brays Bayou confluence to a point 0.43 km (0.27 mi) upstream of Polk Street (above ground portion of the water body)

- Segment 1007L (Perennial Stream w/ intermediate ALU): **Unnamed Tributary of Brays Bayou** (unclassified water body) – From the Brays Bayou confluence near Fondren Road to a point 0.97 km (0.60 mi) upstream in Harris County

- Segment 1007M (Perennial Stream w/ intermediate ALU): **Unnamed Non-Tidal Tributary of Hunting Bayou** (unclassified water body) – From the Hunting Bayou confluence to 0.6 km (0.37 mi) upstream of Gellhorn Road

- Segment 1007N (Perennial Stream w/ intermediate ALU): **Unnamed Non-Tidal Tributary of Sims Bayou** (unclassified water body) – From the Sims Bayou confluence, south of Airport Road to 1.1 km (0.68 mi) upstream of SH 288

- Segment 1007O (Perennial Stream w/ intermediate ALU): **Unnamed Non-Tidal Tributary of Buffalo Bayou** (unclassified water body) – From the Buffalo Bayou confluence to Clinton Drive in Harris County

- Segment 1007P: Retired segment description

- Segment 1007Q: Retired segment description

- Segment 1007R (Perennial Stream w/ intermediate ALU): **Hunting Bayou Above Tidal** (unclassified water body) – From the Hunting Bayou Tidal confluence at IH-10 upstream to Maury Street on the north fork (east of Elysian Street) and upstream to Bain Street on the south fork

- Segment 1007S (Perennial Stream w/ intermediate ALU): **Poor Farm Ditch** (unclassified water body) – From the Brays Bayou confluence upstream 3.6 km (2.3 miles) to the Bissonnet Road bridge crossing

- Segment 1007T (Perennial Stream w/ intermediate ALU): **Bintliff Ditch** (unclassified water body) – From the Brays Bayou confluence upstream 5.8 km (3.6 mi) to the Fondren Road bridge crossing

- Segment 1007U (Perennial Stream w/ intermediate ALU): **Mimosa Ditch** (unclassified water body) – From the Brays Bayou confluence upstream 2.9 km (1.8 miles) to the Chimney Rock bridge crossing

- Segment 1007V (Perennial Stream w/ intermediate ALU): **Unnamed Tributary of Hunting Bayou** (unclassified water body) – From the Hunting Bayou confluence to 1.7 km (1.1 mi) upstream of the confluence (0.3 km west of Collingsworth Street)

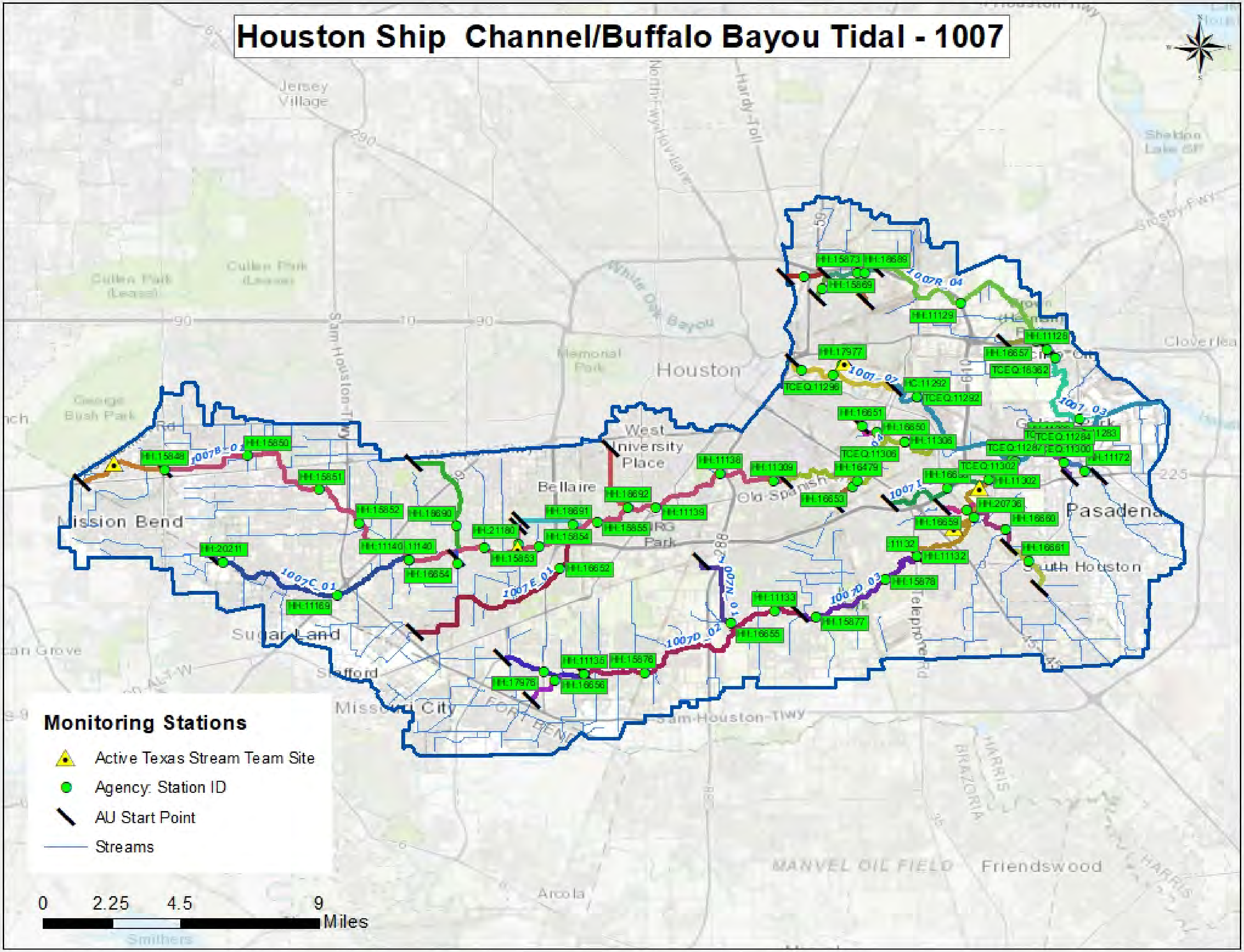
FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11172	1007	LITTLE VINCE BAYOU IMMEDIATELY DOWNSTREAM OF NORTH MAIN STREET IN PASADENA TX	HH	BIMONTHLY	Field, Conventional, Bacteria
11283	1007	HOUSTON SHIP CHANNEL/BUFFALO BAYOU HSC AT WASHBURN TUNNEL	HC	MONTHLY	Field, Conventional, Bacteria
11284	1007	HOUSTON SHIP CHANNEL/BUFFALO BAYOU NEAR FL 165 435 METERS DOWNSTREAM OF VINCE BAYOU	FO	QUARTERLY	Field, Conventional, Bacteria
11287	1007	HOUSTON SHIP CHANNEL/BUFFALO BAYOU AT CONFLUENCE WITH SIMS BAYOU	FO	QUARTERLY	Field, Conventional, Bacteria
11292	1007	HSC/BUFFALO BAYOU IN TURNING BASIN 2.82 K UPSTREAM OF CONFLUENCE WITH BRAYS BAYOU 433 M S AND 182 M W OF INTERSECT OF SIGNET AND DORSETT	HC	MONTHLY	Field, Conventional, Bacteria
11292	1007	HSC/BUFFALO BAYOU IN TURNING BASIN 2.82 K UPSTREAM OF CONFLUENCE WITH BRAYS BAYOU 433 M S AND 182 M W OF INTERSECT OF SIGNET AND DORSETT	FO	QUARTERLY ONE/YEAR TWO/YEAR	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment Metals in Water
11296	1007	BUFFALO BAYOU TIDAL IMMEDIATELY DOWNSTREAM OF HIRSCH RD/YORK STREET	FO	QUARTERLY	Field, Conventional, Bacteria
11298	1007	HUNTING BAYOU TIDAL AT FEDERAL ROAD BRIDGE IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11299	1007	VINCE BAYOU 279 METERS UPSTREAM OF THE HOUSTON SHIP CHANNEL CONFLUENCE	FO	QUARTERLY ONE/YEAR	Field, Conventional, Bacteria Organics in Sediment
11300	1007	VINCE BAYOU IMMEDIATELY UPSTREAM OF NORTH RICHEY STREET IN PASADENA TX	FO	QUARTERLY	Field, Conventional, Bacteria
11302	1007	SIMS BAYOU TIDAL IMMEDIATELY DOWNSTREAM OF LAWNDALE AVENUE IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11302	1007	SIMS BAYOU TIDAL IMMEDIATELY DOWNSTREAM OF LAWNDALE AVENUE IN HOUSTON	FO	QUARTERLY	Field, Conventional, Bacteria
11306	1007	BRAYS BAYOU TIDAL AT 75TH STREET IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11306	1007	BRAYS BAYOU TIDAL AT 75TH STREET IN HOUSTON	FO	QUARTERLY	Field, Conventional, Bacteria
11309	1007	BRAYS BAYOU TIDAL AT SCOTT STREET IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15841	1007	BUFFALO BAYOU TIDAL IMMEDIATELY UPSTREAM OF JENSEN DRIVE IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16479	1007	BRAYS BAYOU AT SOUTH WAYSIDE DRIVE 802 METERS UPSTREAM OF IH 45 IN SOUTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria

16620	1007	HOUSTON SHIP CHANNEL/BUFFALO BAYOU AT MAYO SHELL RD 1.42 KM S AND 41 M W OF INTERSECTION OF MAYO SHELL RD AND CLINTON DR IN HOUSTON	HC	MONTHLY	Field, Conventional, Bacteria
16660	1007	BERRY BAYOU/TRIBUTARY OF SIMS BAYOU IMMEDIATELY UPSTREAM OF AHRENS DRIVE IN SOUTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
18362	1007	HUNTING BAYOU AT MARKET ST	FO	QUARTERLY	Field, Conventional, Bacteria
20736	1007	SIMS BAYOU AT GALVESTON ROAD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16656	1007A	SIMS BAYOU SOUTH BRANCH AT TIFFANY DRIVE IN SOUTH HOUSTON	HH	BIMONTHLY	Field and Bacteria
11138	1007B	BRAYS BAYOU IMMEDIATELY DOWNSTREAM OF ALMEDA ROAD SOUTHWEST OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11139	1007B	BRAYS BAYOU AT SOUTH MAIN ST IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
11140	1007B	BRAYS BAYOU AT SOUTH GESSNER DRIVE IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
15848	1007B	BRAYS BAYOU IMMEDIATELY DOWNSTREAM OF SH 6 IN WEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15850	1007B	BRAYS BAYOU AT DAIRY ASHFORD STREET IN WEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15851	1007B	BRAYS BAYOU AT WILCREST DRIVE IN WEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15852	1007B	BRAYS BAYOU IMMEDIATELY DOWNSTREAM OF BEECHNUT STREET IN WEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15853	1007B	BRAYS BAYOU IMMEDIATELY DOWNSTREAM OF HILLCROFT STREET IN WEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15854	1007B	BRAYS BAYOU IMMEDIATELY DOWNSTREAM OF SOUTH RICE AVENUE IN WEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15855	1007B	BRAYS BAYOU IMMEDIATELY DOWNSTREAM OF STELLA LINK ROAD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11169	1007C	BRAYS/KEEGANS BAYOU IMMEDIATELY DOWNSTREAM OF ROARK ROAD NEAR US 59 AT BELTWAY 8 IN SOUTHWEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
20211	1007C	KEEGAN'S BAYOU AT SYNOTT ROAD 1.1 KM SOUTH OF THE INTERSECTION OF SYNOTT ROAD AND BISSONET STREET IN SOUTHWEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11132	1007D	SIMS BAYOU AT TELEPHONE ROAD/SH 35 IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
11133	1007D	SIMS BAYOU AT CULLEN BLVD/FM 865 SOUTH OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11135	1007D	SIMS BAYOU AT HIRAM CLARKE RD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
15876	1007D	SIMS BAYOU IMMEDIATELY DOWNSTREAM OF ALMEDA ROAD IN SOUTH HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria

15877	1007D	SIMS BAYOU AT MARTIN LUTHER KING JUNIOR BOULEVARD IN SOUTH HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
15878	1007D	SIMS BAYOU AT SWALLOW STREET IN SOUTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
17976	1007D	SIMS BAYOU UPSTREAM TIDAL AT SOUTH POST OAK ROAD IN SOUTHWEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16652	1007E	WILLOW WATERHOLE AT MCDERMED DRIVE IN SOUTHWEST HOUSTON	HH	BIMONTHLY	Field and Bacteria
16661	1007F	BERRY BAYOU IMMEDIATELY UPSTREAM OF SOUTH RICHEY STREET IN SOUTH EAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16653	1007G	KUHLMAN GULLY/TRIBUTARY OF BRAYS BAYOU AT BROCK STREET 311 METERS UPSTREAM OF WHEELER STREET IN SOUTHEAST CENTRAL HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16659	1007H	PINE GULLY/TRIBUTARY OF SIMS BAYOU AT OLD GALVESTON ROAD IN SOUTH EAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16658	1007I	PLUM CREEK/TRIBUTARY OF SIMS BAYOU AT OLD GALVESTON ROAD IN SOUTH EAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16650	1007K	COUNTRY CLUB BAYOU/TRIBUTARY OF BRAYS BAYOU IMMEDIATELY UPSTREAM OF SOUTH WAYSIDE DRIVE/US90A IN CENTRAL HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16651	1007K	COUNTRY CLUB BAYOU/TRIBUTARY OF BRAYS BAYOU AT HUGHES STREET IN CENTRAL HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16654	1007L	UNNAMED TRIBUTARY OF BRAYS BAYOU AT DUMFRIES DRIVE IN SOUTH WEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16657	1007M	UNNAMED TRIBUTARY OF HUNTING BAYOU IMMEDIATELY UPSTREAM OF JOHN RALSTON ROAD IN EAST HOUSTON	HH	BIMONTHLY	Field and Bacteria
16655	1007N	UNNAMED TRIBUTARY OF SIMS BAYOU AT DULCIMER STREET IN SOUTH HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
17977	1007O	UNNAMED TRIBUTARY OF BUFFALO BAYOU IMMEDIATELY DOWNSTREAM OF EMILE ST ON NORTH BANK 120 M SOUTH OF CLINTON DRIVE IN CENTRAL HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11128	1007R	HUNTING BAYOU IMMEDIATELY DOWNSTREAM OF IH 10 EAST OF HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11129	1007R	HUNTING BAYOU AT NORTH LOOP EAST/IH 610 IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria, Flow
15867	1007R	HUNTING BAYOU AT JENSEN DRIVE IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15869	1007R	HUNTING BAYOU AT CAVALCADE ST IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15873	1007R	HUNTING BAYOU AT LOCKWOOD DRIVE IN NORTHEAST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria

18692	1007S	POOR FARM DITCH TRIBUTARY OF BRAYS BAYOU AT EASTBOUND NORTH BRAESWOOD BLVD APPROX 200 M E OF BUFFALO SPEEDWAY IN SW HOUSTON	HH	BIMONTHLY	Field and Bacteria
18690	1007T	BINTLIFF DITCH TRIBUTARY OF BRAYS BAYOU UNDER CENTER OF BISSONNET ST BRIDGE 317 M NE OF BISSONNET AT FONDREN RD IN SW HOUSTON	HH	BIMONTHLY	Field and Bacteria
18691	1007U	MIMOSA DITCH TRIBUTARY OF BRAYS BAYOU AT NEWCASTLE DR IN SOUTHWEST HOUSTON	HH	BIMONTHLY	Field and Bacteria
18689	1007V	UNNAMED TRIBUTARY OF HUNTING BAYOU AT MINDEN STREET APPROXIMATELY 0.3 KM EAST OF LOCKWOOD AND S OF N 610 LOOP EAST	HH	BIMONTHLY	Field and Bacteria
21180	1007W	HARRIS COUNTY FLOOD CONTROL DISTRICT CHANNEL D138 / CHIMNEY DITCH IMMEDIATELY UPSTREAM OF CAVERSHAM DRIVE BETWEEN THE NORTHBOUND AND SOUTHBOUND SECTIONS OF CHIMNEY ROCK ROAD IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HC = Harris County Pollution Control
HH = Houston Health & Human Services



Houston Ship Channel/Buffalo Bayou Tidal - 1007
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
2.25
4.5
9
Miles
Jersey Village
Houston
West University Place
Bellaire
Mission Bend
Sugar Land
Stafford
Missouri City
Pasadena
South Houston
Friendswood
Arcola
Cullen Park (Leased)
George Bush Park
Memorial Park
White Oak Bayou
Sheldon Lake SP
Cloverleaf
MANVEL OIL FIELD

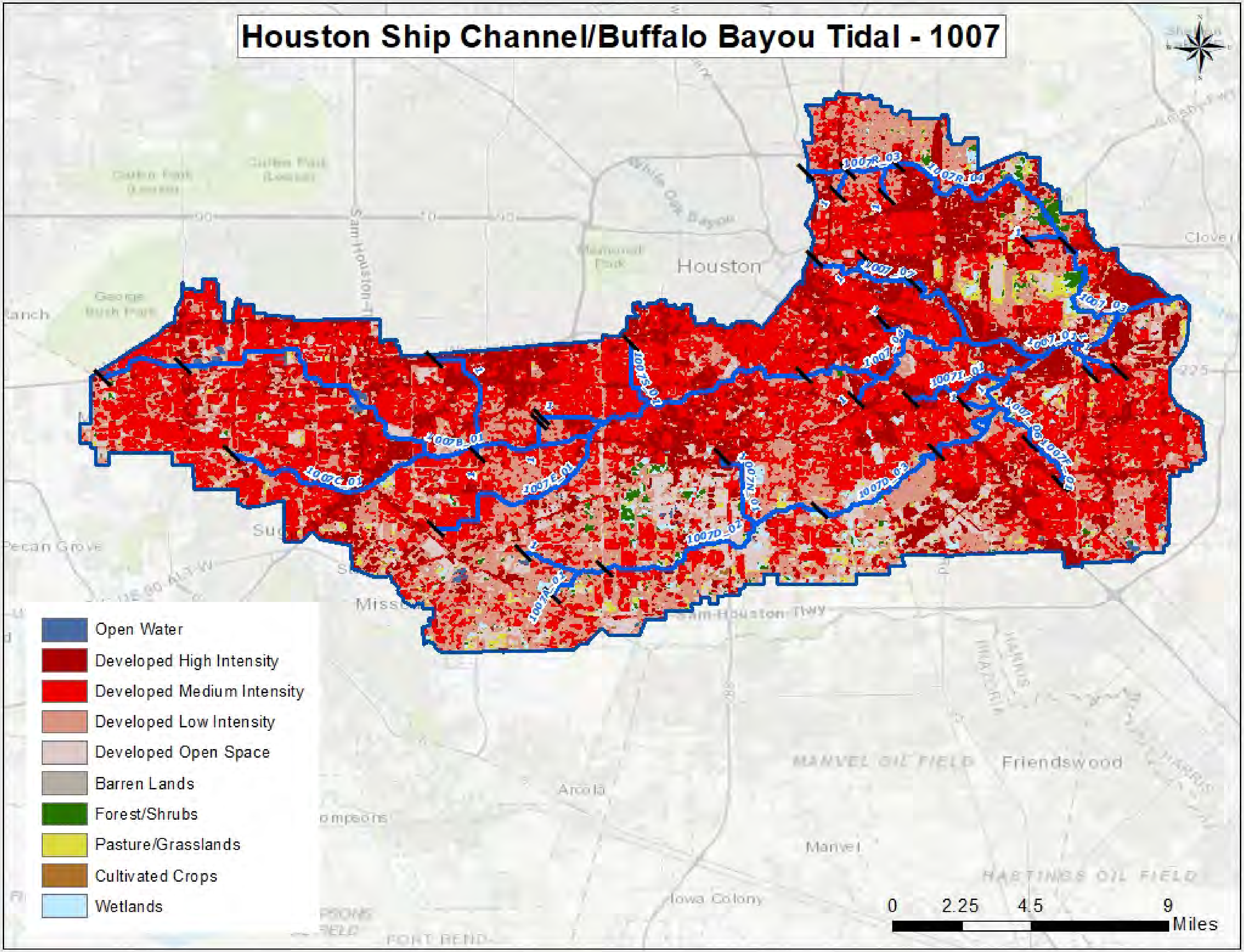
Segment 1007 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia (mg/L):	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	1.0	5.0 / 4.0 / 3.0	Nitrate-N (mg/L):	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	1.0	3.0 / 3.0 / 2.0*	Orthophosphate Phosphorus (mg/L):	0.46	0.37
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus (mg/L):	0.66	0.69
Enterococci (MPN/100mL) (30-day geometric mean> 10 samples):	168		Chlorophyll *a* (µg/L):	21	21 / 14.1
E. coli (MPN/100 mL) (grab):		399			
E. coli (MPN/100 mL) (geometric mean):		126			

*Segment 1007, which is a tidal segment, has many non-tidal tributaries. Depending on whether a tributary is concrete line and maintained or unmaintained channelized, depends on the 'absolute minima' dissolved oxygen assigned to the unclassified segment. Hence, more than one standard.

Segment Discussion

Watershed Characteristics and Land Cover: The Houston Ship Channel / Buffalo Bayou Tidal (1007) watershed is a very urbanized watershed, with developed land cover at 93.32 percent of the watershed. It includes 14 miles of the Houston Ship Channel (HSC) but more than 70 miles of tidal and non-tidal tributary streams. The HSC is lined by heavy industrial and petrochemical complexes. The watershed includes the City of Bellaire, Pasadena, Galena Park, Houston, South Houston and unincorporated Harris County. Numerous permitted wastewater and storm water discharges are located throughout the watershed. The HSC supports heavy boat and barge traffic from Greens Bayou upstream to the turning basin on a continual basis. The cities of Pasadena and South Houston are drained primarily by Vince Bayou, Little Vince Bayou and Berry Bayou, while the two largest tributaries – Sims and Brays Bayous – drain the City of Houston and a host of smaller cities and unincorporated communities to the west. About half of the watershed supports low intensity residential and commercial development while the rest is a mixture of high intensity development, grasslands and small pockets of forested areas. Not all areas are serviced by sanitary sewer despite the numerous wastewater collection and treatment systems located throughout the watershed.

Segment 1007 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	5,144.85	2.72	5,341.00	2.82	3.81
Barren Lands	713.66	0.38	516.84	0.27	-27.58
Developed	175,423.15	92.61	176,784.87	93.32	0.78
Forest/Shrubs	2,345.36	1.24	2,169.67	1.15	-7.49
Open Water	2,422.76	1.28	1,460.90	0.77	-39.70
Wetlands	3,374.38	1.78	3,158.88	1.67	-6.39
TOTAL	**189,424.15**	**100.00**	**189,432.17**	**100.00**	


Houston Ship Channel/Buffalo Bayou Tidal - 1007
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
2.25
4.5
9
Miles
Houston
Friendswood
Manvel
Arcola
Iowa Colony
Sam Houston Tlwy
MANVEL OIL FIELD
HASTINGS OIL FIELD

Water Quality Issues:

Nutrient Concerns

There are numerous nutrient concerns identified in this watershed in the 2020 Integrated Report. In the Houston Ship Channel/Buffalo Bayou Tidal segment, nutrient concerns were observed in every assessment unit. In several of the segments, there were concerns for multiple nutrient parameters. Of the 34 assessment units listed in the 2020 assessment, 17 had concerns for ammonia-N, 20 had concerns for nitrate-N, and 16 had concerns for total phosphorus.

2020 Assessment Results – Nutrient Screening Level Concerns				
Segment Name	**Assessment Unit**	**Ammonia-N Concerns**	**Nitrate-N Concerns**	**Phosphorus Concerns**
Houston Ship Channel/Buffalo Bayou Tidal	1007_01	X	X	X
	1007_02	X	X	X
	1007_03	X	X	
	1007_04	X	X	X
	1007_05	X	X	X
	1007_06		X	X
	1007_07	X	X	X
	1007_08	X	X	X
Canal C-147	1007A_01		X	X
Brays Bayou Above Tidal	1007B_01	X	X	X
	1007B_02	X	X	X
Keegans Bayou Above Tidal	1007C_01		X	X
Sims Bayou Above Tidal	1007D_01		X	X
	1007D_02	X	X	X
	1007D_03	X	X	X
Willow Waterhole Bayou Above Tidal	1007E_01			
Berry Bayou Above Tidal	1007F_01	X	X	X
Kuhlman Gully Above Tidal	1007G_01			
Pine Gully Above Tidal	1007H_01	X		
Plum Creek Above Tidal	1007I_01	X		
Country Club Bayou Above Tidal	1007K_01			
Unnamed Tributary of Brays Bayou	1007L_01		X	
Unnamed Tributary of Hunting Bayou	1007M_01			
Unnamed Tributary of Sims Bayou	1007N_01	X		
Unnamed Tributary of Buffalo Bayou	1007O_01			
Hunting Bayou Above Tidal	1007R_01	X		
	1007R_02			
	1007R_03		X	
	1007R_04		X	
Poor Farm Ditch	1007S_01		X	X
Bintiff Ditch	1007T_01			
Mimosa Ditch	1007U_01			
Unnamed Tributary of Hunting Bayou	1007V_01			
Harris County Flood Control Ditch D 138	1007W_01	X		

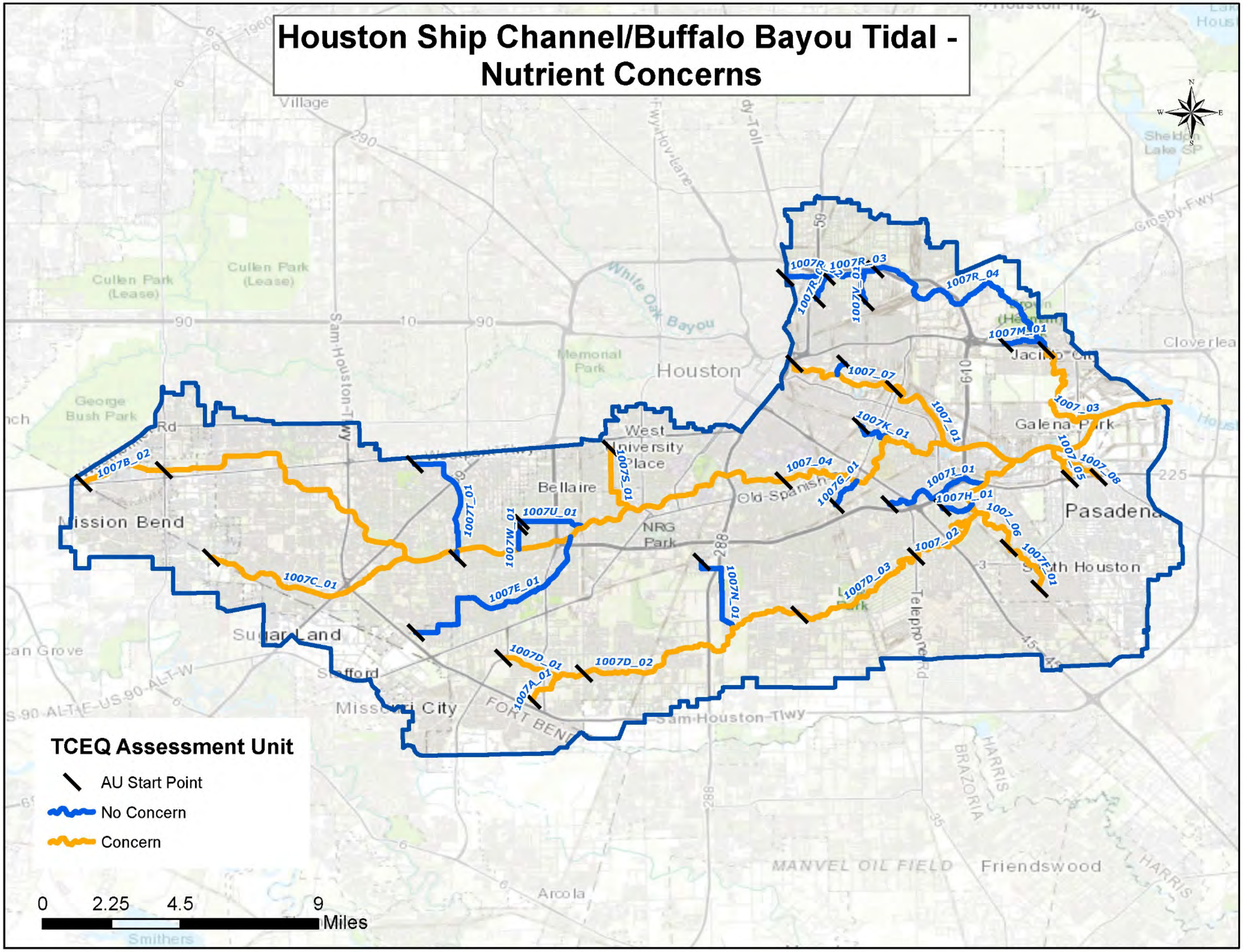
Bacteria Impairments and Concerns
In the Houston Ship Channel/Buffalo Bayou Tidal (1007) segment, AU 1007_05 is not supporting due to elevated levels of enterococci. In this 2020 Integrated Report, the geometric mean for AU 1007_05 was 228.40 MPN/100 mL, which exceeded the water quality standard of 168 MPN/100 mL for this segment. All other AUs for this classified segment met the standard.

None of the tributaries to segment 1007 support their designated recreation use due to elevated levels of *E. coli*, with every segment exceeding the water quality standard of 126 MPN/100 mL. Geometric means for *E. coli* in these tributaries range from 160.27 in Canal C-147 (1007A) to 3,735.64 MPN/100 mL in Plum Creek Above Tidal (1007I). Numerous segments or assessment units had results exceeding 1,000 MPN/100 mL, including in Brays Bayou Above Tidal (1007B_01), Berry Bayou Above Tidal (1007F), Kuhlman Bayou Above Tidal (1007G), Pine Gully Above Tidal (1007H), Plum Creek Above Tidal (1007I), Country Club Bayou Above Tidal (1007K), Hunting Bayou Above Tidal (1007R_01, 1007R_04), Poor Farm Ditch (1007S), Bintliff Ditch (1007T), and Mimosa Ditch (1007U).

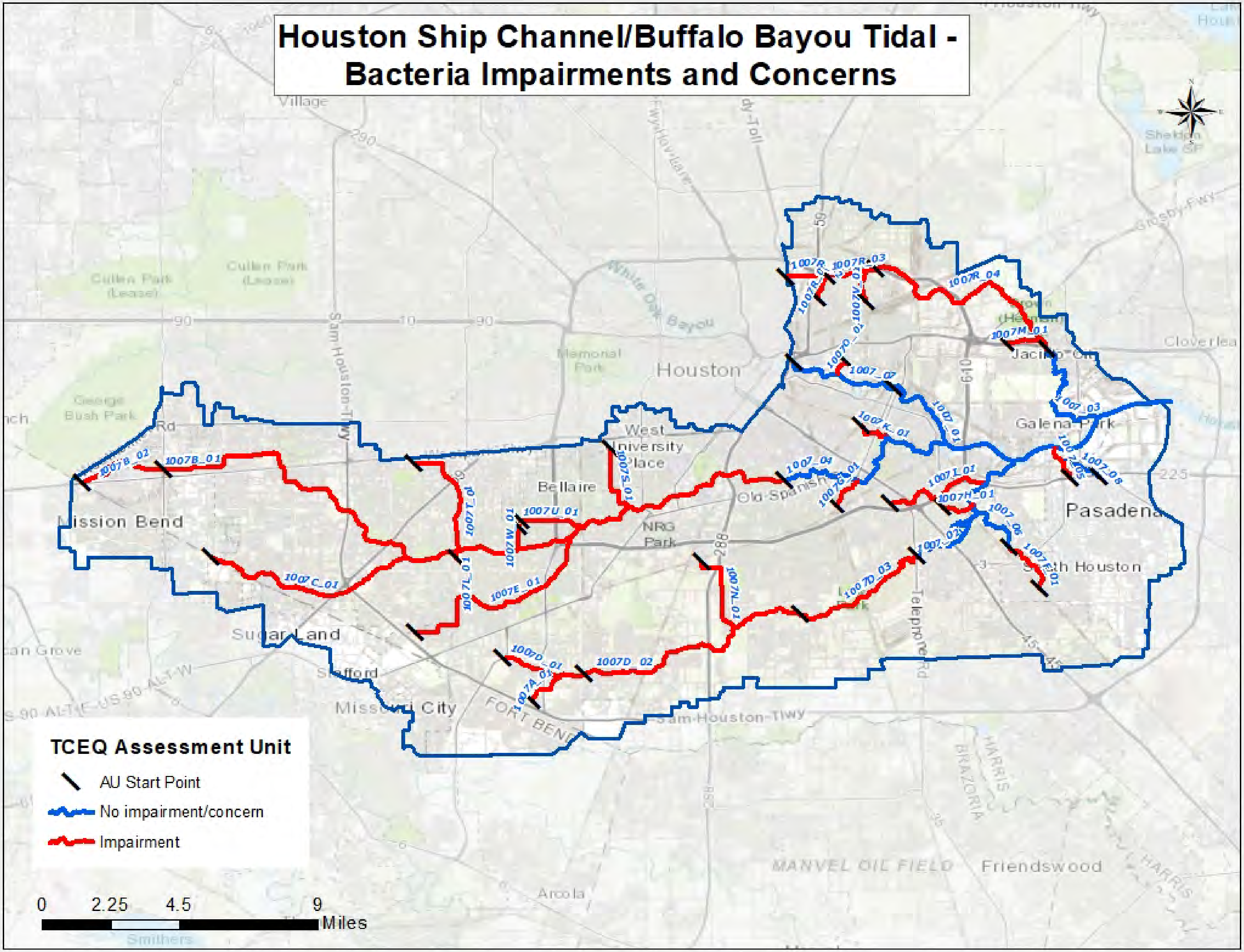
Dissolved Oxygen Impairments and Concerns
In the 2020 Integrated Report, no impairments or concerns for dissolved oxygen were identified in the Houston Ship Channel Buffalo Bayou Tidal segment. However, numerous concerns and impairments were identified in the tributaries. Concerns for dissolved oxygen grab screening levels were identified in segments 1007G, 1007H, 1007N, portions of 1007R, and 1007W. Several segments did not support their designated use based on dissolved oxygen grab minimum results. These include segments 1007H, 1007K, and a portion of 1007R (1007R_01). Impairments based on 24-hour dissolved oxygen assessments were identified in segments 1007I and 1007O, with concerns in 1007K and 1007R_04..

PCBs and Dioxin Impairments
Segment 1007 was deemed to not support the fish consumption use in the 2020 Integrated Report due to elevated levels of PCBs and Dioxin for all species of finfish and blue crabs.

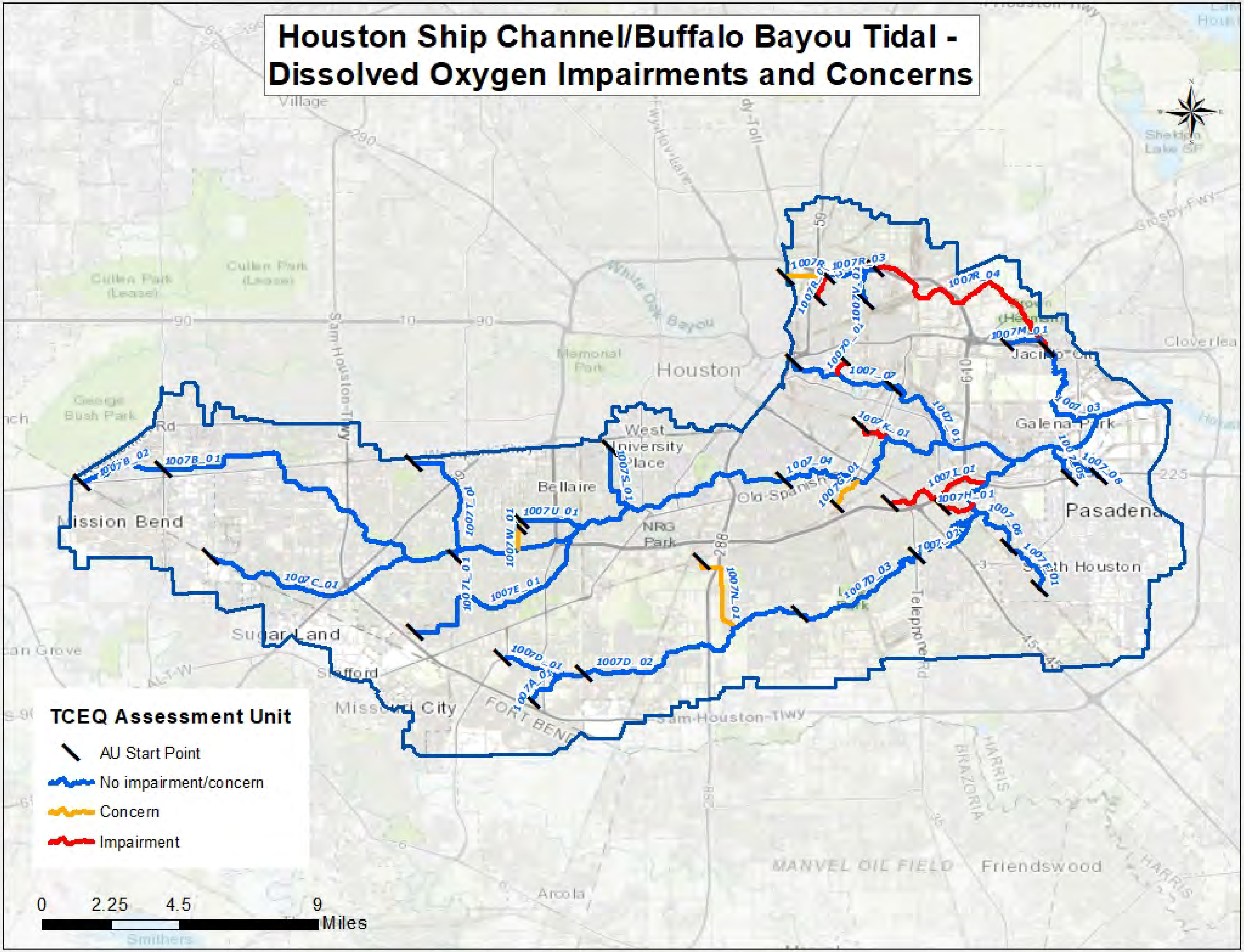
Toxicity in Sediment
Toxic substances in sediment were identified in assessment units 1007_05 of the Houston Ship Channel/Buffalo Bayou Tidal segment.

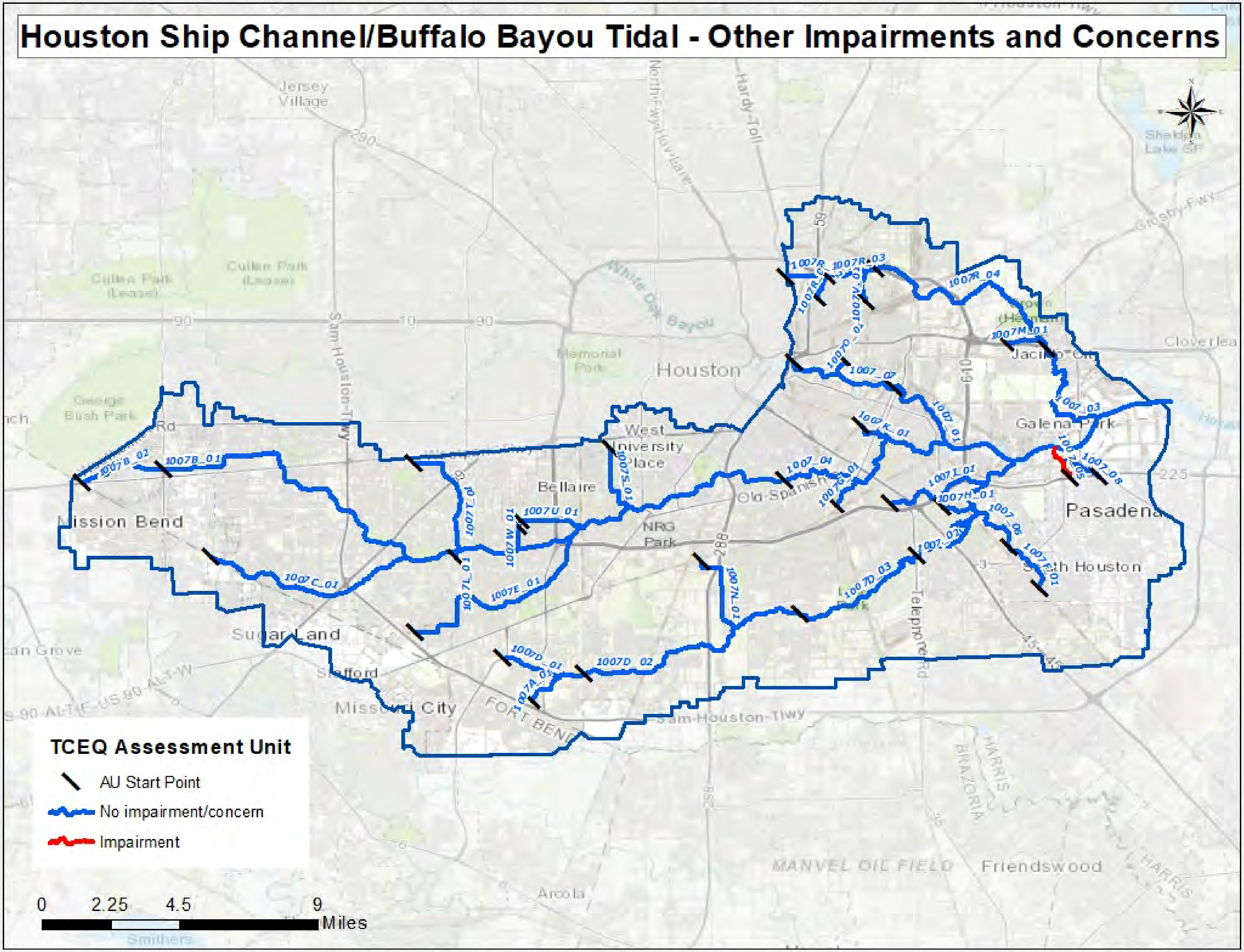


Houston Ship Channel/Buffalo Bayou Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
2.25
4.5
9
Miles
1007B_02
1007C_01
1007T_01
1007W_01
1007U_01
1007E_01
1007S_01
1007D_01
1007D_02
1007A_01
1007N_01
1007D_03
1007_02
1007_04
1007G_01
1007K_01
1007_07
1007_01
1007R_01
1007R_03
1007R_04
1007V_01
1007M_01
1007_03
1007_05
1007_08
1007I_01
1007H_01
1007_06
1007F_01
Mission Bend
Sugar Land
Stafford
Missouri City
Bellaire
West University Place
NRG Park
Houston
Galena Park
Pasadena
South Houston
Friendswood
Arcola
MANVEL OIL FIELD
Memorial Park
George Bush Park
Cullen Park (Lease)
White Oak Bayou
Sam Houston Tlwy
Old Spanish
Telephone Rd

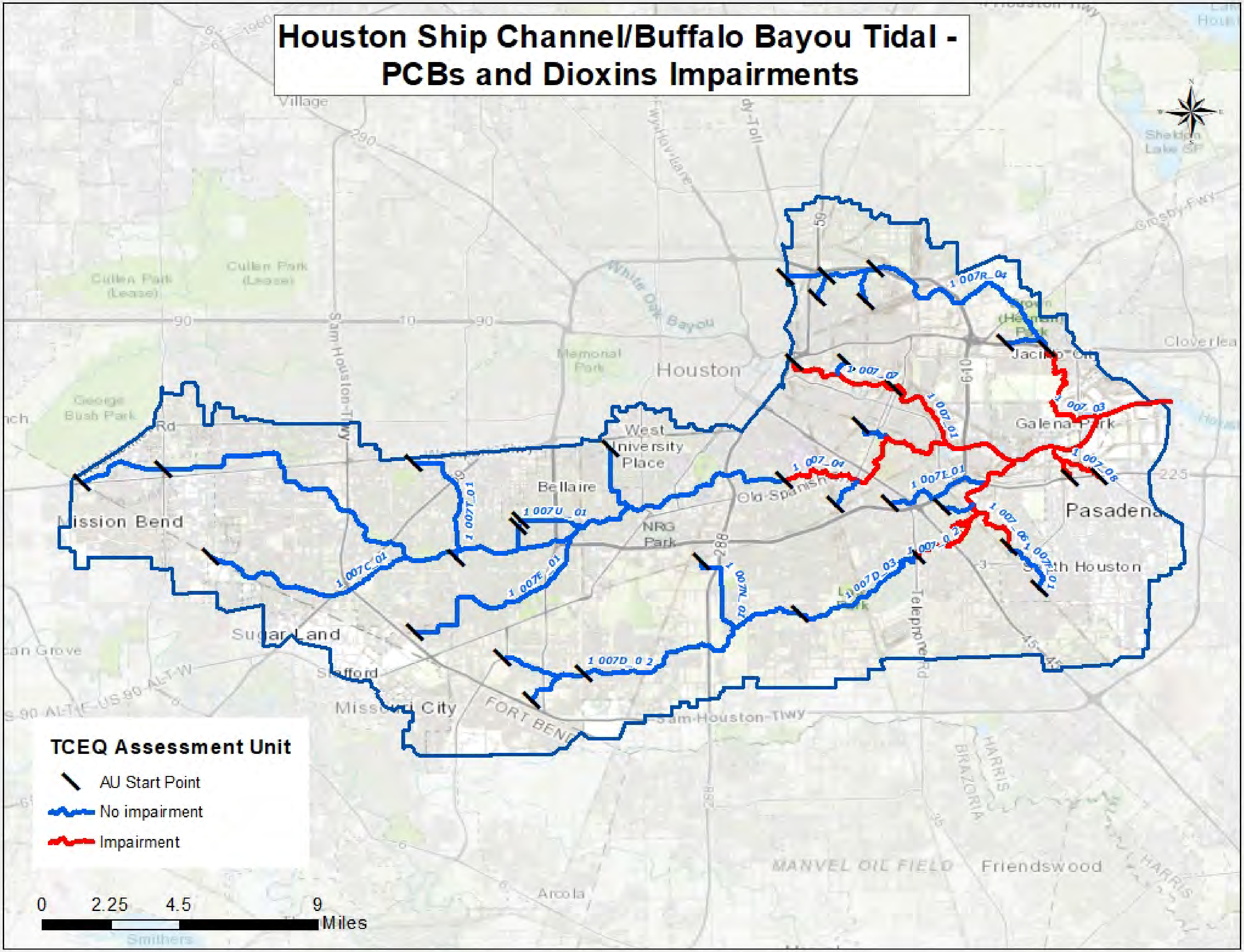


Houston Ship Channel/Buffalo Bayou Tidal -
Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
2.25
4.5
9
Miles
1007B_01
1007B_02
1007C_01
1007T_01
1007L_01
1007W_01
1007U_01
1007E_01
1007S_01
1007D_01
1007D_02
1007A_01
1007N_01
1007D_03
1007_04
1007G_01
1007K_01
1007_07
1007O_01
1007R_03
1007R_04
1007M_01
1007_01
1007_03
1007_05
1007_08
1007I_01
1007H_01
1007_06
1007F_01
Houston
Mission Bend
Sugar Land
Stafford
Missouri City
Bellaire
West University Place
NRG Park
Galena Park
Pasadena
Friendswood
Arcola
MANVEL OIL FIELD
Memorial Park
George Bush Park
Cullen Park (Lease)
Sam Houston Tlwy


Houston Ship Channel/Buffalo Bayou Tidal -
Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0
2.25
4.5
9
Miles
Houston
Mission Bend
Sugar Land
Stafford
Missouri City
Bellaire
West University Place
NRG Park
Galena Park
Pasadena
Memorial Park
George Bush Park
Cullen Park (Lease)
White Oak Bayou
Old Spanish
Friendswood
Arcola
MANVEL OIL FIELD
Cloverleaf
Sheldon Lake SP
Sam Houston Tlwy
FORT BEND
BRAZORIA
HARRIS
1007B_01
1007B_02
1007C_01
1007D_01
1007D_02
1007D_03
1007E_01
1007F_01
1007G_01
1007H_01
1007I_01
1007K_01
1007L_01
1007M_01
1007N_01
1007O_01
1007R_03
1007R_04
1007S_01
1007T_01
1007U_01
1007V_01
1007W_01
1007A_01
1007_01
1007_03
1007_04
1007_05
1007_06
1007_07
1007_08



Houston Ship Channel/Buffalo Bayou Tidal - Other Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0 2.25 4.5 9 Miles


Houston Ship Channel/Buffalo Bayou Tidal -
PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
0
2.25
4.5
9
Miles
Houston
Pasadena
Mission Bend
Sugar Land
Missouri City
Stafford
Bellaire
West University Place
Galena Park
South Houston
Friendswood
Arcola
MANVEL OIL FIELD
NRG Park
Memorial Park
Cullen Park (Lease)
George Bush Park
Sheldon Lake SP
Cloverleaf
1007R_04
1007_07
1007_01
1007_03
1007_04
1007I_01
1007_08
1007_06
1007_02
1007D_03
1007N_01
1007D_02
1007C_01
1007E_01
1007U_01
1007T_01

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Houston Ship Channel/Buffalo Bayou Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal/pet waste.

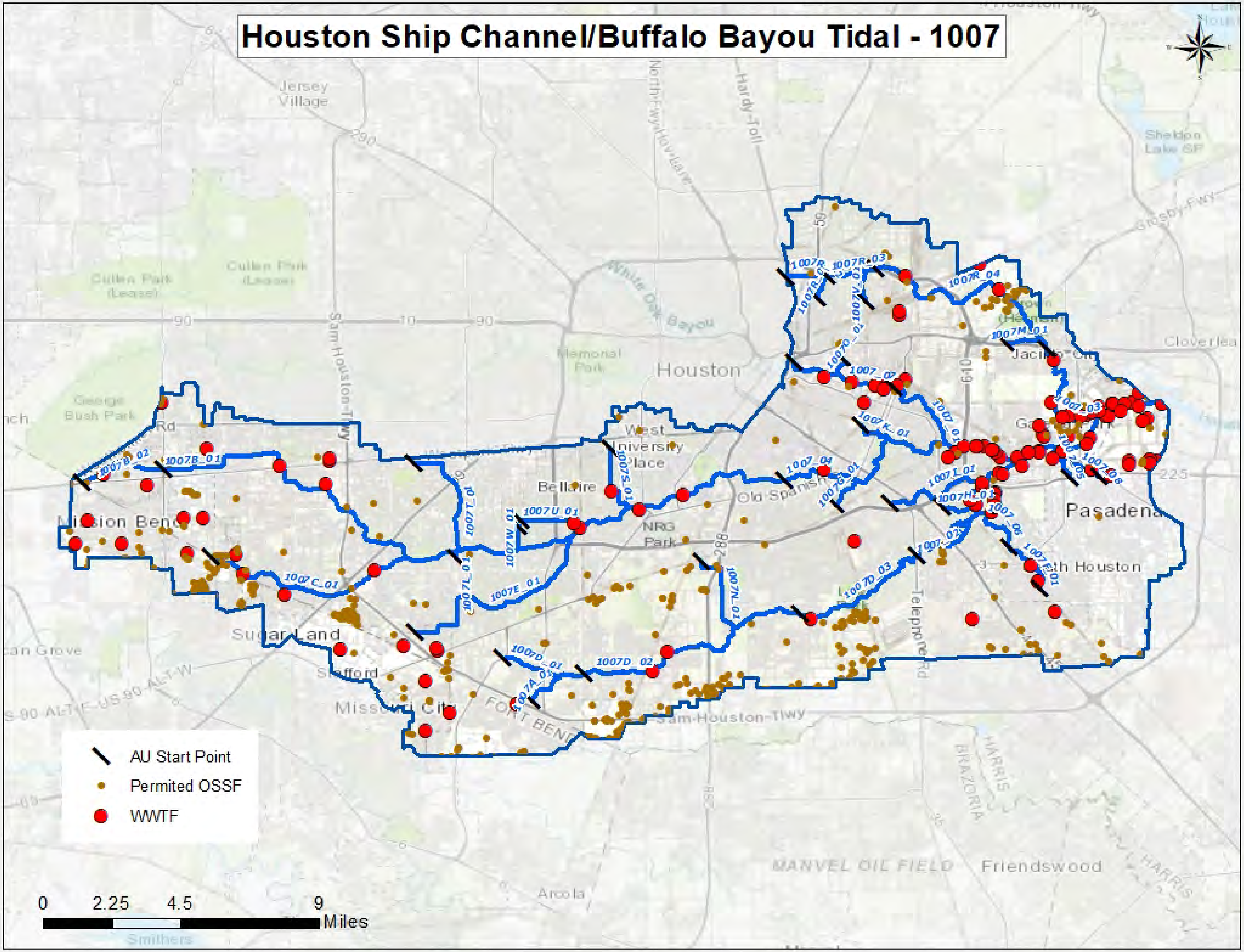
There are 17 permitted wastewater outfalls and 483 permitted on-site sewage facilities in the Houston Ship Channel/Buffalo Bayou Tidal watershed. The wastewater treatment facilities and on-site sewage facilities in the watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 5,060 sanitary sewer overflows reported in the sewer collection systems. These sanitary sewer overflows may contribute to the chronically high bacteria within this waterway. Discrete events may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

Toxicity in sediment is likely the result of unknown industrial or urban sources. These substances are legacy pollutants that persist in the environment, particularly in soils and sediments.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Houston Ship Channel/Buffalo Bayou Tidal watershed.


Houston Ship Channel/Buffalo Bayou Tidal - 1007
AU Start Point
Permited OSSF
WWTF
0
2.25
4.5
9
Miles

Trend Analysis:

Analysis of watershed data from 2005 to 2020 revealed trends for 12 parameters in the classified segments and a total of 15 parameters for the unclassified tributaries. The HSC/Buffalo Bayou Tidal watershed has a bacteria impairment and a concern for nutrients present for the majority of the classified and unclassified tributaries within its boundaries. Enterococci are the indicator bacteria in the AUs in the classified portion of the water body while *E. coli* is the indicator bacteria for the above tidal tributaries. In three of eight AUs that make up the classified segment 1007, ammonia, nitrate, total phosphorus, chloride, DO, chlorophyll *a*, enterococci, pH, specific conductance, and sulfate are showing improvement with concentrations decreasing. While enterococci, nitrate, and total phosphorus were found to be trending towards poorer water quality.

The Secchi transparency and TSS are both improving which means the trends are going down or decreasing. However, there is an inverse relationship between these two parameters. Where sediment loads are increasing, the Secchi transparency depths decrease. Decreasing trends are typically categorized as 'improving' trends, as seen in the graph legend, but the water is actually getting more turbid. Likewise, TSS graphs showing an upward trend confirms the sediment load is increasing. Secchi transparency depths are only increasing in 1007D, 1007L, and 1007S AUs.

In the unclassified segments, 1007A (Harris County's Canal C-147 - a tributary of Sims Bayou Above Tidal) shows improving trends in chloride, DO, specific conductance, and TKN with all other parameters being stable.

Brays Bayou Above Tidal (1007B) shows ammonia, TKN, DO, and *E. coli* concentrations improving, and Secchi transparency depths decreasing while nitrate and total phosphorus concentrations are increasing or deteriorating in water quality. Also, pH is increasing very slightly in 1007B_01 but still acceptable with all measurements being greater than 7.0 standard units but less than 9.5 standard units. There is a slight downward trend in the instantaneous flow graph for 1007B_01 due to fewer extreme measurements collected over time. It is possible the Harris County Flood Control District waterway management projects have been helpful in eliminating some of the extreme peaks in the hydrograph.

Keegans Bayou Above Tidal (1007C) shows only one trend. While pH is decreasing slightly with the average going from approximately 7.2 to 8.2 standard units, more than 90 percent of all pH measurements in that unclassified water body fell between 7.4 and 7.9 standard units. Only a few measurements fell outside of that range so the trend is no a concern for the AU.

Sims Bayou Above Tidal (1007D) shows trends in 13 parameters. This unclassified segment has three AUs and all have 8 or more parameters showing trends. AU1007D has only two bacteria trends – 1007D_01 has an increasing trend and the other 1007D_02 is decreasing. Ammonia, TKN, and sulfate concentrations are decreasing in all three AUs, while chloride is decreasing in two of the three AUs. Nitrate and total phosphorus are also trending up in two of the three AUs.

Willow Waterhole Bayou Above Tidal (1007E) shows trends decreasing for TKN, chloride, and Secchi transparency, while TSS concentrations are showing an increase. In Berry Bayou Above Tidal (1007F), ammonia and DO appear to be improving or decreasing while sulfate concentrations are increasing.

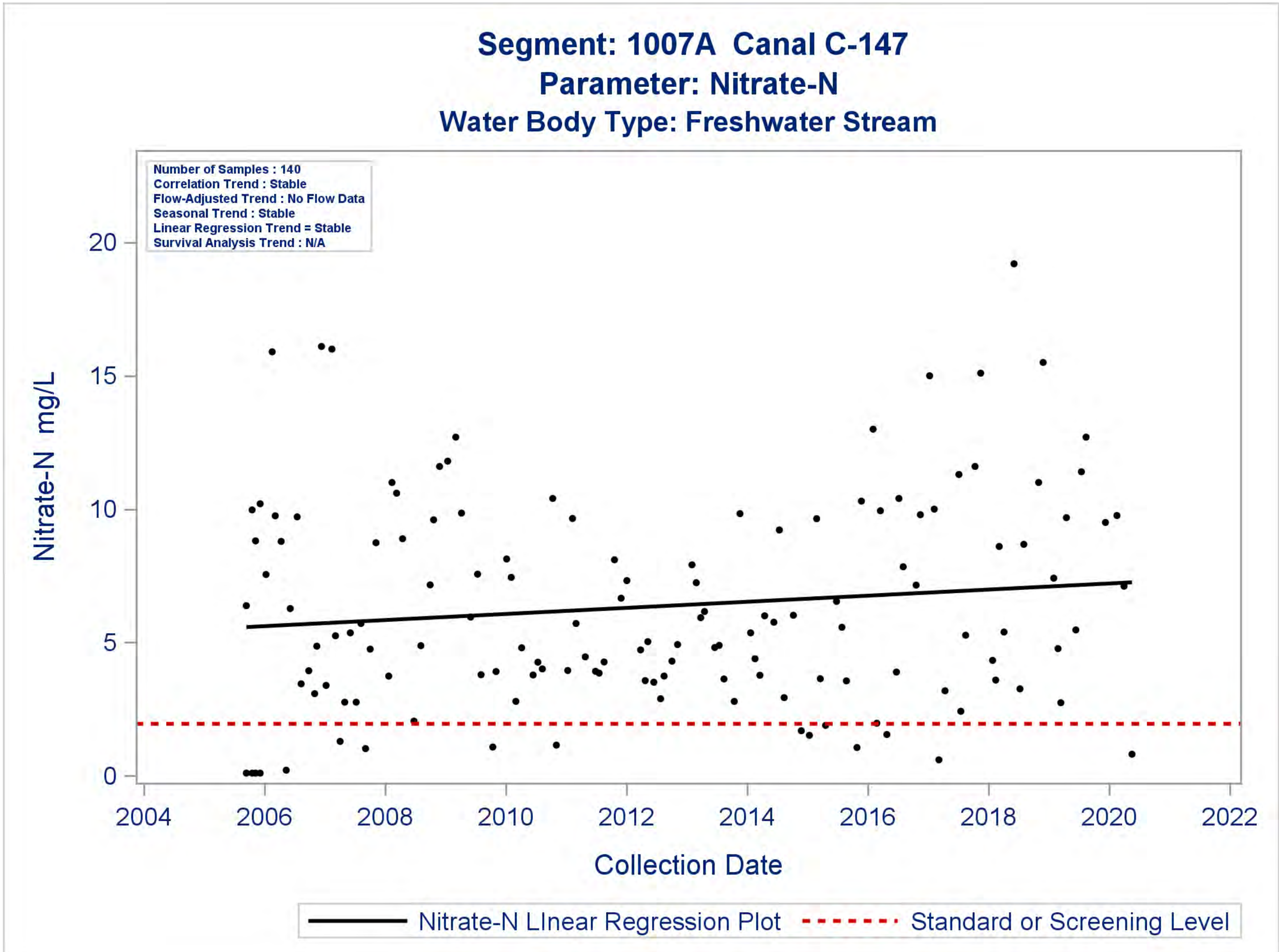
All trends in Kuhlman Gully Above Tidal (1008G) are improving with nitrate being the most significant. Nitrate is also improving in Pine Gully Above Tidal (1008H).

In Plum Creek Above Tidal (1007I) and Country Club Bayou Above Tidal (1007K), the DO concentration is trending down whereas in Sims Bayou Above Tidal (1007D), Unnamed Non-Tidal Tributary of Hunting Bayou (1007M), Unnamed Non-Tidal Tributary of Sims Bayou (1007N), Poor Farm Ditch (1007S), and another Unnamed Tributary of Hunting Bayou (1007V) show DO concentrations improving or increasing over time.

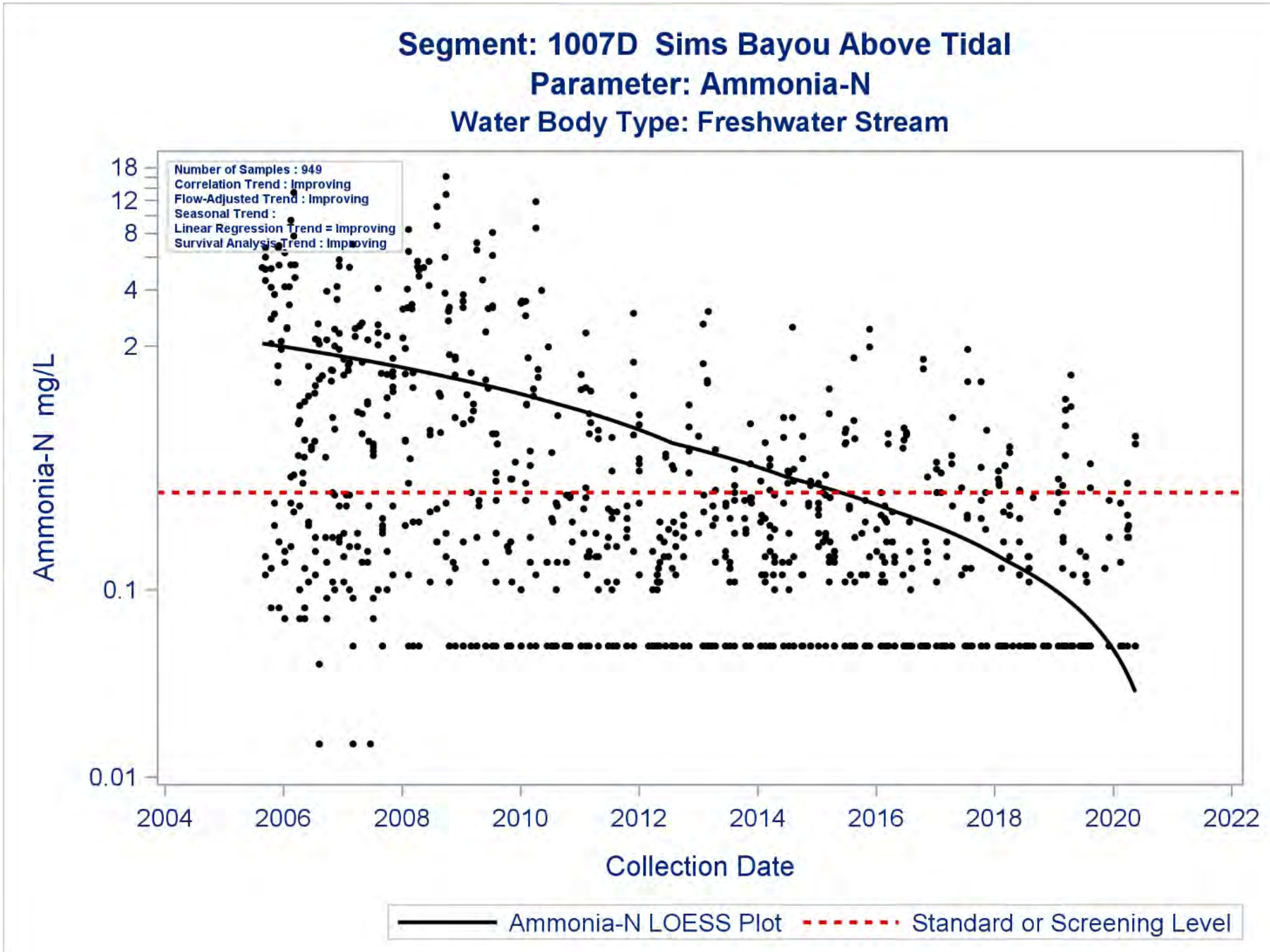
Nitrate concentrations are decreasing in 1007G, 1007H, 1007K, 1007T and 1007V but increasing in AUs 1007B, 1007D, and 1007S. TKN is either stable or improving as in 1007A, 1007B, 1007D, 1007E, 1007K, 1007L, 1007M, 1007R, and 1007T. Increasing total phosphorus trends are seen in several segments, including 1007I, 1007S, and 1007R.

Chlorophyll *a* is collected 'on segment' only. There is a slightly improving trend for chlorophyll *a* levels or decreasing over time. Ammonia concentrations is either stable or consistently improving with downward trends in eight of the 19 unclassified segments. They include 1007B, 1007D, 1007F, 1007K, 1007L, 1007O, 1007S, and 1007V. An increasing ammonia trend is observed in 1007R. DO concentrations are improving or stable in all unclassified segments except for 1007I and 1007K.

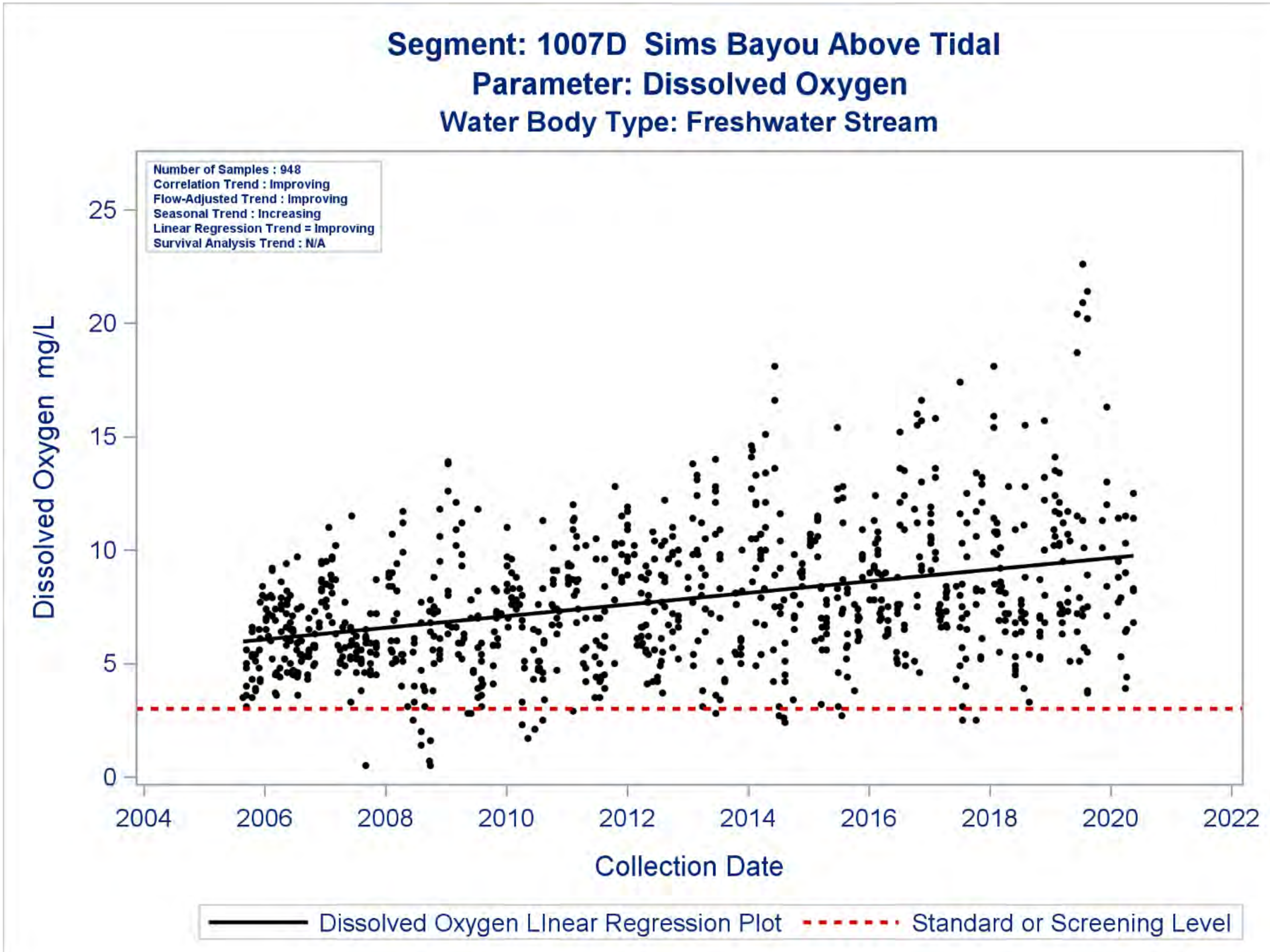
Bacteria continues to be problem throughout the segment with only a few AUs showing improving or decreasing trends. Unfortunately, there are still two AUs indicating a slightly increasing trend for *E. coli* (1007D and 1007R) and one AU (1007_05) indicating an increasing trend in enterococci. Non-point source runoff from pet waste, hobby farms, and SSOs or wastewater treatment facility discharges are the main sources of the pollutant of concern - bacteria. While, sources of nutrients include urban lawn fertilizers, construction sites, hobby farms, as well as illegal discharges or poor effluents from WWTFs and OSSFs.



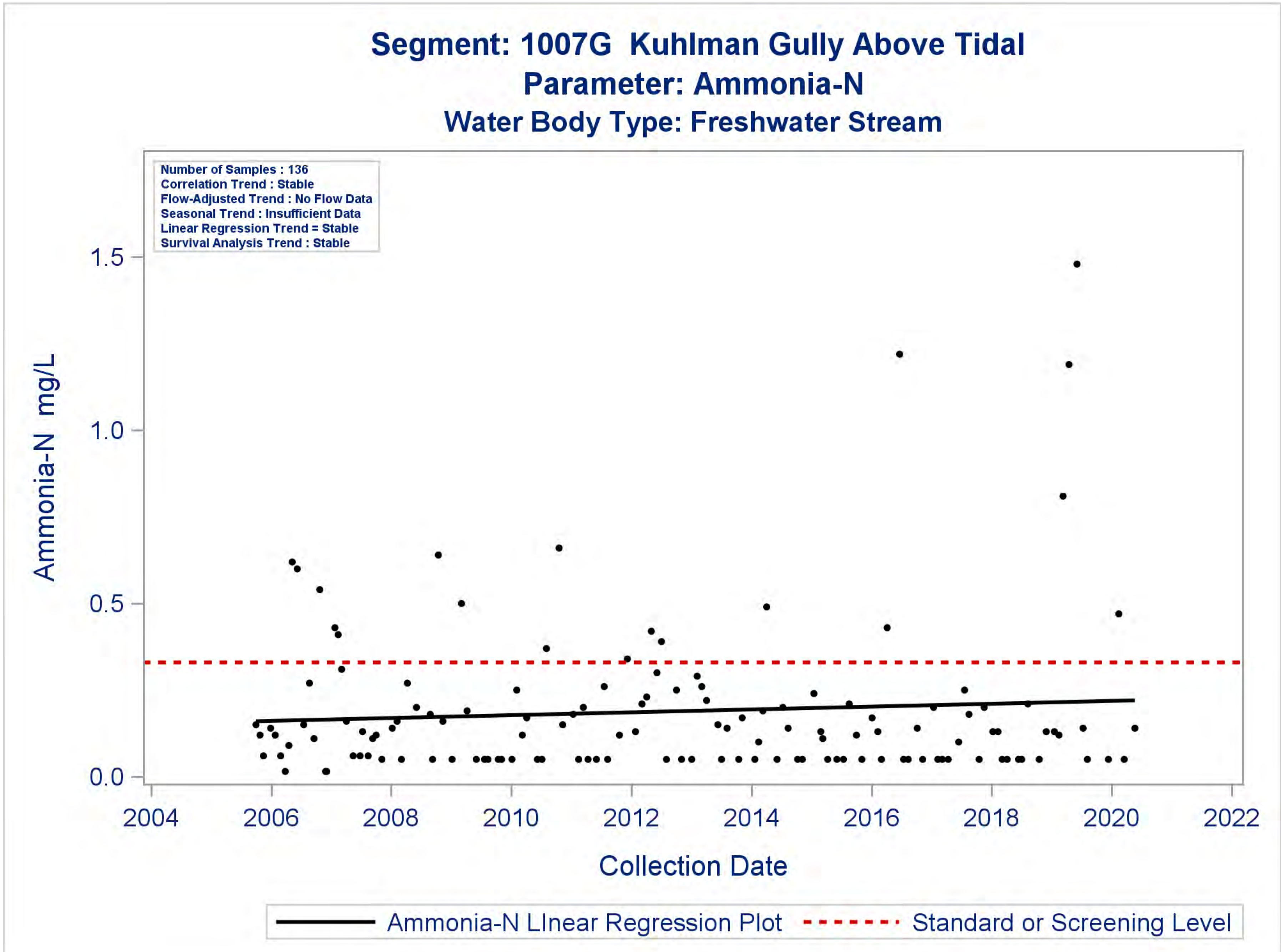
Segment: 1007A Canal C-147
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 140
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Nitrate-N mg/L
0
5
10
15
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level



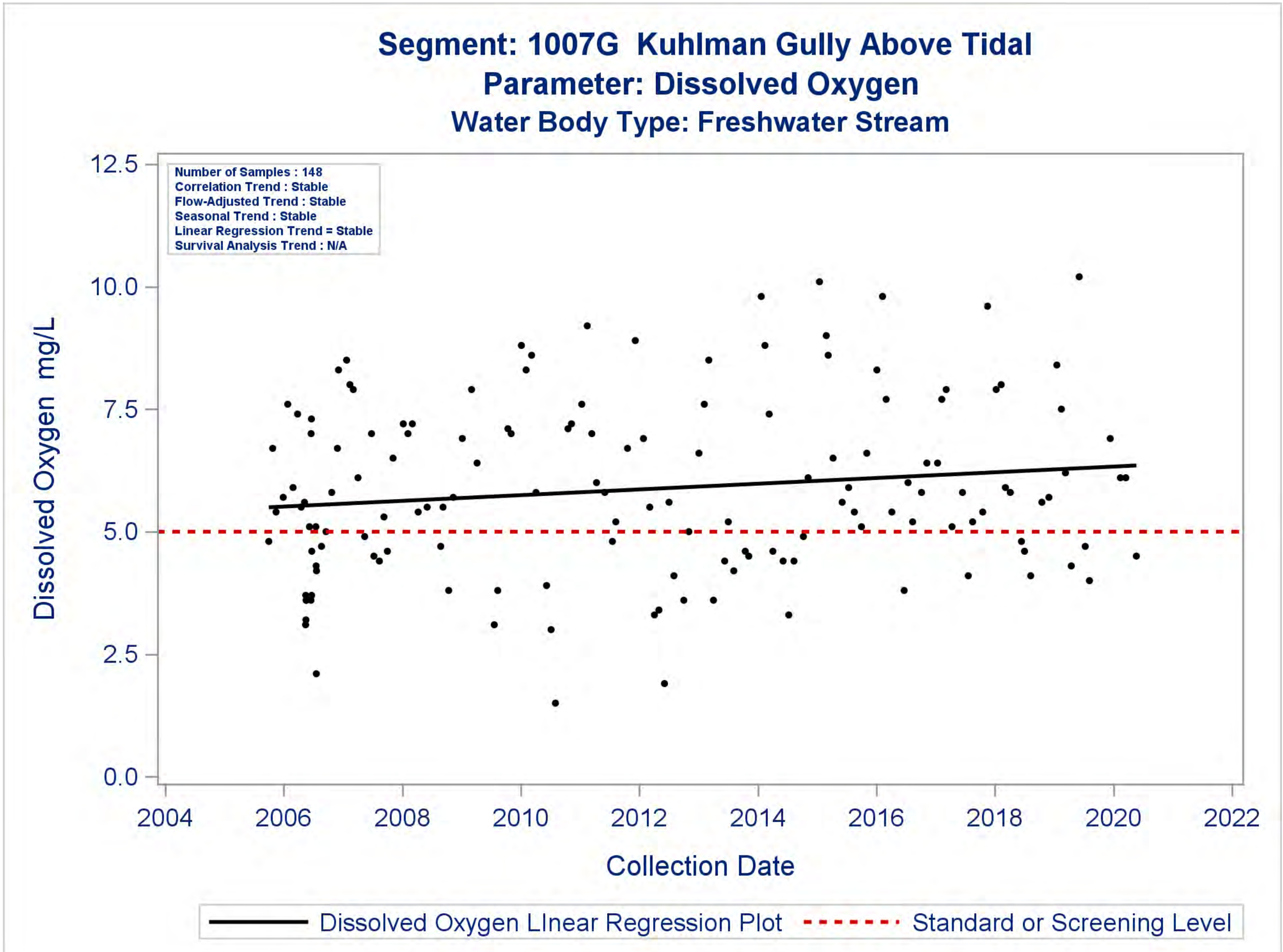
Segment: 1007D Sims Bayou Above Tidal
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 949
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend :
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
18
12
8
4
2
0.1
0.01
Ammonia-N mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level

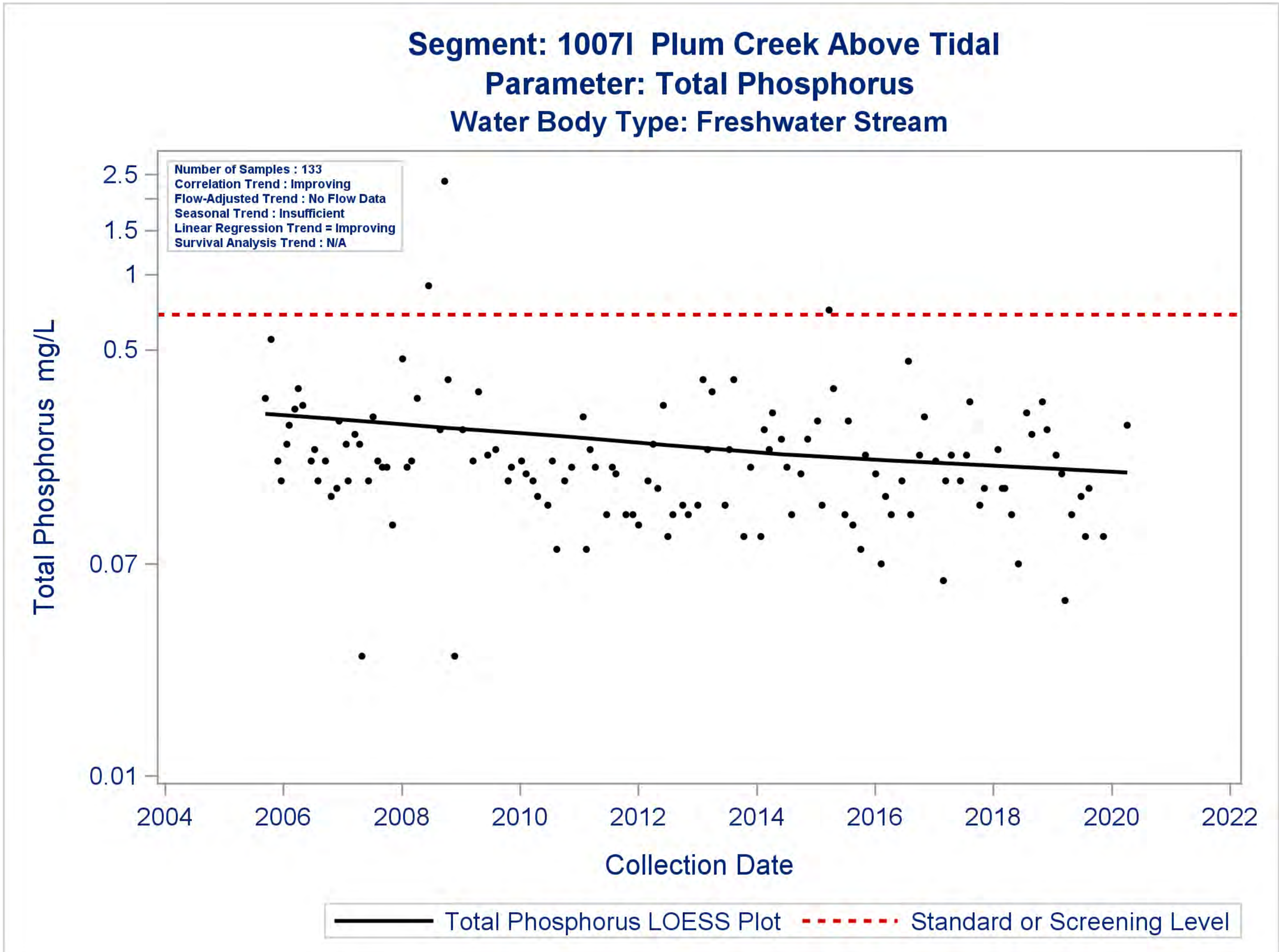


Segment: 1007D Sims Bayou Above Tidal
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 948
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
20
25
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level

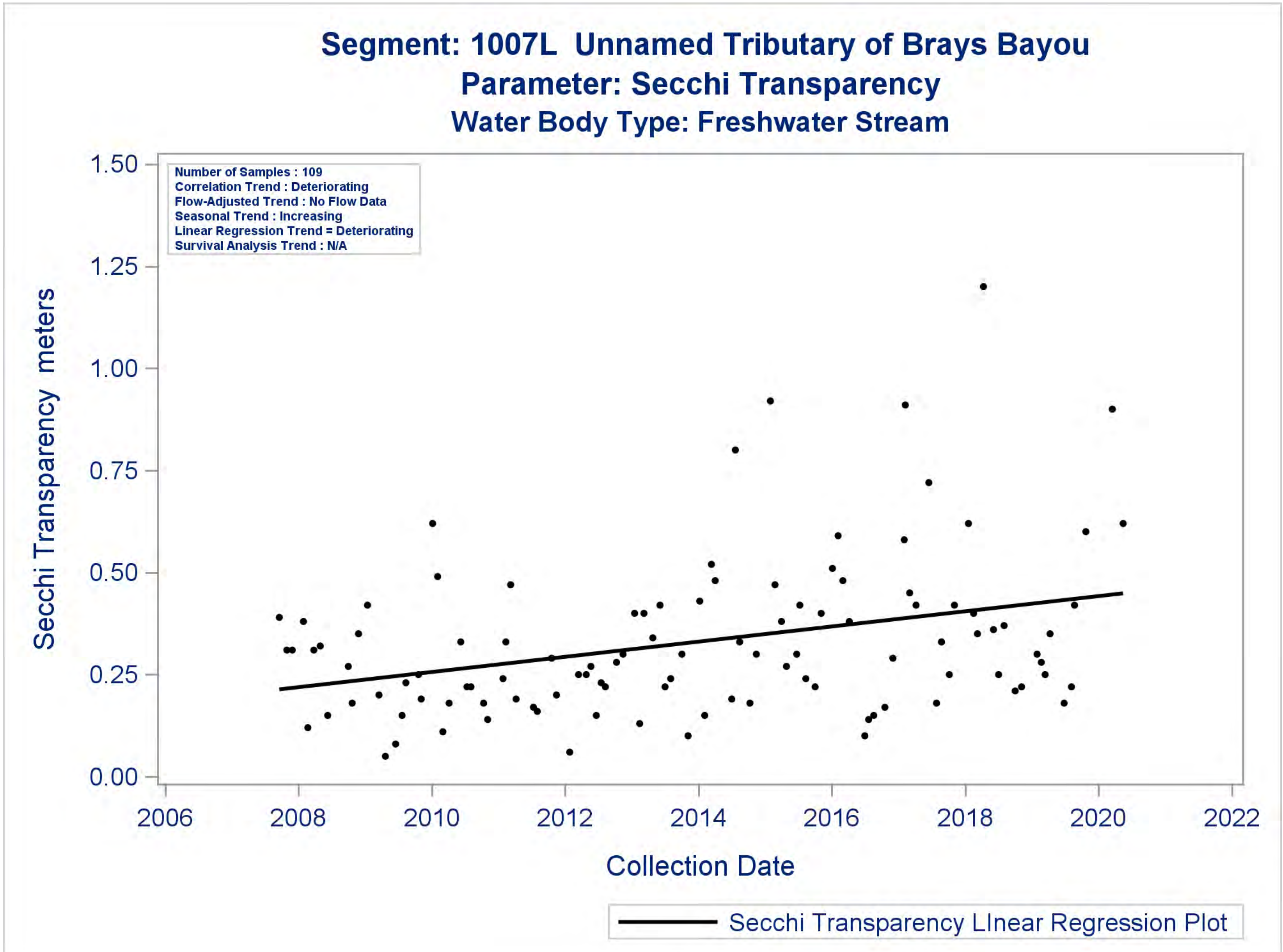


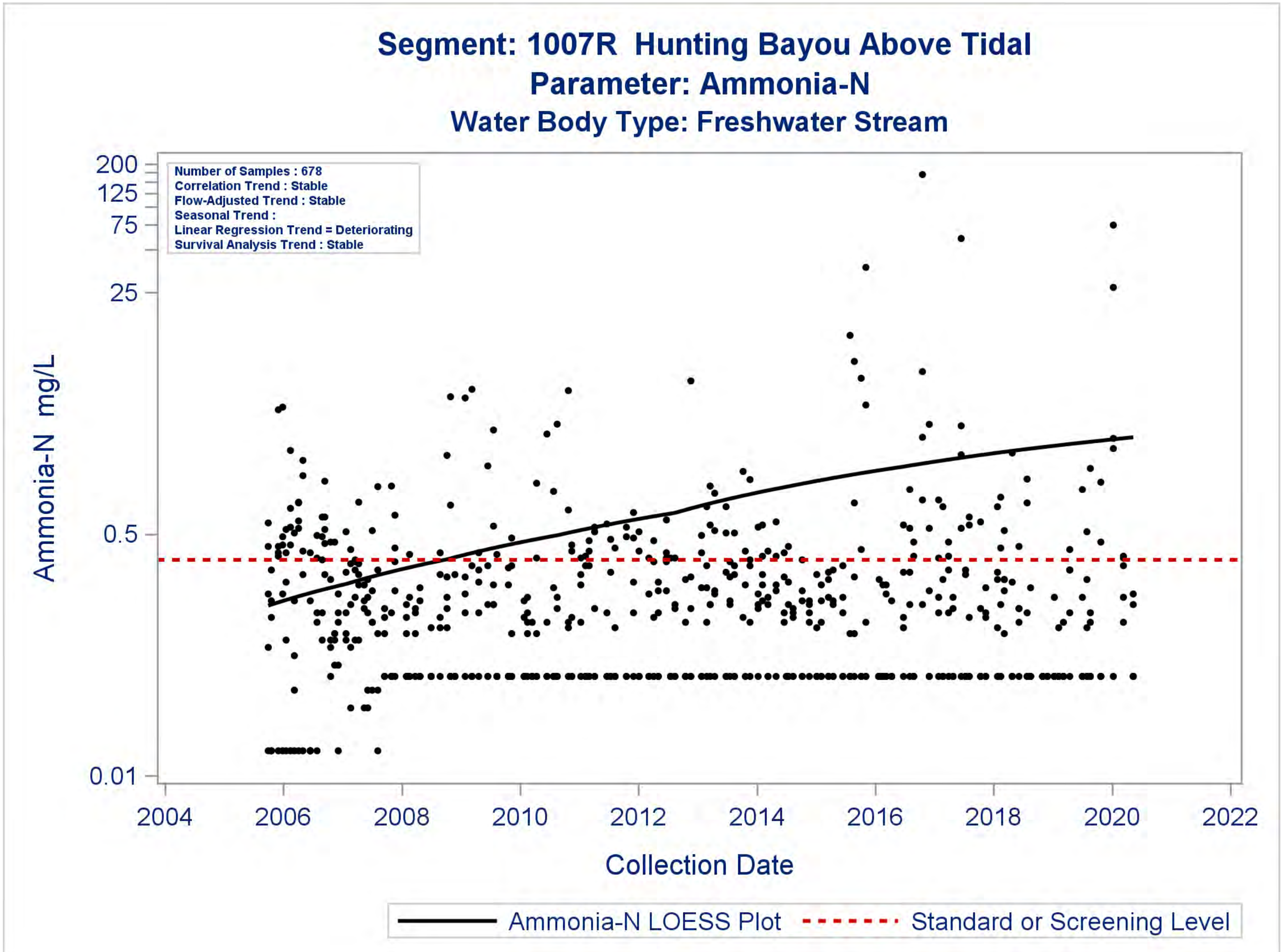
Segment: 1007G Kuhlman Gully Above Tidal
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 136
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Ammonia-N mg/L
0.0
0.5
1.0
1.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level


Segment: 1007G Kuhlman Gully Above Tidal
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 148
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
12.5
10.0
7.5
5.0
2.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level

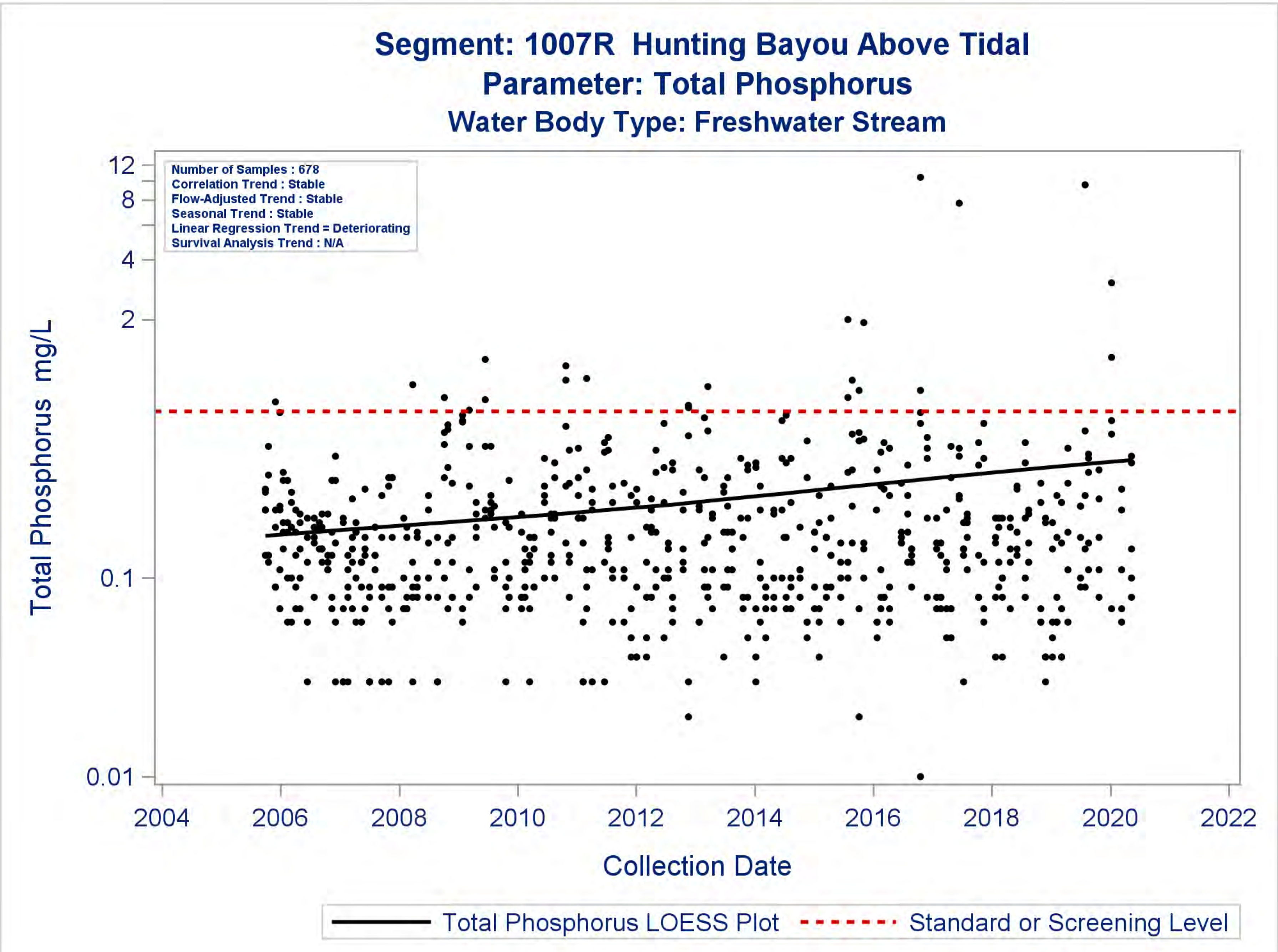


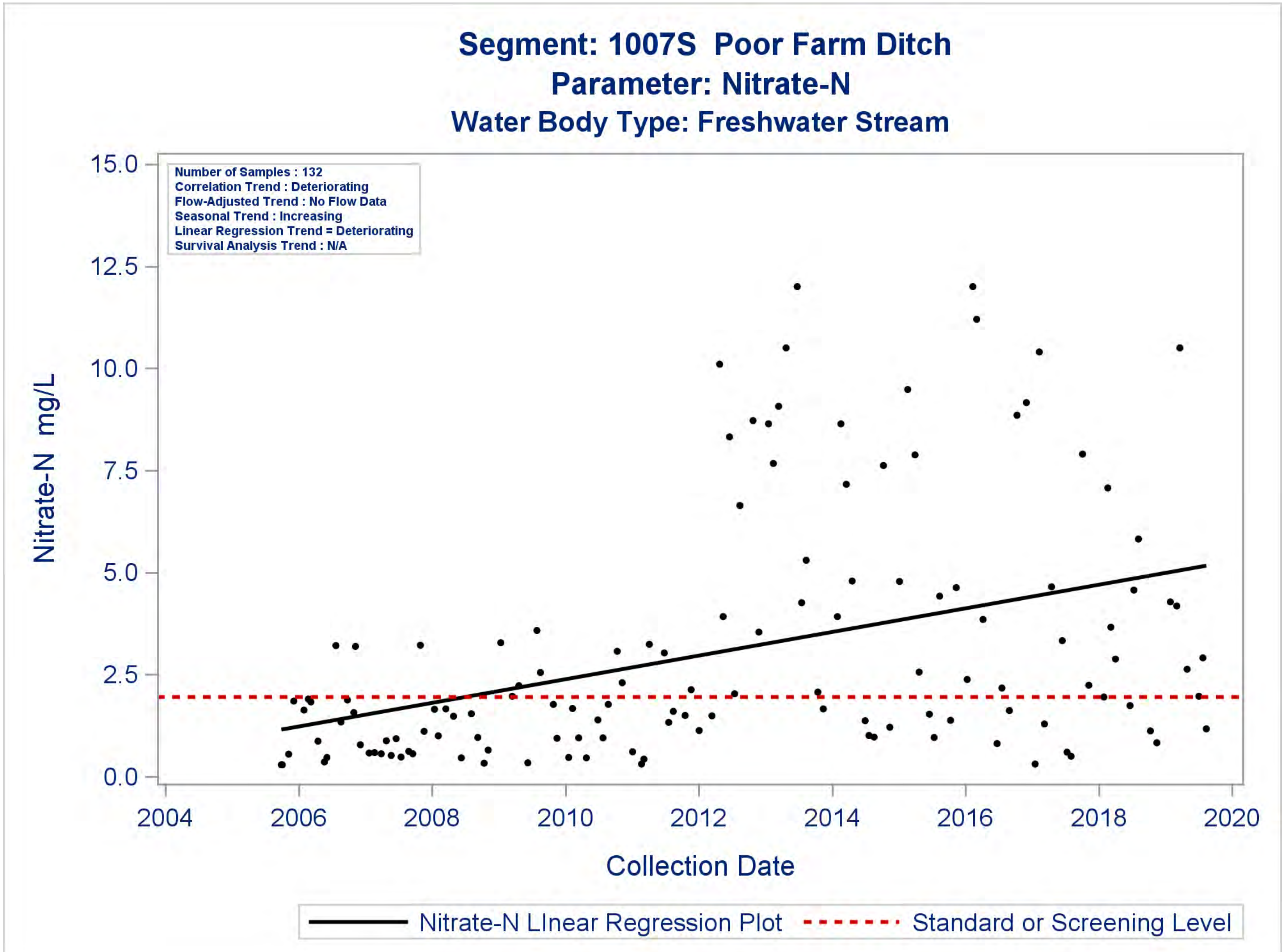
Segment: 1007I Plum Creek Above Tidal
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 133
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
2.5
1.5
1
0.5
0.07
0.01
Total Phosphorus mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

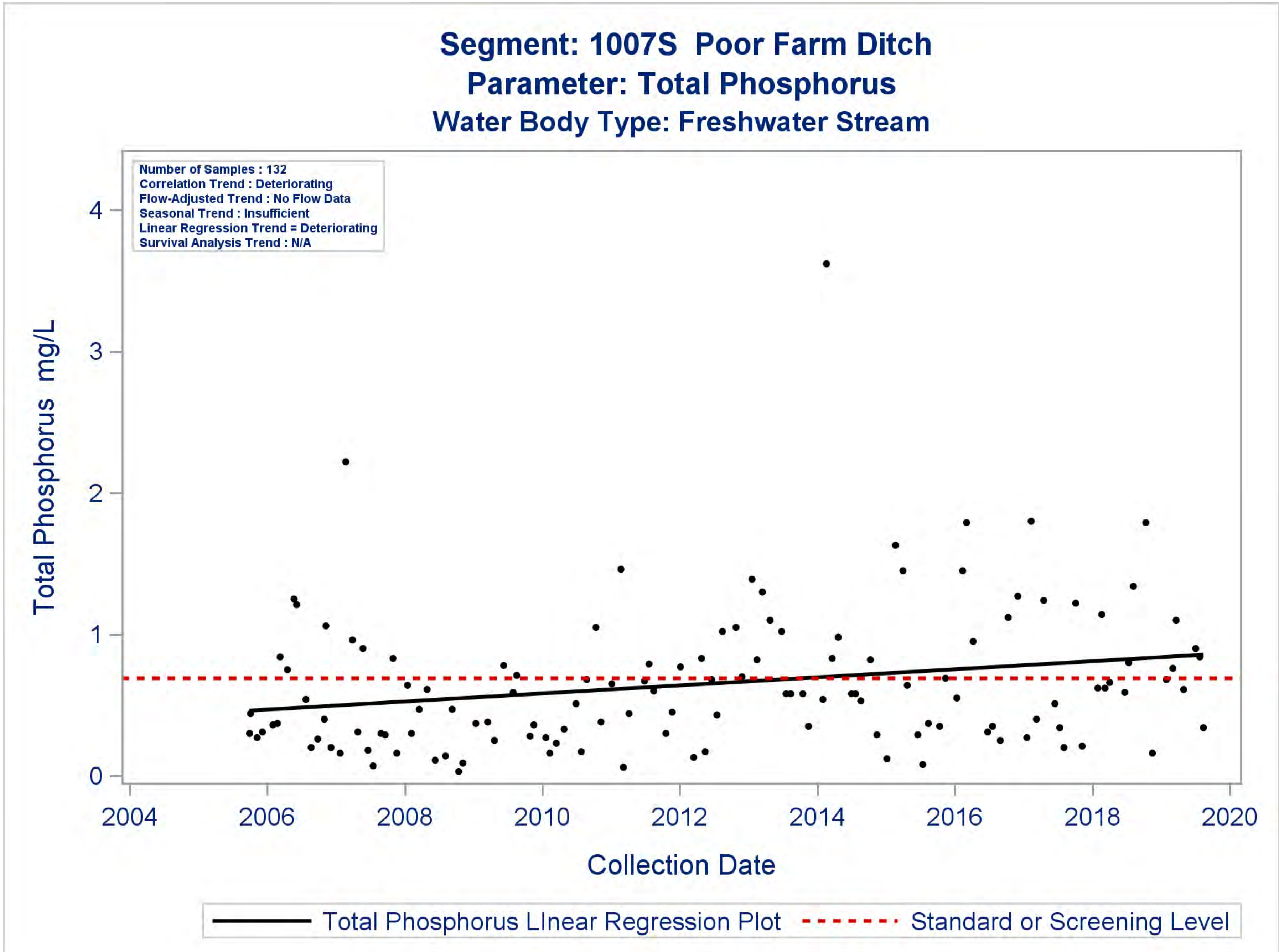

Segment: 1007L Unnamed Tributary of Brays Bayou
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 109
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Secchi Transparency meters
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot



Segment: 1007R Hunting Bayou Above Tidal
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 678
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend :
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Stable
Ammonia-N mg/L
200
125
75
25
0.5
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level


Segment: 1007R Hunting Bayou Above Tidal
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 678
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
12
8
4
2
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


Segment: 1007S Poor Farm Ditch
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 132
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
15.0
12.5
10.0
7.5
5.0
2.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level


Segment: 1007S Poor Farm Ditch
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 132
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
1
2
3
4
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1007_05 I 1007A I 1007B I 1007C I 1007D I 1007E I 1007F I 1007G I 1007H I 1007I I 1007K I 1007L I 1007M I 1007N I 1007O I 1007R I 1007S I 1007T I 1007U I 1007V I 1007W I	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Constructed stormwater controls failing • Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Direct and dry weather discharges • Improper or no pet waste disposal • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Improve compliance and enforcement of existing stormwater quality permits • Improve storm water controls in new developments by adding bacteria reduction measures • Improve construction oversight to minimize TSS discharges to waterways • More public education on pet waste disposal • Promote and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing and alternative water supplies to keep livestock out of or away from waterways
Low Dissolved Oxygen Concentrations	***24-Hour Avg*** 1007I_01 I 1007K_01 C 1007O_01 I 1007R_04 C ***24-Hour Min*** 1007R_04 I ***DO Grab Min*** 1007G C 1007H_01 I 1007K_01 I 1007R_01 I	• Excessive nutrients and organic matter from agricultural production, and related activities • Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) • Vegetative canopy removed • High temperature discharges from industrial WWTFs	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Improve compliance and enforcement of existing stormwater quality permits • Install and/or conserve riparian buffer areas along all waterways • Regionalize chronically non-compliant WWTFs • Improve operation and maintenance of existing WWTF and collection systems • More public education regarding disposal of household fats, oils, and grease

	DO Grab Screening Level 1007H_01 C 1007N_01 C 1007R_01 C 1007R_02 C 1007W_01 C			• Improved education about OSSF maintenance • More public education on pet waste disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating
Elevated Nutrient Concentrations	***Ammonia-N*** 1007 (all AUs except 1007_06) C 1007B C 1007D_02 C 1007D_03 C 1007F C 1007H C 1007I C 1007N C 1007R_01 C 1007W_01 C ***Nitrate-N*** 1007 (all AUs) C 1007A C 1007B C 1007C C 1007D C 1007F C 1007L C 1007R_03 C 1007R_04 C 1007S C ***Phosphorus*** 1007 (all AUs except 1007_02) C 1007A C 1007B C 1007C C 1007D C 1007F C 1007S C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Can increase algal production • Algal growth can affect dissolved oxygen concentrations • Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Dioxin/PCBs in Fish Tissue	1007 I	• Waste pit located along the San Jacinto River immediately upstream of	• The Texas DSHS has concluded that consuming fish from this water body	• Continue to monitor and assess to determine the impairment status

	(Entire Segment)	I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits
Toxicity in Sediment	1007_05 I	• Legacy pollutants in sediment • Unknown industrial or urban sources • Spills at industrial facilities • Dredging of the channel	• Detrimental to the aquatic biological community	• Continue to contain, remove, and monitor known contaminated sites • Additional data or information should be collected and/or evaluated

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 1005 Name: Houston Ship Channel / San Jacinto River

Length:	17 miles	**Watershed Area:**	17 square miles	**Designated Uses:**	Noncontact Recreation; High Aquatic Life
Number of Active Monitoring Stations:	6	**Texas Stream Team Monitoring Stations:**	1	**Permitted WWTF Outfalls:**	13

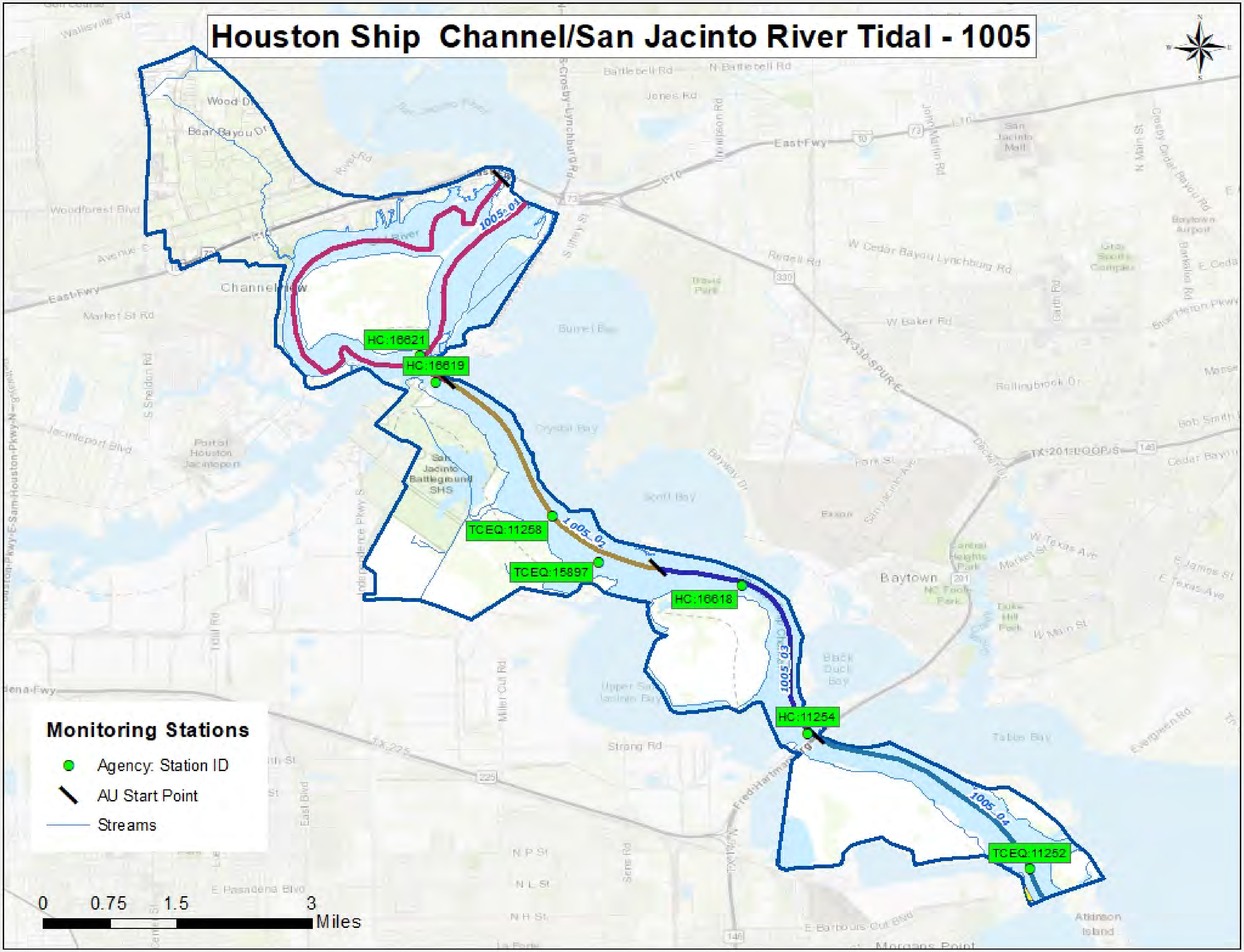
DESCRIPTION

- Segment 1005 (Tidal Stream): **Houston Ship Channel / San Jacinto River** (classified water body) – From the confluence with Galveston Bay at Morgan's Point in Harris/Chamber County to a point 100 meters (110 yards) downstream of Interstate Highway 10 in Harris County

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11252	1005	HOUSTON SHIP CHANNEL AT CM 91 MORGANS POINT 844 METERS NORTH AND 681 METERS EAST OF INTERSECTION OF VINSONIA ST AND BALLESTER	FO	ONCE/YEAR TWO/YEAR QUARTERLY	Metals in Sediment, Organics in Sediment Metals in Water Field, Conventional, Bacteria
11254	1005	HOUSTON SHIP CHANNEL AT BAYTOWN TUNNEL/CM 103 1.84 KM NORTH AND 1.17 KM EAST OF INTERSECTION OF SH 225 AND SH 146	HC	MONTHLY	Field, Conventional, Bacteria
11258	1005	HOUSTON SHIP CHANNEL AT CM 120 692 METERS SOUTH AND 699 METERS WEST OF INTERSECTION OF MAPLETOWN AVENUE AND BAYSHORE DRIVE	FO	QUARTERLY	Field, Conventional, Bacteria
16618	1005	HOUSTON SHIP CHANNEL W OF EXXON DOCKS AND N OF ALEXANDER ISLAND 316 M S AND 1.55 KM W OF INTERSECTION OF BAYWAY DR AND BAYTOWN AVE	HC	MONTHLY	Field, Conventional, Bacteria
16619	1005	HOUSTON SHIP CHANNEL AT LYNCHBURG FERRY INN SOUTH OF LYNCHBURG RD 658 M N AND 802 M E OF INTERSECTION OF BATTLEGROUND RD AND TIDAL RD	HC	MONTHLY	Field, Conventional, Bacteria
16621	1005	SAN JACINTO RIVER TIDAL AT CONFLUENCE WITH HSC 226 M S AND 1.07 KM W OF INTERSECTION OF S LYNCHBURG RD AND POQUENO RD IN HOUSTON	HC	MONTHLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HC = Harris County Pollution Control

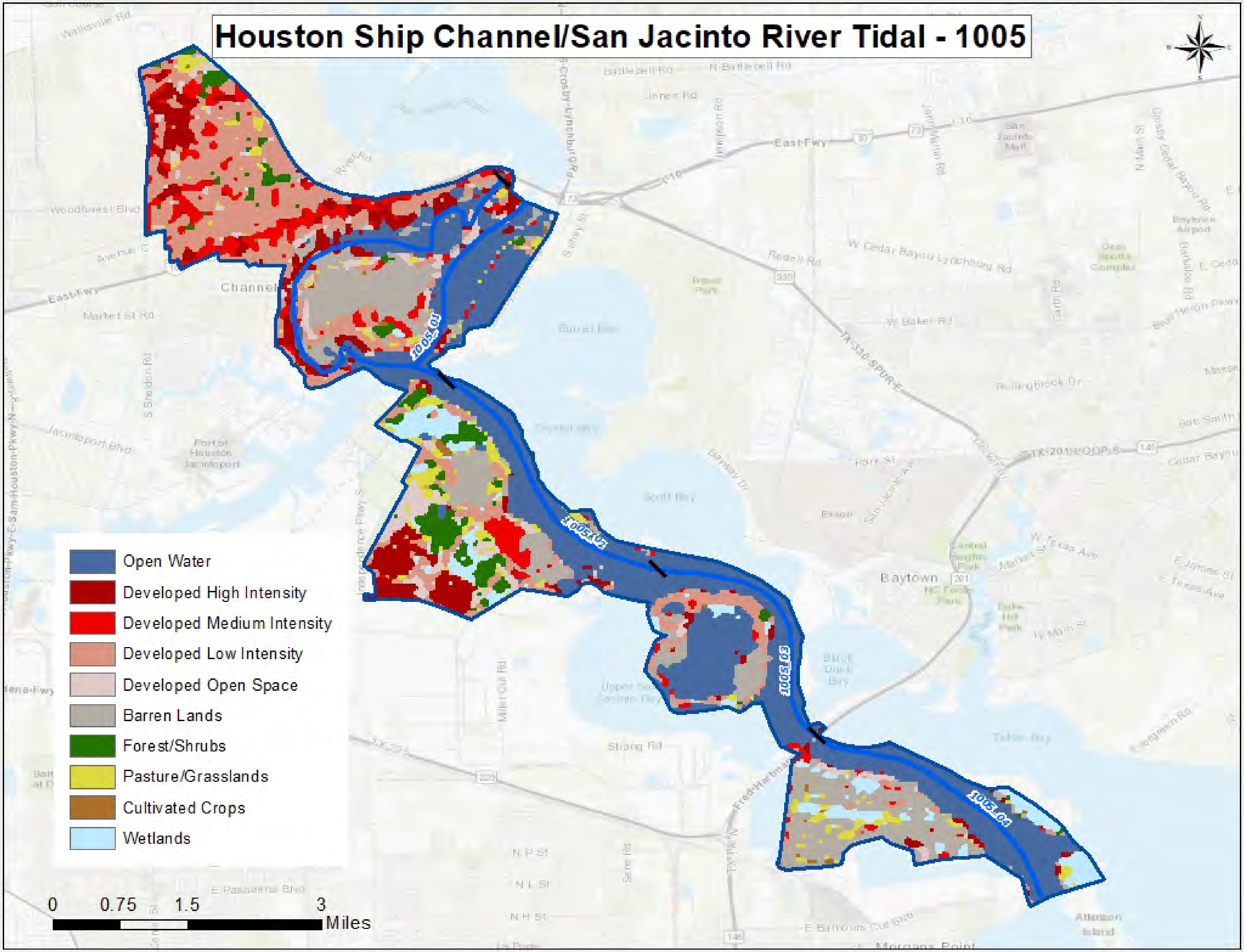

Houston Ship Channel/San Jacinto River Tidal - 1005
HC:16621
HC:16619
TCEQ:11258
TCEQ:15897
HC:16618
HC:11254
TCEQ:11252
1005_01
1005_02
1005_03
1005_04
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0
0.75
1.5
3
Miles

Segment 1005 Water Quality Standards and Screening Levels			
Standards	**Tidal Stream**	**Screening Levels**	**Tidal Stream**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.46
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.66
Enterococci (MPN/100mL) (grab):	104	Chlorophyll *a* (µg/L):	21
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Houston Ship Channel / San Jacinto River watershed (1005) spans from the confluence with Galveston Bay at Morgan's Point in Harris/Chamber County to a point 100 meters (110 yards) downstream of Interstate Highway 10 in Harris County. The watershed includes the cities of Baytown and Highlands and flows along the eastern shore of the cities of Channelview, Deer Park, and La Porte. Developed lands are the largest land cover category, at 37.63 percent of the watershed. The watershed is highly industrialized and also has a lot of residential and commercial development, especially along the shoreline. The Houston Ship Channel (HSC) supports heavy boat and barge traffic on a consistent basis. Bordering the HSC are several side bays which are classified as separate segments. These side bays include: Burnet Bay (2430), Scott Bay (2429), Upper & Lower San Jacinto Bay (2427), Black Duck Bay (2428), Tabbs Bay (2426), and Barbour's Cut (2436) serving Morgan's Point. Goose Creek, a fairly large unclassified water body, drains into Tabbs Bay. Open Water comprises 31.93 percent of the land cover. There are also large areas of barren land, comprising 16.29 percent of the land cover in 2018.

Segment 1005 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	769.48	7.11	539.97	4.98	-29.83
Barren Lands	508.17	4.69	1,764.47	16.29	247.22
Developed	2,463.01	22.75	4,076.70	37.63	65.52
Forest/Shrubs	275.10	2.54	419.21	3.87	52.38
Open Water	3,564.08	32.92	3,459.11	31.93	-2.95
Wetlands	3,246.95	29.99	573.55	5.29	-82.34
TOTAL	**10,826.78**	**100.00**	**10,833.01**	**100.00**	


Houston Ship Channel/San Jacinto River Tidal - 1005
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.75 1.5 3
Miles
1005_01
1005_02
1005_03
1005_04

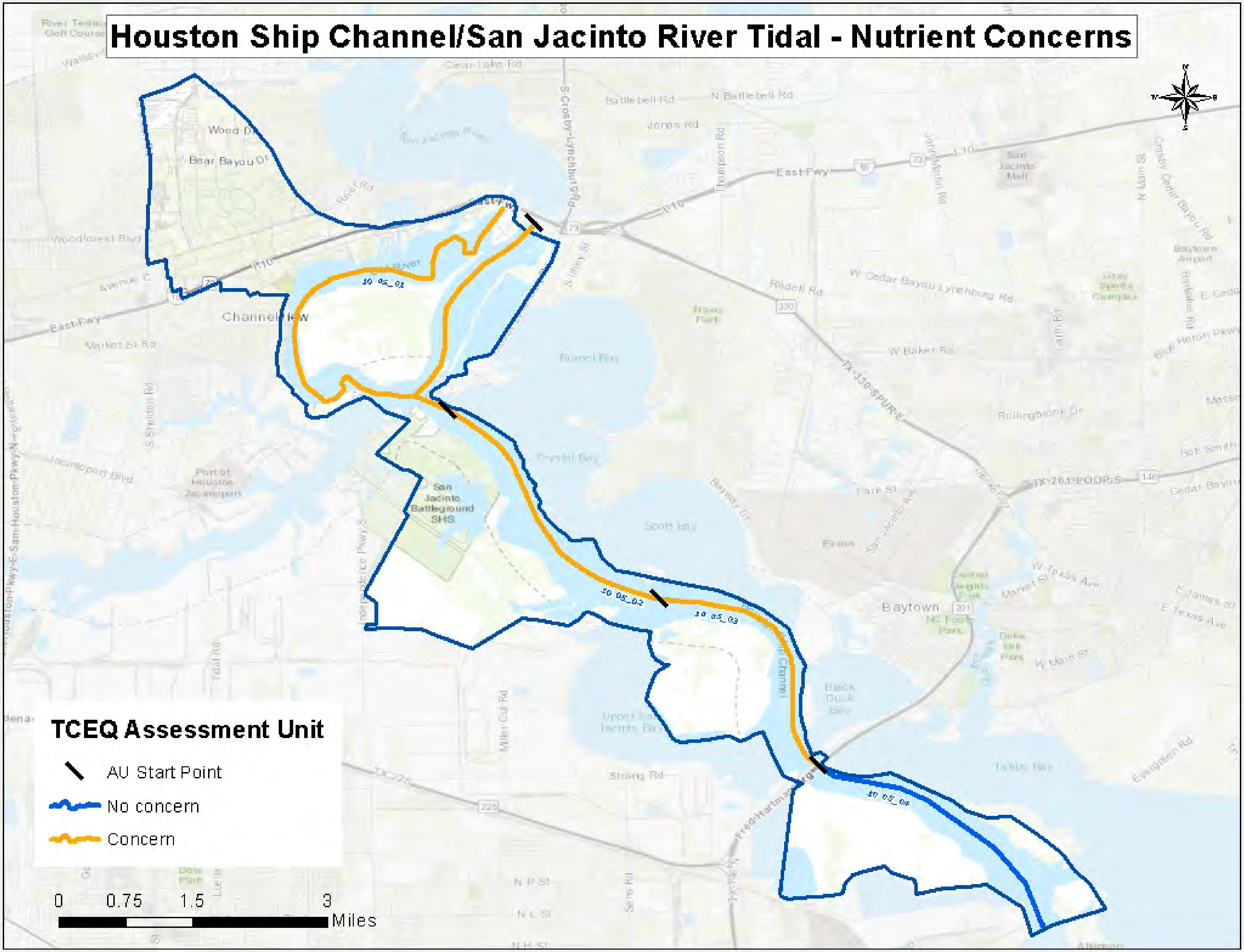
Water Quality Issues:

Bacteria Impairments and Concerns
There are no impairments or concerns for bacteria in the Houston Ship Channel/San Jacinto River Tidal segment.

Dissolved Oxygen Impairments and Concerns
There are no impairments or concerns for dissolved oxygen in the Houston Ship Channel/San Jacinto River Tidal segment.

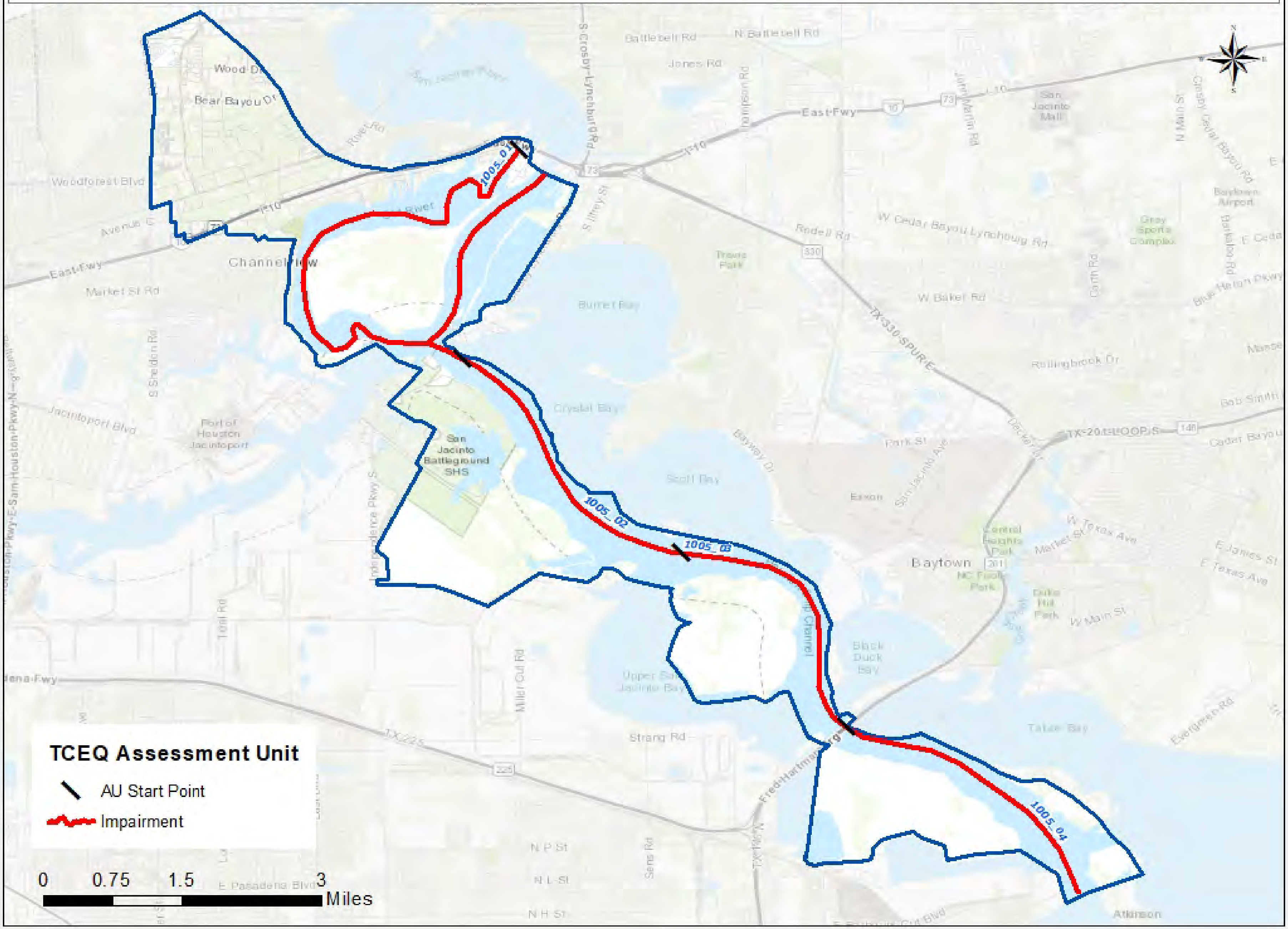
Nutrient Concerns
There are concerns for nitrate screening levels in three of four of the Houston Ship Channel/San Jacinto River Tidal segment's assessment units (1005_01, 1005_02, and 1005_03).

PCBs and Dioxin Impairments
The primary impairments in the Houston Ship Channel/San Jacinto River Tidal segment are dioxin and PCB in the edible tissue of fish. Due to the elevated levels of dioxin and PCBs, the Texas Department of State Health Services issued a Limited Consumption Fish and Shellfish Advisory for all species of finfish and blue crabs.



Houston Ship Channel/San Jacinto River Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No concern
Concern
0 0.75 1.5 3
Miles
10 05_01
10 05_02
10 05_03
10 05_04
Baytown
Channelview
San Jacinto Battleground SHS
Burnet Bay
Crystal Bay
Scott Bay
Black Duck Bay
Tabbs Bay

Houston Ship Channel/San Jacinto River Tidal - PCBs and Dioxins Impairments



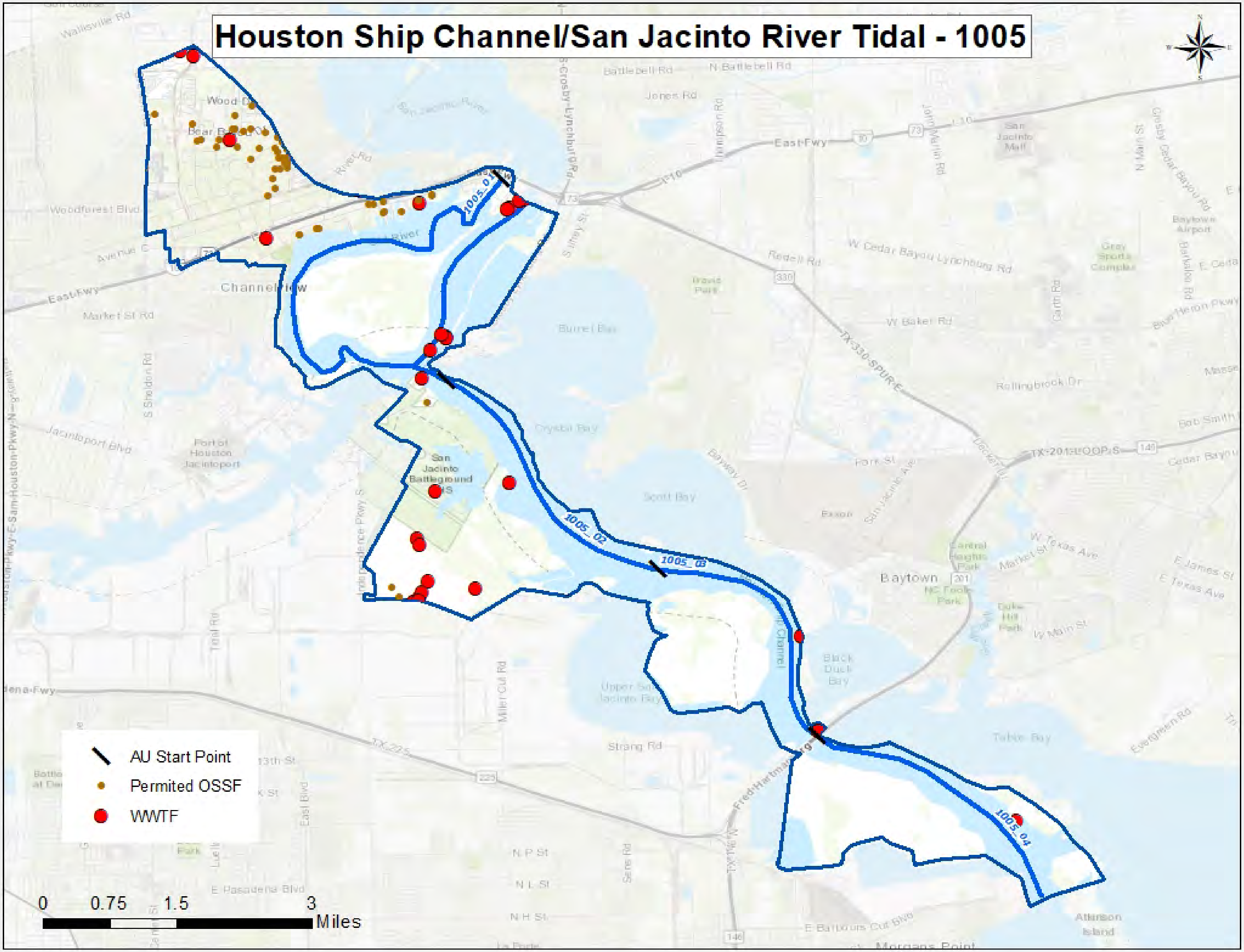
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Houston Ship Channel/San Jacinto River Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 13 permitted wastewater outfalls and 48 permitted on-site sewage facilities in the Houston Ship Channel/San Jacinto River Tidal watershed. The wastewater treatment facilities and on-site sewage facilities in the watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 4 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Houston Ship Channel/San Jacinto River Tidal watershed.

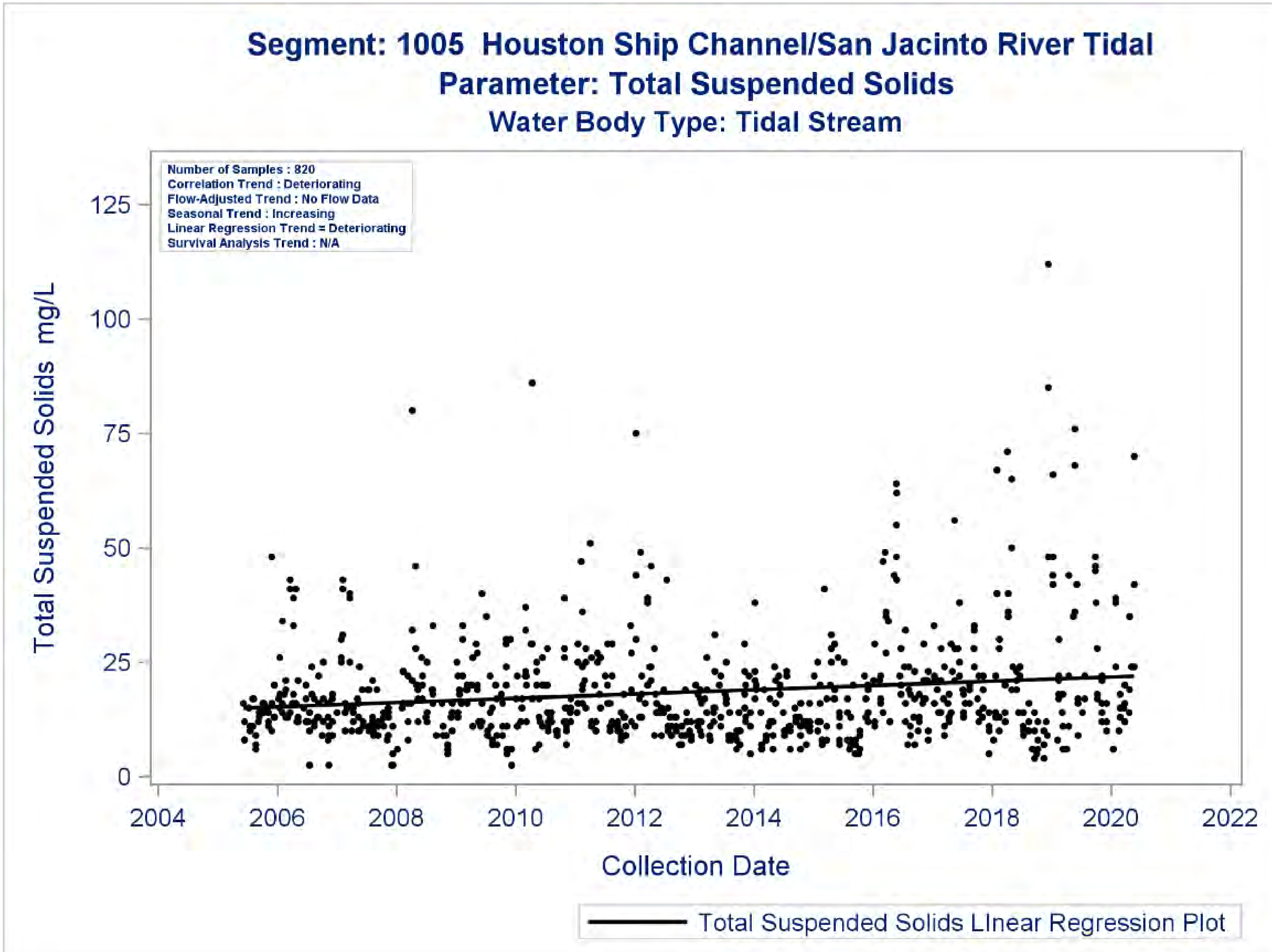

Houston Ship Channel/San Jacinto River Tidal - 1005
AU Start Point
Permited OSSF
WWTF
0
0.75
1.5
3
Miles
1005_01
1005_02
1005_03
1005_04

Trend Analysis:

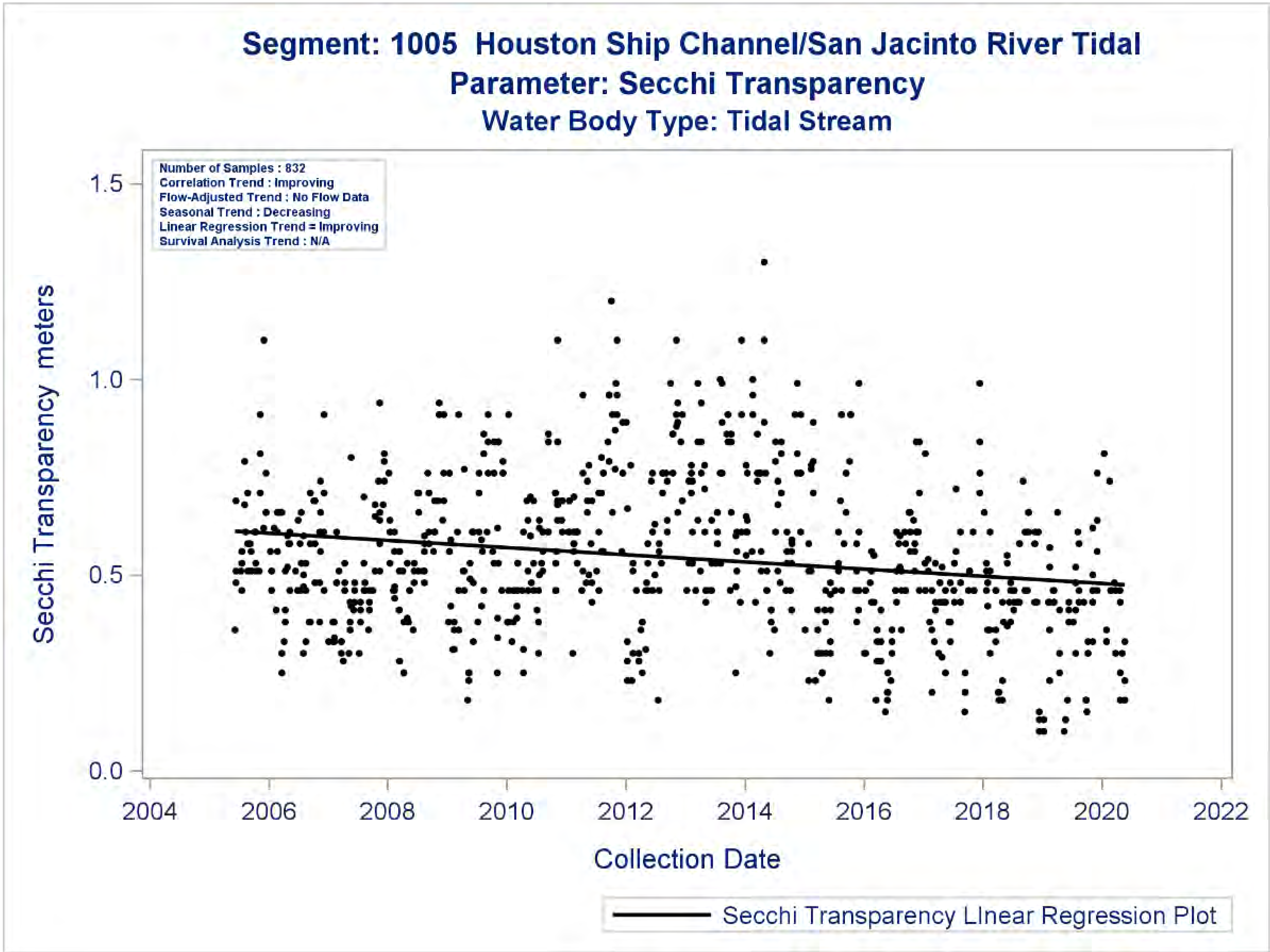
Five parameter trends were detected for the Houston Ship Channel (HSC) /San Jacinto River (SJR) Tidal segment (1005) including increasing TSS concentrations as well as improving or decreasing trends for pH, specific conductance, total phosphorous and Secchi transparency depths. Secchi transparency, while showing decreasing trends, has an inverse relationship to water clarity. Increasing concentrations of TSS and decreasing Secchi transparency indicate deteriorating water clarity conditions, confirming the water is getting more turbid throughout the segment. This could stem from increased volumetric contributions of wastewater effluent, improvements to storm water controls in the area, or increased tidal influences from Galveston Bay and the Gulf of Mexico.

Concentrations of total phosphorus were consistently below the screening criteria of 0.66 mg/L for nearly all samples collected within segment 1005. This decreasing segment trend for total phosphorus is strongly supported by decreasing trends in assessment units 1005_03 and 1005_04 and, especially, at SJR monitoring site 11252. While regression analysis shows TKN concentrations are stable when looking at all 1005 segment samples together, two of the four AUs in segment 1005 have decreasing TKN trends. Nitrate, however, maintained a stable trend throughout the period of observation with measurements evenly distributed below and in excess of the 1.10 mg/L screening criteria. In fact, three of the four AUs in segment 1005 have nutrient screening level concerns for nitrate.

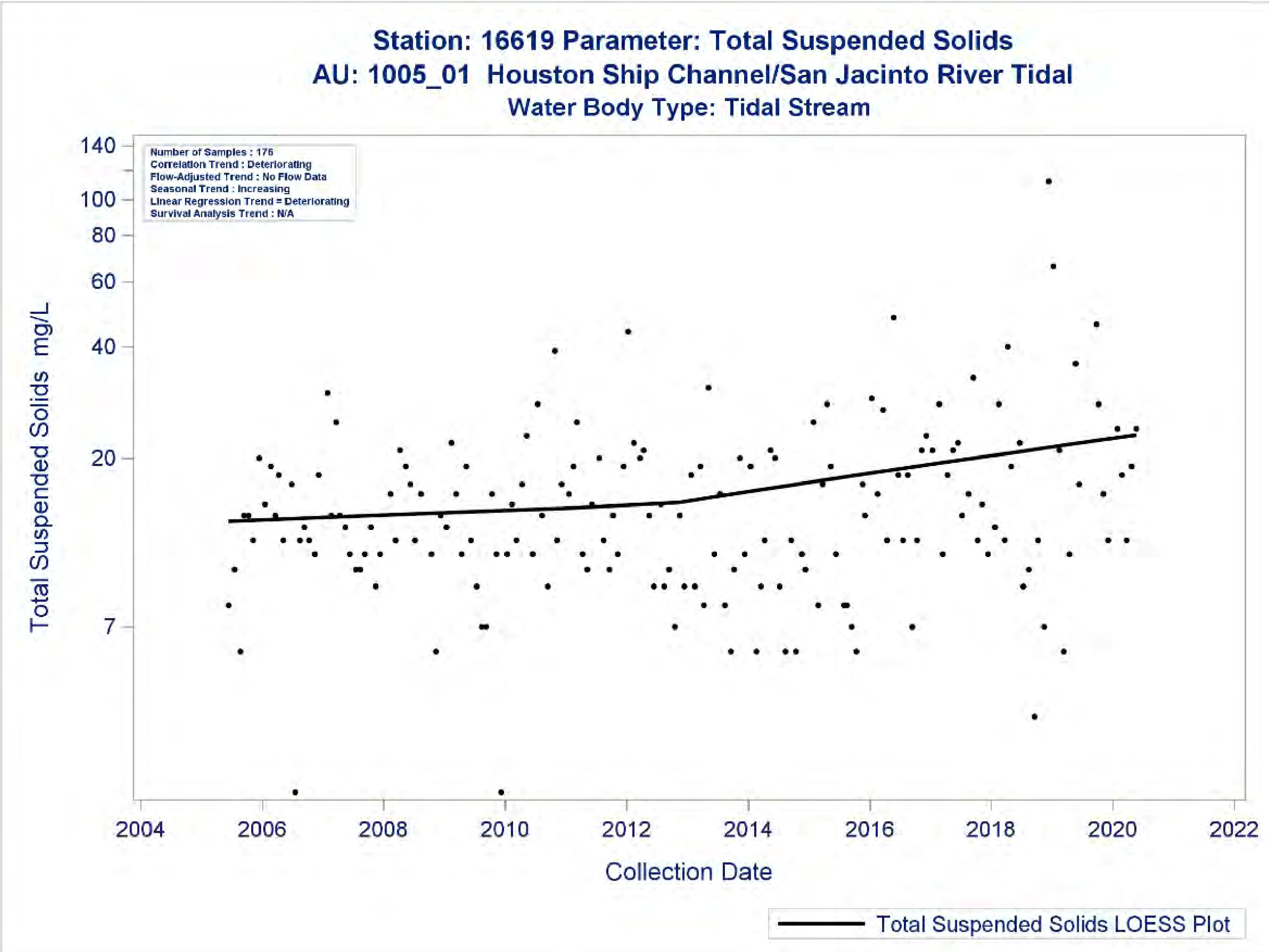
All four assessment units have a restricted fish consumption designation due to PCBs and dioxin in edible fish tissue. Considering dominant land uses within the watershed are developed industrial and residential, the origin of nutrients and pesticides in water are likely attributed to effluent discharges and runoff from over fertilized yards and landscaping in the developed areas of Baytown, Highlands, Channelview, Deer Park, and La Porte.



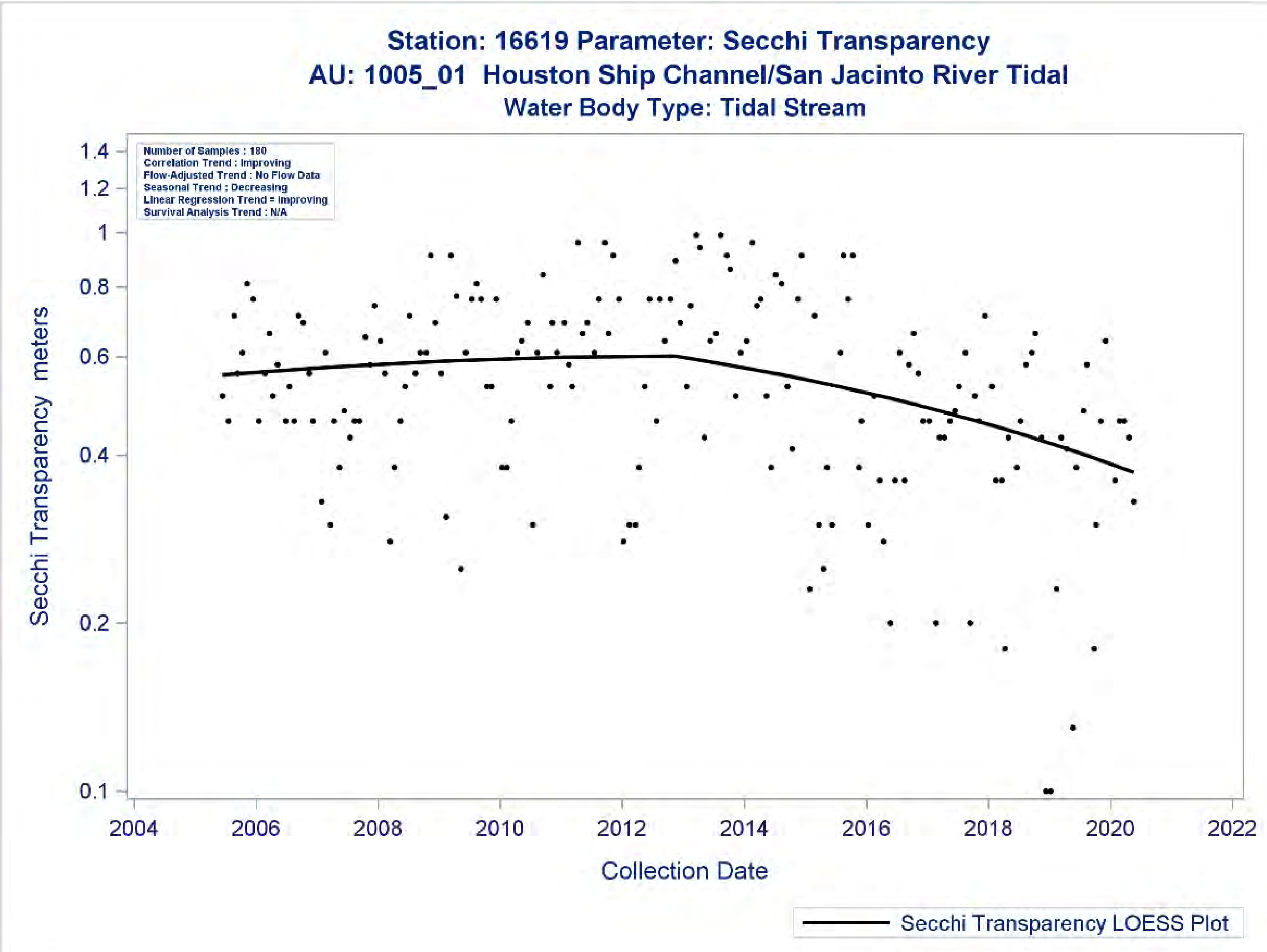
Segment: 1005 Houston Ship Channel/San Jacinto River Tidal
Parameter: Total Suspended Solids
Water Body Type: Tidal Stream
Number of Samples : 820
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
125
100
75
50
25
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot

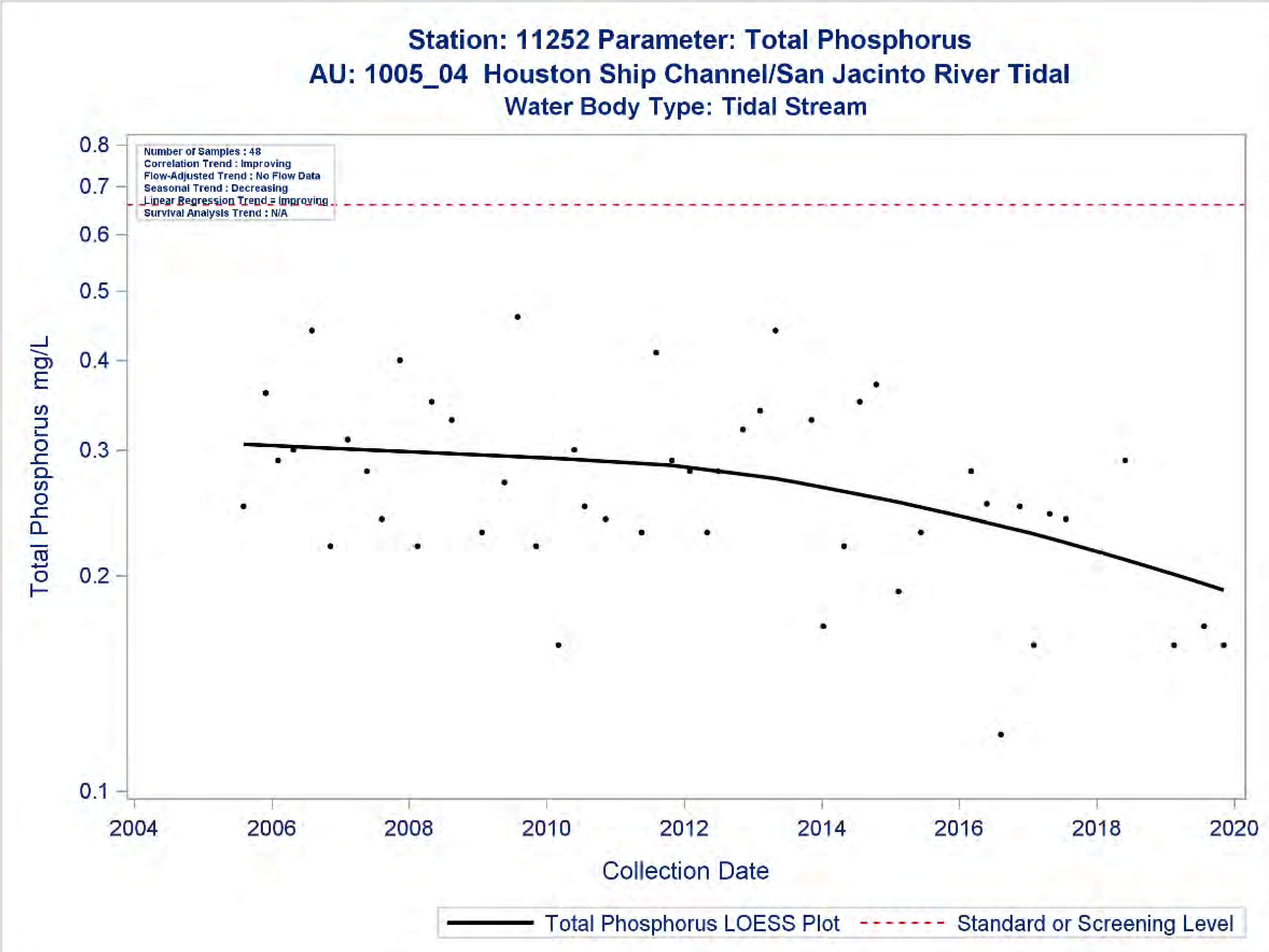


Segment: 1005 Houston Ship Channel/San Jacinto River Tidal
Parameter: Secchi Transparency
Water Body Type: Tidal Stream
Number of Samples : 832
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot

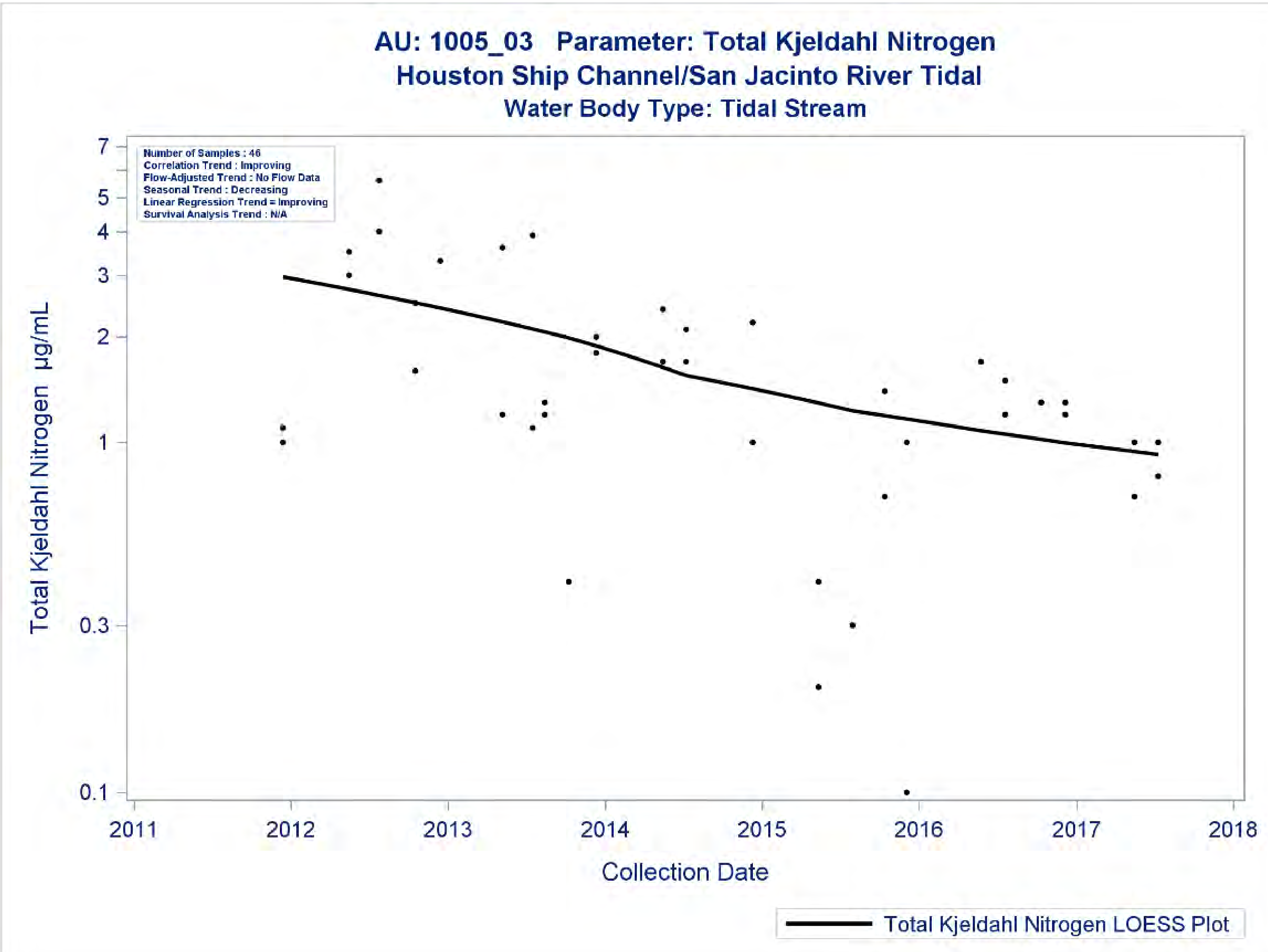


Station: 16619 Parameter: Total Suspended Solids
AU: 1005_01 Houston Ship Channel/San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 176
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
140
100
80
60
40
20
7
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot


Station: 16619 Parameter: Secchi Transparency
AU: 1005_01 Houston Ship Channel/San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 180
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.4
1.2
1
0.8
0.6
0.4
0.2
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot



Station: 11252 Parameter: Total Phosphorus
AU: 1005_04 Houston Ship Channel/San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 48
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


AU: 1005_03 Parameter: Total Kjeldahl Nitrogen
Houston Ship Channel/San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 46
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
7
5
4
3
2
1
0.3
0.1
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nitrate-Nitrogen Concentrations	1005_01 C 1005_02 C 1005_03 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Dioxin/PCBs in Fish Tissue	1005 (Entire Segment) I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue to monitor and assess fish tissue to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

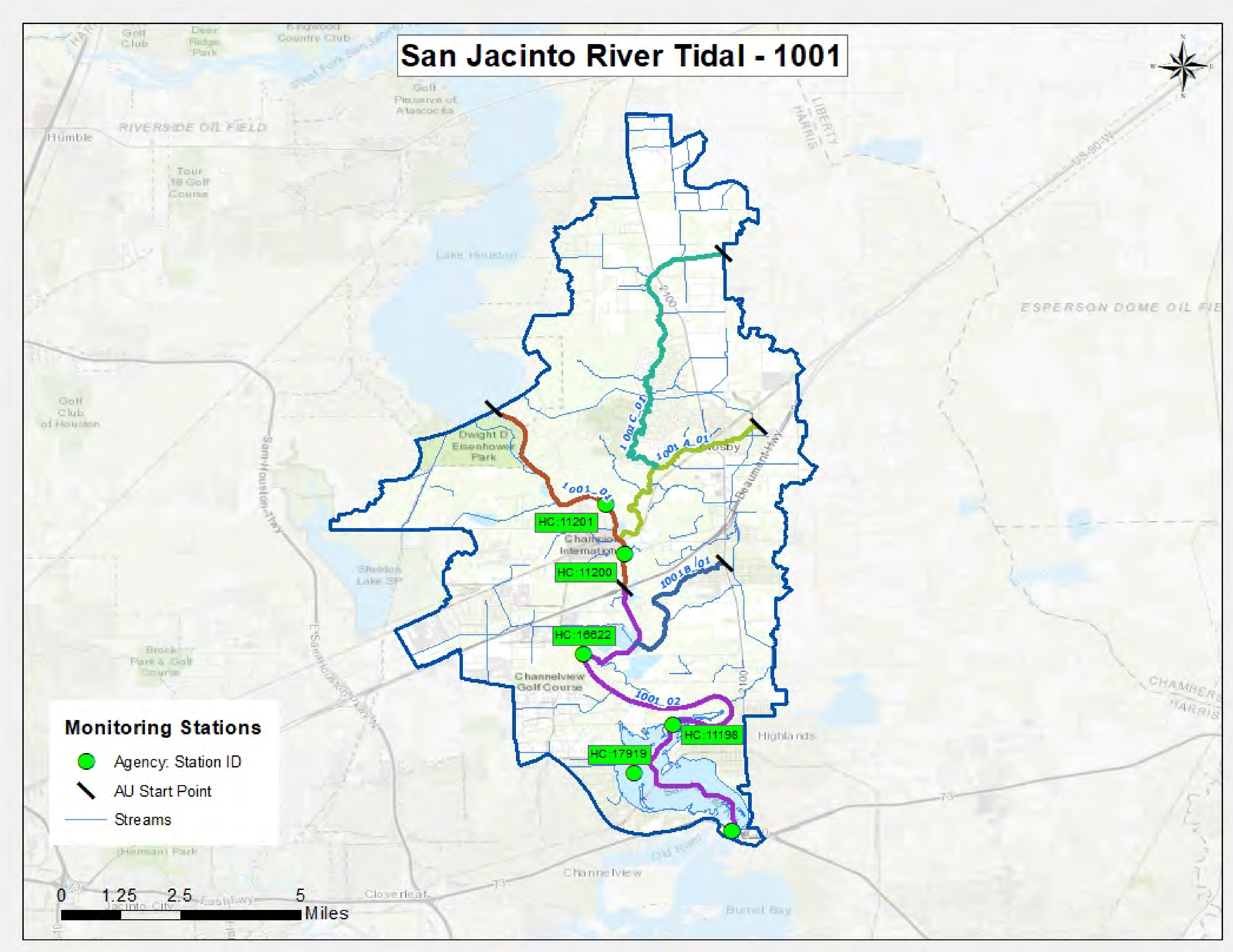
Segment Number:	1001	Name:	San Jacinto River Tidal		
Length:	16 miles	**Watershed Area:**	67 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	6	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	46

DESCRIPTION

- Segment 1001 (Tidal Stream): **San Jacinto River Tidal** (classified water body) – From a point 100 meters (110 yards) downstream of IH 10 in Harris County to Lake Houston Dam in Harris County
- Segment 1001A (Perennial Stream w/ high ALU): **Jackson Bayou** (unclassified water body) – Perennial stream from a point immediately upstream of the tidal portion of Jackson Bayou upstream to the confluence with Gum Gully
- Segment 1001B (Perennial Stream w/ Limited ALU): **Rickett Creek** (unclassified water body) – Intermittent stream with perennial pools from San Jacinto River Tidal upstream to US 90
- Segment 1011C (Perennial Stream w/ high ALU): **Gum Gully** (unclassified water body) – Perennial stream from the confluence with Jackson Bayou upstream to the confluence with an unnamed tributary approximately 0.4 km downstream of Huffman-Crosby Road
- Segment 1001D (Estuary/Tidal Stream w/ high ALU): **Bear Lake** (unclassified water body) – Encompasses the entire tidal portion of the bay (tributary bay of San Jacinto River Tidal)

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11193	1001	SAN JACINTO RIVER TIDAL IMMEDIATELY DOWNSTREAM OF IH 10 BRIDGE EAST OF CHANNELVIEW	HC	MONTHLY	Field, Conventional, Bacteria
11193	1001	SAN JACINTO RIVER TIDAL IMMEDIATELY DOWNSTREAM OF IH 10 BRIDGE EAST OF CHANNELVIEW	FO	QUARTERLY	Field, Conventional, Bacteria
11198	1001	SAN JACINTO RIVER TIDAL 23 METERS SOUTH AND 735 METERS EAST OF INTERSECTION OF WALLISVILLE ROAD AND 7TH STREET	HC	MONTHLY	Field, Conventional, Bacteria
11200	1001	SAN JACINTO RIVER TIDAL IMMEDIATELY DOWNSTREAM OF US 90 BRIDGE EAST OF SHELDON	HC	MONTHLY	Field, Conventional, Bacteria
11201	1001	SAN JACINTO RIVER TIDAL AT MAGNOLIA GARDENS 1.78 KM UPSTREAM OF US BUS 90U/ BEAUMONT HIGHWAY IN HOUSTON	HC	MONTHLY	Field, Conventional, Bacteria
16622	1001	SAN JACINTO RIVER TIDAL AT BANANA BEND ROAD AT END OF PAVEMENT IN HOUSTON	HC	MONTHLY	Field, Conventional, Bacteria
17919	1001	SAN JACINTO RIVER TIDAL MID STREAM AT TERMINUS OF SHADY LANE IN CHANNELVIEW 9 M S AND 648 M W OF INTERSECTION OF SHADY LN AND PARK DR	HC	MONTHLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HC = Harris County Pollution Control

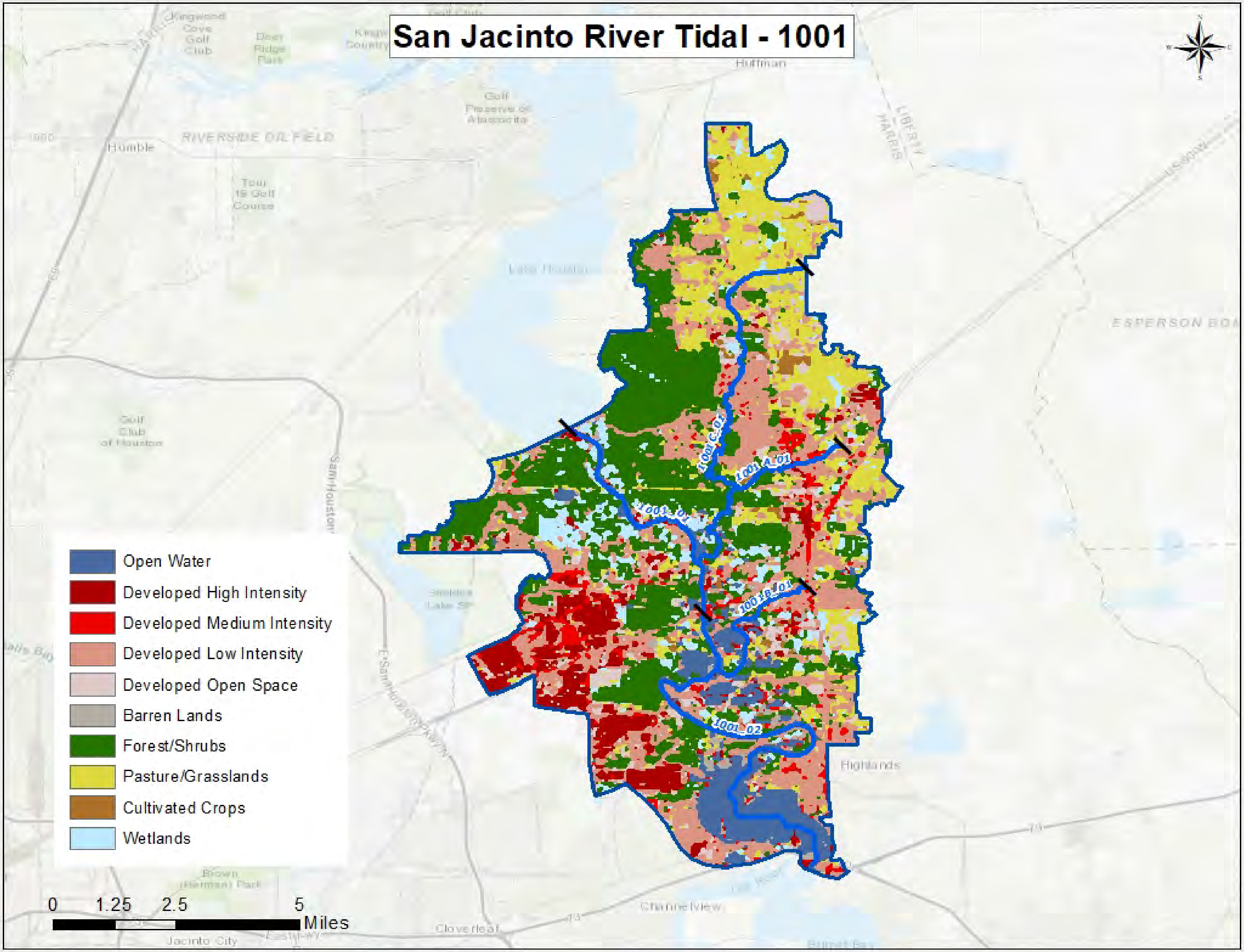

San Jacinto River Tidal - 1001
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
HC:11201
HC:11200
HC:16622
HC:11198
HC:17919
1001_01
1001_02
1001A_01
1001B_01
1001C_01
0
1.25
2.5
5
Miles
Lake Houston
Humble
RIVERSIDE OIL FIELD
ESPERSON DOME OIL FIE
Dwight D Eisenhower Park
Sheldon Lake SP
Channelview Golf Course
Channelview
Highlands
Crosby
Burnet Bay
Cloverleaf
Golf Club of Houston
Tour 18 Golf Course
Golf Preserve of Atascocita
Sam Houston Tlwy
Beaumont Hwy
US-90-W
LIBERTY
HARRIS
CHAMBERS
HARRIS

Segment 1001 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia-N (mg/L):	0.46	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	5.0	Nitrate-N (mg/L):	1.10	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.46	0.46
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.66	0.66
Enterococci (MPN/100mL) (grab):	104		Chlorophyll *a* (µg/L):	21	21
Enterococci (MPN/100mL) (geometric mean):	35				
E. coli (MPN/100 mL) (grab):		399			
E. coli (MPN/100 mL) (geometric mean):		126			

Segment Discussion

Watershed Characteristics and Land Cover: The San Jacinto River Tidal segment (1001) lies between the Lake Houston dam in the north to the I-10 bridge over the San Jacinto River at the southern end. The San Jacinto River Tidal (1001) watershed covers approximately 43,200 acres. The primary land cover types in the watershed are Developed (39.23 percent), Forest/Shrubs (26.90 percent), and Agriculture (17.22 percent). From 2008 to 2018, Developed lands increased from 11,699 acres to 16,937 acres, an increase of approximately 44.8 percent. During the same period, Agriculture land cover decreased by 36.3 percent, from 11,666 acres to 7,432 acres. The lower portion of the watershed is heavily developed with industrial activity along the Houston Ship Channel representing the dominant land use on the western side of the river. The community of Sheldon is situated in the industrial area. The rural communities of Crosby, Barrett, and Highlands are located on the eastern side of the river in the upper, middle, and lower portions of the watershed, respectively. This segment of the San Jacinto River is predominantly surrounded by extensive woody wetlands while cultivated lands dominate the northeast quadrant of the watershed.

Segment 1001 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	11,666.32	27.02	7,432.09	17.22	-36.29
Barren Lands	126.54	0.29	775.15	1.80	512.56
Developed	11,698.79	27.10	16,937.19	39.23	44.78
Forest/Shrubs	4,635.79	10.74	11,614.12	26.90	150.53
Open Water	3,432.87	7.95	3,362.39	7.79	-2.05
Wetlands	11,610.50	26.89	3,049.00	7.06	-73.74
TOTAL	**43,170.81**	**100.00**	**43,169.94**	**100.00**	


San Jacinto River Tidal - 1001
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1.25 2.5 5
Miles
1001C_01
1001A_01
1001_01
1001B_01
1001_02
Humble
Huffman
Highlands
Channelview
Cloverleaf
Jacinto City
RIVERSIDE OIL FIELD
ESPERSON BO
LIBERTY
HARRIS

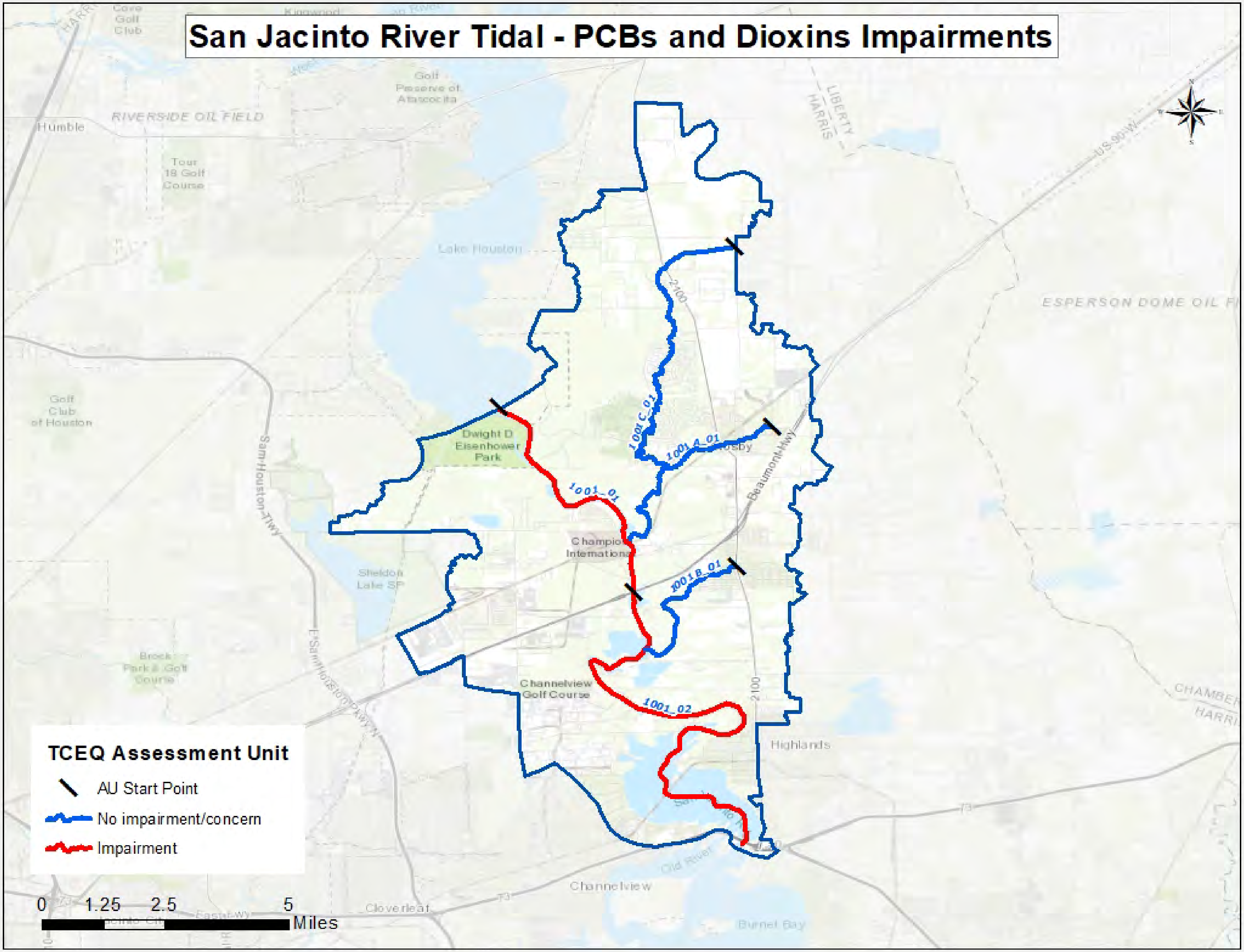
Water Quality Issues:

Bacteria Impairments and Concerns
There are no bacteria impairments or concerns for bacteria in the San Jacinto River Tidal segment.

Dissolved Oxygen Impairments and Concerns
There are no dissolved oxygen impairments or concerns for bacteria in the San Jacinto River Tidal segment.

Nutrient Concerns
There are nutrient screening level concerns for nutrients in the San Jacinto River Tidal segment.

PCBs and Dioxin Impairments
Fish consumption use is not supported in this segment. San Jacinto River Tidal (1001_01 and 1001_02) is listed as impaired for PCBs and Dioxins in fish tissue.



San Jacinto River Tidal - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
1.25
2.5
5
Miles
1001_01
1001_02
1001_A_01
1001_B_01
1001_C_01
Lake Houston
Dwight D Eisenhower Park
Channelview Golf Course
Highlands
Channelview
Humble
RIVERSIDE OIL FIELD
ESPERSON DOME OIL FI
Sheldon Lake SP
Golf Club of Houston
Tour 18 Golf Course
Golf Preserve of Atascocita
Brock Park & Golf Course
Cloverleaf
Burnet Bay
Old River
Crosby
Beaumont Hwy
Sam Houston Tlwy
US-90-W
LIBERTY
HARRIS
CHAMBERS

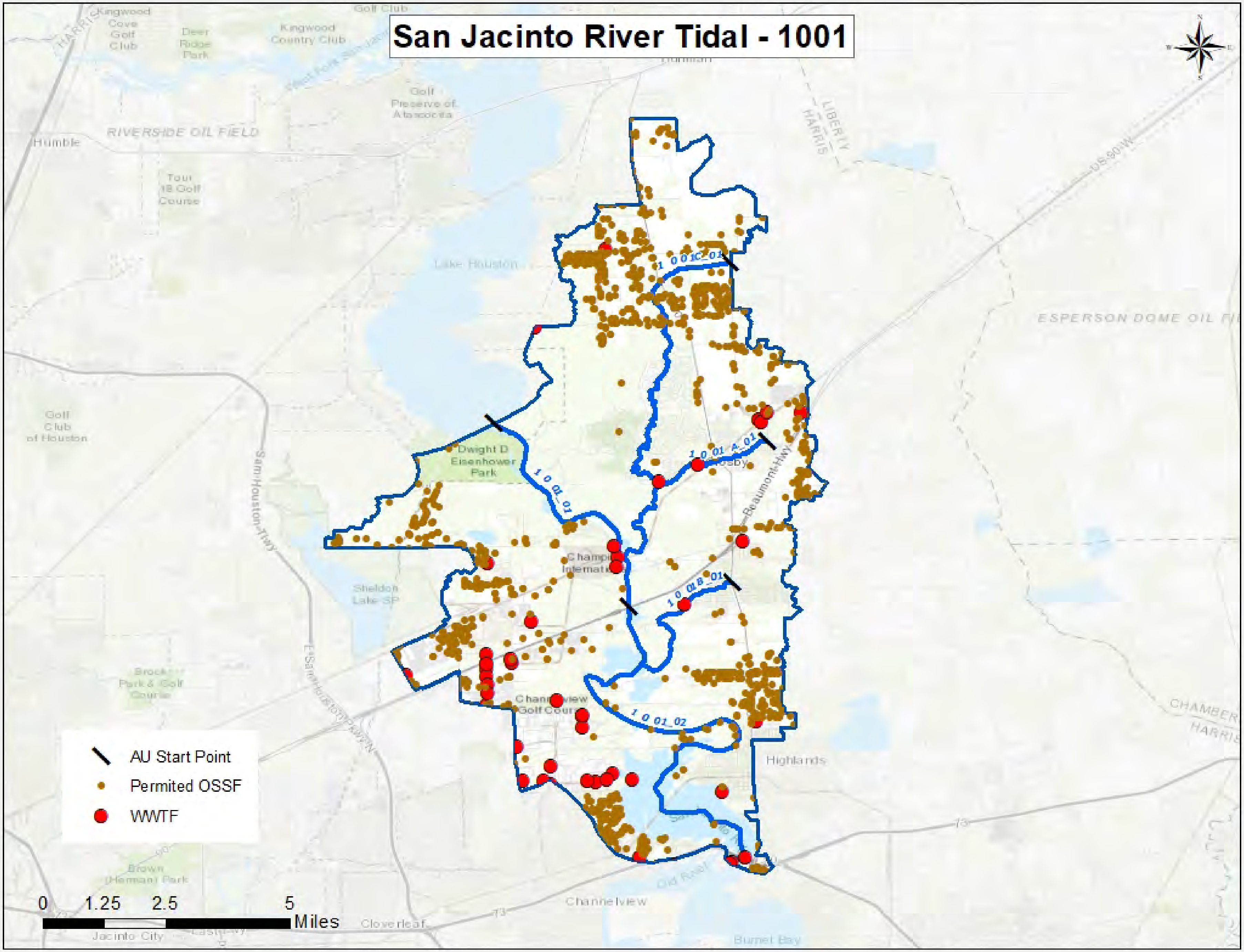
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the San Jacinto River Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 46 permitted wastewater outfalls in the San Jacinto Tidal watershed. In some areas, on-site sewage facilities are the primary source of wastewater disposal. There are 1,122 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the San Jacinto Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 186 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the San Jacinto Tidal watershed.



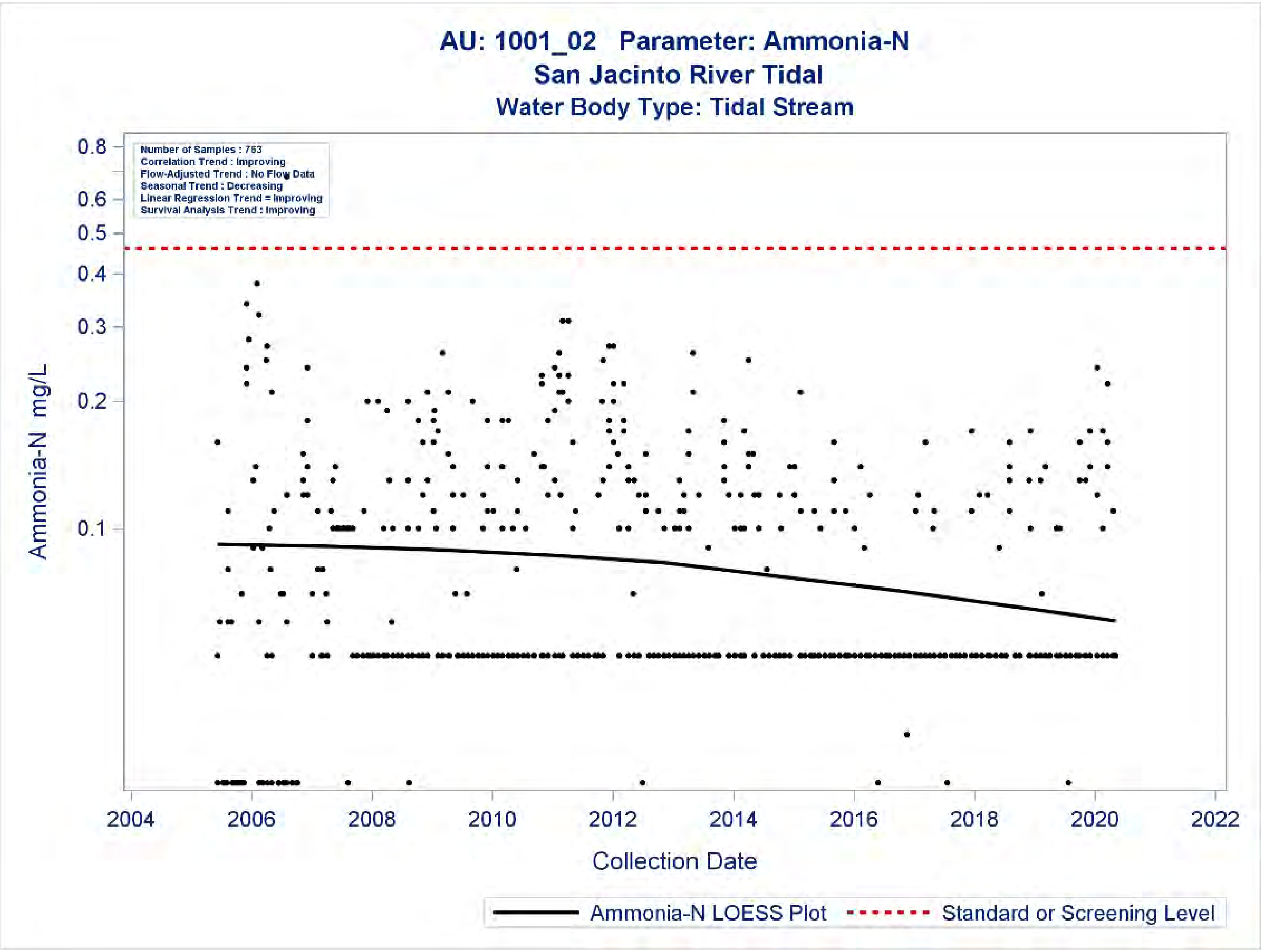
San Jacinto River Tidal - 1001
AU Start Point
Permited OSSF
WWTF
0 1.25 2.5 5
Miles
1001C_01
1001A_01
1001_01
1001B_01
1001_02
Lake Houston
Dwight D Eisenhower Park
Sheldon Lake SP
Highlands
Channelview
Humble
RIVERSIDE OIL FIELD
ESPERSON DOME OIL FI
Beaumont Hwy
Sam Houston Tlwy

Trend Analysis:

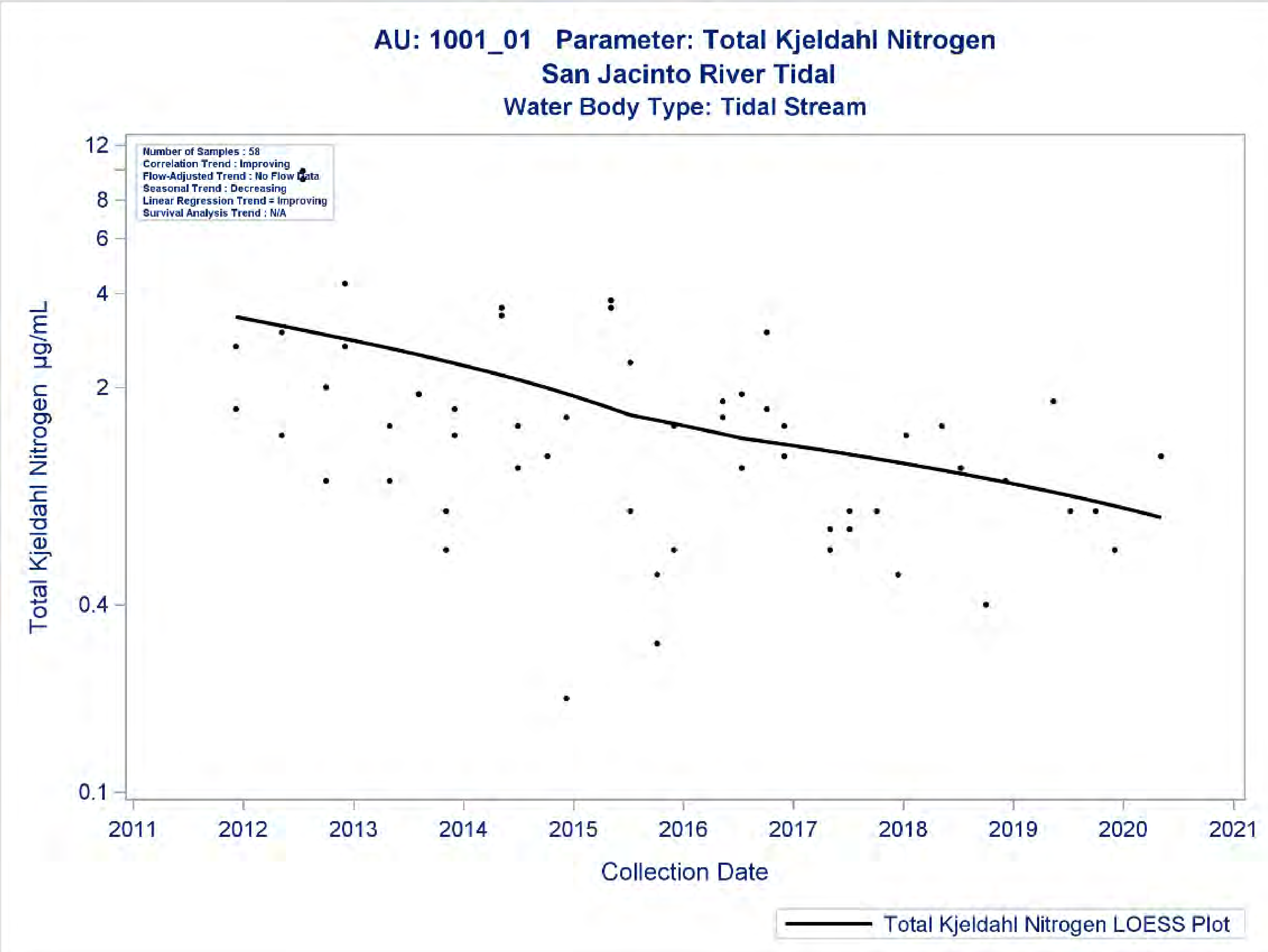
Regression analysis of watershed-level data revealed nine parameter trends for segment 1001 (San Jacinto River). Those trends include ammonia, nitrate, DO, pH, TKN, total phosphorus Secchi transparency, specific conductivity, and TSS. Of the nine parameter trends identified, decreasing concentrations were observe with ammonia, TKN, and total phosphorus, while increasing trends include nitrate and TSS. If there is a trend with the TSS data, there is an inverse relationship to the Secchi transparency data. Where sediment loads are increasing, the Secchi transparency depth is decreasing. Decreasing trends are typically categorized as 'improving' trends, as seen in the graph legend, but the water is actually getting more turbid. Likewise, if the sediments loads are decreasing, the Secchi transparency depths will be increasing.

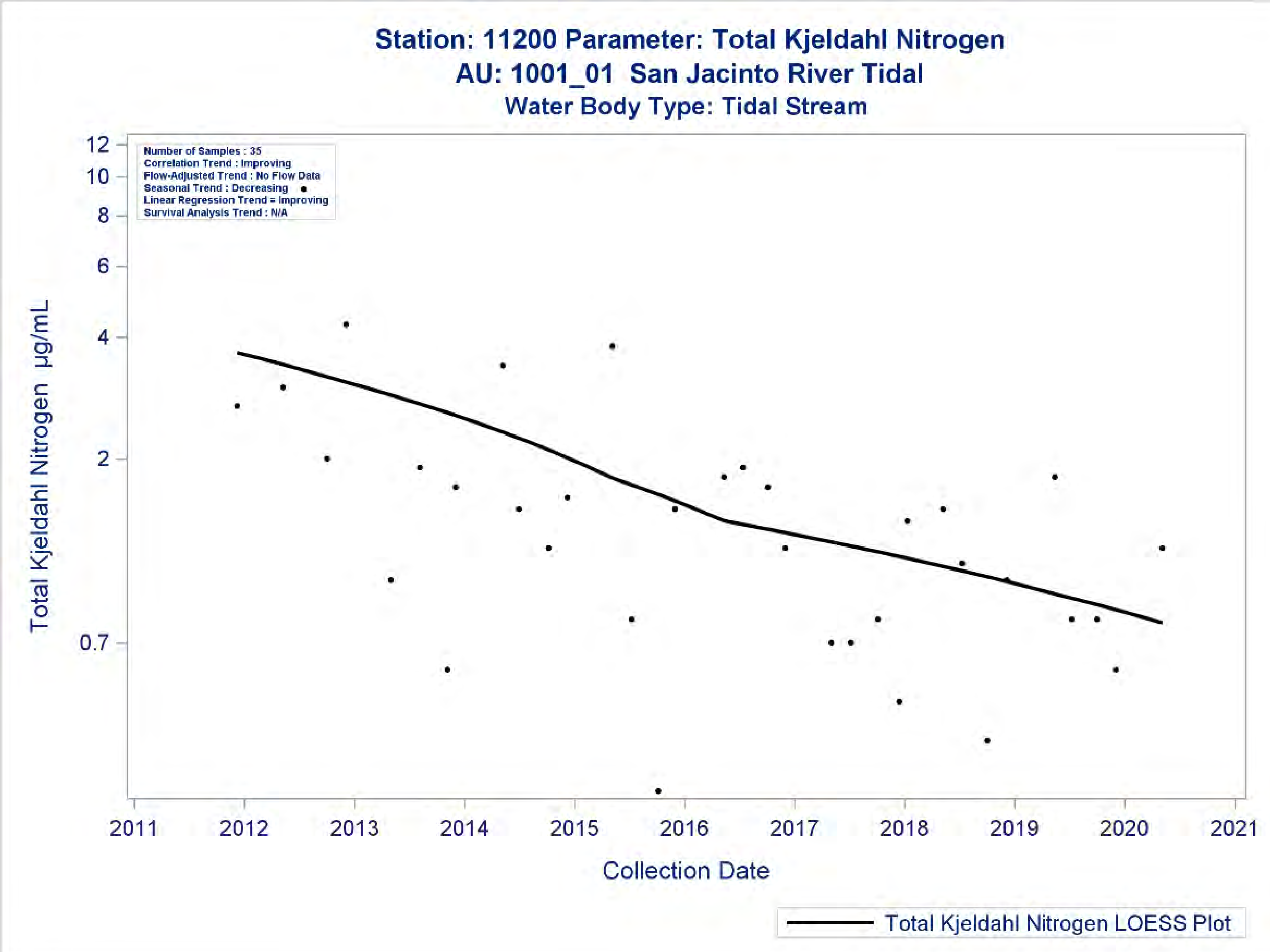
Concentrations of DO are also decreasing but are still above the minimum water quality standard for grab samples. Specific conductance and pH also show decreasing concentrations. These trends may be related to variations in weather patterns during the period of record where drought conditions between 2010 and 2013 may have increased salinity levels through evaporative processes. Other possibilities include changes in wastewater treatment operations, and/or increased tidal influences originating from Galveston Bay and the Gulf of Mexico.

Although there are no nutrient concerns present for this segment in the 2020 Texas Integrated Report, there is an increasing trend in nitrate detected on the main river segment. This increase in nitrate concentration is likely from runoff originating from fertilized yards, landscaping, and cultivated lands in the area. There is also a fish consumption advisory in place due to pesticides in edible fish tissue. Continued monitoring is recommended to better evaluate the origin of pesticides in water and ensure nutrient levels do not exceed the state screening criteria.

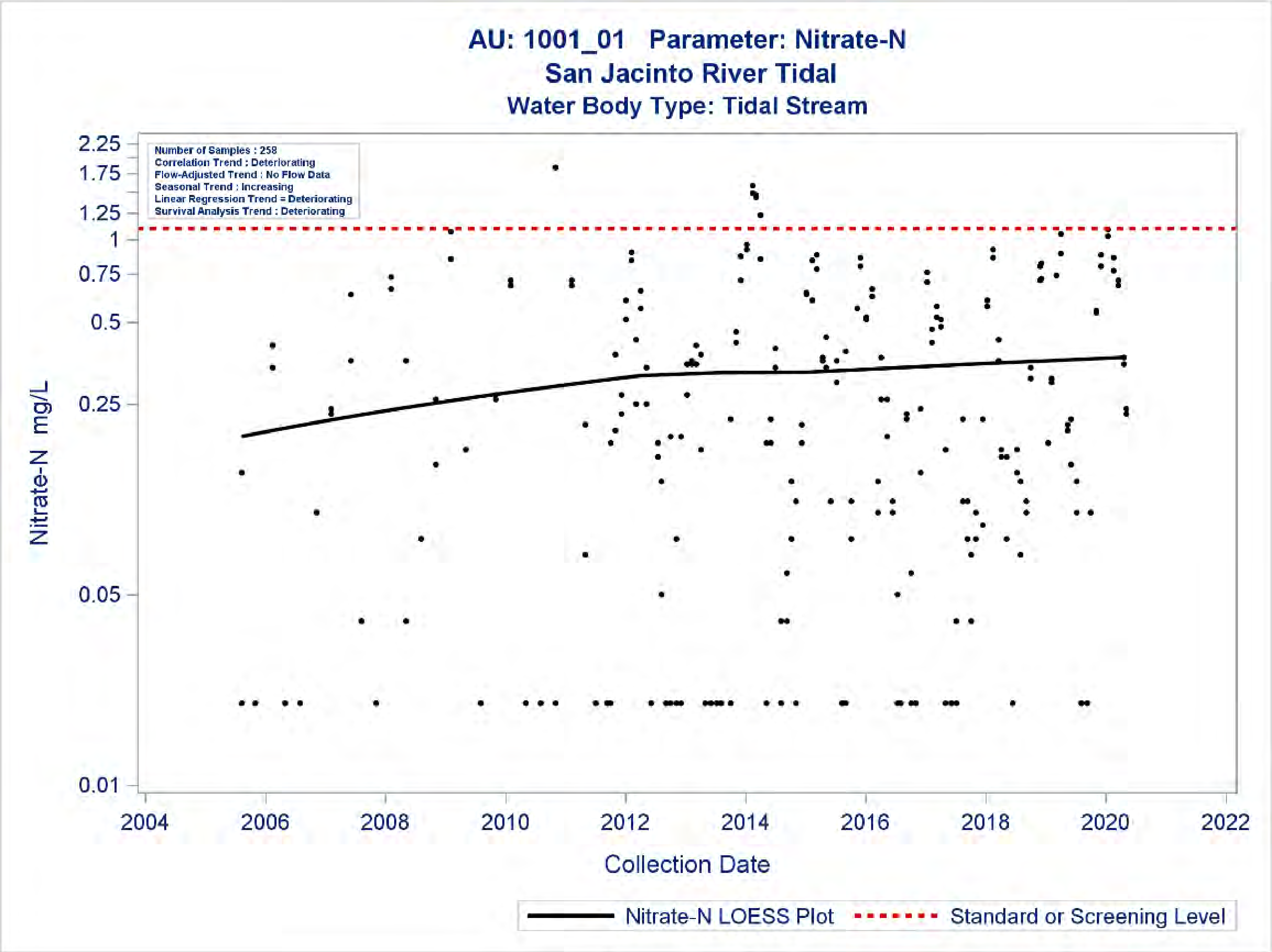


AU: 1001_02 Parameter: Ammonia-N
San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 763
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
0.8
0.6
0.5
0.4
0.3
0.2
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level

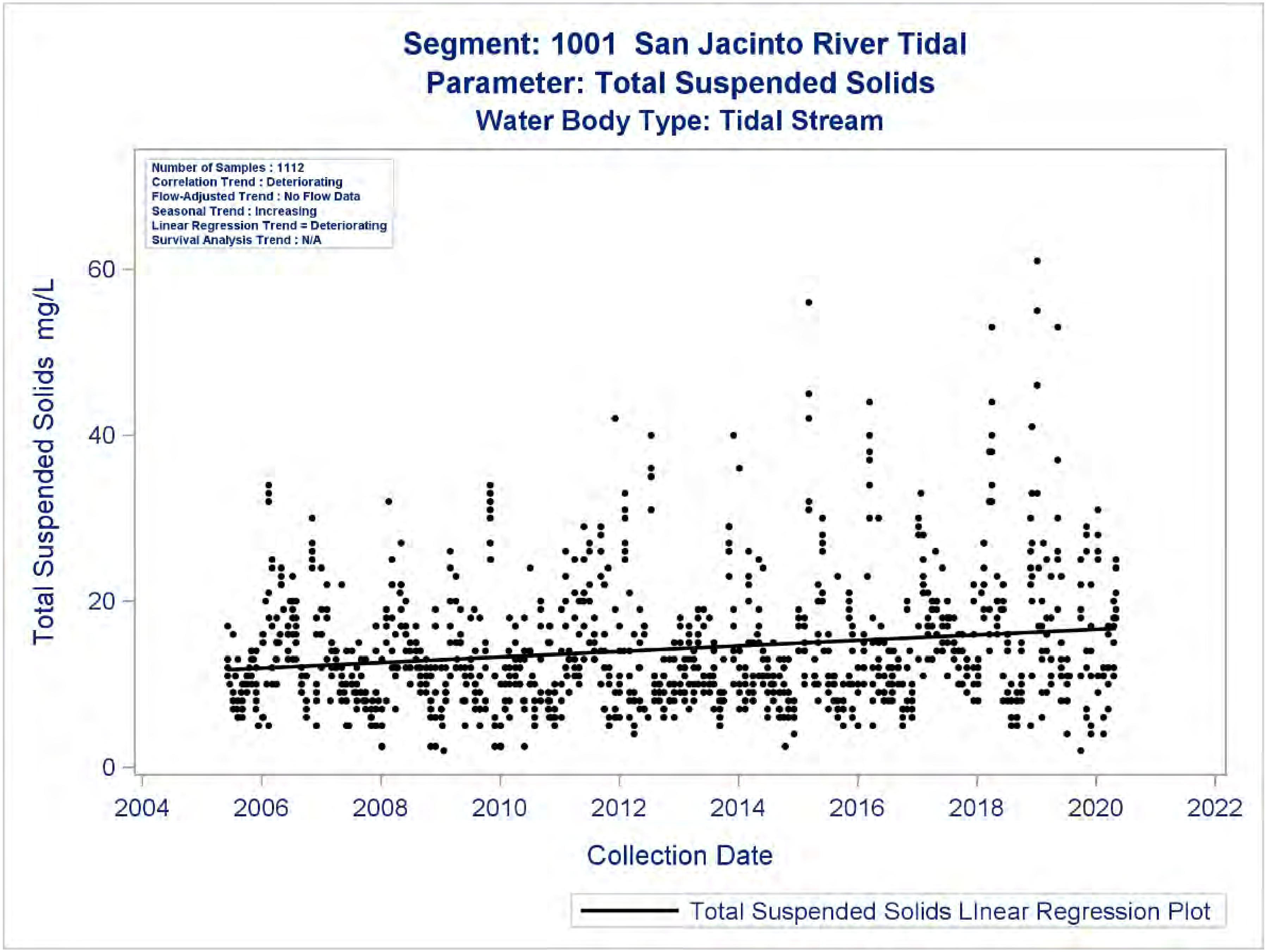

AU: 1001_01 Parameter: Total Kjeldahl Nitrogen
San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 58
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
12
8
6
4
2
0.4
0.1
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



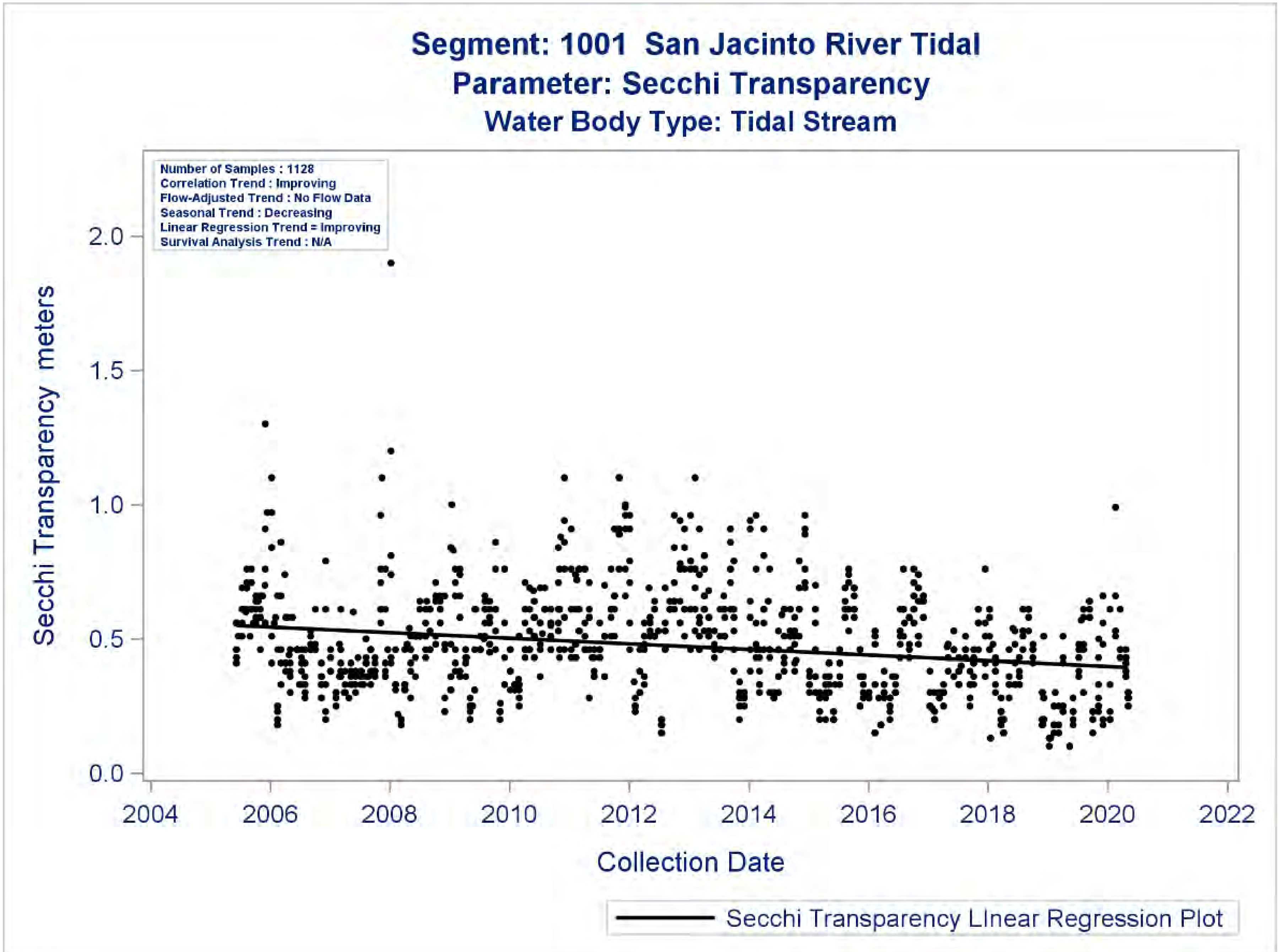
Station: 11200 Parameter: Total Kjeldahl Nitrogen
AU: 1001_01 San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 35
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
12
10
8
6
4
2
0.7
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



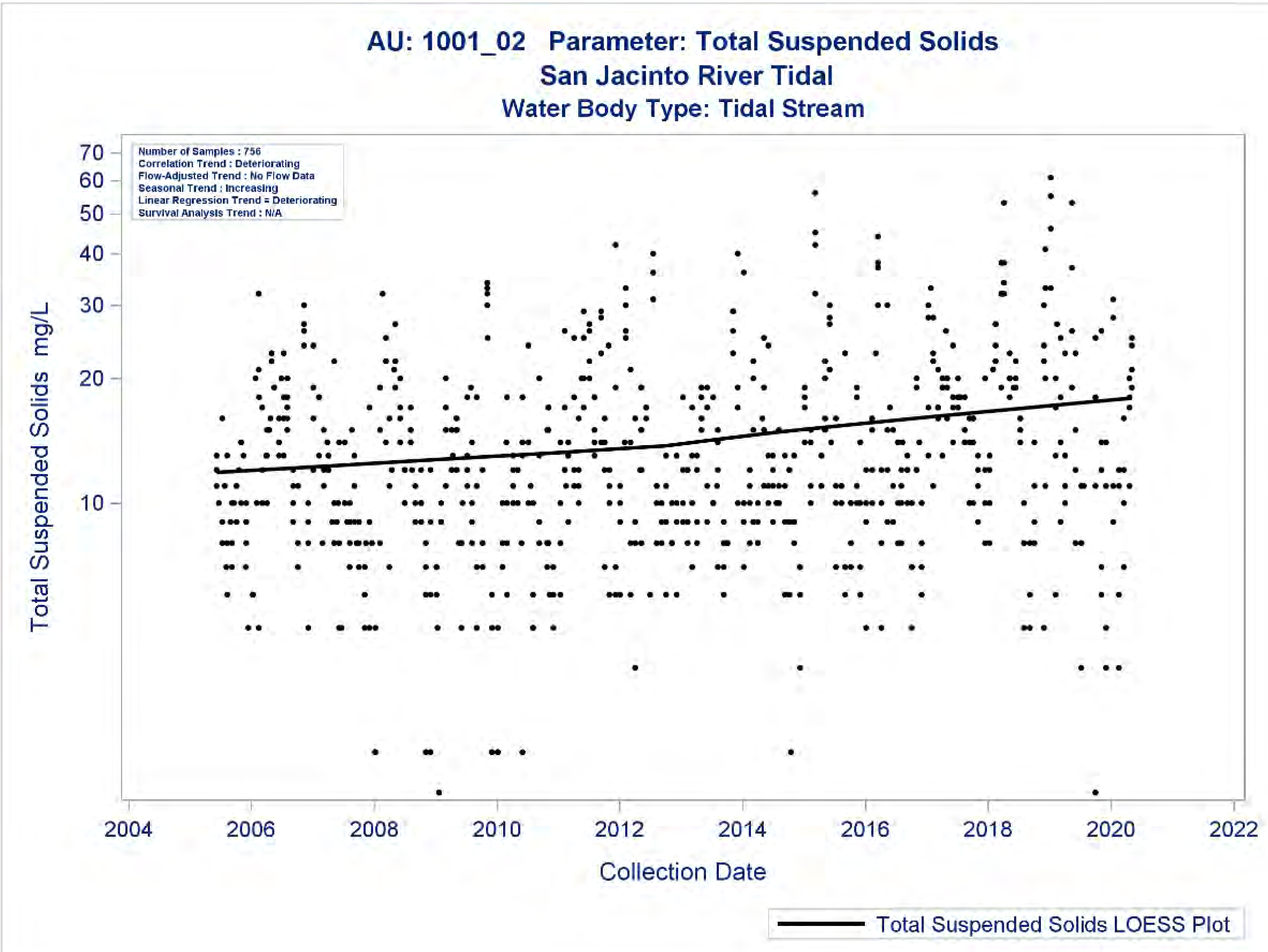
AU: 1001_01 Parameter: Nitrate-N
San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 258
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
2.25
1.75
1.25
1
0.75
0.5
0.25
0.05
0.01
Nitrate-N mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level



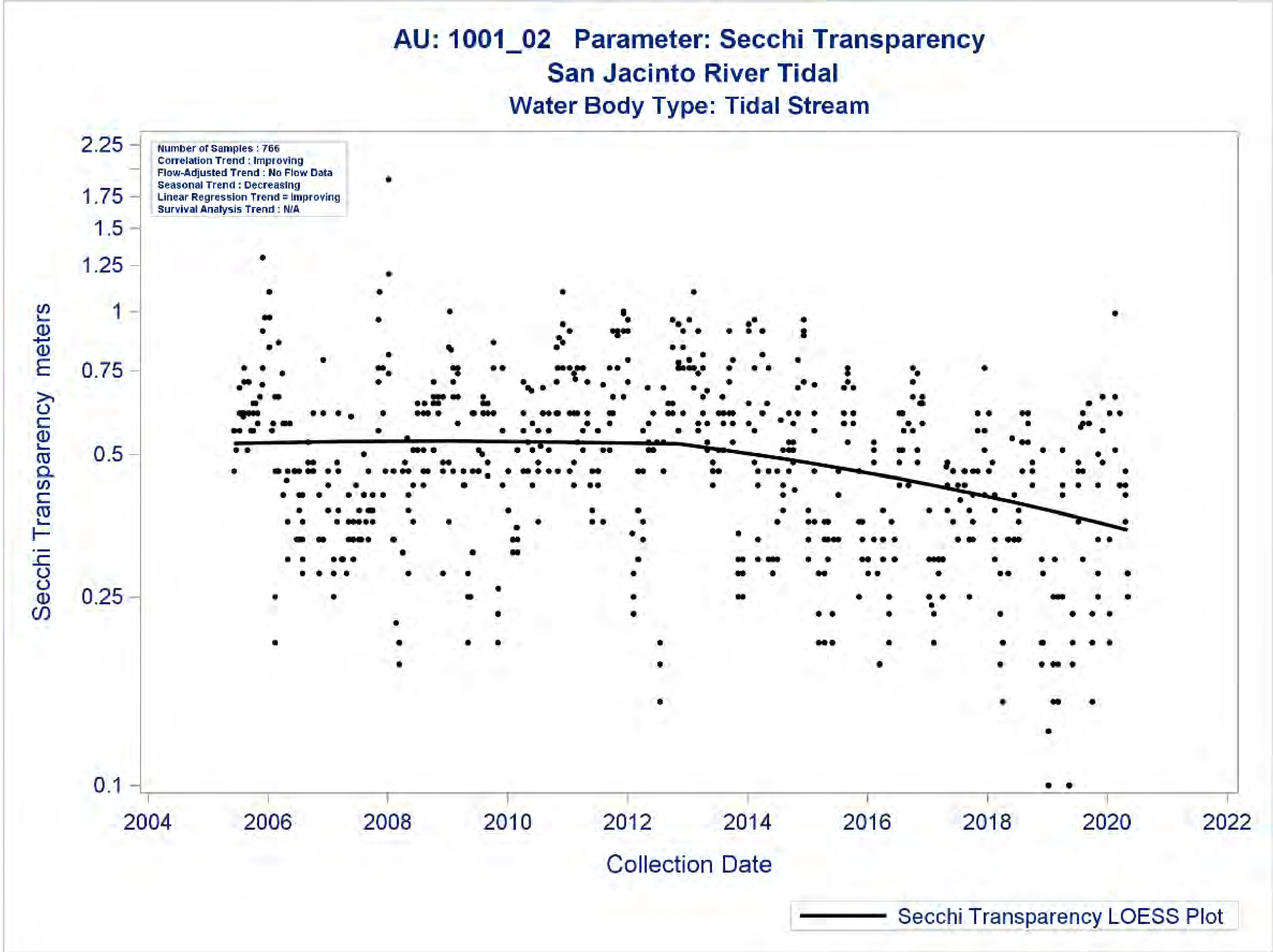
Segment: 1001 San Jacinto River Tidal
Parameter: Total Suspended Solids
Water Body Type: Tidal Stream
Number of Samples : 1112
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
20
40
60
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids Linear Regression Plot



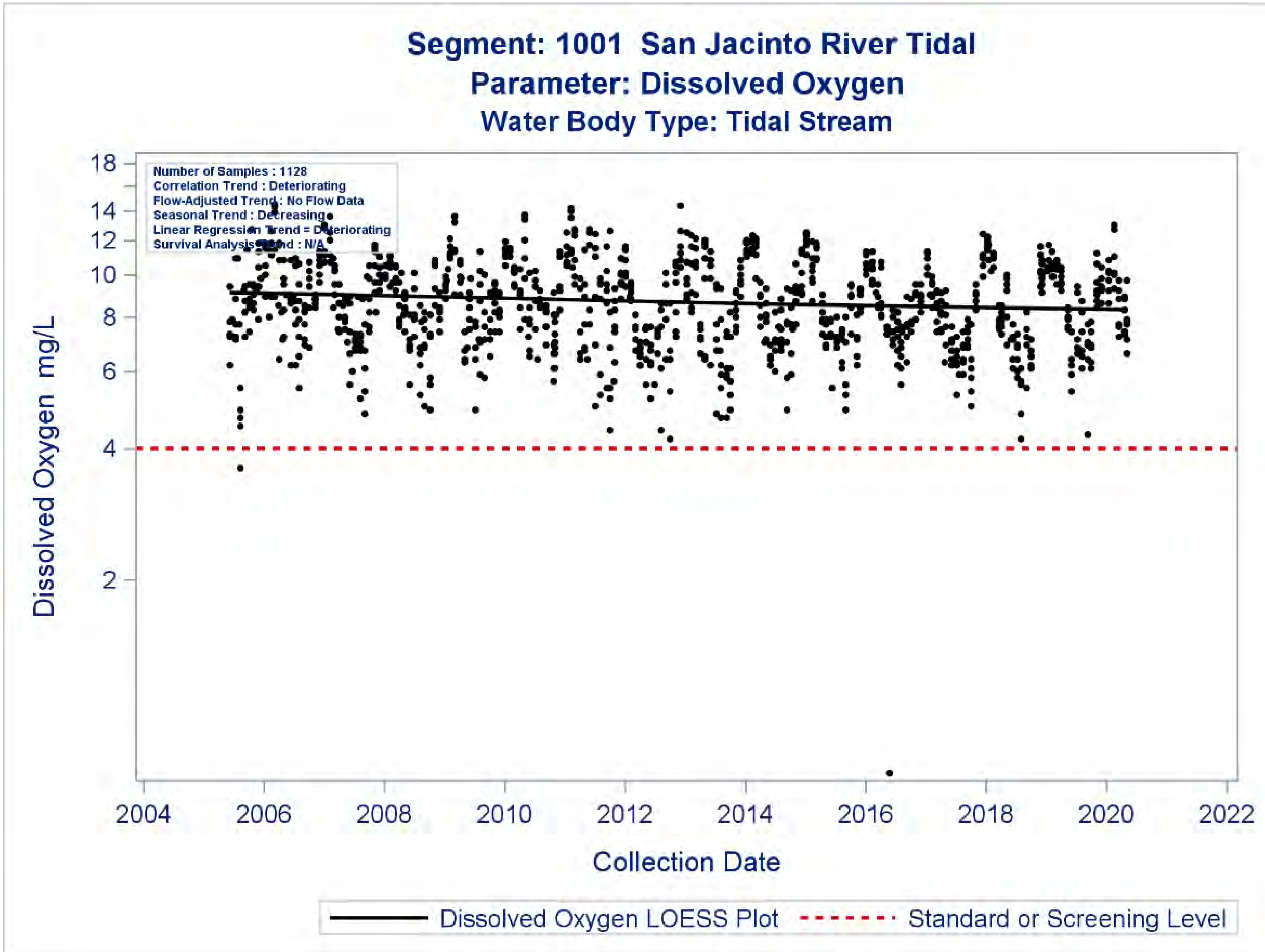
Segment: 1001 San Jacinto River Tidal
Parameter: Secchi Transparency
Water Body Type: Tidal Stream
Number of Samples : 1128
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency Linear Regression Plot



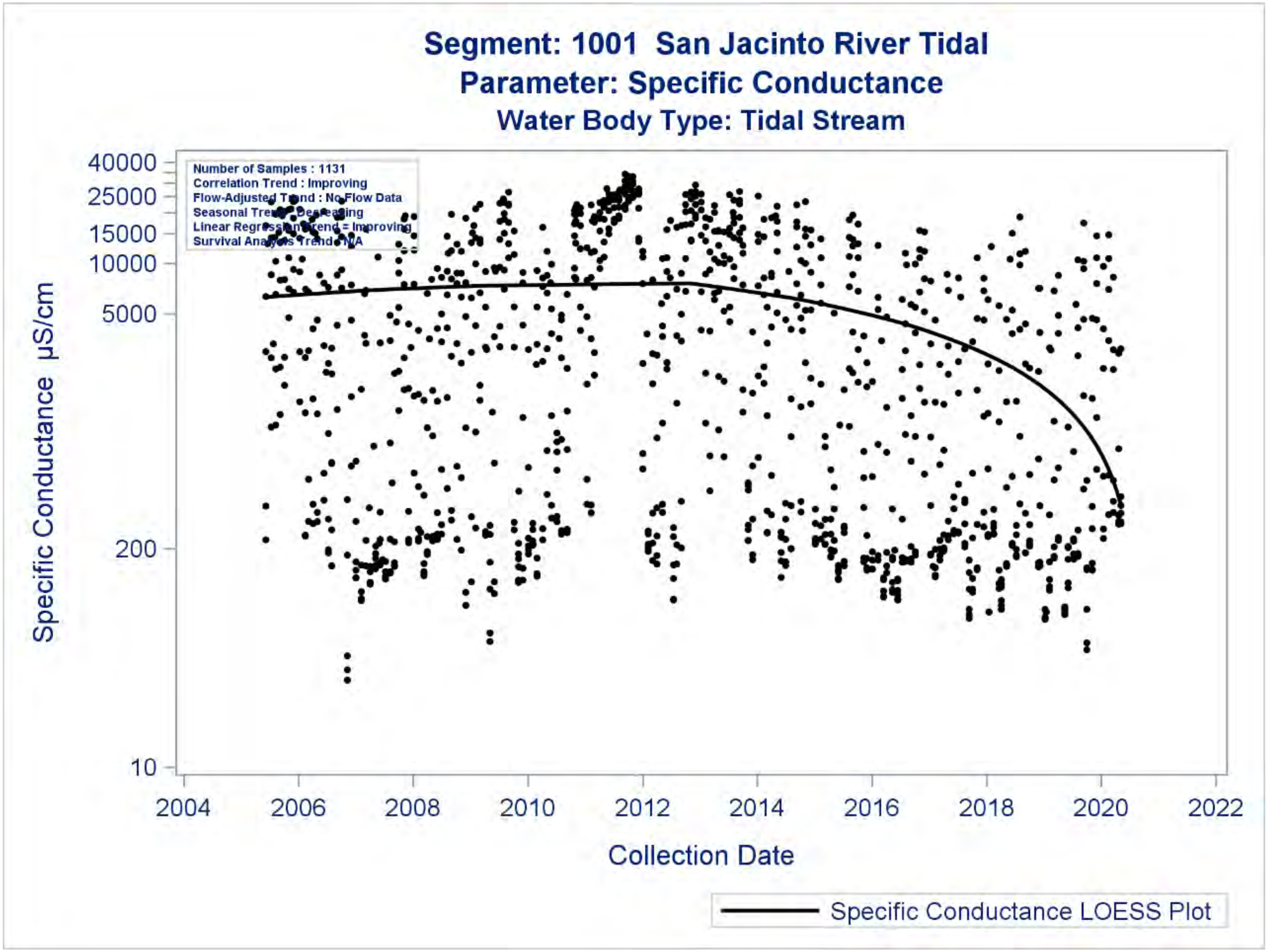
AU: 1001_02 Parameter: Total Suspended Solids
San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 756
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
70
60
50
40
30
20
10
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot



AU: 1001_02 Parameter: Secchi Transparency
San Jacinto River Tidal
Water Body Type: Tidal Stream
Number of Samples : 766
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
2.25
1.75
1.5
1.25
1
0.75
0.5
0.25
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LOESS Plot



Segment: 1001 San Jacinto River Tidal
Parameter: Dissolved Oxygen
Water Body Type: Tidal Stream
Number of Samples : 1128
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
18
14
12
10
8
6
4
2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level


Segment: 1001 San Jacinto River Tidal
Parameter: Specific Conductance
Water Body Type: Tidal Stream
Number of Samples : 1131
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend: Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend: N/A
Specific Conductance µS/cm
40000
25000
15000
10000
5000
200
10
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Dioxin/PCBs in Fish Tissue	Entire Segment (1001) I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

- The San Jacinto River Tidal watershed is part of the Bacteria Implementation Group (BIG). For more information, refer to the Public Involvement and Outreach section of the Basin Summary Report.
- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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

- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 1017	Name: White Oak Bayou Above Tidal

Length:	24 miles	Watershed Area:	88 square miles	Designated Uses:	Primary Contact Recreation 1; Limited Aquatic Life

Number of Active Monitoring Stations:	13	Texas Stream Team Monitoring Stations:	3	Permitted WWTF Outfalls:	44

DESCRIPTION

- Segment 1017 (Perennial Stream w/ limited ALU): **White Oak Bayou Above Tidal** (classified water body) – From a point immediately upstream of the confluence of Little White Oak Bayou in Harris County to a point 3.0 km (1.9 mi) upstream of FM 1960 in Harris County

- Segment 1017A (Perennial Stream w/ limited ALU): **Brickhouse Gully** (unclassified water body) – Perennial stream from the confluence with White Oak Bayou up to Gessner Road

- Segment 1017B (Perennial Stream w/ ALU): **Cole Creek** (unclassified water body) – Perennial stream from the confluence of White Oak Bayou up to south of Beltway 8

- Segment 1017C (Perennial Stream w/ limited ALU): **Vogel Creek** (unclassified water body) – From the White Oak Bayou confluence to a point 3.2 km (2.0 mi) upstream of the White Oak Bayou confluence to just south of State Hwy 249 in Harris County

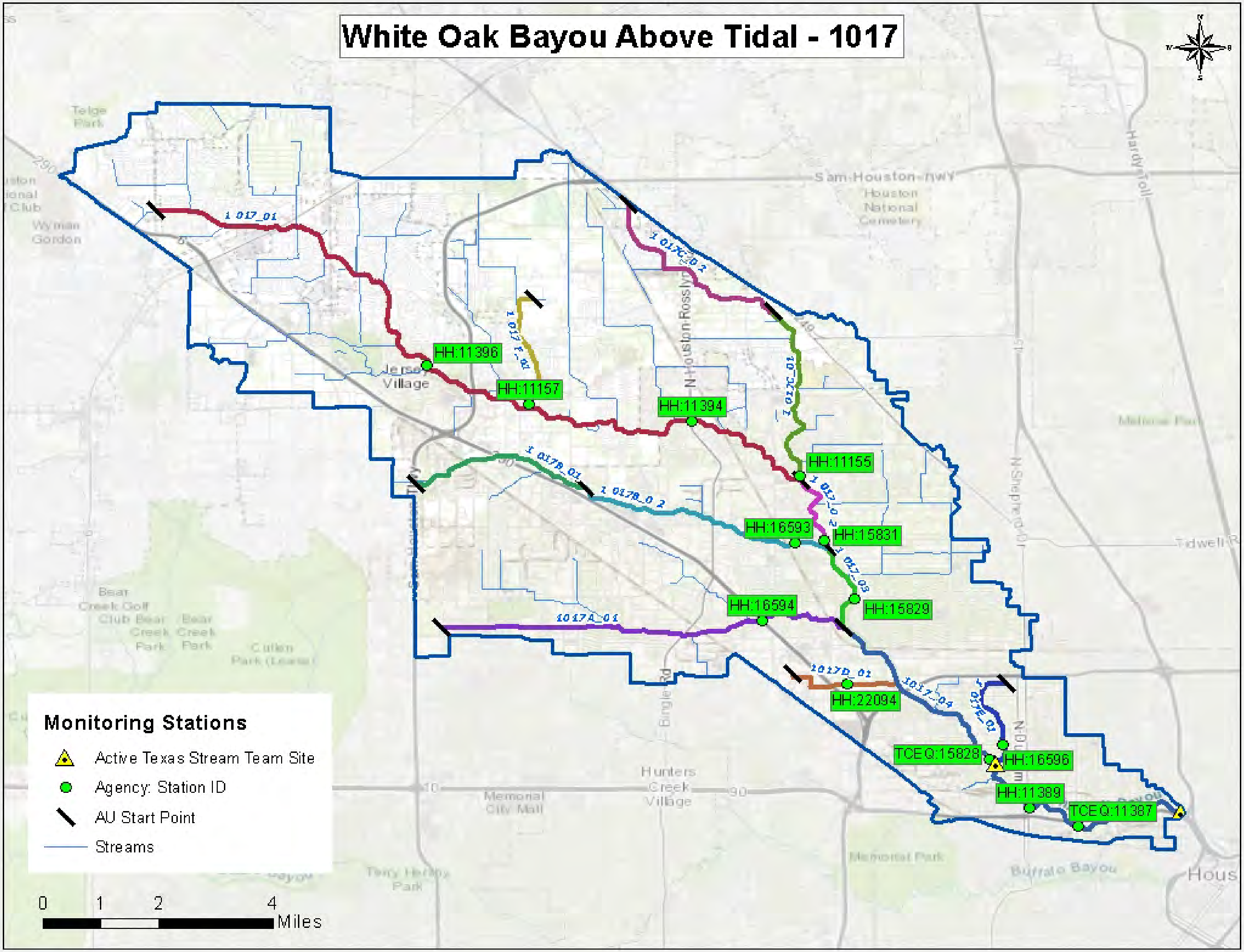
- Segment 1017D (Perennial Stream w/ limited ALU): **Unnamed Tributary of White Oak Bayou** (unclassified water body) – From the confluence with White Oak Bayou Above Tidal confluence downstream of TC Jester, to Hempstead Hwy, north of US Hwy 290 in Harris County

- Segment 1017E (Perennial Stream w/ limited ALU): **Unnamed Tributary of White Oak Bayou** (unclassified water body) – From the confluence with White Oak Bayou Above Tidal, near W 11th Street, to just upstream of W 26th Street, south of Loop 610 W in Harris County

- Segment 1017F (Perennial Stream w/ high ALU): **Rolling Fork Creek** (unnamed tributary) – From the White Oak Bayou Above Tidal confluence to a point 3.9 km (2.4 mi) upstream

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11387	1017	WHITEOAK BAYOU IMMEDIATELY DOWNSTREAM OF HEIGHTS BOULEVARD IN HOUSTON	FO	QUARTERLY	Field, Conventional, Bacteria, Flow
11389	1017	WHITEOAK BAYOU AT NORTH SHEPHERD STREET IN HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11394	1017	WHITEOAK BAYOU AT NORTH HOUSTON ROSSLYN ROAD	HH	BIMONTHLY	Field, Conventional, Bacteria
11396	1017	WHITEOAK BAYOU IMMEDIATELY DOWNSTREAM OF TAHOE DRIVE	HH	BIMONTHLY	Field, Conventional, Bacteria
15828	1017	WHITEOAK BAYOU IMMEDIATELY DOWNSTREAM OF WEST TC JESTER BOULEVARD IN HOUSTON	FO	QUARTERLY	Field, Conventional, Bacteria
15829	1017	WHITEOAK BAYOU IMMEDIATELY DOWNSTREAM OF WEST 43RD STREET IN NORTHWEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
15831	1017	WHITEOAK BAYOU AT WEST TIDWELL ROAD IN NORTHWEST HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
16594	1017A	BRICKHOUSE GULLY AT US 290 IN NORTHWEST HOUSTON 2.03 KM UPSTREAM OF CONFLUENCE WITH WHITEOAK BAYOU	HH	BIMONTHLY	Field, Bacteria, Flow
16593	1017B	COLE CREEK IMMEDIATELY UPSTREAM OF BOLIVIA BLVD 792 METERS UPSTREAM OF CONFLUENCE WITH WHITEOAK BAYOU IN NW HOUSTON	HH	BIMONTHLY	Field, Conventional, Bacteria
11155	1017C	VOGEL CREEK IMMEDIATELY DOWNSTREAM OF WEST LITTLE YORK ROAD	HH	BIMONTHLY	Field, Conventional, Bacteria
22094	1017D	UNNAMED TRIBUTARY OF WHITE OAK BAYOU APPROXIMATELY 30 METERS SW OF HELBERG RD DEAD END.	HH	BIMONTHLY	Field, Conventional, Bacteria
16596	1017E	UNNAMED TRIBUTARY OF WHITE OAK BAYOU AT W 14TH IN WEST HOUSTON 516 METERS UPSTREAM OF CONFLUENCE WITH WHITE OAK BAYOU	HH	BIMONTHLY	Field, Conventional, Bacteria
11157	1017F	ROLLING FORK CREEK IMMEDIATELY DOWNSTREAM OF LAKE LANE	HH	BIMONTHLY	Field, Bacteria

FO = TCEQ Regional Office
HH = Houston Health & Human Services


White Oak Bayou Above Tidal - 1017
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
1
2
4
Miles
HH:11396
HH:11157
HH:11394
HH:11155
HH:16593
HH:15831
HH:15829
HH:16594
HH:22094
TCEQ:15828
HH:16596
HH:11389
TCEQ:11387
1017_01
1017_02
1017_03
1017_04
1017A_01
1017B_01
1017B_02
1017C_01
1017C_02
1017D_01
1017E_01
1017F_01
Jersey Village
Sam Houston Tollway
Houston National Cemetery
Hunters Creek Village
Memorial City Mall
Memorial Park
Buffalo Bayou
Bear Creek Golf Club
Bear Creek Park
Cullen Park
Terry Hershey Park
Telge Park
Tidwell Rd

Segment 1017 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	33 / 92	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0 / 3.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0 / 2.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	110		
Sulfate (mg/L as SO_4):	65		
Total Dissolved Solids (mg/L):	600		

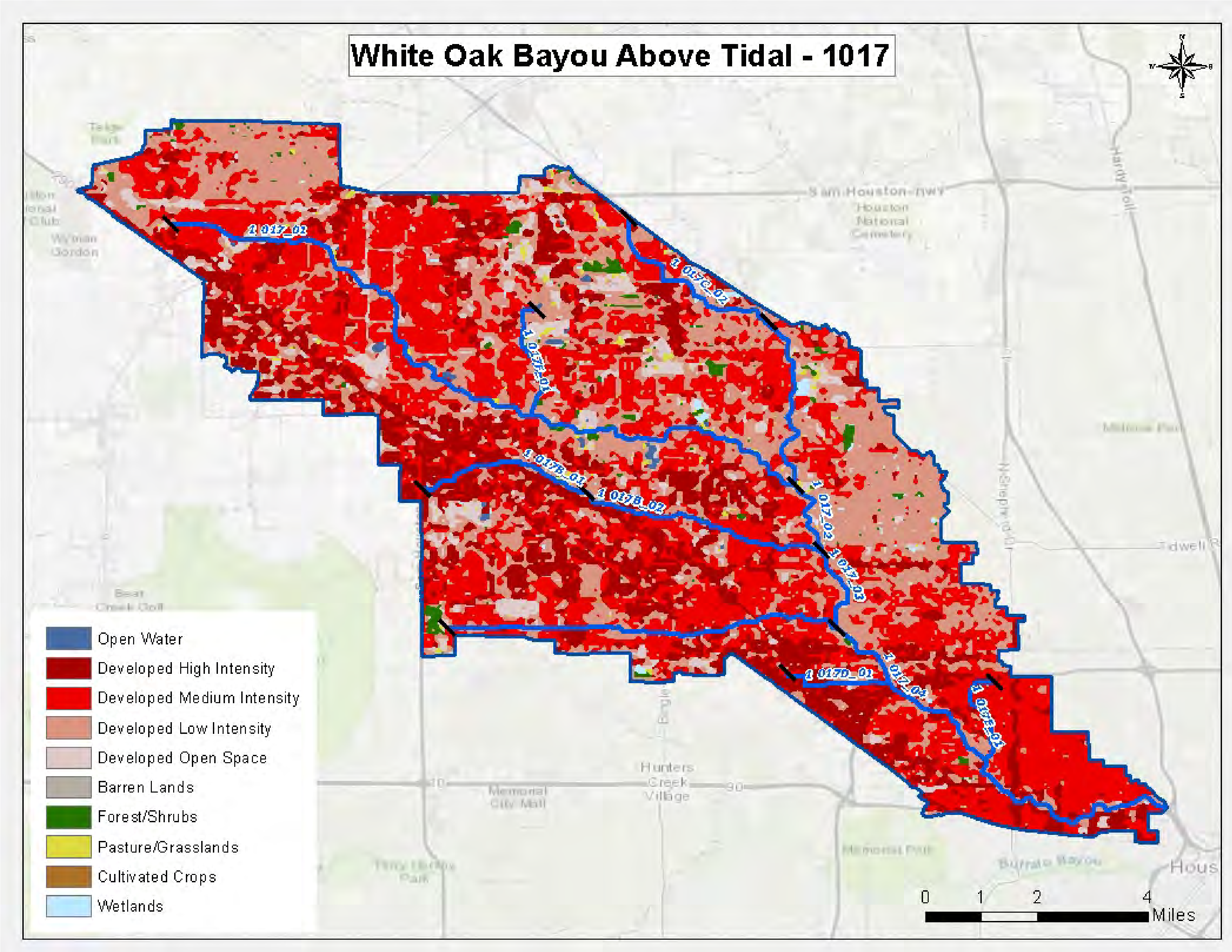
Segment Discussion

Watershed Characteristics and Land Cover: The White Oak Bayou Above Tidal (1017) watershed is defined as from a point immediately upstream of the confluence of Little White Oak Bayou in Harris County to a point 3.0 km (1.9 mi) upstream of FM 1960 in Harris County. Brickhouse Gully and Cole, Little White Oak, and Vogel Creeks are major tributaries to White Oak Bayou Above Tidal. All segments throughout the entire watershed have been channelized, leaving grassy banks and little, if any, vegetative canopy. The main channel in the lower 9.1 miles of the segment has both a concrete bottom and concrete sides halfway up the banks. All grass banks throughout the entire watershed are mowed on a regular basis.

The White Oak Bayou Above Tidal watershed is almost entirely developed, with 96.62 percent of the watershed being developed. The watershed contains widespread residential development with the densest urban population located within the I-610 Loop. High-density commercial development is concentrated along the U.S. Highway 290 corridor. There are pockets of parklands and wooded acreages scattered throughout the watershed. Subdivisions and commercial development have also rapidly expanded to the northwest of Jersey Village.

Segment 1017 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	1,907.25	3.39	664.96	1.18	-65.14
Barren Lands	55.60	0.10	79.39	0.14	42.79
Developed	51,728.51	91.97	54,323.41	96.62	5.02
Forest/Shrubs	1,356.16	2.41	731.23	1.30	-46.08
Open Water	297.34	0.53	130.10	0.23	-56.25
Wetlands	897.36	1.60	296.90	0.53	-66.91
TOTAL	**56,242.21**	**100.00**	**56,225.98**	**100.00**	



White Oak Bayou Above Tidal - 1017
1017_01
1017C_01
1017F_01
1017B_01
1017B_02
1017_02
1017_03
1017D_01
1017_04
1017E_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1
2
4
Miles
Sam Houston Pkwy
Houston National Cemetery
Hunters Creek Village
Memorial City Mall

Water Quality Issues:

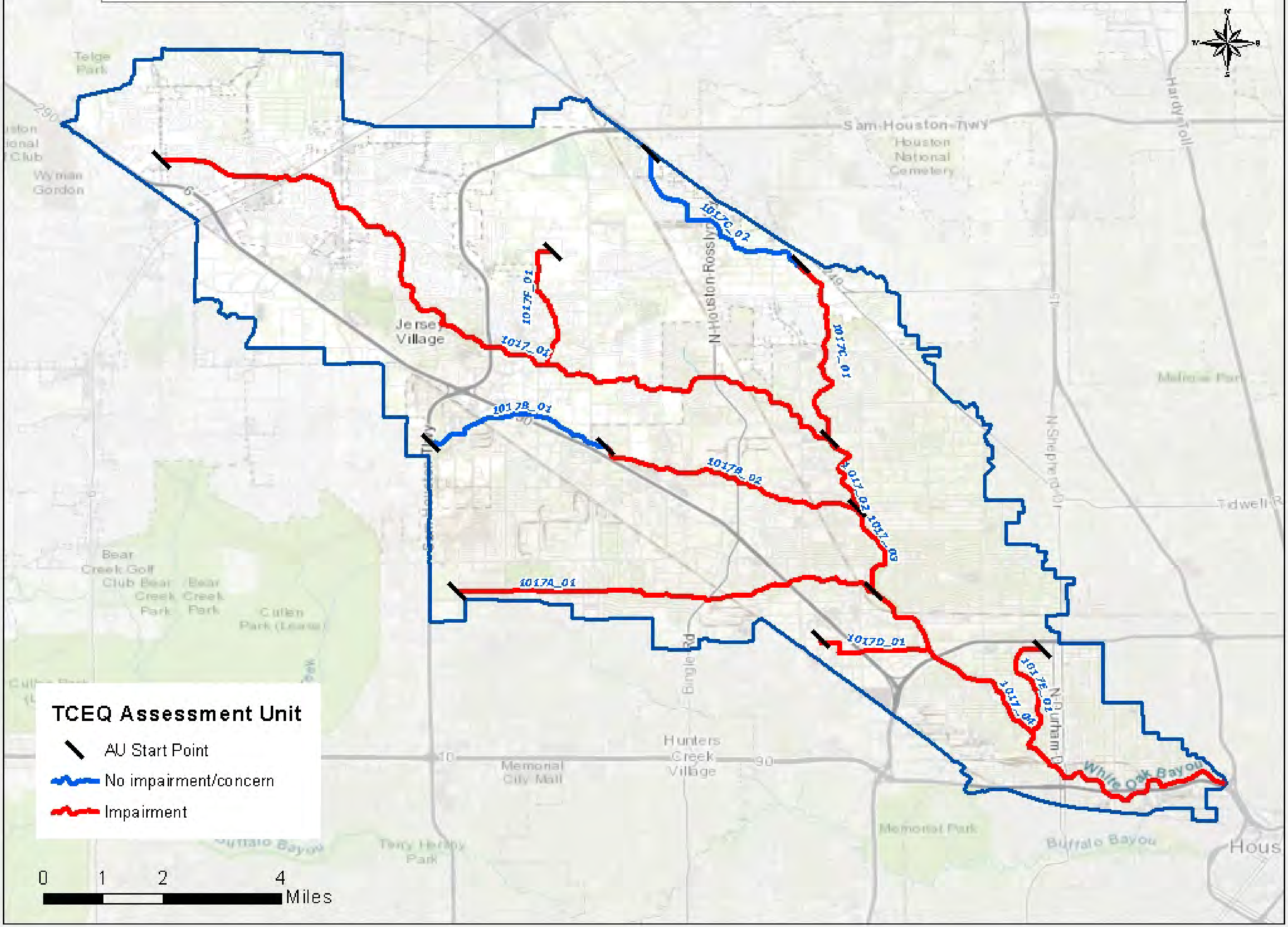
Bacteria Impairments and Concerns
This segment is not supporting its contact recreation use designation. The entire segment, as well as its tributaries, are listed as impaired bacteria in the 2020 Integrated Report.

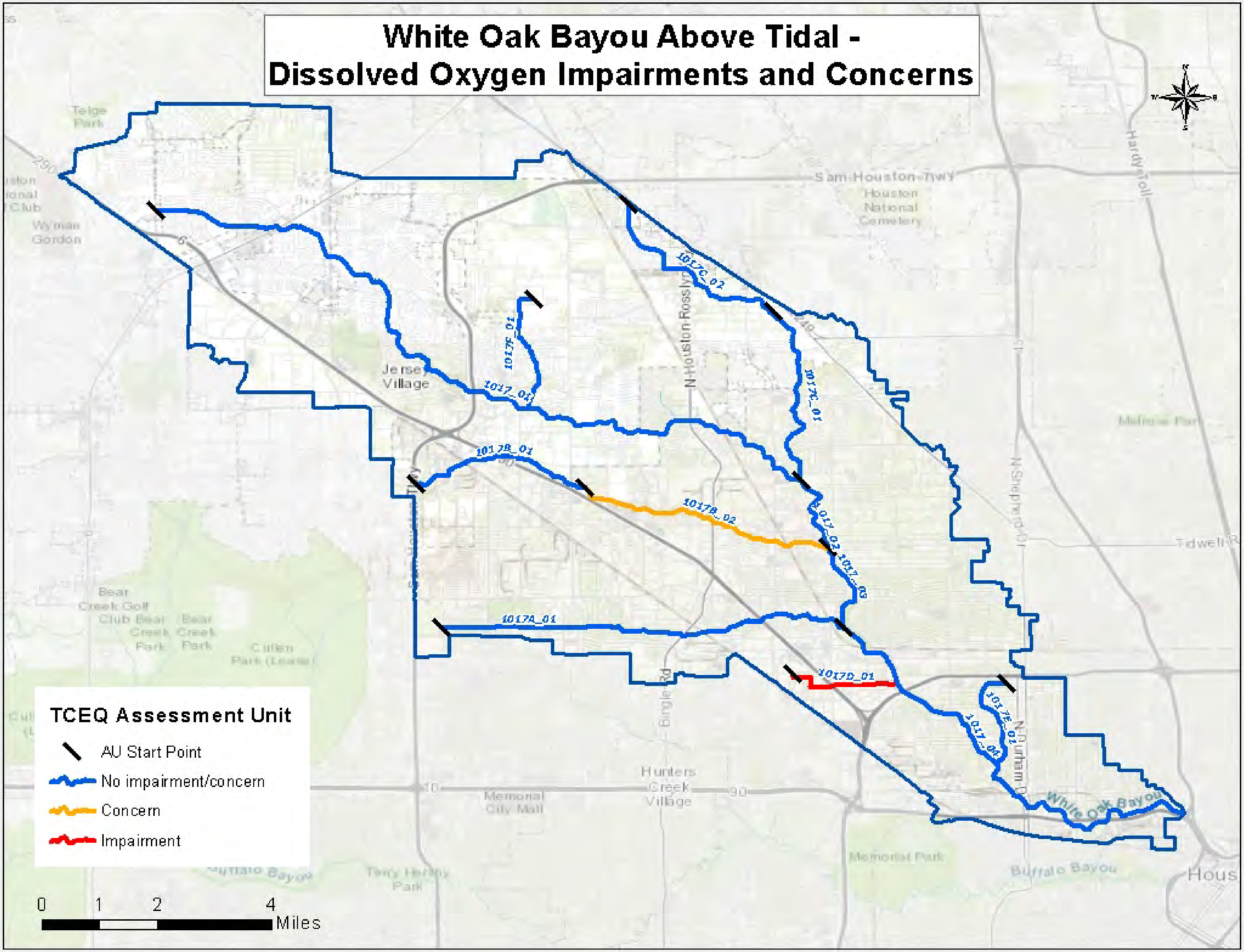
Dissolved Oxygen Impairments and Concerns
A concern for dissolved oxygen is listed for AU 1017B_02 in the 2020 Integrated Report. For this assessment unit, 13 of 62 samples were below the dissolved oxygen grab screening level of 5.0 mg/L. An impairment is listed for AU 1017D_01 based on a carry forward for 24-hour dissolved oxygen average and minimum.

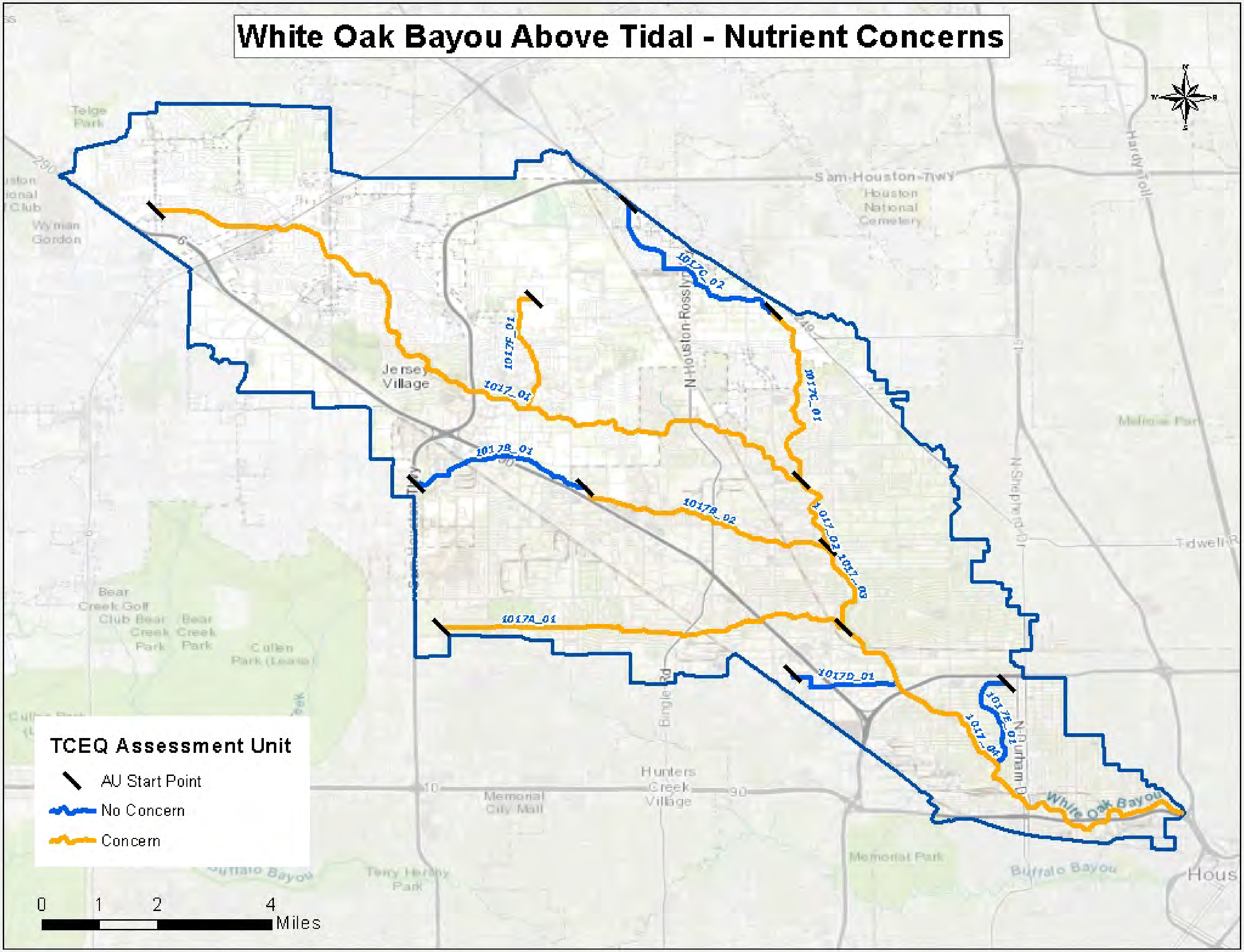
Nutrient Concerns
Nutrient concerns for nitrate-nitrogen and total phosphorus are present in White Oak Bayou Above Tidal (1017), Brickhouse Gully (1017A), Cole Creek (1017B), Vogel Creek (1017C), and Rolling Fork Creek (1017F). In many of these segments, exceedances of the screening level occur in more than 90 percent of samples.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

White Oak Bayou Above Tidal - Bacteria Impairments and Concerns




White Oak Bayou Above Tidal -
Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0
1
2
4
Miles
1017_01
1017_02
1017_03
1017_04
1017A_01
1017B_01
1017B_02
1017C_01
1017C_02
1017D_01
1017E_01
1017F_01
White Oak Bayou
Jersey Village
Hunters Creek Village
Memorial City Mall
Sam Houston Twy
Houston National Cemetery
Tidwell Rd
Bear Creek Golf Club
Cullen Park (Lease)
Buffalo Bayou
Memorial Park



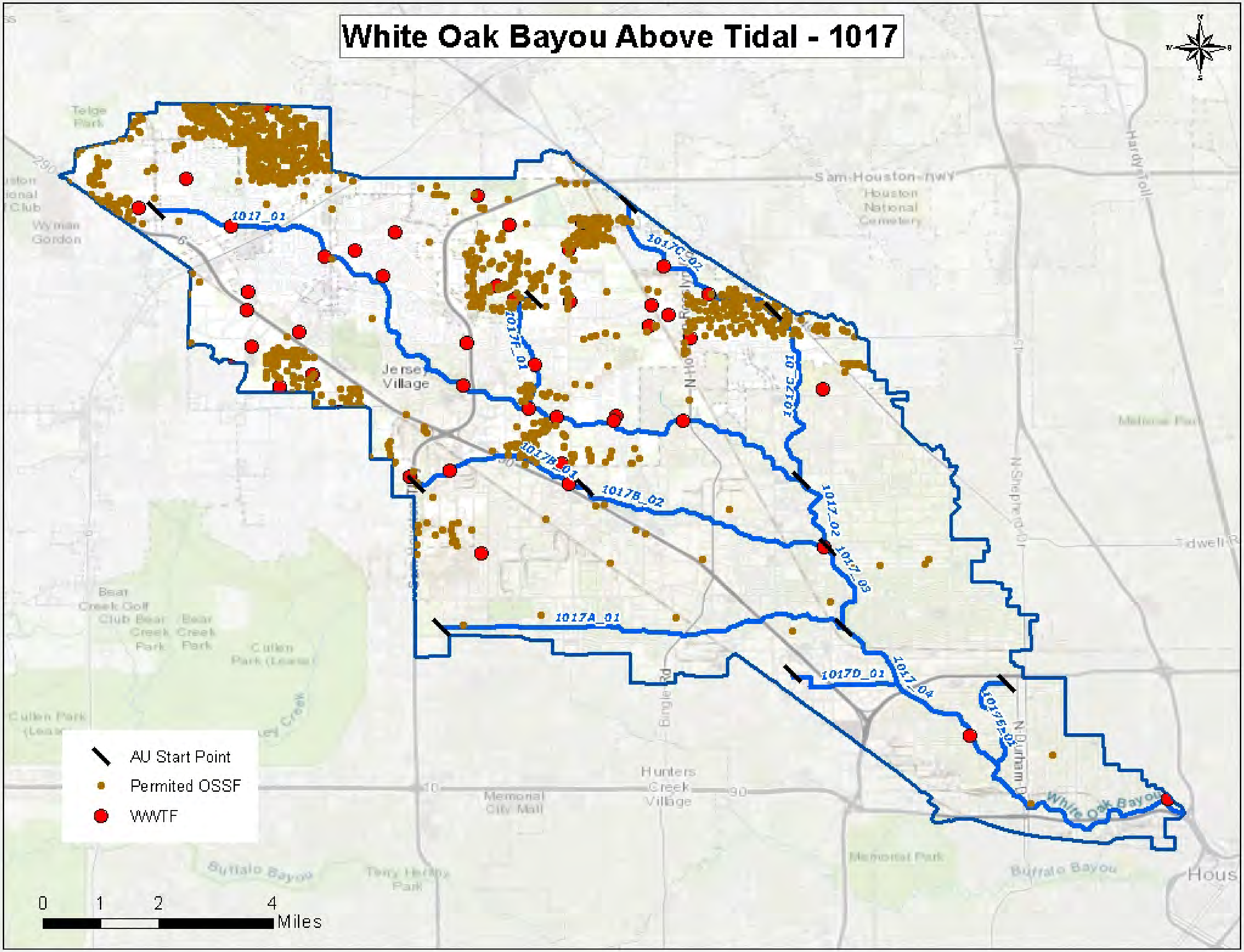
White Oak Bayou Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
1
2
4
Miles
1017C_02
1017C_01
1017E_01
1017_01
1017B_01
1017B_02
1017_02
1017_03
1017A_01
1017D_01
1017E_01
1017_04
White Oak Bayou
Buffalo Bayou
Jersey Village
Sam Houston Tlwy
Houston National Cemetery
Hunters Creek Village
Memorial City Mall
Memorial Park
Bear Creek Golf Club
Bear Creek Park
Cullen Park (Lease)
Telge Park
N Houston Rosslyn
N Shepherd Dr
N Durham Dr
Bingle Rd
Tidwell Rd
Hardy Toll

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the White Oak Bayou Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 44 permitted wastewater outfalls in the White Oak Bayou Above Tidal watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 1,395 permitted systems in the watershed. The wastewater treatment facilities and on-site sewage facilities in the White Oak Bayou Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 655 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the White Oak Bayou Above Tidal watershed.

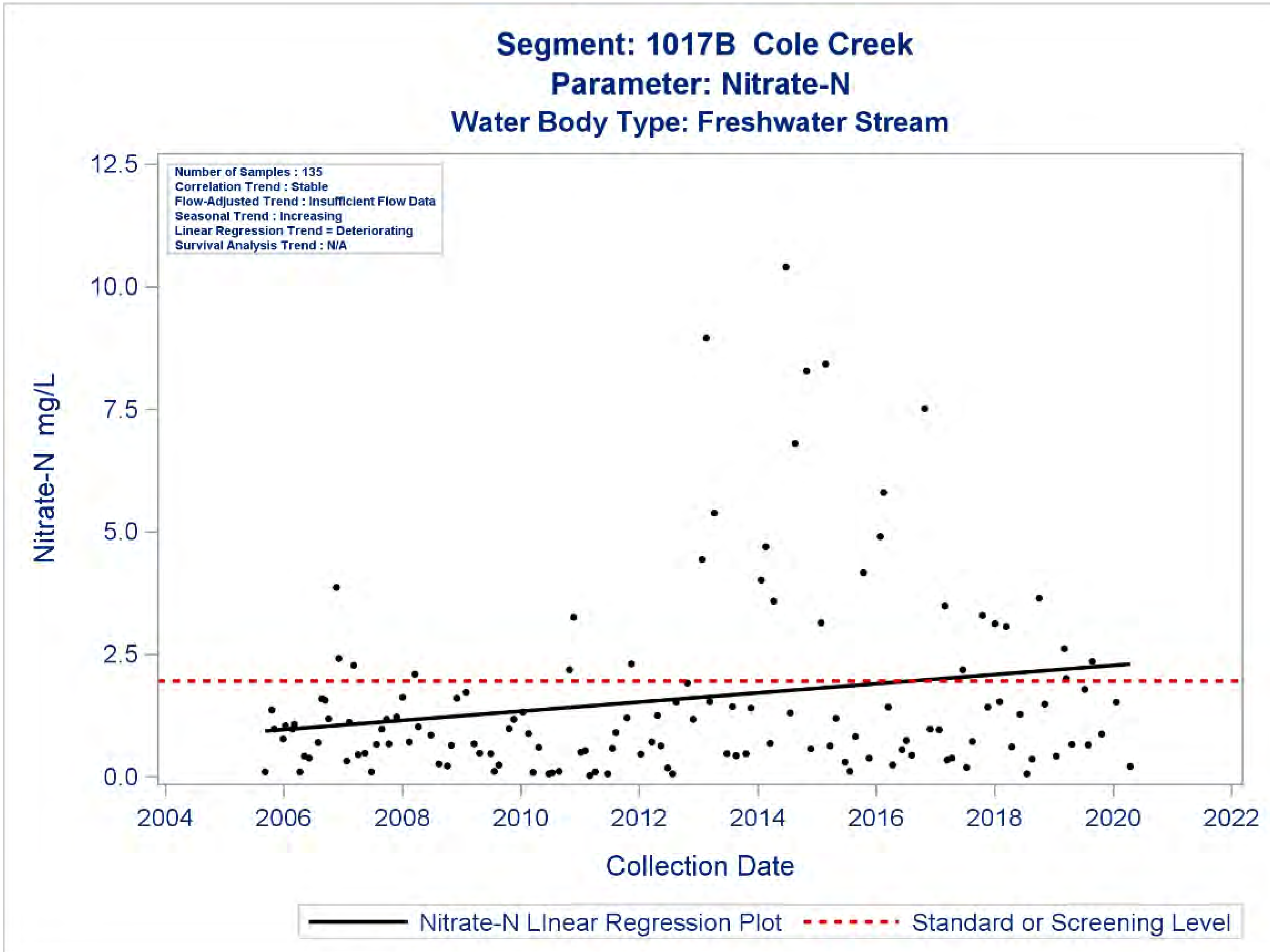

White Oak Bayou Above Tidal - 1017
AU Start Point
Permited OSSF
WWTF
0 1 2 4 Miles
1017_01
1017C_02
1017F_01
1017C_01
1017B_01
1017B_02
1017_02
1017_03
1017A_01
1017D_01
1017_04
1017E_01
White Oak Bayou
Jersey Village
Sam Houston Tollway
Houston National Cemetery
Telge Park
Bear Creek Golf Club
Bear Creek Park
Cullen Park
Hunters Creek Village
Memorial City Mall
Memorial Park
Terry Hershey Park
Buffalo Bayou
N Houston Rosslyn
N Shepherd Dr
N Durham Dr
Bingle Rd
Tidwell Rd
Hardy Toll

Trend Analysis:

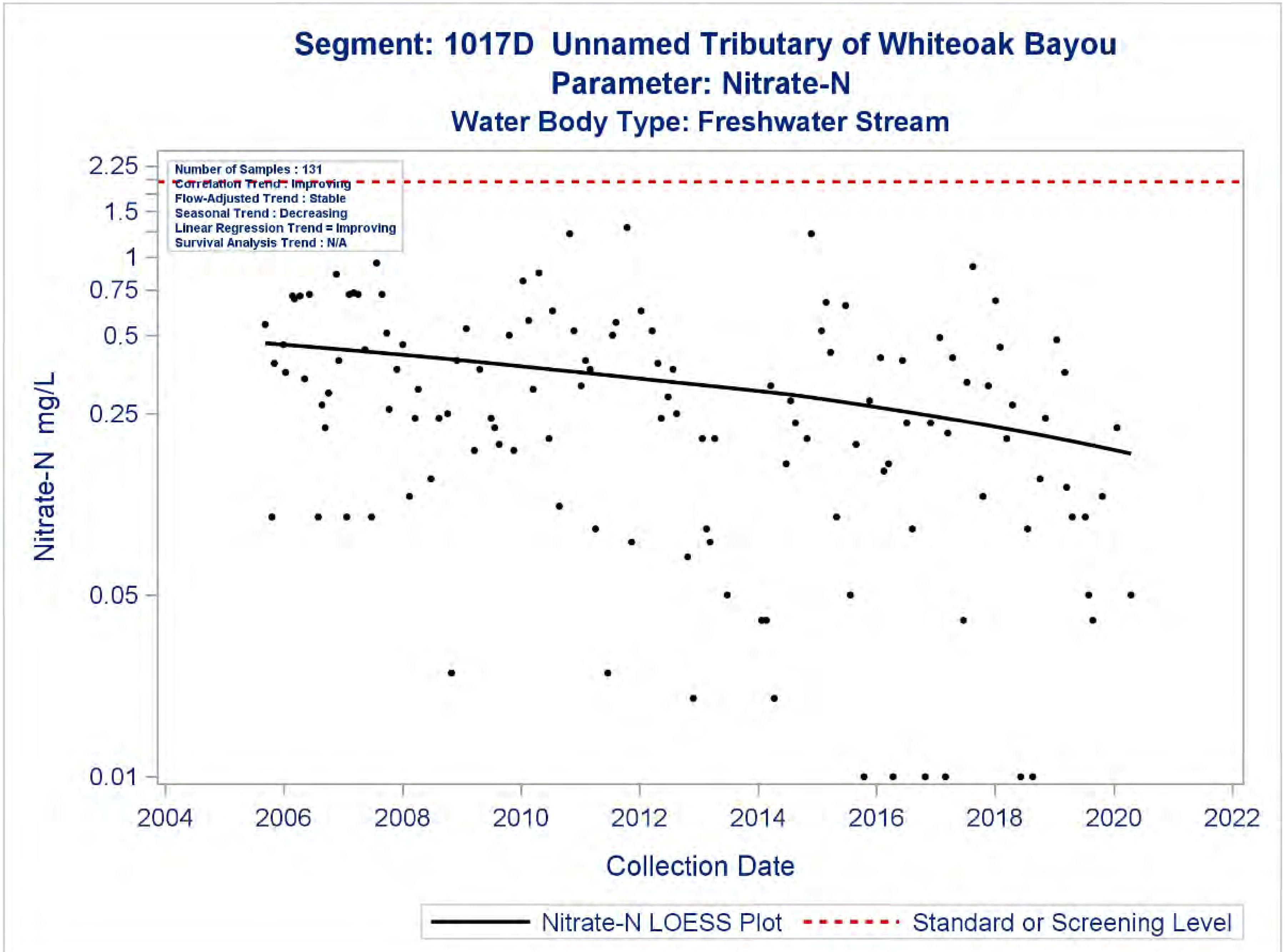
Regression analysis of water quality data revealed stable nutrient trends for nitrate and total phosphorus for the segment and most of its tributaries. A significant portion of samples were above the screening criteria for White Oak Bayou Above Tidal (1017), Brickhouse Gully (1017A), Cole Creek (1017B), Vogel Creek (1017C), and Rolling Fork Creek (1017F), with those AUs listed as having a concern for nitrate and total phosphorus in the 2020 Integrated Report. For the main segment 1017, nitrate samples reached up to 10 times the screening criteria and total phosphorus samples reached up to the four times the screening criteria. Both parameters are stable. There is an improving total phosphorus trend for 1070E and 1017F, but total phosphorus levels on 1017C show a deteriorating trend. In contrast, the unnamed tributaries 1017D and 1017E show stable nitrate and total phosphorus levels with most results below the screening criteria, as well as an improving trend with ammonia concentrations decreasing. It is also worth noting that while 1017A and 1017B show stable levels LOESS correlation but deteriorating Linear Regressions, frequently above the screening criteria for nitrate and total phosphorus, samples from the most recent few years show fewer or less extreme exceedances, which could be a sign of improvement moving forward.

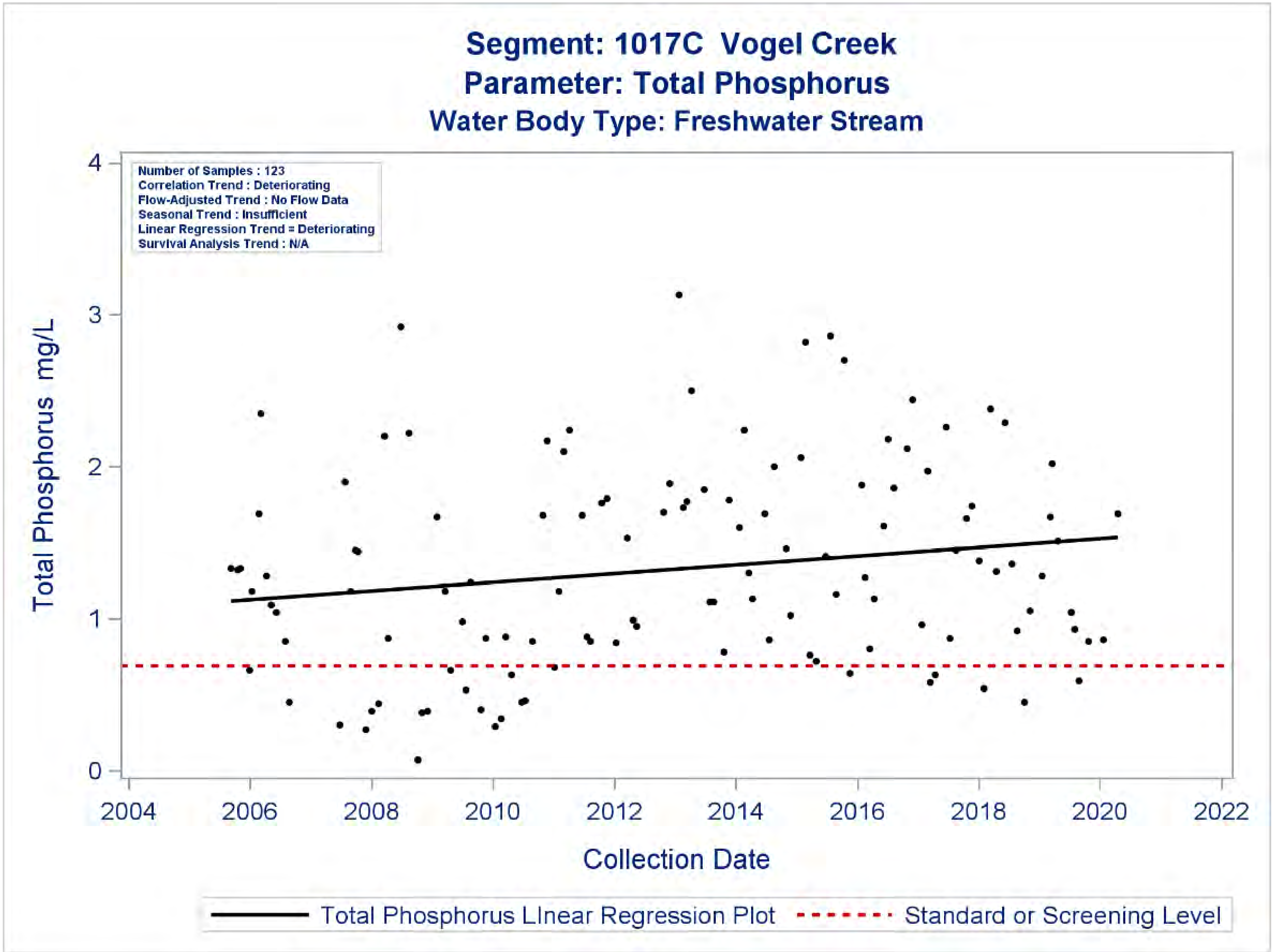
The 2020 Integrated Report also lists unclassified segments 1017B and 1017D as having a concern and impairment for dissolved oxygen (DO), respectively, but regression analysis of DO grab samples shows a stable trend for both AUs. DO levels on 1017B are frequently at or below 5.0 mg/L, but only one sample has fallen below the absolute minimum screening level since 2012. Although the overall trend for 1017D is stable, samples since about 2018 have all been above the absolute minimum screening level and generally appear to be at or above 5.0 mg/L, which might indicate recent improvement.

A bacteria impairment exists for the main segment 1017 and all of its tributaries. Regression analysis shows stable levels above the state standard for contact recreation on 1017 and all tributaries except for 1017E which shows a deteriorating trend with *E. coli* concentration with almost all results above the state standard and increasing.

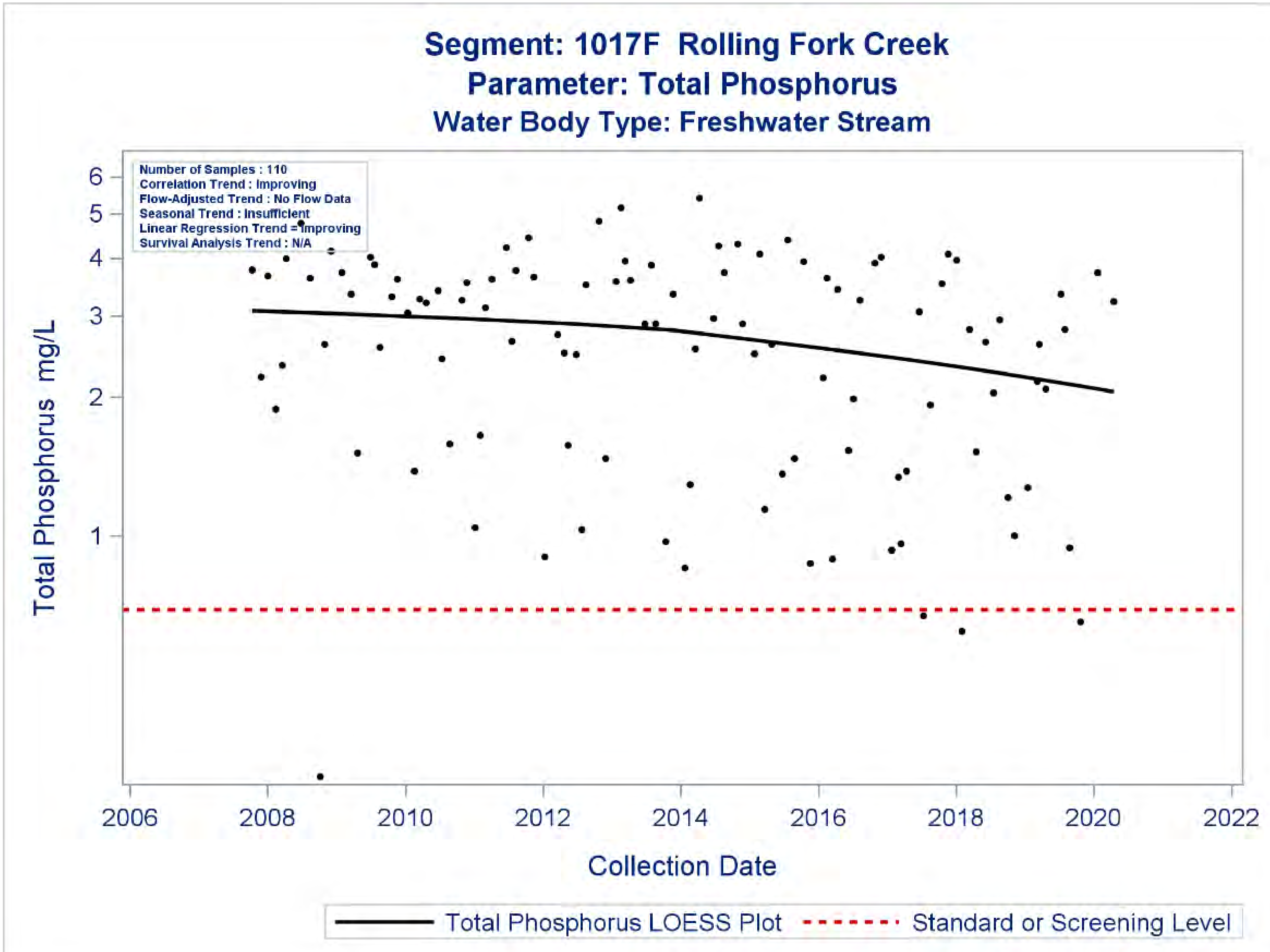


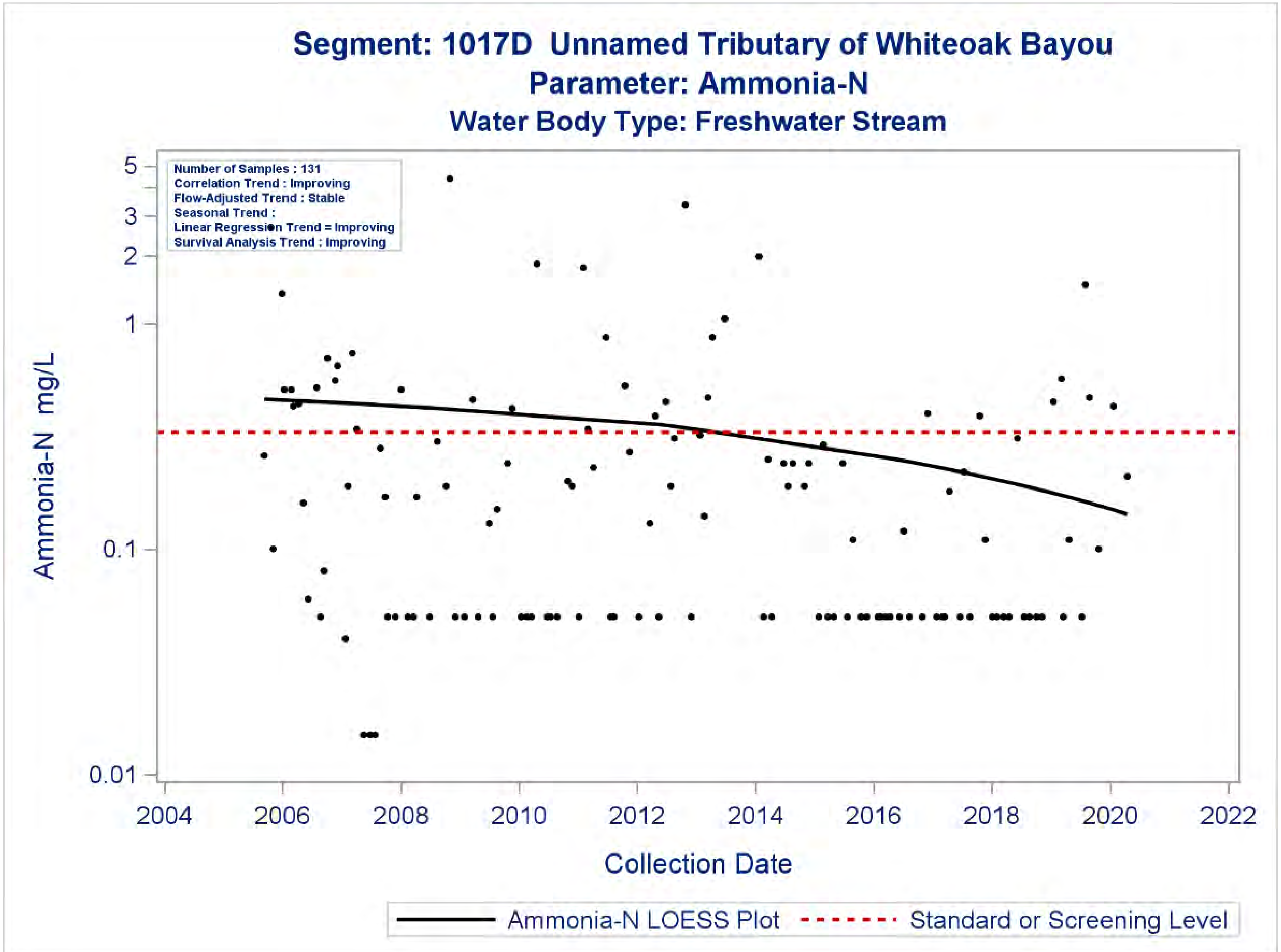
Segment: 1017B Cole Creek
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 135
Correlation Trend : Stable
Flow-Adjusted Trend : Insufficient Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
12.5
10.0
7.5
5.0
2.5
0.0
Nitrate-N mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level


Segment: 1017D Unnamed Tributary of Whiteoak Bayou
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 131
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Nitrate-N mg/L
2.25
1.5
1
0.75
0.5
0.25
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

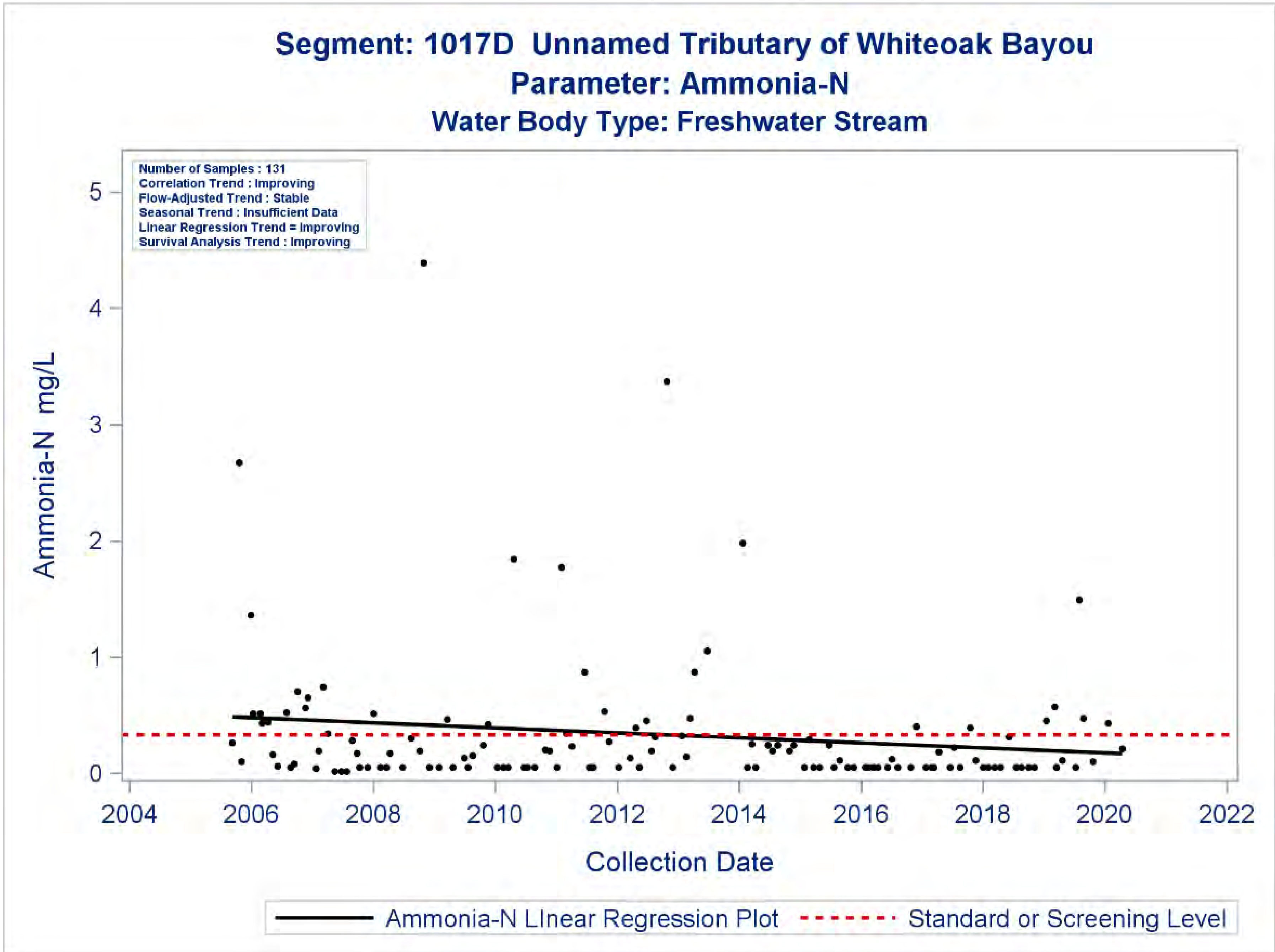


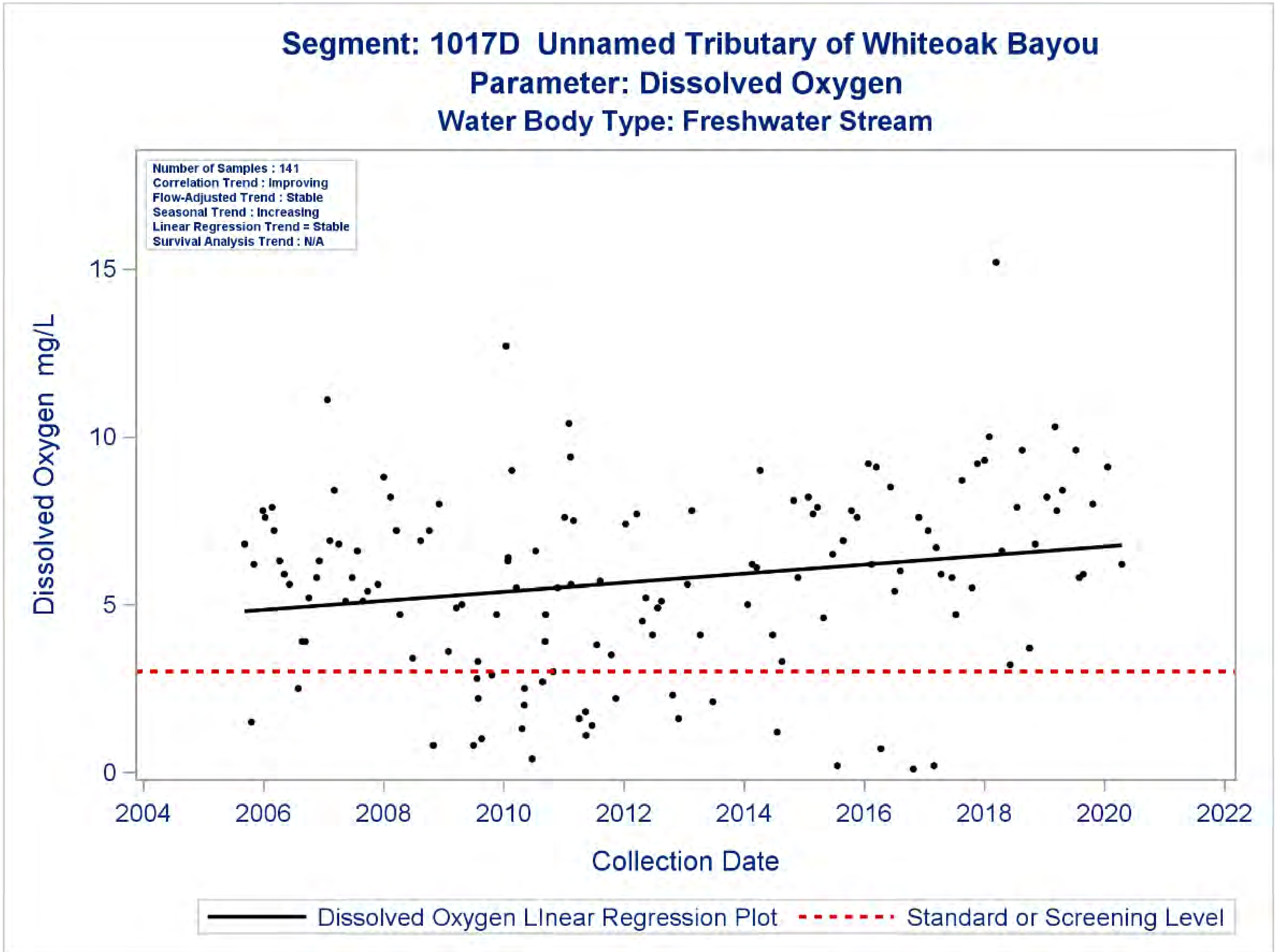
Segment: 1017C Vogel Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 123
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
1
2
3
4
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level

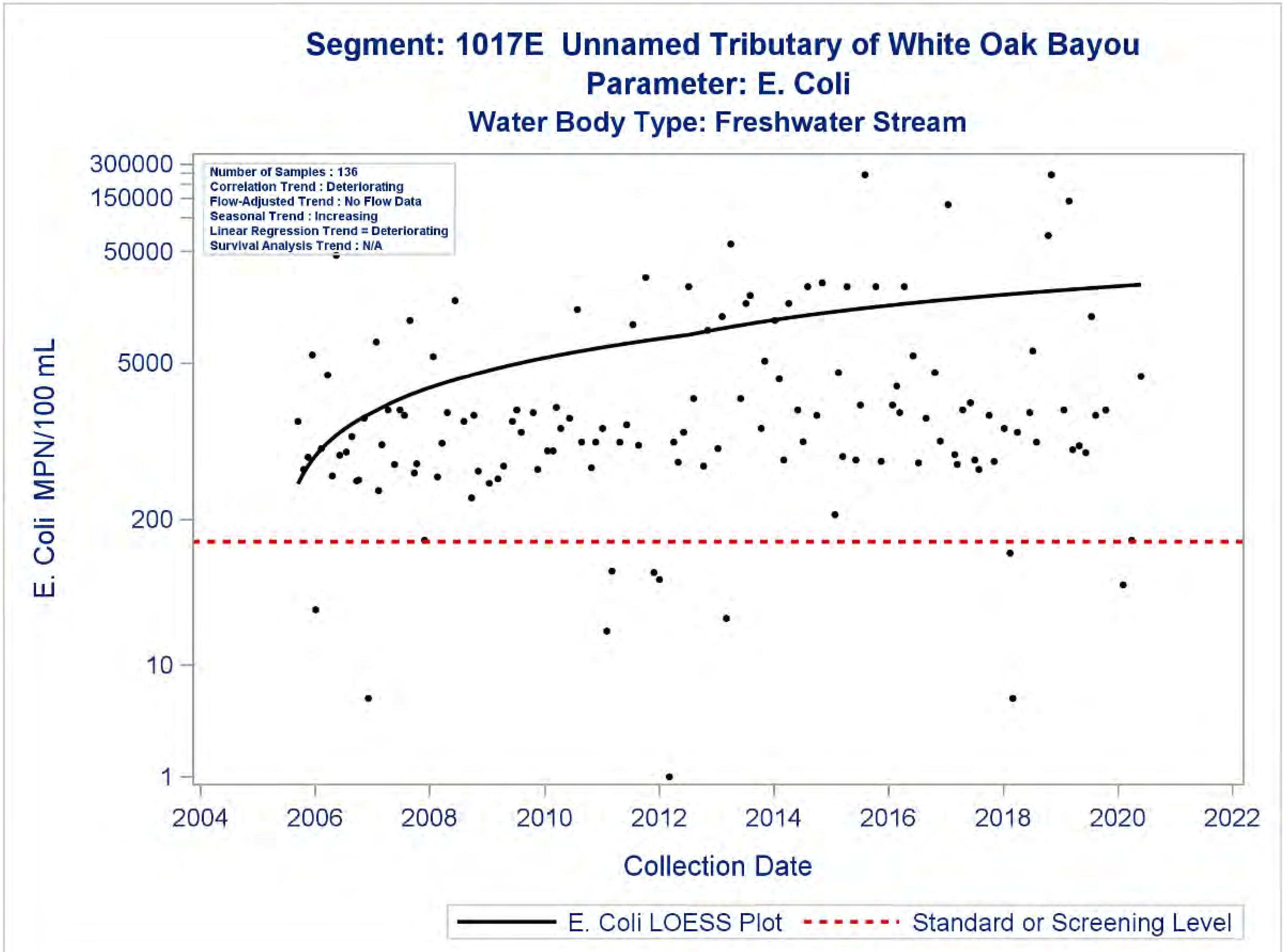

Segment: 1017F Rolling Fork Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 110
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
6
5
4
3
2
1
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



Segment: 1017D Unnamed Tributary of Whiteoak Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 131
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend :
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
5
3
2
1
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level


Segment: 1017D Unnamed Tributary of Whiteoak Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 131
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
0
1
2
3
4
5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level


Segment: 1017D Unnamed Tributary of Whiteoak Bayou
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 141
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level



Segment: 1017E Unnamed Tributary of White Oak Bayou
Parameter: E. Coli
Water Body Type: Freshwater Stream
Number of Samples : 136
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
300000
150000
50000
5000
200
10
1
E. Coli MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1101_01 I 1101_02 I 1101_03 I 1101A_01 I 1101B_01 I 1101B_02 I 1101C_01 I 1101D_01 I 1101E_01 I 1101F_01 I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Waste haulers illegal discharges/improper disposal • Improper or no pet waste disposal • Developments with malfunctioning OSSFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Add water quality features to stormwater systems • Improve compliance and enforcement of existing storm water quality permits to minimize contamination in runoff • Improve construction oversight to minimize TSS discharges to waterways. • Regionalize chronically non-compliant WWTFs • Increase monitoring requirements for self-reporting • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding pet waste disposal • Ensure proper citing of new or replacement OSSFs • More public education regarding OSSF operation and maintenance • Increase monitoring and enforcement efforts to identify and repair failing OSSFs.
Low Dissolved Oxygen Concentrations	1017B C 1017D I	▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Improve compliance and enforcement of existing storm water quality permits • Improve operation and maintenance of existing WWTP and collection systems • Regionalize chronically non-compliant WWTFs • More public education regarding disposal of household fats, oils, and grease • More public education regarding OSSF operation and maintenance • More public education regarding pet waste disposal

				• Work with drainage districts and agencies to change practices of clear-cutting waterways • Conserve or plant canopy trees and habitat along waterways
Elevated Nutrient Concentrations	***Nitrate*** 1017 C 1017A_02 C 1017B_02 C 1017C C 1017F C ***Phosphorus*** 1017 C 1017A_02 C 1017B_02 C 1017C C 1017F C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields	• Detrimental effect on aquatic biological community	• Expand use of LID and green infrastructure practices • Encourage implementation of LID practices in new developments • Maintain riparian buffer areas along waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.

Special Studies:

This segment is part of a larger geographic area covered under several TMDLs, collectively known as the Bacteria Implementation Group (BIG) I-Plan. Implementation efforts in this watershed in particular have been very successful in reducing bacteria levels in White Oak Bayou. For example, the City of Houston and Harris County worked together in reducing sanitary sewer system leaks and overflows and eliminating illegal sewer connections in the watershed. Additionally, the Harris County Flood Control District (HCFCD) now includes water quality features, such as wetlands, in the stormwater detention basins they develop along the bayou.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Encourage implementation of Low Impact Development practices in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Support public education on pet waste disposal

BASIN 11

San Jacinto-Brazos Coastal Basin

1113 – Armand Bayou Tidal

1105 – Bastrop Bayou Tidal

1108 – Chocolate Bayou Above Tidal

1107 – Chocolate Bayou Tidal

1102 – Clear Creek Above Tidal

1101 – Clear Creek Tidal

1104 – Dickinson Bayou Above Tidal

1103 – Dickinson Bayou Tidal

1111 – Old Brazos River Channel Tidal

1110 – Oyster Creek Above Tidal

1109 – Oyster Creek Tidal

Segment Number: 1113 Name: Armand Bayou Tidal

Length:	9 miles	**Watershed Area:**	59 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	10	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	6

DESCRIPTION

- Segment 1113 (Tidal Stream w/ high ALU): **Armand Bayou Tidal** (classified water body) – From the Clear Lake confluence (at NASA Road 1 bridge) in Harris County to a point 0.8 km (0.5 mi) downstream of Genoa-Red Bluff Road in Pasadena in Harris County (includes Mud Lake/Pasadena Lake)

- Segment 1113A (Perennial Stream w/ high ALU): **Armand Bayou Above Tidal** (unclassified water body) – From the upper segment boundary of Armand Bayou Tidal, 0.8 km (0.5 mi) downstream of Genoa-Red Bluff Road), upstream to Beltway 8 in Harris County

- Segment 1113B (Tidal Stream w/ high ALU): **Horsepen Bayou** (unclassified water body) – From the Armand Bayou confluence to the SH 3

- Segment 1113C (Perennial Stream w/ intermediate ALU): **Unnamed Tributary to Horsepen Bayou** (unclassified water body) – From the Horsepen Bayou confluence to Reseda Road

- Segment 1113D (Tidal Stream w/ high ALU): **Willow Springs Bayou** (unclassified water body) – From the Armand Bayou confluence to a point 2.8 km (1.8 mi) upstream to an unnamed tributary

- Segment 1113E (Tidal Stream w/ high ALU): **Big Island Slough** (unclassified water body) – From the Armand Bayou confluence upstream to a point 2.4 km (1.5 mi) north of Spencer Hwy

- Segment 1113F (Perennial Stream w/ high ALU): **Unnamed Tributary of Armand Bayou Above Tidal** (unclassified water body) – From the Armand Bayou Above Tidal confluence upstream to an unnamed tributary 0.48 km (0.3 mi) upstream of Beltway 8

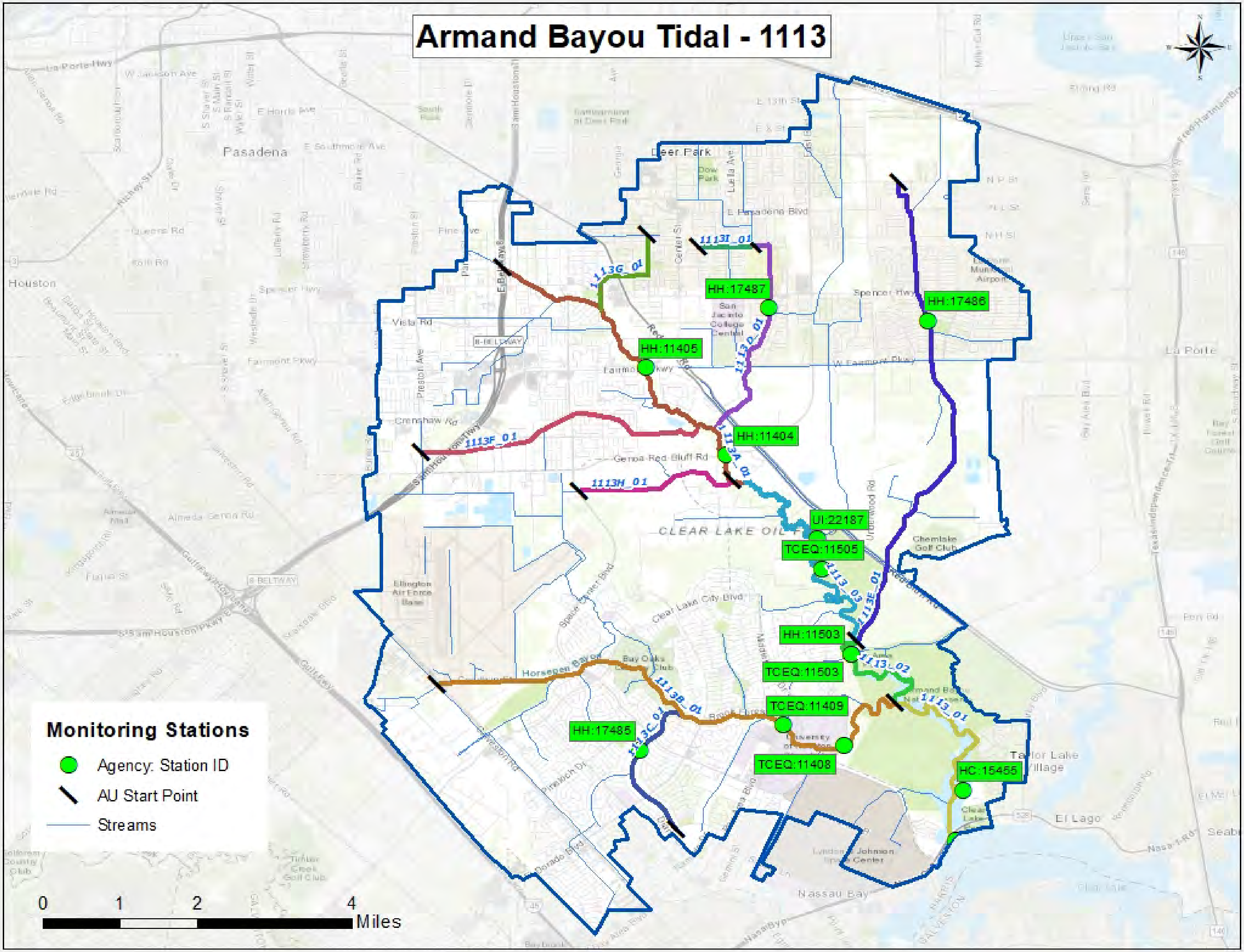
- Segment 1113G (Perennial Stream w/ high ALU): **Unnamed Tributary of Armand Bayou Above Tidal** (unclassified water body) – From the Armand Bayou Above Tidal confluence upstream to an unnamed tributary 1.4 km (0.86 mi) upstream of Red Bluff Road

- Segment 1113H (Perennial Stream w/ high ALU): **Unnamed Tributary of Armand Bayou Above Tidal** (unclassified water body) – From the Armand Bayou Above Tidal to the confluence of an unnamed tributary 3.4 km (2.1 mi) upstream and south of Genoa-Red Road

- 1113I (Perennial Stream w/ high ALU): **Unnamed Tributary of Willow Springs Bayou** (unclassified water body) – From the Will Springs Bayou confluence upstream to a point 0.37 km (0.23 mi) east of Center Street

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11503	1113	ARMAND BAYOU TIDAL AT BAY AREA BLVD NORTH OF NASA AT MIDDLE OF MEDIAN BETWEEN 2 BRIDGES EASTERN SHORE	FO	Quarterly	Field, Conventional, Bacteria
11503	1113	ARMAND BAYOU TIDAL AT BAY AREA BLVD NORTH OF NASA AT MIDDLE OF MEDIAN BETWEEN 2 BRIDGES EASTERN SHORE	HH	Bi-monthly	Field, Conventional, Bacteria
15455	1113	ARMAND BAYOU TIDAL 25 M WEST OF CLEAR LAKE PARK FISHING PIER IN MUD LAKE/PASADENA LAKE IN HARRIS COUNTY	HC	Bi-monthly	Field, Conventional, Bacteria
22187	1113	ARMAND BAYOU TIDAL 100 METERS DOWNSTREAM OF CONFLUENCE WITH SPRING GULLY	UI	Quarterly	Field, Conventional, Bacteria
11404	1113A	ARMAND BAYOU AT GENOA-RED BLUFF RD NE OF ELLINGTON AFB	HH	Bi-Monthly	Field, Conventional, Bacteria
11405	1113A	ARMAND BAYOU AT FAIRMONT PARKWAY ALONG MEDIAN AT MIDPOINT BETWEEN BRIDGES	HH	Bi-Monthly	Field, Conventional, Bacteria
11409	1113B	HORSEPEN BAYOU AT BAY AREA BLVD NORTH OF NASA	FO	Quarterly	Field, Conventional, Bacteria
17317	1113B	HORSEPEN BAYOU AT MIDDLEBROOK DRIVE IN SOUTHEAST HOUSTON	FO	Quarterly	Field, Conventional, Bacteria
17485	1113C	UNNAMED TRIBUTARY OF HORSEPEN BAYOU TIDAL AT PENN HILLS	HH	Bi-Monthly	Field, Conventional, Bacteria
17487	1113D	WILLOW SPRING AT BANDRIDGE ROAD IN SOUTHEAST HOUSTON	HH	Bi-Monthly	Field, Conventional, Bacteria
17486	1113E	BIG ISLAND SLOUGH AT HILLRIDGE ROAD IN SOUTHEAST HOUSTON	HH	Bi-Monthly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HC = Harris County Pollution Control
HH = Houston Health & Human Services
UI = University of Houston Clear Lake – Environmental Institute of Houston



Armand Bayou Tidal - 1113
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0
1
2
4
Miles
HH:17487
HH:17486
HH:11405
HH:11404
UI:22187
TCEQ:11505
HH:11503
TCEQ:11503
TCEQ:11409
TCEQ:11408
HH:17485
HC:15455
1113G_01
1113I_01
1113D_01
1113F_01
1113A_01
1113H_01
1113_03
1113E_01
1113_02
1113_01
1113B_01
1113C_01
Deer Park
Pasadena
Houston
La Porte
Taylor Lake Village
El Lago
Nassau Bay
CLEAR LAKE OIL FIELD

Segment 1113 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F):	35/ 95	35 / 95	Ammonia-N (mg/L):	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	5.0 / 4.0	Nitrate-N (mg/L):	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.46	0.37
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.66	0.69
Enterococci (MPN/100mL) (grab):	104		Chlorophyll *a* (µg/L):	21	14.1
Enterococci (MPN/100mL) (geometric mean):	35				
E. coli (MPN/100 mL) (grab):		399			
E. coli (MPN/100 mL) (geometric mean):		126			

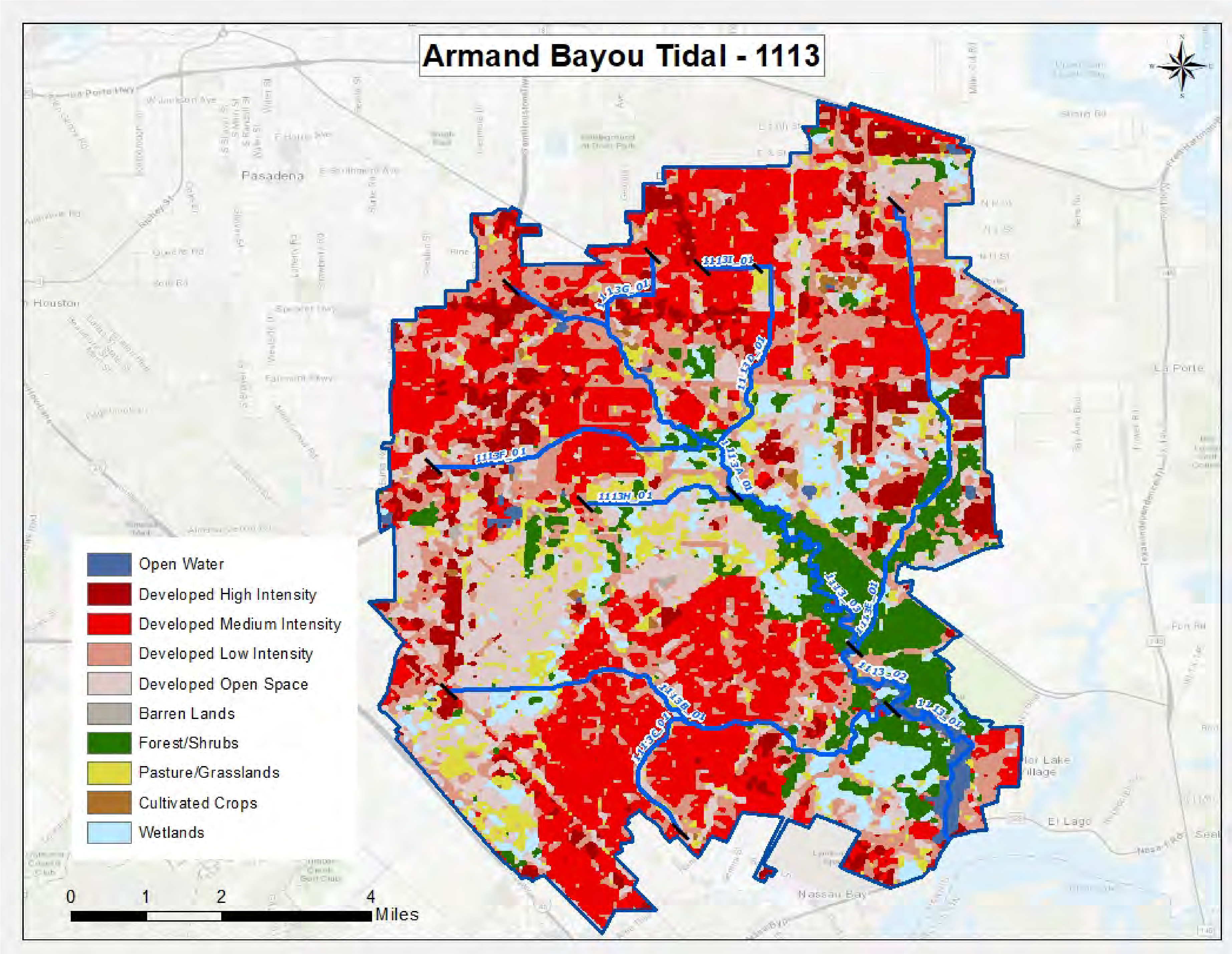
Segment Discussion

Watershed Characteristics and Land Cover: Armand Bayou is a major tributary to Clear Lake. The Armand Bayou Tidal segment (1113) stretches from the Clear Lake confluence in Harris County (at the NASA Road 1 bridge) to a point just downstream of Genoa-Red Bluff Road in Pasadena in Harris County. Armand Bayou Above Tidal (1113A) begins at the upper segment boundary of Armand Bayou Tidal and extends upstream to Beltway 8 in Harris County. Major tributaries include Big Island Slough, Horsepen Bayou, Middle Bayou, Mud Lake, Spring Gully, and Willow Spring Bayou.

The majority of the watershed (73.69 percent) is densely developed and includes portions of the cities of Houston, La Porte, Deer Park, and Pasadena. In addition to residential and commercial development, there are also a number of large industrial facilities, as well as Ellington Air Field. The main segment is primarily lined with forestlands and wetlands while grasslands and agricultural land uses are common throughout the central portions of the watershed. The Johnson Space Center, University of Houston-Clear Lake, and the Armand Bayou Nature Center are located in the southern reaches. The vast majority of this watershed is served by wastewater treatment facilities, although there are a few scattered areas of on-site sewage facilities present as well.

Segment 1113 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	5,722.63	15.12	3,214.70	8.49	-43.82
Barren Lands	173.91	0.46	188.81	0.50	8.57
Developed	26,373.43	69.70	27,891.27	73.69	5.76
Forest/Shrubs	413.21	1.09	3,252.28	8.59	687.08
Open Water	780.60	2.06	534.19	1.41	-31.57
Wetlands	4,374.93	11.56	2,766.58	7.31	-36.76
TOTAL	**37,838.71**	**100.00**	**37,847.82**	**100.00**	


Armand Bayou Tidal - 1113
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1
2
4
Miles
1113I_01
1113G_01
1113D_01
1113F_01
1113A_01
1113H_01
1113_03
1113E_01
1113_02
1113_01
1113B_01
1113C_01
Pasadena
Houston
La Porte
El Lago
Nassau Bay

Water Quality Issues:

Bacteria Impairments and Concerns
The 2020 Integrated Report lists one assessment unit of the classified water body (1113_03) and one unclassified tributary (1113B_01) as impaired for contact recreation due to elevated levels of Enterococci. Four unclassified segments (1113A_01, 1113C_01, 1113D_01, and 1113E_01) are also impaired for contact recreation due to elevated levels of *E. coli*.

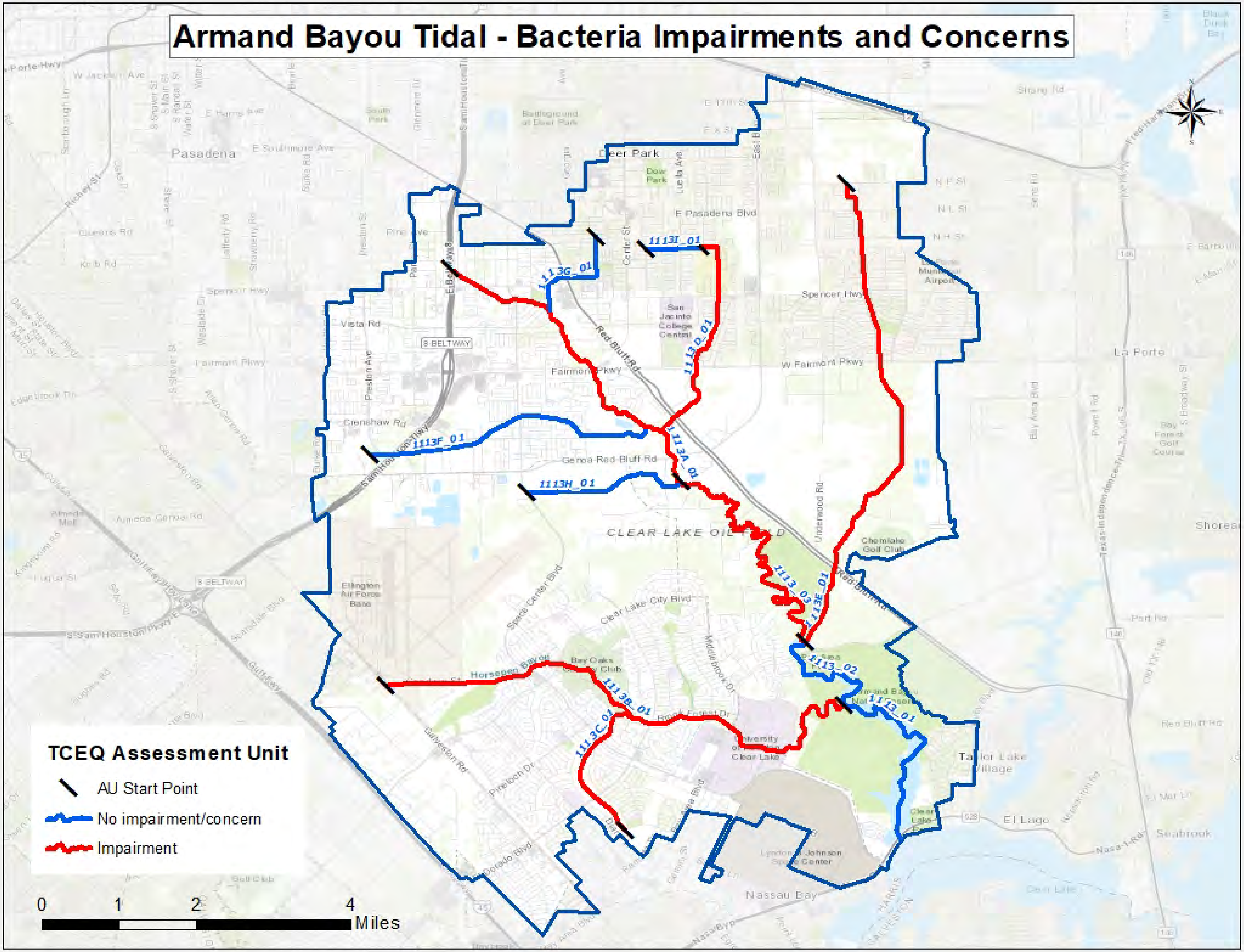
Dissolved Oxygen Impairments and Concerns
Portions of this watershed do not support the designated aquatic life use. Assessment units 1113_02, 1113_03, and 1113A_01 are impaired for depressed dissolved oxygen. A concern for dissolved oxygen grab screening levels was identified for segments 1113B and 1113E.

Nutrient Concerns
Nutrient screening level concerns were identified in Horsepen Bayou Tidal (1113B). In this segment, 15 of 52 ammonia-nitrogen samples (28.8 percent), 50 of 54 nitrate-nitrogen samples (92.6 percent), and 35 of 50 total phosphorus samples (70.0 percent) exceeded the nutrient screening levels.

PCBs and Dioxin Impairments
Armand Bayou Tidal is listed as impaired for PCBs and Dioxins in all species of catfish.

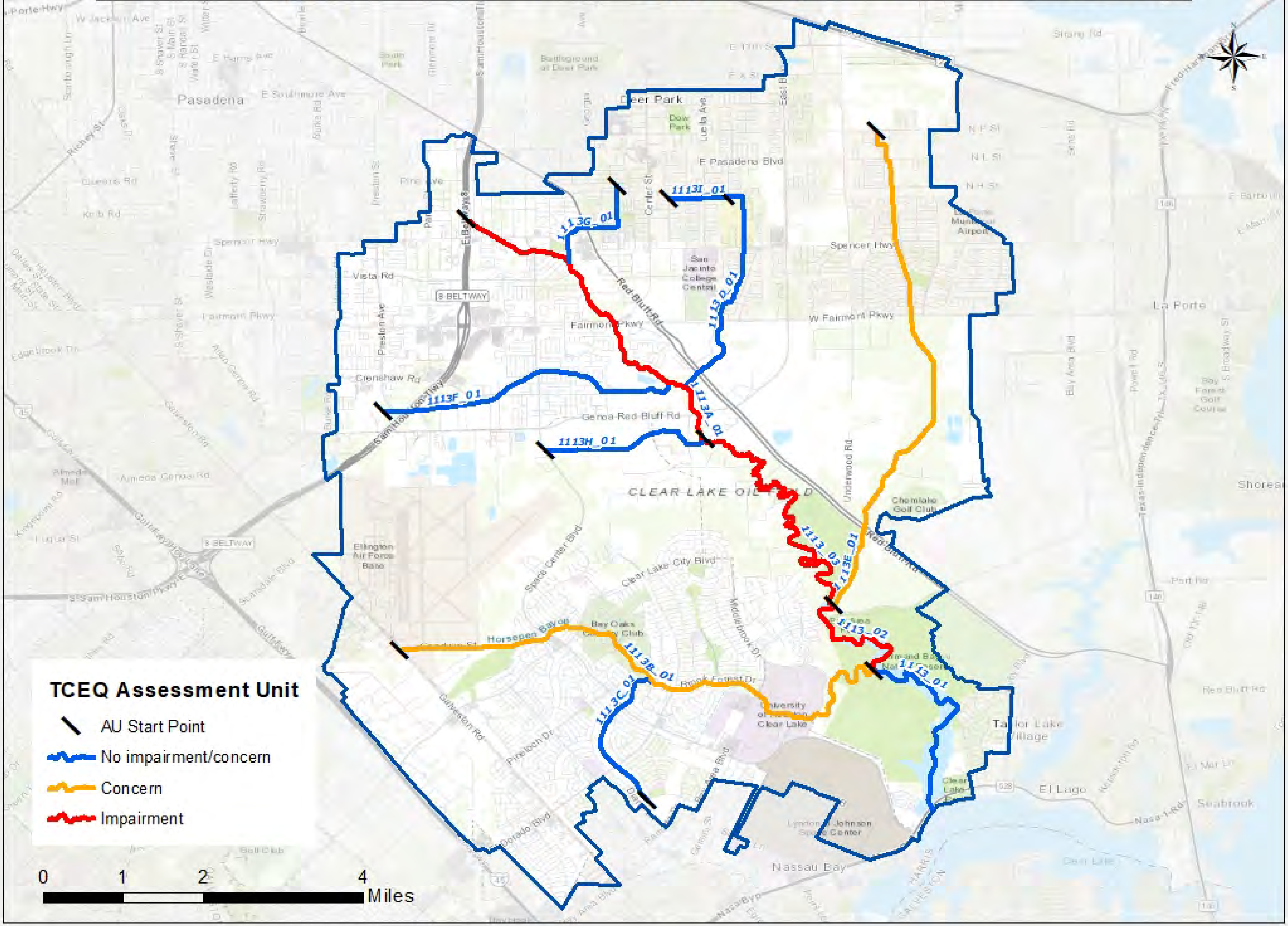
Chlorophyll-a Concerns
Concerns for chlorophyll-a screening criteria were identified in assessment units 1113_02 and 1113B_01. In AU 1113_02, 18 of 27 results (66.7 percent) exceeded the screening level. For AU 1113B_01, 16 of 54 samples (29.6 percent) exceeded the screening level.

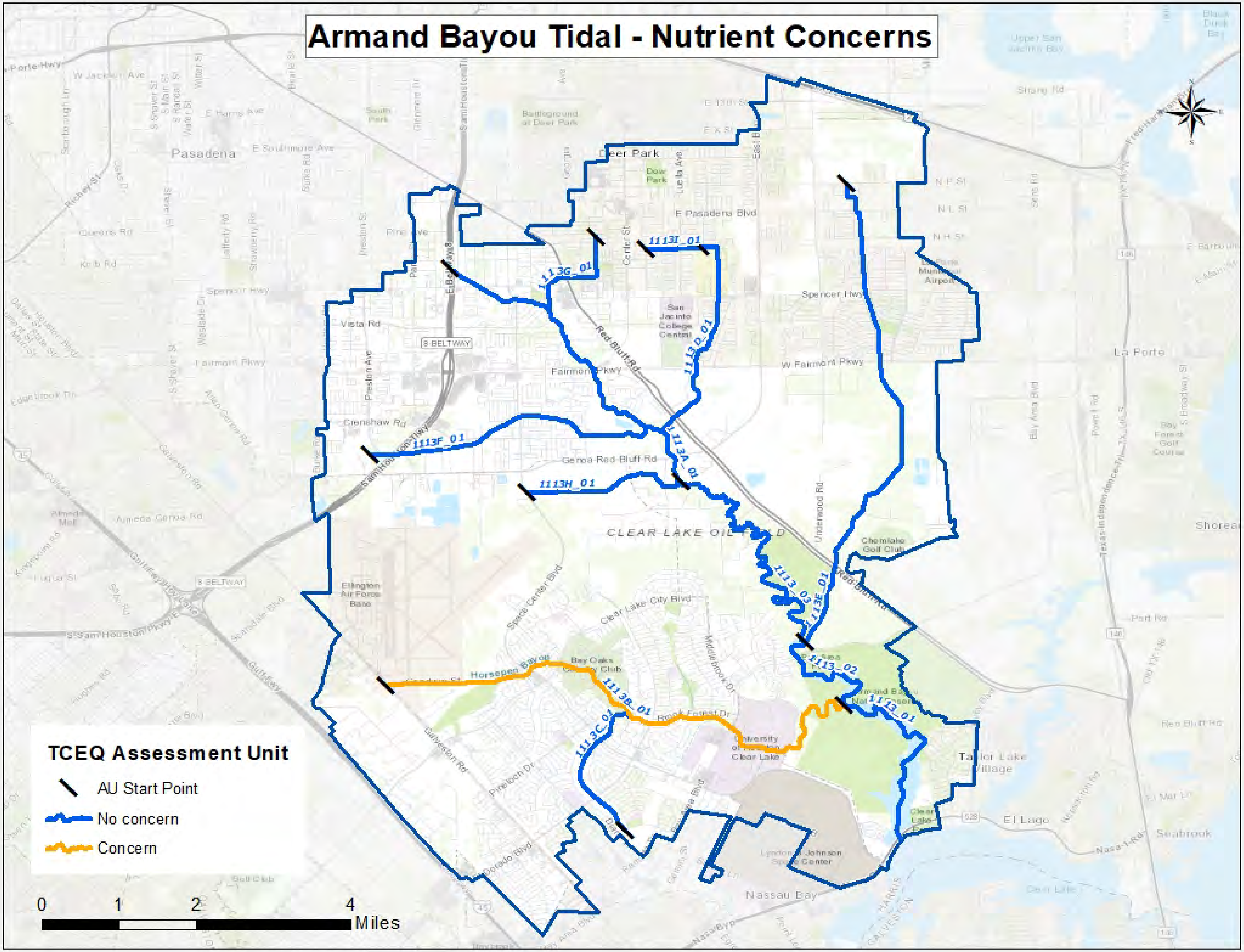
Macrobenthic and Fish Community Impairments
The Armand Bayou Above Tidal segment (1113A) was listed in the 2020 Integrated Report for impaired macrobenthic community and impaired fish community.



Armand Bayou Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
1
2
4
Miles
1113I_01
1113G_01
1113D_01
1113F_01
1113A_01
1113H_01
1113_03
1113E_01
1113_02
1113_01
1113B_01
1113C_01
Pasadena
Deer Park
La Porte
Shoreacres
El Lago
Seabrook
Nassau Bay
Taylor Lake Village
CLEAR LAKE OIL FIELD
Red Bluff Rd
Fairmont Pkwy
Spencer Hwy
Genoa Red Bluff Rd
Clear Lake City Blvd
Space Center Blvd
Horsepen Bayou

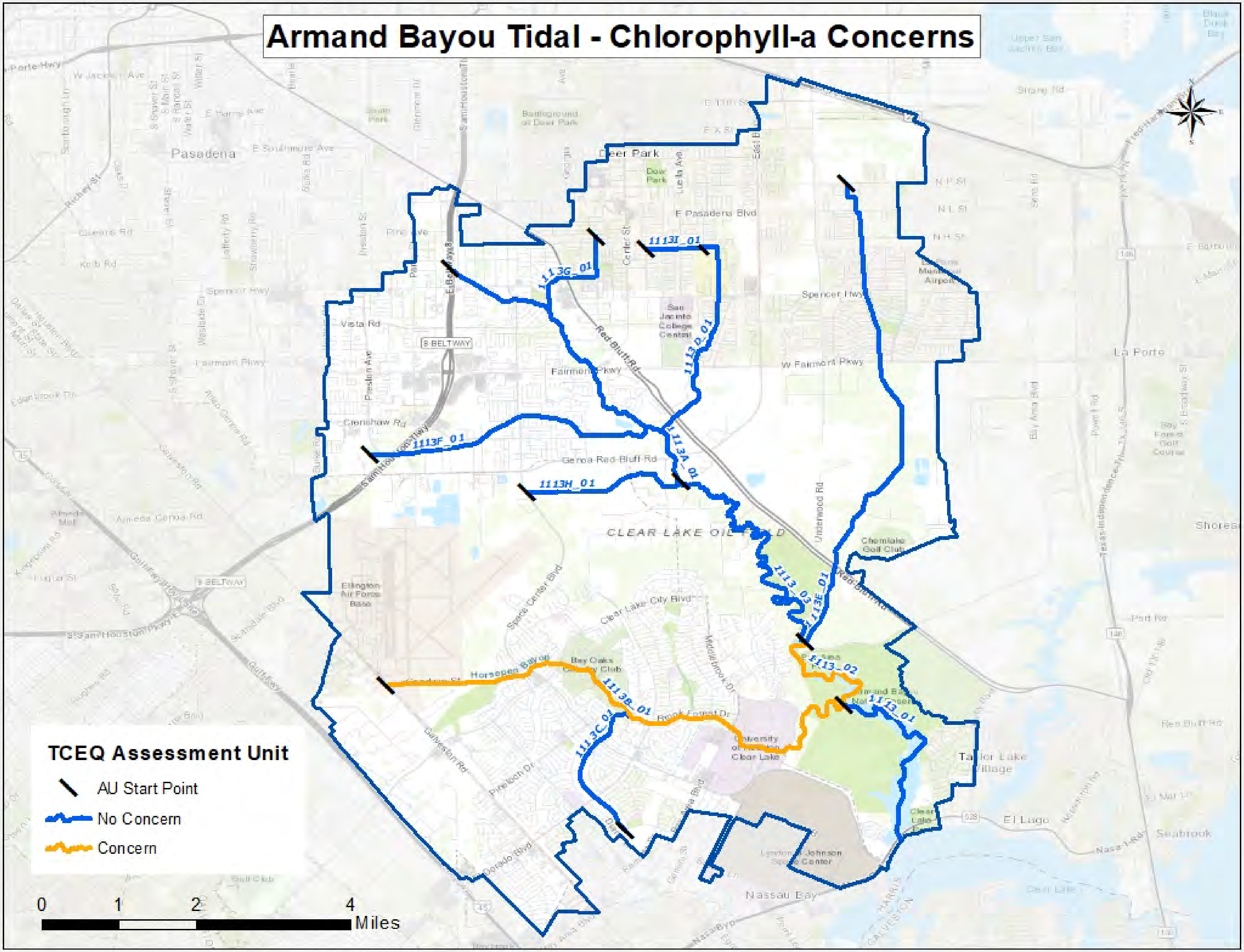
Armand Bayou Tidal - Dissolved Oxygen Impairments and Concerns



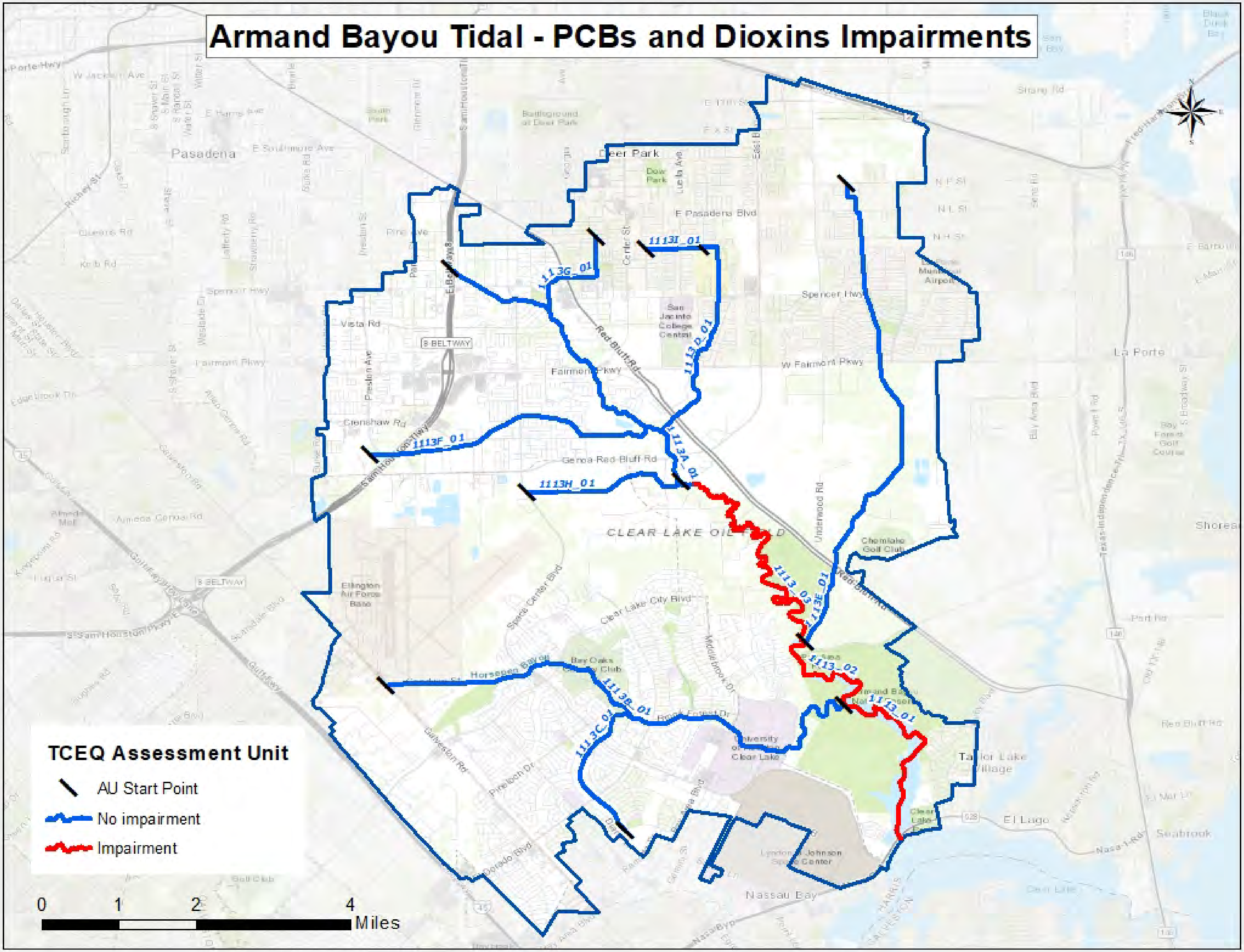


Armand Bayou Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No concern
Concern
0
1
2
4
Miles
1113I_01
1113G_01
1113D_01
1113F_01
1113A_01
1113H_01
1113_03
1113E_01
1113_02
1113_01
1113B_01
1113C_01
Deer Park
Pasadena
La Porte
CLEAR LAKE OIL FIELD
Ellington Air Force Base
University of Houston Clear Lake
Nassau Bay
El Lago
Seabrook
Taylor Lake Village

Armand Bayou Tidal - Chlorophyll-a Concerns



Armand Bayou Tidal - PCBs and Dioxins Impairments



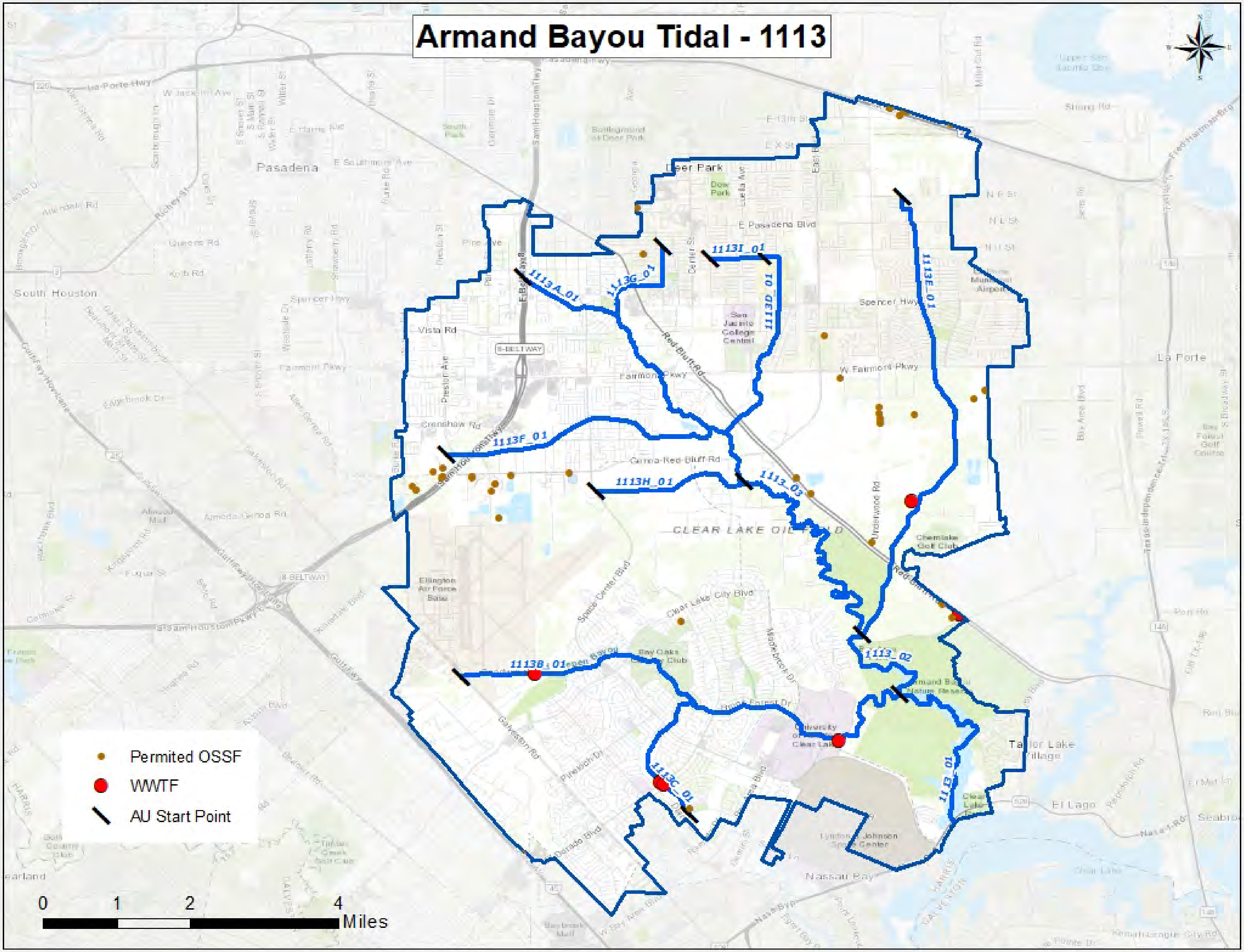
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Armand Bayou Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 6 permitted wastewater outfalls and 44 permitted on-site wastewater facilities in the Armand Bayou Tidal watershed. The wastewater treatment facilities and on-site sewage facilities in the Armand Bayou Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 90 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Armand Bayou Tidal watershed.



Armand Bayou Tidal - 1113
Permited OSSF
WWTF
AU Start Point
0
1
2
4
Miles
1113A_01
1113B_01
1113C_01
1113D_01
1113E_01
1113F_01
1113G_01
1113H_01
1113I_01
1113_01
1113_02
1113_03
Pasadena
Deer Park
South Houston
La Porte
Taylor Lake Village
El Lago
Nassau Bay
CLEAR LAKE OIL FIELD

Trend Analysis:

Regression analysis of water quality data revealed a total of 30 trends spread between 13 individual water quality parameters for the six water bodies located in the Armand Bayou Tidal watershed. The main segment had a total of six parameter trends including decreasing concentrations of chloride, sulfate, Total Kjeldahl Nitrogen (TKN), total phosphorous, total suspended solids (TSS), and specific conductance.

Eight parameter trends were detected for unclassified segment Armand Bayou Above Tidal (1113A) including decreasing trends for ammonia, chloride, Secchi transparency, specific conductance, and sulfate, as well as increasing trends for dissolved oxygen (DO), temperature and TSS. Once again, as TSS concentrations increase, the Secchi transparency measurements decrease as the water gets more turbid.

Analysis of data from unclassified segment 1113B (Horsepen Bayou Tidal) revealed four increasing trends for nitrate, total phosphorus, DO, and pH. In regard to nitrate, very few of the data results have been less than the screening criteria. For total phosphorus, there have been fewer test collected overall and more of the results exceed the screening criteria.

Four parameter trends were identified for the unnamed tributary to Horsepen Bayou (unclassified segment 1113C). These trends include decreasing chloride concentration and decreased Secchi transparency measurements as well as increases in mg/L of DO and sulfate.

Unclassified segment Willow Springs Bayou (1113D) data showed three increasing trends (water temperature, nitrate and DO).

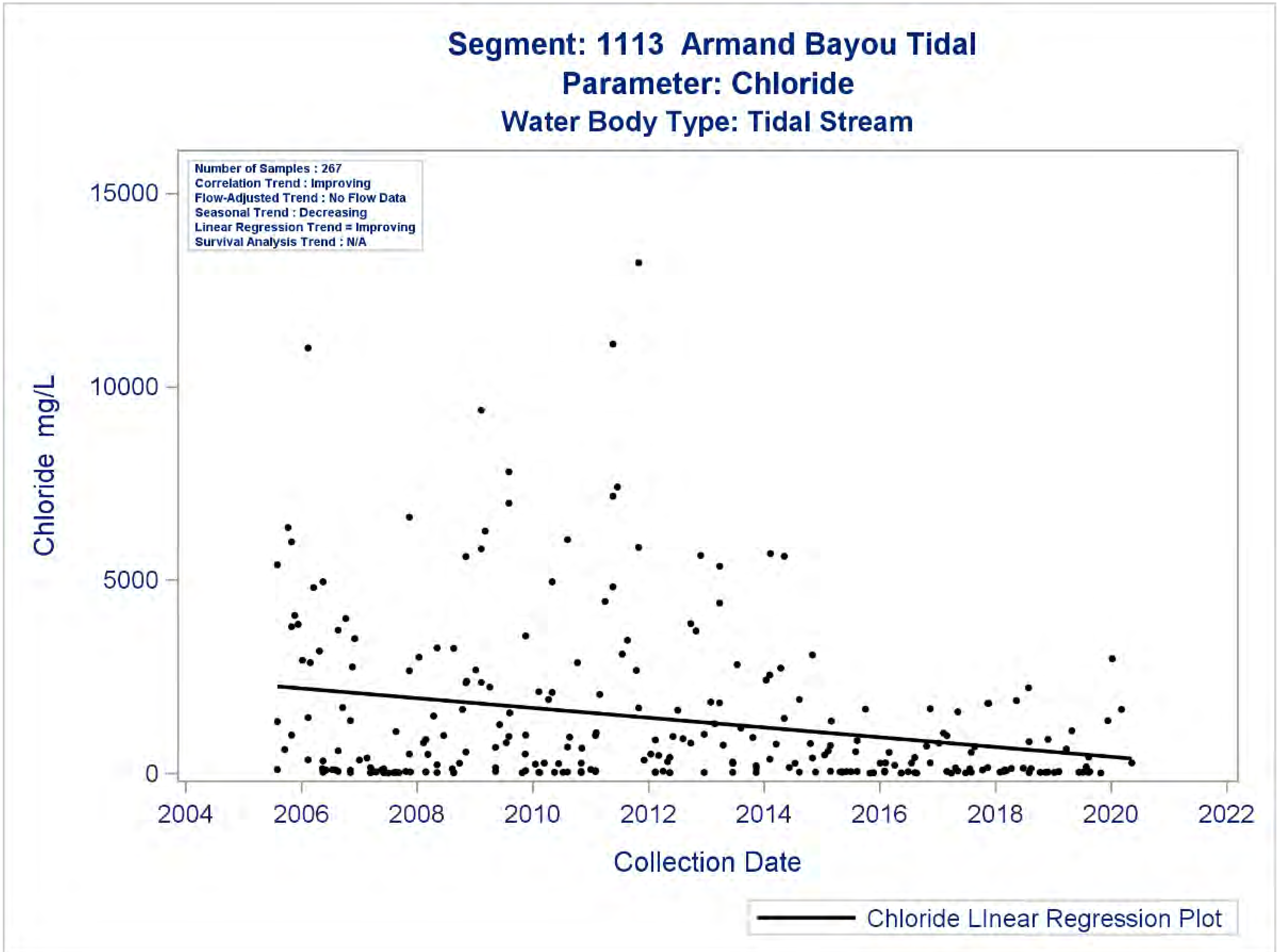
Finally, regression analyses for unclassified segment Big Island Slough (1113E) revealed six parameter trends including decreasing chloride, E. coli, TKN, and Secchi transparency measurements. Conversely, concentrations of TSS and DO were increasing.

Of the water bodies evaluated in 2020 Texas Integrated Report, one of three classified AUs and five of nine unclassified AUs are impaired for bacteria. Trends for bacteria measurements from each of the water bodies in the watershed are generally stable except for the decreases observed in 1113A and 1113E. The classified segment and all unclassified tributaries, whether improving or degrading, continue to have geometric mean concentrations that exceed the state water quality standard for indicator bacteria.

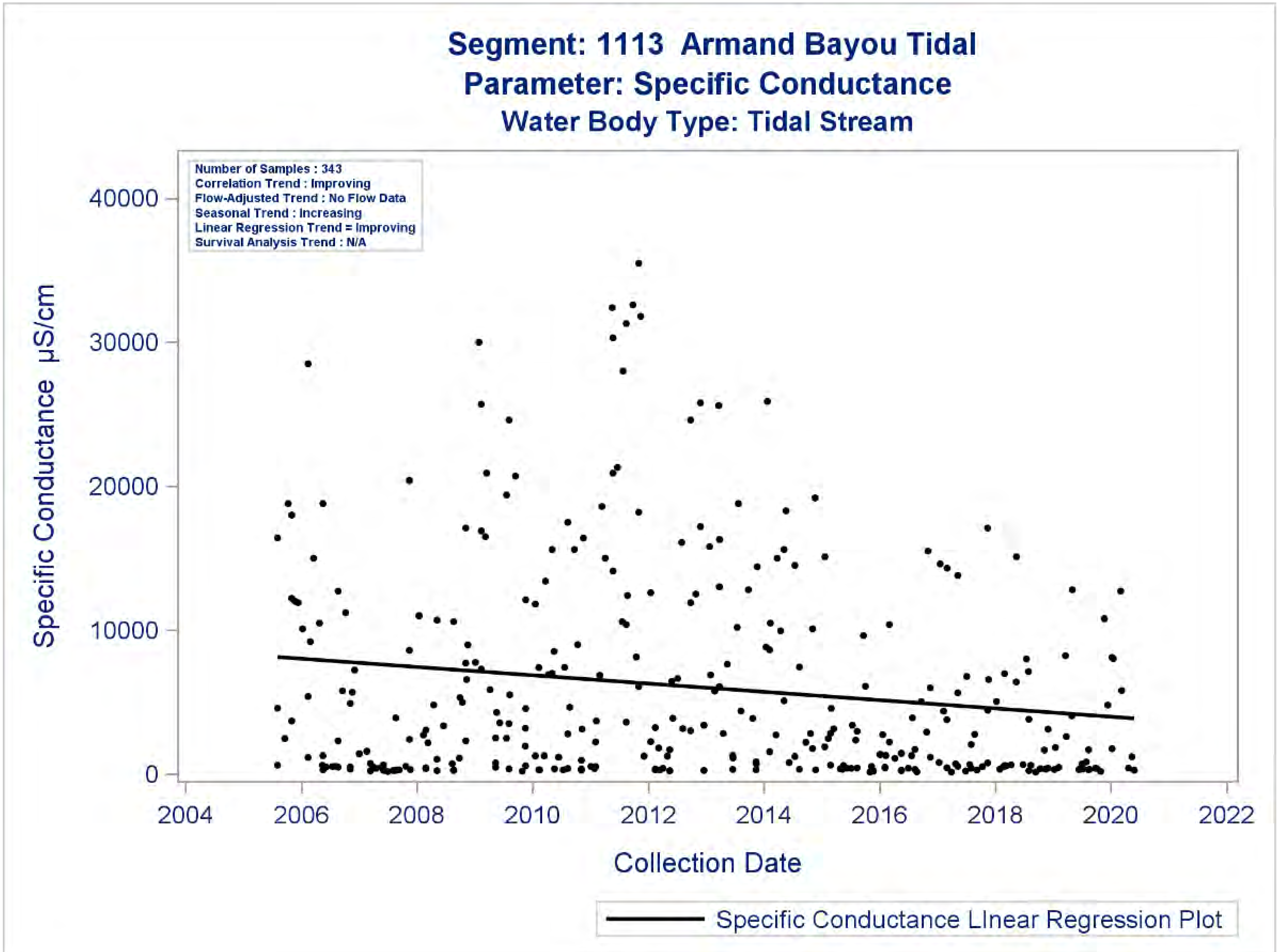
The unclassified tributary 1113B is the only water body in this watershed with nutrient concerns listed in the 2020 IR. Regression analysis of nitrate and total phosphorus data for Horsepen Bayou Tidal revealed increases over time. Additionally, the majority of samples collected during the period of record exceed the screening criteria for both parameters.

Aquatic life use impairments due to low DO have been indicated in the 2020 IR for 1113 and 1113A. The report also indicated DO concerns in 1113B and 1113E. DO concentrations at or below the 3.0 mg/L DO minimum standard still occur throughout the watershed on an infrequent basis. However, almost all water bodies in the watershed show trends toward improvement since 2005 with the exception of 1113, which remains stable. This is of particular note in 1113A which is currently impaired by low DO but could eventually meet the standard with continued improvement. DO is an increasing trend in every unclassified tributary to Armand Bayou Tidal. Concentrations of DO are being measured above 15 mg/L repeatedly which could point to eutrophication of these water bodies.

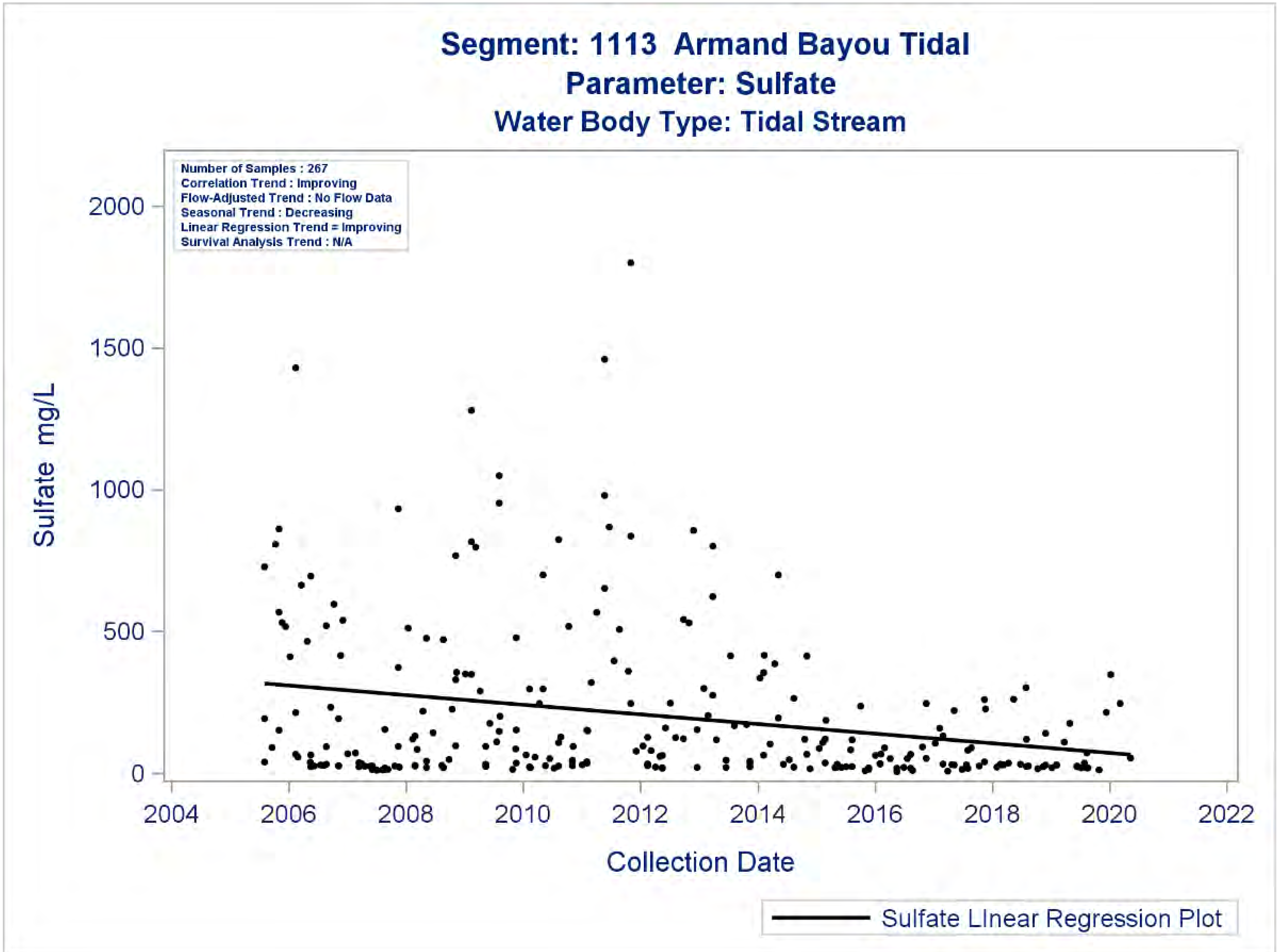
Classified segment 1113 is also listed as having a concern for aquatic life use support due to elevated levels of chlorophyll *a*. However, since 2005, chlorophyll a levels have followed a trend of slight improvement with a fairly even distribution of measurements above and below the 21 µg/L screening criteria.

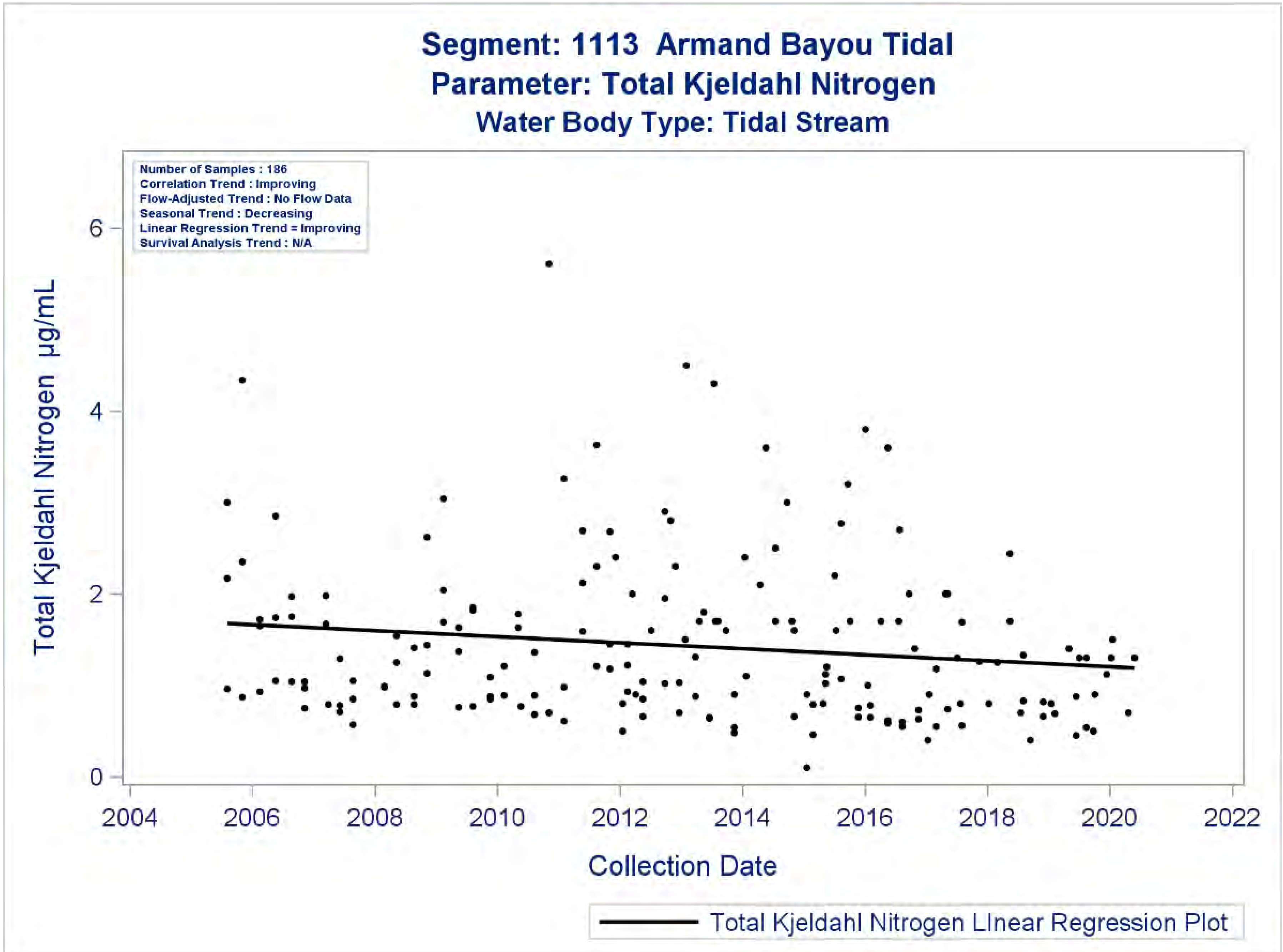


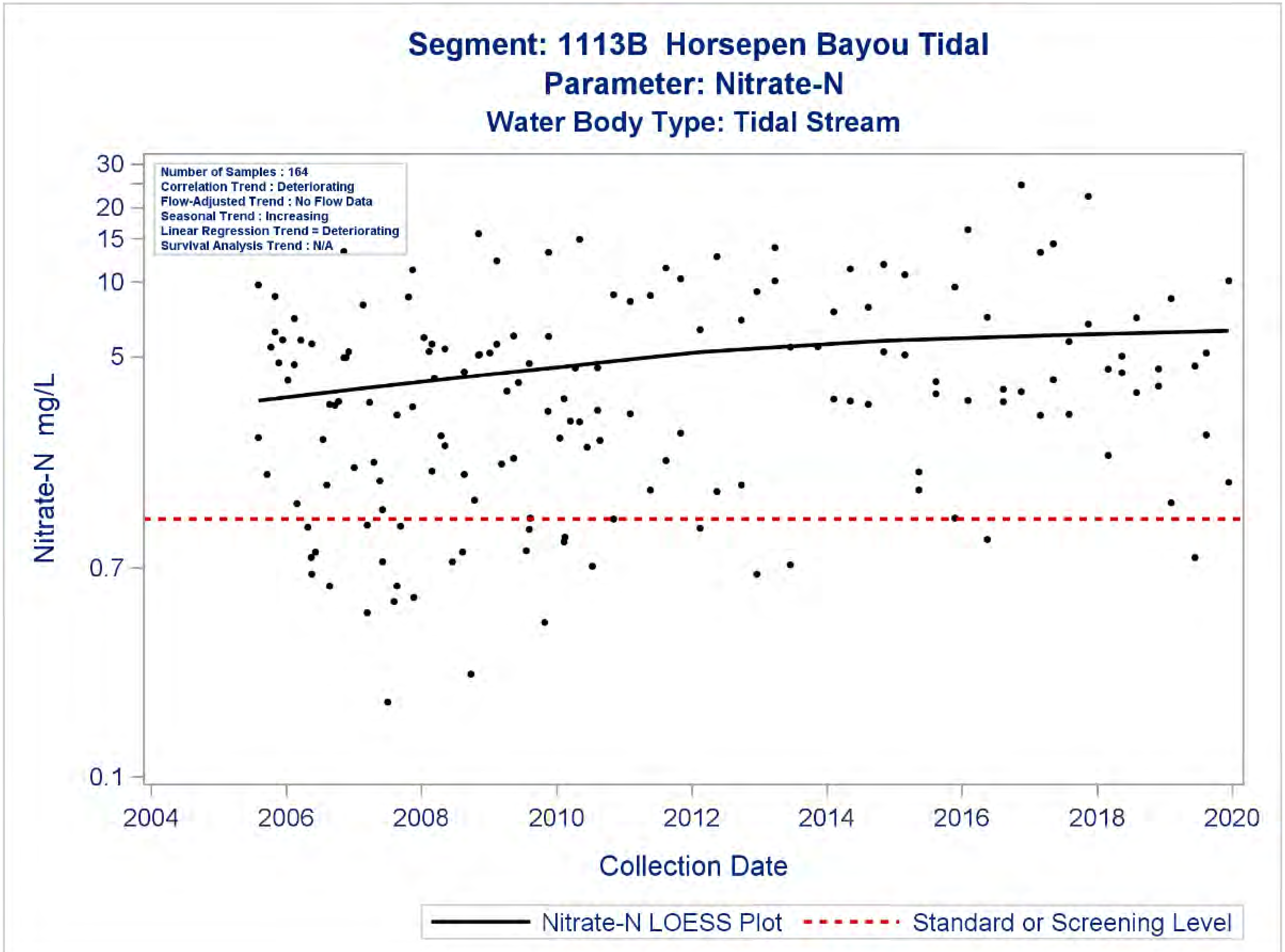
Segment: 1113 Armand Bayou Tidal
Parameter: Chloride
Water Body Type: Tidal Stream
Number of Samples : 267
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
15000
10000
5000
0
Chloride mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LInear Regression Plot



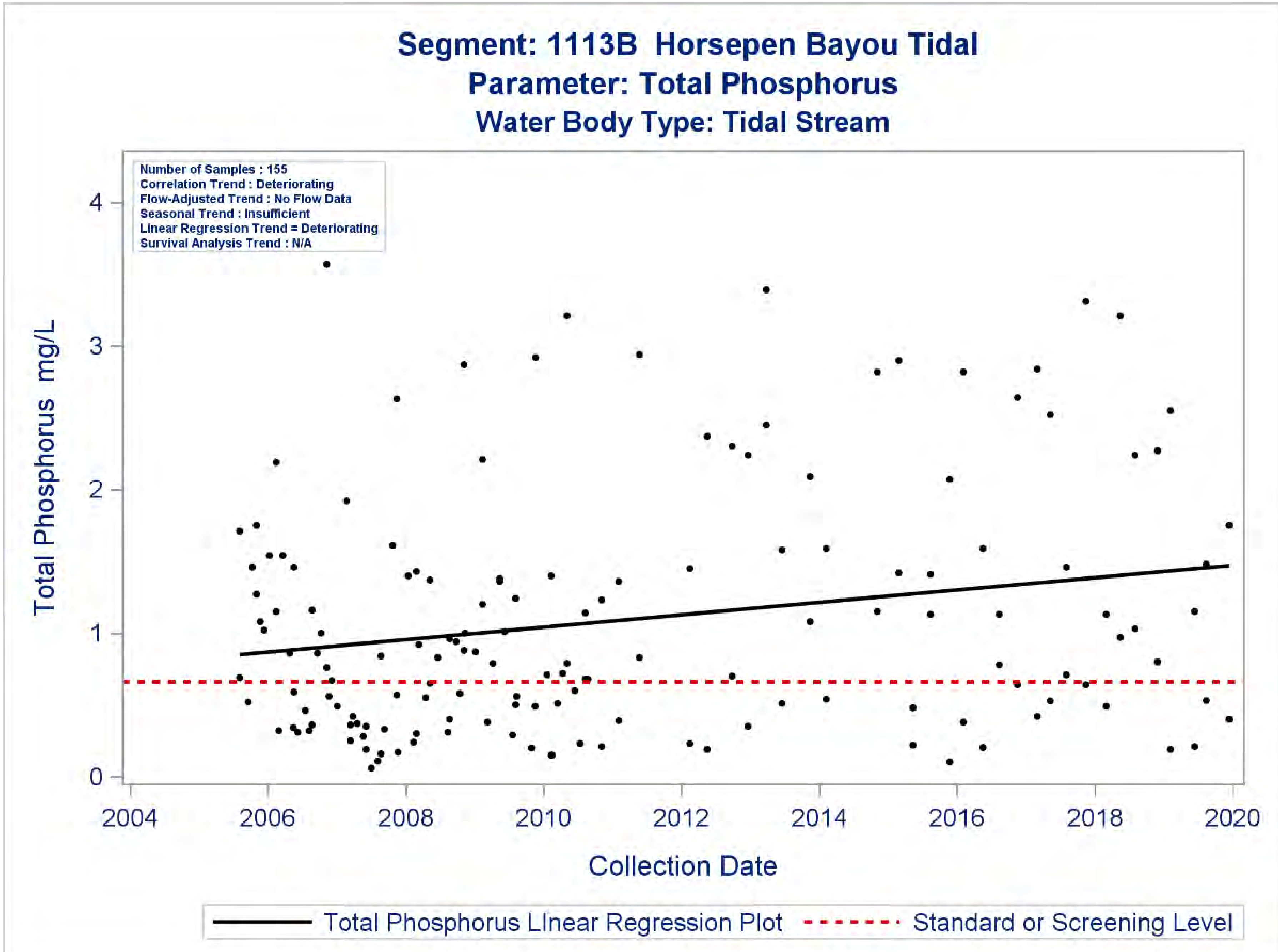
Segment: 1113 Armand Bayou Tidal
Parameter: Specific Conductance
Water Body Type: Tidal Stream
Number of Samples : 343
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Specific Conductance µS/cm
0
10000
20000
30000
40000
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LInear Regression Plot

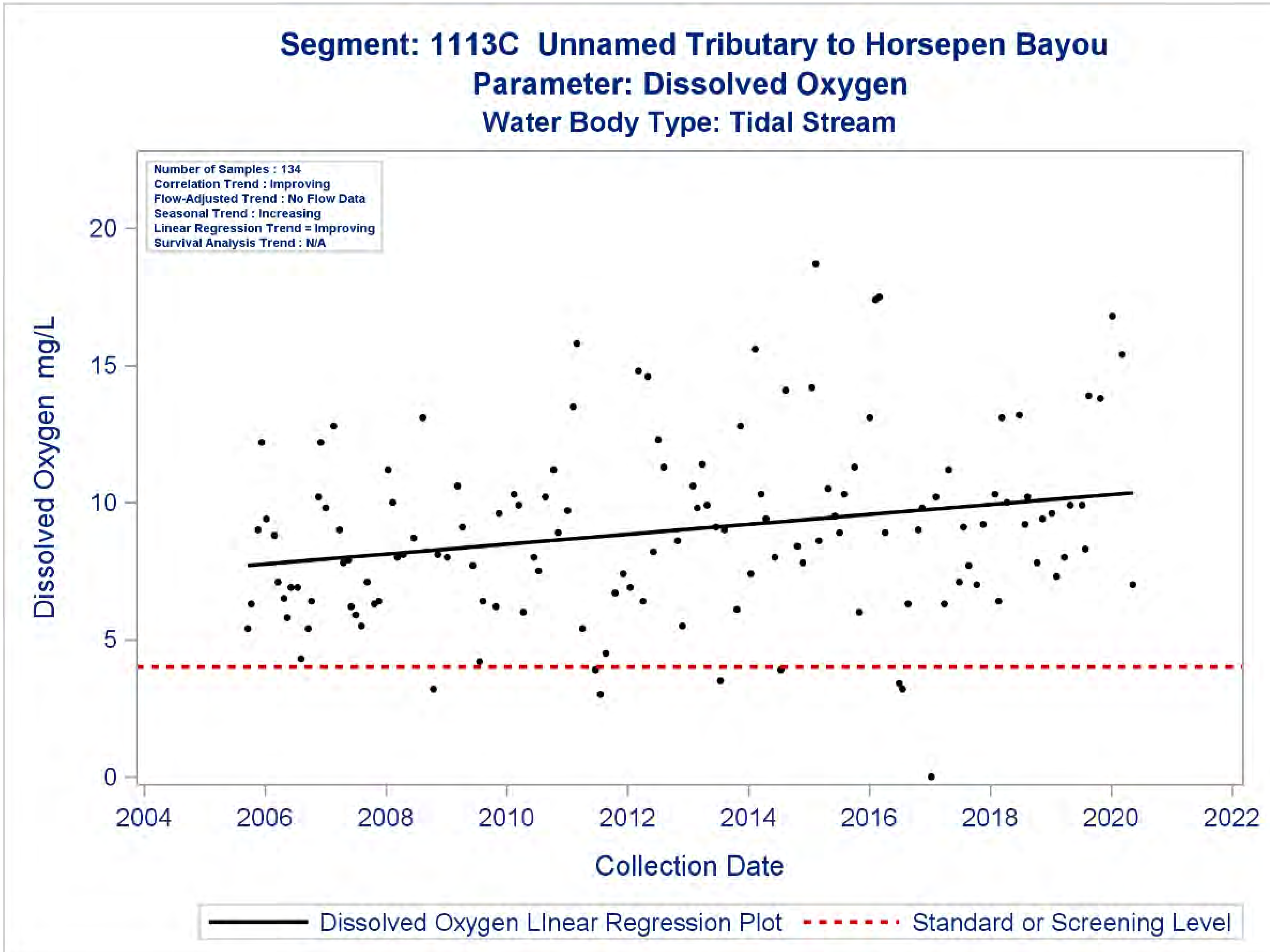

Segment: 1113 Armand Bayou Tidal
Parameter: Sulfate
Water Body Type: Tidal Stream
Number of Samples : 267
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Sulfate mg/L
2000
1500
1000
500
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Sulfate LInear Regression Plot

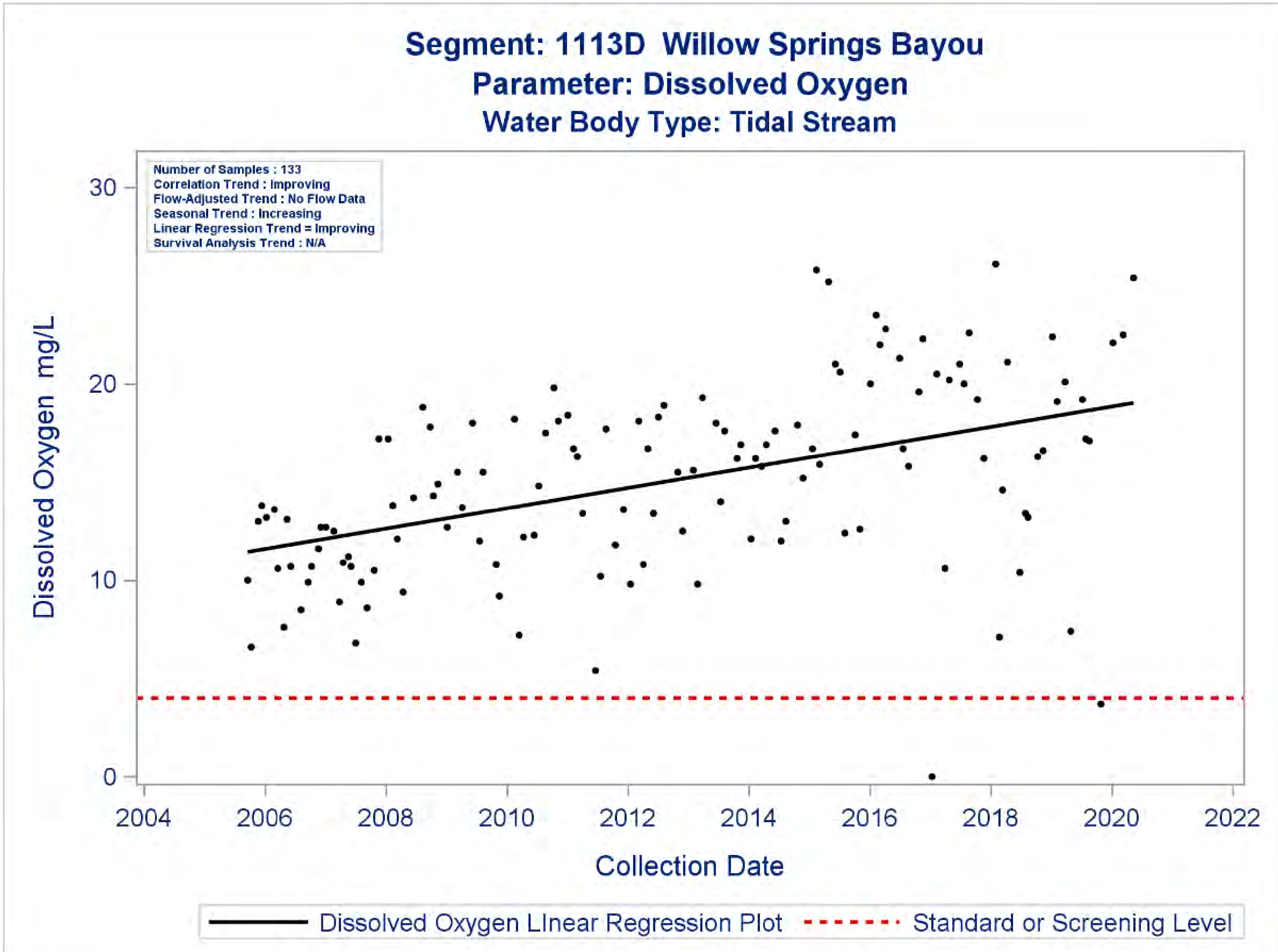

Segment: 1113 Armand Bayou Tidal
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 186
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
2
4
6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



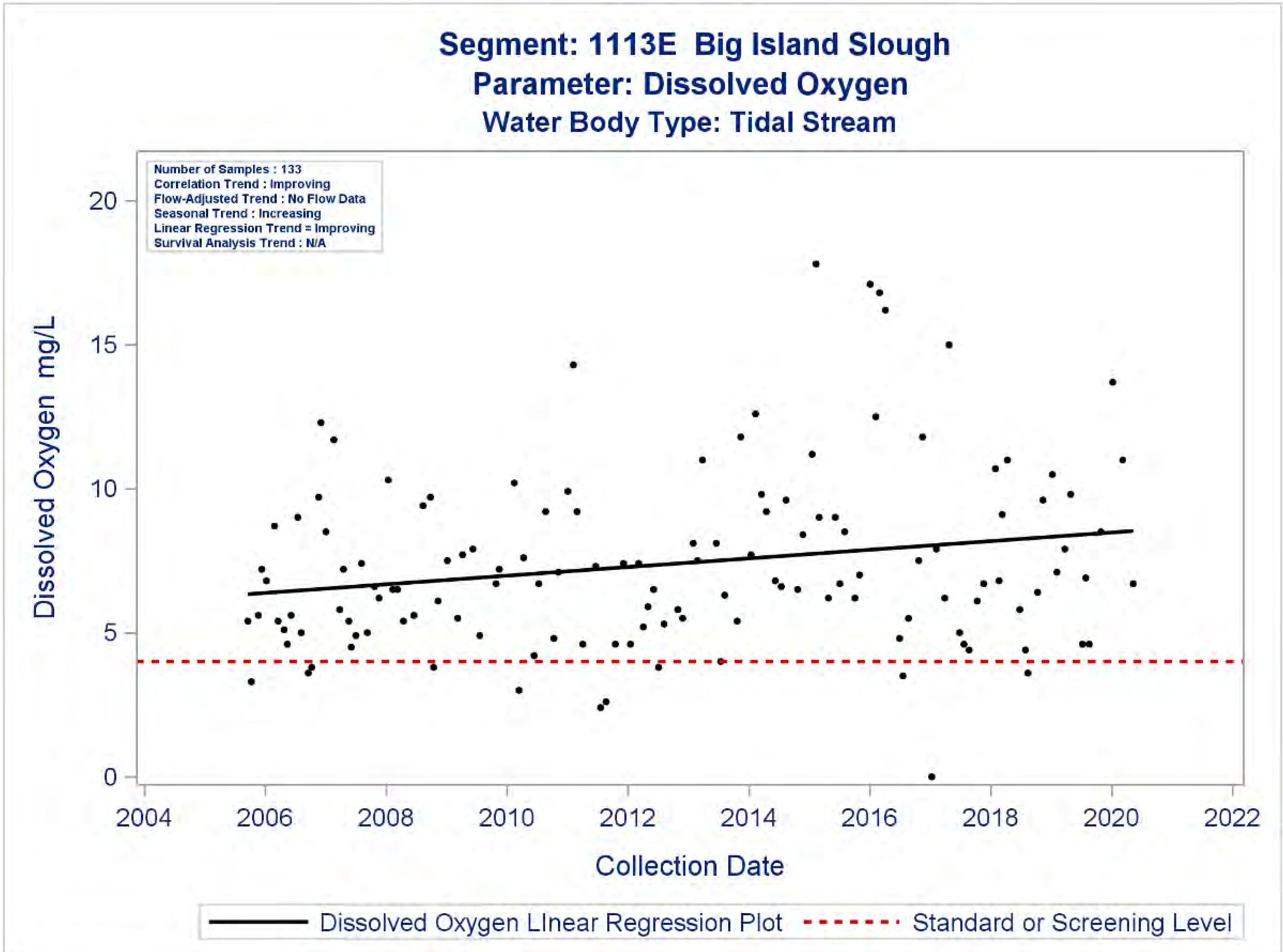
Segment: 1113B Horsepen Bayou Tidal
Parameter: Nitrate-N
Water Body Type: Tidal Stream
Number of Samples : 164
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
30
20
15
10
5
0.7
0.1
Nitrate-N mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level


Segment: 1113B Horsepen Bayou Tidal
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 155
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
1
2
3
4
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level

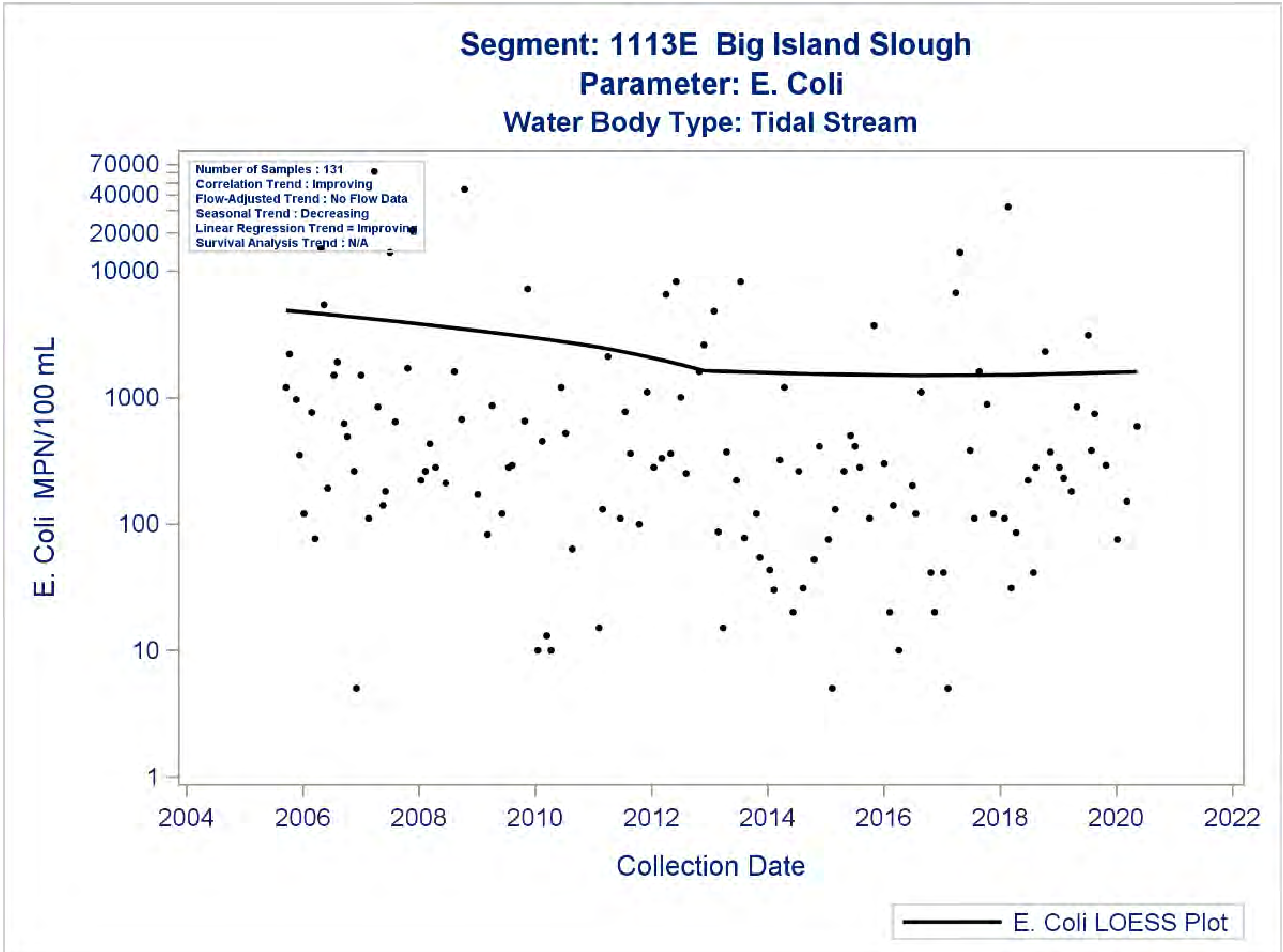

Segment: 1113C Unnamed Tributary to Horsepen Bayou
Parameter: Dissolved Oxygen
Water Body Type: Tidal Stream
Number of Samples : 134
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level



Segment: 1113D Willow Springs Bayou
Parameter: Dissolved Oxygen
Water Body Type: Tidal Stream
Number of Samples : 133
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
30
20
10
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level



Segment: 1113E Big Island Slough
Parameter: Dissolved Oxygen
Water Body Type: Tidal Stream
Number of Samples : 133
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level



Segment: 1113E Big Island Slough
Parameter: E. Coli
Water Body Type: Tidal Stream
Number of Samples : 131
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
70000
40000
20000
10000
1000
100
10
1
E. Coli MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1113_03 I 1113A I 1113B I 1113C I 1113D I 1113E I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Animal waste from hobby farms • Improper or no pet waste disposal • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Developments with malfunctioning OSSFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Encourage Water Quality Management Plans or similar projects for agricultural properties • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education on pet waste disposal • Expand use of LID and green infrastructure practices • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs
Low Dissolved Oxygen Concentrations	***DO Grab Screening Level*** 1113B_01 C 1113E C ***DO 24hr Avg*** 1113_03 I 1113A I ***DO 24hr Min*** 1113_02 I 1113_03 I 1113A I	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, grease and wipes disposal; and OSSF maintenance • Improve compliance and enforcement of existing stormwater quality permits • Restore habitat in riparian areas • Create and implement Water Quality Management Plans for individual agricultural properties • Work with drainage districts and agencies to change practices of clear-cutting and

	1113B_01 I	▪ Vegetative canopy removed		channelizing waterways to protect from solar heating • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water.
Elevated Nutrient Concentrations	***Ammonia*** 1113B C ***Nitrate*** 1113B C ***Phosphorus*** 1113B C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways Monitor phosphorus levels at WWTFs to determine if controls are needed.
Elevated Chlorophyll -*a* Concentrations	1113_02 C 1113B C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from residential and agricultural areas
Impaired Macrobenthic and Fish Community	1113A I	• Loss of habitat due to channelization of waterway • Erosion from construction sites including roads, and commercial and residential developments • Erosion from agricultural properties	• Detrimental to the aquatic biological community	• Work with drainage districts to install/construct habitat that doesn't interfere with water movement • Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat
Dioxin/PCBs in Fish Tissue	1113 (all AUs) I	• Waste pit located along the San Jacinto River immediately upstream of I-10	• The Texas DSHS has concluded that consuming fish from this water body	• Continue to monitor and assess to determine impairment status

		bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	poses an apparent hazard to public health https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf	• Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

Armand Bayou is part of the larger geographical area covered by the Bacteria Implementation Group (BIG).

Armand Bayou was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number:	1105	Name:	Bastrop Bayou Tidal		
Length:	22.9 miles	**Watershed Area:**	217 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	10	**Texas Stream Team Monitoring Stations:**	1	**Permitted WWTF Outfalls:**	17

DESCRIPTION

- Segment 1105 (Tidal Stream w/ high ALU): **Bastrop Bayou Tidal** (classified water body) – From the confluence with Bastrop Bay 1.1 km (0.7 miles) downstream of the Intracoastal Waterway in Brazoria County to a point 8.6 km (5.3 mi) upstream of Business 288 at Lake Jackson in Brazoria County.

- Segment 1105 A (Perennial Stream w/ intermediate ALU): **Flores Bayou** (unclassified water body) – From a point 2.6 km (1.6 mi) downstream of County Road 171 upstream to SH35 in Brazoria County

- Segment 1105B (Tidal Stream w/ high ALU): **Austin Bayou Tidal** (unclassified water body) – From the Bastrop Bayou Tidal confluence to the FM 2004 bridge crossing in Brazoria County

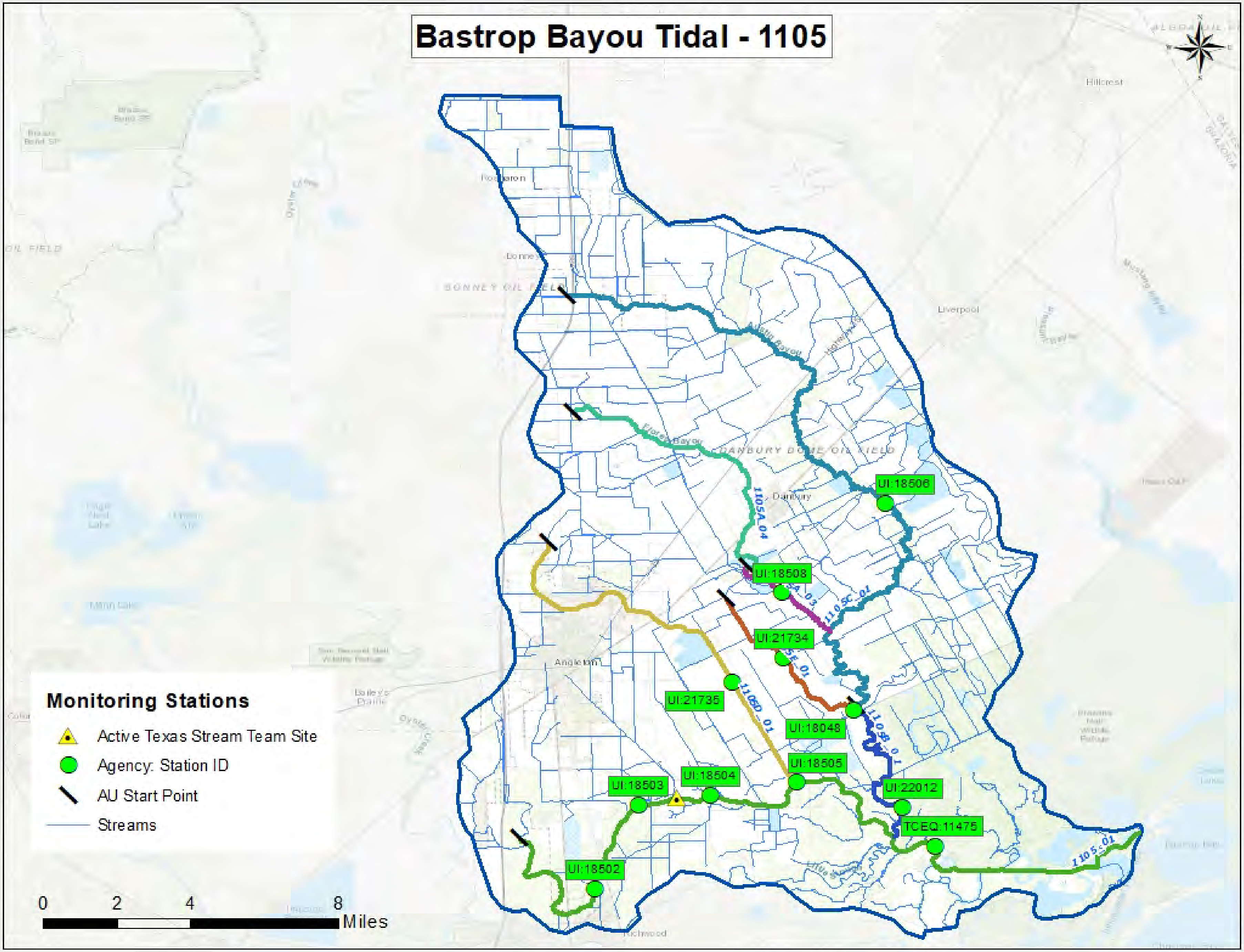
- Segment 1105C (Perennial Stream w/ high ALU): **Austin Bayou Above Tidal** (unclassified water body) – From FM 2004 upstream (Austin Bayou Tidal upper boundary) to 1.73 mi upstream from where the water body crosses County Road 51

- Segment 1105D (Perennial Stream w/ high ALU): **Unnamed Tributary of Bastrop Creek** (unclassified water body)—From the Bastrop Bayou Tidal confluence to 0.57 km (0.35 mi) upstream of SH 288 Bus in Brazoria County

- Segment 1105E (Perennial Stream w/ high ALU): **Brushy Bayou** (unclassified water body) – From the confluence with Austin Bayou Above Tidal (1105C) upstream to end of canal approximately 0.4 mi upstream of FM210 crossing east of the City of Angleton in Brazoria County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11475	1105	BASTROP BAYOU TIDAL AT CR 227	FO	Quarterly	Conventional, Bacteria, Flow
18502	1105	BASTROP BAYOU OFF BAYOU WOOD DR DUE EAST OF BRAZORIA CR 201 AT BASTROP BAYOU DR	UI	Quarterly	Field, Conventional, Bacteria
18503	1105	BASTROP BAYOU TIDAL APPROXIMATELY 15 M OFF NORTH BANK AND 1.55 KM UPSTREAM OF FM 2004 IN RICHWOOD VILLAGE	UI	Quarterly	Field, Conventional, Bacteria
18504	1105	BASTROP BAYOU TIDAL MID CHANNEL AT NORTH END OF BASTROP BEACH ROAD 350 M DOWNSTREAM OF FM 523 SE OF ANGLETON	UI	Quarterly	Field, Conventional, Bacteria
18505	1105	BASTROP BAYOU TIDAL 38 M NORTH OF N END OF COMPASS DR/BRAZORIA CR 504 APPROXIMATELY 4.4 KM DOWNSTREAM OF FM 523 SE OF ANGLETON	UI	Quarterly	Field, Conventional, Bacteria
18508	1105A	FLORES BAYOU IMMEDIATELY UPSTREAM OF DANBURY-ANGLETON ROAD/BRAZORIA CR 210 EAST OF ANGLETON	UI	Quarterly	Field, Conventional, Bacteria, Flow
18048	1105B	AUSTIN BAYOU TIDAL AT FM 2004	UI	Quarterly	Field, Conventional, Bacteria
22012	1105B	AUSTIN BAYOU TIDAL 1.60 KILOMETERS UPSTREAM OF THE CONFLUENCE WITH BASTROP BAYOU IN BRAZORIA COUNTY	UI	Quarterly	Field, Conventional, Bacteria
18506	1105C	AUSTIN BAYOU IMMEDIATELY UPSTREAM OF DANBURY-ANGLETON ROAD/BRAZORIA CR 210 EAST OF DANBURY	UI	Quarterly	Field, Conventional, Bacteria, Flow
21735	1105D	UNNAMED TRIBUTARY OF BASTROP BAYOU TIDAL AT BRAZORIA CR 213 / SHELL ROAD 7.0 KILOMETERS EAST OF ANGLETON	UI	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston



Bastrop Bayou Tidal - 1105
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
2
4
8
Miles
UI:18506
UI:18508
UI:21734
UI:21735
UI:18048
UI:18505
UI:18503
UI:18504
UI:22012
TCEQ:11475
UI:18502
1105A_04
1105C_01
1105D_01
1105B_01
1105_01
Rosharon
Bonney
Liverpool
Danbury
Angleton
Hillcrest
Richwood
Austin Bayou
Flores Bayou
DANBURY DOME OIL FIELD

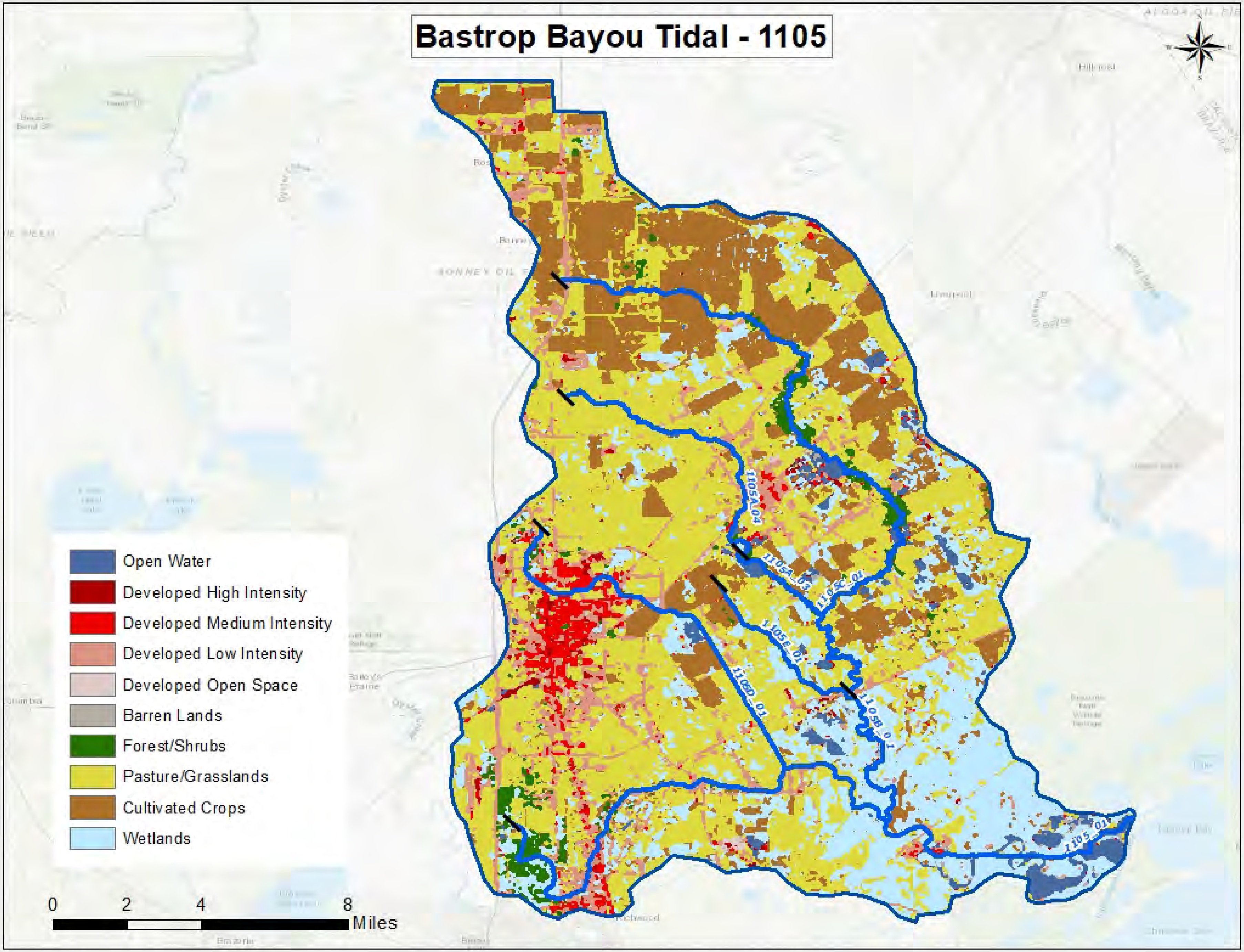
Segment 1105 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F)	35 / 95	35 / 95	Ammonia-N (mg/L)	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L)	4.0	5.0 / 4.0	Nitrate-N (mg/L)	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0	3.0 / 3.0	Orthophosphate Phosphorus (mg/L)	0.46	0.37
pH (standard units)	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L)	0.66	0.69
Enterococci (MPN/100mL) (grab)	89		Chlorophyll *a* (µg/L)	21	14.1
Enterococci (MPN/100mL) (geometric mean)	35				

Segment Discussion

Watershed Characteristics and Land Cover: Bastrop Bayou and its major tributaries, Austin and Flores Bayous, can be found wholly in Brazoria County flowing north to south prior to emptying into Bastrop Bay, a sub bay of Christmas Bay and West Bay. The bayou flows through forested wetlands and cultivated land to coastal prairies and wetlands.

The Bastrop Bayou watershed is predominantly rural in nature with two urban centers of Danbury and the City of Angleton located in the center and western portions of the watershed, respectively. The area adjacent to and downstream of FM 2004 is primarily undeveloped wetlands, a portion of which is part of the Texas Coastal Preserve. This area is home to extensive habitat, endangered and threatened shorebirds, waterfowl, grassland species, and birds of prey. The primary means of wastewater management in this watershed is on-site sewage facilities. The northern portion of the watershed is dominated by agricultural land uses (rice production and cattle grazing). Agricultural uses comprise 62.12 percent of the watershed's land cover, with 20.96 percent of the land cover being wetlands. Only 11.71 percent of the watershed is developed.

Segment 1105 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	91,425.99	65.69	86,455.05	62.12	-5.44
Barren Lands	972.30	0.70	818.41	0.59	-15.83
Developed	8,398.47	6.03	16,296.55	11.71	94.04
Forest/Shrubs	1,374.61	0.99	3,037.90	2.18	121.00
Open Water	3,373.71	2.42	3,391.50	2.44	0.52
Wetlands	33,627.24	24.16	29,169.14	20.96	-13.26
TOTAL	**139,172.33**	**100.00**	**139,168.55**	**100.00**	



Bastrop Bayou Tidal - 1105
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
2
4
8
Miles
1105A_04
1105A_03
1105C_01
1105E_01
1105D_01
1105B_01
1105_01

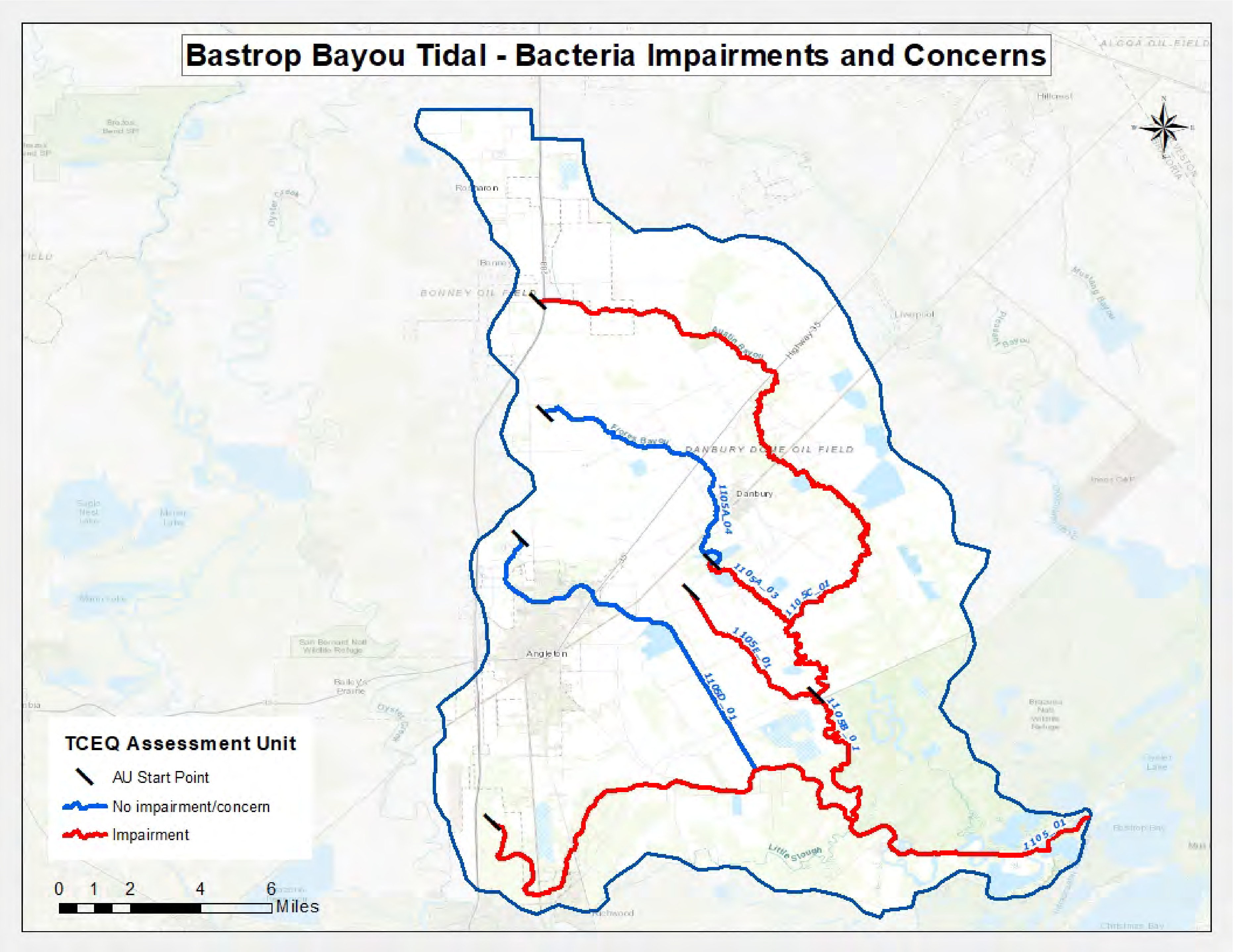
Water Quality Issues:

Bacteria Impairments and Concerns
The 2020 Integrated Report lists Bastrop Bayou Tidal (1105), Flores Bayou (1105A), and Austin Bayou Tidal (1105B) as impaired for contact recreation due to elevated levels of enterococci bacteria. Austin Bayou Above Tidal (1105C) and Brushy Bayou (1105E) are listed as impaired due to elevated levels of *E. coli* bacteria.

Dissolved Oxygen Impairments and Concerns
Assessment unit 1105E_01 is impaired for depressed dissolved oxygen. Concerns based on dissolved oxygen screening levels are also present in 1105_01 and 1105D_01. These segments are not supporting their designated aquatic life use.

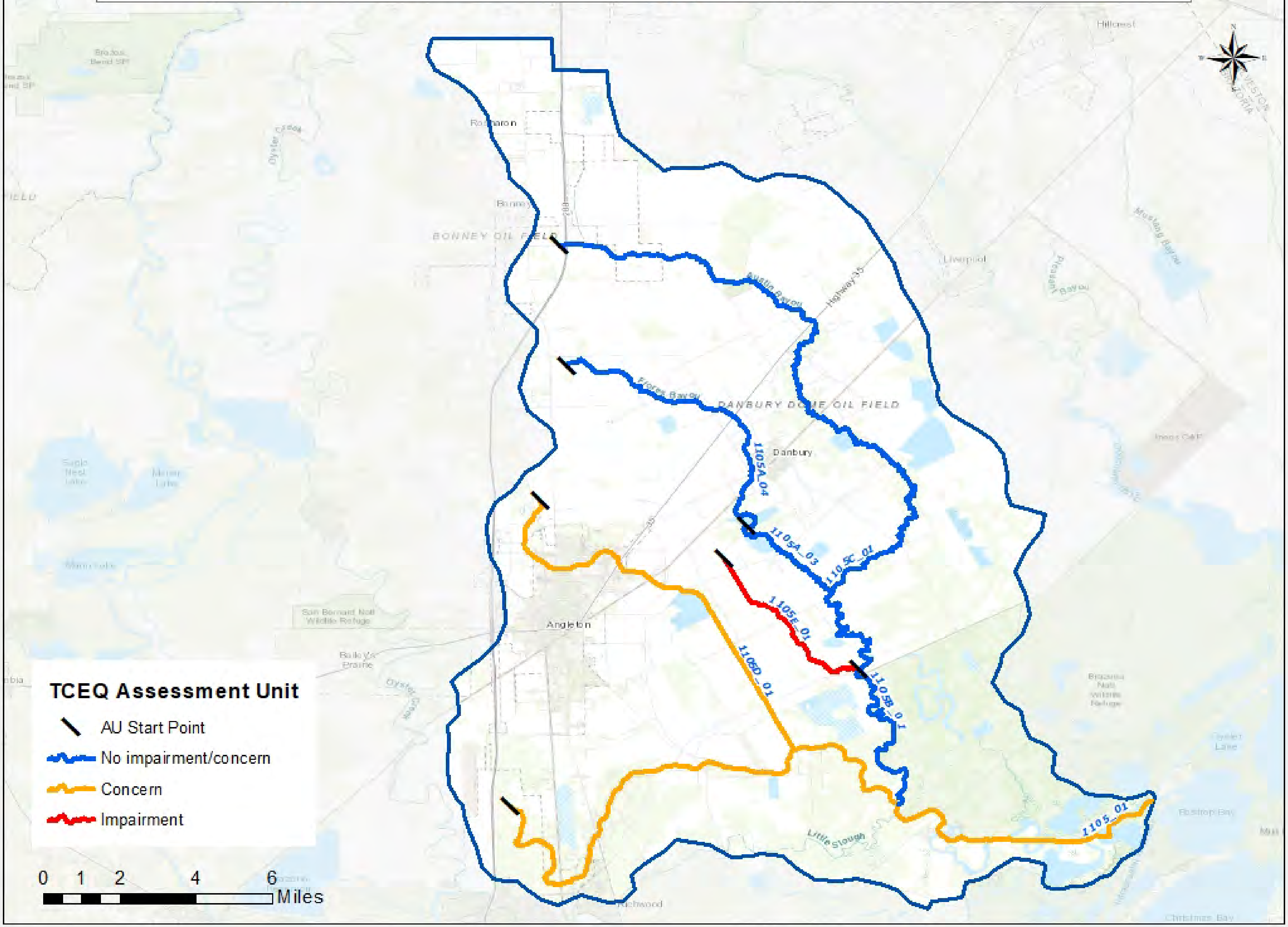
Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.



Bastrop Bayou Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0 1 2 4 6
Miles
Austin Bayou
Flores Bayou
Highway 35
DANBURY DOME OIL FIELD
BONNEY OIL FIELD
Danbury
Angleton
Liverpool
1105A_04
1105A_03
1105C_01
1105E_01
1105D_01
1105B_01
1105_01
Little Slough

Bastrop Bayou Tidal - Dissolved Oxygen Impairments and Concerns

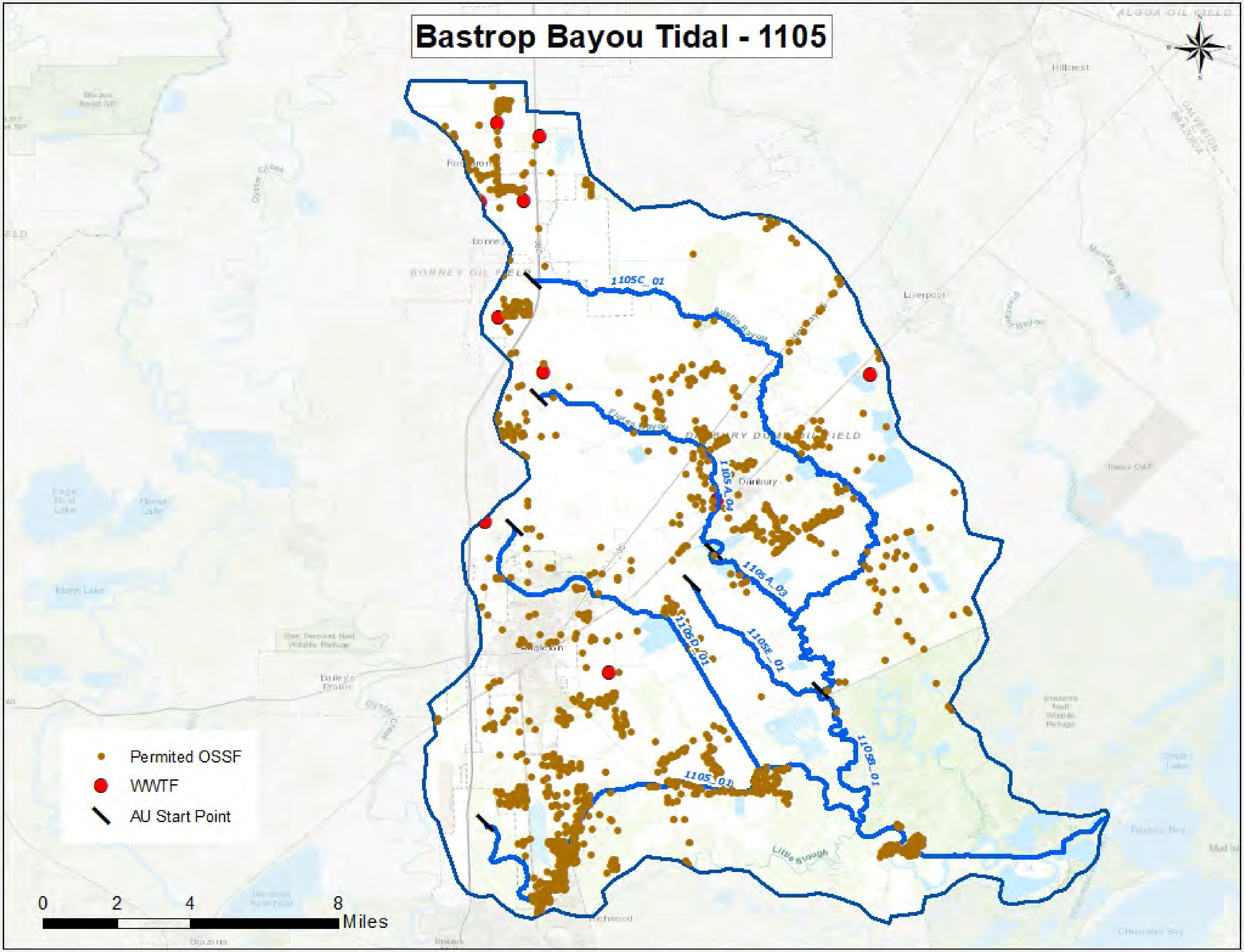


Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria in the Bastrop Bayou Tidal watershed include wastewater treatment facility effluent, failing on-site sewage facilities, and other nonpoint sources, such as wildlife and feral hogs.

There are 17 permitted wastewater outfalls in the Bastrop Bayou Tidal watershed. In most of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 3,863 permitted on-site sewage facilities. The wastewater treatment facilities and on-site sewage facilities in the Bastrop Bayou Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 18 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Bastrop Bayou Tidal watershed.



Bastrop Bayou Tidal - 1105
Permited OSSF
WWTF
AU Start Point
0
2
4
8
Miles
1105C_01
1105A_04
1105A_03
1105D_01
1105E_01
1105B_01
1105_01
Austin Bayou
Little Slough
Danbury
Angleton
Liverpool
Hillcrest
Richwood

Trend Analysis:

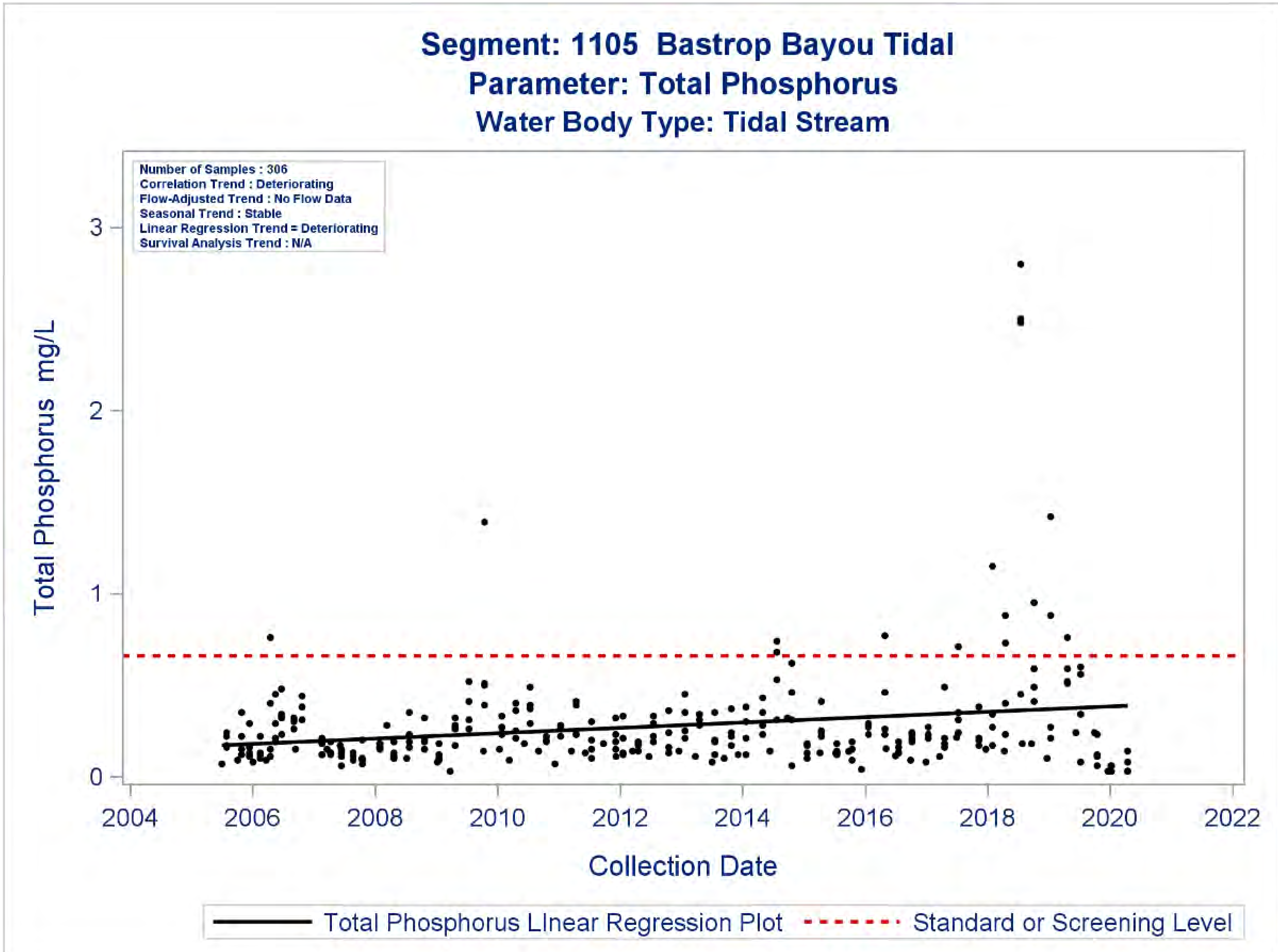
Regression analysis of water quality data revealed trends for eight parameters for the Bastrop Bayou Tidal watershed. The main segment of Bastrop Bayou Tidal had three parameter trends: Secchi transparency measurements are indicating more turbid water, specific conductance is decreasing, and total phosphorus concentrations are increasing. Four of the five unclassified segments had at least two trends each. Unclassified segment 1105E (Brushy Bayou) has a data gap between 2009 and 2015 which precludes confirming trends.

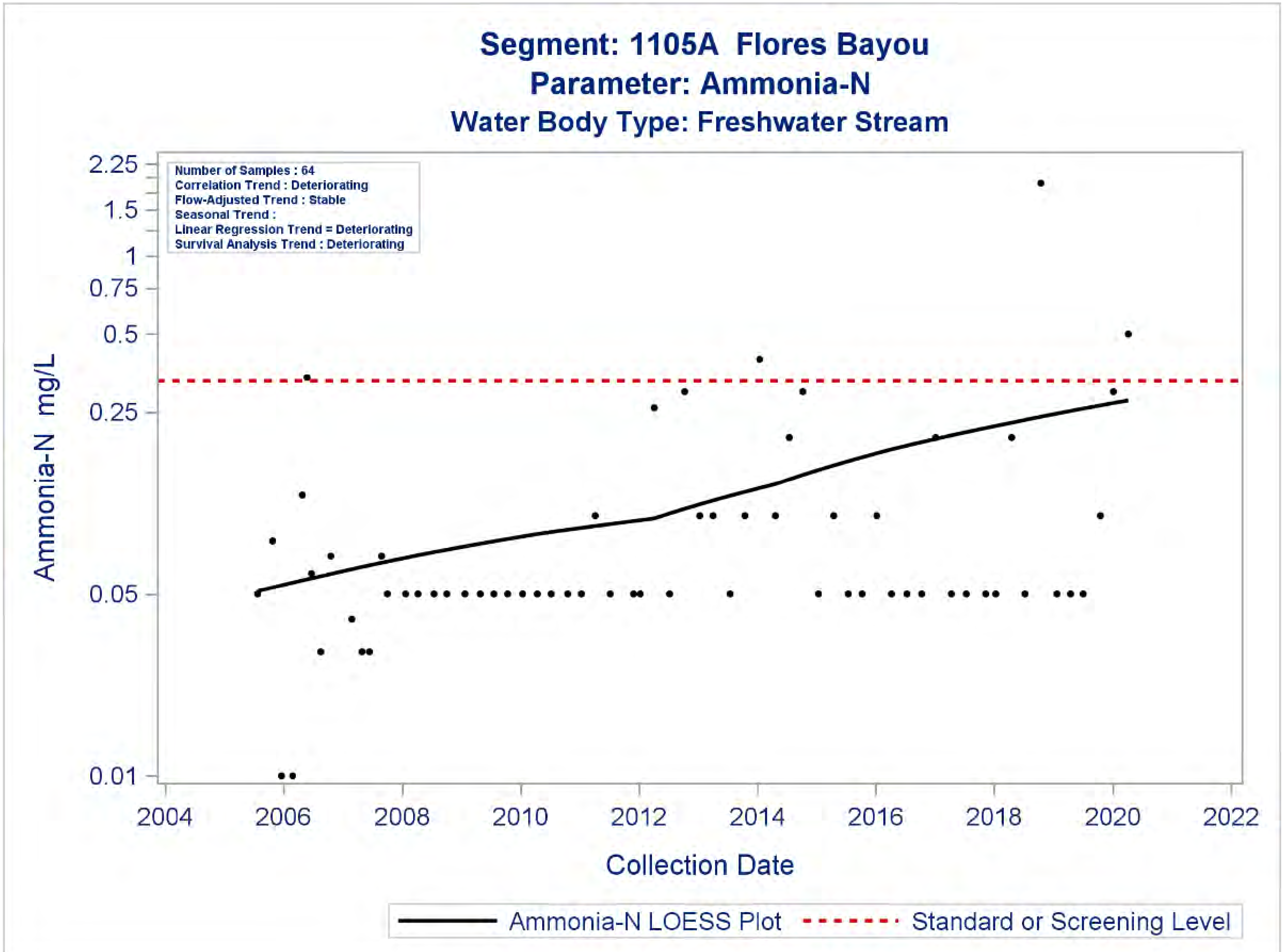
Flores Bayou (unclassified segment 1105A) revealed an increasing trend in ammonia and TSS concentrations as well as an increasing trend in DO where no grab measurements have been found below the standard of 4.0 mg/L since 2013.

Austin Bayou Tidal (unclassified segment 1105B) had four significant parameter trends including increasing TP and decreasing TKN concentrations. Two other trends show that TSS concentrations are increasing while Secchi transparency is decreasing as the water gets more turbid. Unclassified segment Austin Bayou Above Tidal (1105C) showed decreasing sulfate and TKN concentrations during the same period of record.

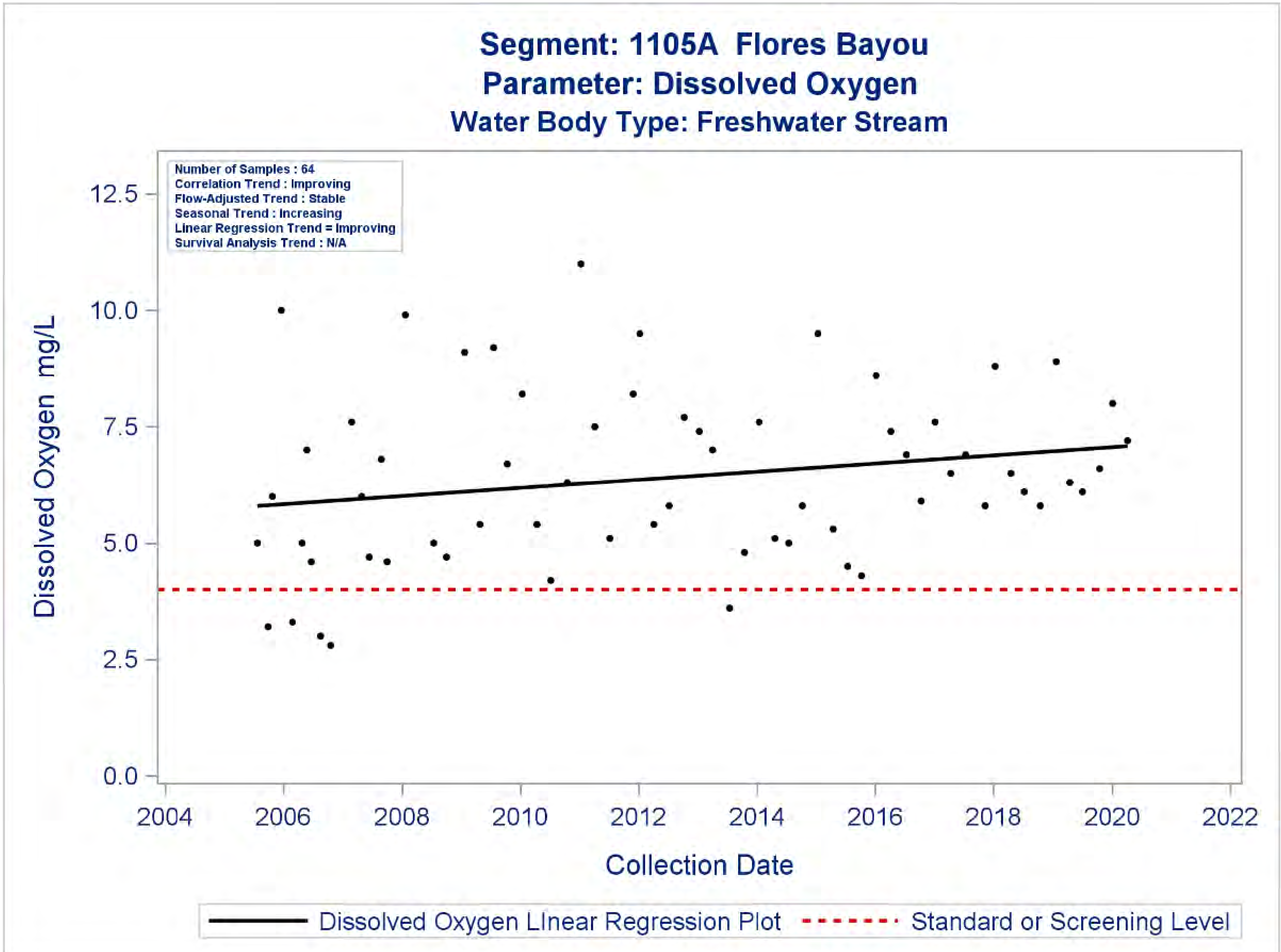
Unclassified segment 1105D showed a decreasing trend for both TKN and total phosphorus concentrations. It is worth noting that only one grab sample has exceeded the screening criteria for total phosphorus during the period of record and that was in 2019.

There were no significant bacteria trends detected during the period of record for the classified and unclassified segments. With the exception of Flores Bayou (1105A), DO concentrations have remained stable throughout the watershed with dips in DO grab sample concentrations periodically being measured less than the minimum standard for each assessment unit and sampling station.

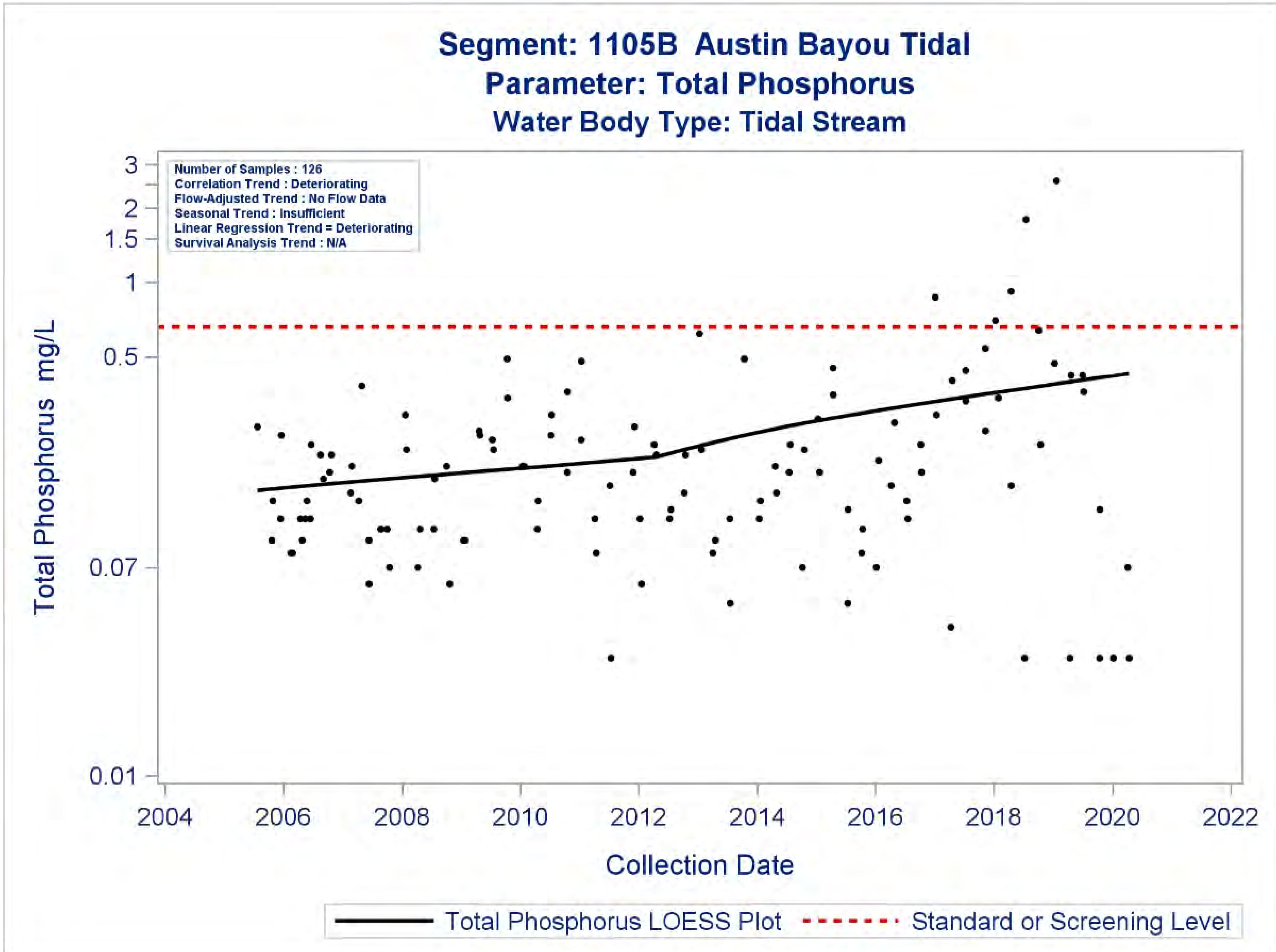

Segment: 1105 Bastrop Bayou Tidal
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 306
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
1
2
3
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level

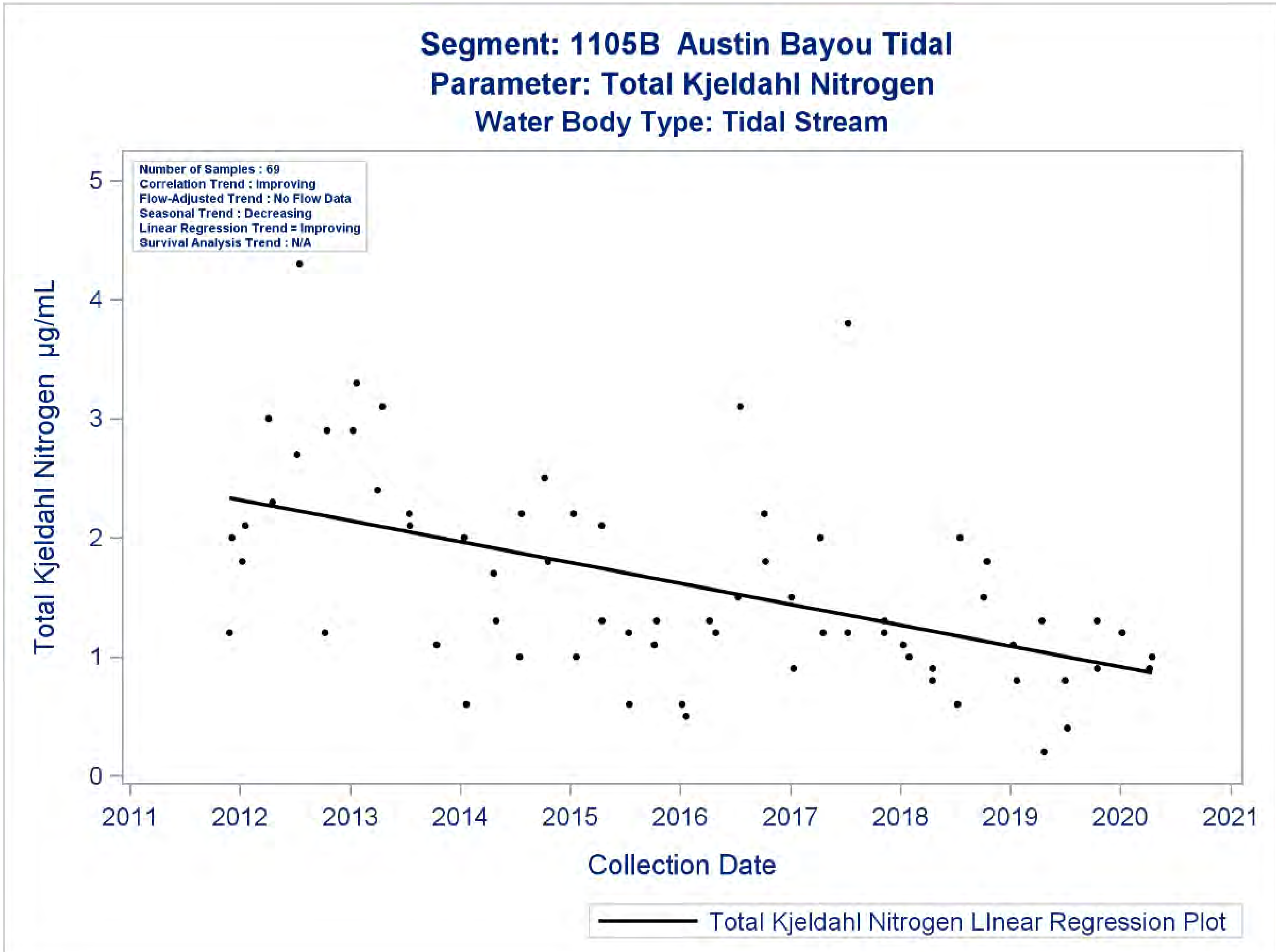


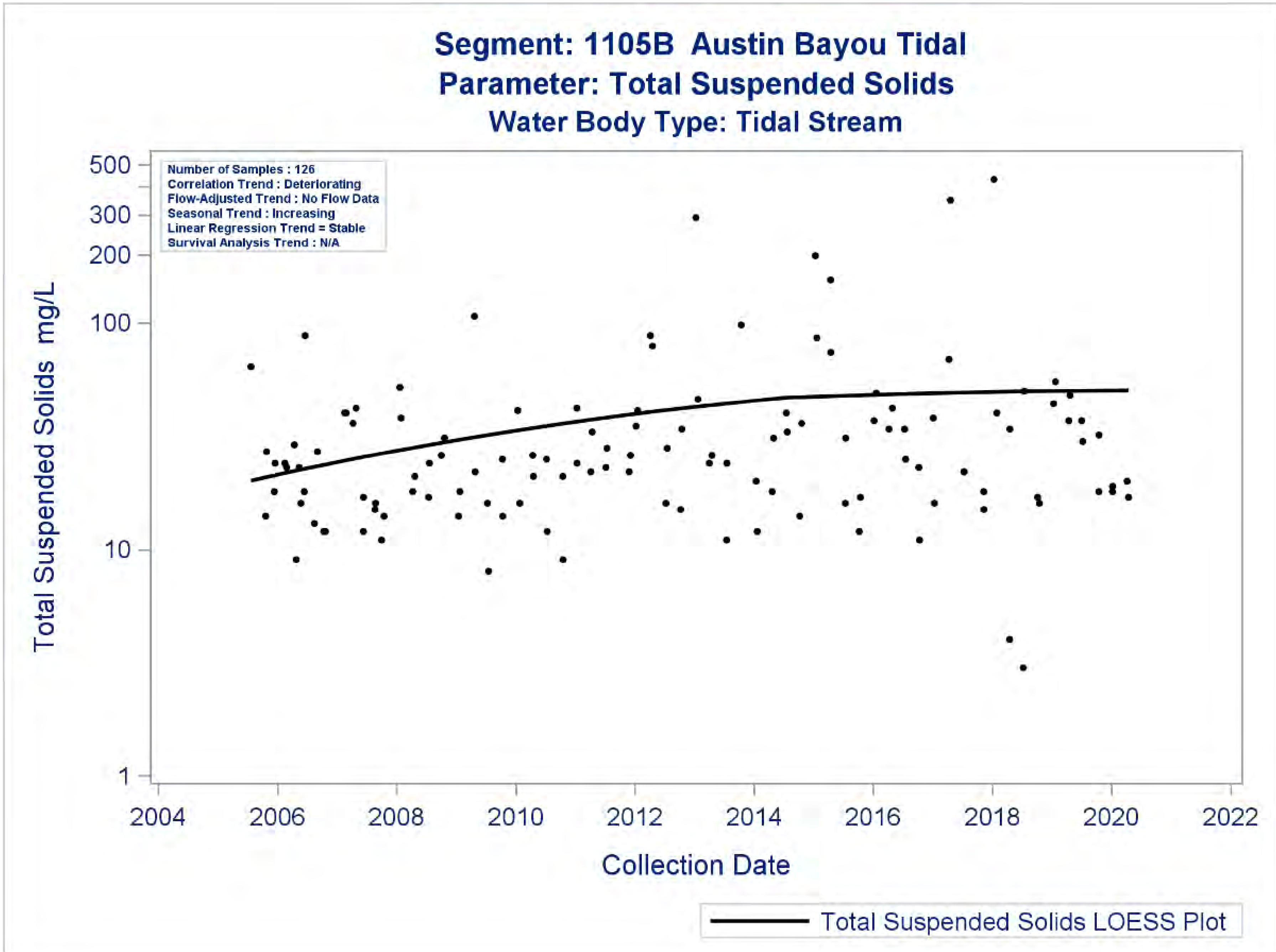
Segment: 1105A Flores Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 64
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend :
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
2.25
1.5
1
0.75
0.5
0.25
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level



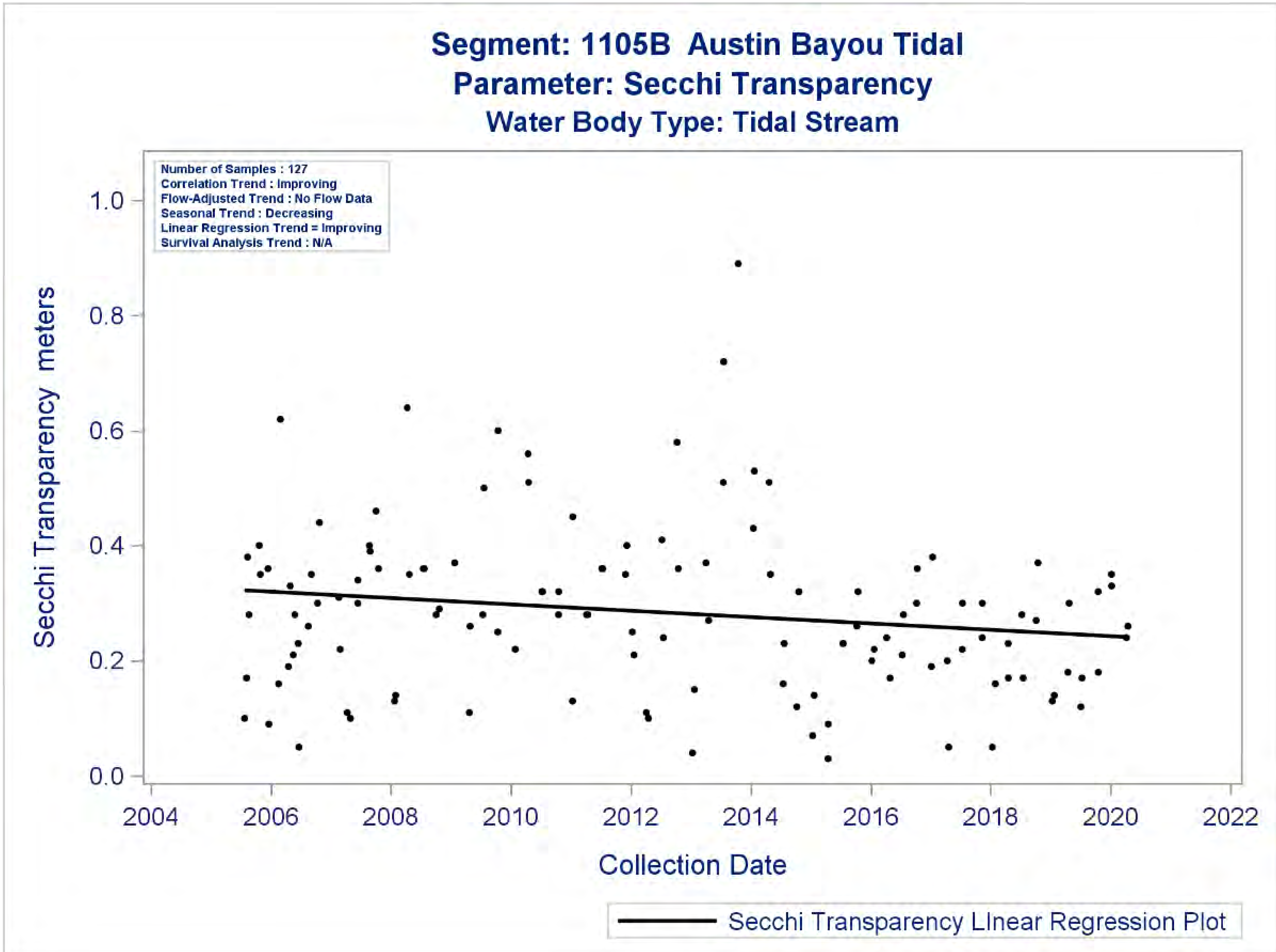
Segment: 1105A Flores Bayou
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 64
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
12.5
10.0
7.5
5.0
2.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level


Segment: 1105B Austin Bayou Tidal
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 126
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
3
2
1.5
1
0.5
0.07
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

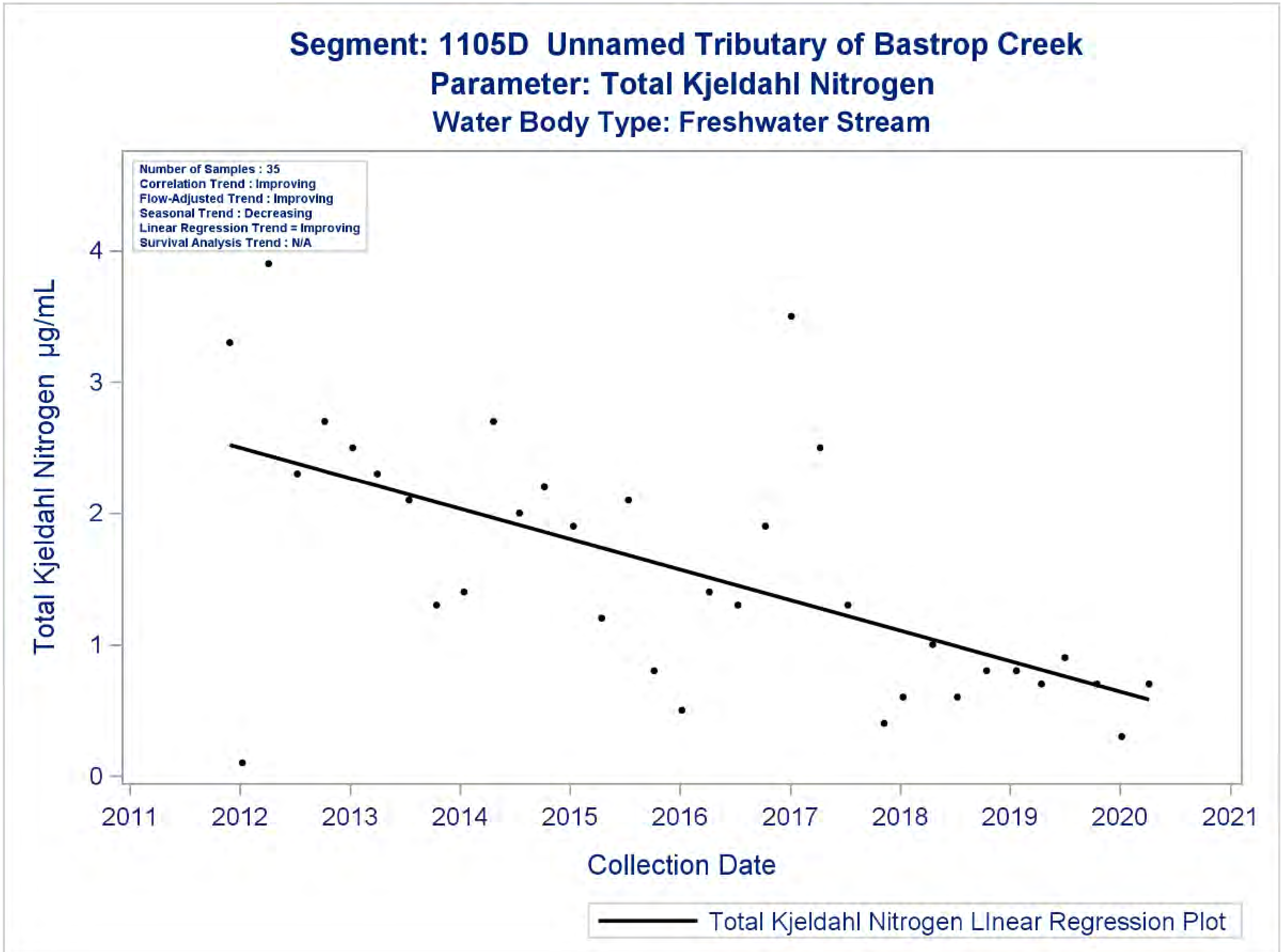

Segment: 1105B Austin Bayou Tidal
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 69
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



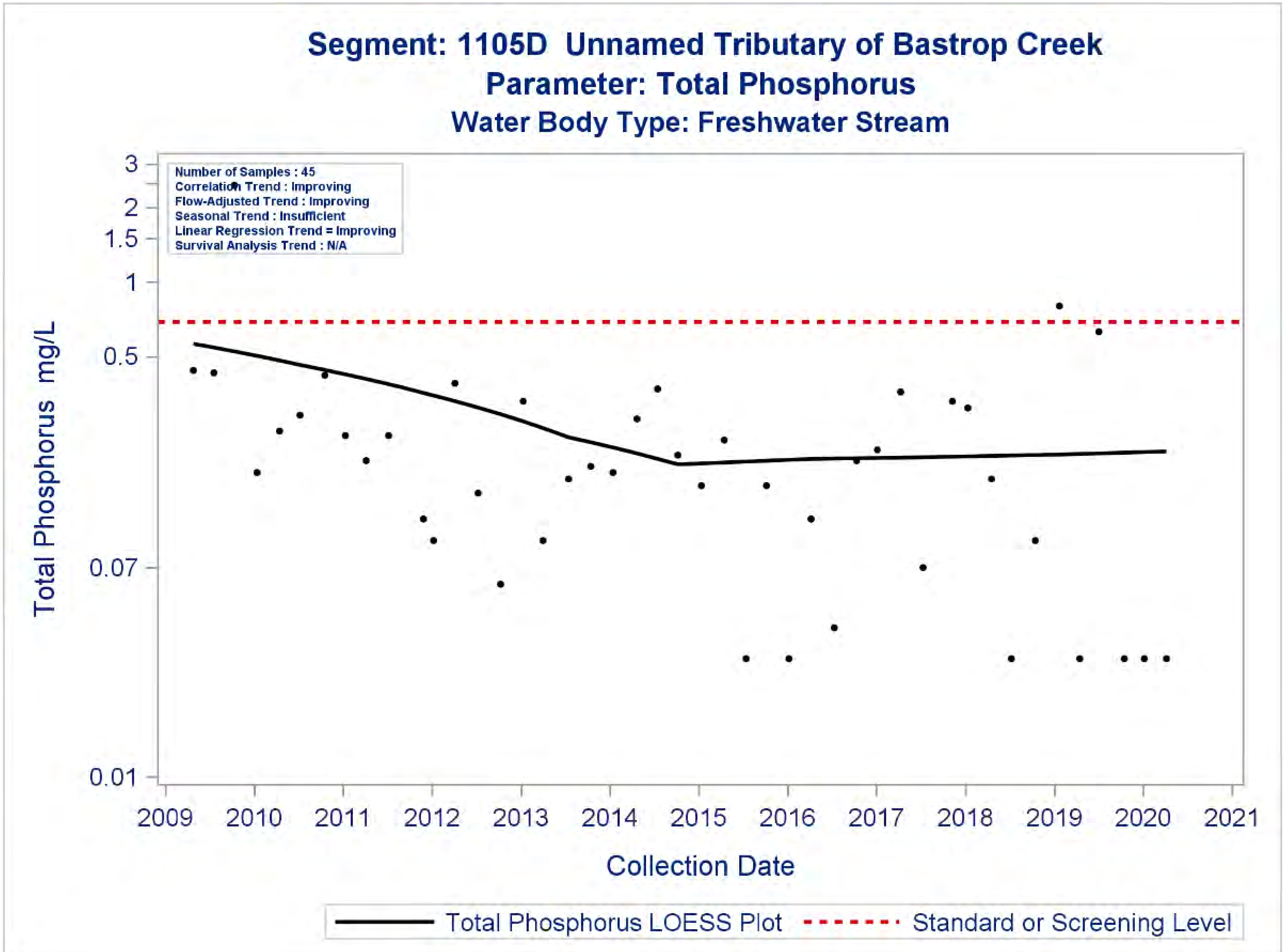
Segment: 1105B Austin Bayou Tidal
Parameter: Total Suspended Solids
Water Body Type: Tidal Stream
Number of Samples : 126
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
500
300
200
100
10
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot



Segment: 1105B Austin Bayou Tidal
Parameter: Secchi Transparency
Water Body Type: Tidal Stream
Number of Samples : 127
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
0.0
0.2
0.4
0.6
0.8
1.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot



Segment: 1105D Unnamed Tributary of Bastrop Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 35
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 1105D Unnamed Tributary of Bastrop Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 45
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
3
2
1.5
1
0.5
0.07
0.01
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1105 I 1105A_03 I 1105B I 1105C I 1105E I	• Animal waste from agricultural production and domestic animal facilities • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operations and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	1105 C 1105D C 1105E I	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste)	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve riparian buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • More public education regarding OSSF operation and maintenance

		▪ High temperature discharges from industrial WWTFs		• More public education on pet waste disposal • More public education regarding disposal of household fats, oils, and grease • Improve operation and maintenance of existing WWTF and collection systems • Regionalize chronically non-compliant WWTFs

Special Studies:

A watershed protection plan was developed for Bastrop Bayou. The Bastrop Bayou Watershed Protection Plan can be located at the following URL: http://www.houstontx.gov/planhouston/sites/default/files/plans/bb_watershed_protection_plan.pdf

Bastrop Bayou was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to evaluate the effectiveness of the watershed protection plan
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans or other agricultural programs for individual agricultural properties
- Support public education on pet waste disposal
- Promote voluntary conservation and forestry projects with water quality benefits

Segment Number: 1108 — Name: Chocolate Bayou Above Tidal

Length:	22 miles	**Watershed Area:**	110 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	1	**Texas Stream Team Monitoring Stations:**	1	**Permitted WWTF Outfalls:**	19

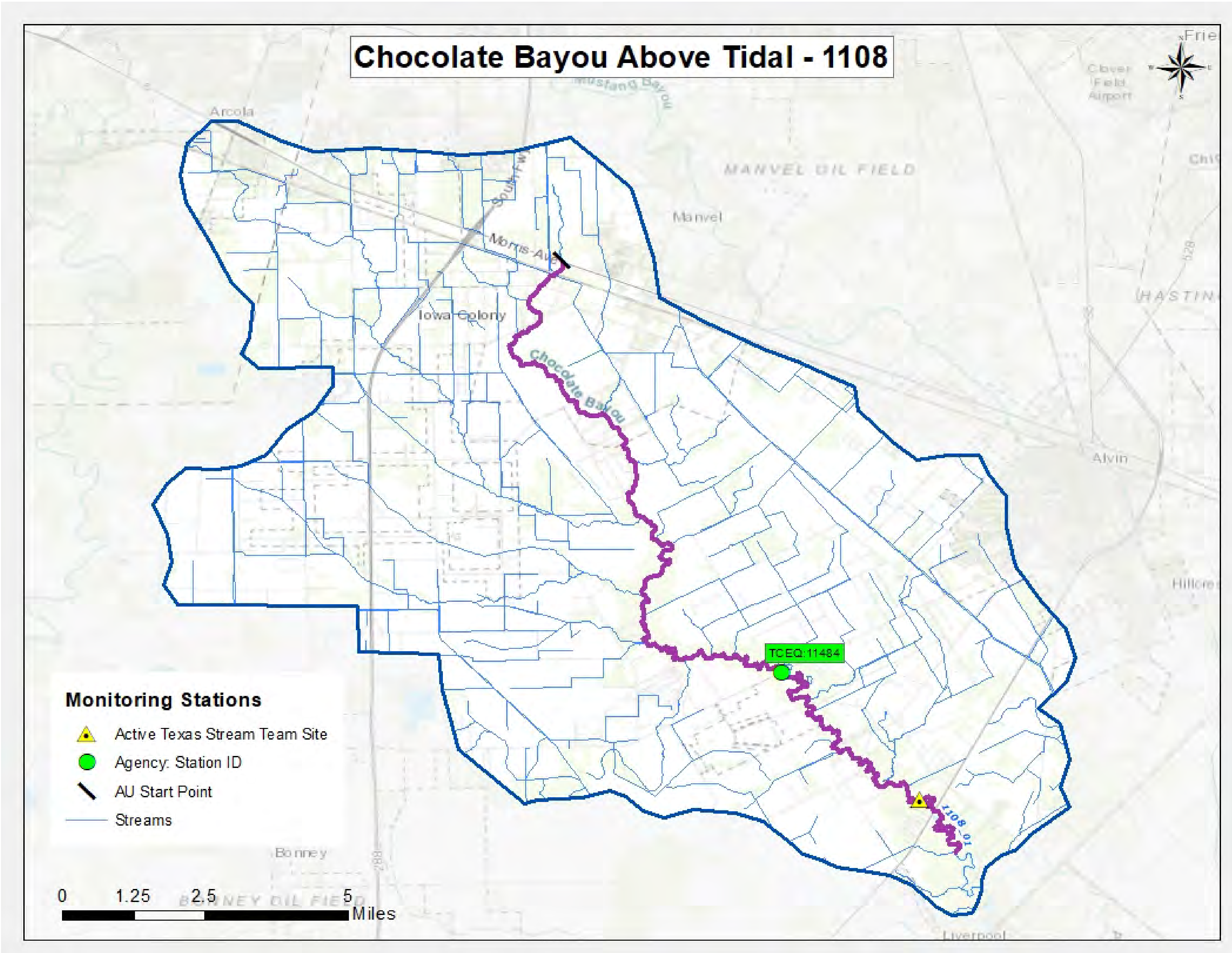
DESCRIPTION

- Segment 1108 (Perennial Stream w/ high ALU): **Chocolate Bayou Above Tidal** (classified water body) – From the salt water barrier (immediately downstream of the Chocolate Bayou Rice Canal) 5.2 km (3.2 mi) downstream of SH 35 in Brazoria County to SH 6 in Brazoria County

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11484	1108	CHOCOLATE BAYOU AT FM 1462 WEST OF ALVIN	FO	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office



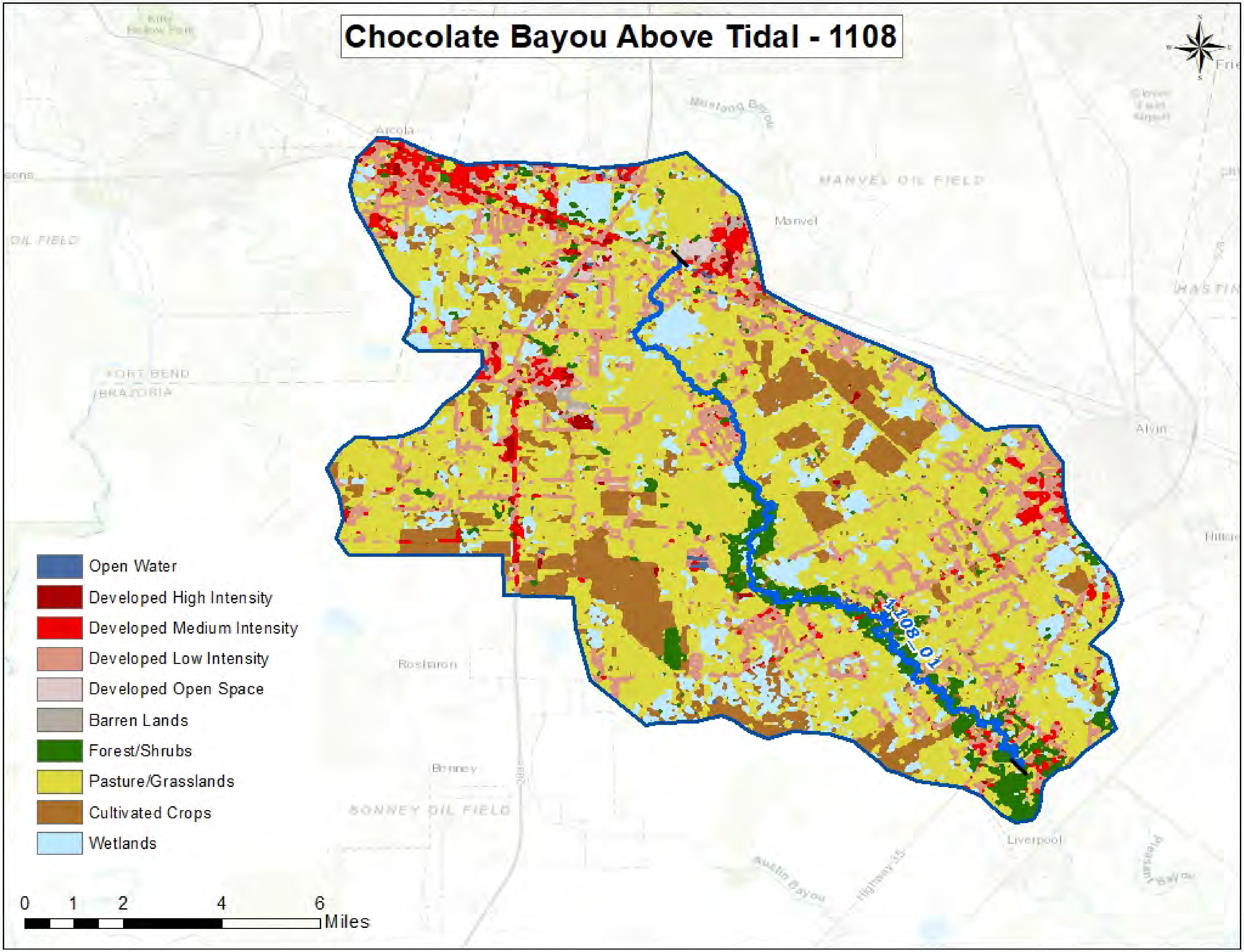
Chocolate Bayou Above Tidal - 1108
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
TCEQ:11484
1108_01
Chocolate Bayou
Mustang Bayou
Arcola
Manvel
MANVEL OIL FIELD
Iowa Colony
Morris Ave
Alvin
Bonney
BONNEY OIL FIELD
Liverpool
Clover Field Airport
0
1.25
2.5
5
Miles

Segment 1108 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F)	32 / 90	Ammonia-N (mg/L)	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L)	5.0	Nitrate-N (mg/L)	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0	Orthophosphate Phosphorus (mg/L)	0.37
pH (standard units)	6.5-9.0	Total Phosphorus-P (mg/L)	0.69
E. coli (MPN/100 mL) (grab)	399	Chlorophyll *a* (µg/L)	14.1
E. coli (MPN/100 mL) (geometric mean)	126		
Chloride (mg/L as Cl)	200		
Sulfate (mg/L as SO_4)	100		
Total Dissolved Solids (mg/L)	900		

Segment Discussion

Watershed Characteristics and Land Cover: The Chocolate Bayou Above Tidal (1108) segment begins at State Highway 6 in Brazoria County and terminates at the salt water barrier immediately downstream of the Chocolate Bayou Rice Canal. Major tributaries include Hayes Creek and West Fork Chocolate Bayou. There are also numerous irrigation canals that run through the watershed. The watershed is primarily rural with agriculture as the predominant land cover (64.16 percent). Although largely undeveloped, there are a few small population centers, including Arcola, Manvel, Iowa Colony, and part of Alvin. More growth has occurred as development has spread south down State Highway 288 in recent years. The H-GAC Regional Growth Forecast anticipates a population increase of 199 percent by 2040. Between 2008 and 2018, developed land cover increased from 8,702 acres (12.27 percent) to 12,877 acres (18.17 percent). On-site sewage facilities are the primary means of wastewater disposal in the watershed.

Segment 1108 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	51,493.89	72.61	45,498.16	64.16	-11.64
Barren Lands	600.91	0.85	340.71	0.48	-43.30
Developed	8,702.04	12.27	12,887.04	18.17	48.09
Forest/Shrubs	707.43	1.00	3,536.95	4.99	399.97
Open Water	203.71	0.29	156.34	0.22	-23.25
Wetlands	9,210.21	12.99	8,491.43	11.97	-7.80
TOTAL	**70,918.19**	**100.00**	**70,910.63**	**100.00**	



Chocolate Bayou Above Tidal - 1108
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1 2 4 6
Miles
1108_01
Arcola
Manvel
MANVEL OIL FIELD
Alvin
FORT BEND
BRAZORIA
OIL FIELD
Rosharon
Bonney
BONNEY OIL FIELD
Liverpool
Austin Bayou
Highway 35
Mustang Bayou

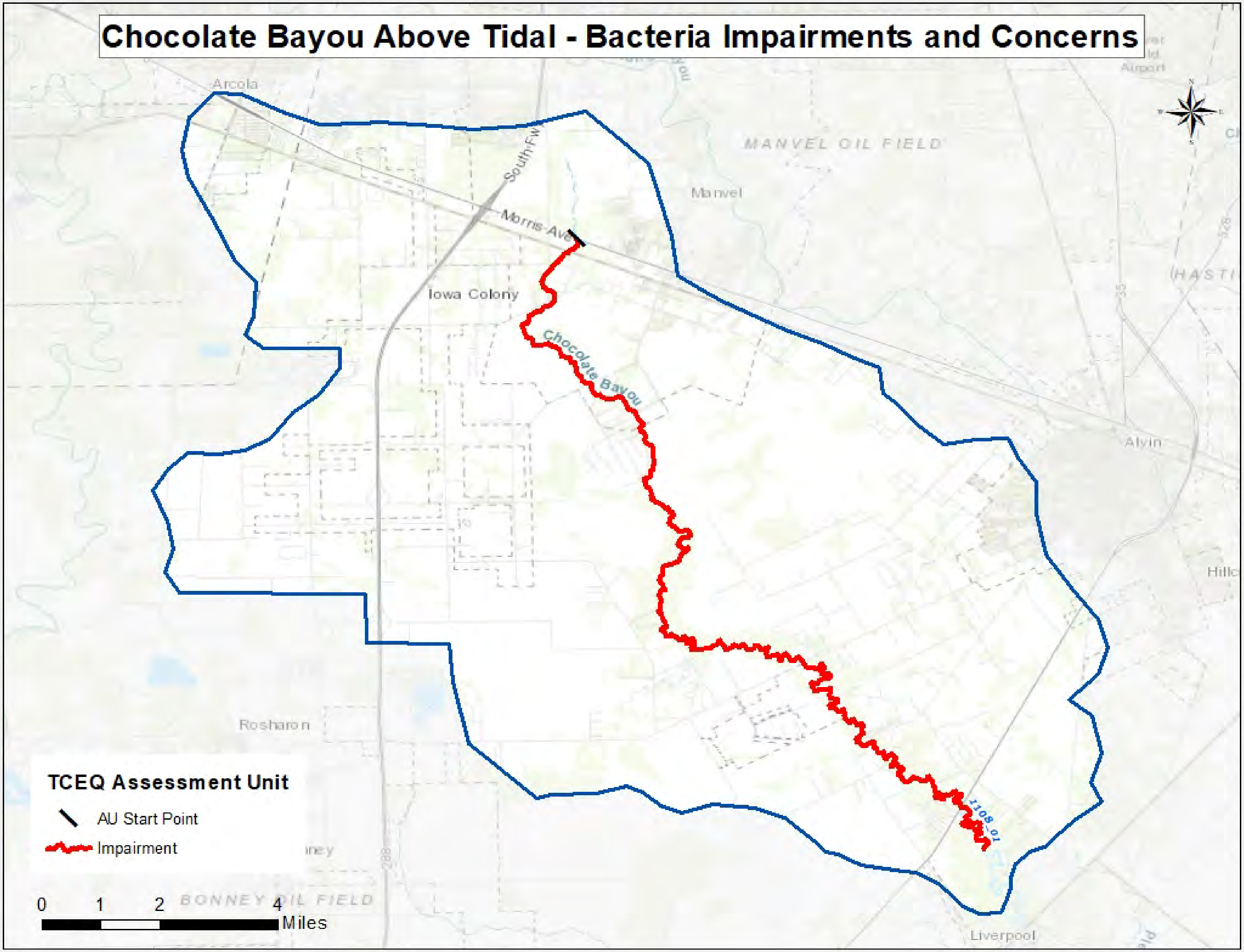
Water Quality Issues:

Bacteria Impairments and Concerns
In the 2020 Integrated Report, Chocolate Bayou Above Tidal (1108) Is listed as impaired for contact recreation due to elevated levels of *E. coli* bacteria.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

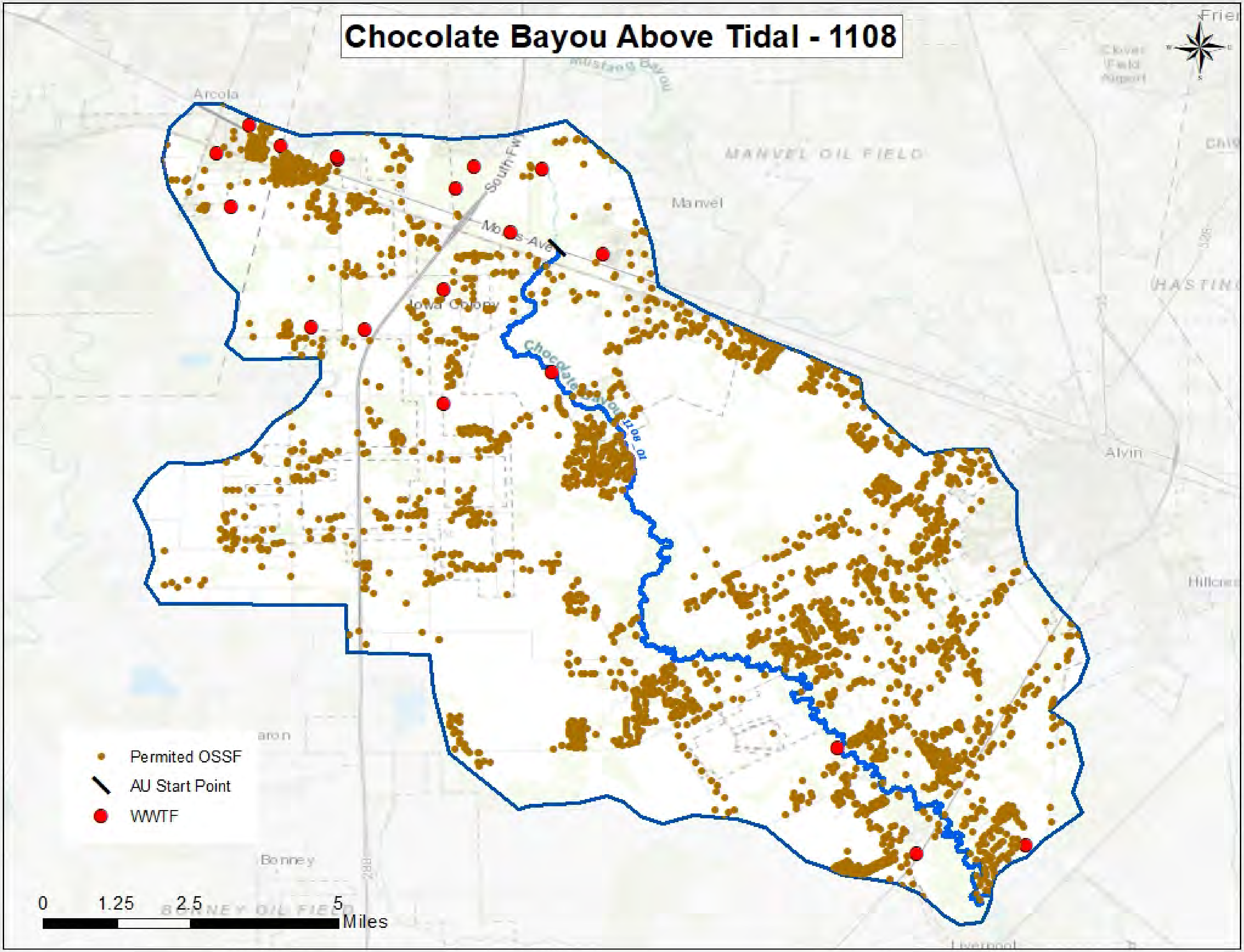

Chocolate Bayou Above Tidal - Bacteria Impairments and Concerns
Arcola
South Fwy
Morris Ave
MANVEL OIL FIELD
Manvel
Iowa Colony
Chocolate Bayou
Alvin
Rosharon
BONNEY OIL FIELD
Liverpool
2108_01
TCEQ Assessment Unit
AU Start Point
Impairment
0
1
2
4
Miles

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Chocolate Bayou Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, agricultural animal waste, and pet waste.

There are 19 permitted wastewater outfalls in the Chocolate Bayou Above Tidal watershed, with most of these outfalls located in the northern portion of the watershed. In most areas, on-site sewage facilities are the primary source of wastewater disposal. There are 3,060 permitted on-site sewage facilities within the watershed. The wastewater treatment facilities and on-site sewage facilities in the Chocolate Bayou Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 23 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Chocolate Bayou Above Tidal watershed.

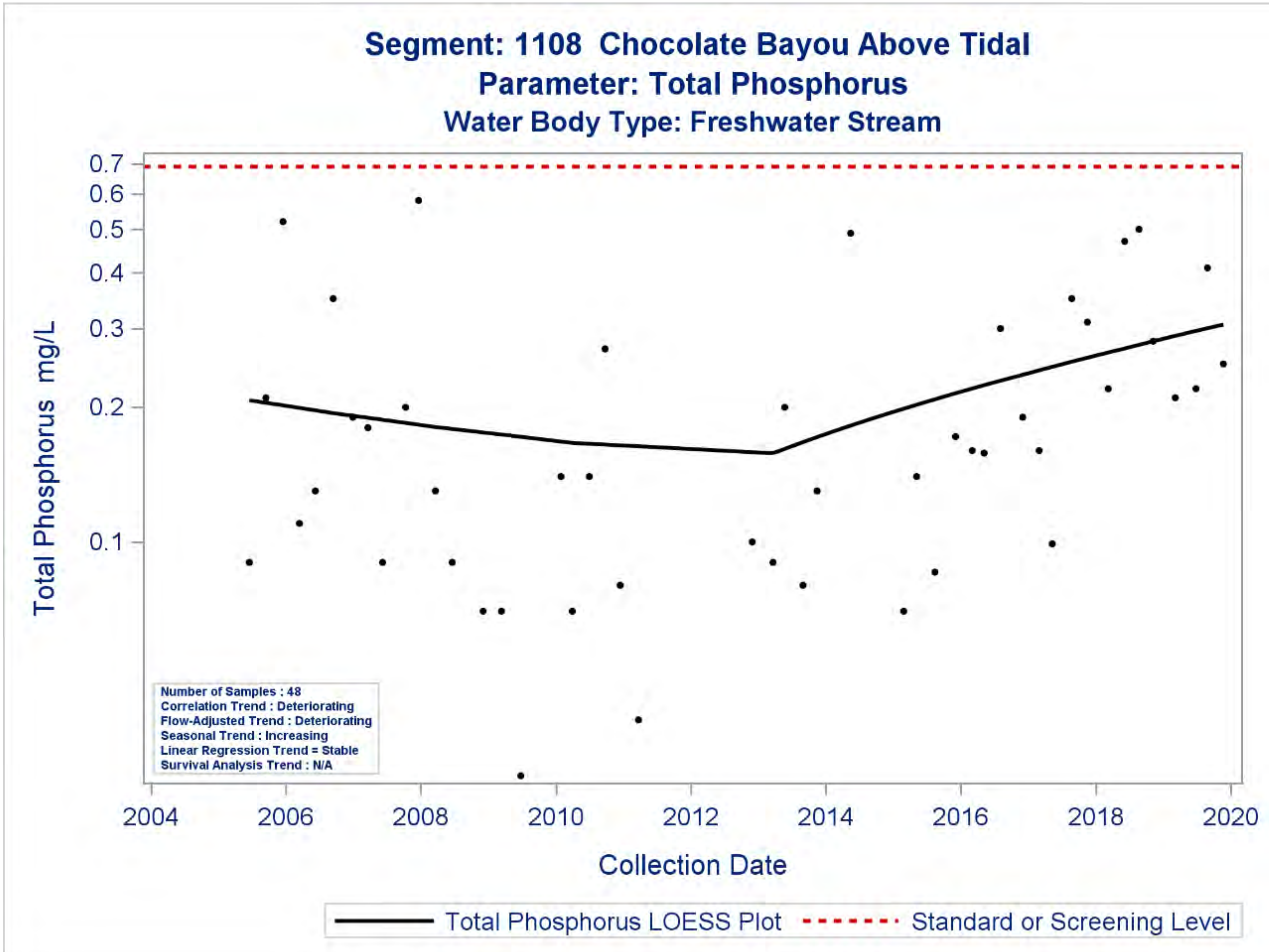


Chocolate Bayou Above Tidal - 1108
Arcola
Mustang Bayou
MANVEL OIL FIELD
Manvel
South Fwy
Mo s Ave
Iowa Colony
Chocolate Bayou
1108_01
Alvin
HASTING
Clover Field Airport
Hillcre
Bonney
BONNEY OIL FIELD
Liverpool
288
Permited OSSF
AU Start Point
WWTF
0
1.25
2.5
5
Miles

Trend Analysis:

Currently, there is only one monitoring station in this watershed and analysis of the available data revealed one statistically significant trend for total phosphorus (TP). The LOESS Plot trend is deteriorating which means the TP concentrations are increasing over time. It should be noted, however, that all sample results were still below the screening criteria for TP. All other parameters are stable.

A bacteria impairment is present for this segment, but regression analysis revealed no significant change in *E. coli* concentrations over the past 15 years. The moving seven-year bacteria geometric mean plots developed for a TMDL project show that *E. coli* geomeans have been hovering around the 126 MPN/100 mL standard with fluctuations periodically exceeding the standard criteria since late 2010.


Segment: 1108 Chocolate Bayou Above Tidal
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Total Phosphorus mg/L
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Number of Samples : 48
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1108 I	• Animal waste from agricultural production, hobby farms, and riding stables • Urbanization and increased impervious cover • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • Implement fats, oils, grease and wipes program • More public education on pet waste disposal • Encourage all systems to develop and implement a utility asset management program and protect against power outages at lift stations

Special Studies:

A Total Maximum Daily Load project is ongoing for Chocolate Bayou. A bacteria reduction I-Plan for the Chocolate Bay watershed, which includes Chocolate Bayou, is anticipated to be completed in 2023.

Segment 1108 was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation
- Support stakeholder actions to reduce fecal bacteria which are being considered for the Chocolate Bay I-Plan
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Enhance Municipal Separate Storm Sewer Program implementation to address impaired waters through the use of LID and green infrastructure (https://h-gac.com/low-impact-development)
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease, and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- Pursue new local partners to collect additional data to help better isolate problem areas
- Expand use of LID and green infrastructure practices
- Expand volunteer monitoring with Texas Stream Team in areas without professional monitoring
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

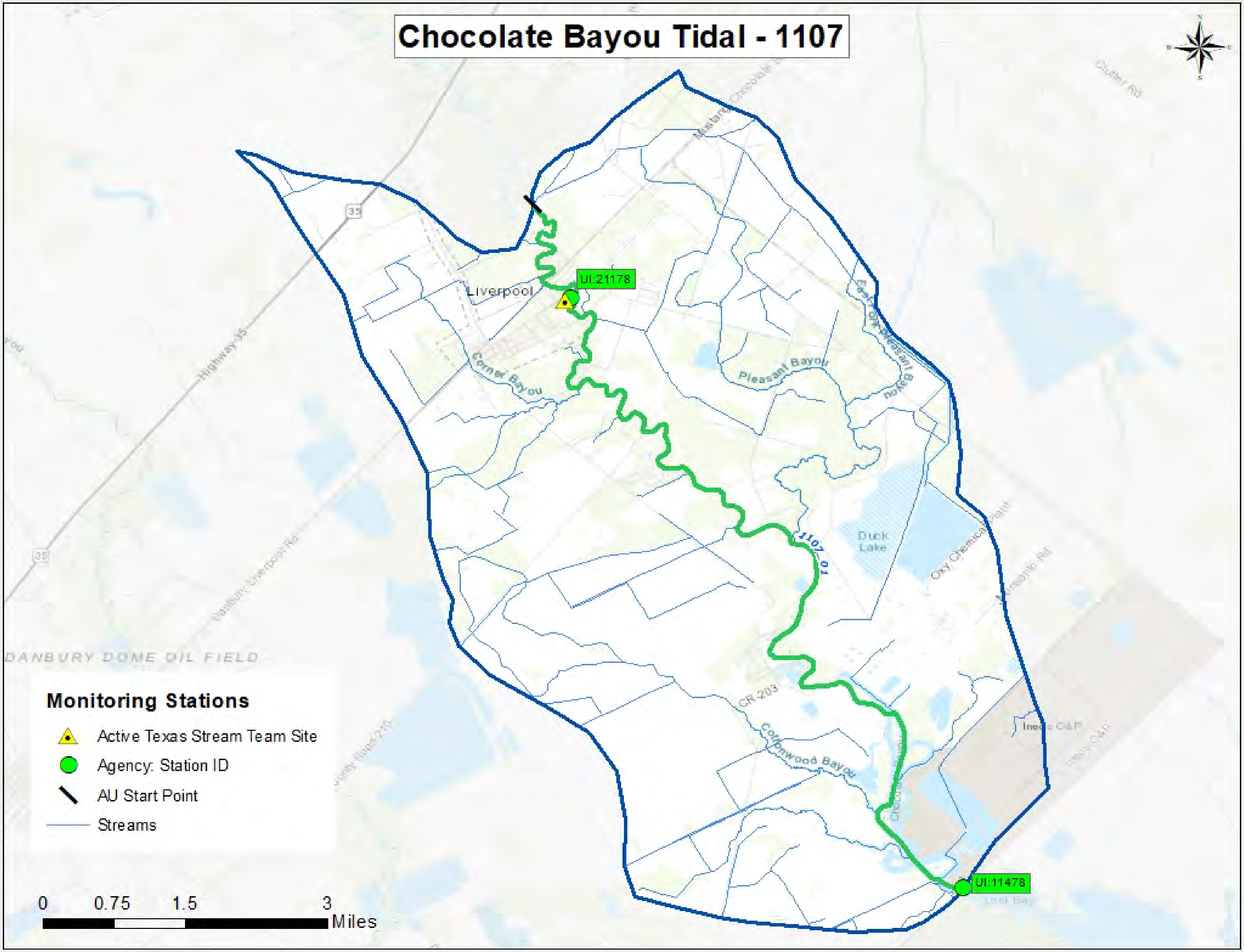
Segment Number:	1107	Name:	Chocolate Bayou Tidal
Length: 16 miles	**Watershed Area:** 37 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations: 2	**Texas Stream Team Monitoring Stations:** 1	**Permitted WWTF Outfalls:**	11

DESCRIPTION

- Segment 1107 (Tidal Stream w/ high ALU): **Chocolate Bayou Tidal** (classified water body) – From the confluence with Chocolate Bay 1.4 km (0.9 mi) downstream of FM 2004 in Brazoria County to the salt water barrier (immediately downstream of the Chocolate Bayou Rice Canal) 5.2 km (3.2 mi) downstream of SH 35 in Brazoria County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11478	1107	CHOCOLATE BAYOU TIDAL AT FM 2004 BRIDGE SOUTH OF ALVIN	UI	Quarterly	Field, Conventional, Bacteria
21178	1107	CHOCOLATE BAYOU IMMEDIATELY UPSTREAM OF BRAZORIA CR 171 / MUSTANG CHOCOLATE BAYOU ROAD IN LIVERPOOL	UI	Quarterly	Field, Conventional, Bacteria

UI = University of Houston Clear Lake – Environmental Institute of Houston


Chocolate Bayou Tidal - 1107
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
UI:21178
UI:11478
Liverpool
Corner Bayou
Pleasant Bayou
East Fork Pleasant Bayou
Duck Lake
Oxy Chemical Plant
Cottonwood Bayou
CR-203
1107_01
Highway 35
Danbury Liverpool Rd
DANBURY DOME OIL FIELD
0
0.75
1.5
3
Miles

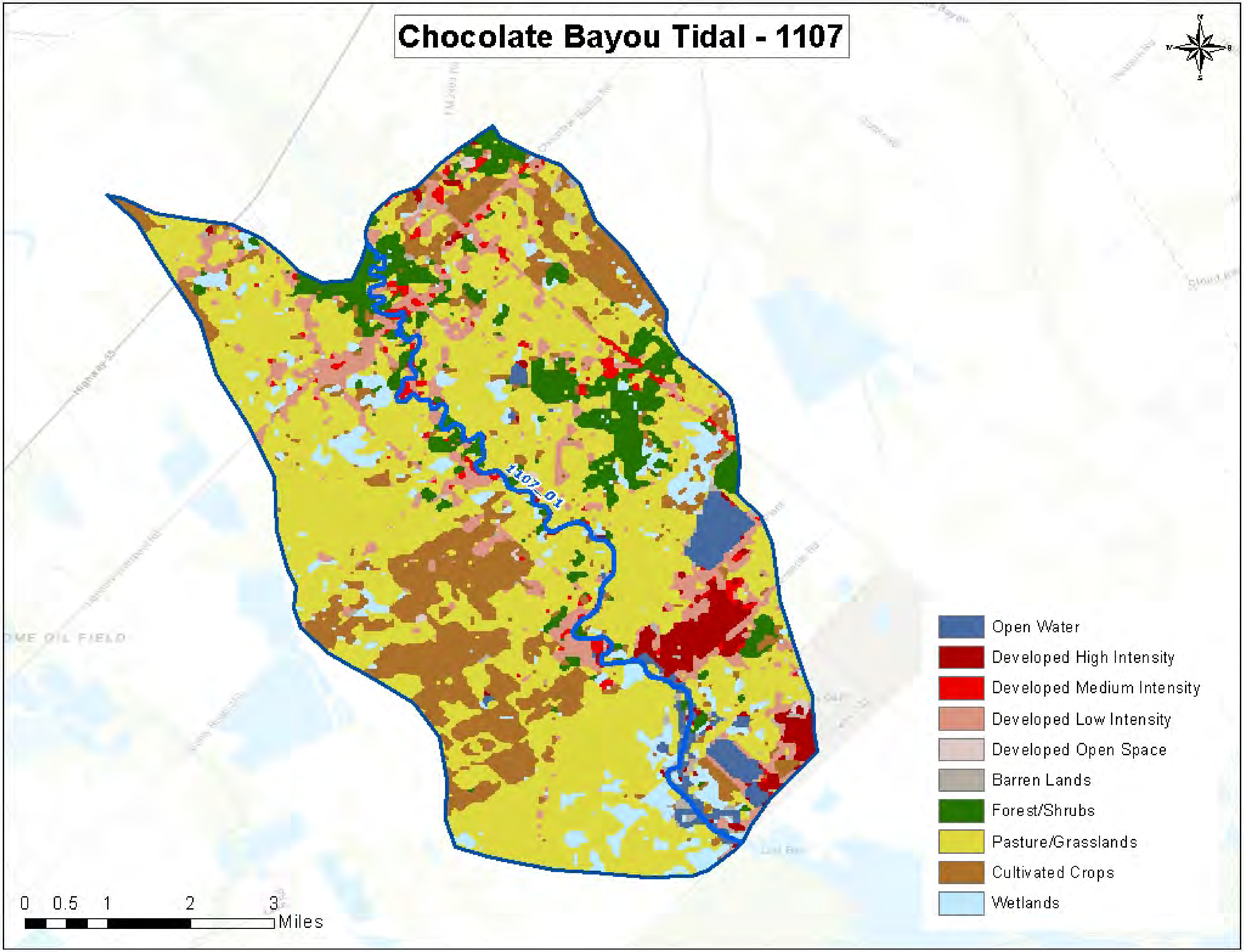
Segment 1107 Water Quality Standards and Screening Levels			
Standards	**Tidal Stream**	**Screening Levels**	**Tidal Stream**
Temperature (°C/°F)	35 / 95	Ammonia-N (mg/L)	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L)	4.0	Nitrate-N (mg/L)	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0	Orthophosphate Phosphorus (mg/L)	0.46
pH (standard units)	6.5-9.0	Total Phosphorus-P (mg/L)	0.66
Enterococci (MPN/100mL) (grab)	104	Chlorophyll *a* (µg/L)	21
Enterococci (MPN/100mL) (geometric mean)	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Chocolate Bayou Tidal (1107) segment begins at the salt water barrier immediately downstream of the Chocolate Bayou Rice Canal downstream of State Highway 35 in Brazoria County and terminates at its confluence with Chocolate Bay 0.9 miles downstream of Farm-to-Market 2004 in Brazoria County. Major tributaries include Corner Bayou, Cottonwood Bayou, Perry Bayou, Pleasant Bayou, and Salt Bayou.

The watershed is predominantly rural with pockets of urban and industrial development scattered throughout. Developed land cover is 13.46 percent of the watershed. The community of Liverpool is located in the northwest and a large industrial complex is located in the southeast portion of the watershed. Duck Lake and Monsanto Reservoir are impoundments used primarily for industrial purposes. The rest of the watershed is used for agriculture and contains several irrigation canals. Agriculture land cover (comprised of cultivated crops and pasture/grassland) is 67.56 percent of the watershed.

Segment 1107 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	16,150.44	68.79	15,864.89	67.56	-1.77
Barren Lands	424.77	1.81	246.41	1.05	-41.99
Developed	1,171.57	4.99	3,161.77	13.46	169.87
Forest/Shrubs	921.82	3.93	1,743.34	7.42	89.12
Open Water	856.44	3.65	649.17	2.76	-24.20
Wetlands	3,954.16	16.84	1,818.07	7.74	-54.02
TOTAL	**23,479.20**	**100.00**	**23,483.65**	**100.00**	


Chocolate Bayou Tidal - 1107
1107_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.5 1 2 3
Miles

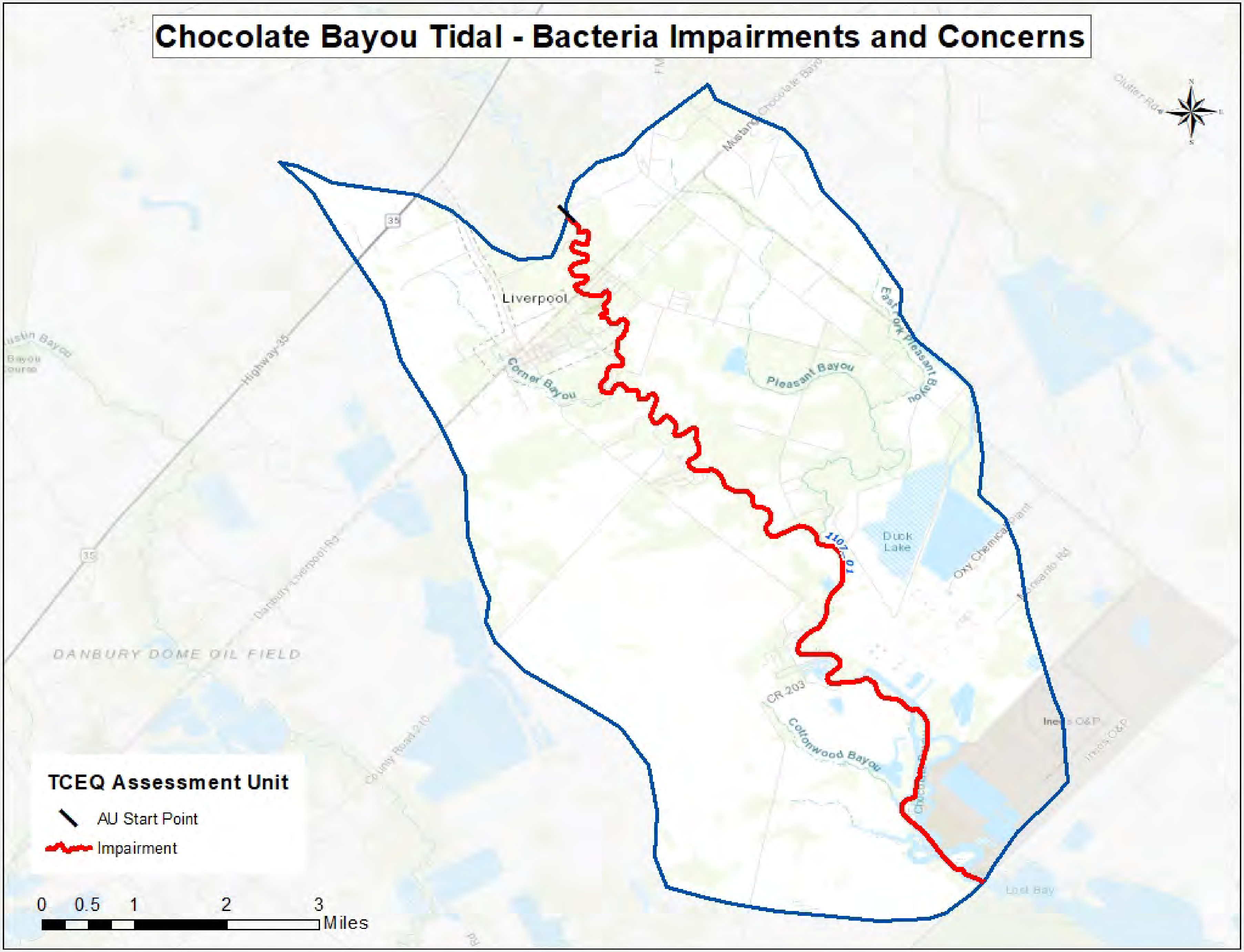
Water Quality Issues:

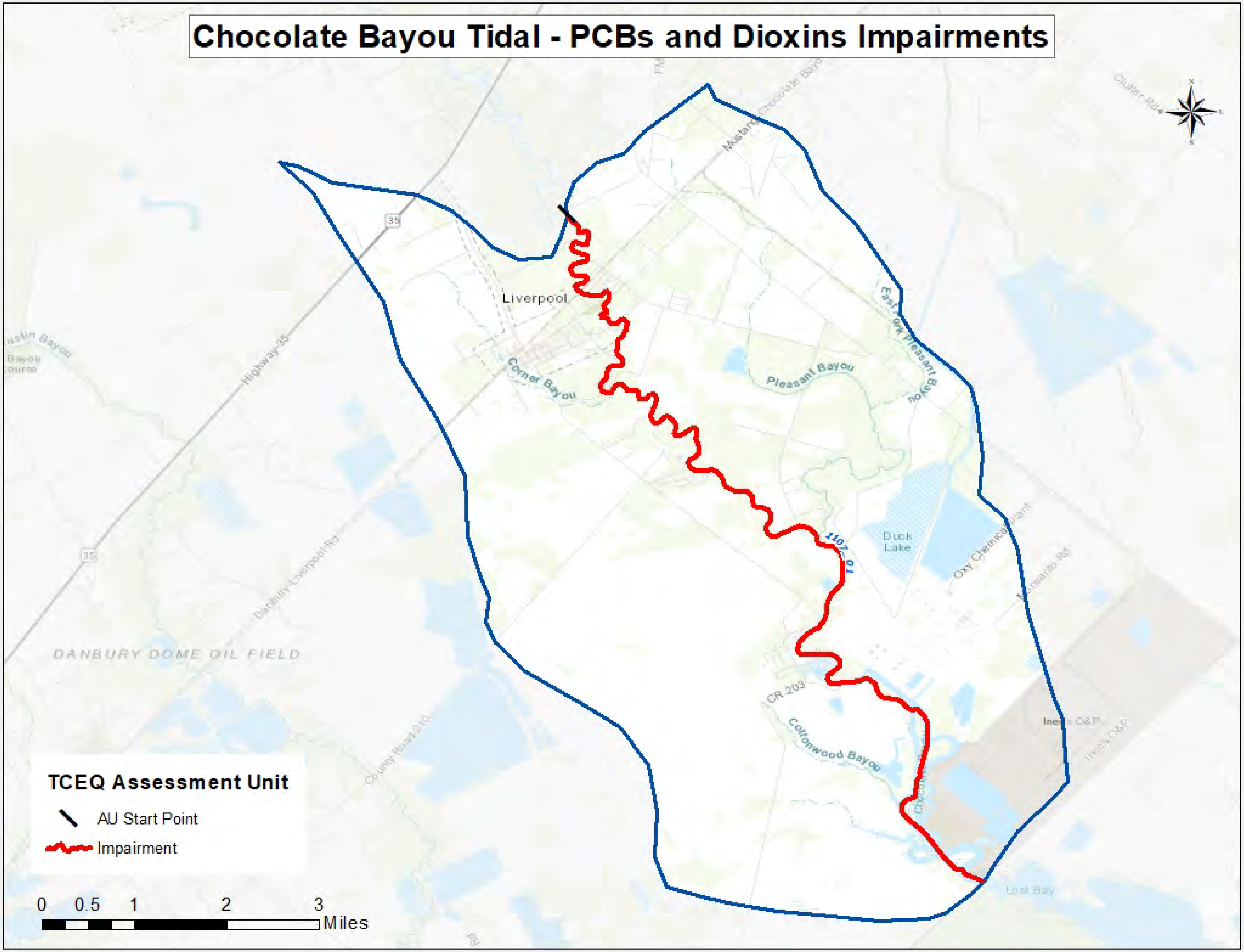
Bacteria Impairments and Concerns
The 2020 Integrated Report lists AU 1107_01 as impaired for contact recreation use due to elevated levels of enterococci bacteria. The bacteria geometric mean for this assessment unit was 106.88 MPN/100 mL, which exceeds the standard of 35 MPN/100 mL.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxin Impairments
The Texas Department of State Health Services has issued a Limited Consumption Fish Advisory for Chocolate Bayou Tidal due to high levels pf PCBs and dioxin found in all species of catfish.


Chocolate Bayou Tidal - Bacteria Impairments and Concerns
Liverpool
Corner Bayou
Pleasant Bayou
East Fork Pleasant Bayou
Duck Lake
1107_01
Oxy Chemical Plant
Monsanto Rd
Highway 35
Danbury-Liverpool Rd
DANBURY DOME OIL FIELD
County Road 210
CR 203
Cottonwood Bayou
Lost Bay
TCEQ Assessment Unit
AU Start Point
Impairment
0 0.5 1 2 3
Miles



Chocolate Bayou Tidal - PCBs and Dioxins Impairments
Liverpool
Corner Bayou
Pleasant Bayou
East Fork Pleasant Bayou
Highway 35
Danbury Liverpool Rd
DANBURY DOME OIL FIELD
Duck Lake
Oxy Chemical Plant
Monsanto Rd
1107_01
CR 203
Cottonwood Bayou
County Road 210
Mustang Chocolate Bayou
Lost Bay
35
TCEQ Assessment Unit
AU Start Point
Impairment
0
0.5
1
2
3
Miles

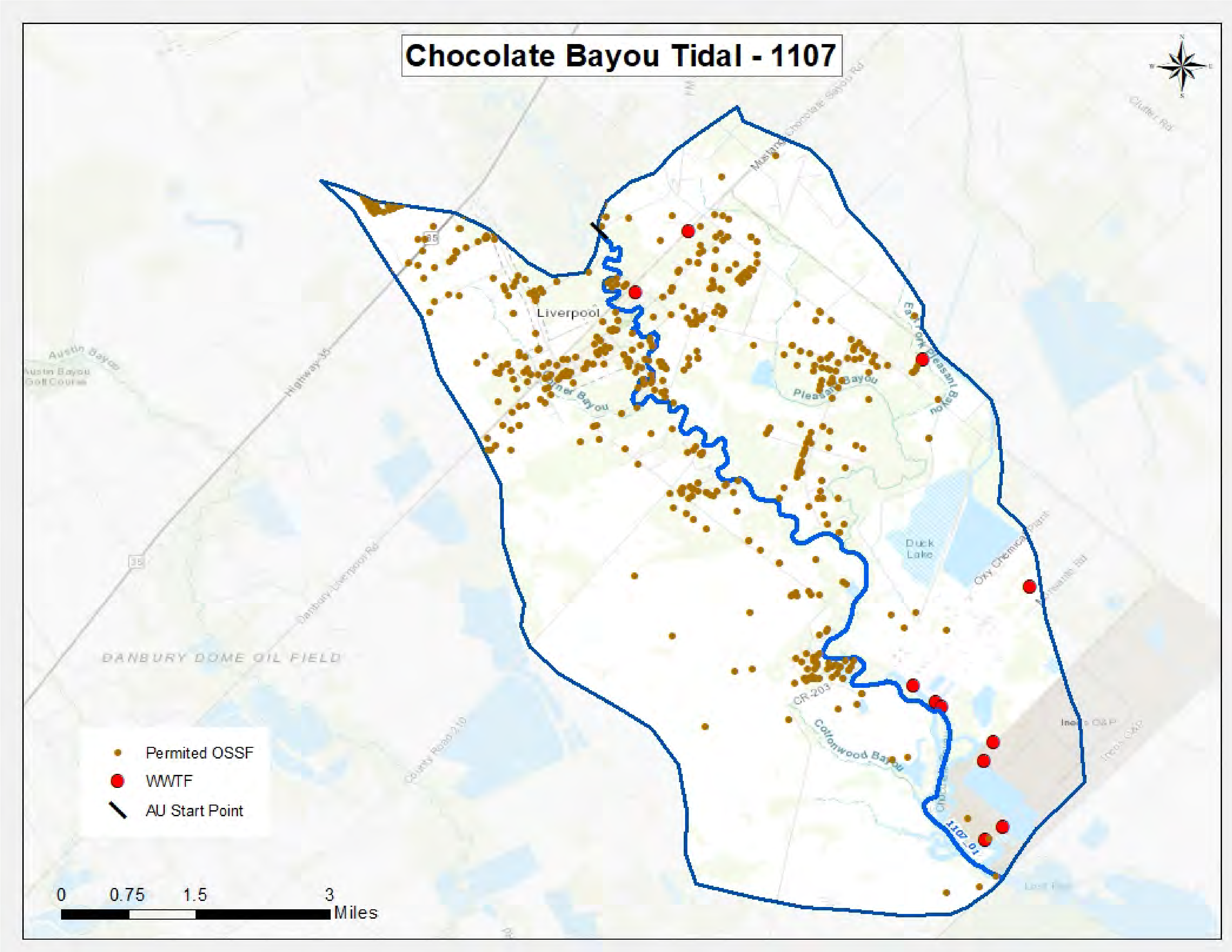
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria in the Chocolate Bayou Tidal watershed include wastewater treatment facility effluent, failing on-site sewage facilities, and other nonpoint sources, including wildlife and feral hogs.

There are 11 permitted wastewater outfalls in the Chocolate Bayou Tidal watershed. In much of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 510 permitted systems located within the watershed. The wastewater treatment facilities and on-site sewage facilities in the Chocolate Bayou Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there was only 1 reported sanitary sewer overflow in the sewer collection systems. While this number of sanitary sewer overflows would not cause chronically high bacteria within this waterway, each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Chocolate Bayou Tidal watershed.



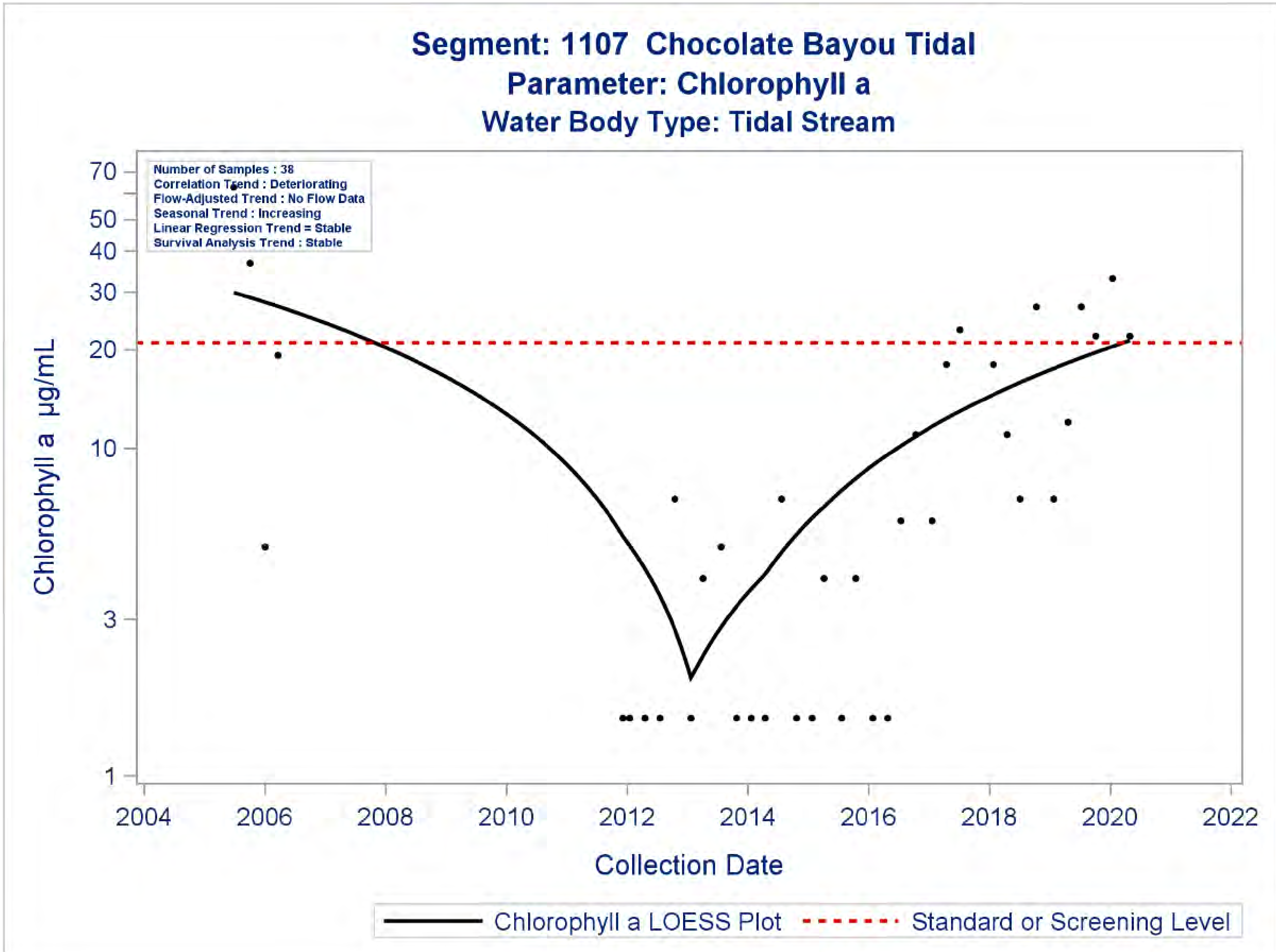
Chocolate Bayou Tidal - 1107
Liverpool
Duck Lake
DANBURY DOME OIL FIELD
Highway 35
Danbury-Liverpool Rd
County Road 210
CR-203
Cottonwood Bayou
Pleasant Bayou
East Fork Pleasant Bayou
Oxy Chemical Plant
Austin Bayou
1107_01
Permited OSSF
WWTF
AU Start Point
0
0.75
1.5
3
Miles

Trend Analysis:

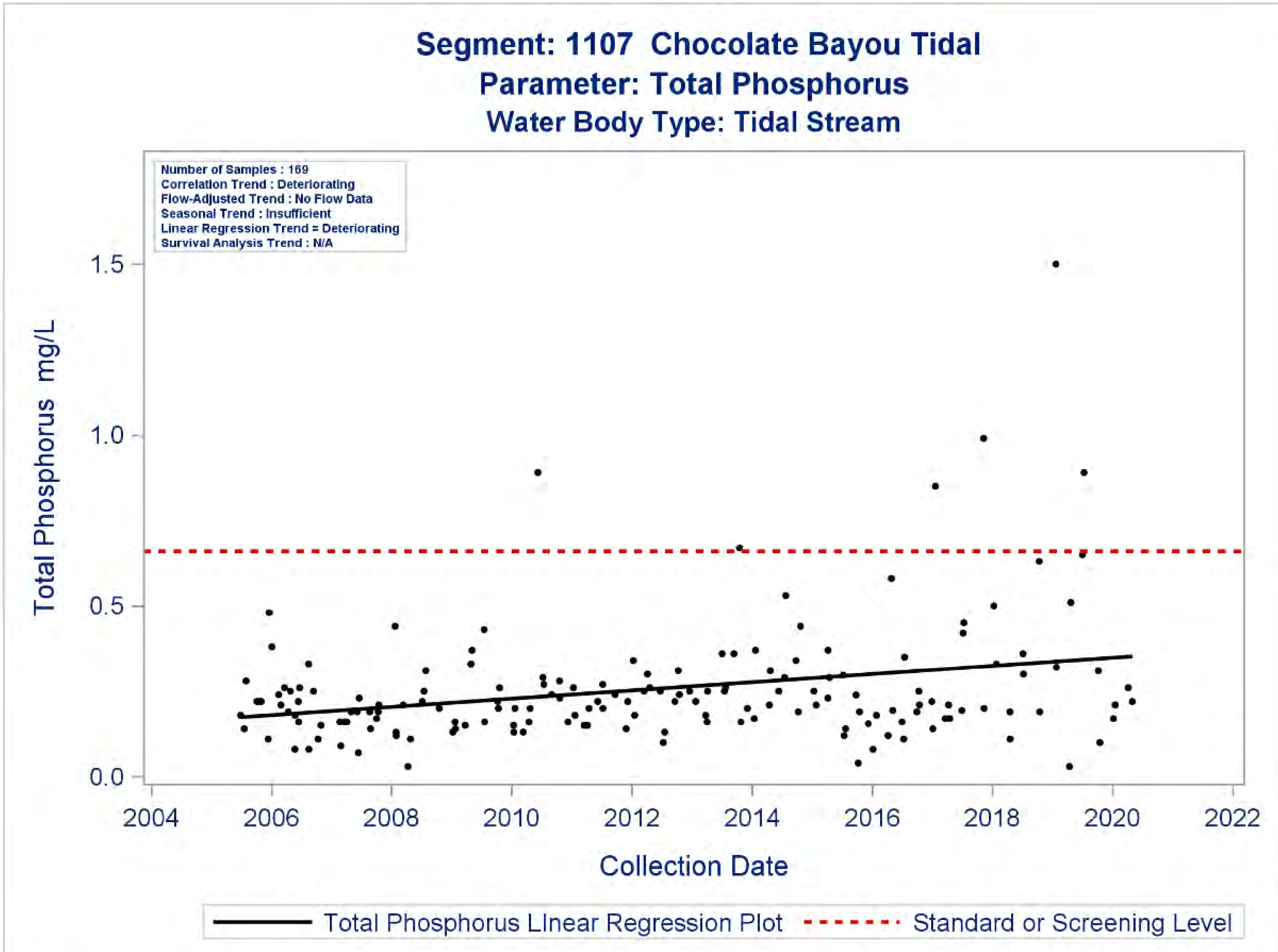
Regression analysis of segment data revealed statistically significant trends for two parameters including increasing chlorophyll *a* and total phosphorus concentrations. The chlorophyll a increasing trend is based upon only the data collected since 2012. The All other parameters were stable over the period of record at the segment level.

Station 11478, which is located at the most downstream sampling location in Chocolate Bayou Tidal, has been assessed for over two decades. Data collection for station 21178, located further upstream adjacent to the watersheds urban center of Liverpool, began in 2004. Data trends for station 21178 reflect the two parameter trends seen on the main segment plus it includes an improving trend for TKN where concentrations are decreasing.

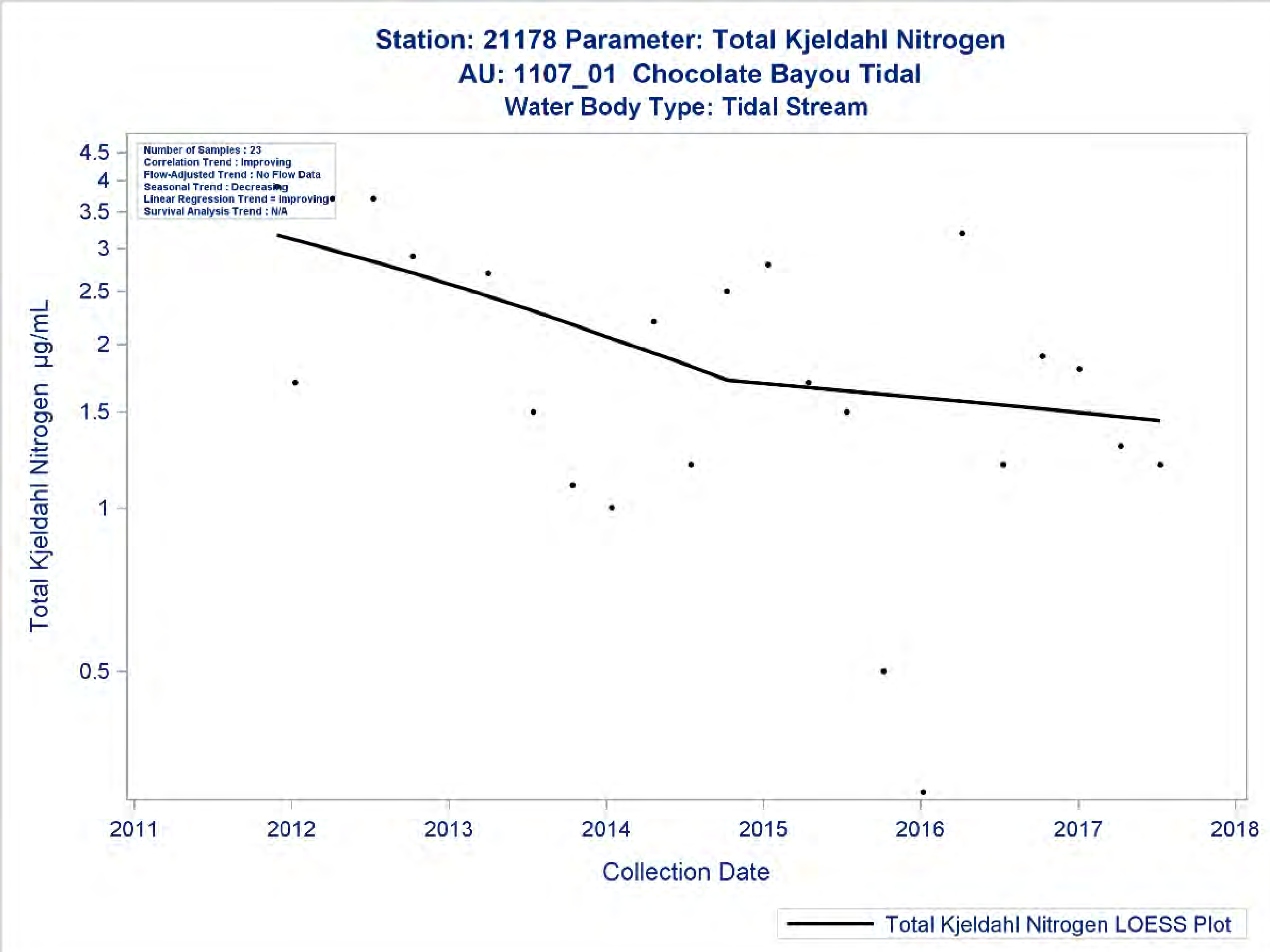
Chocolate Bayou Tidal is impaired for bacteria. Enterococci bacteria concentrations continue to be stable throughout the waterway, but the majority of the sample results exceed the state water quality standard for contact recreation.



Segment: 1107 Chocolate Bayou Tidal
Parameter: Chlorophyll a
Water Body Type: Tidal Stream
Number of Samples : 38
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Chlorophyll a µg/mL
70
50
40
30
20
10
3
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chlorophyll a LOESS Plot
Standard or Screening Level



Segment: 1107 Chocolate Bayou Tidal
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 169
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.5
1.0
1.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



Station: 21178 Parameter: Total Kjeldahl Nitrogen
AU: 1107_01 Chocolate Bayou Tidal
Water Body Type: Tidal Stream
Number of Samples : 23
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
4.5
4
3.5
3
2.5
2
1.5
1
0.5
Total Kjeldahl Nitrogen µg/mL
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LOESS Plot

Water Quality Issues Summary					
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*		**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1107	I	• Animal waste from agricultural production, hobby farms, and riding stables • Urbanization and increased impervious cover • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • Waste haulers illegal discharges/improper disposal • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Dioxin/PCBs in Fish Tissue	1107	I	• Concentrated deposits outside boundaries of the waste pits located adjacent to San Jacinto River and I-10 bridge • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf	• Continue monitoring and assessment of fish tissue to determine status of impairment • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

A Total Maximum Daily Load Implementation Plan is in development for Chocolate Bayou.

Segment 1107 was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Create and implement Water Quality Management Plans for individual agricultural properties
- Expand use of LID and green infrastructure practices
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number:	1102	Name:	Clear Creek Above Tidal

Length:	31 miles	Watershed Area:	115 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	9	Texas Stream Team Monitoring Sites:	4	Permitted WWTF Outfalls:	13

DESCRIPTION

- Segment 1102 (Perennial Stream w/ high ALU): **Clear Creek Above Tidal** (classified water body) – From a point 100 meters (110 yards) upstream of FM 528 in Galveston/Harris County to Rouen Road in Fort Bend County

- Segment 1102A (Intermittent Stream with Pools w/ limited ALU): **Cowart Creek** (unclassified water body) – From the Clear Creek Above Tidal confluence in Galveston County to Texas State Highway 35 in Brazoria County

- Segment 1102B (Perennial Stream w/ intermediate ALU): **Mary’s Creek/North Fork Mary’s Creek** (unclassified water body) – Perennial stream from the confluence with Clear Creek Above Tidal to confluence with North and South Fork Mary’s Creek near FM 1128, approximately 5 km (3.1 mi) southwest of Pearland. Includes perennial portion of North Fork Mary’s Creek to confluence with an unnamed tributary 1.98 miles upstream of FM 1128

- Segment 1102C (Perennial Stream w/ high ALU): **Hickory Slough** (unclassified water body) – From the Clear Creek Above Tidal confluence to a point 0.69 km (0.43 mi) upstream of Mykawa Road

- Segment 1102D (Perennial Stream w/ high ALU): **Turkey Creek** (unclassified water body) – From the Clear Creek Above Tidal confluence to a point 0.98 km (0.61 mi) upstream of Scarsdale Boulevard

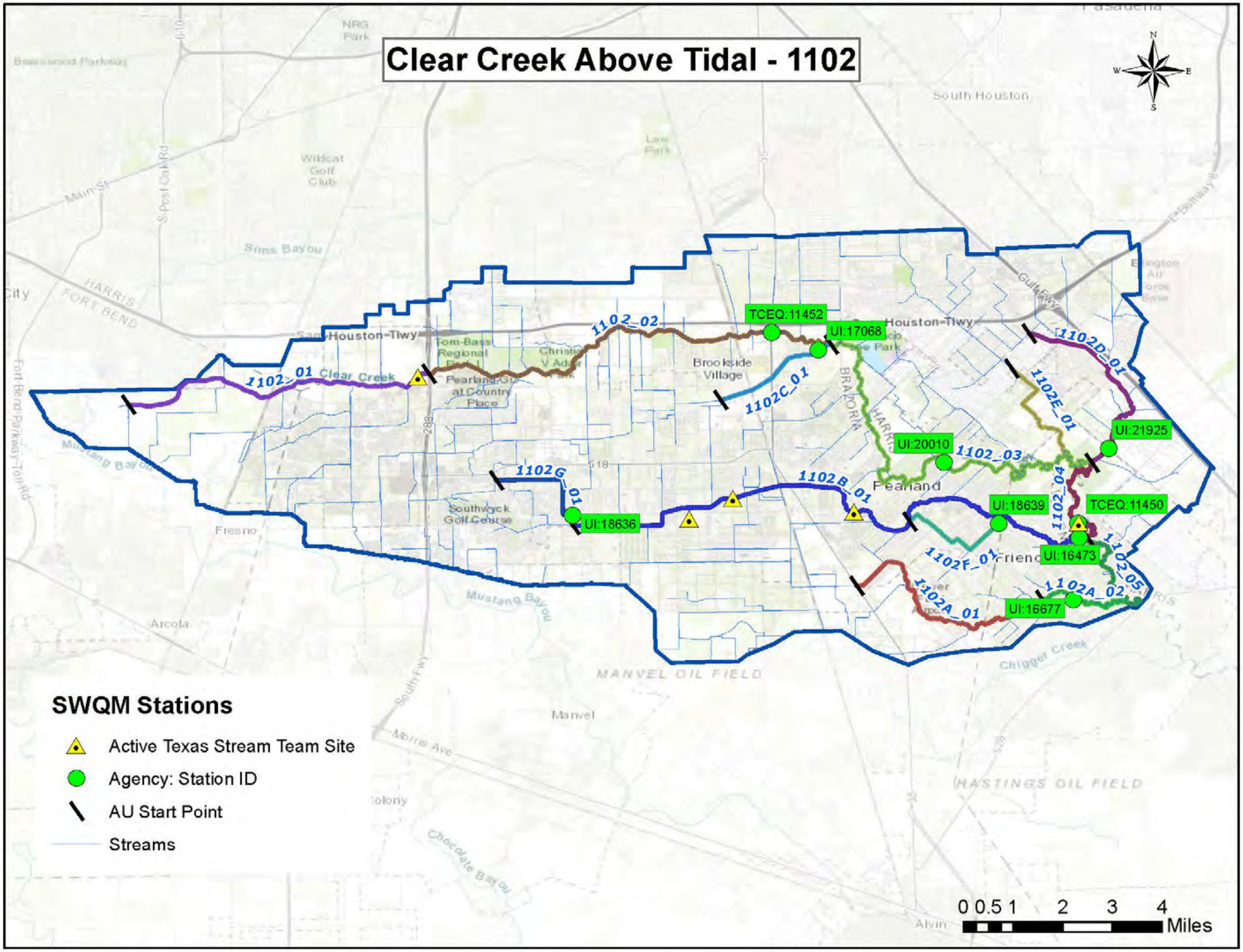
- Segment 1102E (Perennial Stream w/ high ALU): **Mud Gully** (unclassified water body) – From the Clear creek Above Tidal confluence to a point 0.80 km (0.49 mi) downstream of Hughes Road

- Segment 1102F (Perennial Stream w/ high ALU): **Mary’s Creek Bypass** (unclassified water body) – From the Mary’s Creek confluence northeast of FM 518 to a point 0.96 km (0.60 mi) upstream to the Mary’s Creek confluence (northwest of County Road 126)

- Sub-Segment 1102G (Perennial Stream w/ high ALU): **Unnamed Tributary of Mary’s Creek** (unclassified water body) – From the Mary's Creek confluence 1.3 km (0.84 mi) west of FM 1128 to a point 1.2 km (0.75 mi) upstream to the confluence of an unnamed tributary

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11450	1102	CLEAR CREEK AT FM2351 / CHOATE RD NEAR FRIENDSWOOD	FO	Quarterly	Field, Conventional, Bacteria
11452	1102	CLEAR CREEK AT TELEPHONE RD SH35 IN SOUTH HOUSTON	FO	Quarterly	Field, Conventional, Bacteria, Flow
20010	1102	CLEAR CREEK ABOVE TIDAL AT YOST ROAD TERMINUS IN PEARLAND IN BRAZORIA COUNTY	UI	Quarterly	Field, Conventional, Bacteria, Flow
16677	1102A	COWART CREEK 9 METERS UPSTREAM FROM CASTLEWOOD DRIVE BRIDGE IN FRIENDSWOOD	UI	Quarterly	Field, Conventional, Bacteria, Flow
16473	1102B	MARYS CREEK AT MARYS CROSSING IN NORTH FRIENDSWOOD	UI	Quarterly	Field, Conventional, Bacteria, Flow
17068	1102C	HICKORY SLOUGH AT ROBINSON DRIVE IN PEARLAND	UI	Quarterly	Field, Conventional, Bacteria, Flow
21925	1102D	TURKEY CREEK AT BEAMER ROAD 1.5 KM SOUTHEAST OF FM 1959/DIXIE FARM ROAD IN FRIENDSWOOD	UI	Quarterly	Field, Conventional, Bacteria, Flow
18639	1102F	MARYS CREEK BYPASS AT EAST BROADWAY ST/FM 518 WEST OF SUNSET MEADOWS DR IN PEARLAND	UI	Quarterly	Field, Conventional, Bacteria, Flow
18636	1102G	UNNAMED TRIB OF MARYS CREEK 8 M DOWNSTREAM OF THALERFIELD DR E OF OLD CHOCOLATE BAYOU RD/BRAZORIA CR 89 APPROX 300 M UPST SILVER LAKE WWTP	UI	Monthly Quarterly	Field, Flow Conventional, Bacteria

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston


Clear Creek Above Tidal - 1102
SWQM Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
1102_01 Clear Creek
1102_02
1102C_01
1102D_01
1102E_01
1102_03
1102_04
1102_05
1102G_01
1102B_01
1102F_01
1102A_01
1102A_02
TCEQ:11452
UI:17068
UI:20010
UI:21925
UI:18639
TCEQ:11450
UI:16473
UI:16677
UI:18636
Houston-Tlwy
Pearland
Brookside Village
Sims Bayou
Mustang Bayou
Chigger Creek
Chocolate Bayou
MANVEL OIL FIELD
HASTINGS OIL FIELD
Manvel
Fresno
Arcola
Alvin
South Houston
0 0.5 1 2 3 4
Miles

Segment 1102 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F)	35 / 95	Ammonia-Nitrogen (mg/L)	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L)	5.0 / 4.0	Nitrate-Nitrogen (mg/L)	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0 / 3.0	Total Phosphorus-P (mg/L)	0.69
pH (standard units)	6.5-9.0	Chlorophyll-*a* (µg/L)	14.1
E. coli (MPN/100 mL) (grab)	399		
E. coli (MPN/100 mL) (geometric mean)	126		
Chloride (mg/L as Cl)	200		
Sulfate (mg/L as SO_4)	100		
Total Dissolved Solids (mg/L)	600		

Segment Discussion

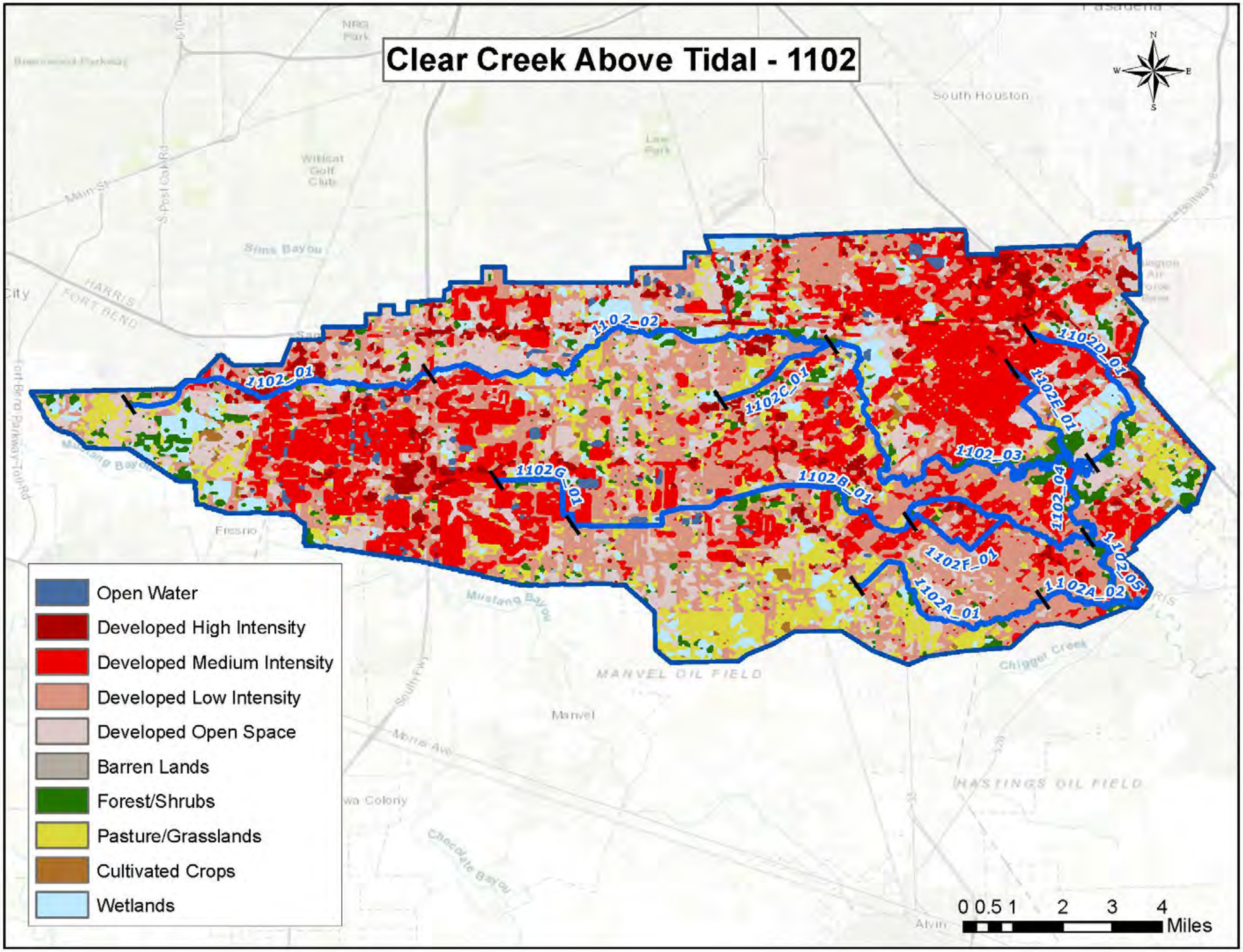
Watershed Characteristics and Land Cover: Clear Creek Above Tidal is a freshwater stream in the southern portion of Houston. Historically, the area has been primarily rural, but has undergone tremendous growth in recent years, particularly in the FM 518 and SH 288 corridor, that has resulted in an increased amount of development. Rapid population growth in the Clear Creek Above Tidal watershed has sparked the expansion of residential and commercial development primarily along FM 518 though Friendswood and Pearland. Scattered areas of open space are still present throughout the watershed but will likely be developed as growth continues in the area. There are also some agricultural land uses in the southern and western portions of the watershed. Most of the development is served by wastewater treatment facilities, but there are still several areas that use on-site sewage facilities as their primary means of wastewater treatment.

The Clear Creek Above Tidal watershed covers approximately 73,456 acres. Developed lands are dispersed throughout the watershed and compose 72.91 percent of the land cover. Agriculture, made up of cultivated crops and pasture/grassland, is the next largest land cover category, at 13.71 percent. High intensity developments have increased exponentially along the State Highway 288 corridor which run north-south through the west side of Pearland. Slightly more than 3,000 acres of land has been converted to development in the watershed between 2008 and 2018.

With more impervious cover, the lower AUs in the segment are now showing higher instantaneous flows compared to previous years, especially during rain events.

Segment 1102 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	12,935.50	17.60	10,071.31	13.71	-22.14
Barren Lands	1,497.15	2.03	612.25	0.83	-59.11
Developed	50,472	68.71	53,560.15	72.91	6.12
Forest/Shrubs	1,504.27	2.05	3,643.69	4.96	142.22
Open Water	1,056.59	1.44	683.19	0.93	-35.34
Wetlands	5,990.84	8.15	4,885.54	6.65	-18.45
TOTAL	**73,456.40**	**100.00**	**73,456.15**	**100.00**	



Clear Creek Above Tidal - 1102
1102_01
1102_02
1102_03
1102_04
1102_05
1102A_01
1102A_02
1102B_01
1102C_01
1102D_01
1102E_01
1102F_01
1102G_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
South Houston
Sims Bayou
Mustang Bayou
Fresno
Manvel
MANVEL OIL FIELD
HASTINGS OIL FIELD
Chigger Creek
Chocolate Bayou
Alvin
0 0.5 1 2 3 4
Miles

Water Quality Issues: The primary water quality issues for Clear Creek Above Tidal and its tributaries are elevated levels of bacteria and nutrients and low DO and loss of habitat concerns in a few AUs. PCBs have been identified in fish tissue samples, leading to the issuance of a fish consumption advisory for Clear Creek.

Bacteria Impairments and Concerns

In the 2020 IR, Clear Creek Above Tidal (1102) has bacteria impairments for three of five assessment units (1102_02, 1102_03, and 1102_04). The most upstream AU (1102_01) and downstream AU (1102_05) were not assessed for bacteria, as there are currently no active monitoring stations in these AUs. In segment 1102, the *E. coli* geometric mean ranges from 184.60 MPN/100 mL in 1102_03 to 300.84 MPN/100 mL in 1102_04. Mary's Creek (1102B), Turkey Creek (1102D), Mary's Creek Bypass (1102F), and the Unnamed Tributary of Mary's Creek (1102G) are all listed as Non-Supporting for Primary Contact Recreation. Hickory Slough (1102C) is Fully Supporting for Primary Contact Recreation with an *E. coli* geometric mean of 93.40 MPN/100 mL. While the geometric means for 1102B, 1102D, and 1102F are two to three times the water quality standard, segment 1102G is listed based on a result of 24,000 MPN/100 mL (1 sample assessed). This result is over 190 times higher than the water quality standard. Further sampling is necessary to determine if this value is representative of normal conditions.

Dissolved Oxygen Impairments and Concerns

One AU within the classified segment (1102_05) and three of the unclassified segments (1102D_01, 1102E_01, and 1102F_01) have concerns for depressed dissolved oxygen. AU 1102C also has a concern for dissolved oxygen screening levels.

Nutrient Concerns

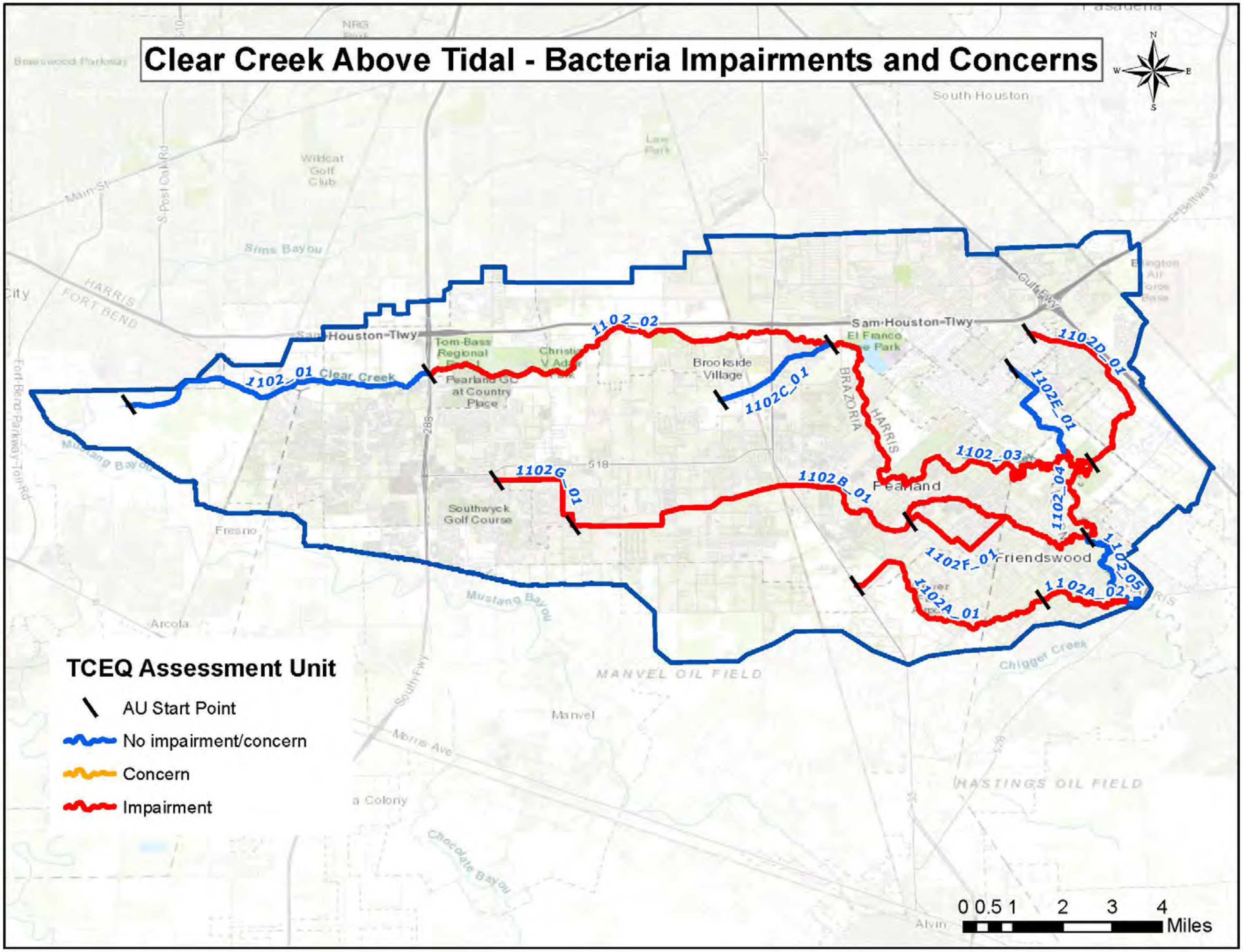
Many of the assessment units in this watershed have concerns for nutrients. Of the 13 assessment units in the watershed, seven are listed for nitrate, six for total phosphorus, and four for ammonia.

2020 Assessment Results – Nutrient Screening Level Concerns				
Segment Name	**Assessment Unit**	**Ammonia-N Concerns**	**Nitrate-N Concerns**	**Phosphorus Concerns**
Clear Creek Above Tidal	1102_01			
	1102_02	X	X	X
	1102_03	X	X	X
	1102_04		X	X
	1102_05		X	
Cowart Creek	1102A_01			
	1102A_02	X		
Mary's Creek/North Fork Mary's Creek	1102B_01		X	X
Hickory Slough	1102C_01			
Turkey Creek	1102D_01	X	X	X
Mud Gully	1102E_01		X	
Mary's Creek Bypass	1102F_01			X
Unnamed Tributary of Mary's Creek	1102G_01			

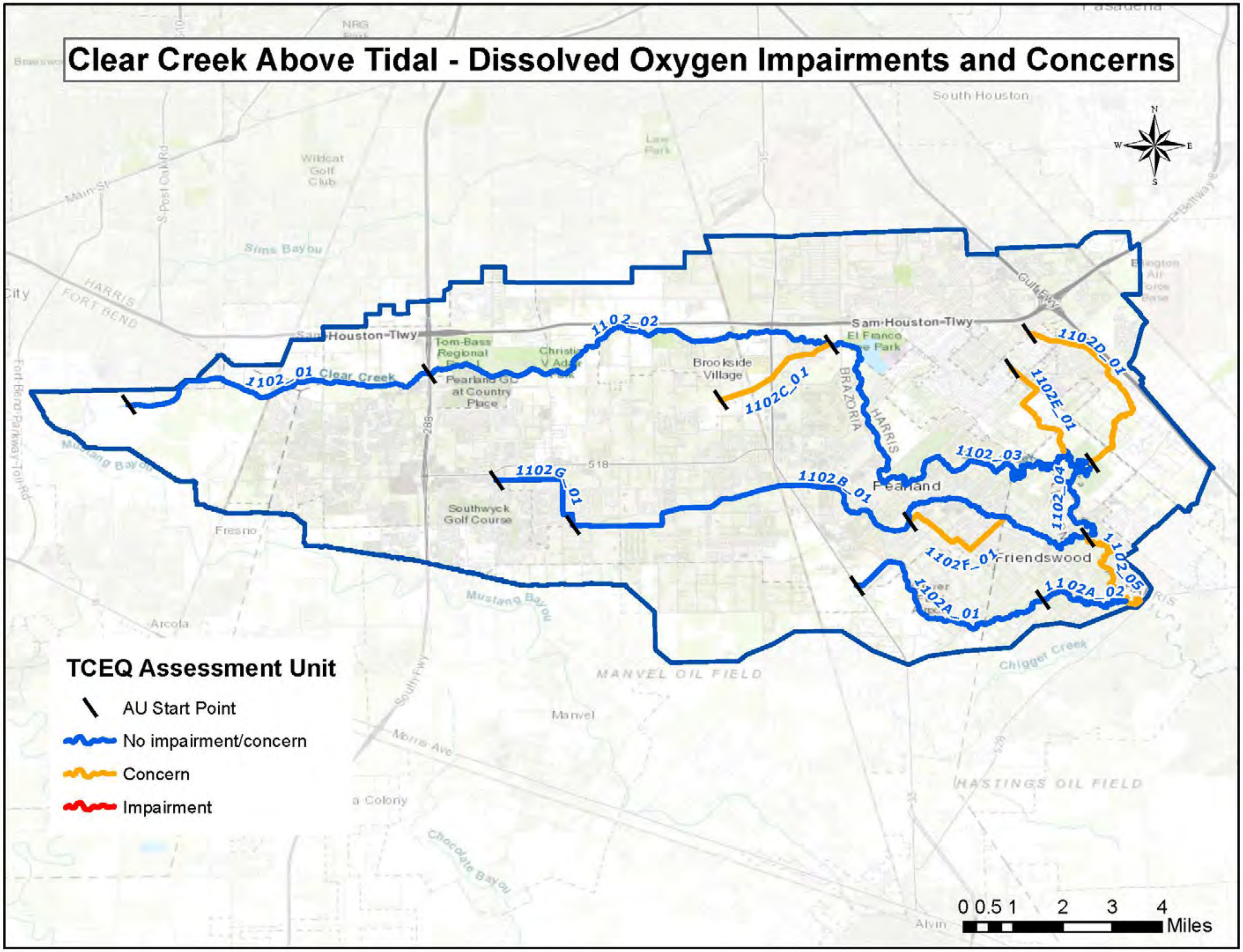
PCBs and Dioxin Impairments

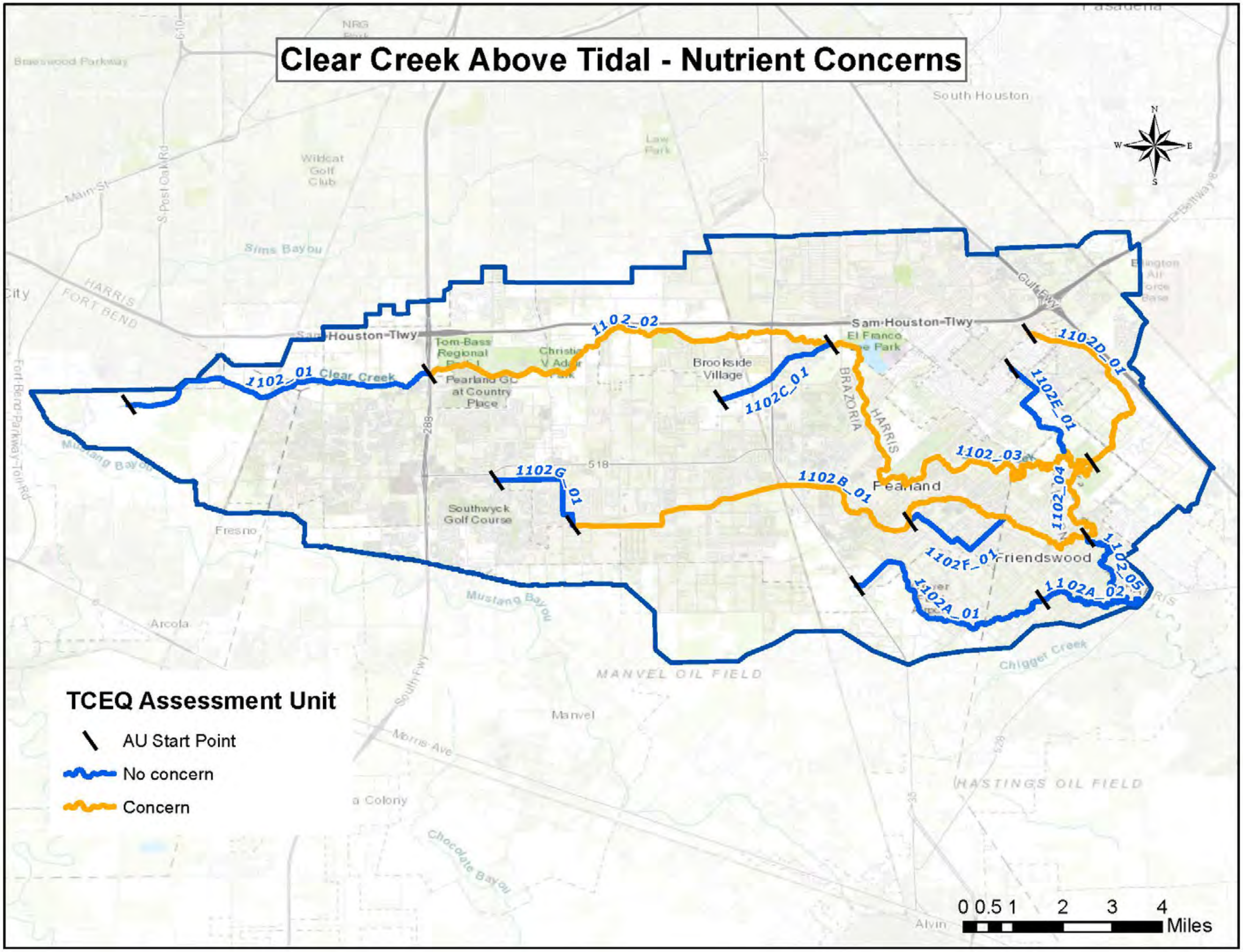
Clear Creek Above Tidal is listed as impaired for PCBs and Dioxins in fish tissue. Fish samples collected from Clear Creek indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) on July 8, 2009 advises that people should not consume any species of fish from these waters.

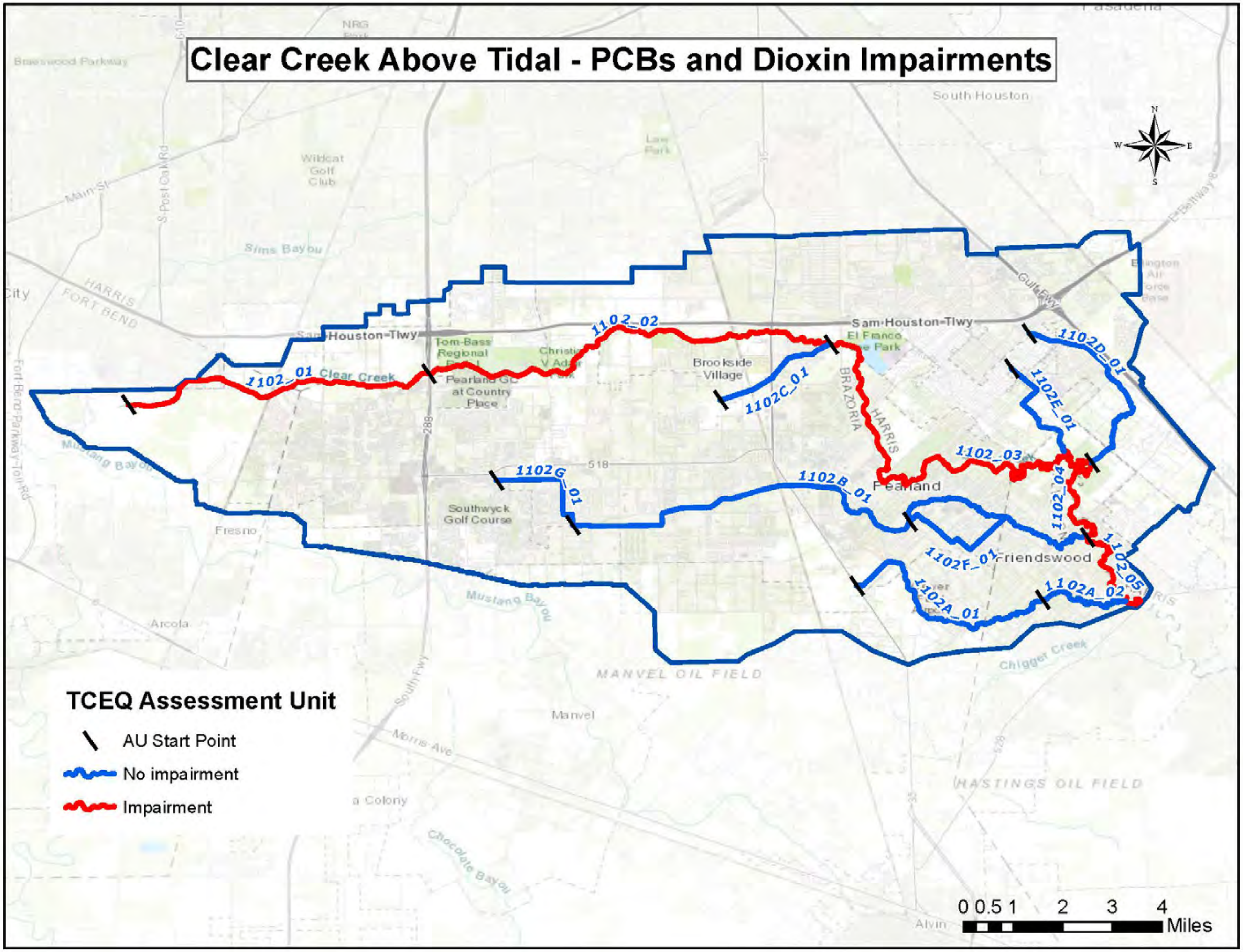
Fish/Community Habitat
There is a concern for Habitat in AU 1102_02.



Clear Creek Above Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
1102_01 Clear Creek
1102_02
1102_03
1102_04
1102_05
1102A_01
1102A_02
1102B_01
1102C_01
1102D_01
1102E_01
1102F_01
1102G_01
Sam Houston Tlwy
Pearland
Friendswood
Brookside Village
Southwyck Golf Course
Mustang Bayou
Sims Bayou
Chigger Creek
Chocolate Bayou
MANVEL OIL FIELD
HASTINGS OIL FIELD
Manvel
Fresno
Arcola
Alvin
South Houston
0 0.5 1 2 3 4
Miles


Clear Creek Above Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
1102_01 Clear Creek
1102_02
1102_03
1102_04
1102_05
1102A_01
1102A_02
1102B_01
1102C_01
1102D_01
1102E_01
1102F_01
1102G_01
Sam Houston Tlwy
Pearland
Friendswood
Brookside Village
Southwyck Golf Course
Tom Bass Regional
Sims Bayou
Mustang Bayou
Chocolate Bayou
Chigger Creek
MANVEL OIL FIELD
HASTINGS OIL FIELD
Manvel
Fresno
Arcola
Alvin
South Houston
Wildcat Golf Club
HARRIS
FORT BEND
BRAZORIA
0 0.5 1 2 3 4 Miles


Clear Creek Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No concern
Concern
1102_01 Clear Creek
1102_02
1102C_01
1102D_01
1102E_01
1102_03
1102_04
1102B_01
1102G_01
1102F_01
1102A_01
1102A_02
1102_05
Sam Houston Tlwy
Pearland
Friendswood
Brookside Village
Southwyck Golf Course
Fresno
Arcola
Manvel
MANVEL OIL FIELD
HASTINGS OIL FIELD
Mustang Bayou
Chocolate Bayou
Chigger Creek
Sims Bayou
South Houston
Alvin
0 0.5 1 2 3 4 Miles


Clear Creek Above Tidal - PCBs and Dioxin Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
1102_01 Clear Creek
1102_02
1102_03
1102_04
1102_05
1102A_01
1102A_02
1102B_01
1102C_01
1102D_01
1102E_01
1102F_01
1102G_01
Pearland
Friendswood
Brookside Village
Sam Houston Tlwy
Mustang Bayou
Sims Bayou
Fresno
Arcola
Manvel
MANVEL OIL FIELD
HASTINGS OIL FIELD
Chocolate Bayou
Chigger Creek
South Houston
Alvin
0 0.5 1 2 3 4
Miles

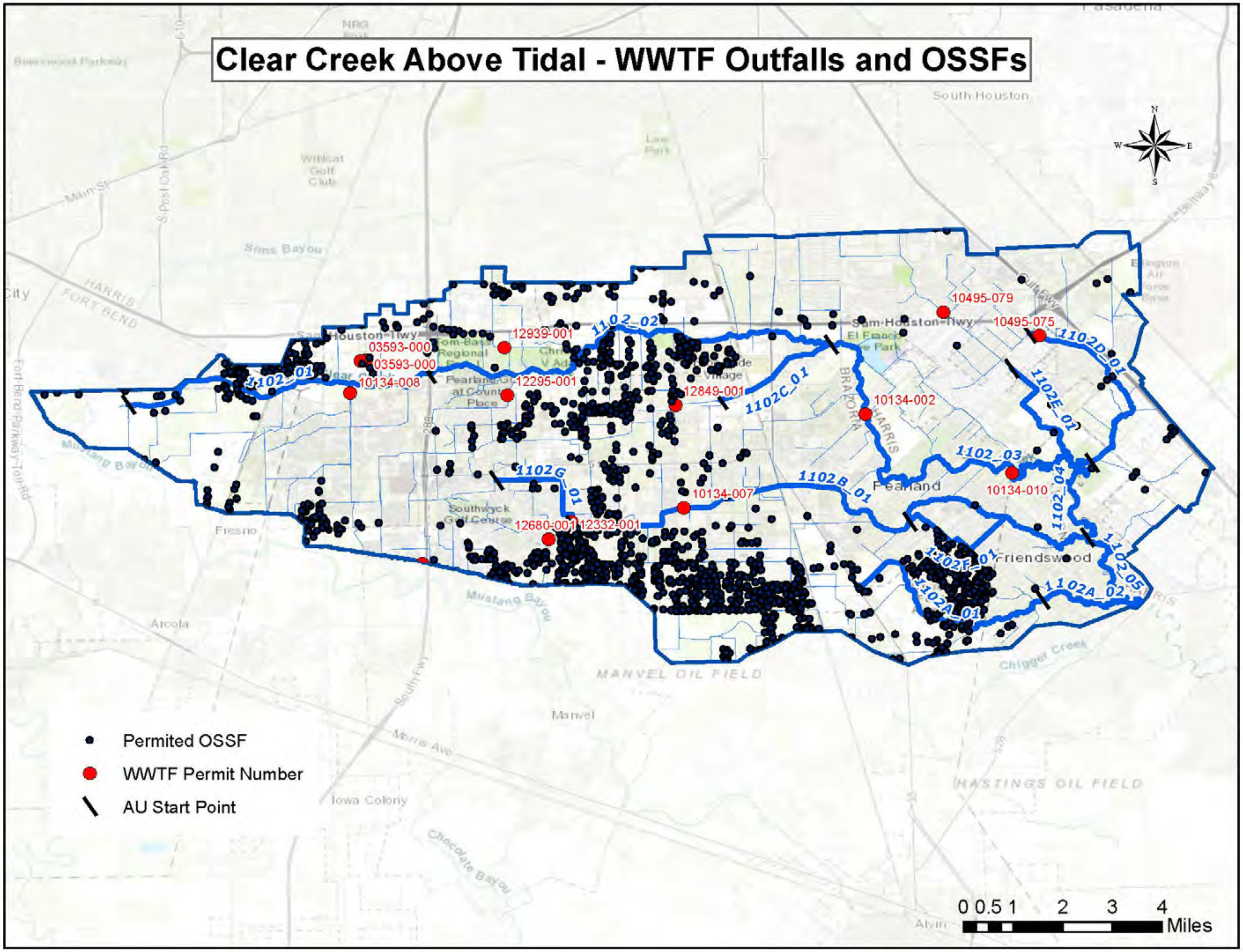
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Clear Creek Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, fertilizer application, and animal/pet waste.

There are 13 permitted wastewater outfalls in the Clear Creek Above Tidal watershed. In many areas, on-site sewage facilities are the primary source of wastewater disposal, with 2,035 permitted on-site sewage facilities in the watershed. Many of these are in the less developed southern portion of the watershed. The wastewater treatment facilities and on-site sewage facilities in the Clear Creek Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 269 sanitary sewer overflows reported in the sewer collection systems. While these sanitary sewer overflows may be of greatest concern on an episodic basis, the dense urban character of the watershed and appreciable role of effluent and urban stormwater therein means they may be a contributing factor to chronically high bacteria within this waterway.. Discrete events may also cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Clear Creek Above Tidal watershed.


Clear Creek Above Tidal - WWTF Outfalls and OSSFs
Permited OSSF
WWTF Permit Number
AU Start Point
10495-079
10495-075
12939-001
03593-000
03593-000
10134-008
12295-001
12849-001
10134-002
10134-010
10134-007
12680-001
12332-001
1102_01
1102_02
1102_03
1102_04
1102_05
1102A_01
1102A_02
1102B_01
1102C_01
1102D_01
1102E_01
1102F_01
1102G_01
Pearland
Friendswood
Fresno
Arcola
Manvel
Iowa Colony
Alvin
South Houston
MANVEL OIL FIELD
HASTINGS OIL FIELD
Sims Bayou
Mustang Bayou
Chocolate Bayou
Chigger Creek
Sam Houston Tlwy
BRAZORIA
HARRIS
FORT BEND
0 0.5 1 2 3 4
Miles

Trend Analysis:

Regression analysis on existing data for the segment revealed thirteen parameter trends in the system, with ten on the main segment and ten on the unclassified tributaries. Notable trends for 1102 include increases in nitrate and total phosphorus (TP) concentrations. Ammonia concentrations were also rising until around 2016 when the trend reversed and now shows a downward trend with concentrations near or below the screening criteria. Chloride levels decreased in this segment sometime after 2010. This improvement was the result of an effort by The Texas Railroad Commission to plug uncapped wellheads located throughout the above tidal segment. That plugging effort eliminated unpermitted discharges of high saline water from uncapped wells. That effort was very successful and chloride levels have remained under the state standard for chlorides in freshwater since then. Specific conductance and sulfate concentrations follow the improvements made in the reduction of chlorides as well.

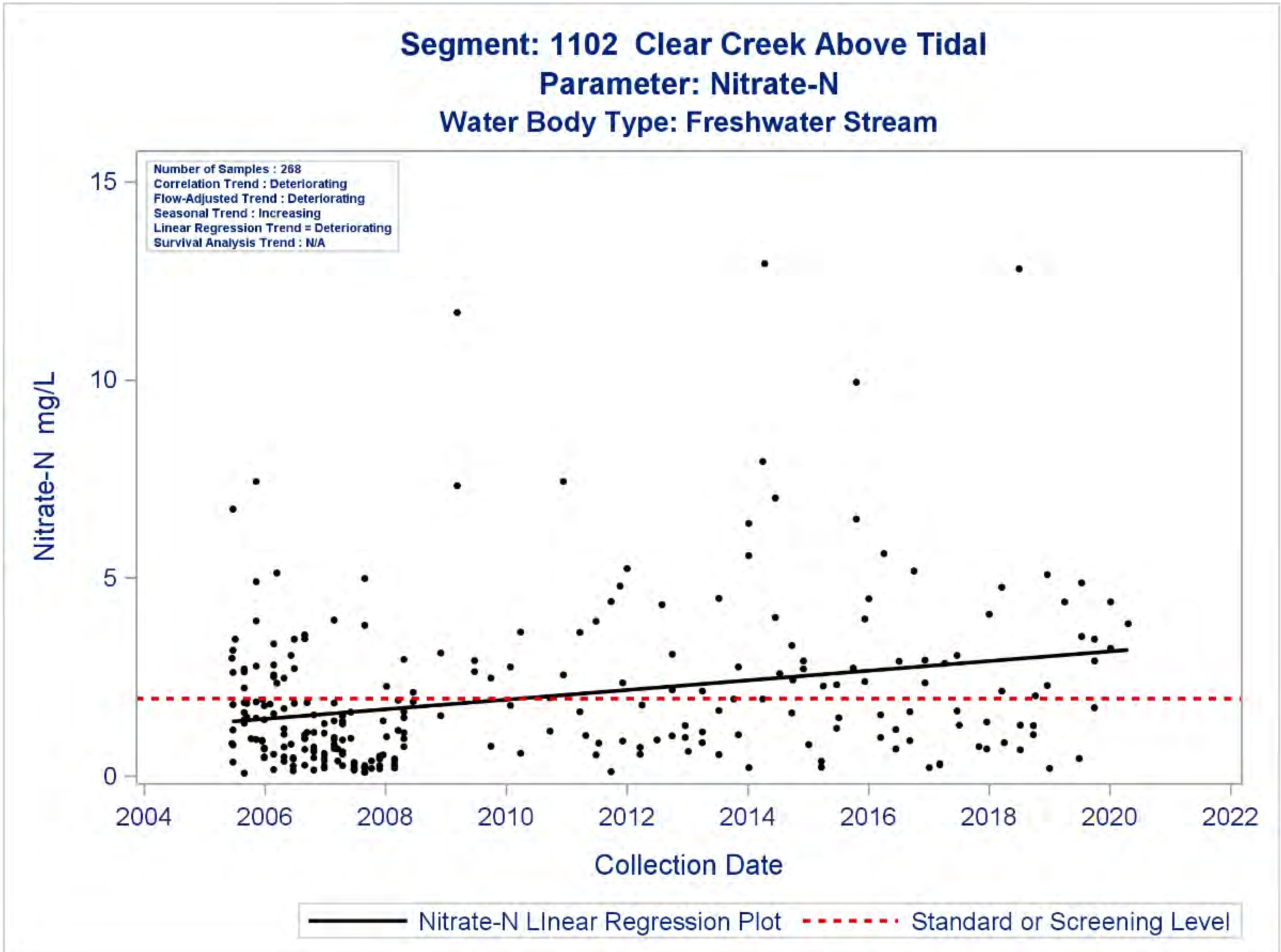
Cowart Creek (unclassified segment1102A) has increasing ammonia concentrations but improving Secchi depths with less turbid water and lower sulfate concentrations.

Unclassified segment 1102B (Mary's Creek/North Fork Mary's Creek) shows an increase in ammonia and nitrate concentrations that are above the screening criteria. While sulfate and TKN are showing improving trends with decreasing concentrations of both parameters. *E. coli* bacteria continues to be consistently above the state standard for contact recreation.

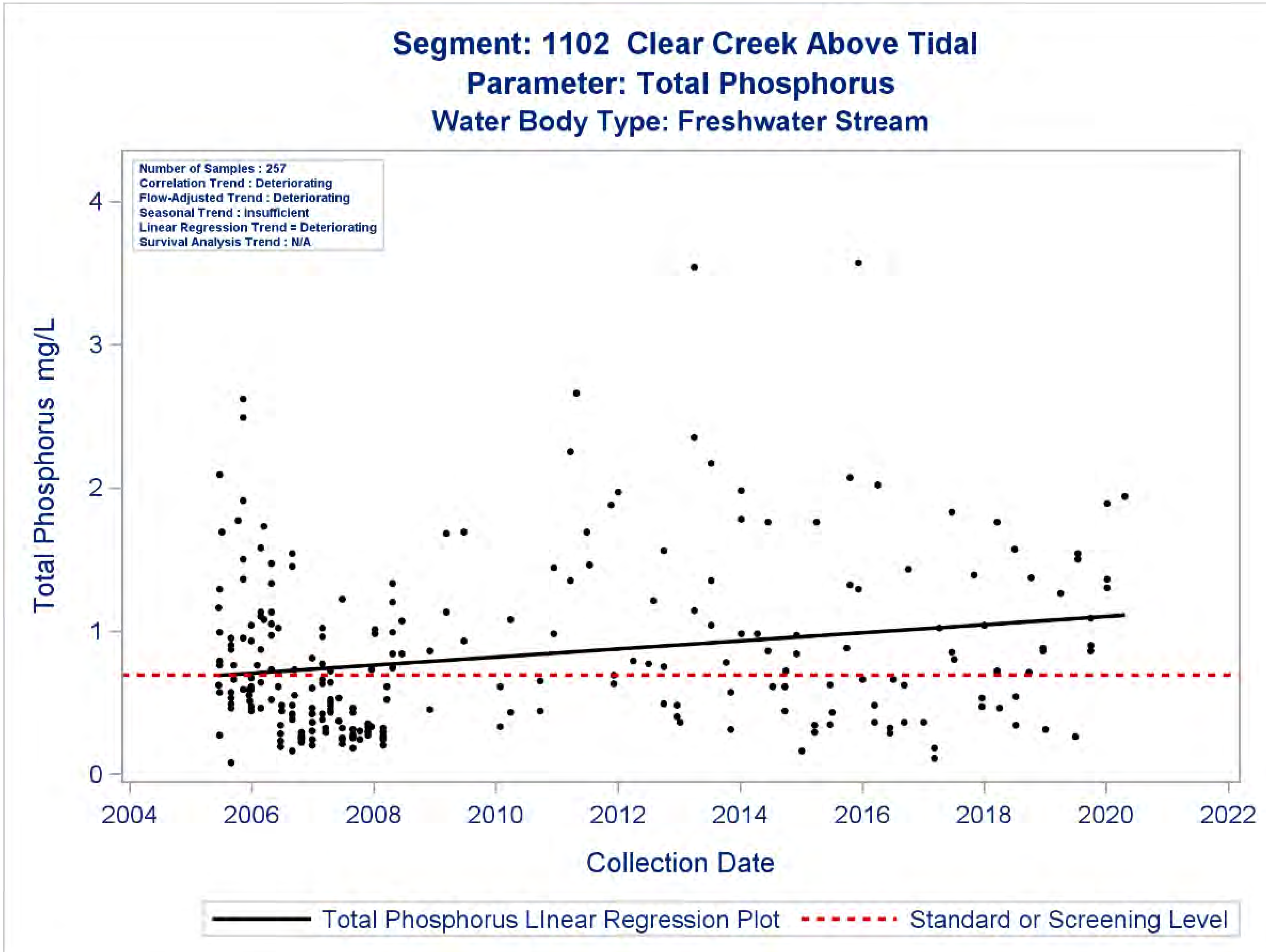
Hickory Slough (unclassified segment 1102C) has decreasing sulfate and TKN levels but increasing total phosphorus concentrations. *E. coli* in this segment was decreasing slightly, but has shown an increasing trend since 2014.

For unclassified segments Turkey Creek (1102D), Mud Gully (1102E), Marys Creek Bypass (1102F), and an unnamed tributary of Marys Creek (1102G), there is insufficient data or large data gaps during the period of record.

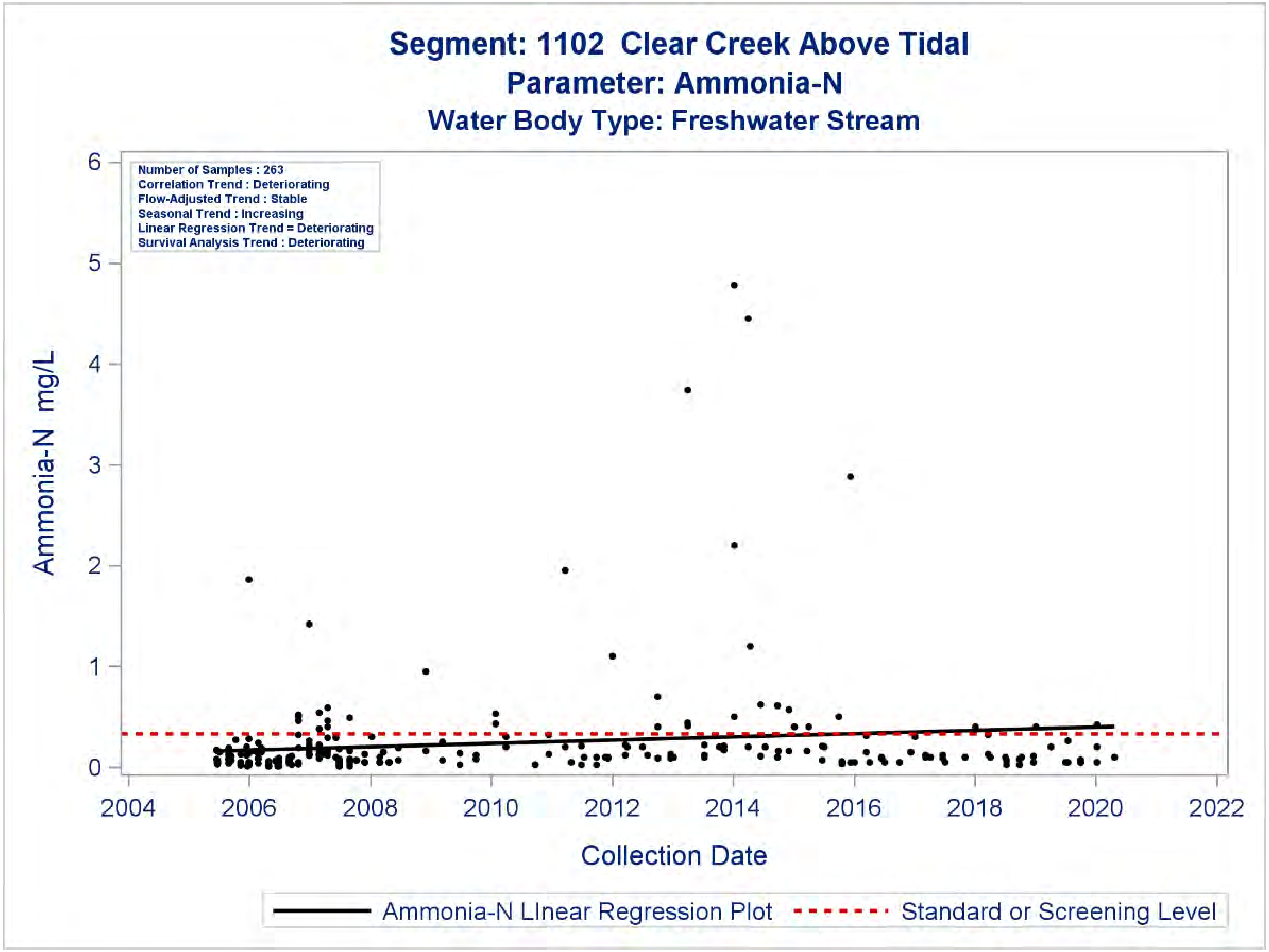
E. coli levels are not increasing dramatically in most areas of the waterway, but the average values across all aspects of the system are still generally above the state standard for contact recreation. Continued development in the upstream areas of the watershed may exacerbate existing water quality issues downstream, where much of the watershed is closer to being built out or developmentally static.



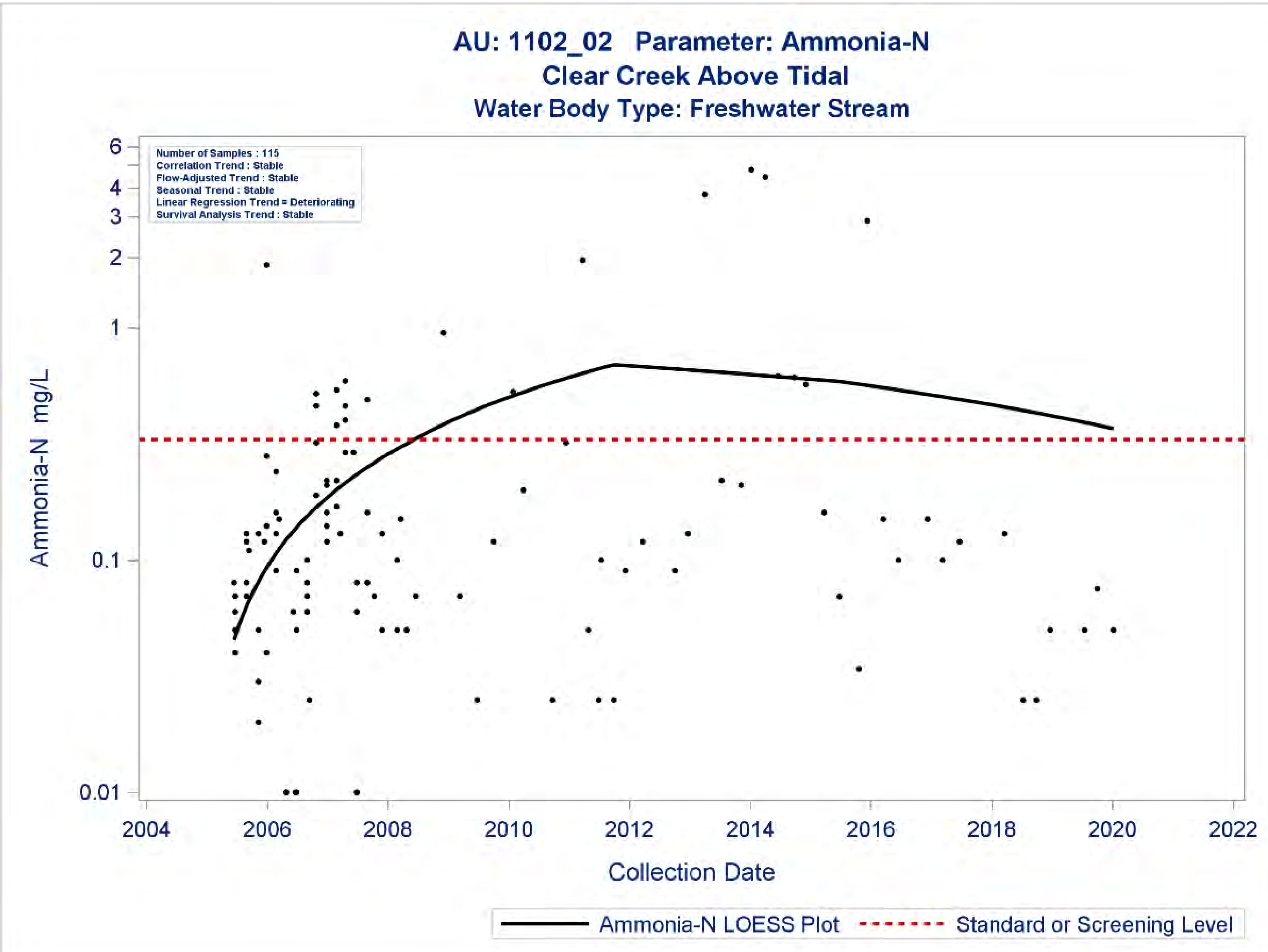
Segment: 1102 Clear Creek Above Tidal
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 268
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
15
10
5
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

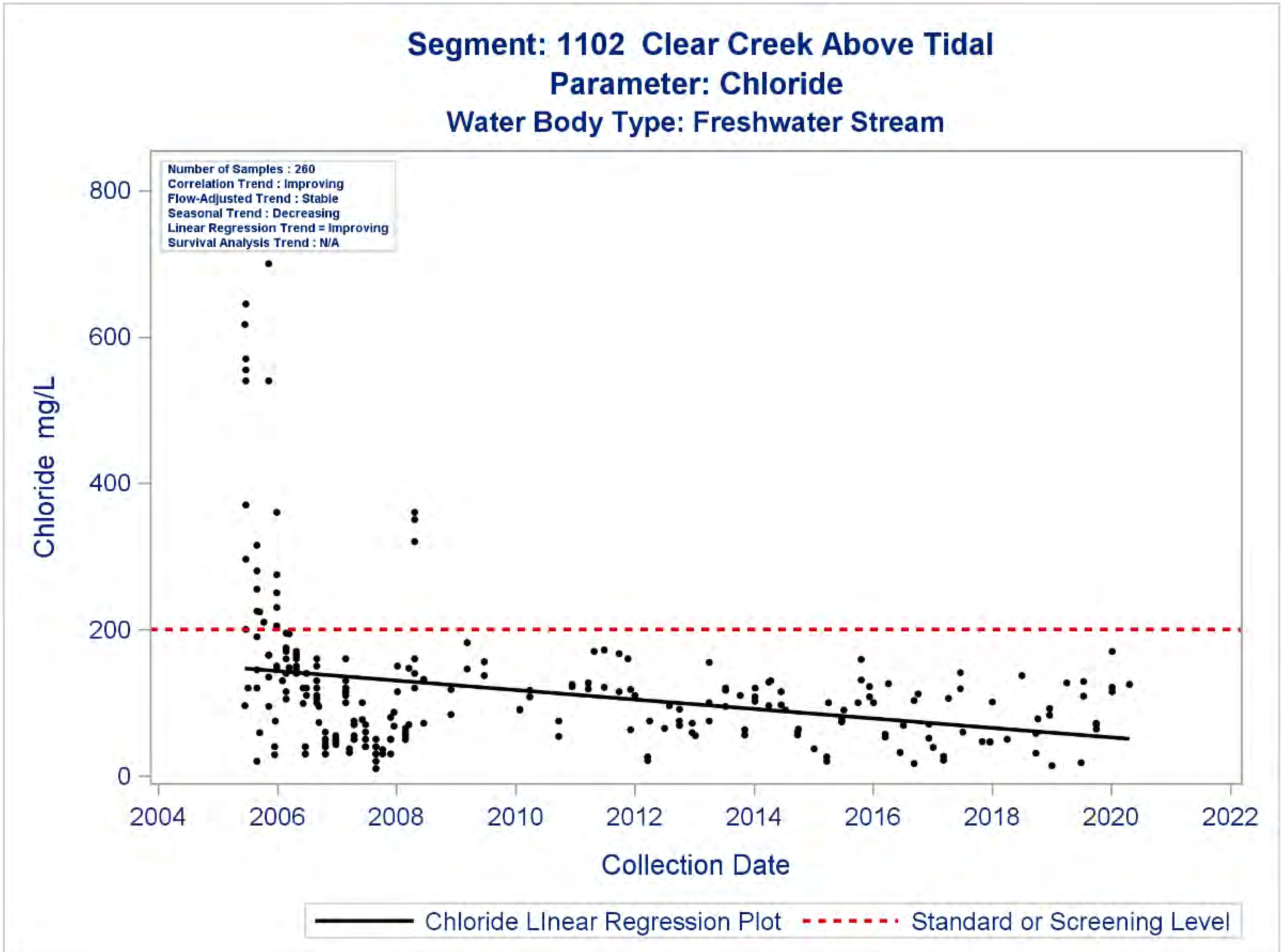


Segment: 1102 Clear Creek Above Tidal
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 257
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
1
2
3
4
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level

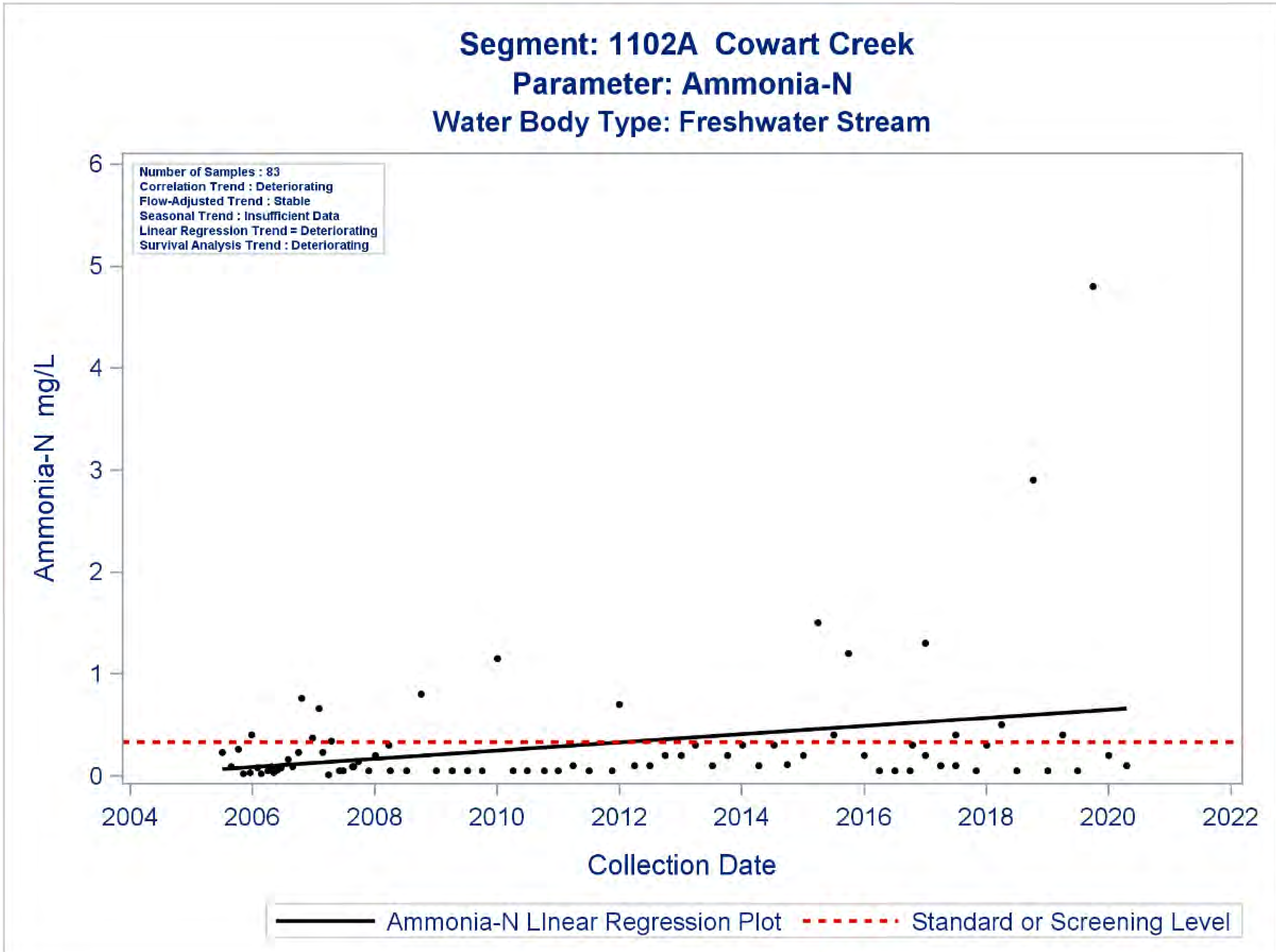


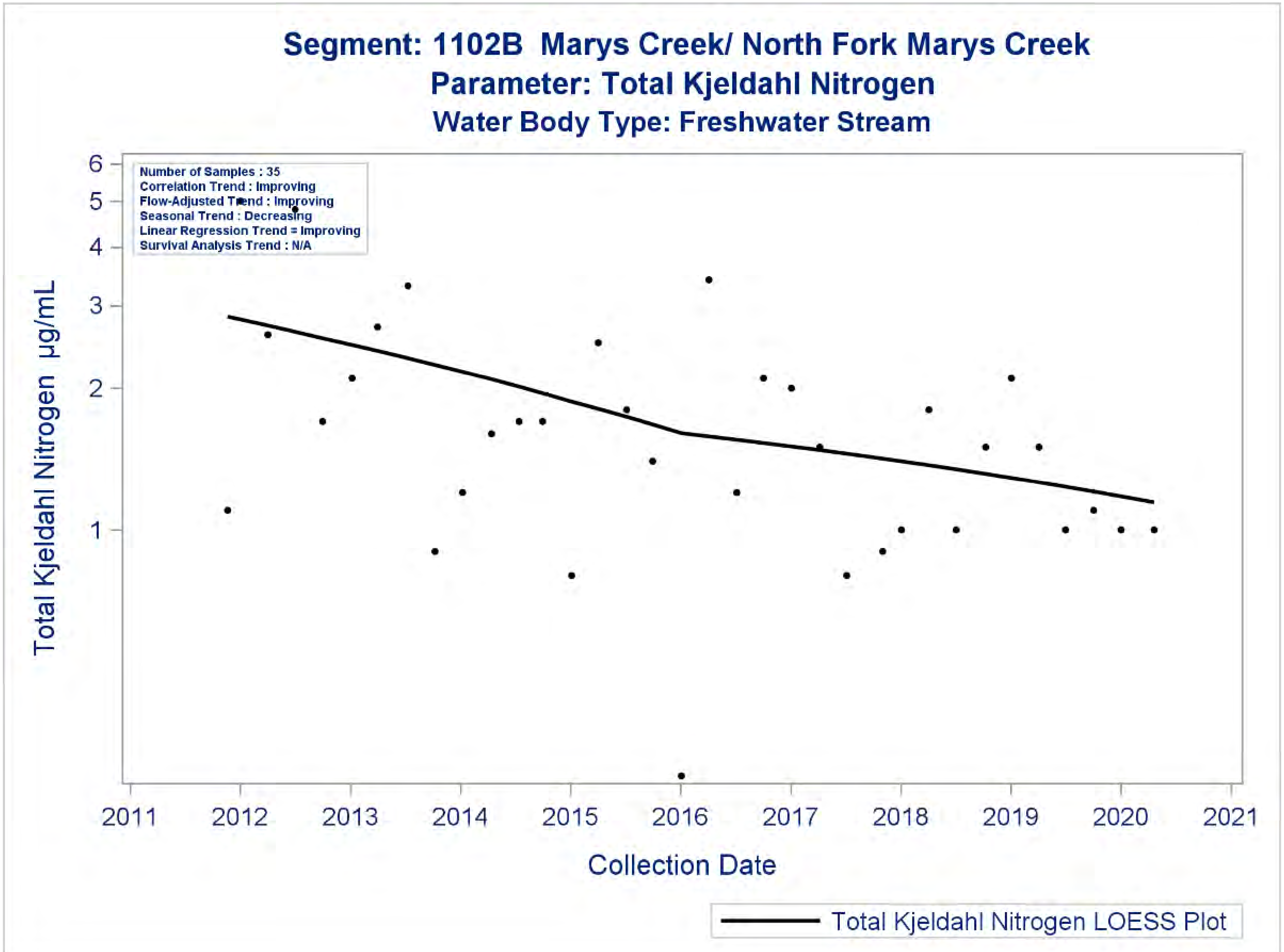
Segment: 1102 Clear Creek Above Tidal
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 263
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
0
1
2
3
4
5
6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

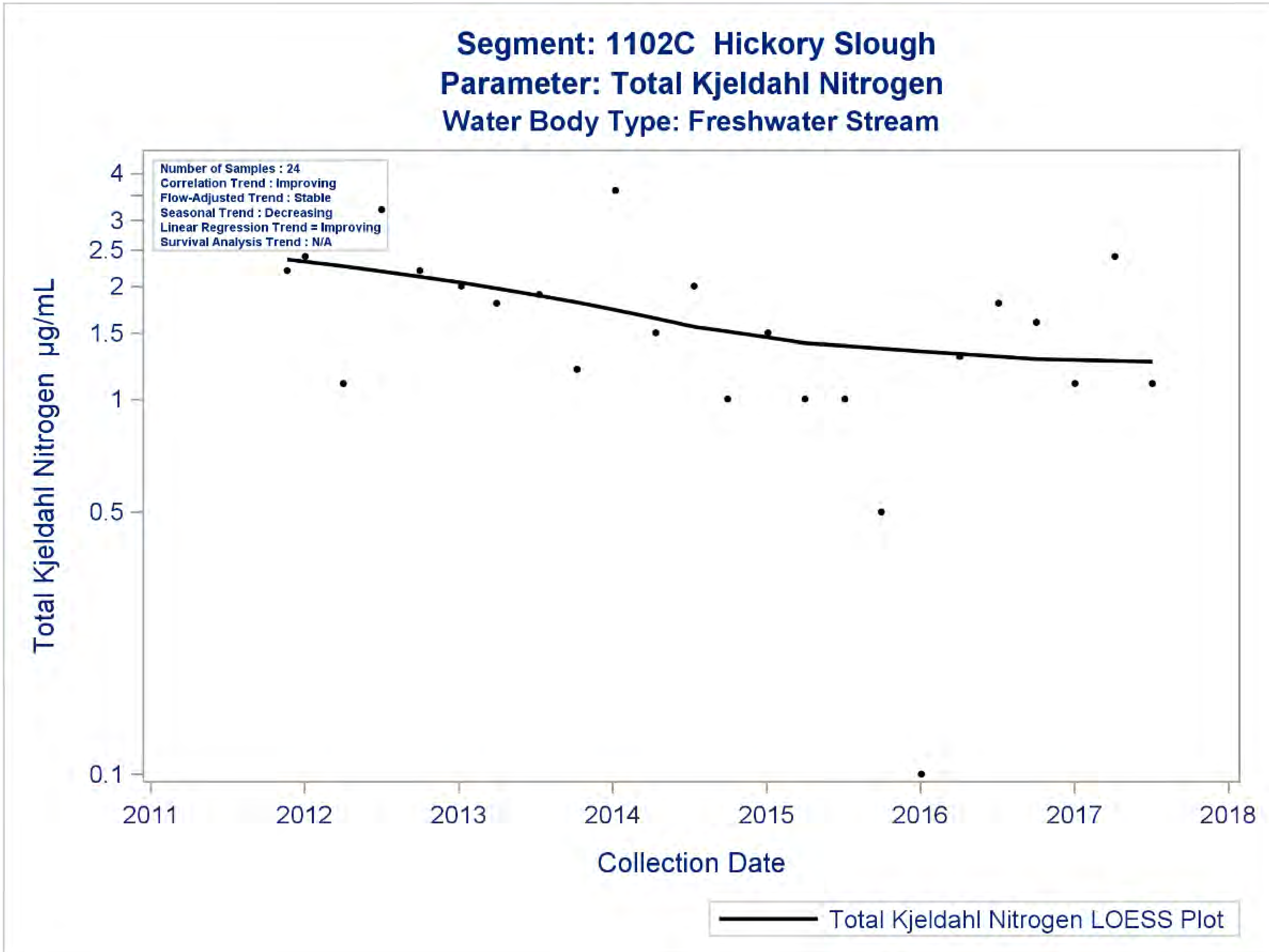

AU: 1102_02 Parameter: Ammonia-N
Clear Creek Above Tidal
Water Body Type: Freshwater Stream
Number of Samples : 115
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Stable
Ammonia-N mg/L
6
4
3
2
1
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level



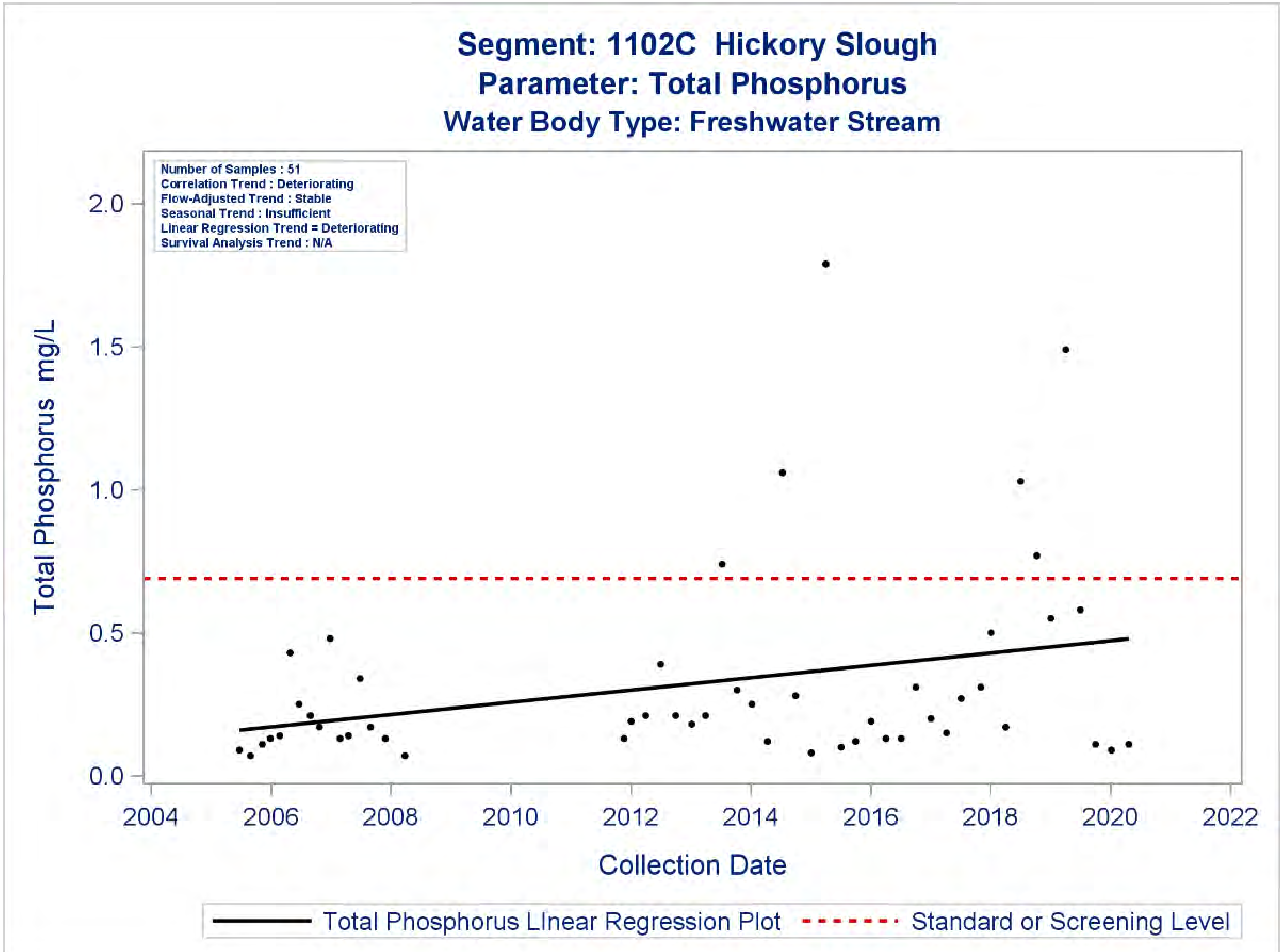
Segment: 1102 Clear Creek Above Tidal
Parameter: Chloride
Water Body Type: Freshwater Stream
Number of Samples : 260
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Chloride mg/L
800
600
400
200
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LInear Regression Plot
Standard or Screening Level


Segment: 1102A Cowart Creek
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 83
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
0
1
2
3
4
5
6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level


Segment: 1102B Marys Creek/ North Fork Marys Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 35
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
6
5
4
3
2
1
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



Segment: 1102C Hickory Slough
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 24
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
4
3
2.5
2
1.5
1
0.5
0.1
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



Segment: 1102C Hickory Slough
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 51
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1102_02 I 1102_03 I 1102_04 I 1102A I 1102B I 1102D I 1102F I 1102G I	• Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Constructed stormwater controls failing • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Improper or no pet waste disposal • Developments with malfunctioning OSSFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Elevated levels of bacteria can increase the risk of gastrointestinal illnesses during contact recreation (e.g., swimming)	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education on pet waste disposal • Ensure proper citing of new or replacement OSSFs • More public education regarding OSSF operation and maintenance
Low Dissolved Oxygen Concentrations	1102_05 C 1102C C 1102D C 1102E C 1102F C	• Excessive nutrients and organic matter from agricultural production, and related activities • Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) • Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Improve compliance and enforcement of existing stormwater quality permits • Install and/or conserve riparian buffer areas along all waterways • Regionalize chronically non-compliant WWTFs

		• High temperature discharges from industrial WWTFs		• Improve operation and maintenance of existing WWTF and collection systems • More public education regarding disposal of household fats, oils, and grease • More public education about OSSF maintenance • More public education on pet waste disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating
Elevated Nutrient Concentrations	***Ammonia*** 1102_02 C 1102_03 C 1102A_02 C 1102D C ***Nitrate*** 1102_02 C 1102_03 C 1102_04 C 1102_05 C 1102B C 1102D C 1102E C ***Phosphorus*** 1102_02 C 1102_03 C 1102_04 C 1102B C 1102D C 1102F C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Monitor phosphorus levels at WWTFs to determine if controls are needed. • Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Implement YardWise and Watersmart landscape practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Dioxin/PCBs in Fish Tissue	1102 I (All AUs)	• Concentrated deposits outside boundaries of the waste pits located adjacent to San Jacinto River and I-10 bridge • Waste pit located along the San Jacinto River immediately upstream of I-10 • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://www.dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-37_ClearCreekMap.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage regulators and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified

					• Encourage additional testing to locate all unknown sources/deposits
Fish/Community Habitat	1102_02	C	▪ Loss of habitat due to channelization of waterway ▪ Ongoing maintenance of modified channel ▪ Bank and streambed erosion or erosion of farm fields and construction sites	• Detrimental effect on aquatic biological community	• Re-connect oxbows and lost channels to augment water storage and retention • Work with drainage districts to install/construct habitat that does not interfere with water movement • Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat

Special Studies: H-GAC has been tasked by the TCEQ to implement a basin-wide approach for addressing bacterial impairments for the San Jacinto-Brazos Coastal Basin which includes Clear Creek. Development for the basin-wide TMDL began in September of 2015 and resulted in a final Basin 11 Summary Report that summarized basin characteristics, water quality impairments, potential bacteria sources, and recommendations for bacterial reduction. This segment is also part of the geographic area for the Bacteria Implementation Group (BIG) Total Maximum Daily Load.

In partnership with TCEQ, H-GAC and local stakeholders will develop a watershed protection plan for Clear Creek Above Tidal and Clear Creek Tidal as part of a project initiated in 2021.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with the watershed protection plan development and related modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Work with TCEQ to enhance reporting of sanitary sewer overflows by permittees, including more exact locations of overflows
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Continue collecting water quality data and expand monitoring efforts to support actions associated with the Total Maximum Daily Load program and future watershed protection plan development

- Create and implement Water Quality Management Plans for individual agricultural properties
- Support programs to responsibly eliminate feral hog populations in the watershed, particularly in the less urbanized areas in the western portion of the watershed
- Support public education on pet waste disposal
- Implement activities (such as planting vegetation, bank erosion measures, etc.) to improve habitat

Segment Number:	1101	Name:	Clear Creek Tidal

Length:	12 miles	**Watershed Area:**	57 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	8	**Texas Stream Team Monitoring Sites:**	2	**Permitted WWTF Outfalls:**	7

DESCRIPTION

- Segment 1101 (Tidal Stream w/ high ALU): **Clear Creek Tidal** (classified water body) – From the Clear Lake confluence at a point 3.2 km (2.0 miles) downstream of El Camino Real in Galveston/Harris County to a point 100 m (110 yards) upstream of FM528 in Galveston/Harris County

- Segment 1101A (Intermittent Stream with Pools w/ intermediate ALU): **Magnolia Creek** (unclassified water body) – From the Clear Creek Tidal confluence upstream to 0.8 km (0.5 mi) upstream of the confluence with the second unnamed tributary

- Segment 1101B (Intermittent Stream with Pools w/ limited ALU): **Chigger Creek** (unclassified water body) – From the Clear Creek Tidal confluence to the Brazos River Authority Canal near CR 143 in Galveston County

- Segment 1101C (Tidal Stream w/ high ALU): **Cow Bayou** (unclassified water body) – From the Clear Creek Tidal confluence to SH 3 in Galveston County

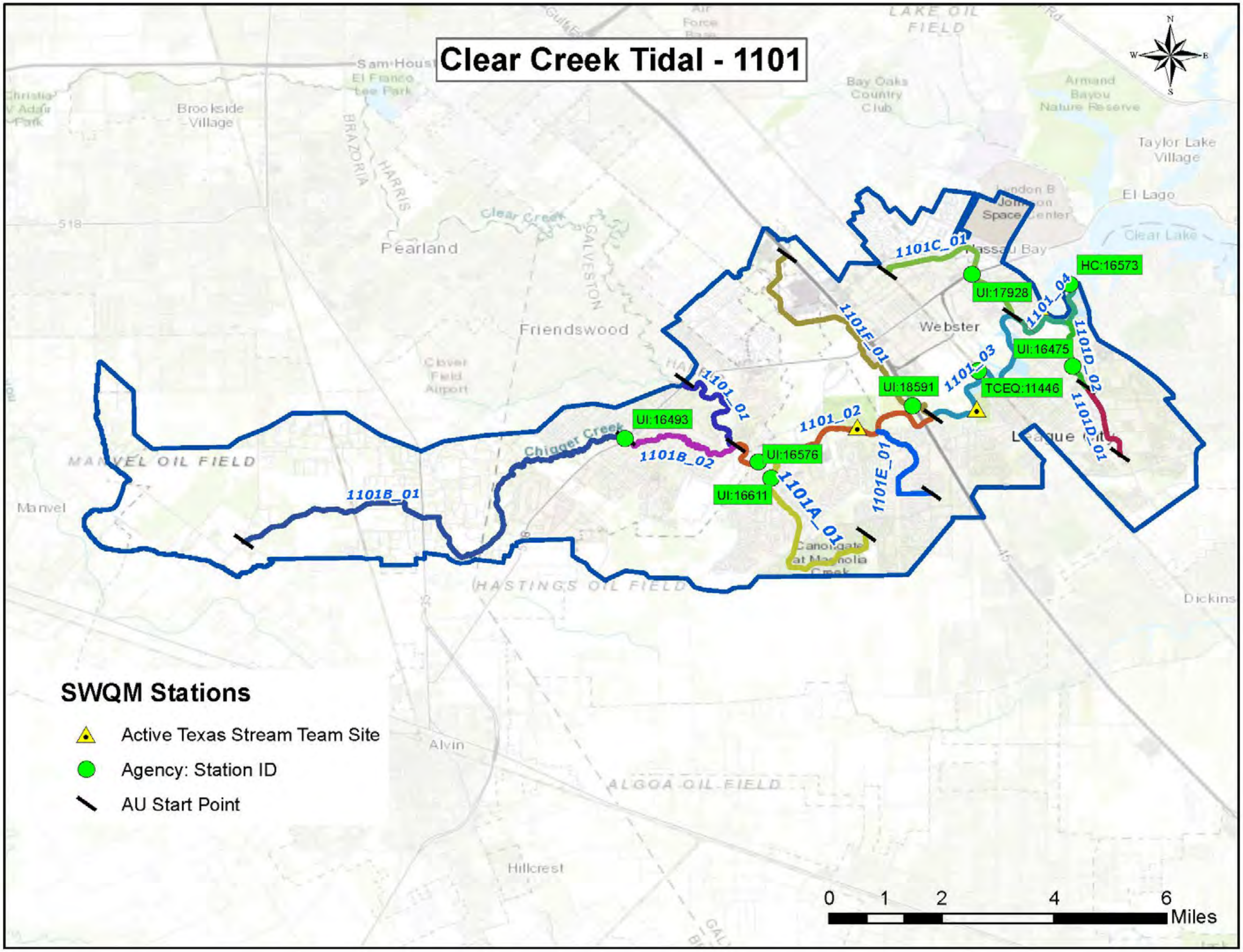
- Segment 1101D (Tidal Stream w/ high ALU): **Robinson Bayou** (unclassified water body) – From Clear Creek Tidal 0.33 mi upstream of Webster Street in Galveston County

- Segment 1101E (Tidal Stream w/ high ALU): **Unnamed Tributary (Newport Ditch) of Clear Creek Tidal** (unclassified water body) – From Clear Creek Tidal confluence to a point 3.2 km (2.0 mi) immediately downstream of I-45 in Galveston County

- Segment 1101F (Perennial Stream w/ high ALU): **Unnamed Tributary (Cemetery Ditch) of Clear Creek Tidal** (unclassified water body) – From Clear Creek Tidal confluence to a point 7.8 km (4.8 mi) upstream

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11446	1101	CLEAR CREEK TIDAL AT SH3 NEAR WEBSTER	FO	Quarterly	Field, Conventional, Bacteria
16573	1101	CLEAR CREEK TIDAL AT THE CONFLUENCE WITH CLEAR LAKE 30 M NORTH AND 266 M WEST OF DAVIS ROAD AT VEGA COURT IN LEAGUE CITY IN HARRIS COUNTY	HC	Bimonthly	Field, Conventional, Bacteria
16576	1101	CLEAR CREEK TIDAL AT BROOKDALE DR APPROX 0.1MI DOWNSTREAM OF GRISSOM RD IN COUNTRYSIDE PARK IN CANOE LAUNCHING AREA IN LEAGUE CITY	UI	Quarterly	Field, Conventional, Bacteria
16611	1101A	MAGNOLIA CREEK AT W BAY AREA BLVD LEAGUE CITY APPROX 250 M UPSTREAM OF WWTP PERMIT WQ0010568-003	UI	Quarterly	Field, Conventional, Bacteria, Flow
16493	1101B	CHIGGER CREEK AT FM528 BRIDGE IN FRIENDSWOOD	UI	Quarterly	Field, Conventional, Bacteria, Flow
17928	1101C	COW BAYOU AT NASA ROAD 1 IN WEBSTER 100 M EAST OF FM 270/EL CAMINO REAL	UI	Quarterly	Field, Conventional, Bacteria
16475	1101D	ROBINSONS BAYOU AT FM270 IN LEAGUE CITY	UI	Quarterly	Field, Conventional, Bacteria
18591	1101F	UNNAMED TRIBUTARY OF CLEAR CREEK TIDAL IN FOREST PARK CEMETERY IMMEDIATELY UPSTREAM OF S FEEDER RD OF I 45/GULF FWY S OF NASA RD 1 IN WEBSTER	UI	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
HC = Harris County Pollution Control
UI = University of Houston Clear Lake – Environmental Institute of Houston



Clear Creek Tidal - 1101
SWQM Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
1101C_01
1101F_01
1101_01
1101_02
1101_03
1101_04
1101D_02
1101D_01
1101E_01
1101A_01
1101B_01
1101B_02
HC:16573
UI:17928
UI:16475
TCEQ:11446
UI:18591
UI:16493
UI:16576
UI:16611
0 1 2 4 6
Miles
Pearland
Friendswood
Webster
Nassau Bay
El Lago
Taylor Lake Village
Clear Lake
Brookside Village
Manvel
Alvin
Hillcrest
MANVEL OIL FIELD
HASTINGS OIL FIELD
ALGOA OIL FIELD
Chigger Creek
Clear Creek
Bay Oaks Country Club
Armand Bayou Nature Reserve
Clover Field Airport

Segment 1101 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F)	35 / 95	35 / 95	Ammonia-Nitrogen (mg/L)	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L)	4.0 / 3.0	5.0	Nitrate-Nitrogen (mg/L)	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0 / 2.0	3.0	Total Phosphorus-P (mg/L)	0.66	0.69
pH (standard units)	6.5-9.0	6.5-9.0	Chlorophyll-*a* (µg/L)	21	14.1
Enterococci (MPN/100mL) (grab)	104				
Enterococci (MPN/100mL) (geometric mean)	35				
E. coli (MPN/100 mL) (grab)		399			
E. coli (MPN/100 mL) (geometric mean)		126			

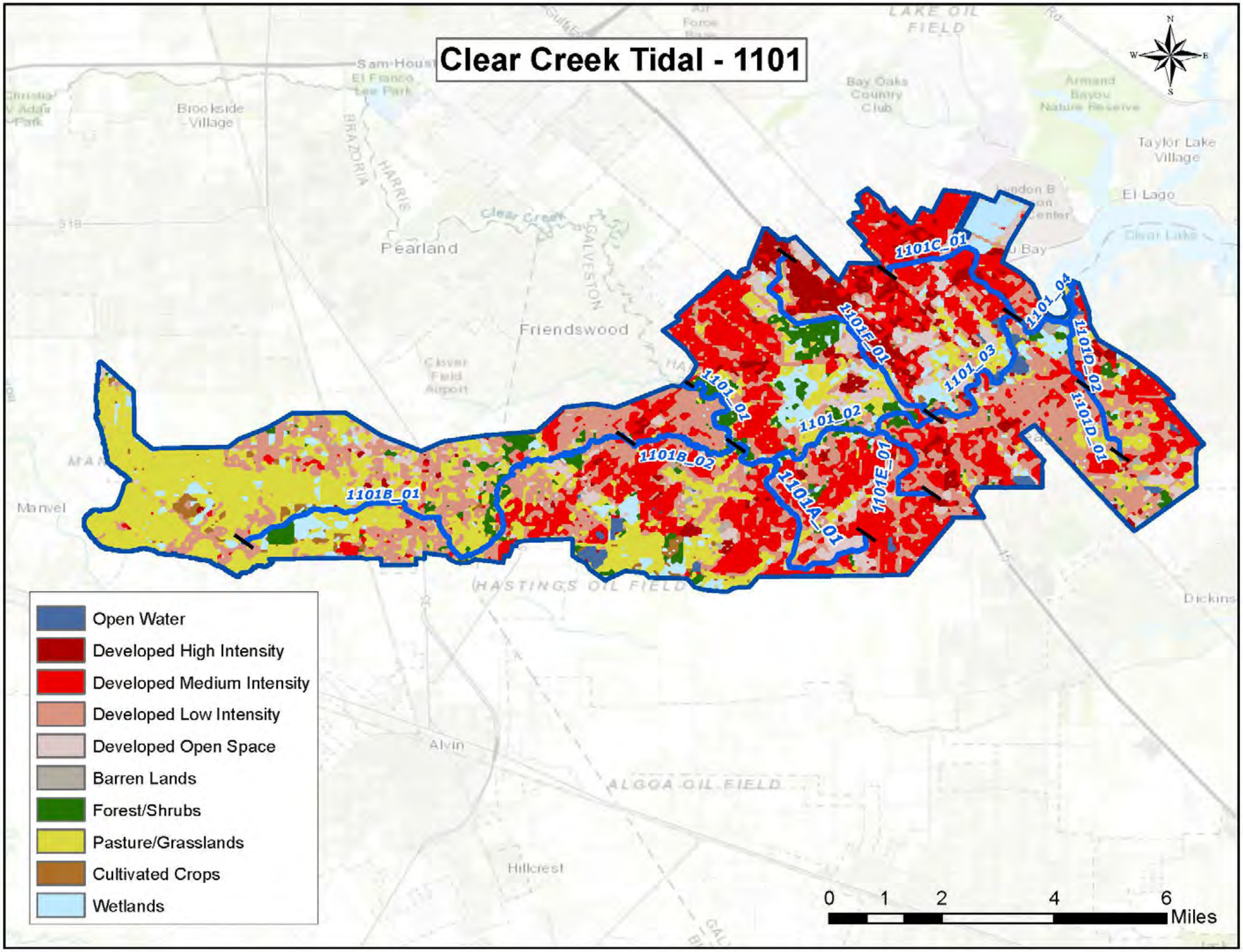
Segment Discussion

Watershed Characteristics and Land Cover: Clear Creek forms the boundary between Galveston and Harris counties, with the Clear Creek Tidal segment draining into Clear Lake. Clear Creek passes through highly developed residential and commercial areas It is densely urbanized in the eastern half of the segment. The Clear Creek Tidal watershed covers approximately 37,739 acres, with 62.60 percent of the land being developed. Agricultural uses are the next largest category, at 23.74 percent, with most of the agricultural uses occurring in the western portion of the watershed.

The Clear Creek Tidal watershed has experienced rapid growth of residential and commercial development over the past decade. Most of the higher intensity development is centered along the I-45 corridor in the eastern side of the watershed in the cities of Nassau Bay, Webster, Friendswood, and League City. The cities of League City and Friendswood sit on the south side of Clear Creek with Webster, parts of Friendswood and the part of Houston known as Clear Lake sitting to the north of the creek. Much of the high intensity development is served by wastewater treatment facilities, but some of the surrounding lower intensity development in the unincorporated areas rely on on-site sewage facilities.

Segment 1101 Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	8,349.77	22.72	8,723.39	23.74	4.48
Barren Lands	973.42	2.64	448.79	1.22	-53.90
Developed	22,029.63	59.96	23,000.39	62.60	4.41
Forest/Shrubs	1,020.12	2.78	1,621.92	4.41	58.99
Open Water	738.79	2.01	491.49	1.34	-33.47
Wetlands	3,630.35	9.88	2,453.00	6.68	-32.43
TOTAL	**36,742.08**	**100.00**	**37,738.97**	**100.00**	


Clear Creek Tidal - 1101
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
1101B_01
1101B_02
1101_01
1101_02
1101_03
1101_04
1101A_01
1101C_01
1101D_01
1101D_02
1101E_01
1101F_01
Pearland
Friendswood
Manvel
Alvin
Hillcrest
El Lago
Taylor Lake Village
Brookside Village
HASTINGS OIL FIELD
ALGOA OIL FIELD
0 1 2 4 6 Miles

Water Quality Issues:

Bacteria Impairments and Concerns

In the 2020 IR, Clear Creek Tidal (1101) has bacteria impairments for three of four assessment units, with the most downstream AU (1101_04) being fully supporting. In total, 82% of the stream miles for Segment 1101 are impaired for bacteria.

The bacteria geomean for Enterococcus in Segment 1101 ranges from a low of 19.01 MPN/100 mL in AU 1101_04 to a high of 111.49 MPN/100 mL in AU 1101_03. The upper portion of the segment (AU 1101_01) was not assessed due to insufficient data but has an integrated level of support of Not Supporting. This is a carry forward from a previous assessment. Cow Bayou (1101C) also has elevated bacteria, with an Enterococcus geometric mean of 369.66 MPN/100 mL, which is greater than 10 times the standard of 35 MPN/100 mL. Robinson Bayou (1101D_01) also has an elevated Enterococcus geometric mean at 188.99 MPN/100 mL.

In the non-tidal segments, the *E. coli* geometric mean for Magnolia Creek (1101A) is Not Supporting the Primary Contact Recreation Use at 507.28 MPN/100 mL. In Chigger Creek (1101B_01), the geometric mean for *E. coli* is 265.71 MPN/100 mL, which is Not Supporting. For 1101B_02, there are currently no monitoring stations, so there is no data to assess.

Segment 1101E (unnamed tributary) was not assessed due to insufficient data but has an integrated level of support of Not Supporting. Segment 1101F (unnamed tributary) was not assessed for bacteria.

Dissolved Oxygen Impairments and Concerns

In the Clear Creek Tidal segment, AUs 1101_02, 1101_03, and 1101_04 are supporting for the dissolved oxygen grab minimum. AU 1101_01 was not assessed. A concern for dissolved oxygen screening levels was identified for 1101_03. The unnamed tributary upstream of I-45 (1101E), also known locally as Newport Ditch, is the only AU in the Clear Creek Tidal segment which does not support its high ALU designation. Monitoring is not currently being conducted on this segment. Concerns for DO grab screening levels are present in AUs 1101_03, 1101C_01, 1101D_01, 1101D_02, and 1101F_01.

Nutrient Concerns

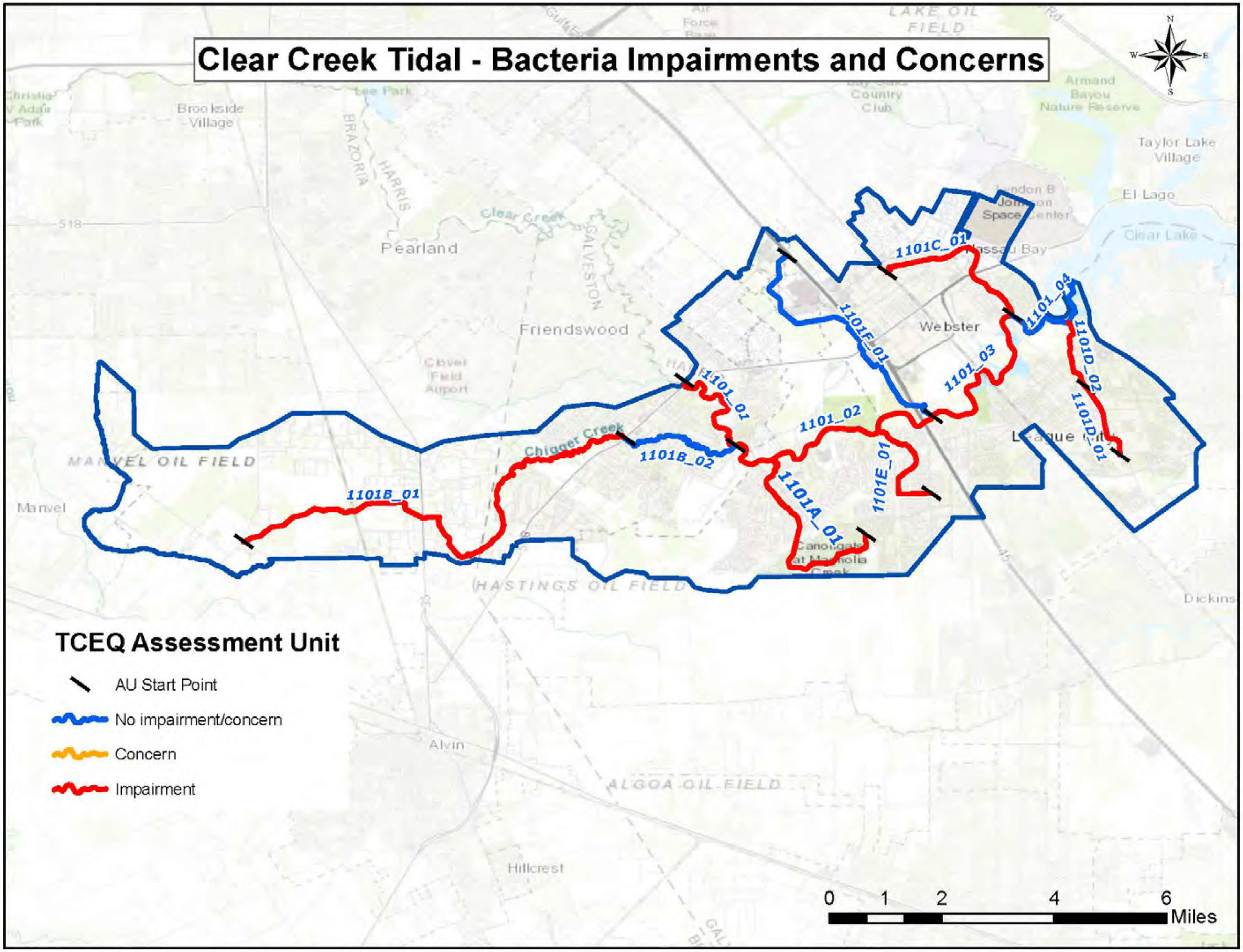
There are numerous concerns for nitrate and total phosphorus in Clear Creek Tidal (1101) and Magnolia Creek (1101A). In Clear Creek Tidal, there is a concern for screening levels for nitrate in three AUs (1101_02, 1101_03, and 1101_04). There are concerns for screening levels for total phosphorus in 1101_02 and 1102_03. There a concern for both nitrate and total phosphorus screening levels in Magnolia Creek (1101A). There were no concerns identified for ammonia-nitrogen screening levels in Clear Creek Tidal or any of the unclassified segments within the watershed.

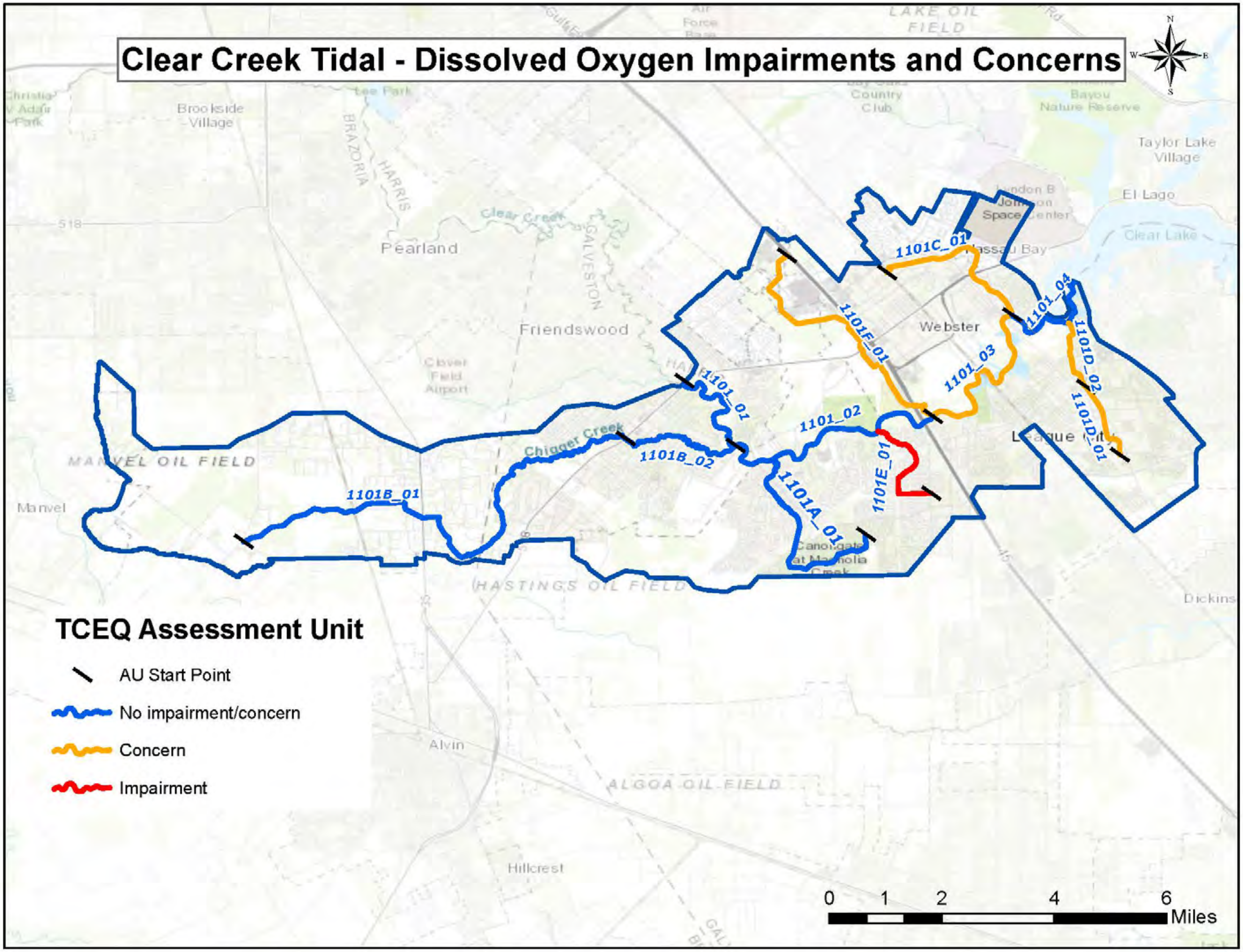
Chlorophyll-a Concerns

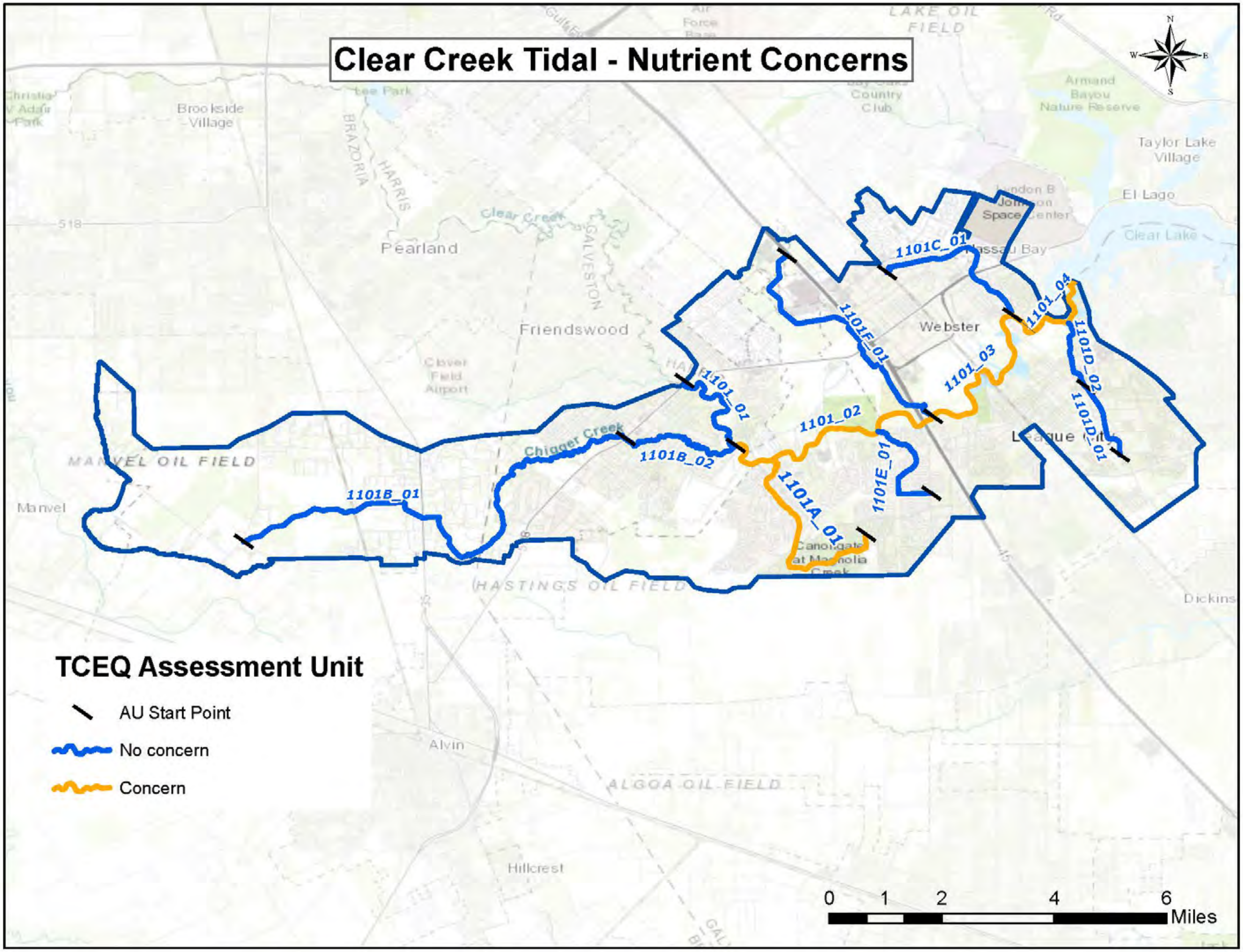
A concern for screening level for chlorophyll-*a* was identified in the 2020 IR for AU 1101_04. There were insufficient data collected during the assessment period, so this impairment is a carry-forward from the previous assessment. No other chlorophyll concerns were identified.

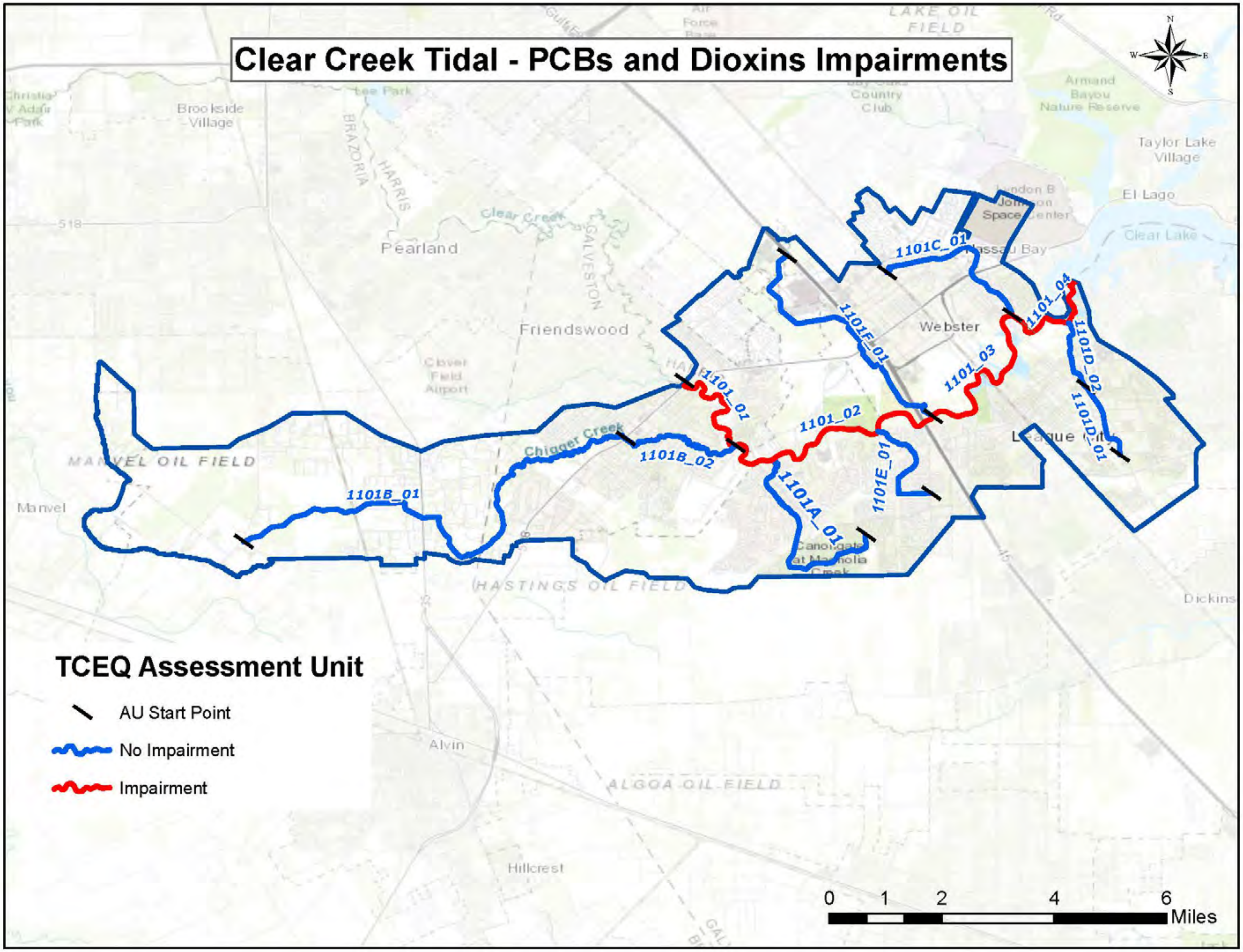
PCBs and Dioxin Impairments

Clear Creek Tidal is listed as impaired for PCBs and Dioxins in fish tissue. Fish samples collected from Clear Creek indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) advises that people should not consume any species of catfish from these waters.


Clear Creek Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
1101_01
1101_02
1101_03
1101_04
1101A_01
1101B_01
1101B_02
1101C_01
1101D_01
1101D_02
1101E_01
1101F_01
Chigger Creek
Clear Creek
Pearland
Friendswood
Webster
Brookside Village
Clover Field Airport
Manvel
Alvin
Hillcrest
Taylor Lake Village
El Lago
Clear Lake
Armand Bayou Nature Reserve
MANVEL OIL FIELD
HASTINGS OIL FIELD
ALGOA OIL FIELD
LAKE OIL FIELD
BRAZORIA
HARRIS
GALVESTON
0 1 2 4 6
Miles


Clear Creek Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
1101_01
1101_02
1101_03
1101_04
1101A_01
1101B_01
1101B_02
1101C_01
1101D_01
1101D_02
1101E_01
1101F_01
Pearland
Friendswood
Webster
Manvel
Alvin
Hillcrest
Brookside Village
Taylor Lake Village
El Lago
Clear Lake
Clear Creek
Chigger Creek
MANVEL OIL FIELD
HASTINGS OIL FIELD
ALGOA OIL FIELD
Clover Field Airport
0 1 2 4 6
Miles


Clear Creek Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No concern
Concern
1101C_01
1101F_01
1101_04
1101_03
1101_02
1101_01
1101D_02
1101D_01
1101E_01
1101A_01
1101B_02
1101B_01
Chigger Creek
Clear Creek
Pearland
Friendswood
Webster
Brookside Village
Manvel
Alvin
Hillcrest
El Lago
Taylor Lake Village
Clear Lake
Armand Bayou Nature Reserve
MANVEL OIL FIELD
HASTINGS OIL FIELD
ALGOA OIL FIELD
LAKE OIL FIELD
Clover Field Airport
0
1
2
4
6
Miles


Clear Creek Tidal - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No Impairment
Impairment
1101_01
1101_02
1101_03
1101_04
1101A_01
1101B_01
1101B_02
1101C_01
1101D_01
1101D_02
1101E_01
1101F_01
Webster
Friendswood
Pearland
Manvel
Alvin
Hillcrest
Brookside Village
Taylor Lake Village
El Lago
Clear Lake
Clear Creek
Chigger Creek
MANVEL OIL FIELD
HASTINGS OIL FIELD
ALGOA OIL FIELD
Clover Field Airport
Armand Bayou Nature Reserve
Dickinson
0 1 2 4 6
Miles

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Clear Creek Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, and stormwater runoff, and animal/pet waste.

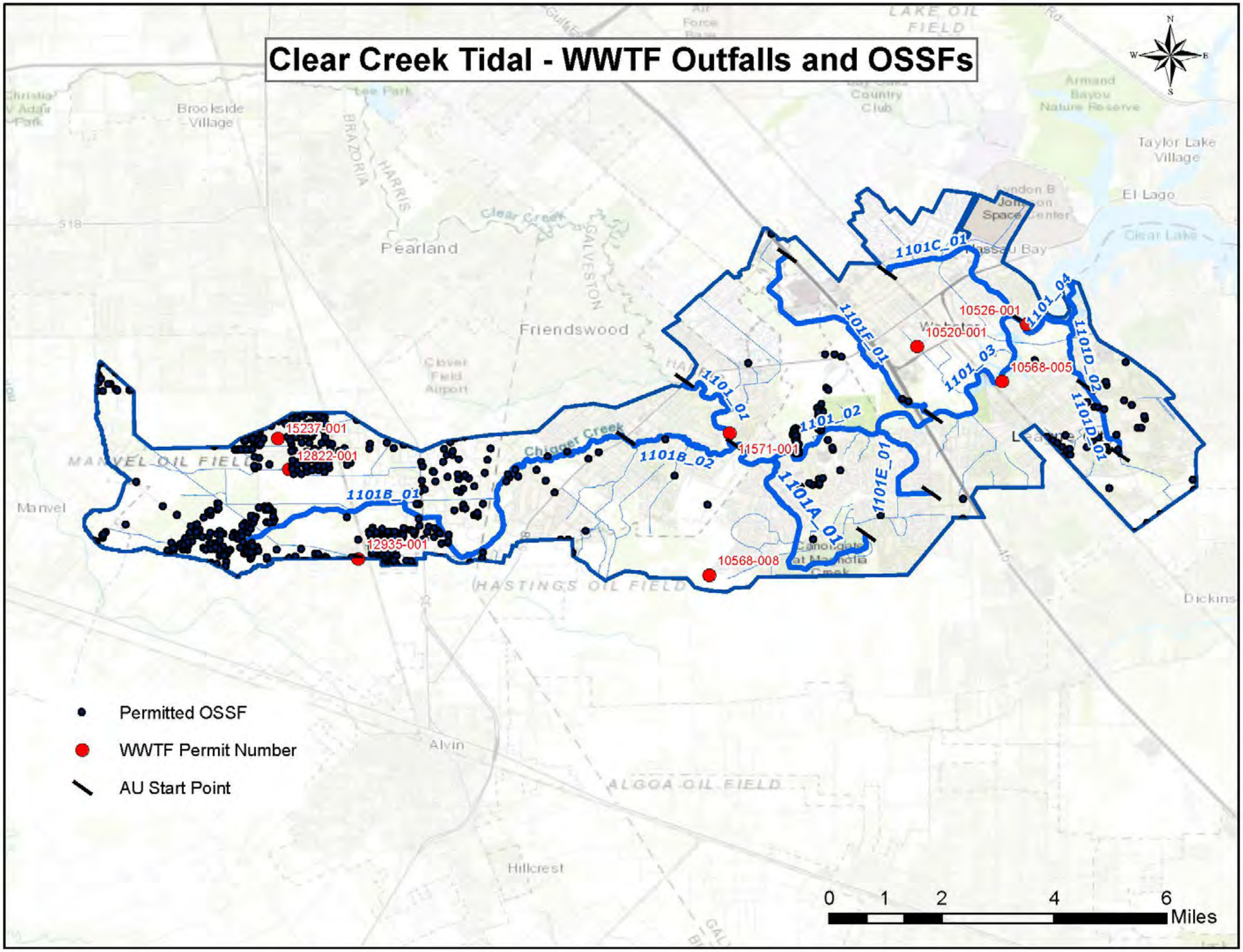
There are 7 permitted wastewater outfalls in the Clear Creek Tidal watershed. In some areas, on-site sewage facilities are the primary source of wastewater disposal, with 619 permitted on-site sewage facilities in the watershed. Most of these are in the less developed western portion of the watershed. The wastewater treatment facilities and on-site sewage facilities in the Clear Creek Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 120 sanitary sewer overflows reported in the sewer collection systems. While these sanitary sewer overflows may be of greatest concern on an episodic basis, the dense urban character of the watershed and appreciable role of effluent and urban stormwater therein means they may be a contributing factor to chronically high bacteria within this waterway. Discrete events may also cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Landscaping related to residential developments, golf courses, etc., and the application of fertilizers may be an important source of elevated nutrients within certain areas of the watershed, particularly Magnolia Creek. Pet waste may be a significant contributor to bacteria levels, particularly in the heavily populated areas of the watershed. Hobby farms, supporting a small number of animals, are also common in the upper reach of Chigger and Robinson Creeks which would be another potential source of bacteria and nutrients.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Clear Creek Tidal watershed.


Clear Creek Tidal - WWTF Outfalls and OSSFs
Permitted OSSF
WWTF Permit Number
AU Start Point
15237-001
12822-001
12935-001
10568-008
11571-001
10520-001
10526-001
10568-005
1101B_01
1101B_02
1101_01
1101_02
1101_03
1101_04
1101A_01
1101C_01
1101D_01
1101D_02
1101E_01
1101F_01
Pearland
Friendswood
Manvel
Alvin
Hillcrest
Brookside Village
Taylor Lake Village
El Lago
0 1 2 4 6 Miles

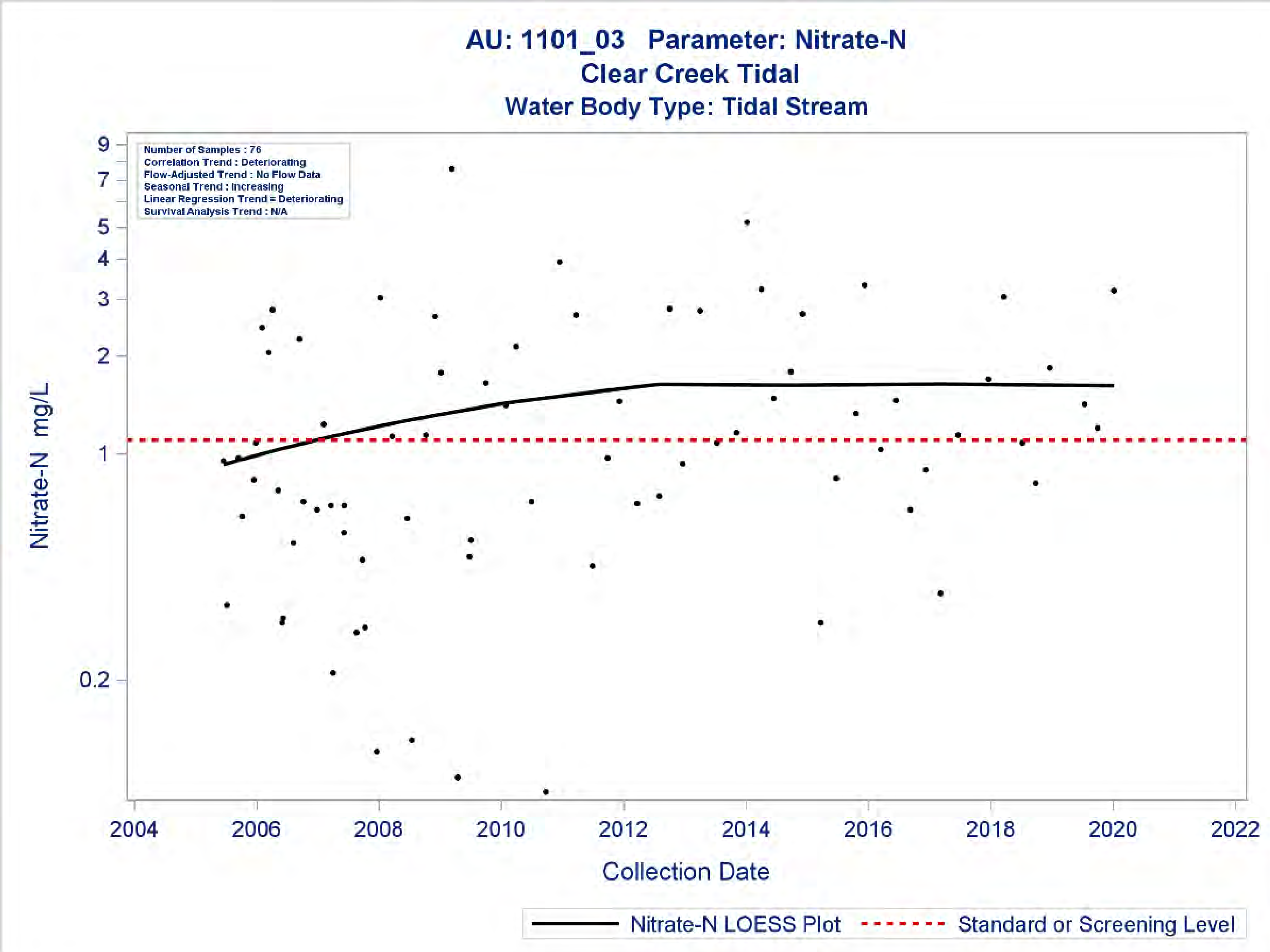
Trend Analysis:

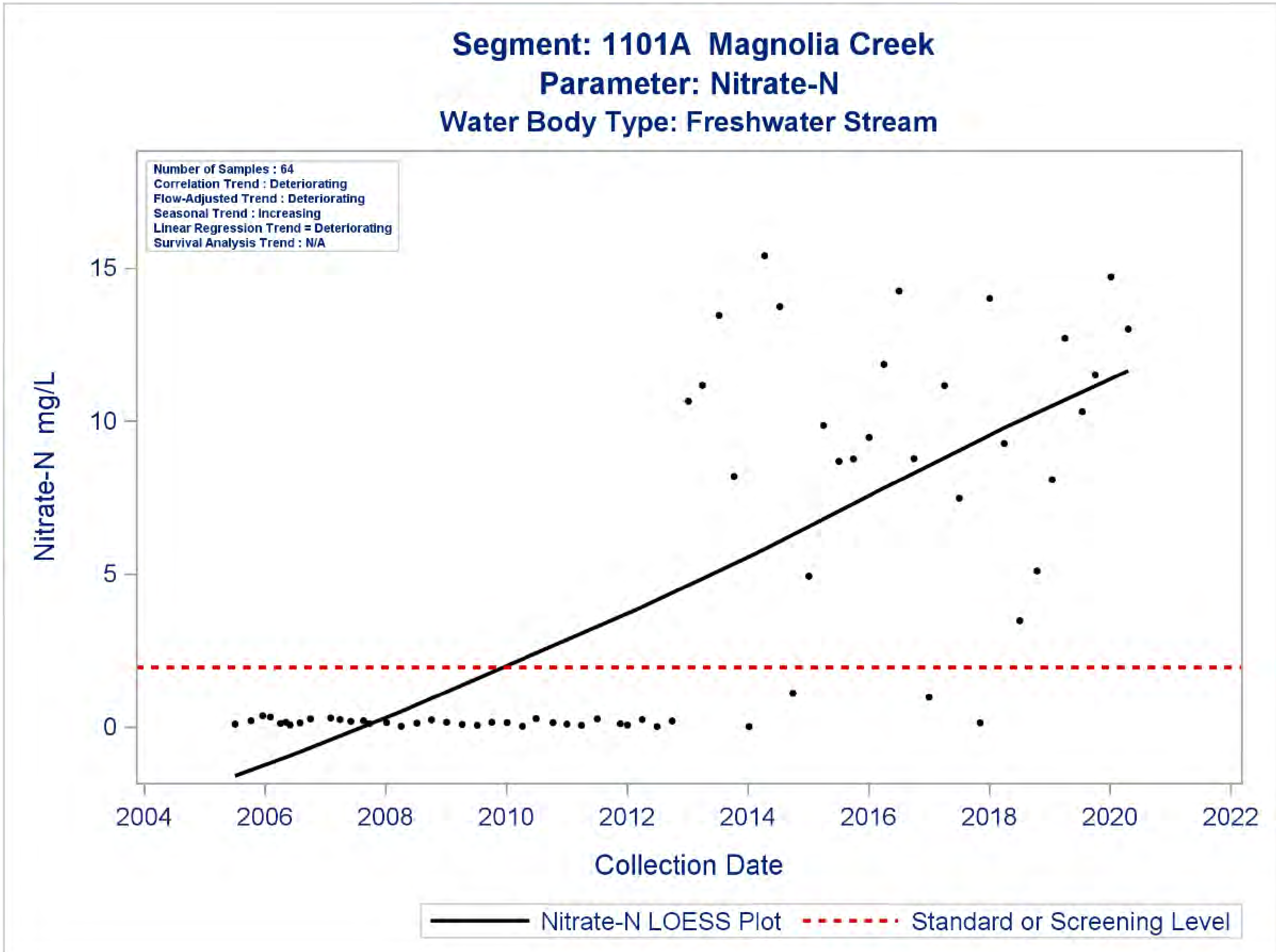
Regression analysis on existing data for the segment revealed twelve parameter trends in the system, with ten on the main stem and a combination of ten different parameters on the unclassified tributaries. On 1101, notable trends included decreasing concentrations in total suspended solids (TSS), chloride, sulfate, and total Kjeldahl nitrogen (TKN). Enterococcus levels have also decreased but levels remain appreciable above the standard. Nitrate concentrations, however, are increasing in assessment unit (AU) 1101_03 on the main segment.

Magnolia Creek (unclassified segment 1101A) experienced a dramatic change in water quality with nitrate and total phosphorus concentrations increasing significantly around 2014. This is most likely the result of a golf course being developed in the upper portion of the tributary's watershed and possible fertilizers being used on the grounds. The improving dissolved oxygen (DO) levels may also be influenced by higher levels of the nutrients which would increase growth of phytoplankton within the waterway. Results from 24-hour DO monitoring met state water quality standards and there is no longer a DO concern in this segment. All DO grab samples have been above the screening level since approximately 2011.

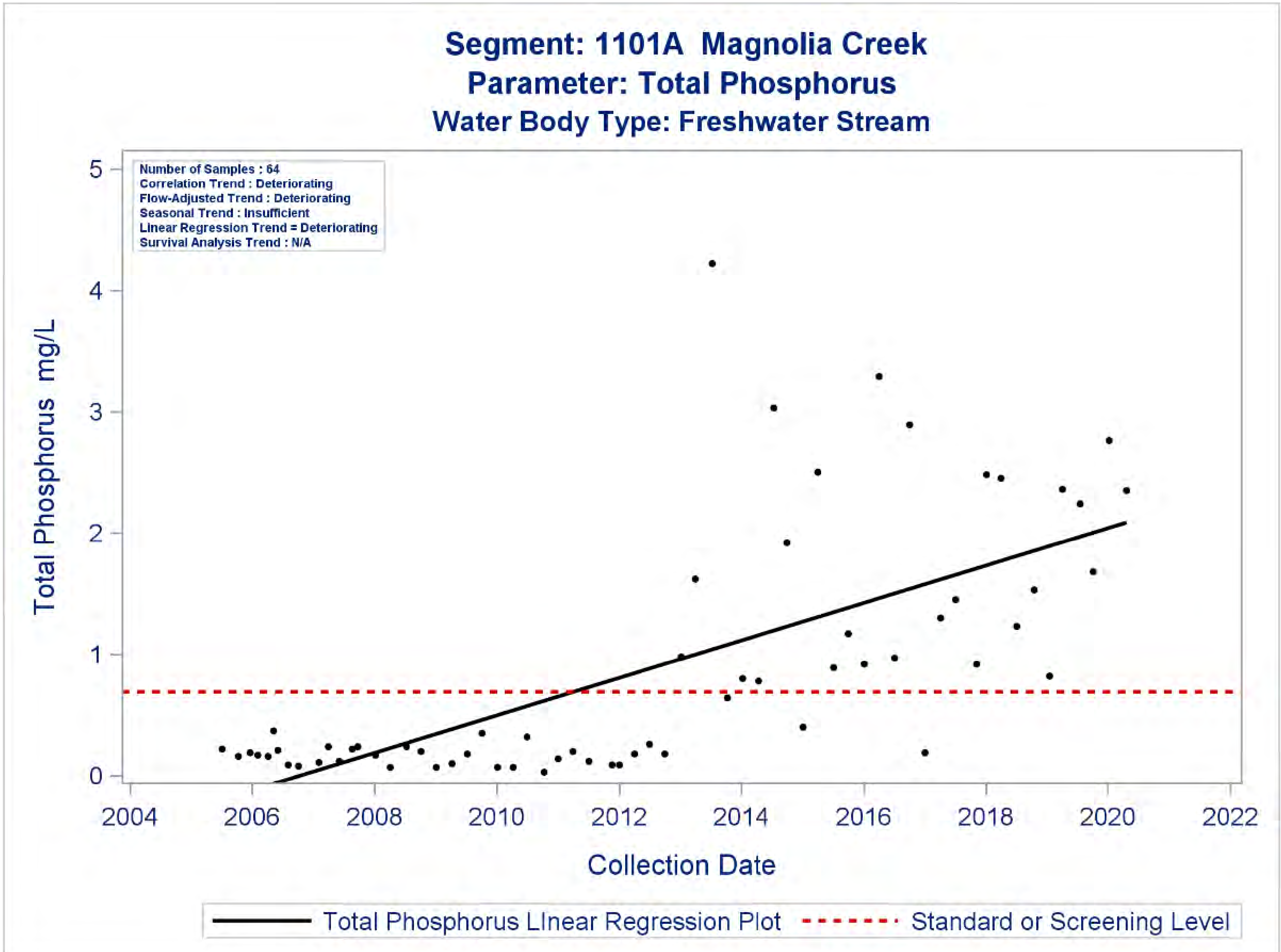
Chigger Creek (unclassified tributary 1101B) trends indicate increasing DO concentrations, increasing Secchi depth measurements indicating less turbid water along with decreasing TSS concentrations. Cow Bayou (unclassified segment 1101C) has only one water quality trend with TKN levels. While TKN was not a concern, the concentrations are still decreasing over time. Unclassified segment 1101D (Robinson Bayou) also has decreasing TKN levels and increasing Secchi depth measurements for less turbid water. DO is also improving but shows variability with many samples below the standard. Enterococcus levels are generally decreasing but still include some very high outliers in the dataset.

Enterococcus and E. coli bacteria levels are improving or stable throughout much of the watershed, but the average values across all aspects of the system are still generally above the state contact recreation standard with many individual results in the thousands. Continued development in the upstream areas of the watershed and 1102 (Clear Creek Above Tidal) may exacerbate existing water quality issues downstream, where much of the watershed is closer to being built out or developmentally static and more impacted by tidal action.

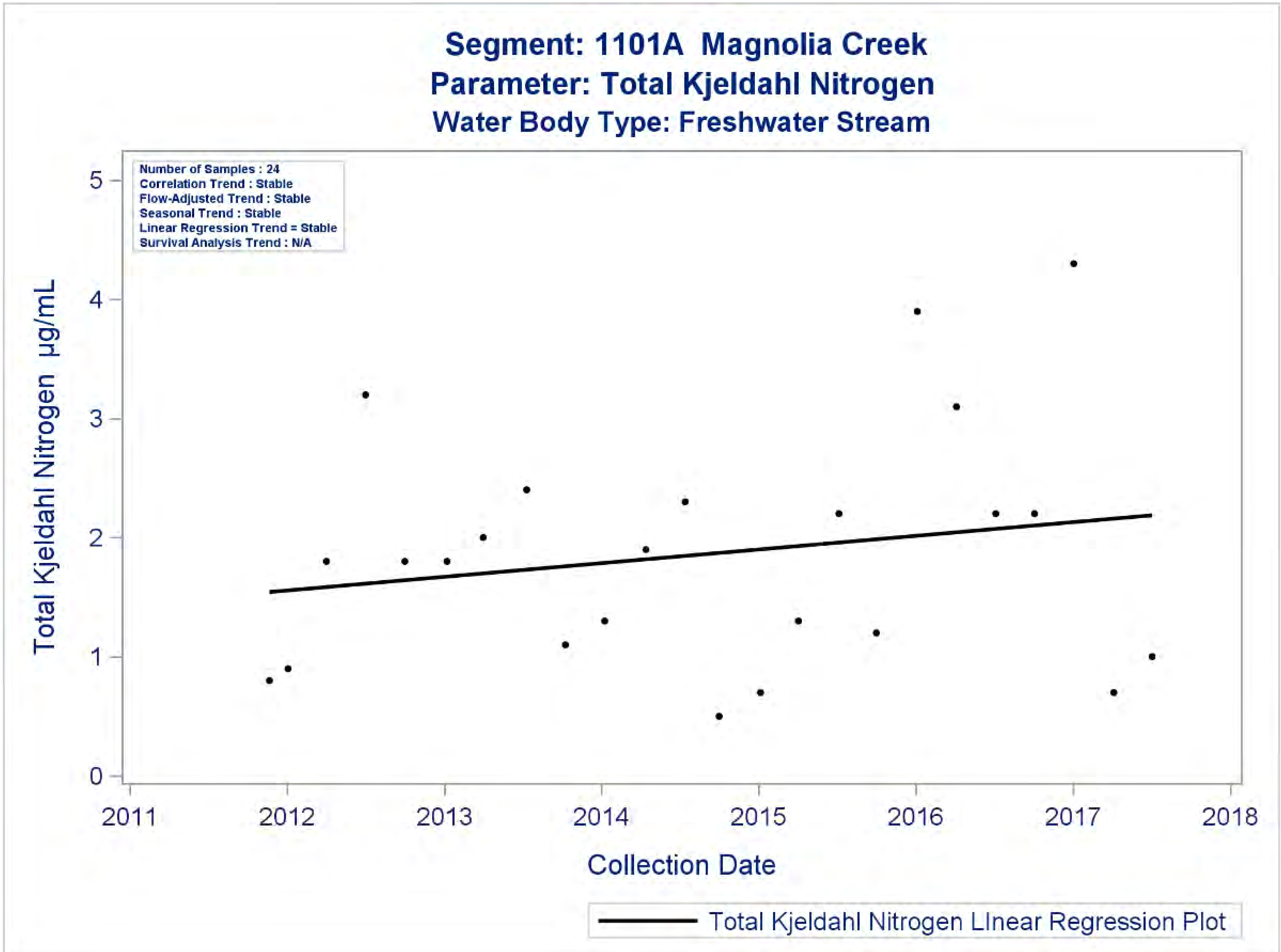

AU: 1101_03 Parameter: Nitrate-N
Clear Creek Tidal
Water Body Type: Tidal Stream
Number of Samples : 76
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
9
7
5
4
3
2
1
0.2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

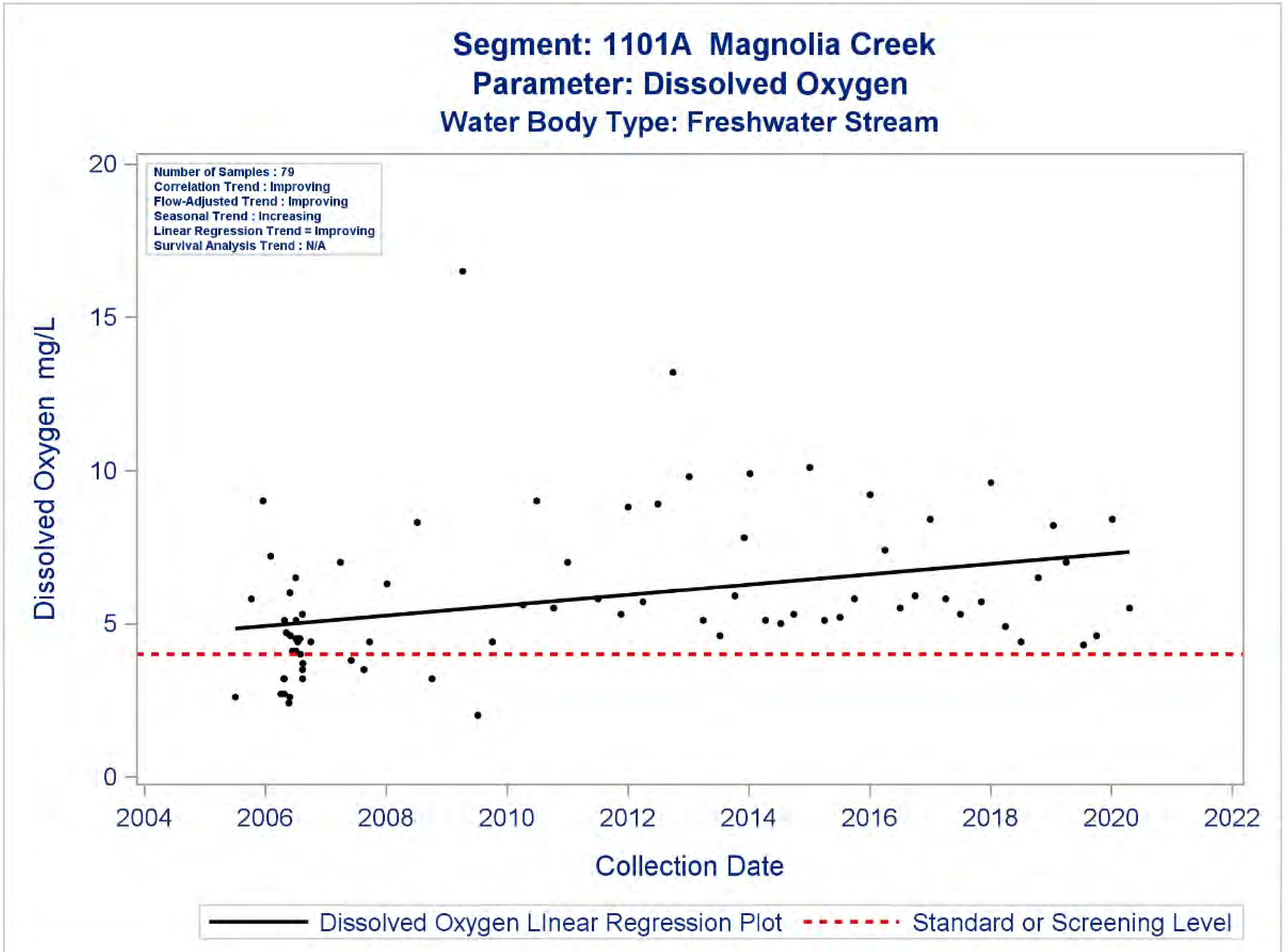


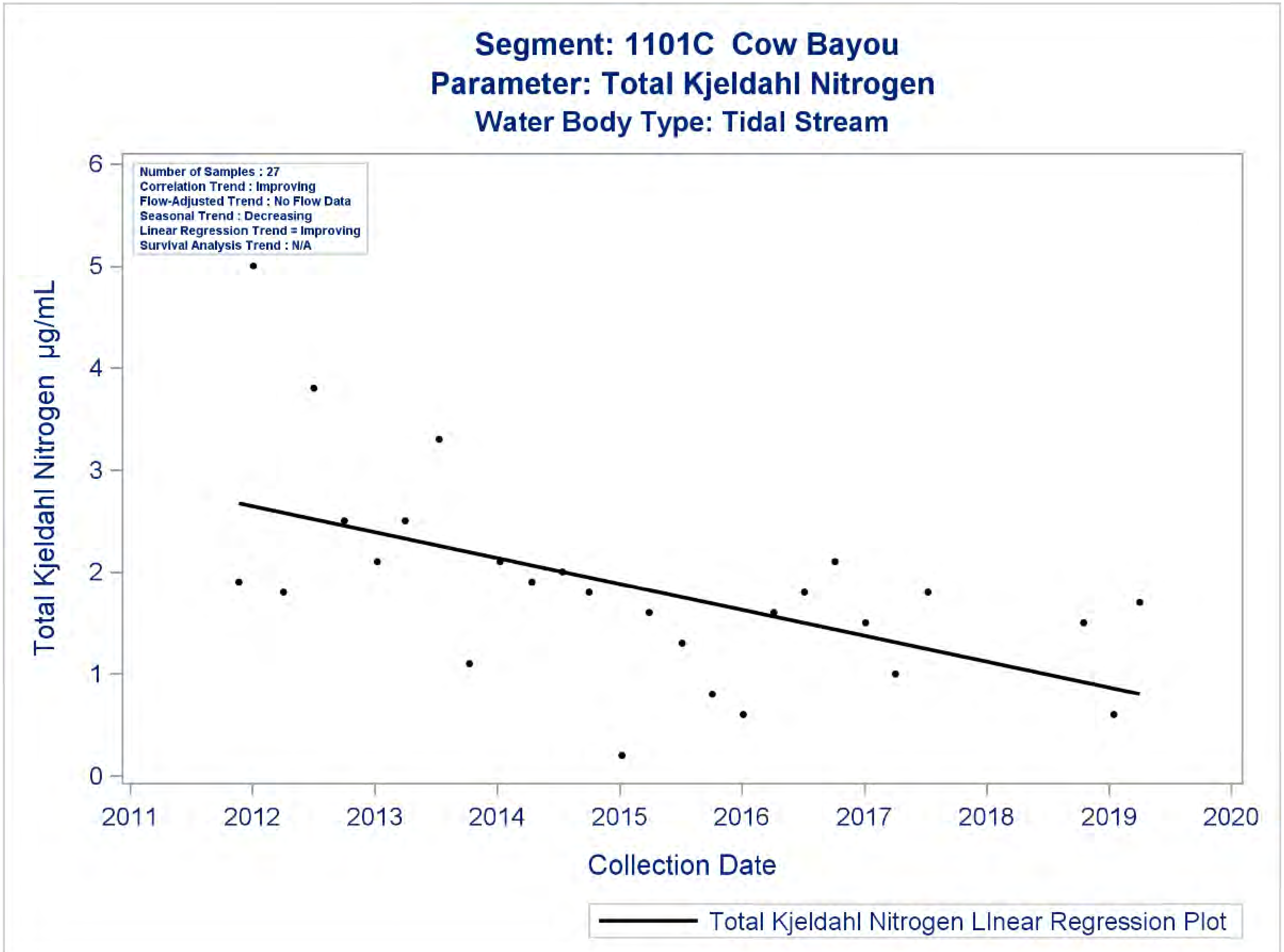
Segment: 1101A Magnolia Creek
Parameter: Nitrate-N
Water Body Type: Freshwater Stream
Number of Samples : 64
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
15
10
5
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

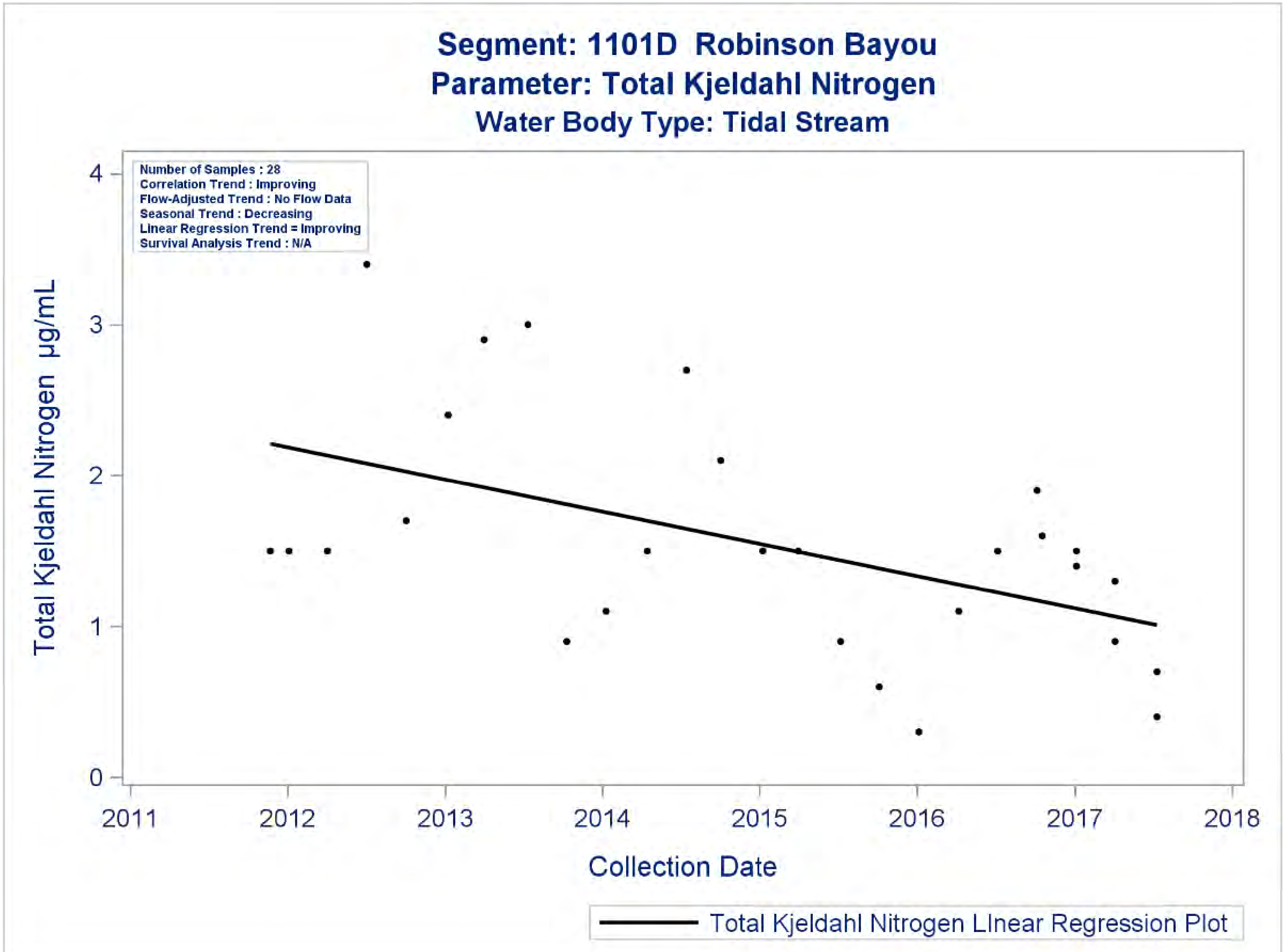


Segment: 1101A Magnolia Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 64
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0
1
2
3
4
5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level

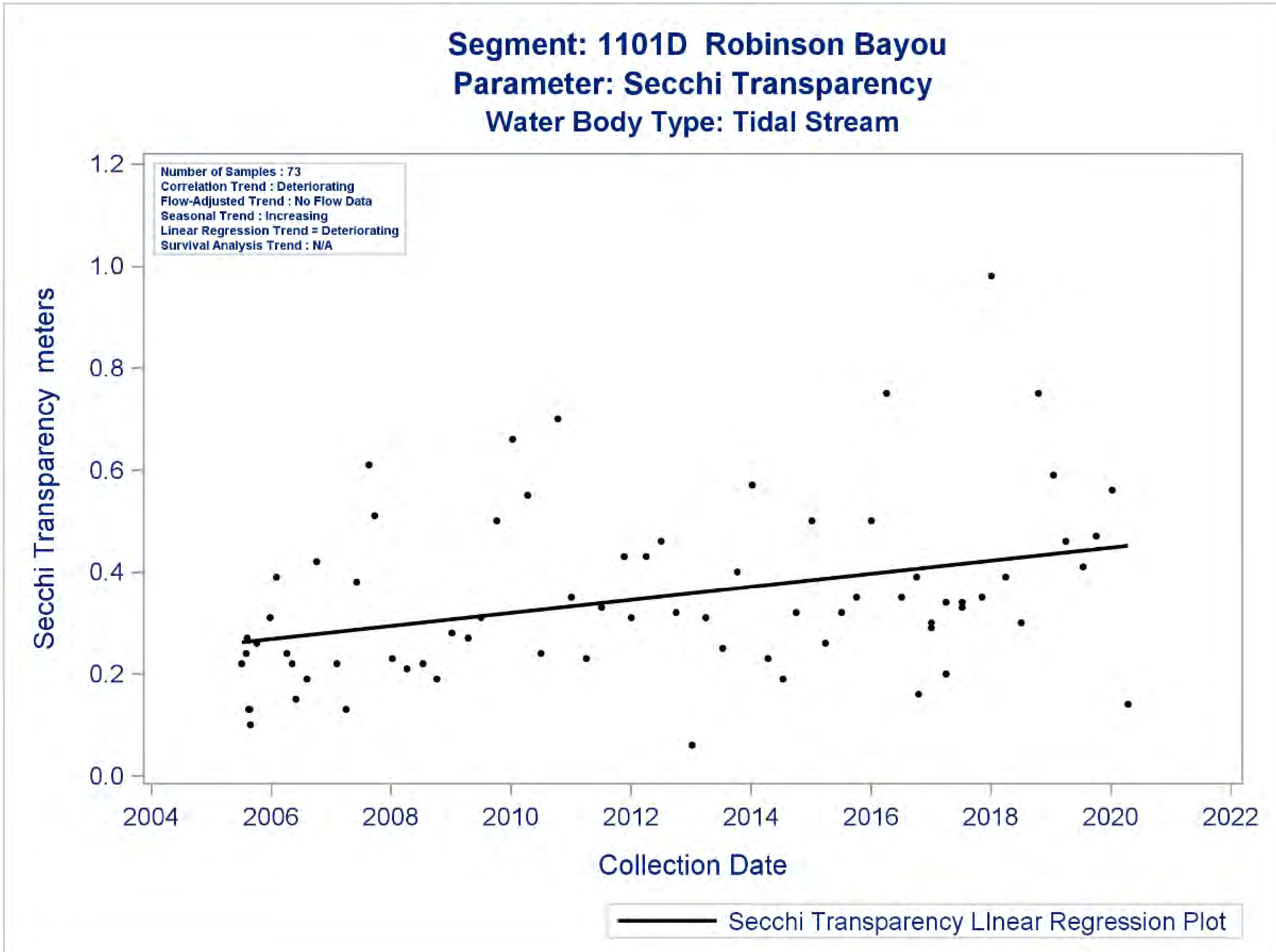

Segment: 1101A Magnolia Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 24
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot

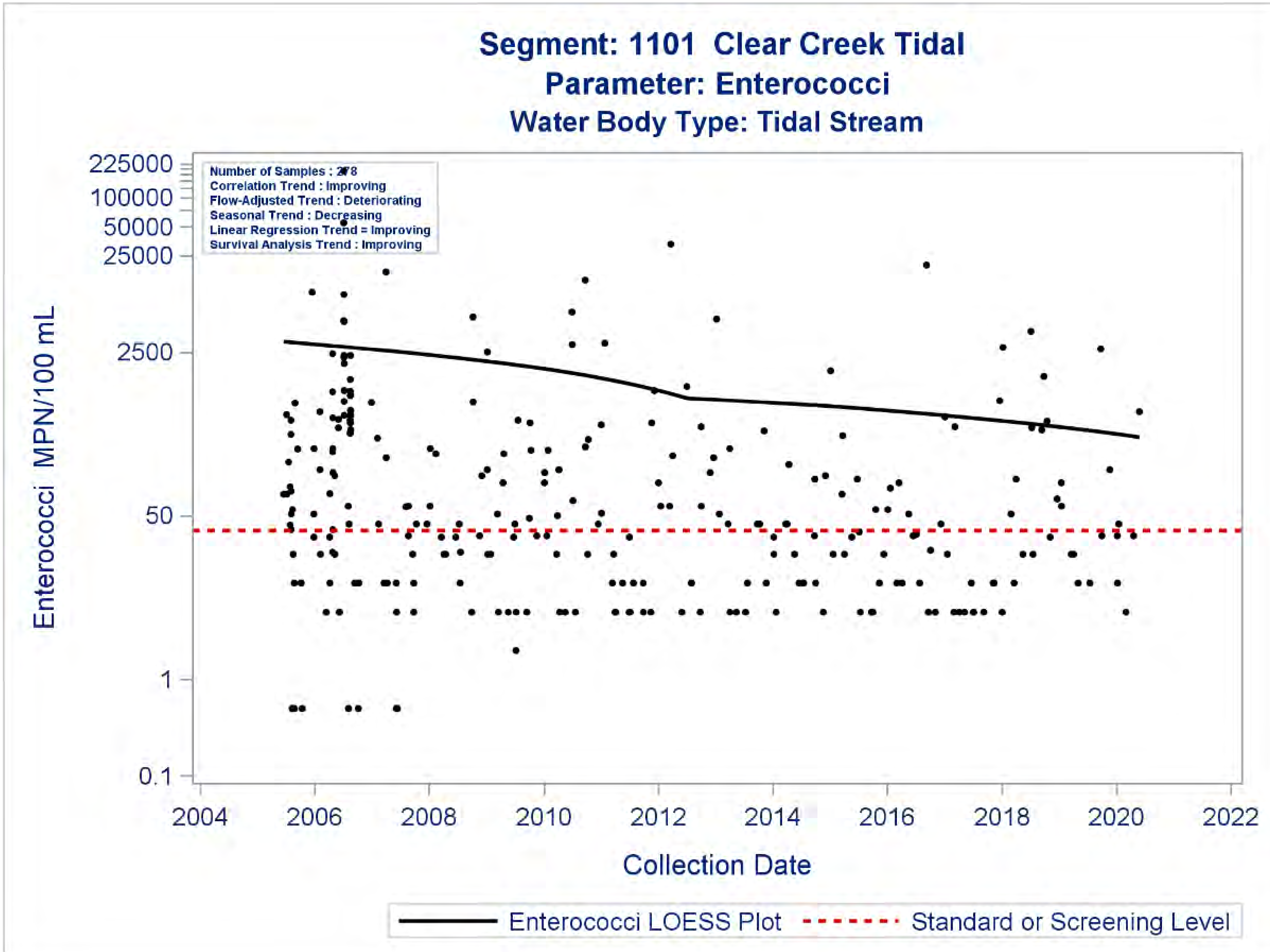

Segment: 1101A Magnolia Creek
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 79
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen Linear Regression Plot
Standard or Screening Level


Segment: 1101C Cow Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 27
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
6
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 1101D Robinson Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 28
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot


Segment: 1101D Robinson Bayou
Parameter: Secchi Transparency
Water Body Type: Tidal Stream
Number of Samples : 73
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Secchi Transparency meters
0.0
0.2
0.4
0.6
0.8
1.0
1.2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot



Segment: 1101 Clear Creek Tidal
Parameter: Enterococci
Water Body Type: Tidal Stream
Number of Samples : 278
Correlation Trend : Improving
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Enterococci MPN/100 mL
225000
100000
50000
25000
2500
50
1
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Enterococci LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1101_01 I 1101_02 I 1101_03 I 1101A_01 I 1101B_01 I 1101B_02 I 1101C_01 I 1101D_01 I 1101E_01 I 1101F_01 I	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Constructed stormwater controls failing • Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Direct and dry weather discharges • Improper or no pet waste disposal • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Elevated levels of bacteria can increase the risk of gastrointestinal illnesses during contact recreation (e.g., swimming)	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Improve compliance and enforcement of existing stormwater quality permits • Improve storm water controls in new developments by adding bacteria reduction measures • Improve construction oversight to minimize TSS discharges to waterways • More public education on pet waste disposal • Promote and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing and alternative water supplies to keep livestock out of or away from waterways
Low Dissolved Oxygen Concentrations	1101_03 C 1101C_01 C 1101D_01 C 1101E_01 I 1101F_01 C	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, and grease disposal; and OSSF maintenance • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Work with drainage districts and agencies to change practices of clear-cutting and

				channelizing waterways to protect from solar heating • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water.
Elevated Nutrient Concentrations	***Nitrate*** 1101_02 C 1101_03 C 1101_04 C 1101A_01 C ***Phosphorus*** 1101_02 C 1101_03 C 1101A_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Elevated Chlorophyll *-a* Concentrations	1101_04 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	1101 (all AUs) I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

H-GAC has been tasked by the TCEQ to implement a basin-wide approach for addressing bacterial impairments for the San Jacinto-Brazos Coastal Basin which includes Clear Creek. Development for the basin-wide Total Maximum Daily Load began in September 2015 and resulted in a final Basin 11 Summary Report that summarized basin characteristics, water quality impairments, potential bacteria sources, and recommendations for bacterial reduction. This segment is also part of the geographic area for the Bacteria Implementation Group (BIG) Total Maximum Daily Load.

H-GAC will also develop a watershed protection plan for Clear Creek as part of a project that initiated in 2021.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with the watershed protection plan development and related modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Work with TCEQ to enhance reporting of sanitary sewer overflows by permittees, including more exact locations of overflows
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 1104				Name: Dickinson Bayou Above Tidal	
Length:	8.2 miles	**Watershed Area:**	32 square miles	**Designated Uses:**	Primary Contact Recreation 1; Intermediate Aquatic Life
Number of Active Monitoring Stations:	1	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	3

DESCRIPTION

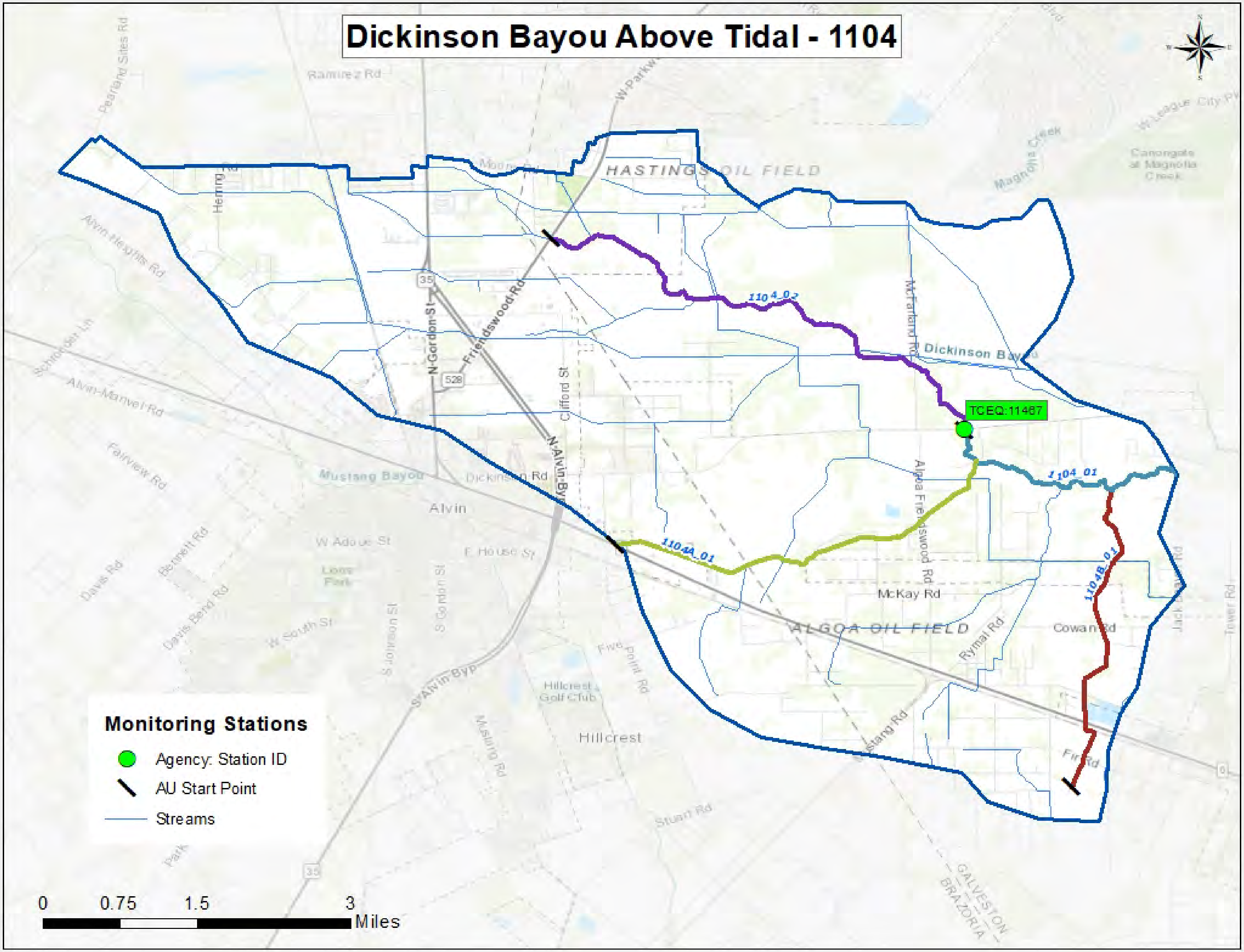
- Segment 1104 (Perennial Stream w/ intermediate ALU): **Dickinson Bayou Above Tidal** (classified water body) – from a point 4.0 km (2.5 mi) downstream of FM 517 in Galveston County to FM 528 in Galveston County

- Segment 1104A (Perennial Stream w/ high ALU): **Unnamed Tributary of Dickinson Bayou Above Tidal** (unclassified water body) – From the Dickinson Bayou Above Tidal confluence to State Hwy 6

- Segment 1104B (Perennial Stream w/ high ALU): **Unnamed Tributary of Dickinson Bayou Above Tidal** (unclassified water body) – From the Dickinson Bayou Above Tidal confluence to a point 0.46 km (0.73 mi) upstream of State Hwy 6

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11467	1104	DICKINSON BAYOU TIDAL AT CR 227 NEAR MIMS	F0	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office

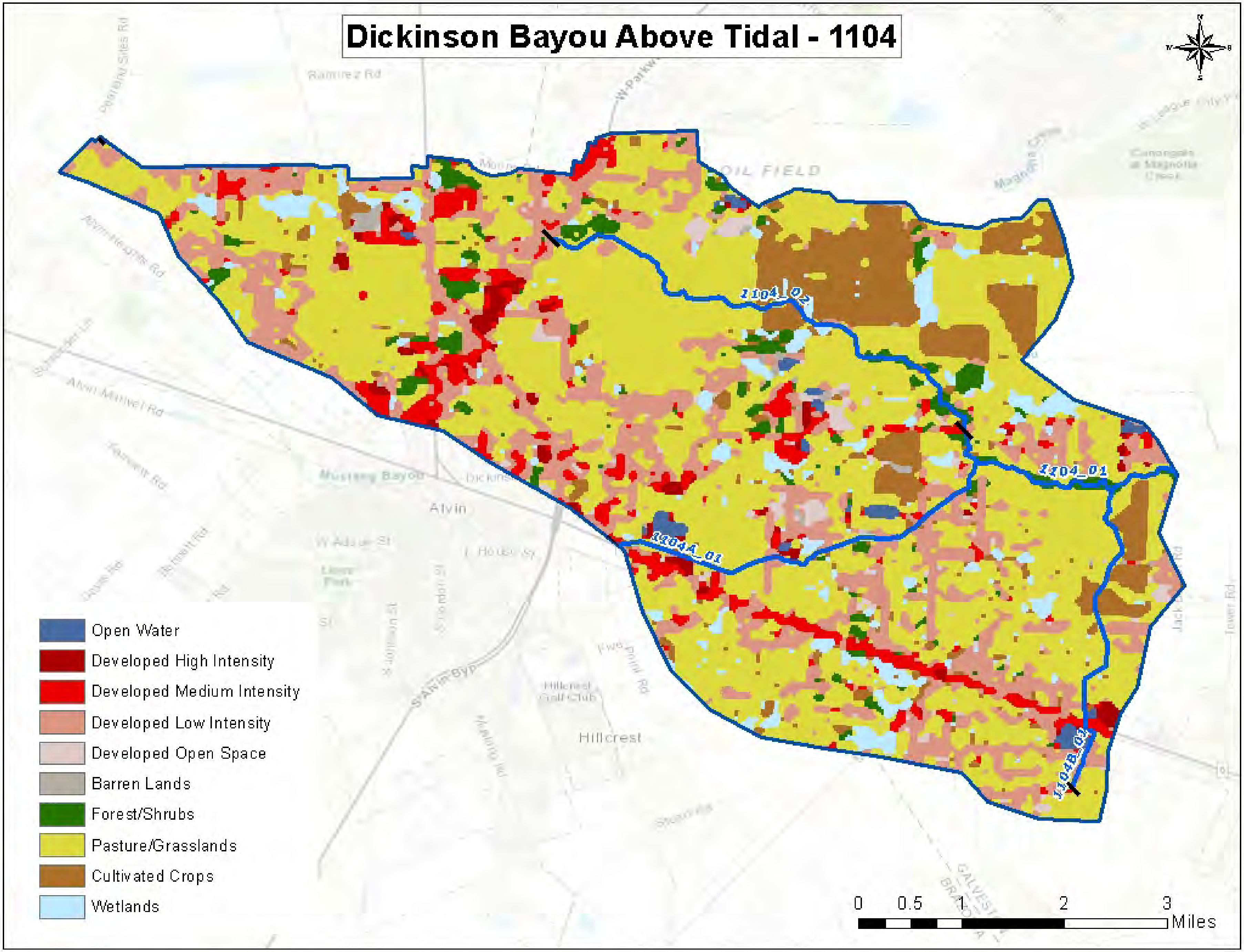

Dickinson Bayou Above Tidal - 1104
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
TCEQ:11467
1104_02
1104_01
1104A_01
1104B_01
Dickinson Bayou
HASTINGS OIL FIELD
ALGOA OIL FIELD
Mustang Bayou
Alvin
Hillcrest
0
0.75
1.5
3
Miles

Segment 1104 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F)	35 / 95	Ammonia-N (mg/L)	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L)	5.0 / 4.0	Nitrate-N (mg/L)	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0 / 3.0	Orthophosphate Phosphorus (mg/L)	0.37
pH (standard units)	6.5-9.0	Total Phosphorus-P (mg/L)	0.69
E. coli (MPN/100 mL) (grab)	399	Chlorophyll *a* (µg/L)	14.1
E. coli (MPN/100 mL) (geometric mean)	126		
Chloride (mg/L as Cl)	200		
Sulfate (mg/L as SO_4)	100		
Total Dissolved Solids (mg/L)	600		

Segment Discussion

Watershed Characteristics and Land Cover: The Dickinson Bayou Above Tidal (1104) segment has headwaters in Brazoria County and travels eastward into Galveston County. This watershed is not as developed as many of the surrounding watersheds. It includes portions of the cities of Santa Fe, League City, Friendswood, and Alvin. Residential and commercial development has been occurring throughout the watershed along major thoroughfares such as Farm-to-Market 528 and Texas State Highway 6. The predominant land use in the watershed is agriculture (62.89 percent). Residents in the majority of the watershed utilize on-site sewage facilities (OSSF) for wastewater treatment. There is a large wildlife ranch located immediately downstream of Farm-to-Market 517 on the western and southern shoreline of the bayou.

Segment 1104 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	11,499.53	55.99	12,915.06	62.89	12.31
Barren Lands	296.45	1.44	115.20	0.56	-61.14
Developed	6,511.02	31.70	5,596.98	27.25	-14.04
Forest/Shrubs	363.61	1.77	656.51	3.20	80.55
Open Water	179.92	0.88	148.11	0.72	-21.47
Wetlands	1,687.74	8.22	1,103.96	5.38	-34.59
TOTAL	**20,538.27**	**100.00**	**20,535.82**	**100.00**	


Dickinson Bayou Above Tidal - 1104
1104_02
1104_01
1104A_01
1104B_01
OIL FIELD
Alvin
Hillcrest
Mustang Bayou
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
0.5
1
2
3
Miles

Water Quality Issues:

Bacteria Impairments and Concerns
The entire Dickinson Bayou Above Tidal (1104) watershed is designated as impaired for bacteria. In the 2020 IR, both assessment units for segment 1103 have an integrated level of support of Not Supporting due to elevated bacteria. AU 1104_01 was not assessed, as there are no active monitoring stations in that assessment unit. This AU is listed as category 4a, indicating that a Total Maximum Daily Load was completed to address the impairments and has been accepted by the EPA. AU 1104_02, which is also listed as category 4a, was assessed based upon 26 data points collected between 12/1/11 – 11/30/18. The *E. coli* geometric mean for these samples was 289.73 MPN/100 mL, which exceeds the Primary Contract Recreation 1 standard of 126 MPN/100 mL. Neither of the two unclassified segments were assessed as there are no monitoring stations on those segments.

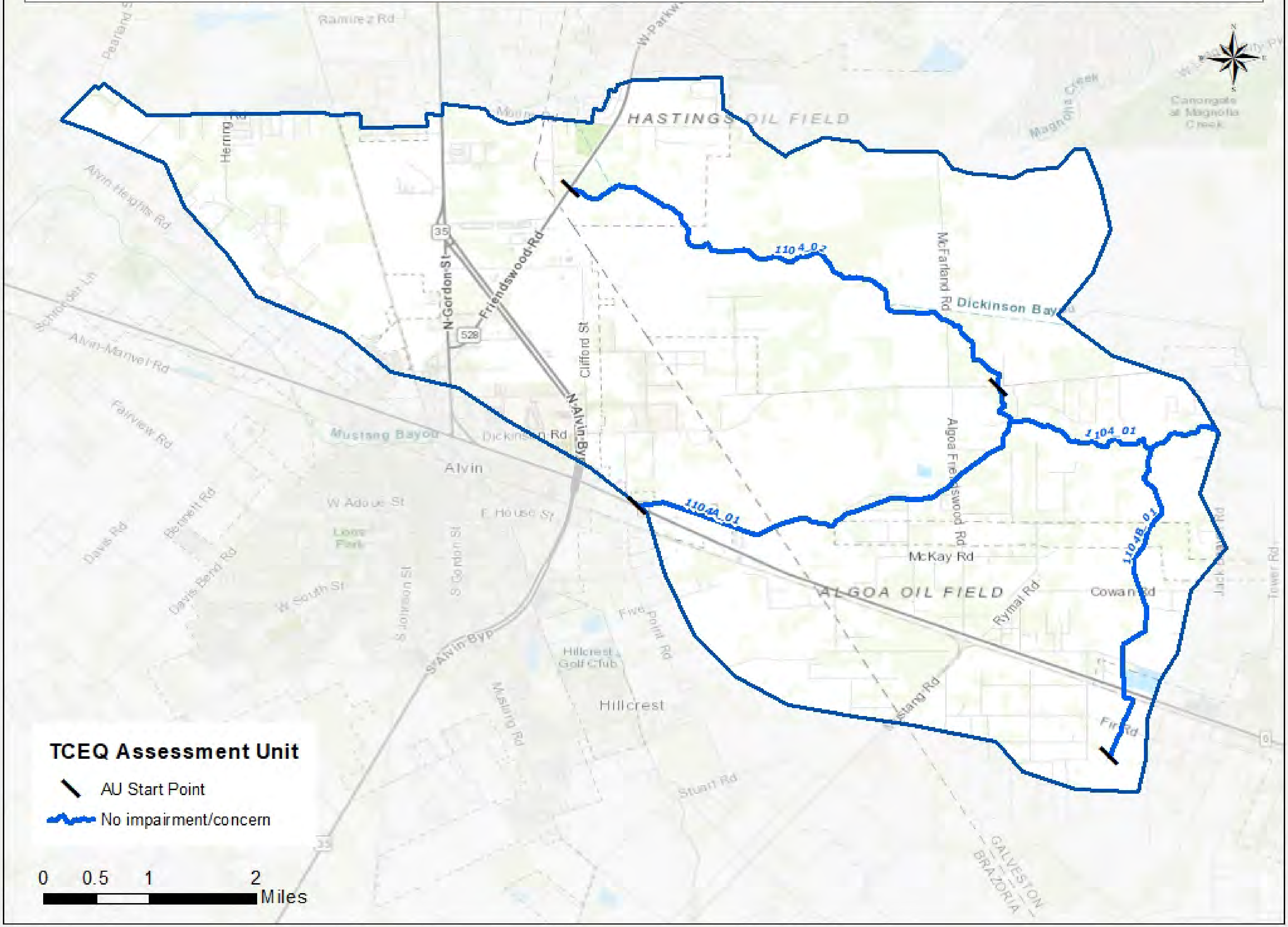
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

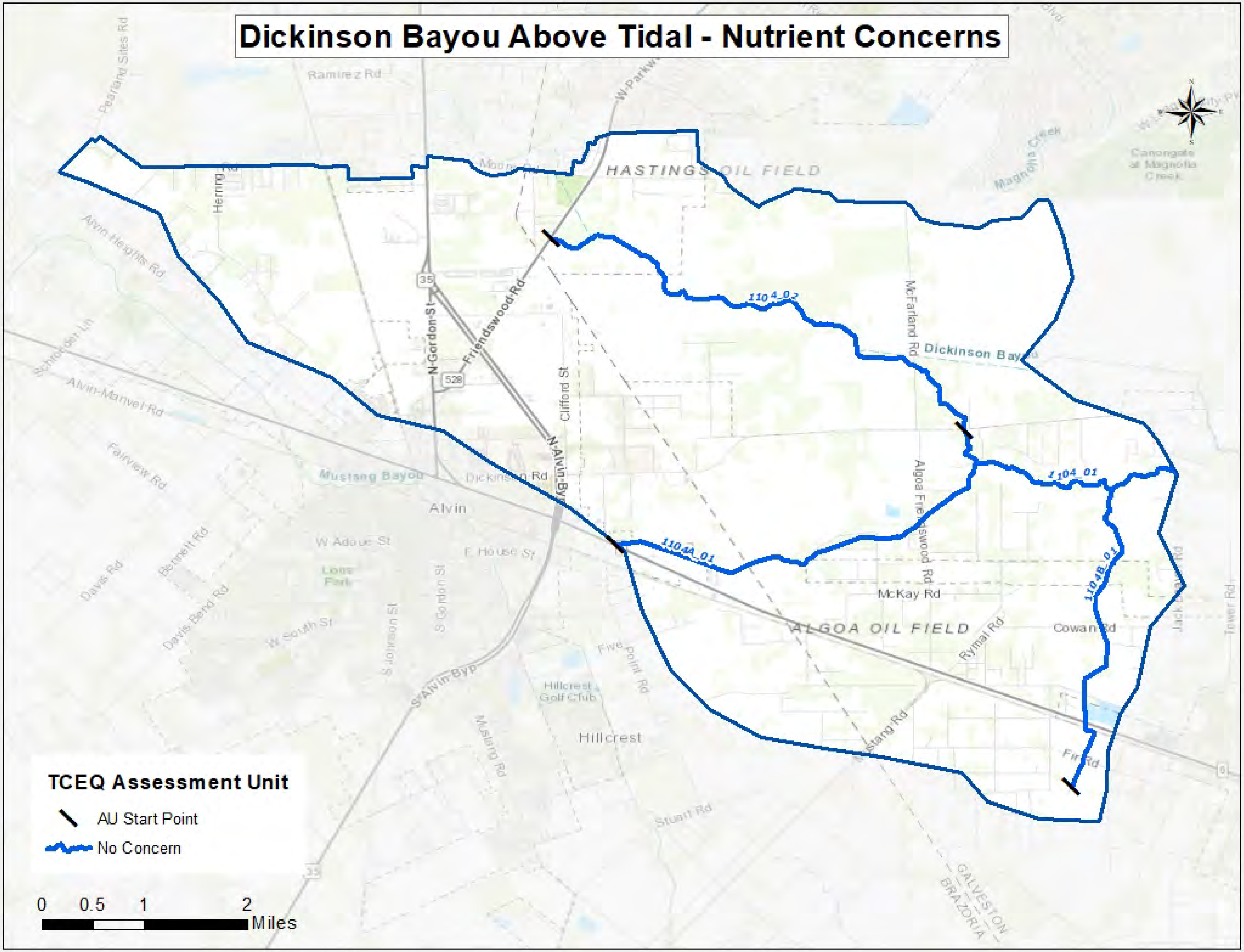
Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Dickinson Bayou Above Tidal - Bacteria Impairments and Concerns

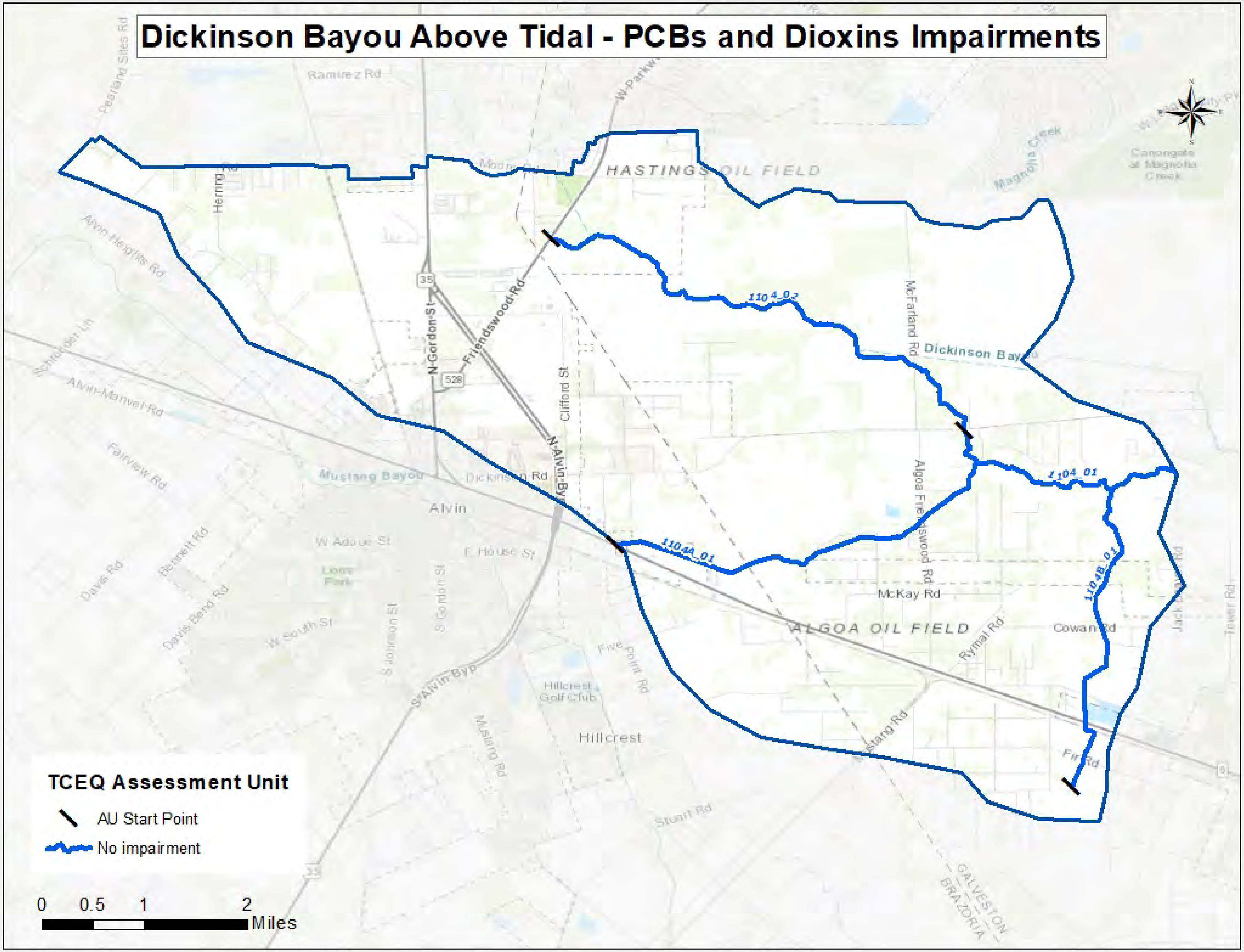
Dickinson Bayou Above Tidal - Dissolved Oxygen Impairments and Concerns





Dickinson Bayou Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
0 0.5 1 2
Miles
1104_02
1104_01
1104A_01
1104B_01
Dickinson Bayou
Mustang Bayou
HASTINGS OIL FIELD
ALGOA OIL FIELD
Alvin
Hillcrest
Hillcrest Golf Club
McFarland Rd
Algoa Friendswood Rd
McKay Rd
Cowan Rd
Friendswood Rd
N Gordon St
N Alvin Byp
Clifford St
Dickinson Rd
Alvin-Manvel Rd
Alvin Heights Rd
Herring Rd
Ramirez Rd
Magnolia Creek
GALVESTON
BRAZORIA

Dickinson Bayou Above Tidal - PCBs and Dioxins Impairments



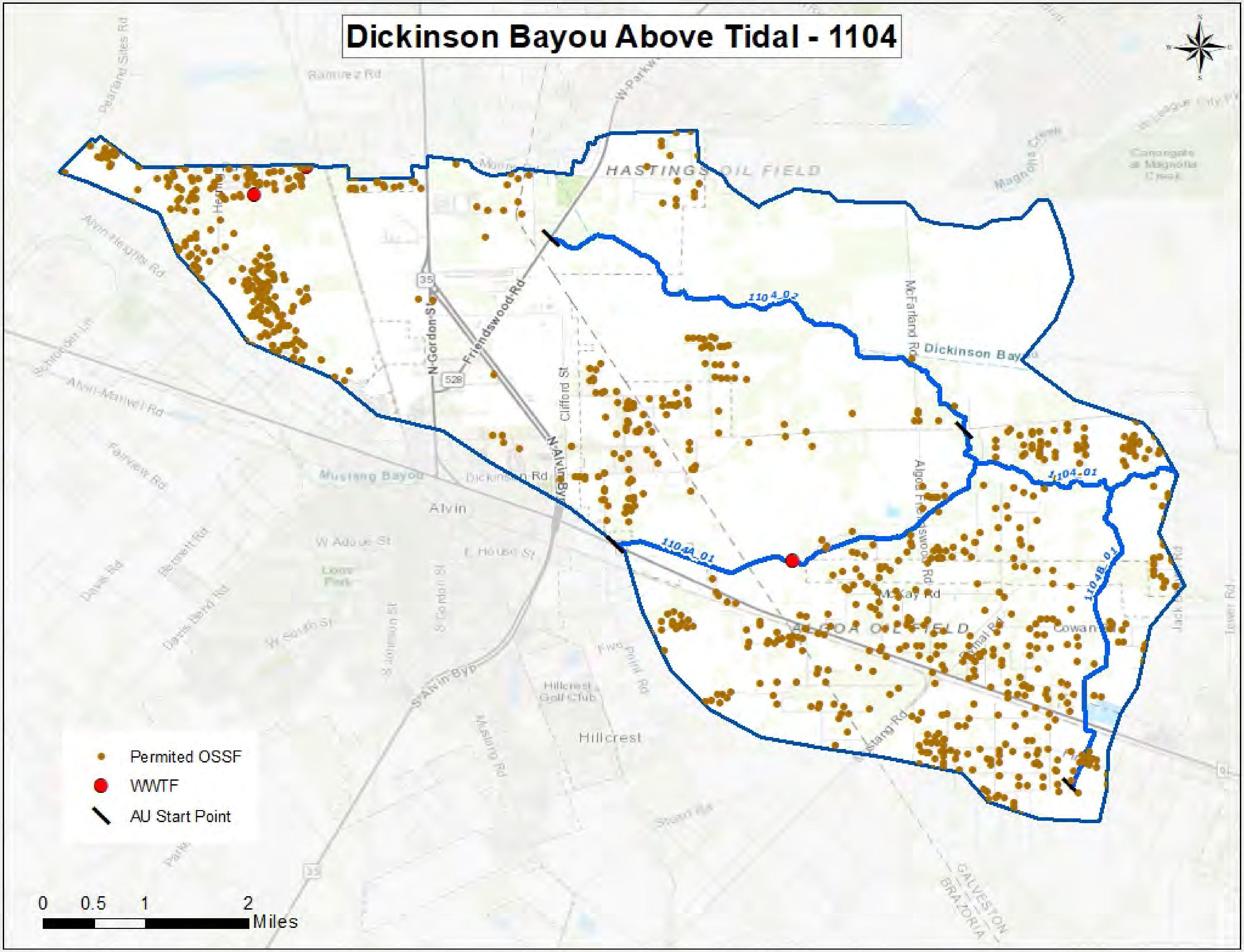
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria in the Dickinson Bayou Above Tidal watershed include wastewater treatment facility effluent, sanitary sewer overflows, failing on-site sewage facilities, and other nonpoint sources, including wildlife and feral hogs.

There are 3 permitted wastewater outfalls in the Dickinson Bayou Above Tidal watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 876 permitted systems located within the watershed. The wastewater treatment facilities and on-site sewage facilities in the Dickinson Bayou Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a no sanitary sewer overflows reported in the sewer collection systems.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Dickinson Bayou Above Tidal watershed.

Dickinson Bayou Above Tidal - 1104

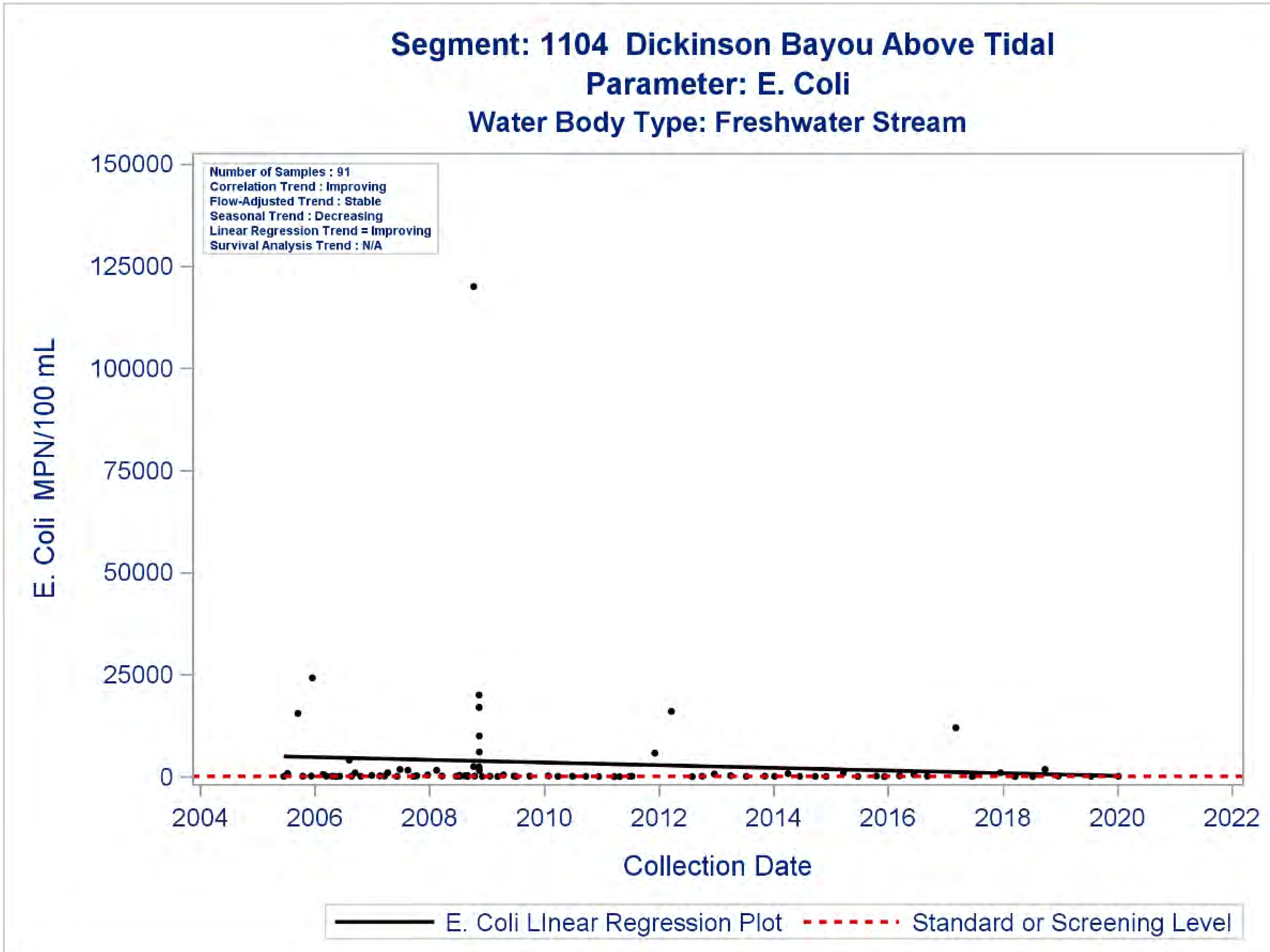


Trend Analysis:

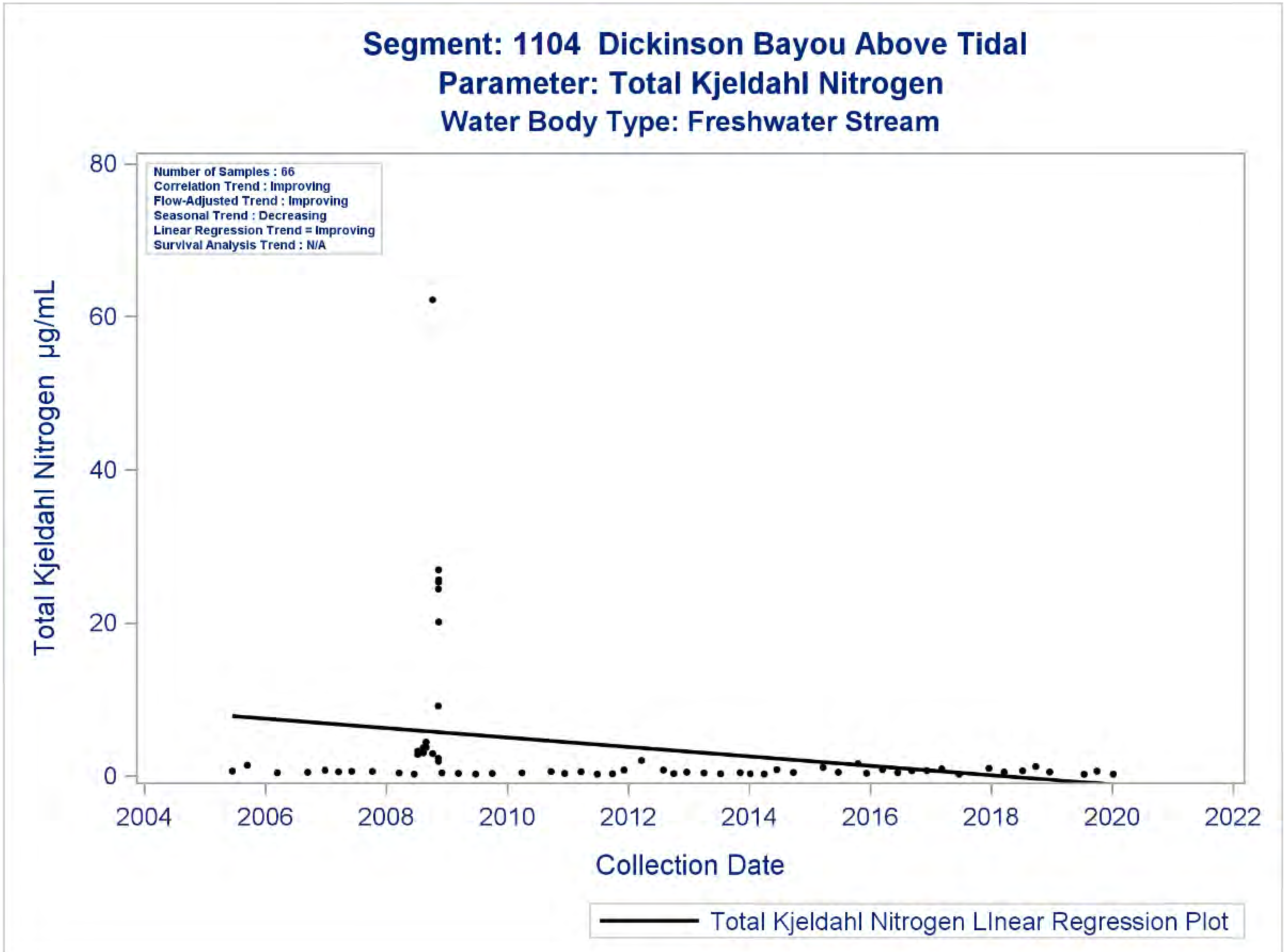
Regression analysis of water quality data for the Dickinson Bayou Above Tidal segment revealed only two parameter trends with decreasing concentrations of E. coli and total Kjeldahl nitrogen (TKN). This segment is currently impaired for bacteria and while there is a downward trend in E. coli, there are numerous results which are extremely elevated that are influencing the trend. The TKN trend has a brief intensive study period between 2008 and 2010 which had some high results. The intensive monitoring revealed high results which are creating the current downward trend.

The Integrated Report (IR) also shows a concern for dissolved oxygen (DO) concentrations in this segment. Grab samples for DO show a stable trend with some samples still being measured below the 3.0 minimum standard.

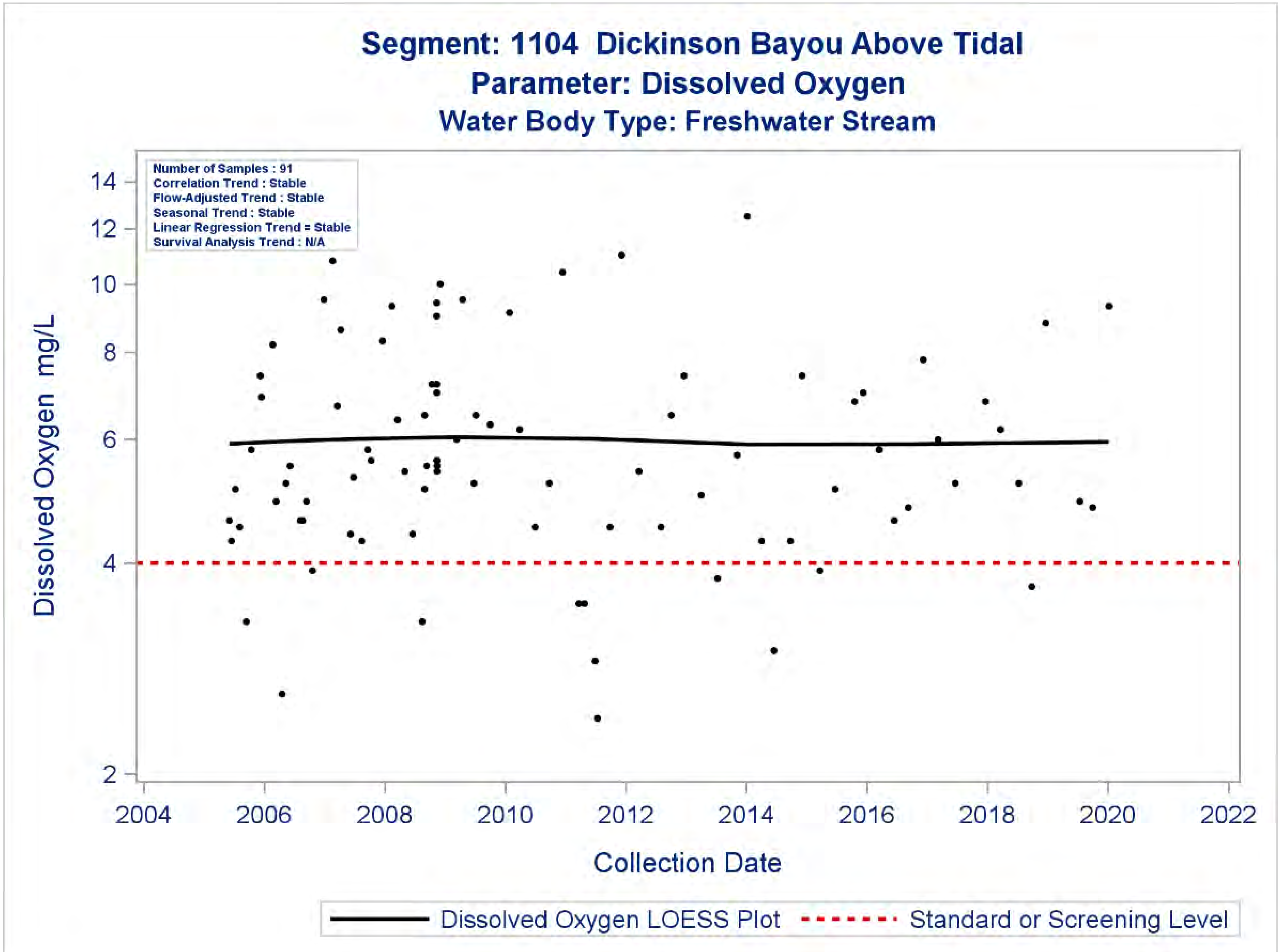
Analysis revealed a positive finding with total phosphorus. All samples since around 2009 have been below the screening criteria.

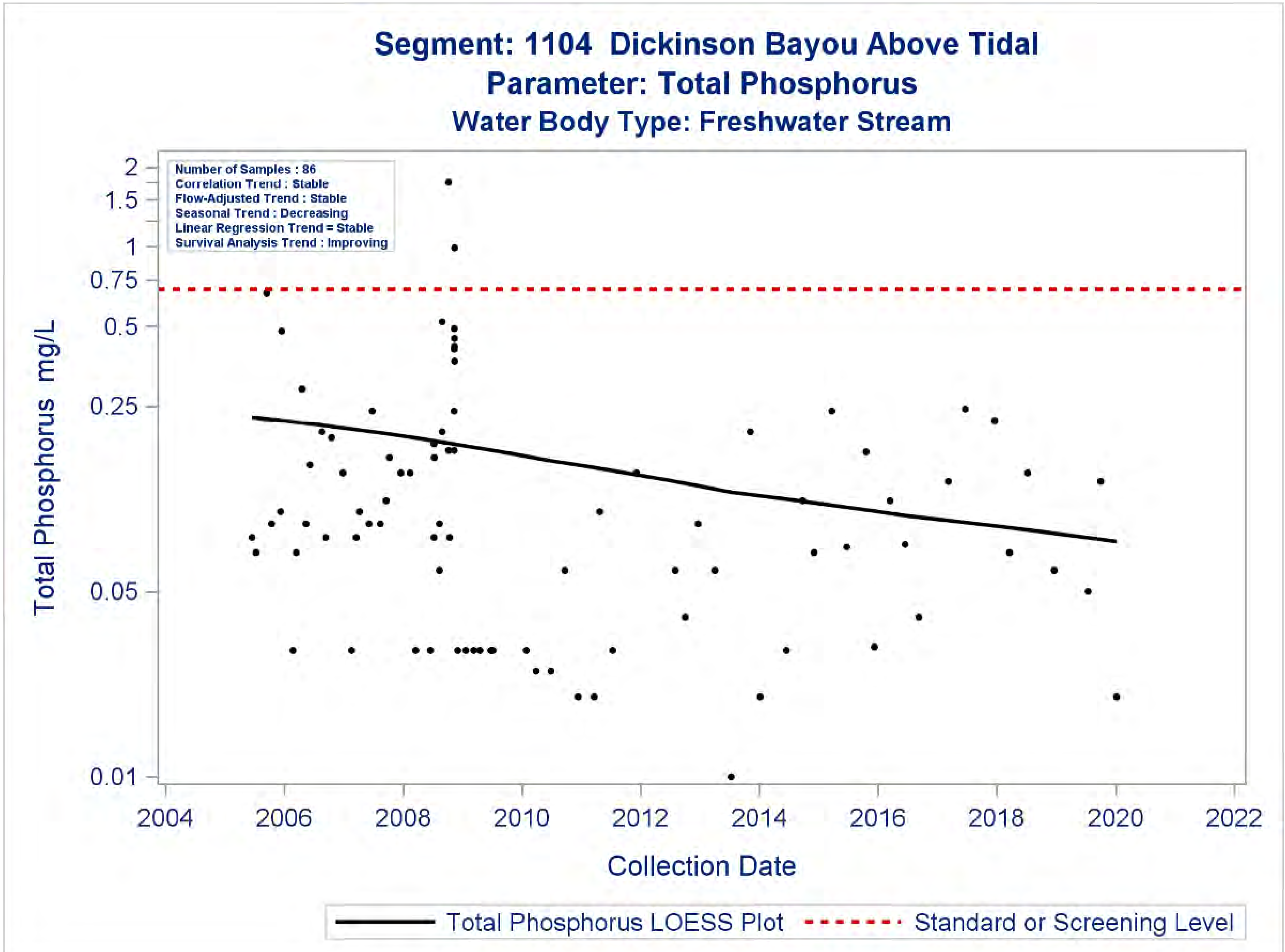


Segment: 1104 Dickinson Bayou Above Tidal
Parameter: E. Coli
Water Body Type: Freshwater Stream
Number of Samples : 91
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
E. Coli MPN/100 mL
150000
125000
100000
75000
50000
25000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
E. Coli LInear Regression Plot
Standard or Screening Level



Segment: 1104 Dickinson Bayou Above Tidal
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 66
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
80
60
40
20
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot


Segment: 1104 Dickinson Bayou Above Tidal
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 91
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
14
12
10
8
6
4
2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level



Segment: 1104 Dickinson Bayou Above Tidal
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 86
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Stable
Survival Analysis Trend : Improving
Total Phosphorus mg/L
2
1.5
1
0.75
0.5
0.25
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1104_01 I 1104_02 I	• Animal waste from agricultural production, wildlife ranch, and domestic animal facilities • Constructed stormwater controls failing • Urbanization and increased impervious cover • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Poorly operated or undersized WWTFs • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations

Special Studies:

The TCEQ conducted a Total Maximum Daily Load project to protect recreational uses and restore water quality in Dickinson Bayou. The initial TMDL project addressed bacteria impairments in Segments 1103 (Dickinson Bayou Tidal) and 1104 (Dickinson Bayou Above Tidal), as well as three of the tributaries to segment 1103. In 2016, the TMDL was updated to add a portion of Dickinson Bayou Tidal (AU 1103_01) and two additional tributaries to 1103 which were not addressed in the initial TMDL project.

The TCEQ adopted the first TMDLs on February 8, 2012, and these TMDLs were approved by the EPA on June 6, 2012. The final I-Plan for this project was approved by TCEQ on January 15, 2014. An addendum to the original TMDL, adding Gum Bayou, Cedar Creek, and AU 1103_01 of Dickinson Bayou Tidal, was adopted by TCEQ and incorporated into the State's Water Quality Management Plan in July 206, with EPA approval of the addendum on September 30, 2016.

For more information on this project, please refer to https://www.tceq.texas.gov/waterquality/tmdl/80-dickinsonbayoubacteria.html or the website of the Dickinson Bayou Watershed Partnership (https://agrilife.org/dickinsonbayou/).

Segment 1104 was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with Texas AgriLife and local stakeholders to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 1103				Name: Dickinson Bayou Tidal	
Length:	14.6 miles	**Watershed Area:**	57 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	11	**Texas Stream Team Monitoring Stations:**	2	**Permitted WWTF Outfalls:**	9

DESCRIPTION

- Segment 1103 (Tidal Stream w/ high ALU): **Dickinson Bayou Tidal** (classified water body) – from the confluence with Dickinson Bay 2.1 km (1.3 mi) downstream of SH 146 in Galveston County to a point 4.0 km (2.5 mi) downstream of FM 517 in Galveston County

- Segment 1103A (Tidal Stream w/ high ALU): **Bensons Bayou** (unclassified water body) – From the Dickinson Bayou Tidal confluence to point 0.6 km (0.37 mi) upstream of FM 646

- Segment 1103B (Tidal Stream w/ high ALU): **Bordens Gully** (unclassified water body) — From the Dickinson Bayou Tidal confluence to a point 1.4 km (0.87 mi) upstream of FM 646 in Galveston County

- Segment 1103C (Tidal Stream w/ high ALU): **Geisler Bayou** (unclassified water body) — From the Dickinson Bayou Tidal confluence to a point 1.37 km (0.85 mi) upstream of FM 646 in Galveston County

- Segment 1103D (Tidal Stream w/ high ALU): **Gum Bayou** (unclassified water body) — From the Dickinson Bayou Tidal confluence to State Hwy 96 in Galveston County

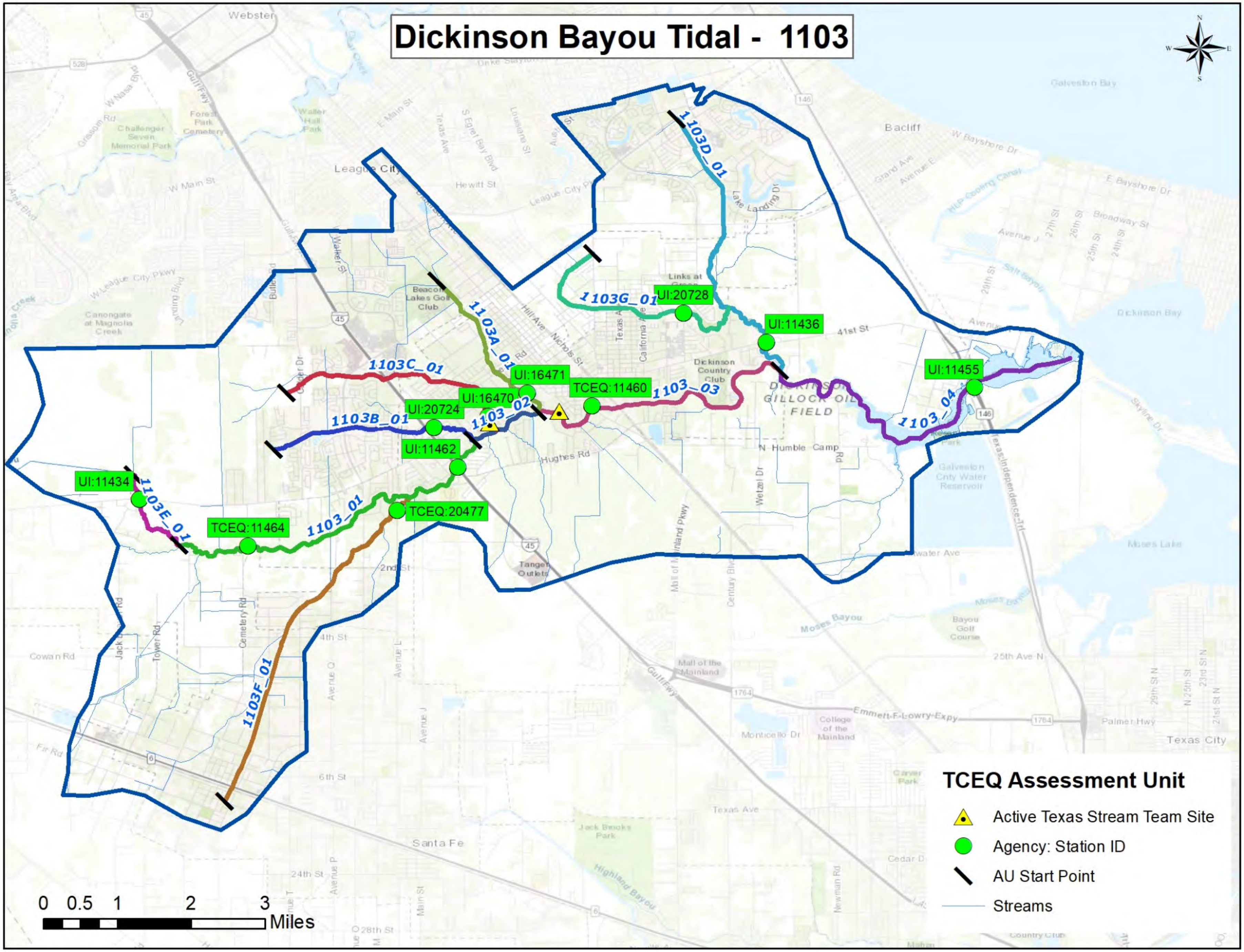
- Segment 1103E (Perennial Stream w/ high ALU): **Cedar Creek** (unclassified water body) — From the Dickinson Bayou Tidal confluence to a point 0.63 km (0.39 mi) upstream FM 517 in Galveston County

- Segment 1103F (Tidal Stream w/ high ALU): **Unnamed tributary of Dickinson Bayou Tidal** (unclassified water body) – From the Dickinson Bayou Tidal confluence to a point 0.36 km (0.22 mi) upstream of State Hwy 6

- Segment 1103G (Tidal Stream w/ high ALU): **Unnamed Tributary of Gum Bayou** (unclassified water body) – From the confluence with Gum Bayou to a point 0.39 miles south of the FM 646/FM 1266 intersection between League City and Dickinson

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11455	1103	DICKINSON BAYOU TIDAL AT SH 146 BRIDGE EAST OF DICKINSON	UI	Quarterly	Field, Conventional, Bacteria
11460	1103	DICKINSON BAYOU TIDAL AT SH 3 BRIDGE IN DICKINSON CAMS733	FO	Quarterly	Field, Conventional, Bacteria
11462	1103	DICKINSON BAYOU TIDAL AT IH 45	UI	Quarterly	Field, Conventional, Bacteria
11464	1103	DICKINSON BAYOU TIDAL AT CEMETERY ROAD NORTH OF ARCADIA	FO	Quarterly	Field, Conventional, Bacteria
16471	1103A	BENSONS BAYOU AT FM 517 / PINE DR IN DICKINSON	UI	Quarterly	Field, Conventional, Bacteria
20724	1103B	BORDENS GULLY AT SPRUCE DRIVE IN DICKINSON	UI	Quarterly	Field, Conventional, Bacteria, Flow
16470	1103C	GEISLER BAYOU AT FM517 BRIDGE 0.19MI UPSTREAM OF DICKINSON BAYOU IN DICKINSON	UI	Quarterly	Field, Conventional, Bacteria
11436	1103D	GUM BAYOU AT FM 517 E OF DICKINSON	UI	Quarterly	Field, Conventional, Bacteria
11434	1103E	CEDAR CREEK AT FM 517 W OF DICKINSON	UI	Quarterly	Field, Conventional, Bacteria, Flow
20477	1103F	UNNAMED TRIBUTARY OF DICKINSON BAYOU AT AVENUE L 88 METERS SOUTH TO THE INTERSECTION OF OAK LANE AND AVENUE L SOUTHWEST OF DICKINSON	FO	Quarterly	Field, Conventional, Bacteria
20728	1103G	UNNAMED TRIBUTARY OF GUM BAYOU AT OWENS DRIVE 1.51 KILOMETERS UPSTREAM OF CONFLUENCE WITH GUM BAYOU IN DICKINSON	UI	Quarterly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston



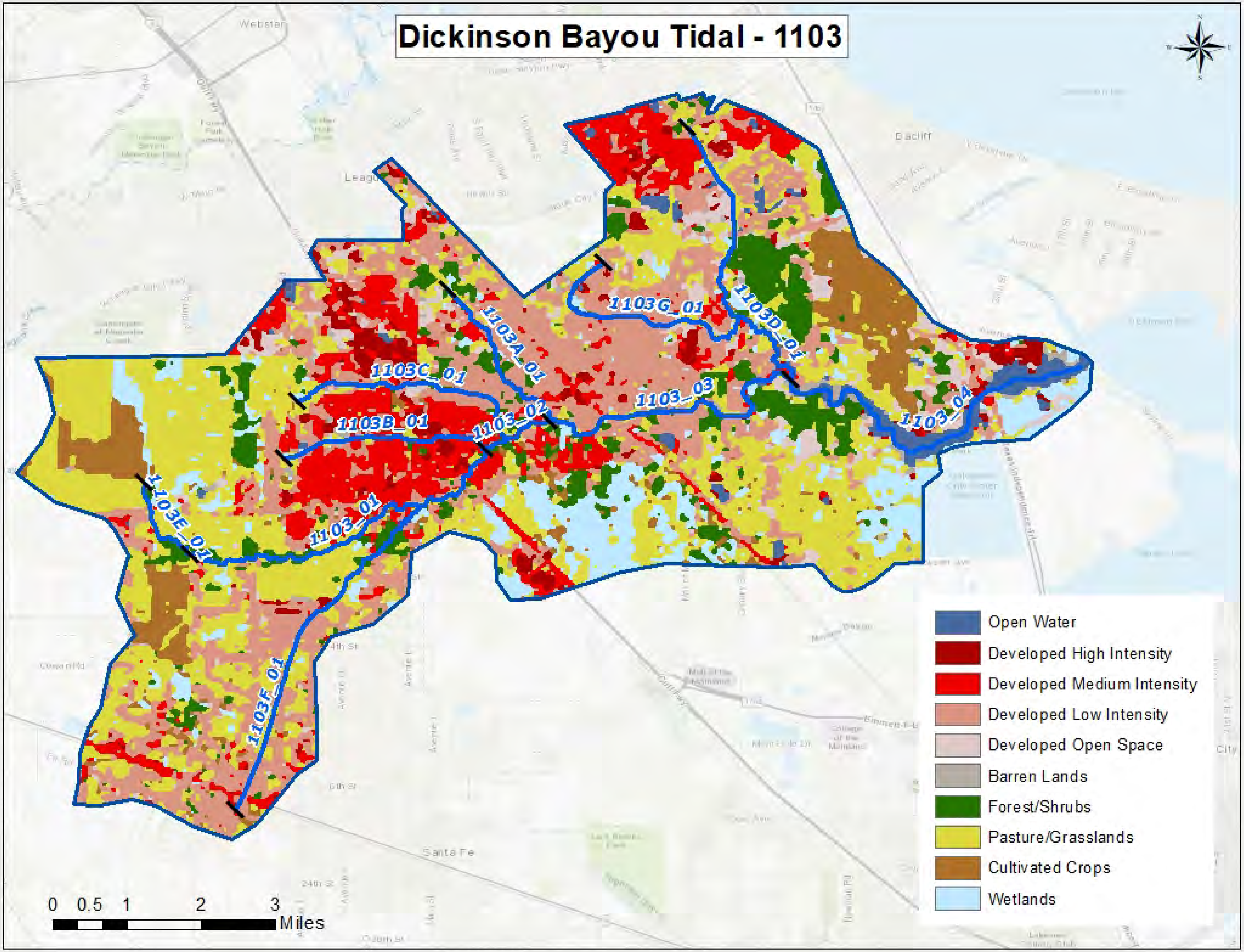
Dickinson Bayou Tidal - 1103
1103D_01
1103G_01
1103A_01
1103C_01
1103B_01
1103_02
1103_03
1103_04
1103_01
1103E_01
1103F_01
UI:20728
UI:11436
UI:16471
UI:16470
UI:20724
UI:11462
UI:11455
UI:11434
TCEQ:11460
TCEQ:20477
TCEQ:11464
TCEQ Assessment Unit
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0 0.5 1 2 3
Miles

Segment 1103 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F)	35 / 95	35 / 95	Ammonia-N (mg/L)	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L)	4.0	5.0	Nitrate-N (mg/L)	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L)	3.0	3.0	Orthophosphate Phosphorus (mg/L)	0.46	0.37
pH (standard units)	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L)	0.66	0.69
Enterococci (MPN/100mL) (grab)	104		Chlorophyll *a* (µg/L)	21	14.1
Enterococci (MPN/100mL) (geometric mean)	35				
E. coli (MPN/100 mL) (grab)		399			
E. coli (MPN/100 mL) (geometric mean)		126			

Segment Discussion

Watershed Characteristics and Land Cover: The Dickinson Bayou Tidal Watershed is heavily developed in the areas surrounding I-45 and FM 517 around the City of Dickinson. This watershed also includes parts of Santa Fe and Texas City. Large tracts of the watershed are still undeveloped or are used for agriculture particularly at the west end of FM517 and south of the City of Dickinson. There are a number of small acreage farms is these areas that are used for cattle and horse grazing. Most of the developed areas within the City of Dickinson are served by wastewater treatment facilities (WWTF) but the rest of the rural area uses on-site sewage facilities (OSSF). Major tributaries to Dickinson Bayou Tidal include Bordens Gully, Cedar Creek, Geisler Bayou, Gum Bayou, and Bensons Bayou. This segment discharges to Dickinson Bay and ultimately to Lower Galveston Bay.

Segment 1103 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	13,026.26	35.71	13,475.49	36.93	3.45
Barren Lands	1,026.57	2.81	428.33	1.17	-58.28
Developed	15,162.13	41.56	15,586.01	42.72	2.80
Forest/Shrubs	1,178.46	3.23	2,770.58	7.59	135.10
Open Water	1,023.01	2.80	865.11	2.37	-15.43
Wetlands	5,065.90	13.89	3,362.59	9.22	-33.62
TOTAL	**36,482.33**	**100.00**	**36,488.11**	**100.00**	


Dickinson Bayou Tidal - 1103
1103G_01
1103D_01
1103A_01
1103C_01
1103_03
1103B_01
1103_02
1103_04
1103E_01
1103_01
1103F_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.5 1 2 3
Miles

Water Quality Issues:

Bacteria Impairments and Concerns

The entire Dickinson Bayou Tidal (1103) watershed is designated as impaired for bacteria and does not meet its primary contact recreation use designation. In the 2020 Integrated Report, Dickinson Bayou Tidal has bacteria impairments for all four assessment units. Additionally, all unclassified segments in the Dickinson Bayou Tidal watershed are listed as impaired for elevated bacteria. Bacteria geometric mean values for Enterococcus are lowest in AU 1103_01 at 43.11 MPN/100 mL and highest in AU 1103_04, at 105.81 MPN/100 mL. AU 1103_03 was not assessed in the 2020 IR but is listed as a carry-forward based upon previous data. Bacteria levels are even more elevated in the unclassified segments that flow into Dickinson Bayou Tidal, ranging from 102.99 MPN/100 mL in 1103D (Gum Bayou) to 522.19 MPN/100 mL in AU 1103G (Unnamed Tributary of Gum Bayou). Bacteria impairments in 1103, 1103A, 1103B, 1103C, 1103D, and 1103E are listed as Category 4a, indicating that a Total Maximum Daily Load was completed to address the impairments and has been accepted by the EPA. Segments 1103F and 1103G are classified as Category 5a, indicating that a Total Maximum Daily load is underway, scheduled, or may be scheduled.

Dissolved Oxygen Impairments and Concerns

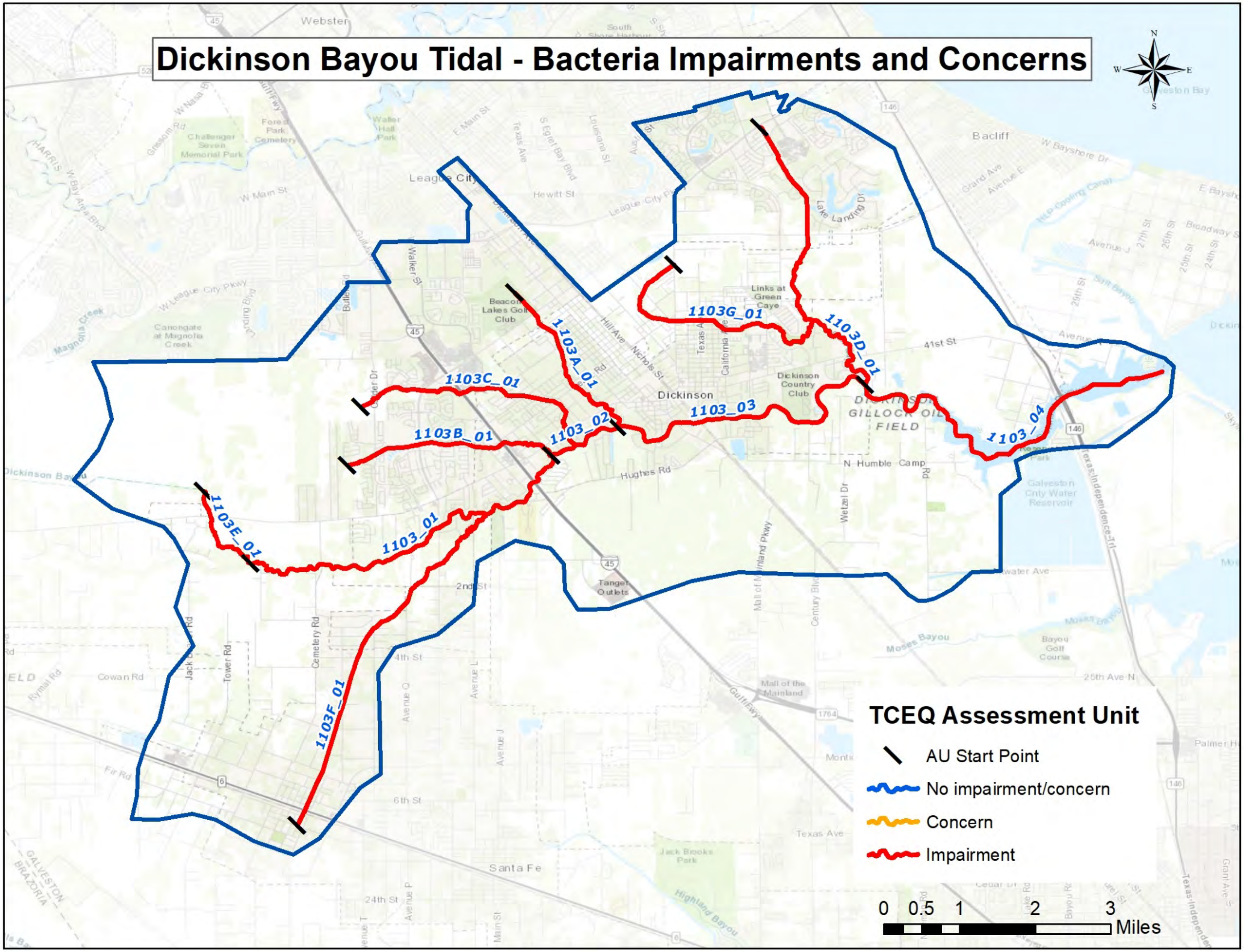
Assessment units 1103_01, 1103_02, and 1103_03 have impairments for dissolved oxygen. Assessment units 1103_04, 1103A_01, 1103B_01, 1103C_01, and 1103F_01 have both impairments as well as concerns for dissolved oxygen. Assessment units 1103E_01 and 1103G_01 are listed as a concern for water quality screening levels for depressed dissolved oxygen.

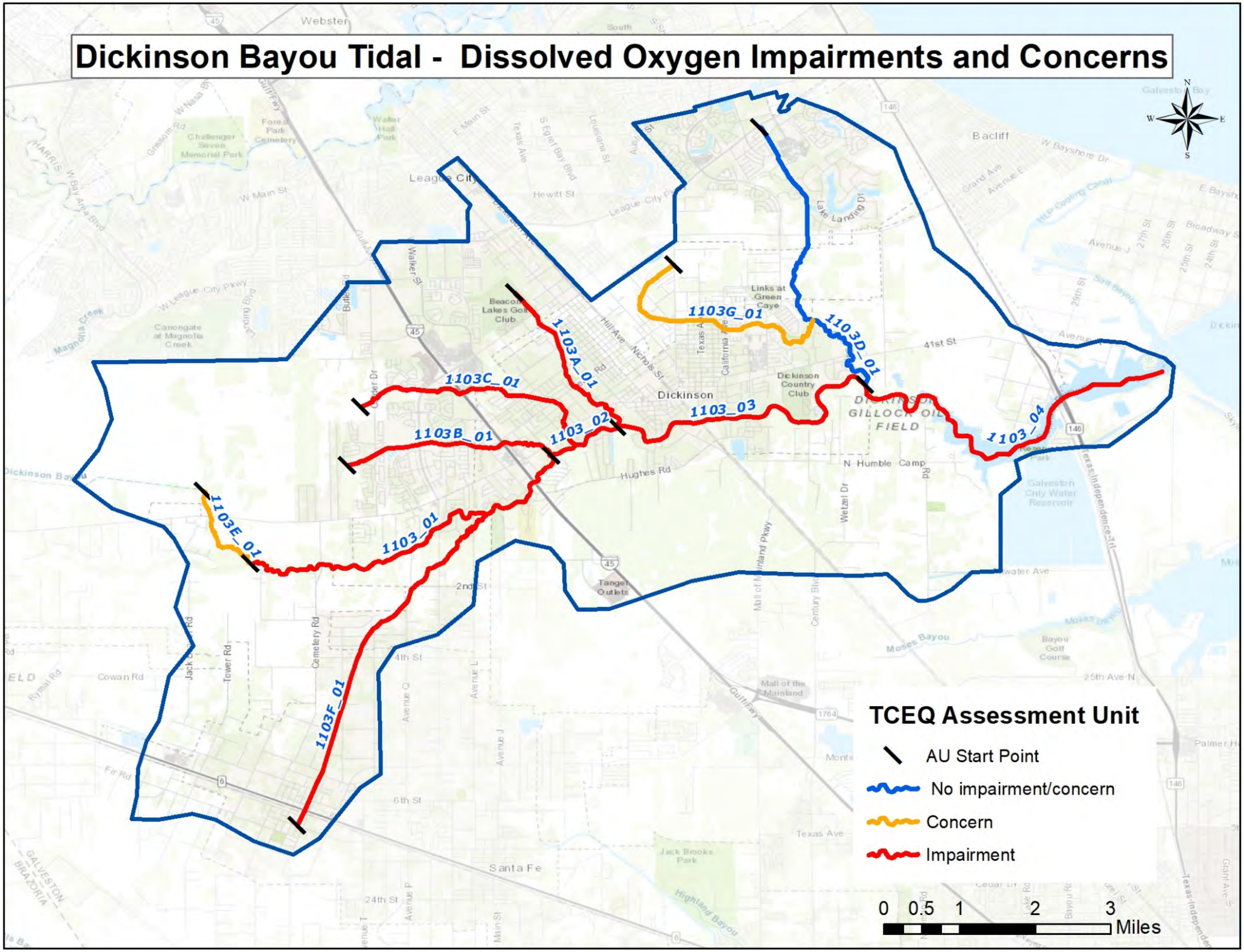
Nutrient Concerns

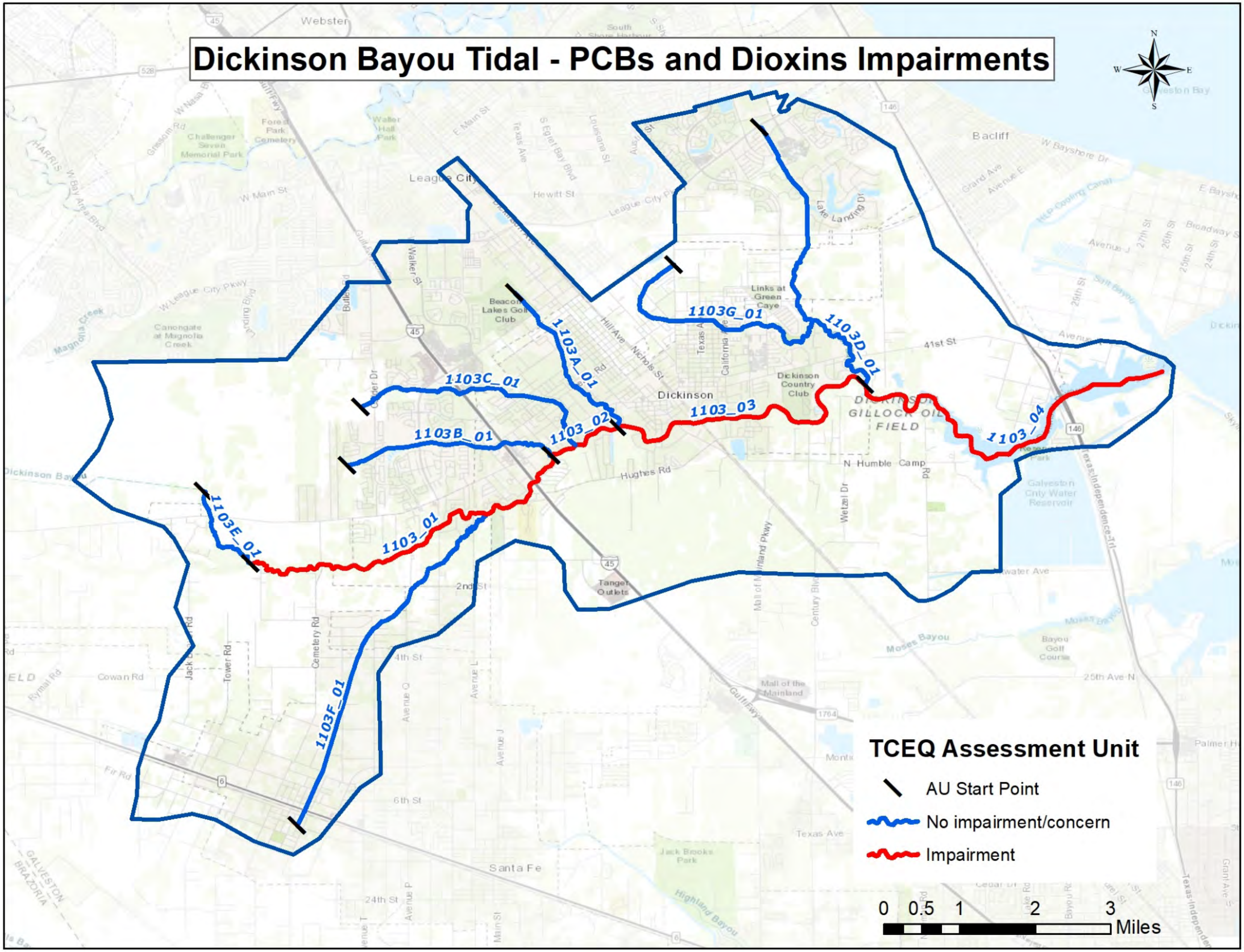
There are no nutrient concerns in this segment.

PCBs and Dioxin Impairments

Dickinson Bayou Tidal is listed as impaired for PCBs and Dioxins in all species of catfish.


Dickinson Bayou Tidal - Bacteria Impairments and Concerns
1103G_01
1103D_01
1103A_01
1103C_01
1103_03
1103_02
1103B_01
1103_04
1103E_01
1103_01
1103F_01
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0 0.5 1 2 3
Miles


Dickinson Bayou Tidal - Dissolved Oxygen Impairments and Concerns
1103A_01
1103B_01
1103C_01
1103D_01
1103E_01
1103F_01
1103G_01
1103_01
1103_02
1103_03
1103_04
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0 0.5 1 2 3
Miles


Dickinson Bayou Tidal - PCBs and Dioxins Impairments
1103G_01
1103D_01
1103A_01
1103C_01
1103B_01
1103_02
1103_03
1103_04
1103_01
1103E_01
1103F_01
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0 0.5 1 2 3
Miles

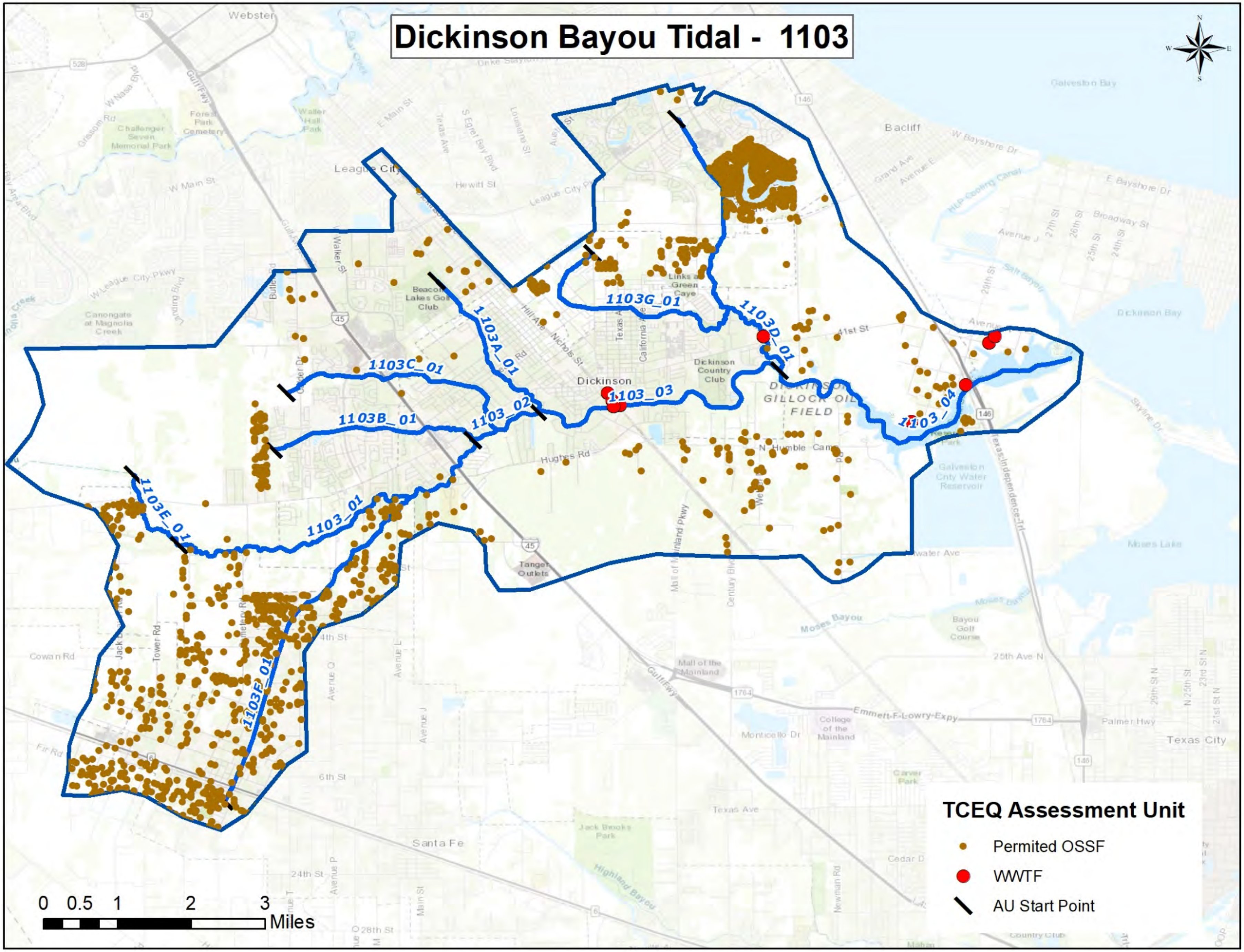
Potential Sources of Water Quality Issues: Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Dickinson Bayou Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 9 permitted wastewater outfalls in the Dickinson Bayou Tidal watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal, with 1,285 permitted systems located within the watershed. The wastewater treatment facilities and on-site sewage facilities in the Dickinson Bayou Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 11 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Dickinson Bayou Tidal watershed.



Dickinson Bayou Tidal - 1103
1103A_01
1103B_01
1103C_01
1103D_01
1103E_01
1103F_01
1103G_01
1103_01
1103_02
1103_03
1103_04
TCEQ Assessment Unit
Permited OSSF
WWTF
AU Start Point
0 0.5 1 2 3
Miles

Trend Analysis:

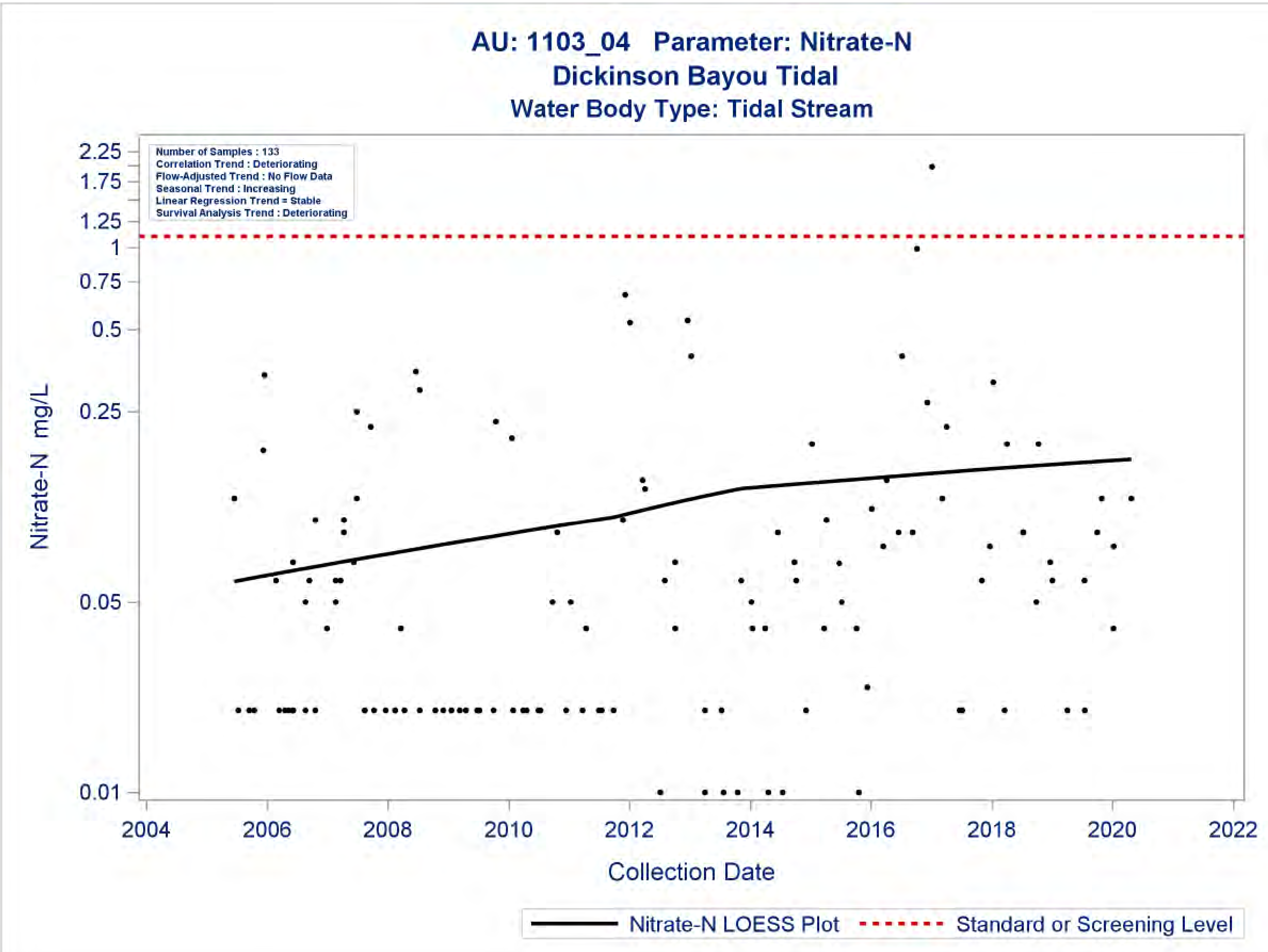
Analysis of water quality data for Dickinson Bayou Tidal revealed eight parameter trends but only a few were significant. Seven parameter trends were detected for the main segment and seven different parameter trends were detected in the unclassified tributaries. Cedar Creek (1003E) was the only unclassified segment with trends for six parameters, the other unclassified segments had no more than two parameter trends. The notable trends included increasing total suspended solids (TSS), decreasing concentrations of total Kjeldahl nitrogen (TKN), decreasing Specific Conductance, and increasing nitrate in assessment unit (AU) 1103_04 only.

Unclassified segments Benson Bayou (1103A) and Gum Bayou (1103D) both show decreasing trends in TKN concentrations. While decreasing Specific Conductance has been trending in four of the unclassified segments since around 2015 – Bordens (1103B), Geisler (1103C), and Gum Bayou (1103D), and Cedar Creek 1103E). This is possibly related to increased rainfall events since that time.

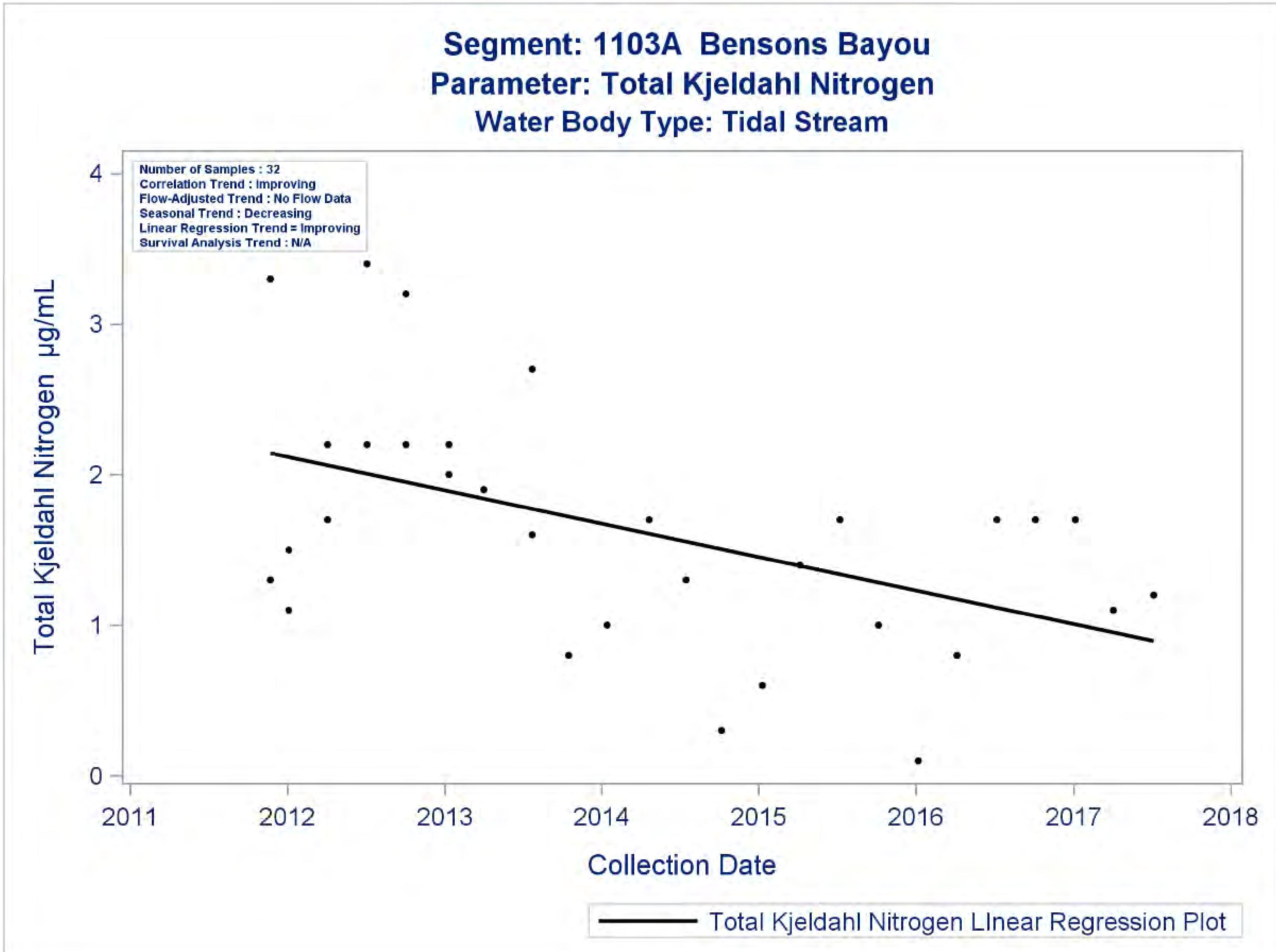
Unclassified segment 1103E (Cedar Creek) is a very rural watershed and is showing trends with decreasing chlorides and sulfate but is experiencing increased total phosphorus concentrations over time. Cedar Creek is also experiencing increased TSS loading which in turn is decreasing the Secchi transparency measurements confirming more turbid water over time.

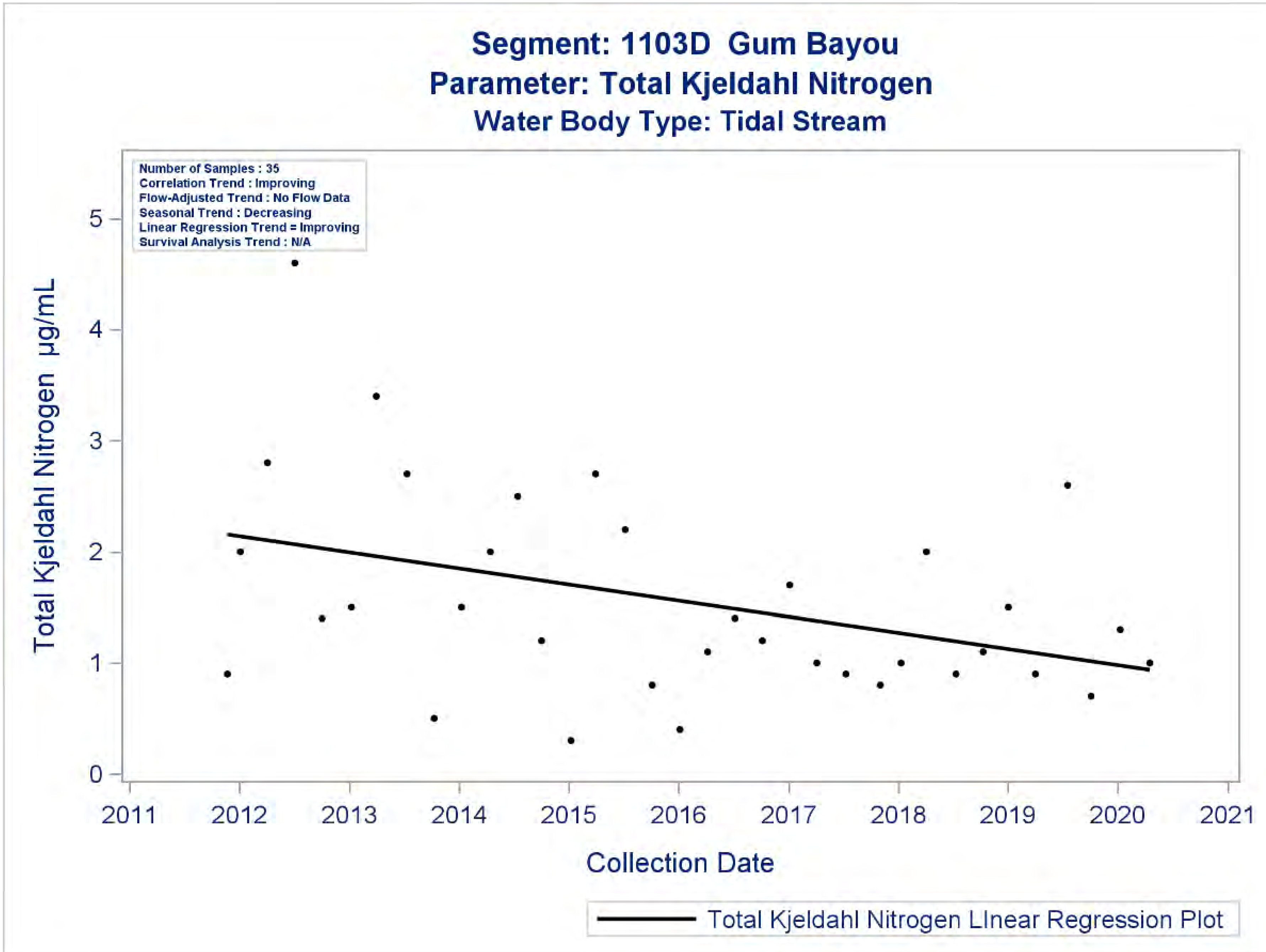
Unclassified segment 1103F (Unnamed Tributary of Dickinson Bayou Tidal) has a data gap between 2009 and 2013 so there are no reportable trends.

The entire Dickinson Bayou Tidal watershed is designated as impaired for bacteria. Currently, the enterococci trend is stable with majority of bacteria samples still exceeding the state standard for contact recreation.

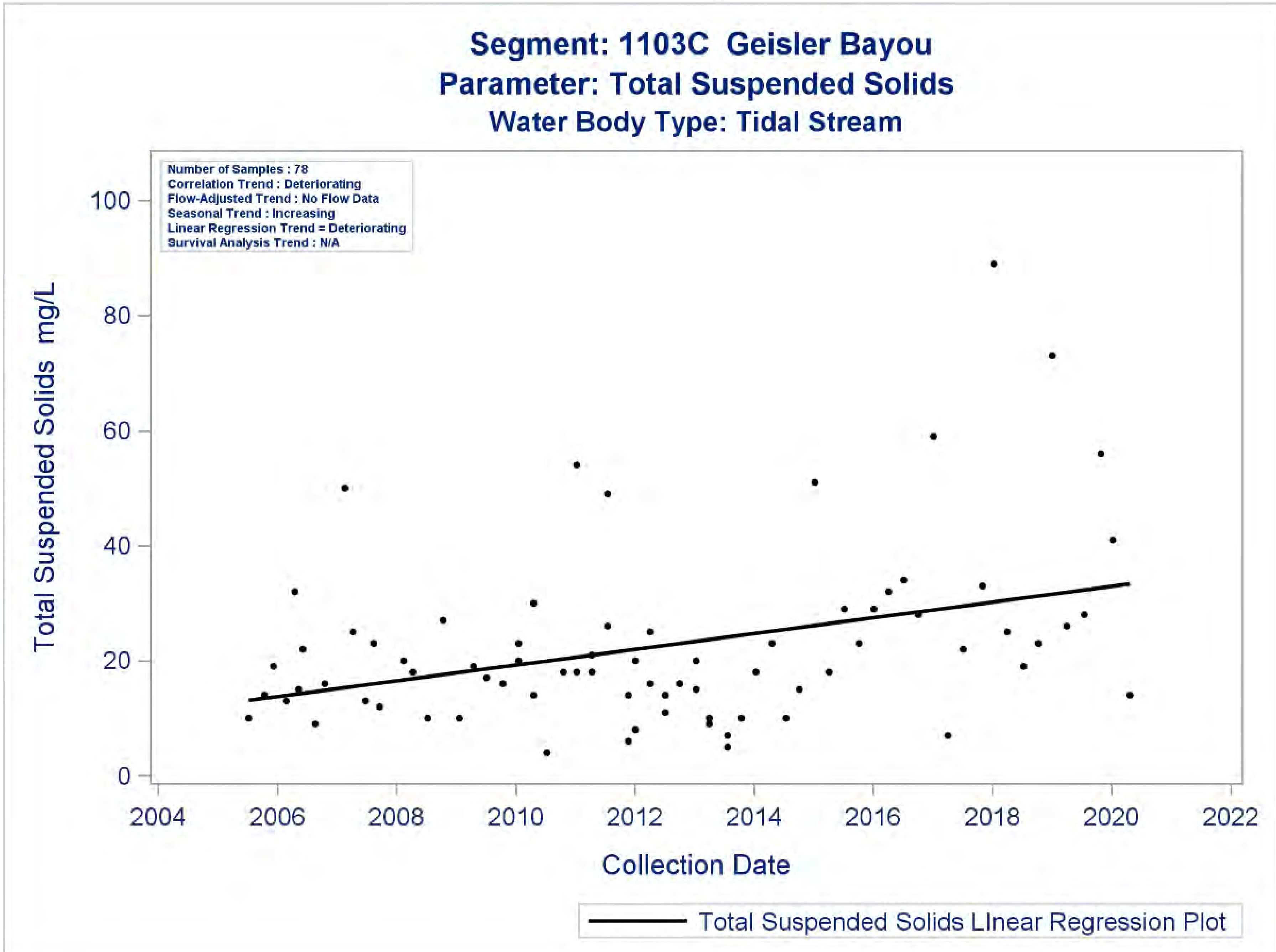


AU: 1103_04 Parameter: Nitrate-N
Dickinson Bayou Tidal
Water Body Type: Tidal Stream
Number of Samples : 133
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
2.25
1.75
1.25
1
0.75
0.5
0.25
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

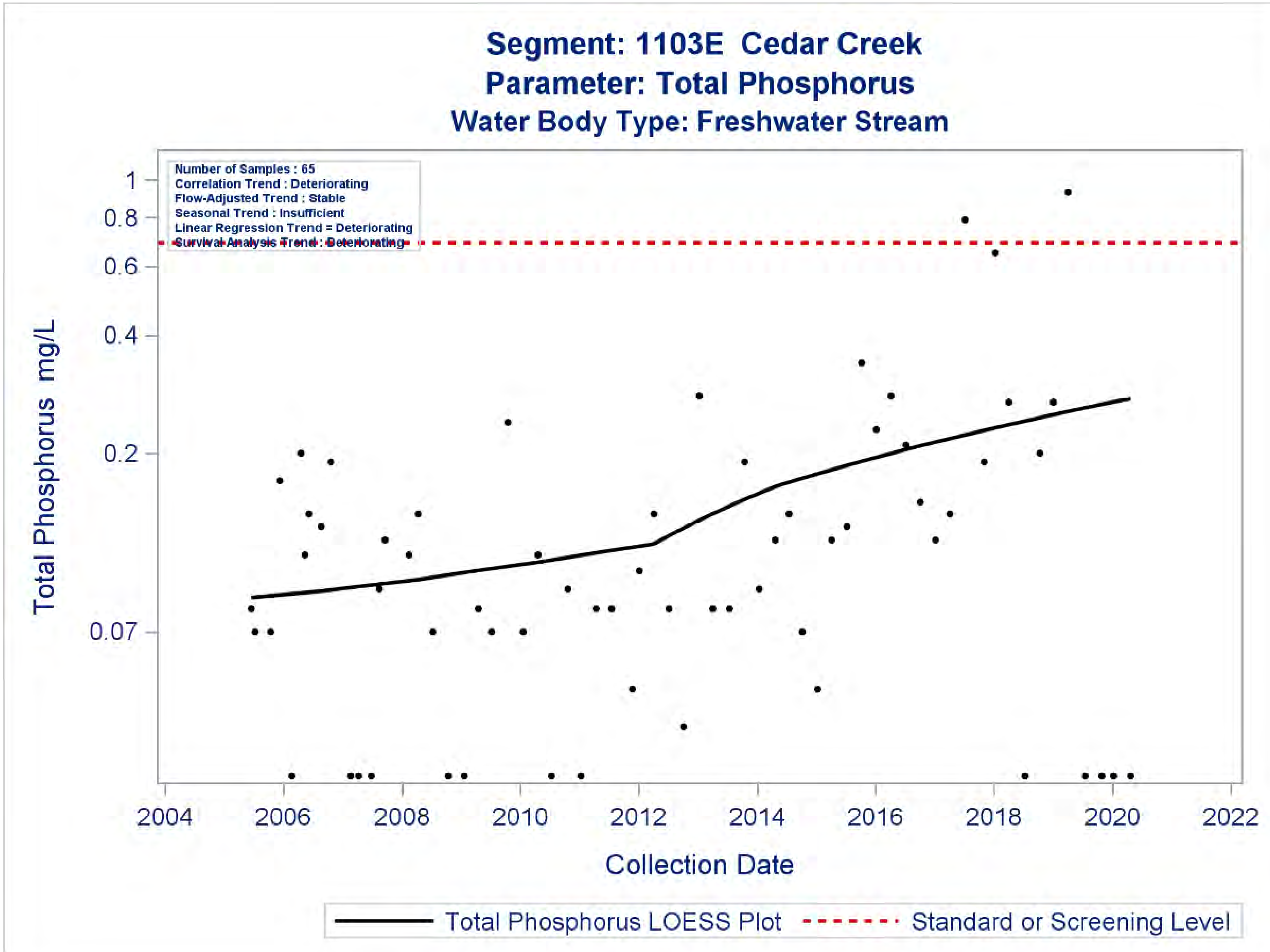

Segment: 1103A Bensons Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 32
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



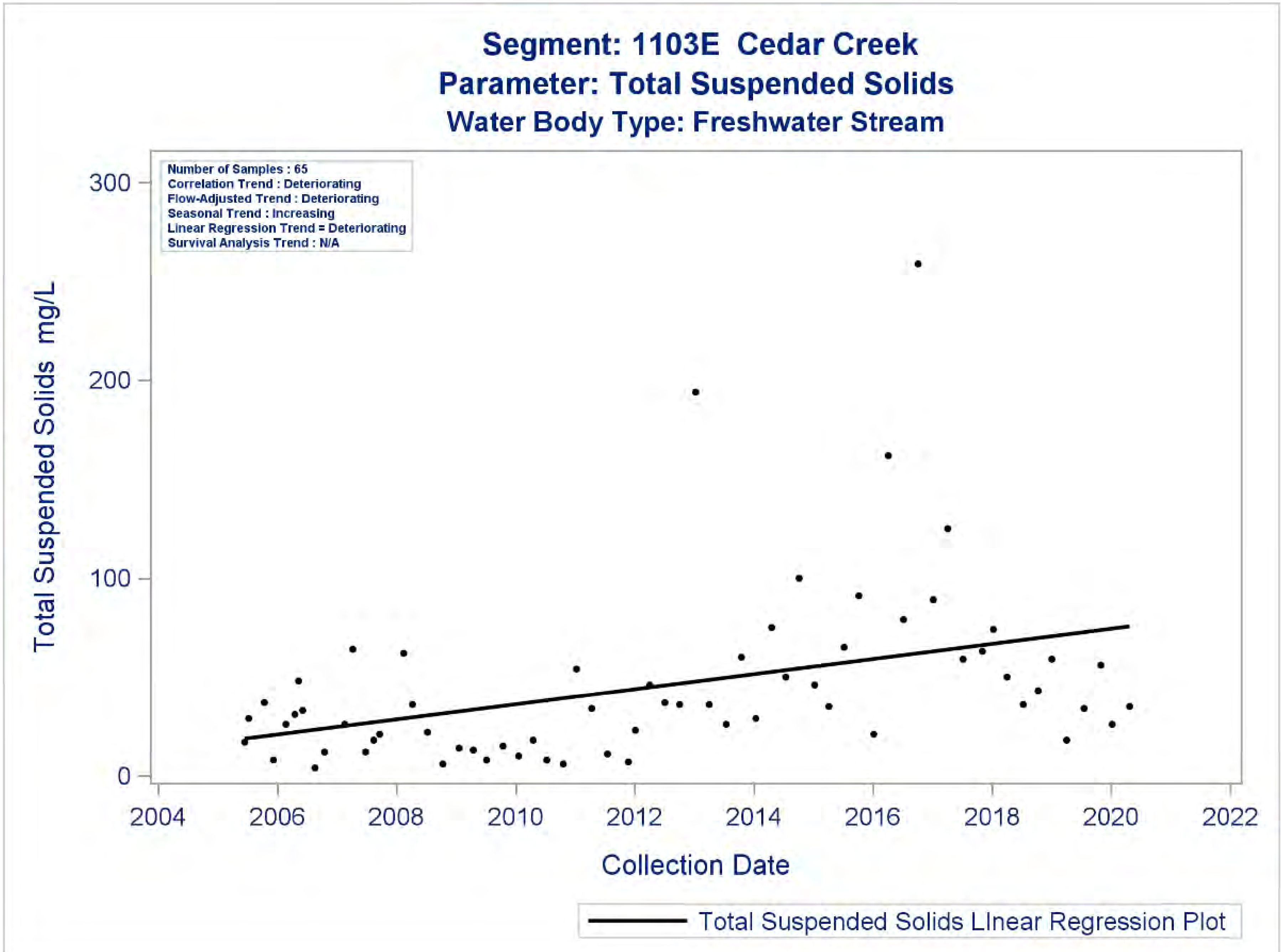
Segment: 1103D Gum Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 35
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot

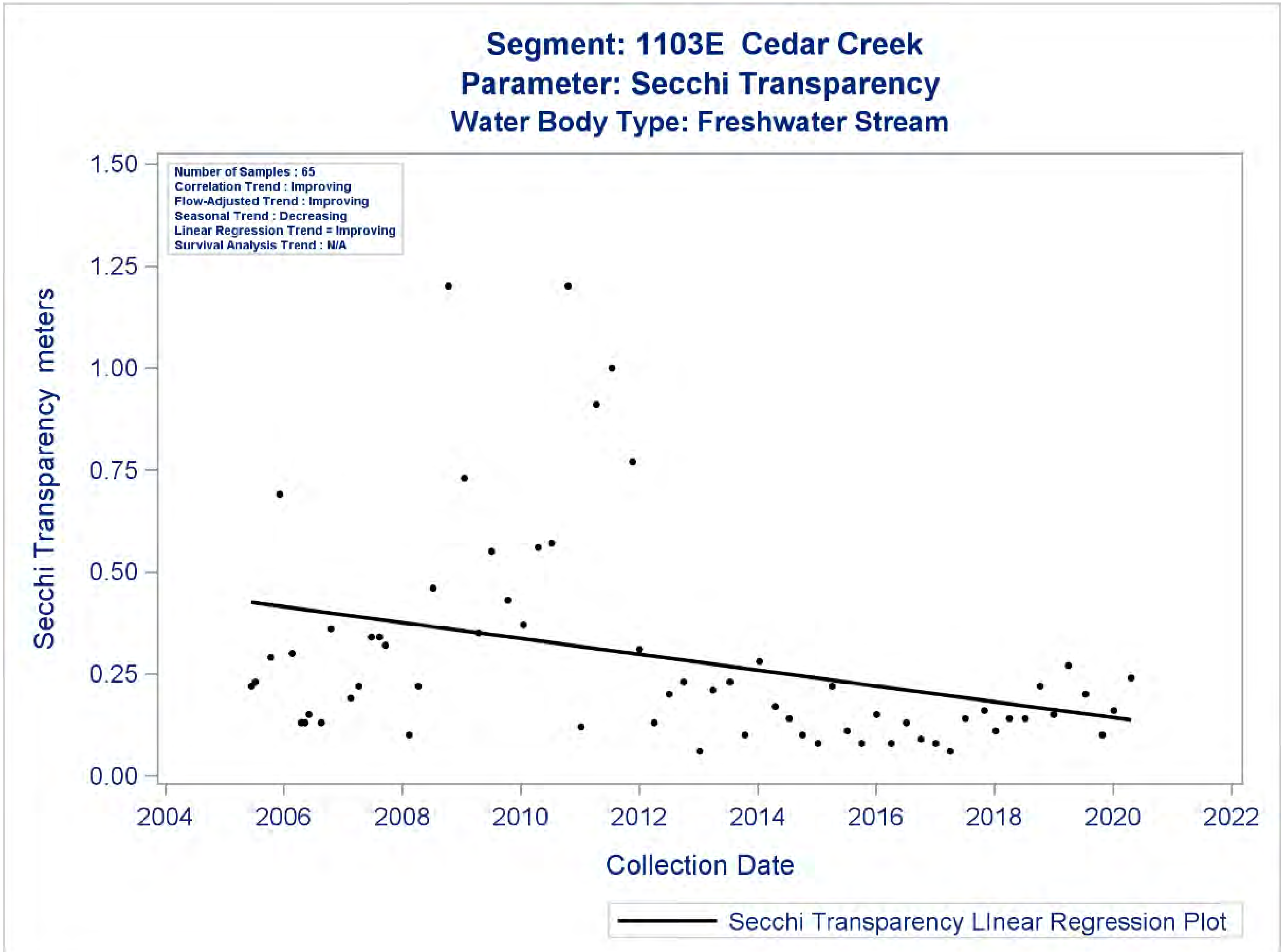


Segment: 1103C Geisler Bayou
Parameter: Total Suspended Solids
Water Body Type: Tidal Stream
Number of Samples : 78
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
20
40
60
80
100
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot



Segment: 1103E Cedar Creek
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 65
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Total Phosphorus mg/L
1
0.8
0.6
0.4
0.2
0.07
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


Segment: 1103E Cedar Creek
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 65
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
300
200
100
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot



Segment: 1103E Cedar Creek
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 65
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1103 I 1103A I 1103B I 1103C I 1103D I 1103E I 1103F I 1103G I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Animal waste from agricultural production and domestic animal facilities • WWTF non-compliance, overflows, and collection system by-passes • Poorly operated or undersized WWTFs • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Improper or no pet waste disposal • Developments with malfunctioning OSSFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education on pet waste disposal • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs
Low Dissolved Oxygen Concentrations	***DO Grab Min*** 1103_01 I 1103_04 I 1103A_01 I 1103B_01 I 1103C_01 I 1103F_01 I ***DO Grab Screening***	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, sanitary sewer overflows, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste, such as grass clippings and pet waste	• Detrimental effect on aquatic biological community	• Install and/or maintain riparian buffer areas between agricultural fields and waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Improve compliance and enforcement of existing stormwater quality permits • Improve operation and maintenance of existing WWTF and collection systems

	1103_04 C 1103A_01 C 1103B_01 C 1103C_01 C 1103E_01 C 1103F_01 C 1103G_01 C ***DO 24hr Avg*** 1103_02 I 1103_03 I ***DO 24hr Min*** 1103_02 I 1103_03 I	▪ High temperature discharges from industrial WWTFs		• Regionalize chronically non-compliant WWTFs • More public education regarding disposal of household fats, oils, and grease • More public education on pet waste disposal • More public education about OSSF maintenance
Dioxin/PCBs in Fish Tissue	1103 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge • Concentrated deposits outside boundaries of the waste pits located adjacent to San Jacinto River and I-10 bridge	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

The TCEQ conducted a Total Maximum Daily Load project to protect recreational uses and restore water quality in Dickinson Bayou. The initial TMDL project addressed bacteria impairments in Segments 1103 (Dickinson Bayou Tidal) and 1104 (Dickinson Bayou Above Tidal), as well as three of the tributaries — 1103A (Bensons Bayou), 1103B (Bordens Gully), and 1103C (Giesler Bayou). In 2016, the TMDL was updated to add a portion of Dickinson Bayou Tidal (AU 1103_01) and two additional tributaries, 1103D (Gum Bayou) and 1103E (Cedar Creek) which were not addressed in the initial TMDL project.

The TCEQ adopted the first TMDLs on February 8, 2012, and these TMDLs were approved by the EPA on June 6, 2012. The final I-Plan for this project was approved by TCEQ on January 15, 2014. An addendum to the original TMDL, adding Gum Bayou, Cedar Creek, and AU 1103_01 of Dickinson Bayou Tidal, was adopted by TCEQ and incorporated into the State's Water Quality Management Plan in July 2016, with EPA approval of the addendum on September 30, 2016.

For more information on this project, please refer to https://www.tceq.texas.gov/waterquality/tmdl/80-dickinsonbayoubacteria.html or the website of the Dickinson Bayou Watershed Partnership (https://agrilife.org/dickinsonbayou/).

Segment 1103 was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to work with Texas AgriLife and local stakeholders to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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 Total Maximum Daily Load program and watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 1111 Name: Old Brazos River Channel Tidal

Length:	6 miles	**Watershed Area:**	30 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	1	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	32

DESCRIPTION

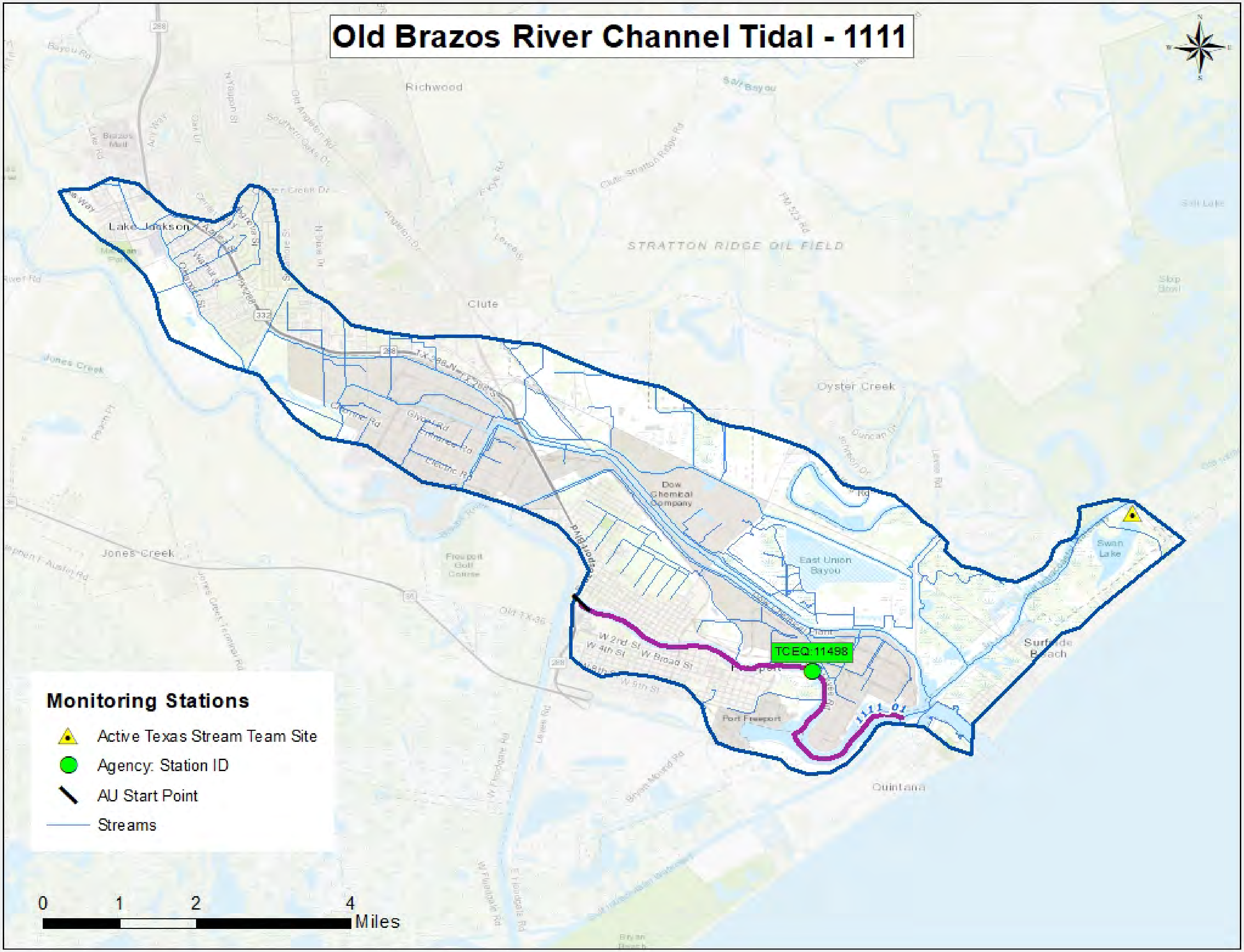
- Segment 1111: **Old Brazos River Channel Tidal** (classified water body) – From the Intracoastal Waterway confluence to SH 288 in Brazoria County

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11498	1111	OLD BRAZOS RIVER CHANNEL MID-WAY BETWEEN MOUTH AND TERMINUS 1453 METERS DOWNSTREAM FR FM 1495	FO	Quarterly One/Year	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment

FO = TCEQ Regional Office

Old Brazos River Channel Tidal - 1111

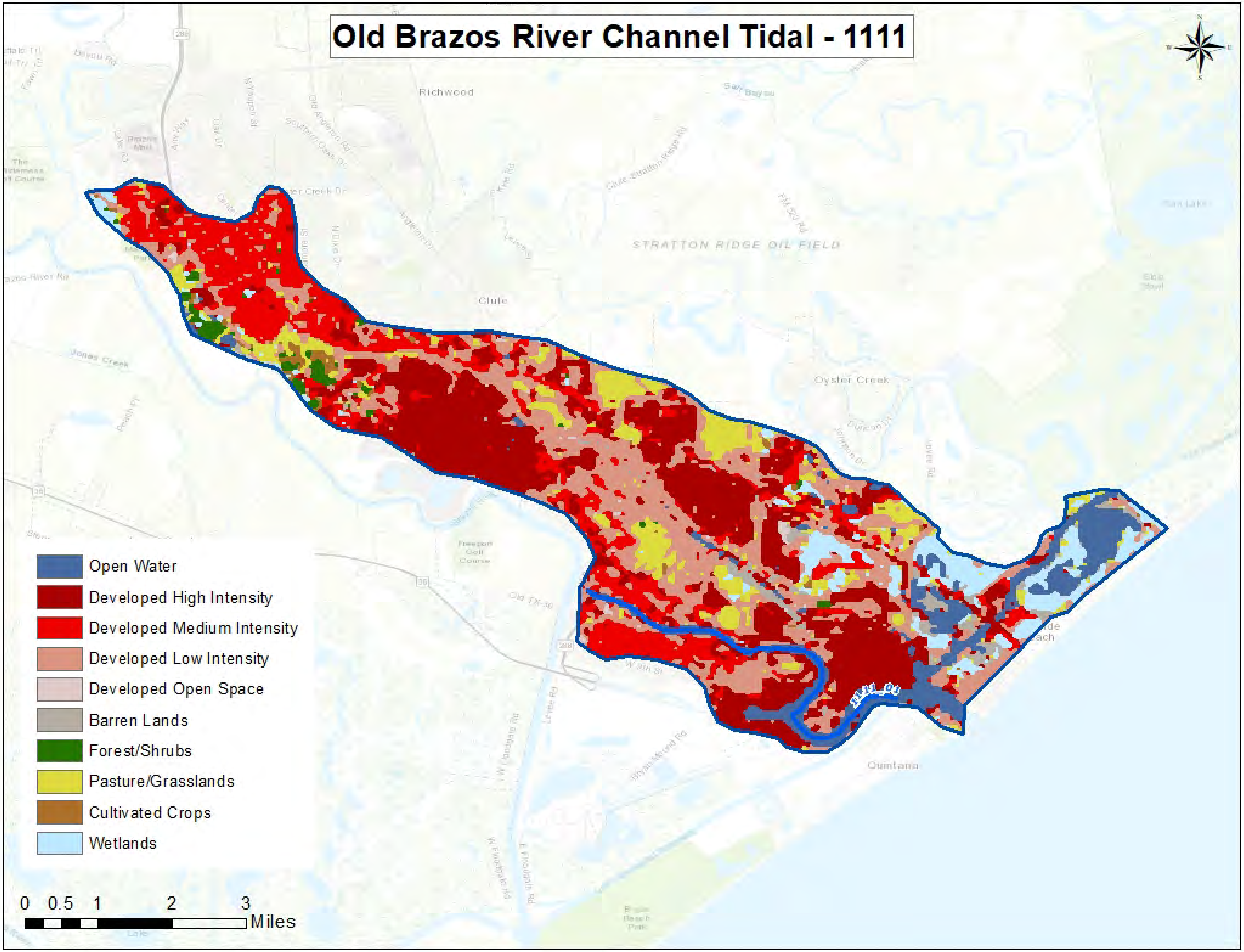


Segment 1111 Water Quality Standards and Screening Levels			
Standards	**Tidal Stream**	**Screening Levels**	**Tidal Stream**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.46
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.66
Enterococci (MPN/100mL) (grab):	104	Chlorophyll *a* (µg/L):	21.0
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: This small watershed comprises what was once the mouth of the Brazos River, in southern Brazoria County, and terminates at the Gulf Intracoastal Waterway. The Old Brazos River Channel Tidal watershed is home to the Freeport petrochemical complex, which dominates the landscape. The watershed is predominantly developed (71.28 percent of the watershed). Beachfront residential development along with water recreational activities are present in the lower reaches of the watershed at Surfside Beach and Quintana. There are large expanses of wetlands within and surrounding the watershed.

Segment 1111 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	1,267.64	6.80	1,932.38	10.37	52.44
Barren Lands	308.02	1.65	468.81	2.51	52.20
Developed	10,616.18	56.98	13,288.02	71.28	25.17
Forest/Shrubs	136.77	0.73	233.29	1.25	70.57
Open Water	1,922.59	10.32	1,493.15	8.01	-22.34
Wetlands	4,379.82	23.51	1,225.83	6.58	-72.01
TOTAL	**18,631.02**	**100.00**	**18,641.47**	**100.00**	


Old Brazos River Channel Tidal - 1111
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.5 1 2 3
Miles
Richwood
Clute
Oyster Creek
STRATTON RIDGE OIL FIELD
Quintana

Water Quality Issues:

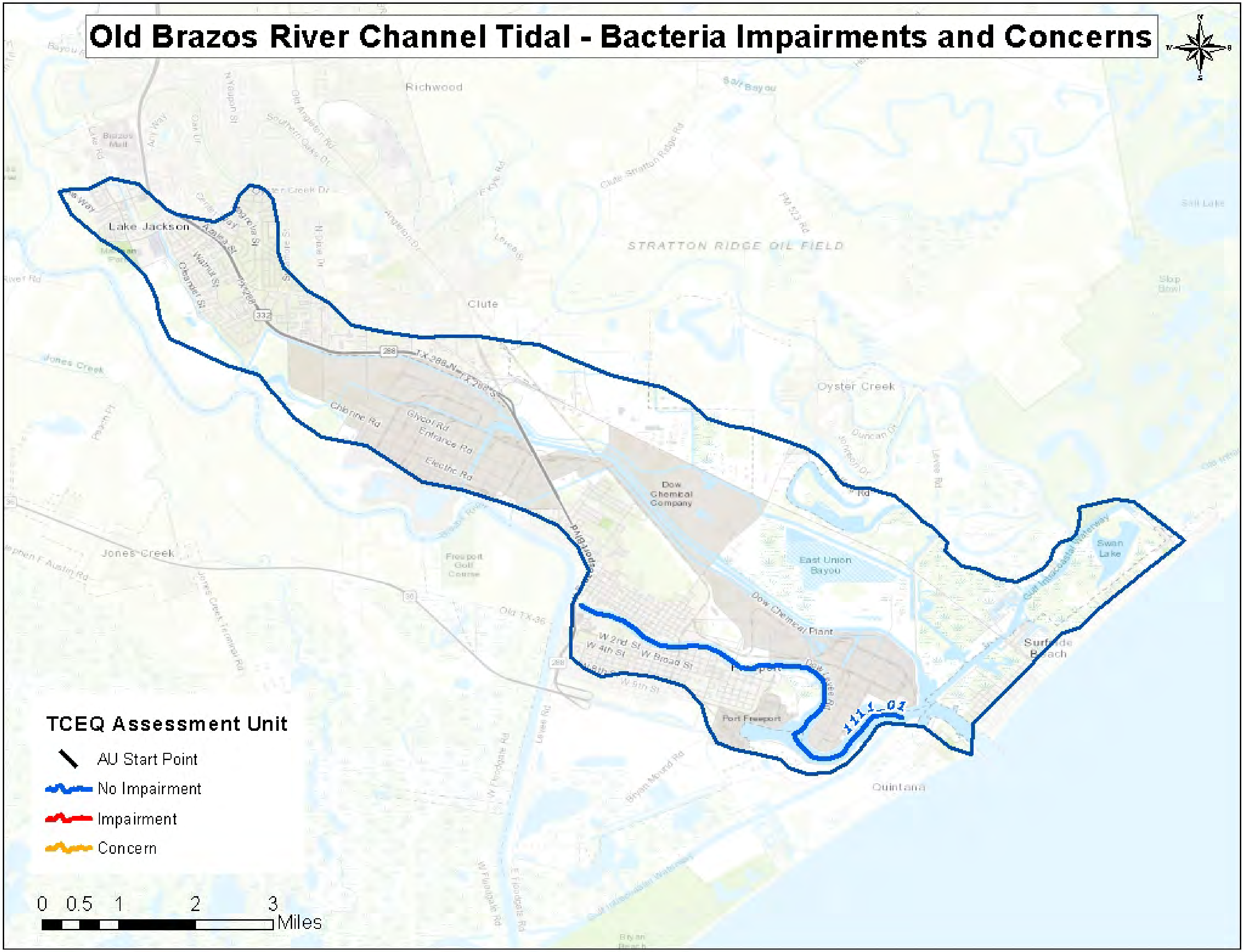
There were no impairments or concerns for the Old Brazos River Channel (1111) segment identified in the 2020 Integrated Report.

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

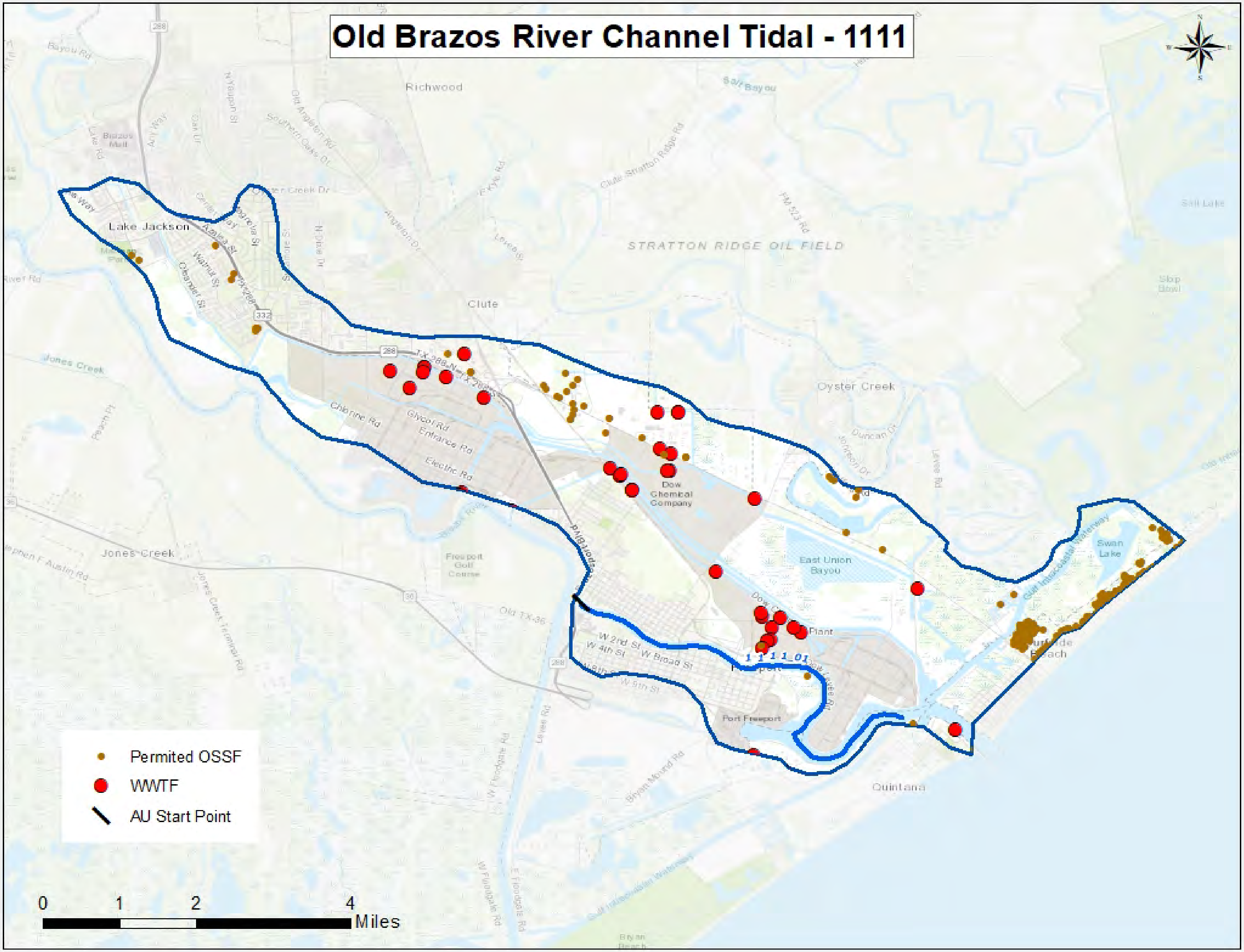

Old Brazos River Channel Tidal - Bacteria Impairments and Concerns
Richwood
Lake Jackson
Clute
STRATTON RIDGE OIL FIELD
Oyster Creek
Dow Chemical Company
East Union Bayou
Dow Chemical Plant
Swan Lake
Surfside Beach
Jones Creek
Freeport Golf Course
Port Freeport
Quintana
1111_01
TCEQ Assessment Unit
AU Start Point
No Impairment
Impairment
Concern
0 0.5 1 2 3
Miles

Potential Sources of Water Quality Issues: There are currently no impairments or concerns for bacteria or nutrients. However, there are potential sources of both that still need to be monitored and evaluated. Potential sources of fecal indicator bacteria and nutrients in the Old Brazos River Channel Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 32 permitted wastewater outfalls in the Old Brazos River Channel Tidal watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 253 of these systems in the watershed, with the majority predominantly located near the coast. The wastewater treatment facilities and on-site sewage facilities in the Old Brazos River Channel Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 7 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

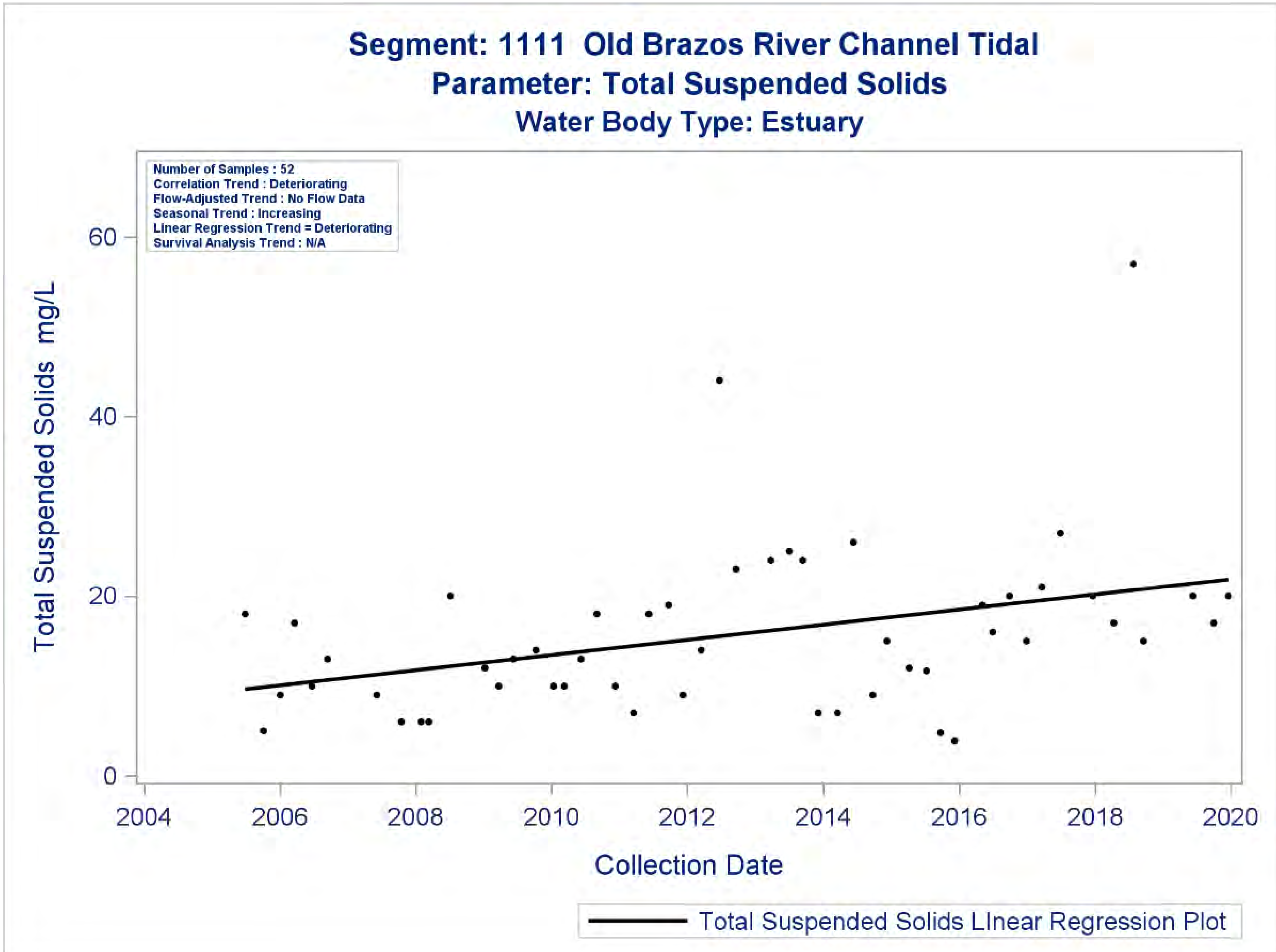
For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Old Brazos River Channel Tidal watershed.

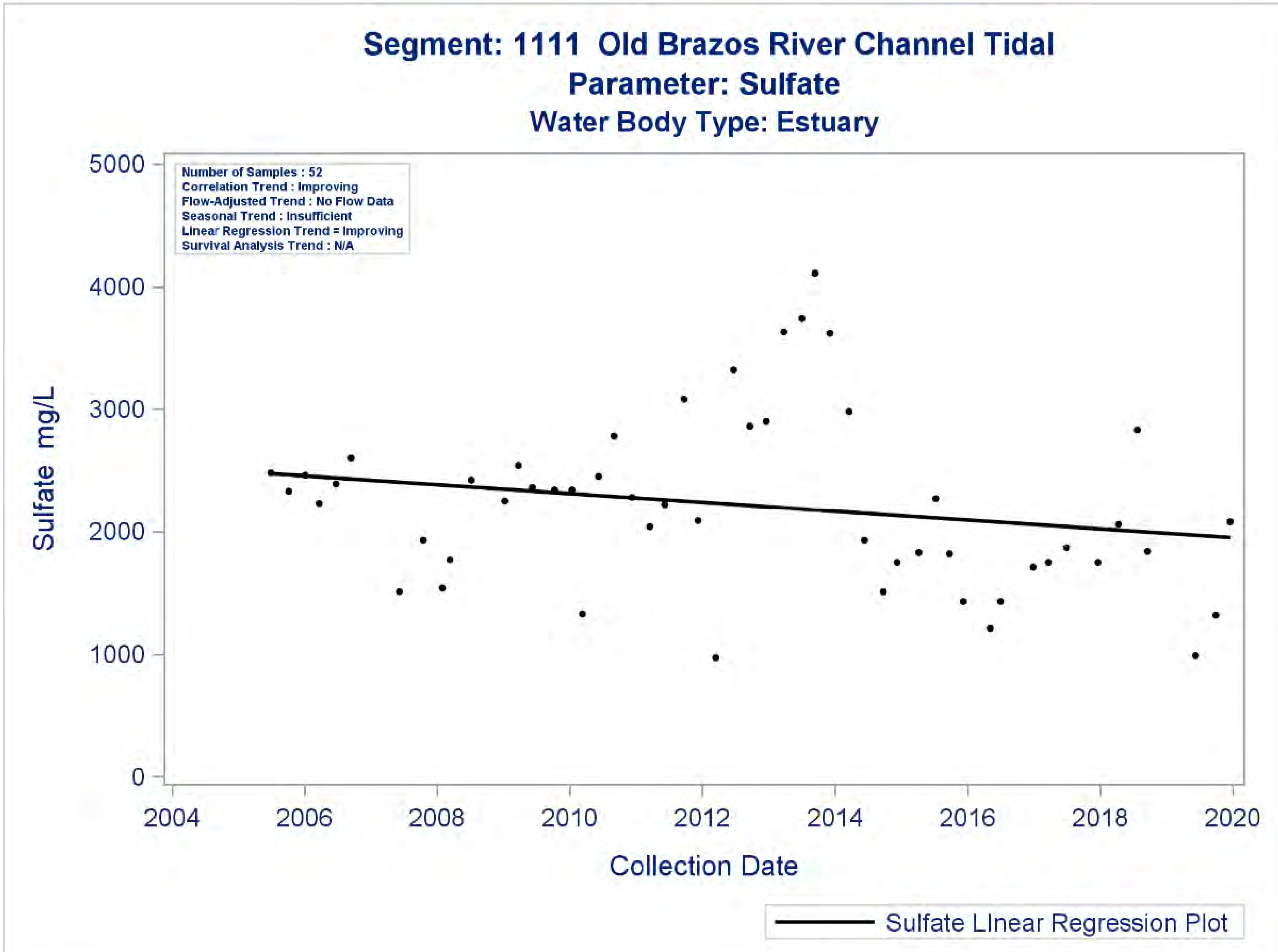

Old Brazos River Channel Tidal - 1111
Permited OSSF
WWTF
AU Start Point
0
1
2
4
Miles
Lake Jackson
Richwood
Clute
STRATTON RIDGE OIL FIELD
Oyster Creek
Jones Creek
Dow Chemical Company
East Union Bayou
Swan Lake
Port Freeport
Quintana
1111_01

Trend Analysis:

Regression analysis of water quality data for the tidal portion of Old Brazos River Channel (1111) revealed two parameter trends including increasing concentrations of total suspended solids and decreasing sulfate concentrations. Currently, no water quality impairments or concerns are listed in the 2020 Texas Integrated Report of Surface Water Quality for this water body.

Common water quality concerns throughout the region include elevated levels of bacteria and nutrients, as well as low dissolved oxygen, but these issues have not been observed in 1111. The majority of measurements for enterococci collected since 2005 were below the state water quality standard of 35 MPN/100 mL for contact recreation and follow a slightly decreasing trend due to one really high measurement back in 2008. Similarly, nitrate and total phosphorous measurements throughout the period of record mostly fell below their respective screening levels of 1.10 mg/L and 0.66 mg/L. Total phosphorus measurements appear to remain stable over time whereas nitrate slightly increases. Dissolved oxygen has been observed to consistently exceed the minimum standard of 3.00 mg/L in this water body and holds to a stable trend.


Segment: 1111 Old Brazos River Channel Tidal
Parameter: Total Suspended Solids
Water Body Type: Estuary
Number of Samples : 52
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
20
40
60
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Suspended Solids LInear Regression Plot


Segment: 1111 Old Brazos River Channel Tidal
Parameter: Sulfate
Water Body Type: Estuary
Number of Samples : 52
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Sulfate mg/L
5000
4000
3000
2000
1000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Sulfate LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
There were no impairments or concerns identified in this segment.				

Special Studies:

Segment 1111 was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Support public education on pet waste disposal

Segment Number:	1110	Name:	Oyster Creek Above Tidal

Length:	78 miles	Watershed Area:	167 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	4	Texas Stream Team Monitoring Stations:	1	Permitted WWTF Outfalls:	17

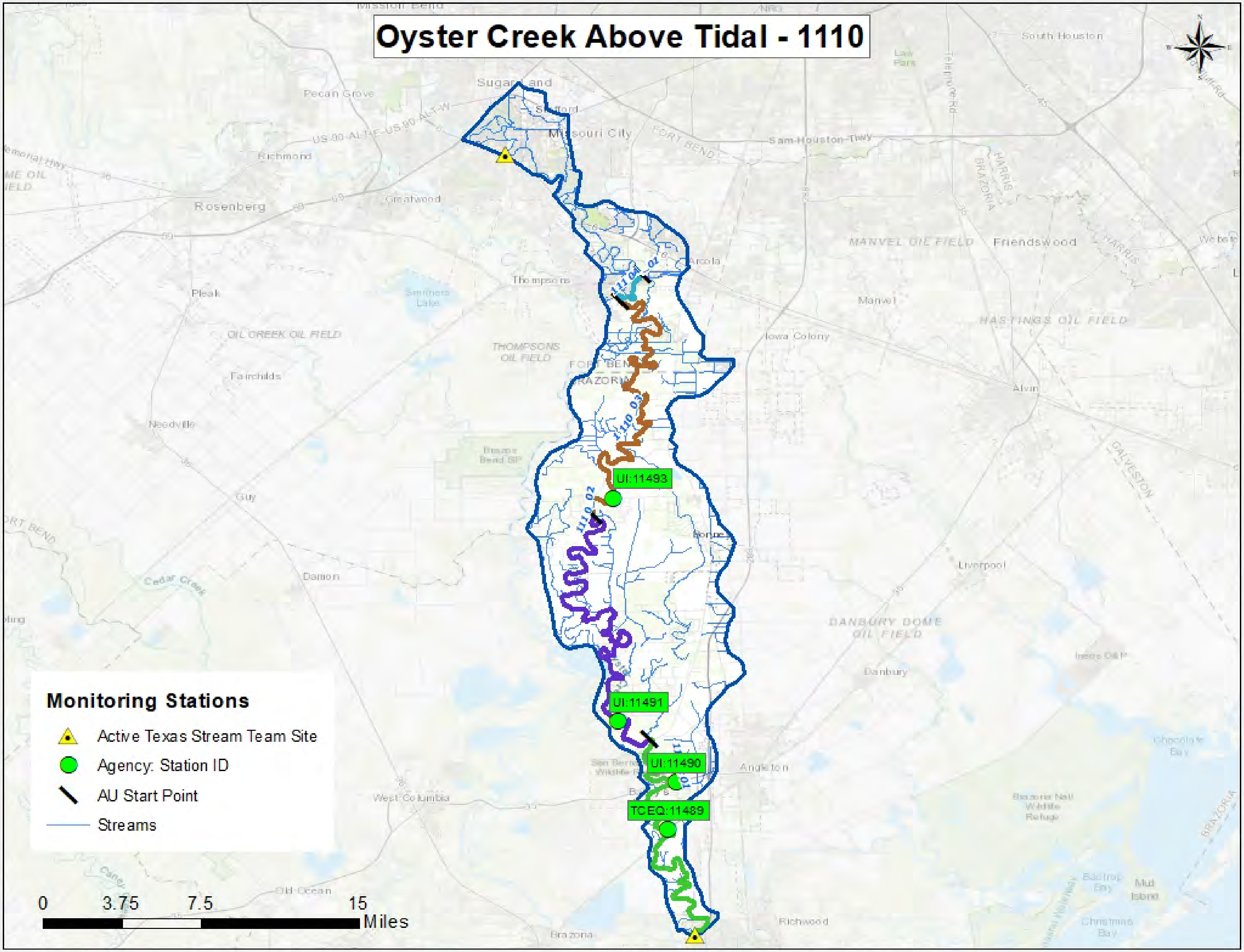
DESCRIPTION

- Segment 1110: **Oyster Creek Above Tidal** (classified water body) – From a point 100 meters (110 yards) upstream of FM 2004 in Brazoria County to a point 4.3 km (2.7 mi) upstream of Scanlan Road in Fort Bend County

- Segment 1110A (Perennial Stream w/ high ALU): **Upper Oyster Creek Above Tidal** (unclassified water body) – From a point 4.3 km (2.7 mi) upstream of Scanlan Road in Fort Bend County upstream to the confluence with Middle Oyster Creek approximately 325 m south of McKeever Road In Fort Bend County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11489	1110	OYSTER CREEK 15 METERS DOWNSTREAM FROM WALKER ST CO ROAD 290 NEAR WARD LAKE	FO	Quarterly	Field, Conventional, Bacteria
11490	1110	OYSTER CREEK IMMEDIATELY DOWNSTREAM OF SH 35 WEST OF ANGLETON	UI	Quarterly	Field, Conventional, Bacteria, Flow
11491	1110	OYSTER CREEK AT SIMS RD / BRAZORA CR 30 WEST OF ANGLETON	UI	Monthly, Quarterly	Field, Flow Field, Conventional, Bacteria, Flow
11493	1110	OYSTER CREEK AT FM 1462 WEST OF ROSHARON	UI	Monthly Quarterly	Field, Flow Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston



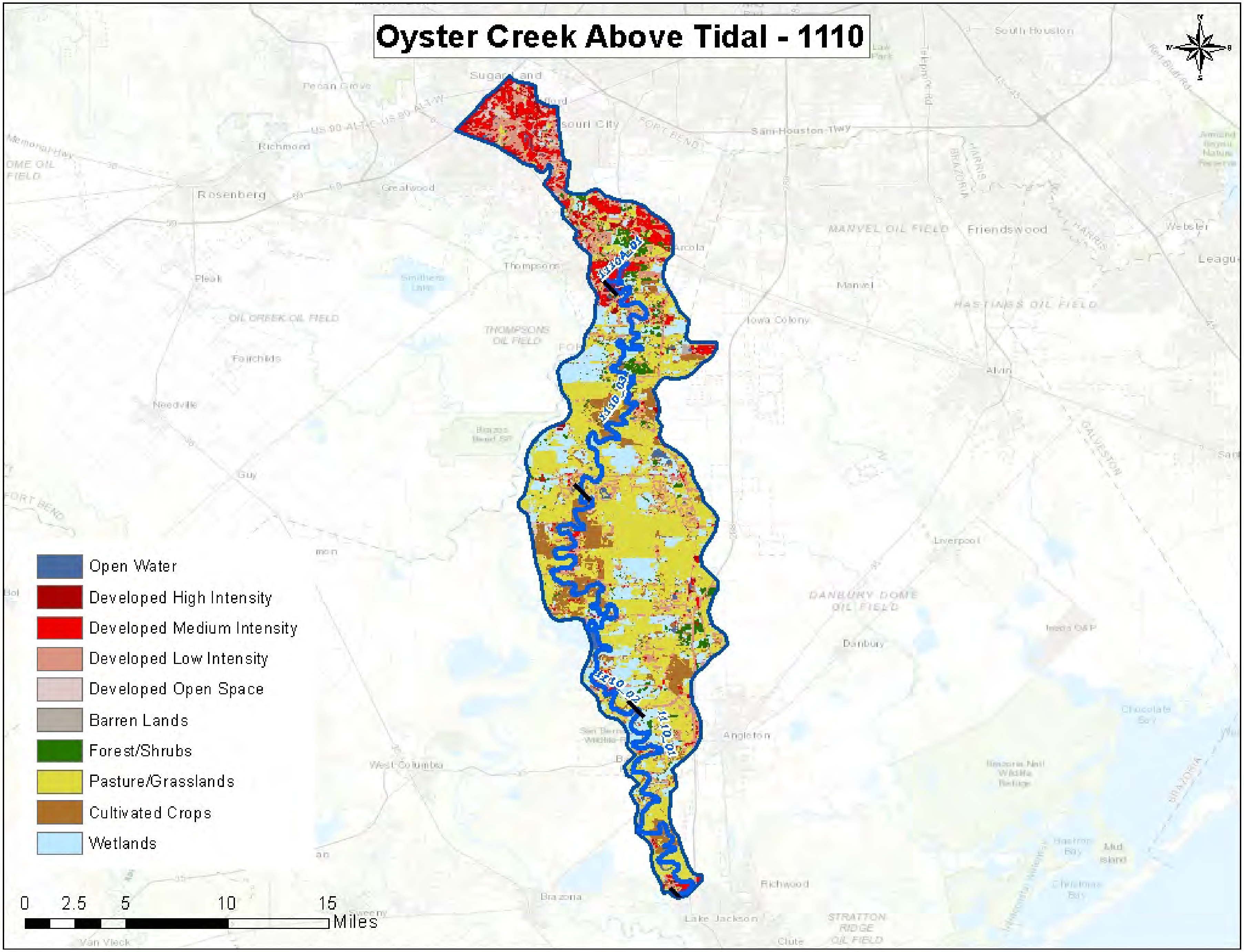
Oyster Creek Above Tidal - 1110
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
3.75
7.5
15
Miles
UI:11493
UI:11491
UI:11490
TCEQ:11489
Sugar Land
Stafford
Missouri City
Pecan Grove
Richmond
Rosenberg
Greatwood
Pleak
Fairchilds
Needville
Guy
Damon
West Columbia
Thompsons
Arcola
Manvel
Iowa Colony
Alvin
Friendswood
South Houston
Liverpool
Danbury
Angleton
Richwood
Brazoria
Bonney
Old Ocean
MANVEL OIL FIELD
HASTINGS OIL FIELD
OIL CREEK OIL FIELD
THOMPSONS OIL FIELD
DANBURY DOME OIL FIELD
Cedar Creek
Smithers Lake
Sam Houston Tlwy

Segment 1110 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	300		
Sulfate (mg/L as SO_4):	150		
Total Dissolved Solids (mg/L):	750		

Segment Discussion

Watershed Characteristics and Land Cover: The Oyster Creek Above Tidal (1110) segment is very sinuous with numerous oxbow lakes. The majority of the watershed is not developed and is used for agricultural purposes, with agriculture land cover at 52.84 percent of the watershed. There are a few pockets of development associated with Arcola, Sienna Plantation, Fresno, Bailey's Prairie, Bonney Village, Angleton, Holiday Lakes, and Lake Jackson. The very top of the watershed is highly developed and is part of Sugar Land and Missouri City. The Texas Department of Correction maintains three correctional facilities within the watershed that support confined animal feeding operations.

Segment 1110 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	61,192.03	57.15	56,576.03	52.84	-7.54
Barren Lands	1,073.94	1.00	261.53	0.24	-75.65
Developed	16,210.27	15.14	25,436.26	23.76	56.91
Forest/Shrubs	1,574.77	1.47	4,030.88	3.76	155.97
Open Water	1,427.77	1.33	1,017.45	0.95	-28.74
Wetlands	25,588.16	23.90	19,753.44	18.45	-22.80
TOTAL	**107,066.93**	**100.00**	**107,075.60**	**100.00**	



Oyster Creek Above Tidal - 1110
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 2.5 5 10 15
Miles
Sugar Land
Missouri City
Richmond
Rosenberg
Arcola
Thompsons
Iowa Colony
Manvel
Friendswood
Alvin
Liverpool
Danbury
Angleton
Richwood
Lake Jackson
Clute
Brazoria
West Columbia
MANVEL OIL FIELD
HASTINGS OIL FIELD
DANBURY DOME OIL FIELD
THOMPSONS OIL FIELD
Fairchilds
Needville
Guy
Pleak

Water Quality Issues:

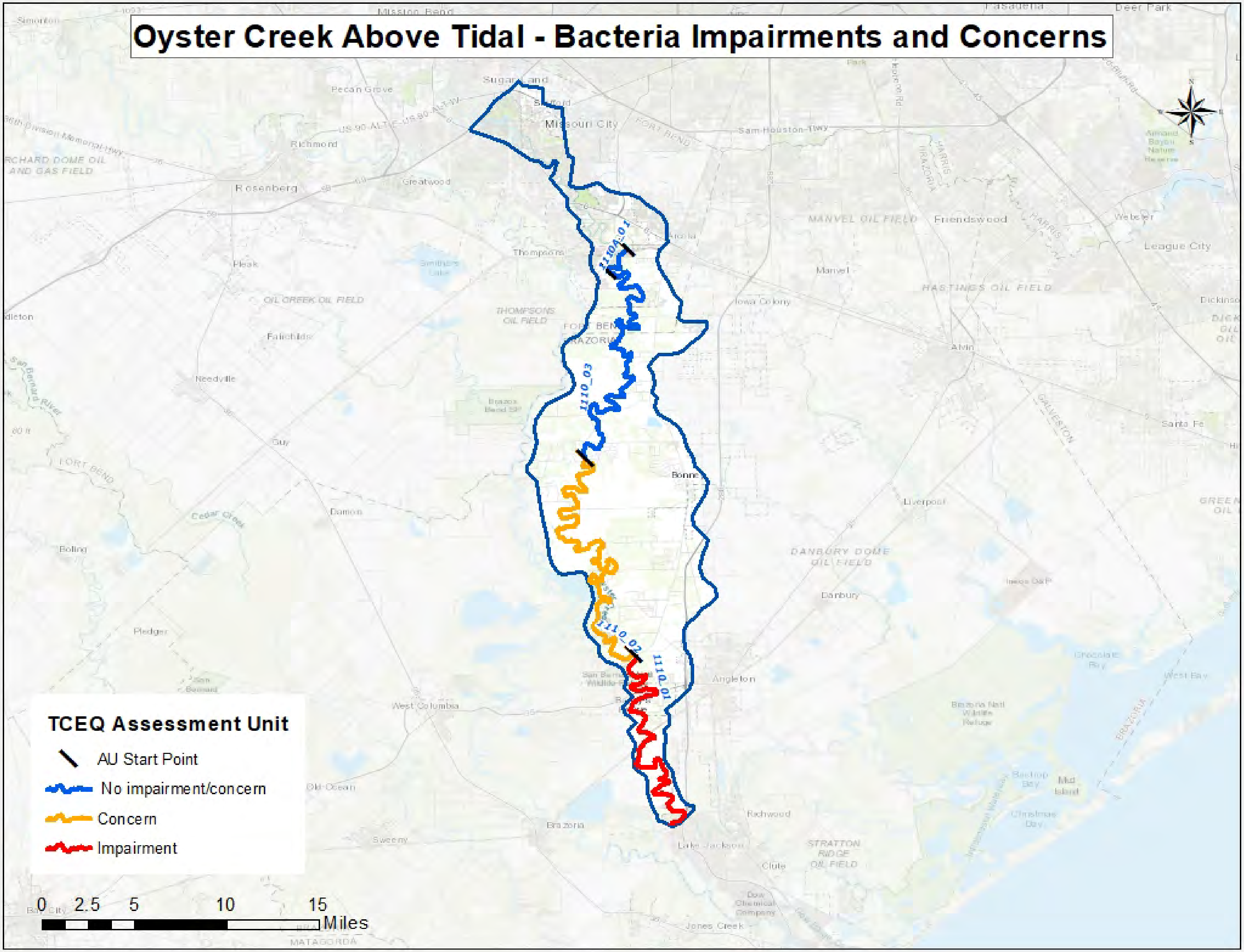
Bacteria Impairments and Concerns
In the 2020 Integrated Report, assessment unit 1110_01 is listed as impaired due to elevated levels of *E. coli* bacteria. In this AU, the bacteria geometric mean was 243.26 MPN/100 mL, which exceeds the water quality standard of 126 MPN/100 mL. A concern was also identified in AU 1110_02, with a geometric mean of 186.52 MPN/100 mL. For this AU, the assessment was based on limited data (9 results).

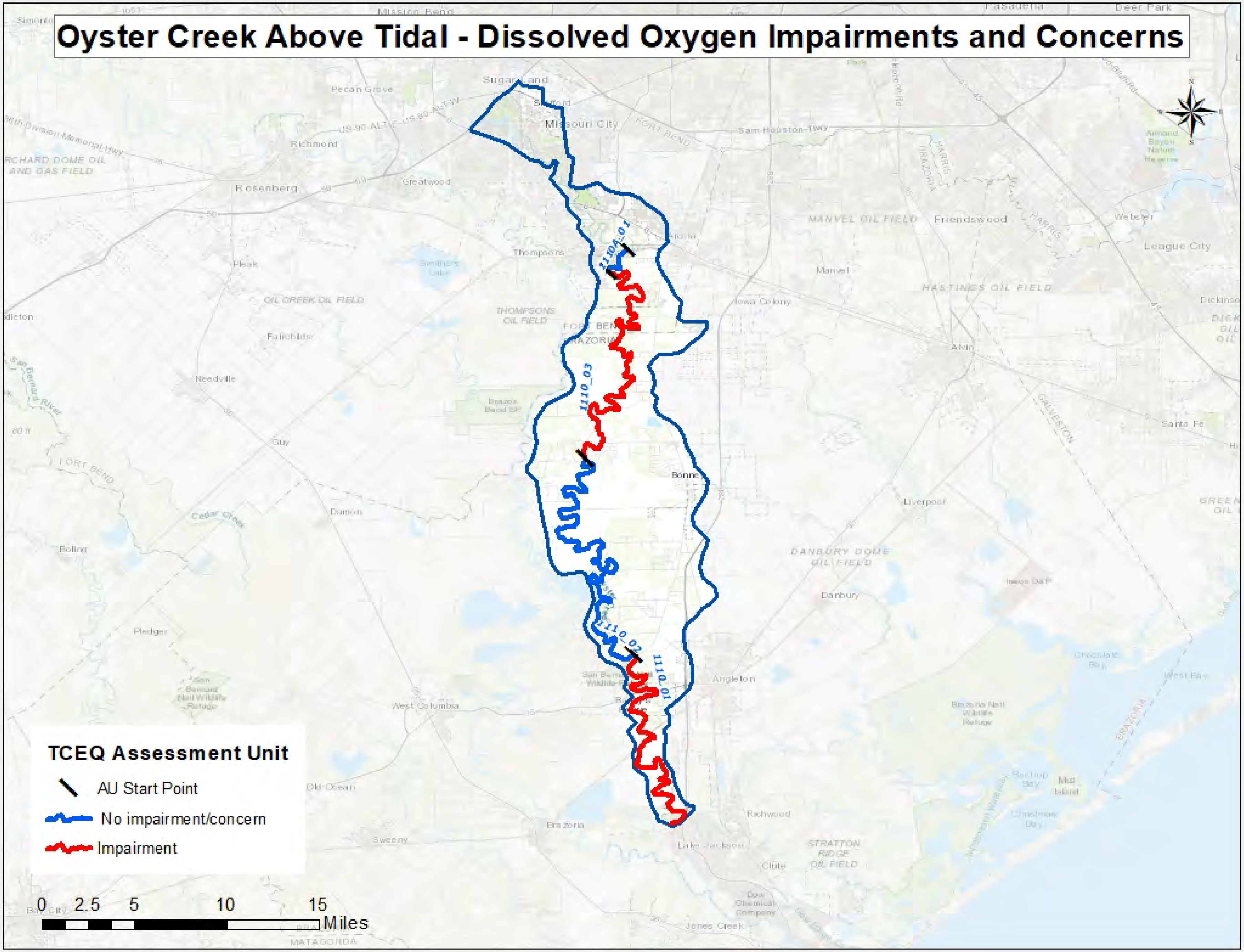
Dissolved Oxygen Impairments and Concerns
Two assessment units of Oyster Creek Above Tidal (1110_01 and 1110_03) are not supporting the segment's designated aquatic life use due to depressed dissolved oxygen.

Nutrient Concerns
A concern for Total Phosphorus is present in AU 1110_02. This is based on limited data (4 results), but all results exceeded the nutrient screening level.

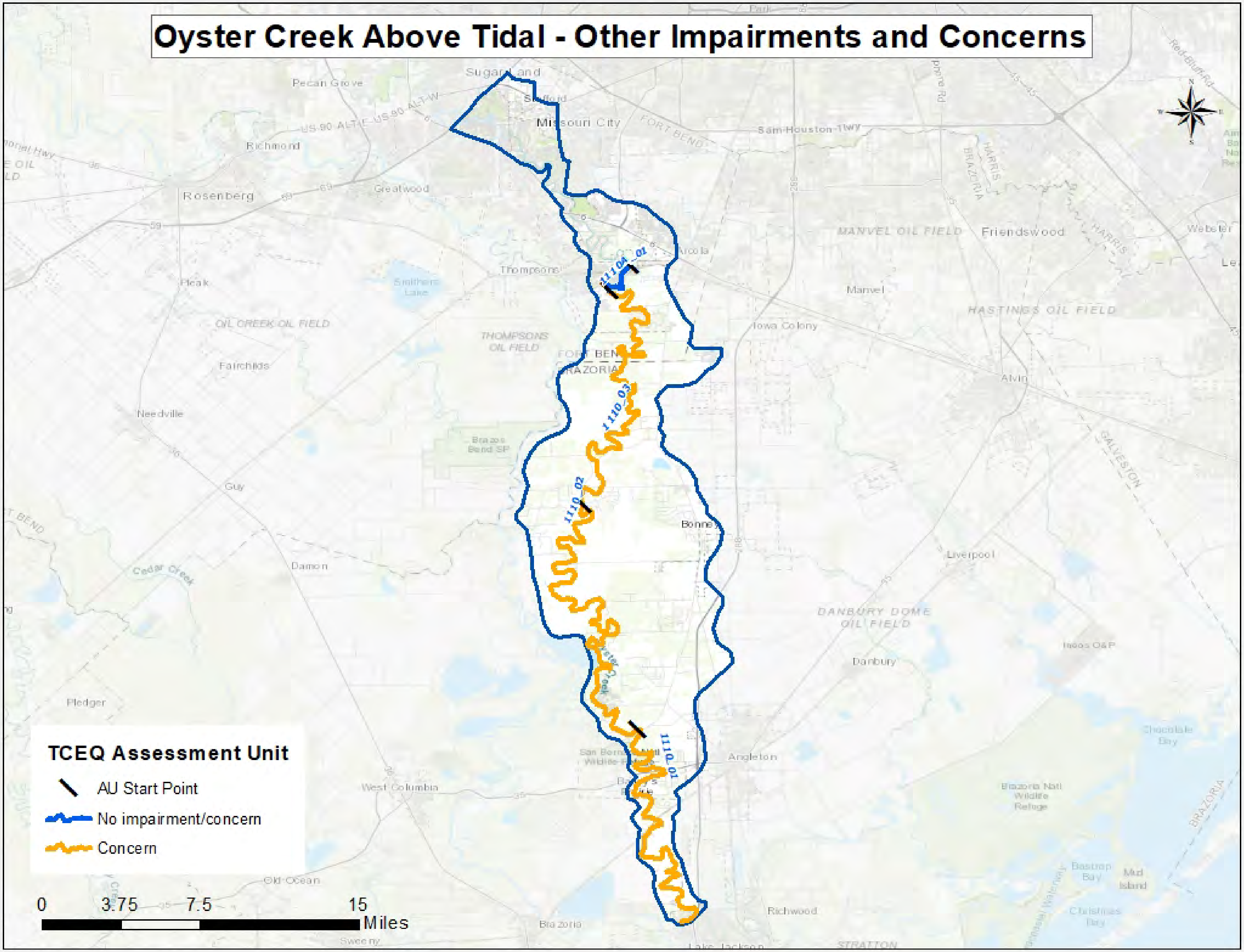
Impaired Habitat
A concern for impaired habitat was identified in all assessment units of Oyster Creek Above Tidal.

Impaired Macrobenthic Community
A concern for impaired macrobenthic community was identified in AU 1110_02.


Oyster Creek Above Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0 2.5 5 10 15
Miles
1110A_01
1110_03
1110_02
1110_01
Sugar Land
Missouri City
Richmond
Rosenberg
Pecan Grove
Greatwood
Thompsons
Arcola
Manvel
Friendswood
League City
Webster
Deer Park
Pasadena
Mission Bend
Iowa Colony
Alvin
Dickinson
Santa Fe
Liverpool
Danbury
Angleton
Richwood
Lake Jackson
Clute
Jones Creek
Brazoria
Sweeny
West Columbia
Old Ocean
Damon
Guy
Needville
Fairchilds
Pleak
Boling
Pledger
Bonney
MANVEL OIL FIELD
HASTINGS OIL FIELD
THOMPSONS OIL FIELD
OIL CREEK OIL FIELD
DANBURY DOME OIL FIELD
STRATTON RIDGE OIL FIELD
Cedar Creek
Chocolate Bay
West Bay
Christmas Bay
Bastrop Bay
Mud Island
MATAGORDA
Sam Houston Tlwy
FORT BEND
BRAZORIA
GALVESTON
HARRIS



Oyster Creek Above Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
1110A_01
1110_03
1110_02
1110_01
0
2.5
5
10
15
Miles
Sugar Land
Missouri City
Pecan Grove
Richmond
Rosenberg
Greatwood
Thompsons
Arcola
Fresno
Iowa Colony
Manvel
Friendswood
League City
Webster
Alvin
Santa Fe
Pleak
Fairchilds
Needville
Guy
Damon
Boling
Pledger
West Columbia
Angleton
Danbury
Liverpool
Bonney
Brazoria
Sweeny
Old Ocean
Lake Jackson
Clute
Richwood
Jones Creek
Pasadena
Deer Park
Mission Bend
Sam Houston Tlwy
MANVEL OIL FIELD
HASTINGS OIL FIELD
THOMPSONS OIL FIELD
OIL CREEK OIL FIELD
DANBURY DOME OIL FIELD
STRATTON RIDGE OIL FIELD
Cedar Creek
San Bernard River

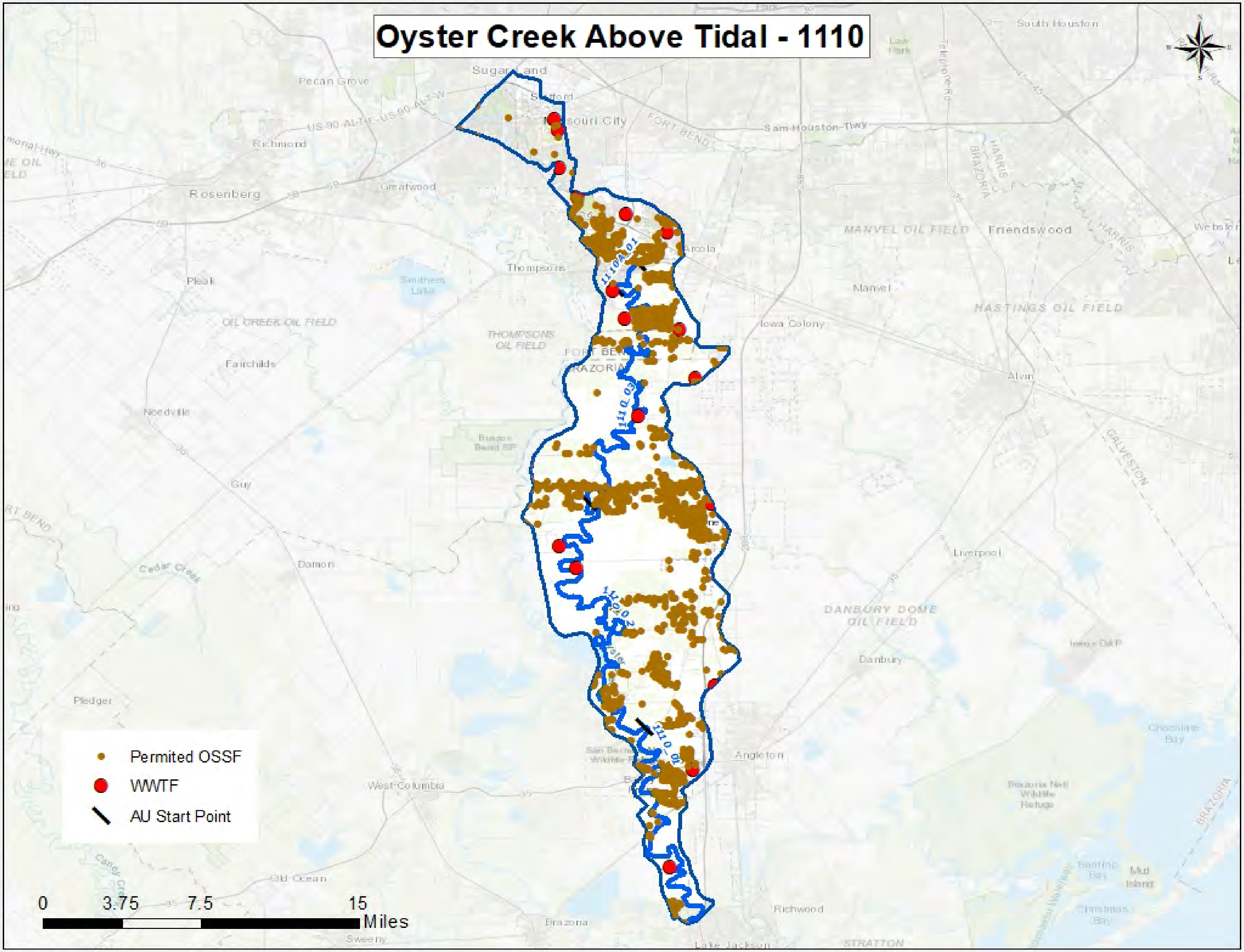

Oyster Creek Above Tidal - Other Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
1110_01
1110_02
1110_03
1110_04_01
0
3.75
7.5
15
Miles
Sugar Land
Missouri City
Rosenberg
Richmond
Pecan Grove
Arcola
Thompsons
Manvel
Iowa Colony
Friendswood
Alvin
Needville
Fairchilds
Guy
Damon
Bonney
Liverpool
Danbury
Angleton
West Columbia
Richwood
Pledger
Brazoria
MANVEL OIL FIELD
HASTINGS OIL FIELD
DANBURY DOME OIL FIELD
THOMPSONS OIL FIELD
OIL CREEK OIL FIELD
Sam Houston Tlwy
Cedar Creek

Potential Sources of Water Quality Issues: Potential Sources of fecal bacteria present in this watershed include rural and developed sources from agriculture, failing septic tanks, sanitary sewer overflows and residential stormwater.

There are 17 permitted wastewater outfalls in the Oyster Creek Above Tidal watershed. In most of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 1,925 permitted on-site sewage facilities in this watershed. The wastewater treatment facilities and on-site sewage facilities in the Oyster Creek Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 15 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Oyster Creek Above Tidal watershed.

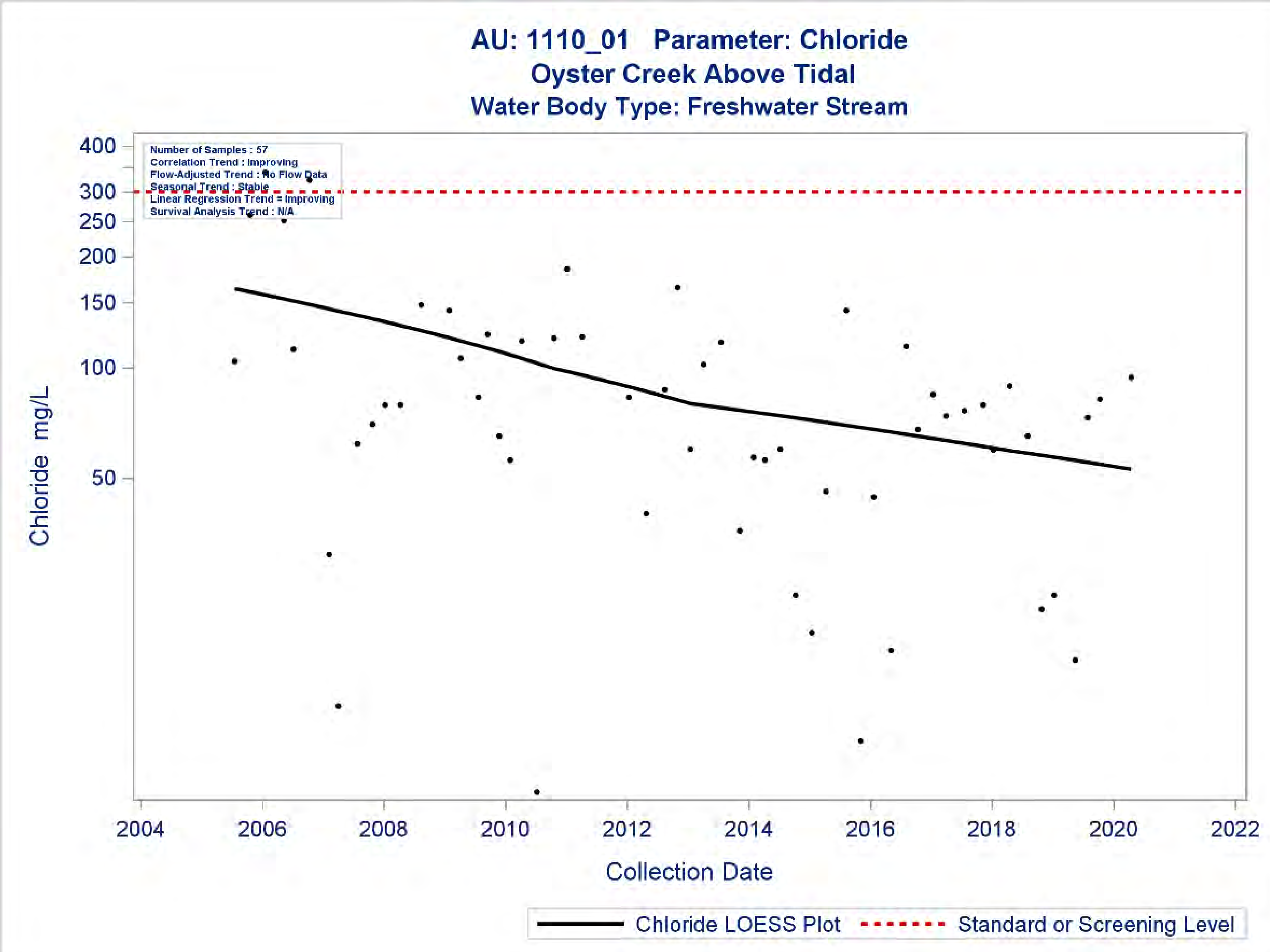

Oyster Creek Above Tidal - 1110
Permited OSSF
WWTF
AU Start Point
0
3.75
7.5
15
Miles
Sugar Land
Missouri City
Rosenberg
Richmond
Pecan Grove
Greatwood
Thompsons
Arcola
Manvel
Iowa Colony
Alvin
Friendswood
South Houston
Liverpool
Danbury
Angleton
West Columbia
Brazoria
Richwood
Lake Jackson
Sweeny
Old Ocean
Damon
Guy
Needville
Fairchilds
Pleak
Pledger
MANVEL OIL FIELD
HASTINGS OIL FIELD
DANBURY DOME OIL FIELD
THOMPSONS OIL FIELD
OIL CREEK OIL FIELD
Sam Houston Tlwy

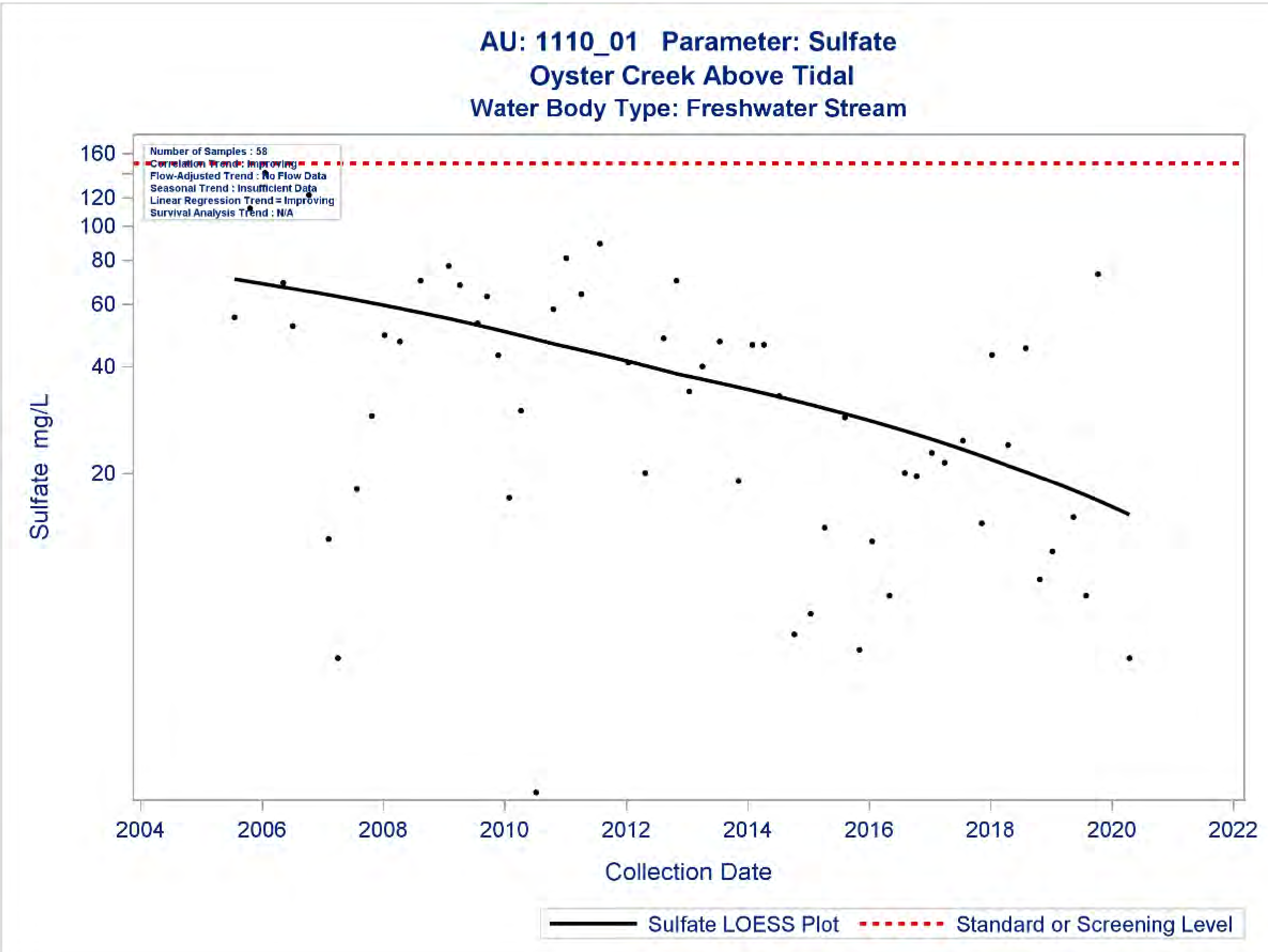
Trend Analysis:

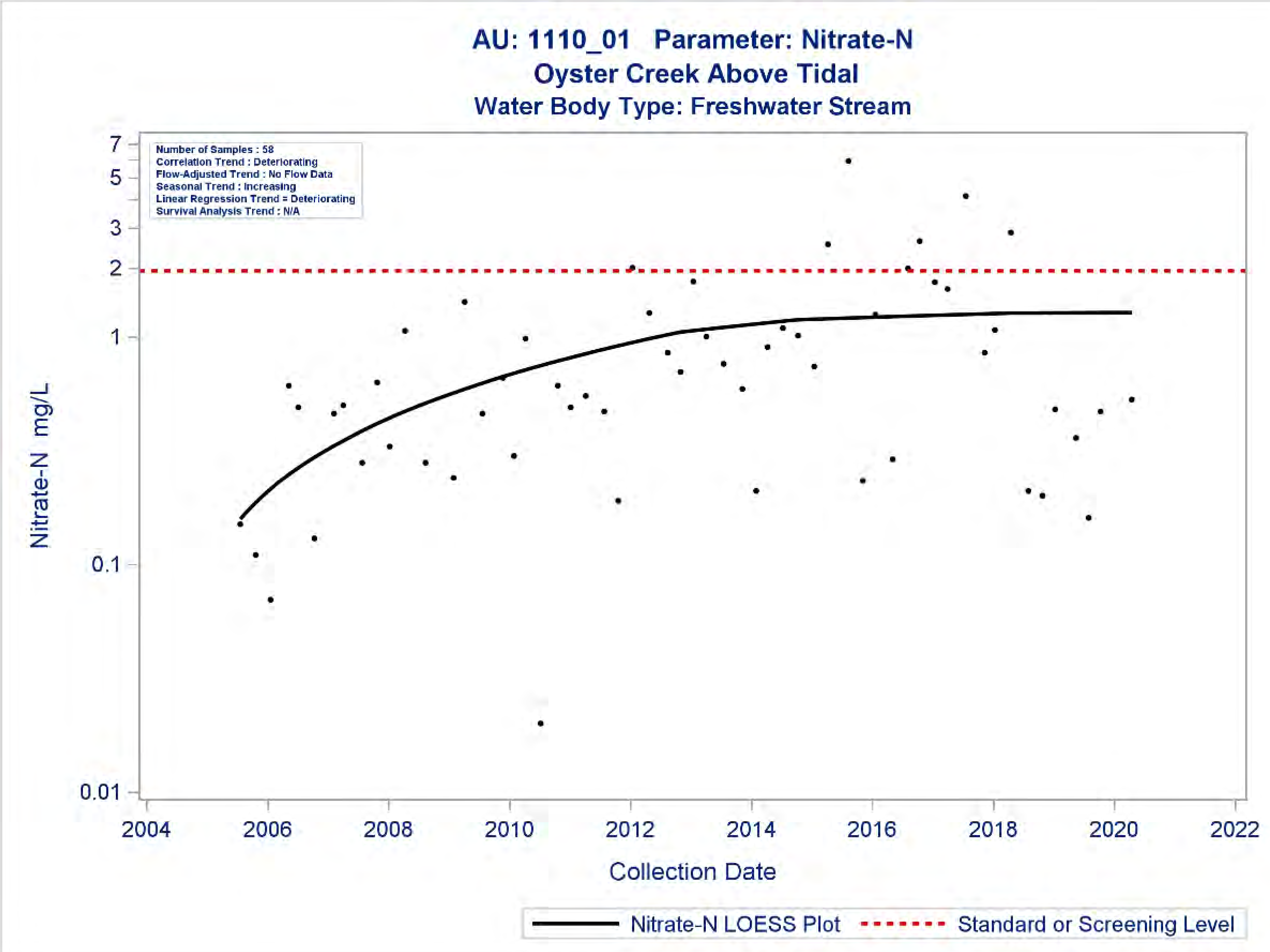
Regression analysis of water quality data for the Oyster Creek Above Tidal watershed revealed four significant parameter trends including decreasing chloride and sulfate. The chloride graph shows that this above tidal segment has been getting less saline over time. Sulfate concentrations are also decreasing over time with both parameters not having exceeded their screening criteria or water quality standard once since 2007. Conversely, two of the four trends show nitrate and total phosphorus concentrations increasing. After 2010, both began to exceed their screening criteria intermittently.

There are currently four sampling stations in this watershed – sites 11489, 11490, 11491, and 11493. However, there is insufficient data to conduct trends analysis for three of those stations (11490,11491, and 11493).

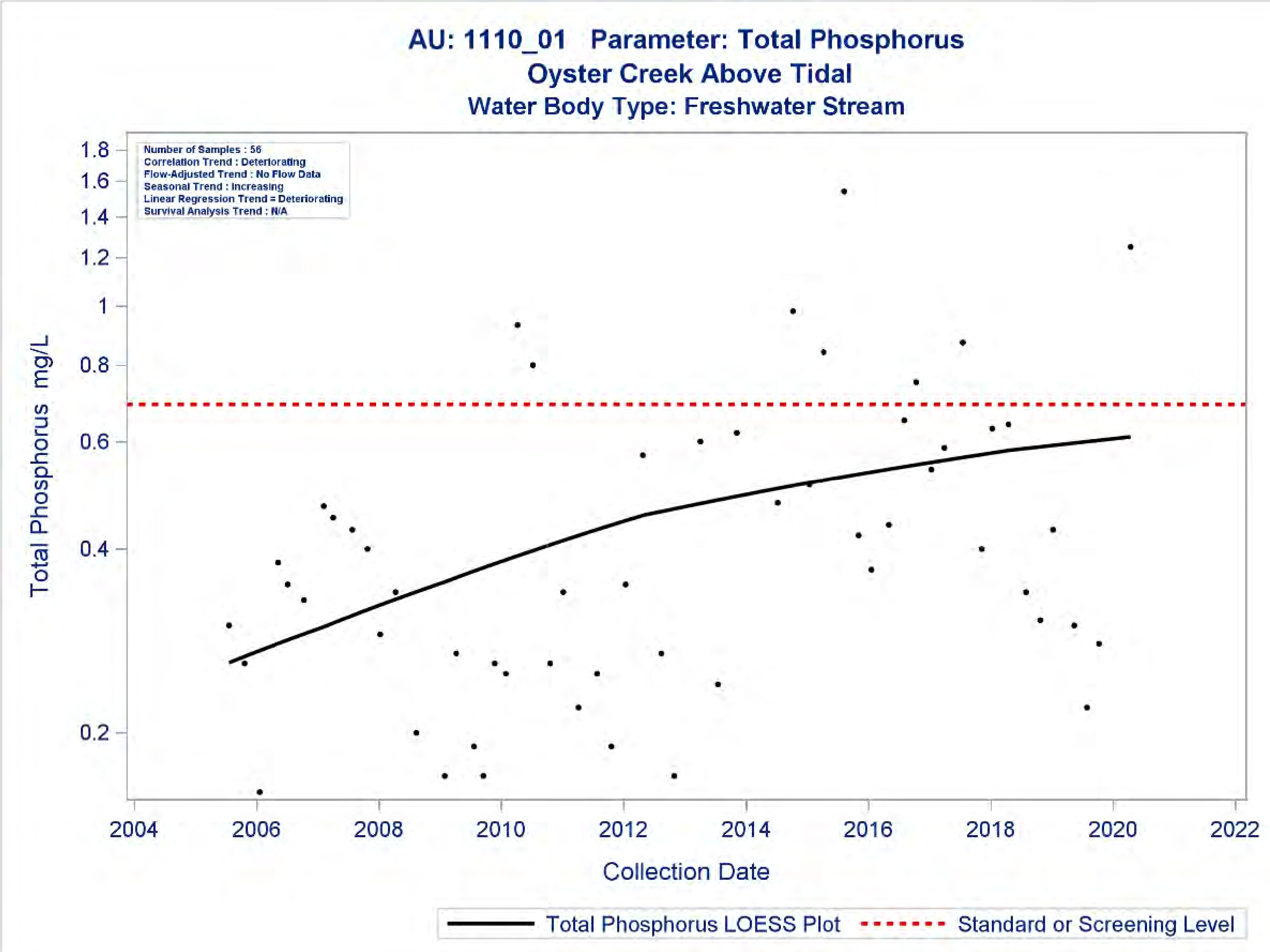
The 2020 Texas Integrated Report (IR) lists this segment as impaired for bacteria but no trends were identified by the regression analysis.


AU: 1110_01 Parameter: Chloride
Oyster Creek Above Tidal
Water Body Type: Freshwater Stream
Number of Samples : 57
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
400
300
250
200
150
100
50
Chloride mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LOESS Plot
Standard or Screening Level


AU: 1110_01 Parameter: Sulfate
Oyster Creek Above Tidal
Water Body Type: Freshwater Stream
Number of Samples : 58
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Sulfate mg/L
160
120
100
80
60
40
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Sulfate LOESS Plot
Standard or Screening Level



AU: 1110_01 Parameter: Nitrate-N
Oyster Creek Above Tidal
Water Body Type: Freshwater Stream
Number of Samples : 58
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Nitrate-N mg/L
7
5
3
2
1
0.1
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level



AU: 1110_01 Parameter: Total Phosphorus
Oyster Creek Above Tidal
Water Body Type: Freshwater Stream
Number of Samples : 56
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1110_01 I 1110_02 C	• Animal waste from agricultural production and domestic animal facilities • Urbanization and increased impervious cover • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Create and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operations and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	***DO 24hr Avg*** 1110_01 I 1110_03 I ***DO 24hr Min*** 1110_01 I 1110_03 I	▪ Excessive nutrients and organic matter from agricultural production and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Improve compliance and enforcement of existing stormwater quality permits • More public education regarding OSSF operation and maintenance • More public education regarding disposal of household fats, oils, and grease

				• Improve operation and maintenance of existing WWTF and collection systems • Regionalize chronically non-compliant WWTFs • More public education on pet waste disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating • Conserve or restore trees and habitat along waterways to maintain/create shade to cool water
Elevated Nutrient Concentrations	***Phosphorus*** 1110_02 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Monitor phosphorus levels at WWTFs to determine if controls are needed. • Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Implement YardWise and Watersmart landscape practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Impaired Habitat and Macrobenthic Community	***Habitat*** 1110_01 C 1110_02 C 1110_03 C ***Macrobenthics*** 1110_02 C	• Ongoing maintenance of modified channel • Bank and streambed erosion or erosion of farm fields and construction sites • Loss of habitat due to channelization of waterway	• Detrimental effect on aquatic biological community	• Re-connect oxbows and lost channels to augment water storage and retention • Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat • Work with drainage districts to install/construct habitat that doesn’t interfere with water movement

Special Studies:

The Oyster Creek TMDL project was initiated in 2016. The TMDL documents have been created and the stakeholder I-Plan is being drafted. The I-Plan documents will likely be submitted in the fall of 2021 for public comment. Approval by TCEQ is expected in the fall of 2021 or early 2022.

Oyster Creek was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to work with the stakeholders to implement the Oyster Creek I-Plan recommendations (when completed) for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

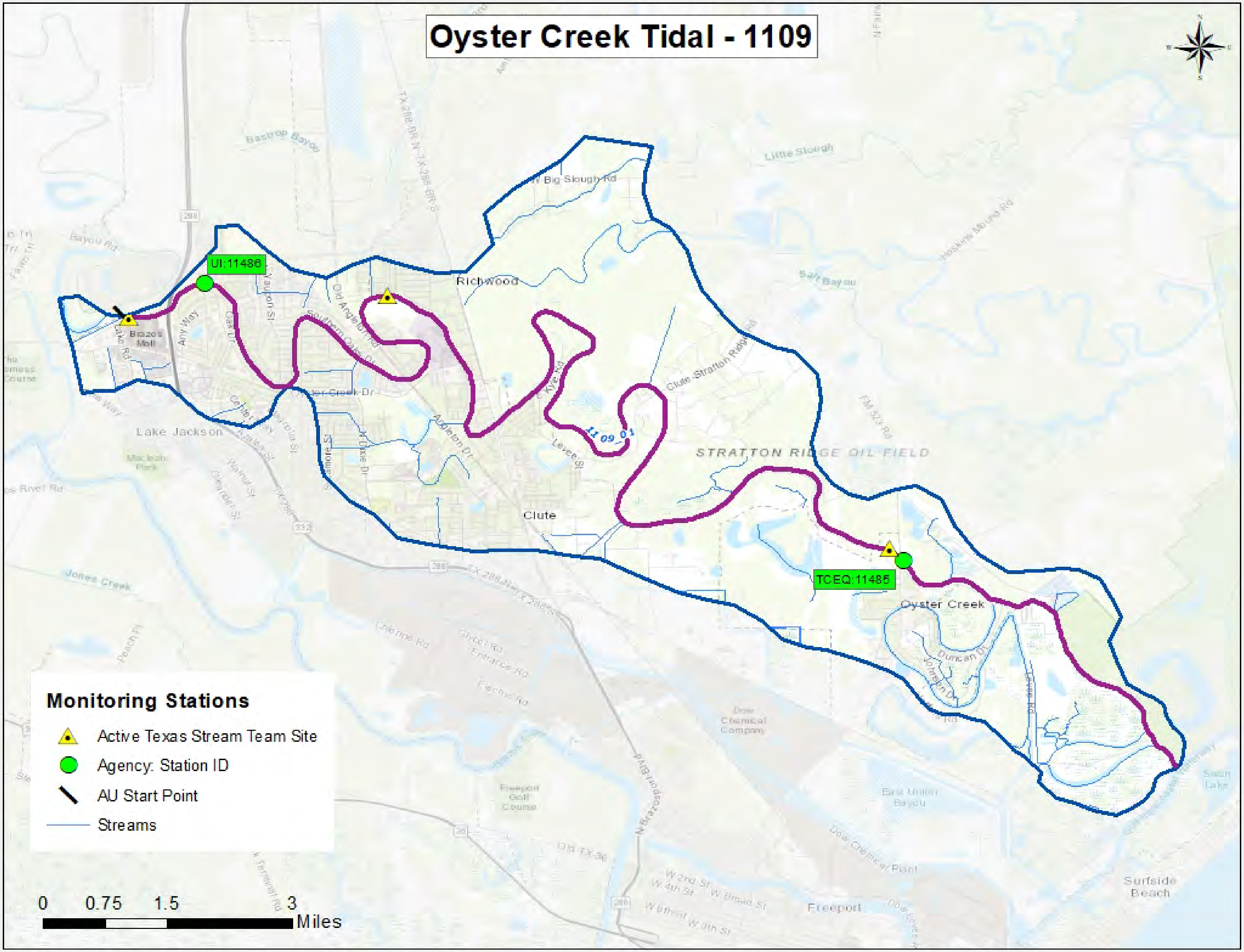
Segment Number: 1109		Name: Oyster Creek Tidal	
Length: 25 miles	**Watershed Area:** 32 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations: 2	**Texas Stream Team Monitoring Stations:** 4	**Permitted WWTF Outfalls:** 3	

DESCRIPTION

- Segment 1109 (Tidal Stream w/ high ALU): **Oyster Creek Tidal** (classified water body) – From the confluence with the Intracoastal Waterway in Brazoria County to a point 100 meters (110 yards) upstream of FM 2004 in Brazoria County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
11485	1109	OYSTER CREEK TIDAL AT FM 523 SE OF ANGLETON ON WEST BANK 78 METERS DOWNSTREAM FROM FM 523	FO	Quarterly	Field, Conventional, Bacteria
11486	1109	OYSTER CREEK TIDAL AT THAT-WAY DRIVE 0.5 MILES BELOW FM 2004	UI	Quarterly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston



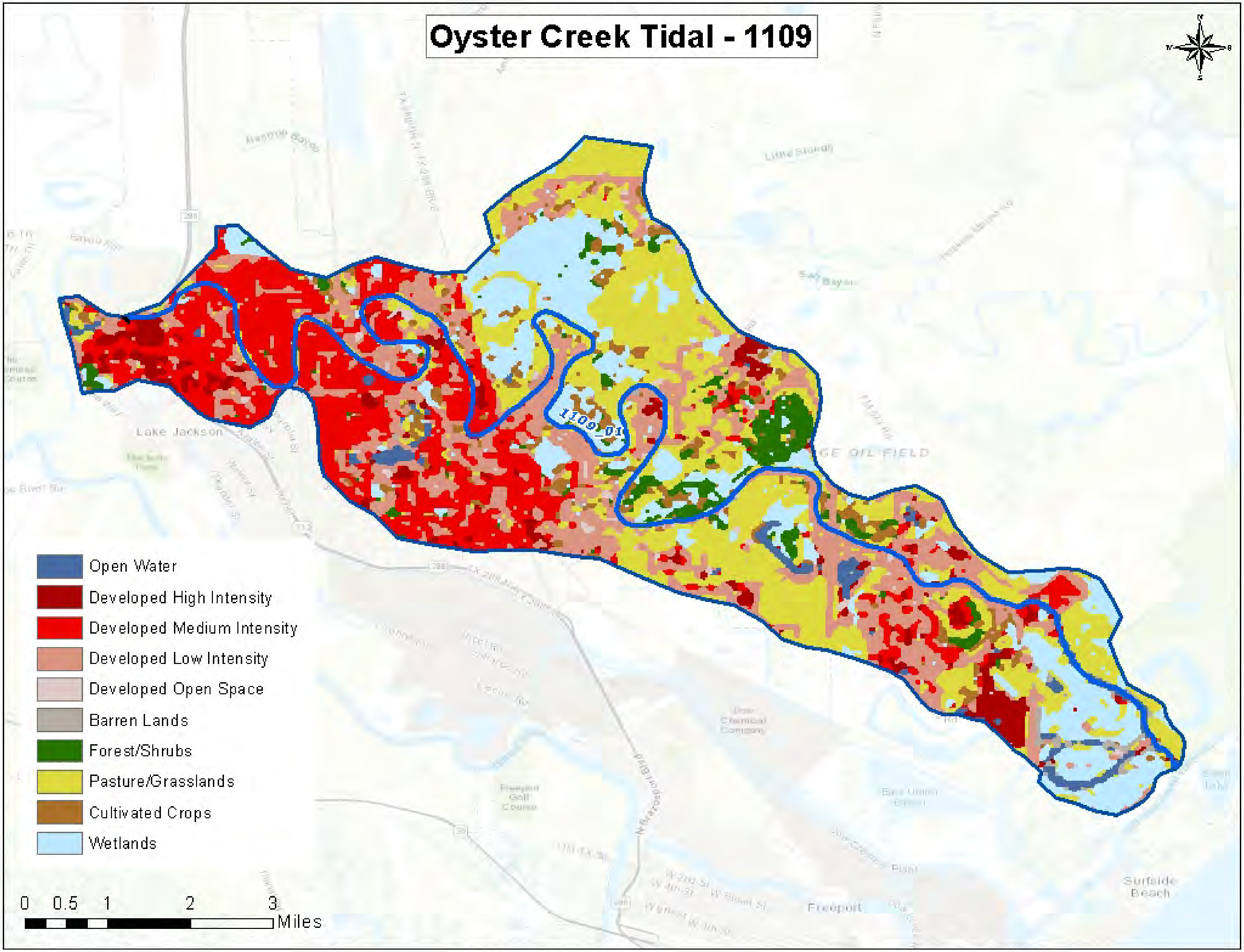
Oyster Creek Tidal - 1109
UI:11486
TCEQ:11485
Richwood
Lake Jackson
Clute
Oyster Creek
STRATTON RIDGE OIL FIELD
1109_01
Freeport
Surfside Beach
Dow Chemical Company
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0 0.75 1.5 3
Miles

Segment 1109 Water Quality Standards and Screening Levels			
Standards	**Tidal Stream**	**Screening Levels**	**Tidal Stream**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.46
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.66
Enterococci (MPN/100mL) (grab):	104	Chlorophyll *a* (µg/L):	21
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: While the largest land cover category in the Oyster Creek Tidal (1109) watershed is developed lands at 45.26%, the watershed is primarily characterized as rural. Large areas of the watershed are utilized for agricultural uses (31.69%), while 16.31% of the land cover is wetlands. There are many oxbow lakes and extensive coastal wetlands in the southern and northeastern portions of the watershed. Urban centers in this watershed include Richwood, Clute, and Lake Jackson in the northwestern portions of the watershed. There are also a few pockets of development at Oyster Creek and along CR226 to the east of Clute. Small plots of agricultural lands are also present in the northern reaches of the watershed. This segment terminates at the Gulf Intracoastal Waterway.

Segment 1109 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	3,093.72	15.05	6,510.57	31.69	110.44
Barren Lands	223.51	1.09	189.92	0.92	-15.02
Developed	7,063.00	34.37	9,298.50	45.26	31.65
Forest/Shrubs	886.68	4.31	749.91	3.65	-15.43
Open Water	696.76	3.39	446.79	2.17	-35.88
Wetlands	8,587.50	41.79	3,350.58	16.31	-60.98
TOTAL	**20,551.17**	**100.00**	**20,546.27**	**100.00**	


Oyster Creek Tidal - 1109
1109_01
Lake Jackson
Surfside Beach
Freeport
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.5 1 2 3
Miles

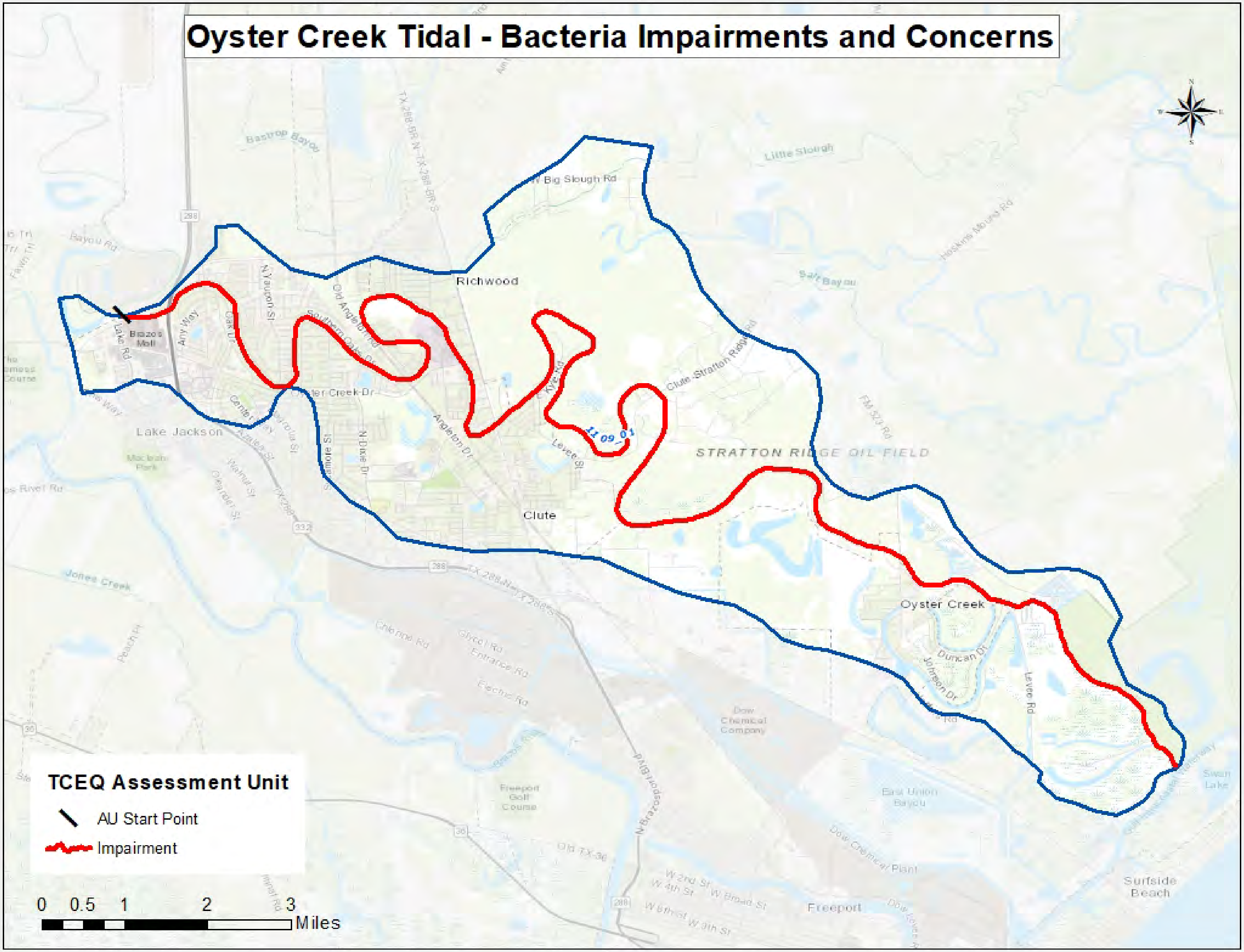
Water Quality Issues:

Bacteria Impairments and Concerns
The 2020 Integrated Report lists Oyster Creek Tidal (1109) as impaired due to elevated levels of enterococci bacteria. This water body does not fully support its primary contact recreation designation. The Enterococcus geometric mean in AU 1109_01 is 60.65 MPN/100 mL, which exceeds the water quality standard of 35 MPN/100 mL.

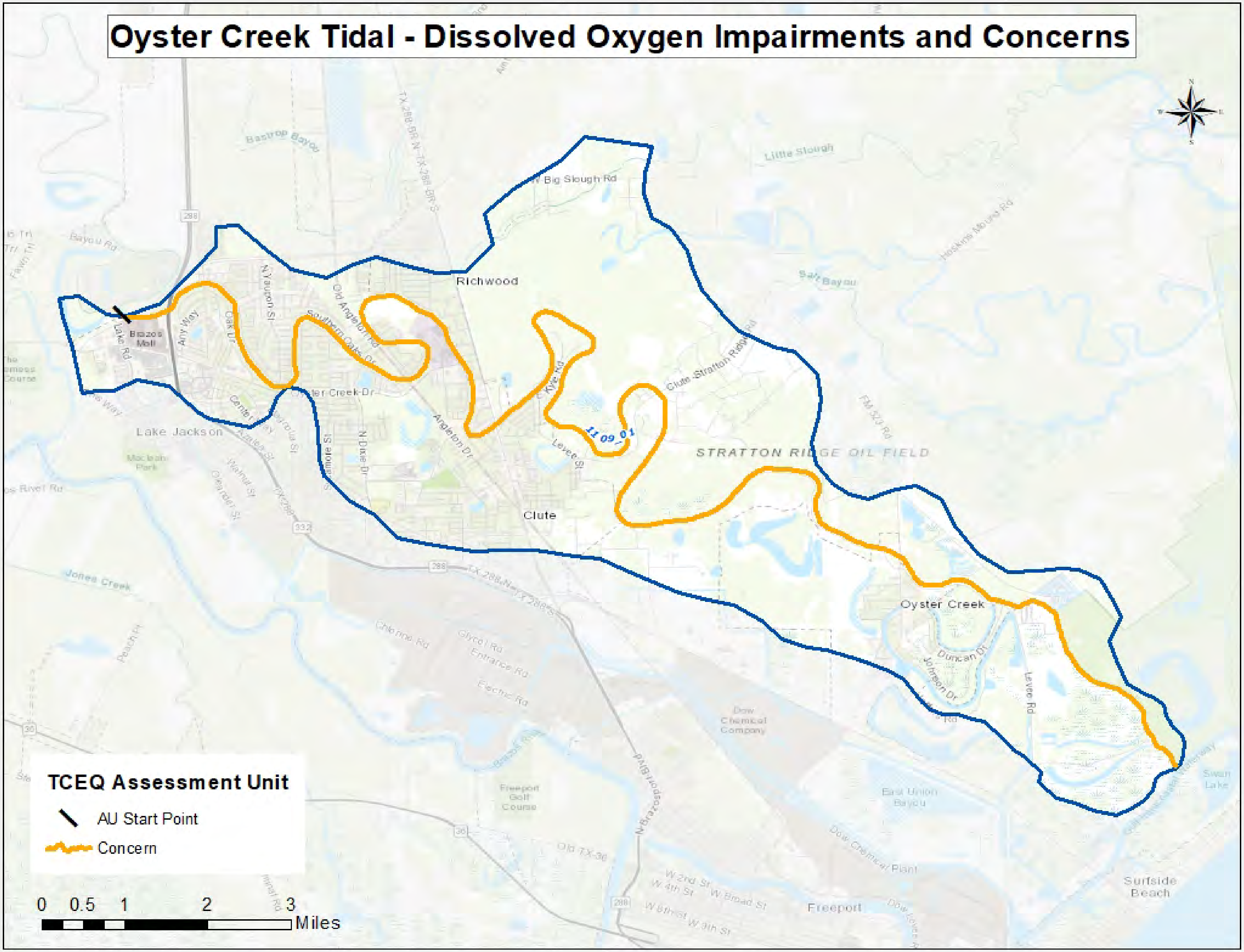
Dissolved Oxygen Impairments and Concerns
A concern for depressed dissolved oxygen has been identified in this segment. In the 2020 Integrated Report, 11 of 56 dissolved oxygen grab samples were below the single grab screening level of 4.0 mg/L.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.



Oyster Creek Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
Impairment
0 0.5 1 2 3
Miles
Richwood
Lake Jackson
Clute
Oyster Creek
STRATTON RIDGE OIL FIELD
Freeport
Surfside Beach
1109_01

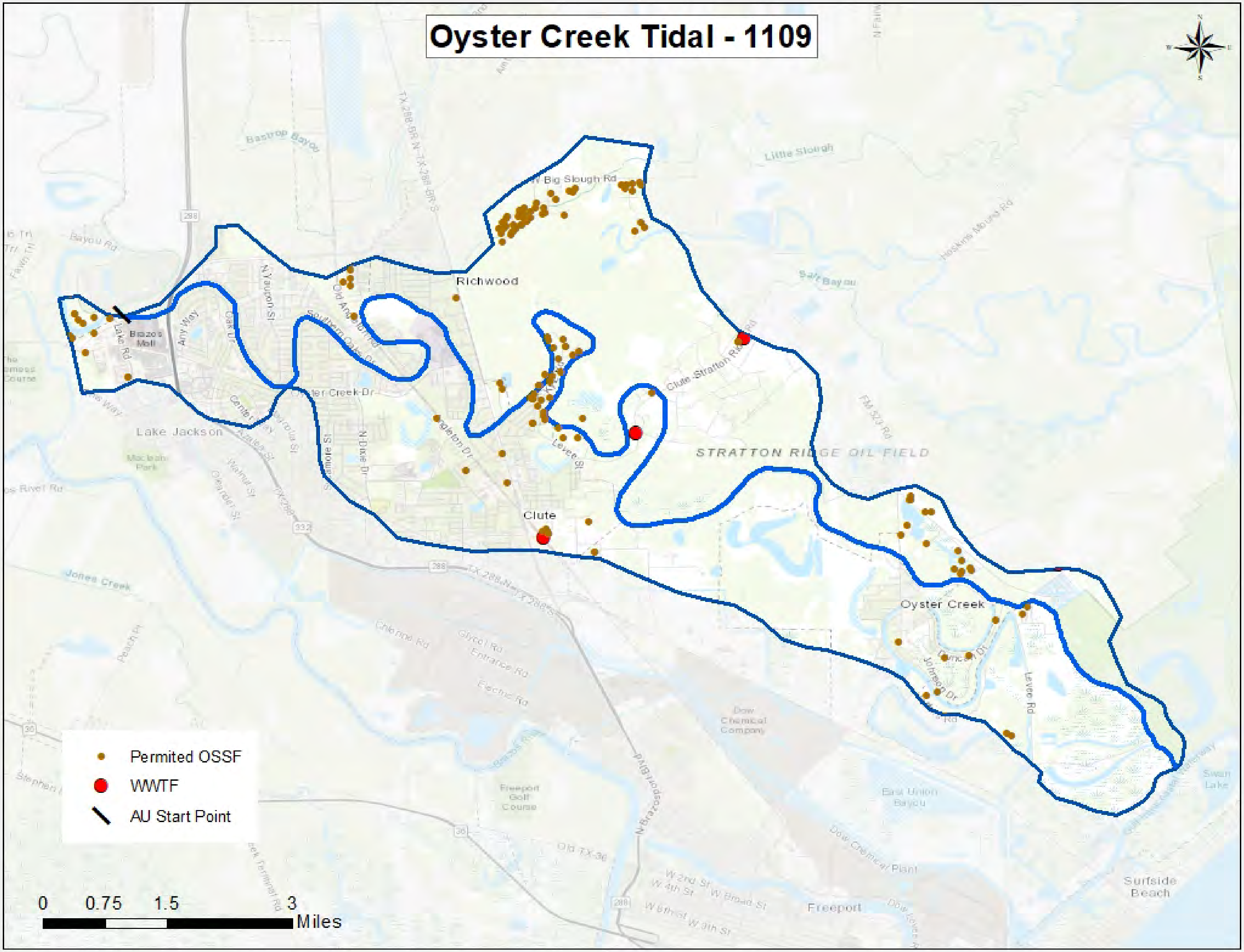

Oyster Creek Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
Concern
0 0.5 1 2 3 Miles
1109_01
Richwood
Lake Jackson
Clute
Oyster Creek
STRATTON RIDGE OIL FIELD
Freeport
Surfside Beach

Potential Sources of Water Quality Issues: Potential Sources of fecal bacteria present in this watershed include rural and developed sources from agriculture, failing on-site sewage facilities, sanitary sewer overflows and residential stormwater.

There are 3 permitted wastewater outfalls in the Oyster Creek Tidal watershed. In much of the populated portions of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 142 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Oyster Creek Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 3 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Oyster Creek Tidal watershed.

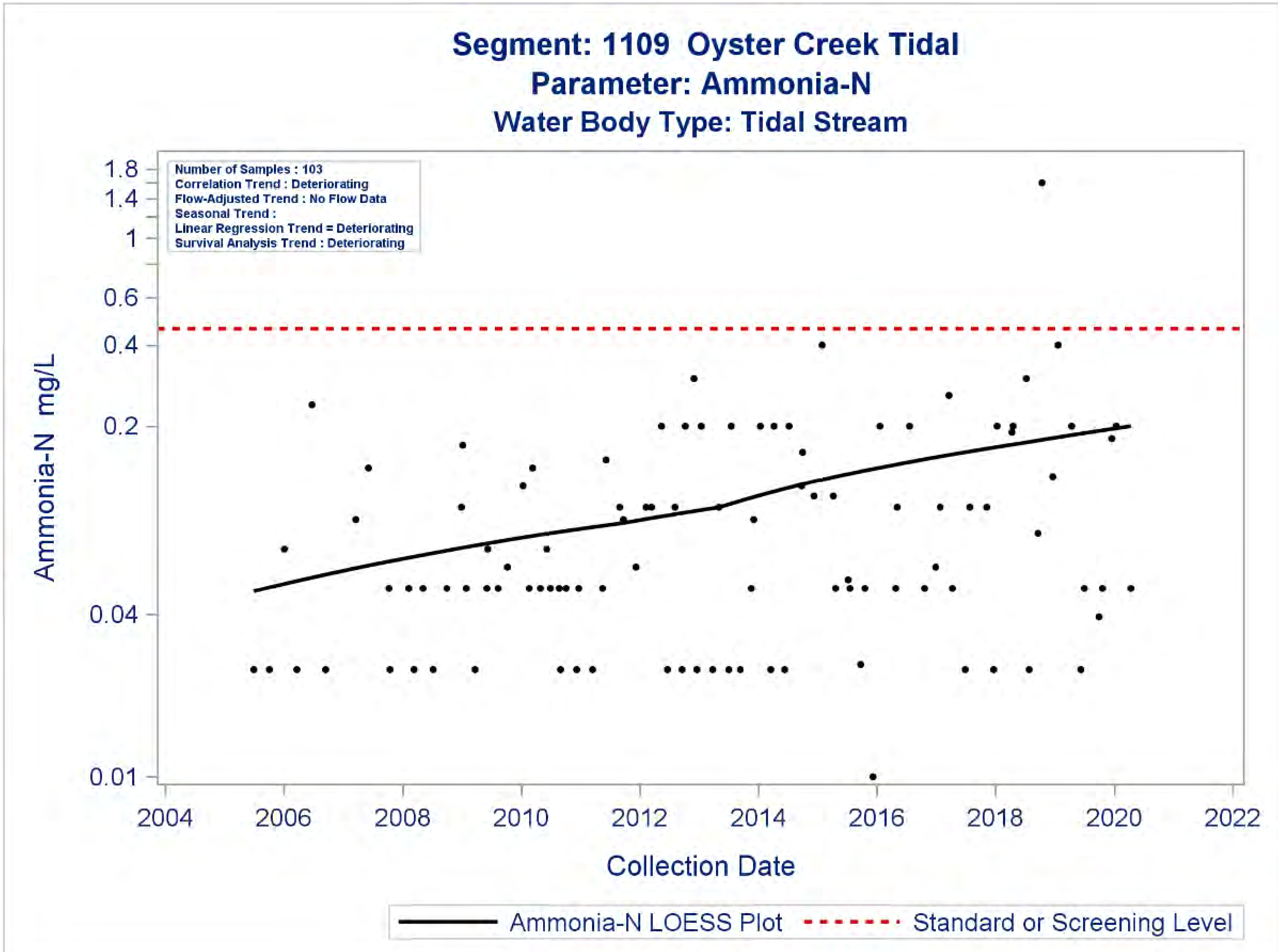

Oyster Creek Tidal - 1109
Permited OSSF
WWTF
AU Start Point
0
0.75
1.5
3
Miles
Richwood
Lake Jackson
Clute
Oyster Creek
STRATTON RIDGE OIL FIELD
Freeport
Surfside Beach
Dow Chemical Company
Brazos Mall
W Big Slough Rd
Clute Stratton Rd
Levee St
Levee Rd
Johnson Dr
Bastrop Bayou
Little Slough
Salt Bayou
Jones Creek
Hoskins Mound Rd
FM 523 Rd
Dow Chemical Plant
Freeport Golf Course
East Union Bayou
Swan Lake
Old TX-36
Chlorine Rd
Glycol Rd
Entrance Rd
Electric Rd

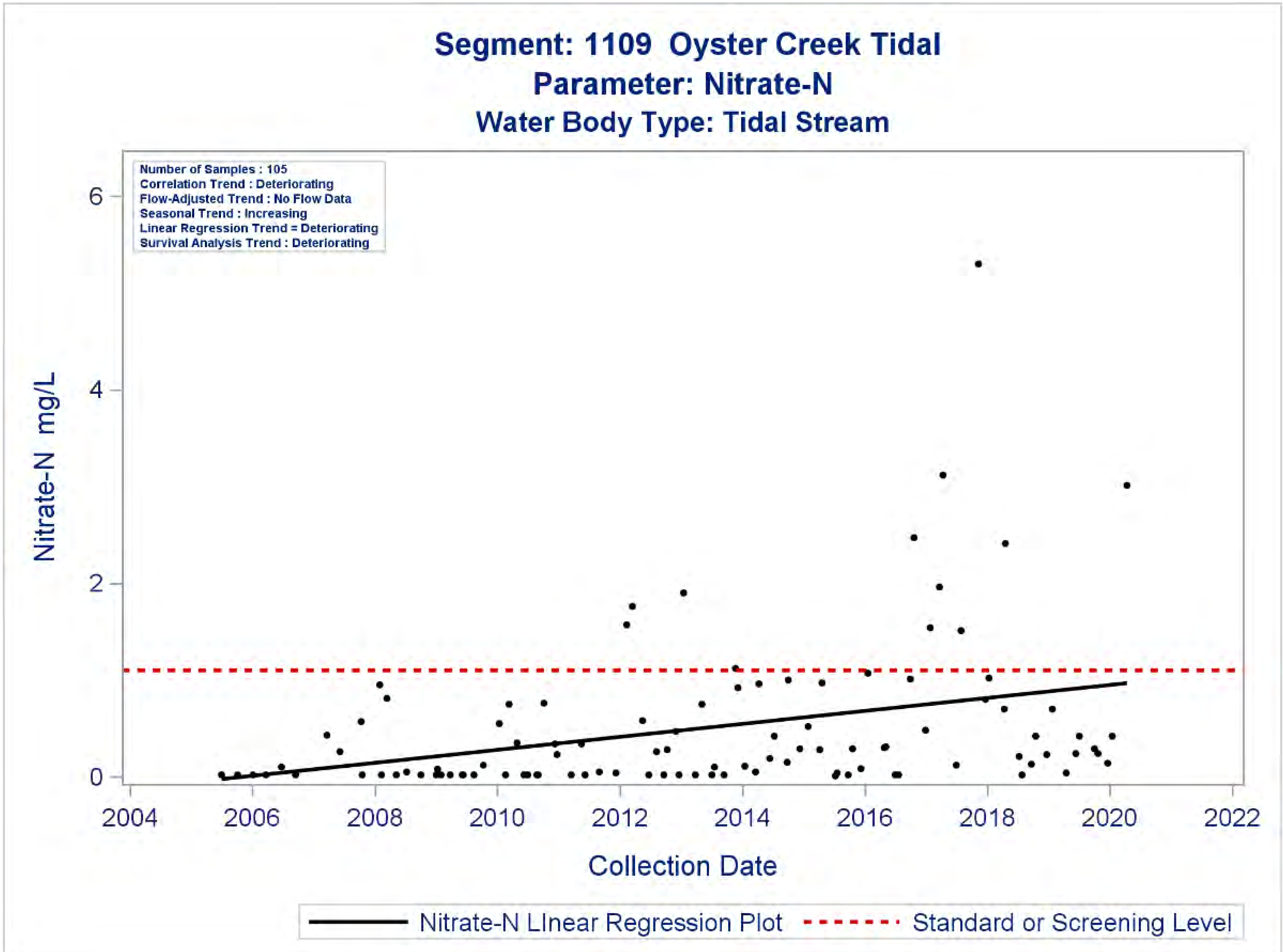
Trend Analysis:

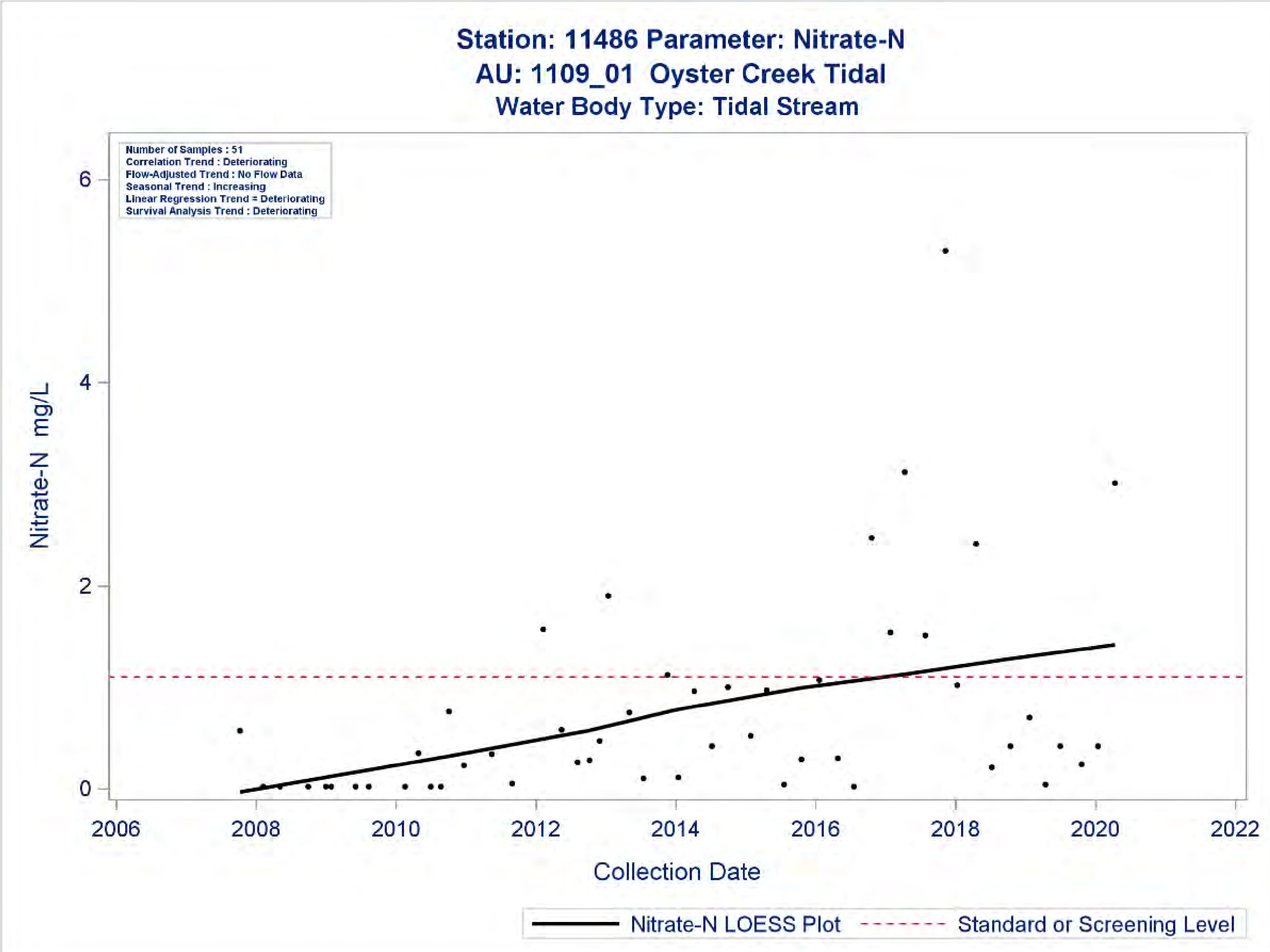
Regression analysis of water quality data for the Oyster Creek Tidal watershed revealed four parameter trends including decreasing pH and specific conductance and deteriorating ammonia and nitrate. Concentrations of both nutrient parameters are increasing over time but are just beginning to exceed the screening criteria for the first time in 2019. There are two sampling stations in this watershed – sites 11485 and 11486. TKN has been collected at 11485 since 2005 and at 11486 since 2012. The first site, 11485, exhibits stable results with no improving or deteriorating trend. However, even with only five and one-half years of TKN data from site 11486, TKN concentrations are decreasing and demonstrating an improving trend in both the LOESS plot and the linear regression plot analysis.

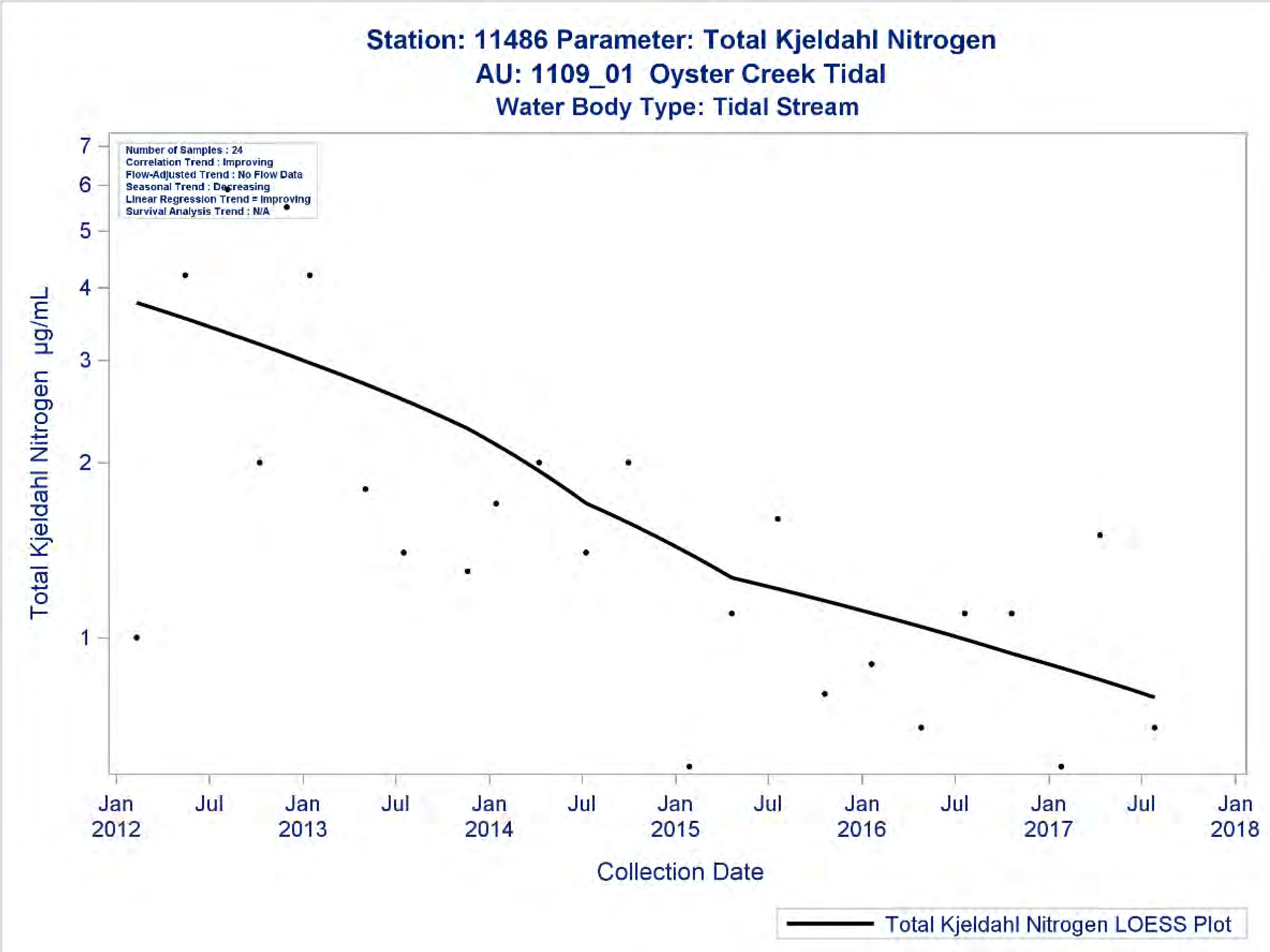
The 2020 Texas Integrated Report (IR) lists this segment as impaired for bacteria. Analysis of enterococci data show approximately half of the samples collected since 2006 are not in compliance with state water quality standards for contact recreation. This relatively equal distribution of bacteria levels has resulted in an overall stable trend in enterococci over time; however, exceedances have sporadically reached such high levels that the overall geometric means for enterococci remain significantly higher than the state water quality standard.

The IR also identified a concern for DO grab samples with many results being measured below the grab screening level. A coastal tidal segment is a slow-moving body of water that is frequently prone to having DO issues and Oyster Creek Tidal is no different. It should be noted that lower DO concentrations are being measured more frequently than prior to 2013.

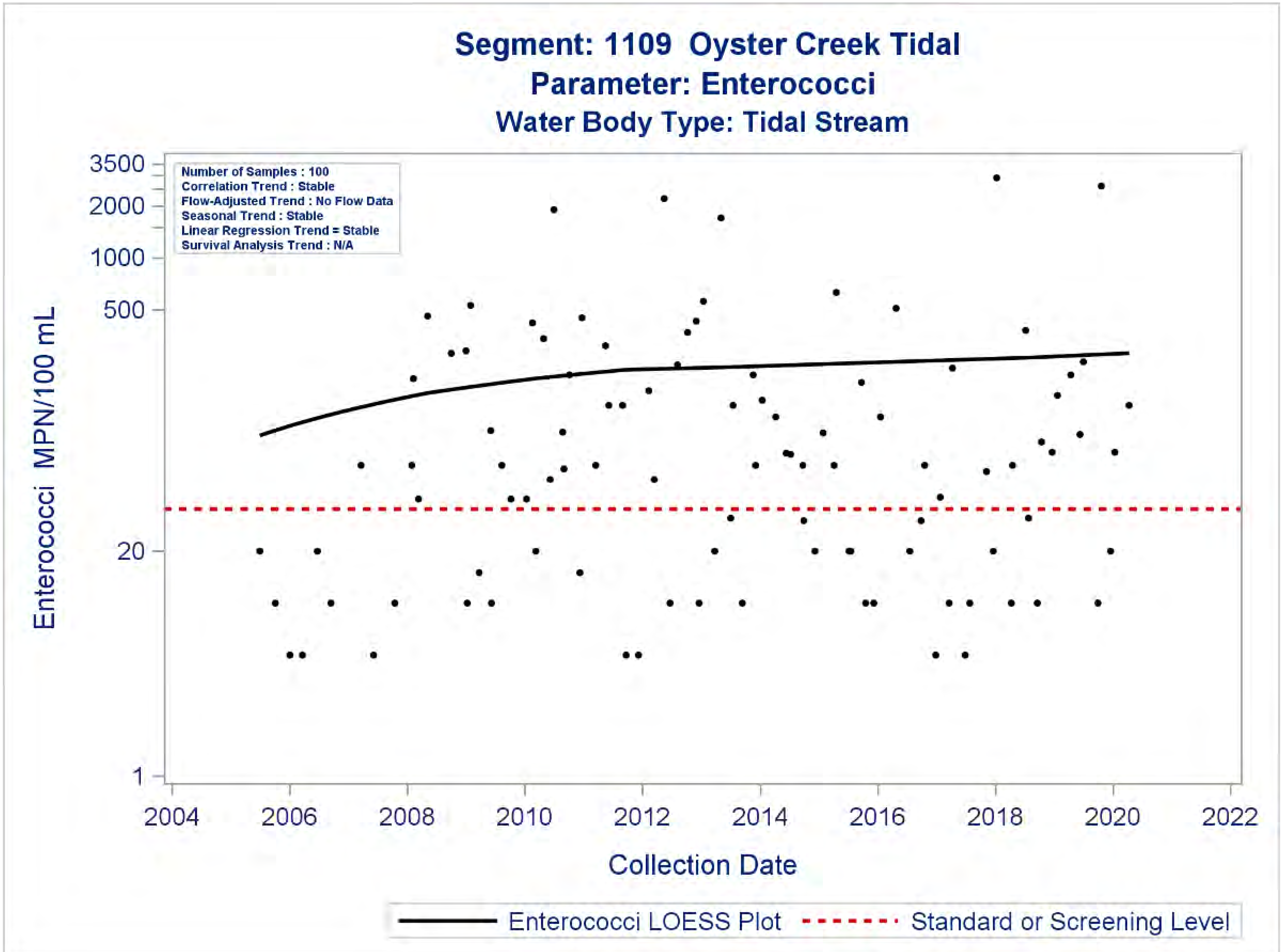

Segment: 1109 Oyster Creek Tidal
Parameter: Ammonia-N
Water Body Type: Tidal Stream
Number of Samples : 103
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend :
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
1.8
1.4
1
0.6
0.4
0.2
0.04
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level


Segment: 1109 Oyster Creek Tidal
Parameter: Nitrate-N
Water Body Type: Tidal Stream
Number of Samples : 105
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0
2
4
6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

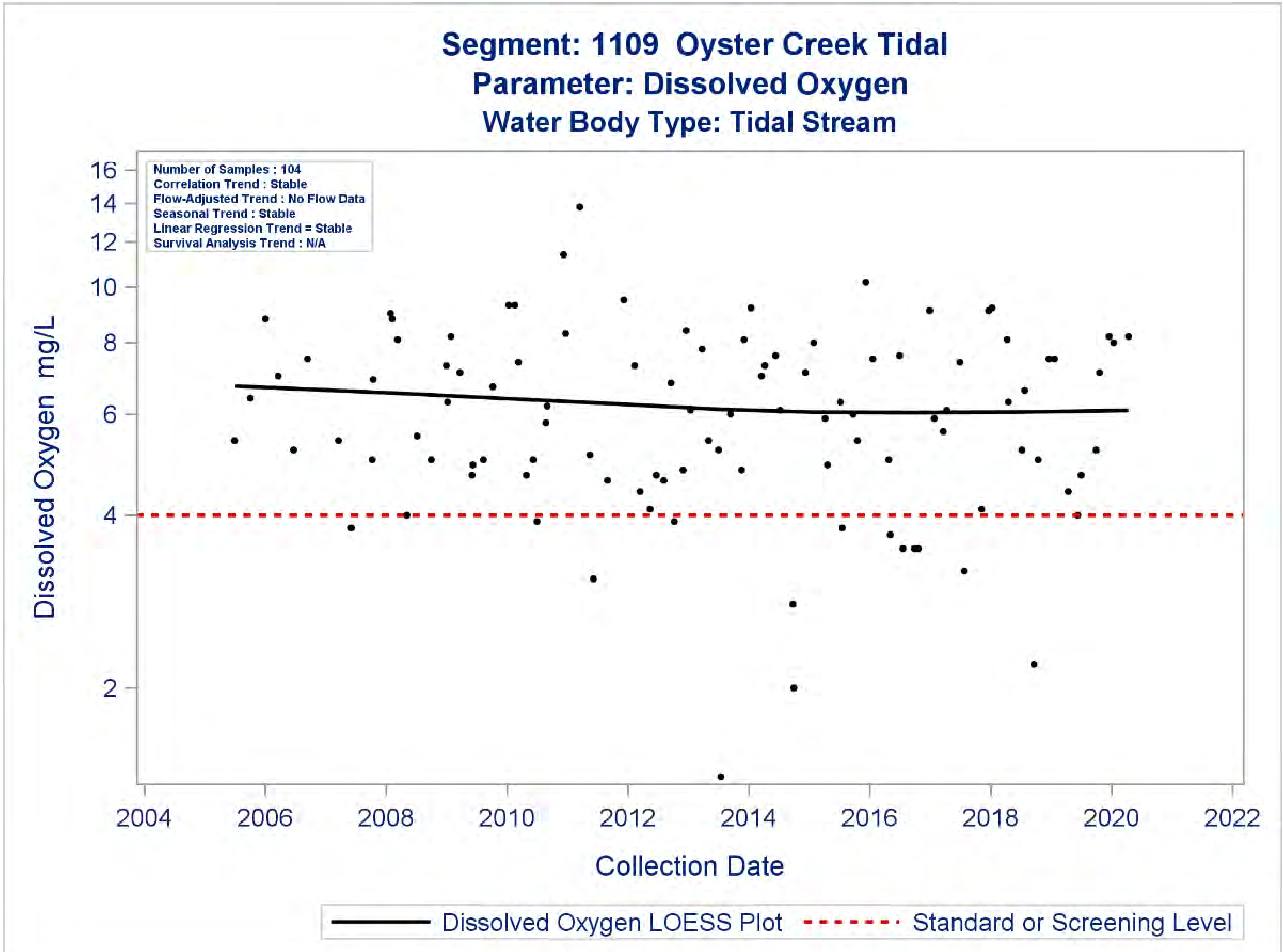

Station: 11486 Parameter: Nitrate-N
AU: 1109_01 Oyster Creek Tidal
Water Body Type: Tidal Stream
Number of Samples : 51
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0
2
4
6
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level



Station: 11486 Parameter: Total Kjeldahl Nitrogen
AU: 1109_01 Oyster Creek Tidal
Water Body Type: Tidal Stream
Number of Samples : 24
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
7
6
5
4
3
2
1
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Jul
Jan 2018
Collection Date
Total Kjeldahl Nitrogen LOESS Plot



Segment: 1109 Oyster Creek Tidal
Parameter: Enterococci
Water Body Type: Tidal Stream
Number of Samples : 100
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Enterococci MPN/100 mL
3500
2000
1000
500
20
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Enterococci LOESS Plot
Standard or Screening Level



Segment: 1109 Oyster Creek Tidal
Parameter: Dissolved Oxygen
Water Body Type: Tidal Stream
Number of Samples : 104
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
16
14
12
10
8
6
4
2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1109 I	• Urbanization and increased impervious cover • Animal waste from agricultural production, hobby farms, and riding stables • Constructed stormwater controls failing • Improper or no pet waste disposal • Developments with malfunctioning OSSFs • Direct and dry weather discharges • Poorly operated or undersized WWTFs • Waste haulers illegal discharges/improper disposal • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Add water quality features to stormwater systems • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • More public education about proper disposal of household fats, oils, and grease • More public education on pet waste disposal • Ensure proper citing of new or replacement OSSFs • More public education regarding OSSF operation and maintenance • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	1109 C	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Excessive nutrients and organic matter from agricultural production, and related activities	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water

		▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Vegetative canopy removed		• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, and grease disposal; and OSSF maintenance • Improve compliance and enforcement of existing stormwater quality permits • Implement YardWise and Watersmart landscape practices

Special Studies:

The Oyster Creek TMDL project was initiated in 2016. The TMDL documents have been created and the stakeholder I-Plan is being drafted. The I-Plan documents will likely be submitted in the fall of 2021 for public comment. Approval by TCEQ is expected in the fall of 2021 or early 2022.

Oyster Creek was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- Support actions associated with the Total Maximum Daily Load program and future TMDL I-Plan bacteria reduction measures
- 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
- Continue collecting water quality data and expand monitoring efforts to support actions associated with the Total Maximum Daily Load program and future watershed protection plan development
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

BASIN 13

Brazos-Colorado Coastal Basin

1305 – Caney Creek Above Tidal

1304 – Caney Creek Tidal

1302 – San Bernard River Above Tidal

1301 – San Bernard River Tidal

Segment Number:	1305	Name:	Caney Creek Above Tidal

Length:	98 miles	Watershed Area:	135 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life

Number of Active Monitoring Stations:	3	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	3

DESCRIPTION

- Segment 1305 (Perennial Stream w/ high ALU): **Caney Creek Above Tidal** (classified water body) – From a point 1.9 km (1.2 mi) upstream of the confluence of Linnville Bayou in Matagorda County to the confluence of Water Hole Creek in Matagorda County

- Segment 1305A (Perennial Stream w/ intermediate ALU): **Hardeman Slough** (unclassified water body) – From the confluence with Caney Creek to 0.3 km upstream of Matagorda County Rd 110

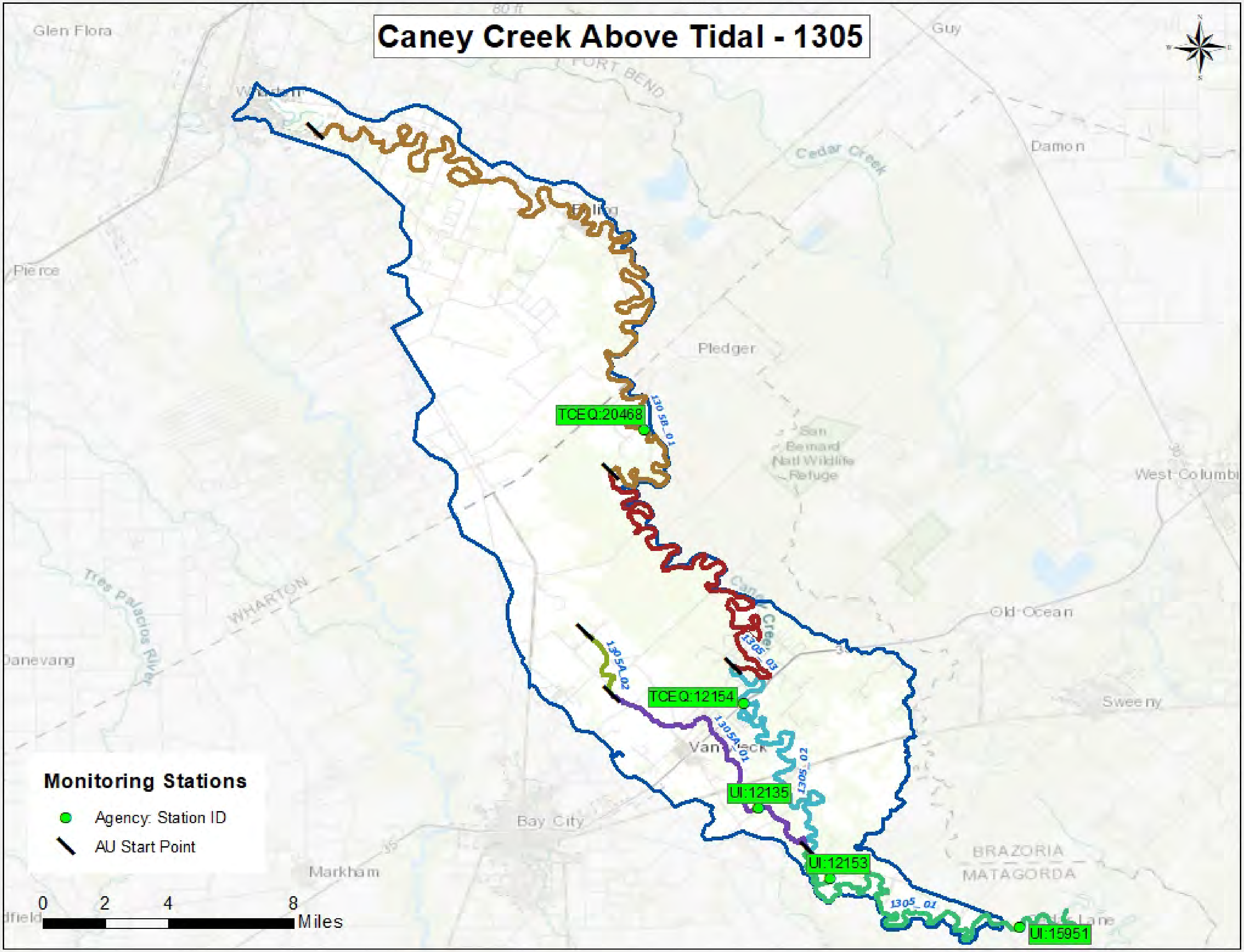
- Segment 1305B (Perennial Stream w/ intermediate ALU): **Caney Creek Above Water Hole Creek** (unclassified water body) – From the confluence with Water Hole Creek in Matagorda County (at the upper end of Segment 1305) to the headwaters approximately 43 mi at Old Caney Rd in Wharton County

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
12153	1305	CANEY CREEK AT SERGEANT JOE PARKS JR MEMORIAL HIGHWAY / FM 457 IN MATAGORDA COUNTY	UI	Quarterly	Field, Conventional, Bacteria, Flow
12154	1305	CANEY CREEK AT SH 35 APPROXIMATELY 3.75 KM NE OF VAN VLECK	FO	Quarterly	Field, Conventional, Bacteria, Flow
12135	1305A	HARDEMAN SLOUGH IMMEDIATELY DOWNSTREAM OF ALLENHURST RD NE OF FM 2540 NEAR ALLENHURST COMMUNITY	UI	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston

Caney Creek Above Tidal - 1305

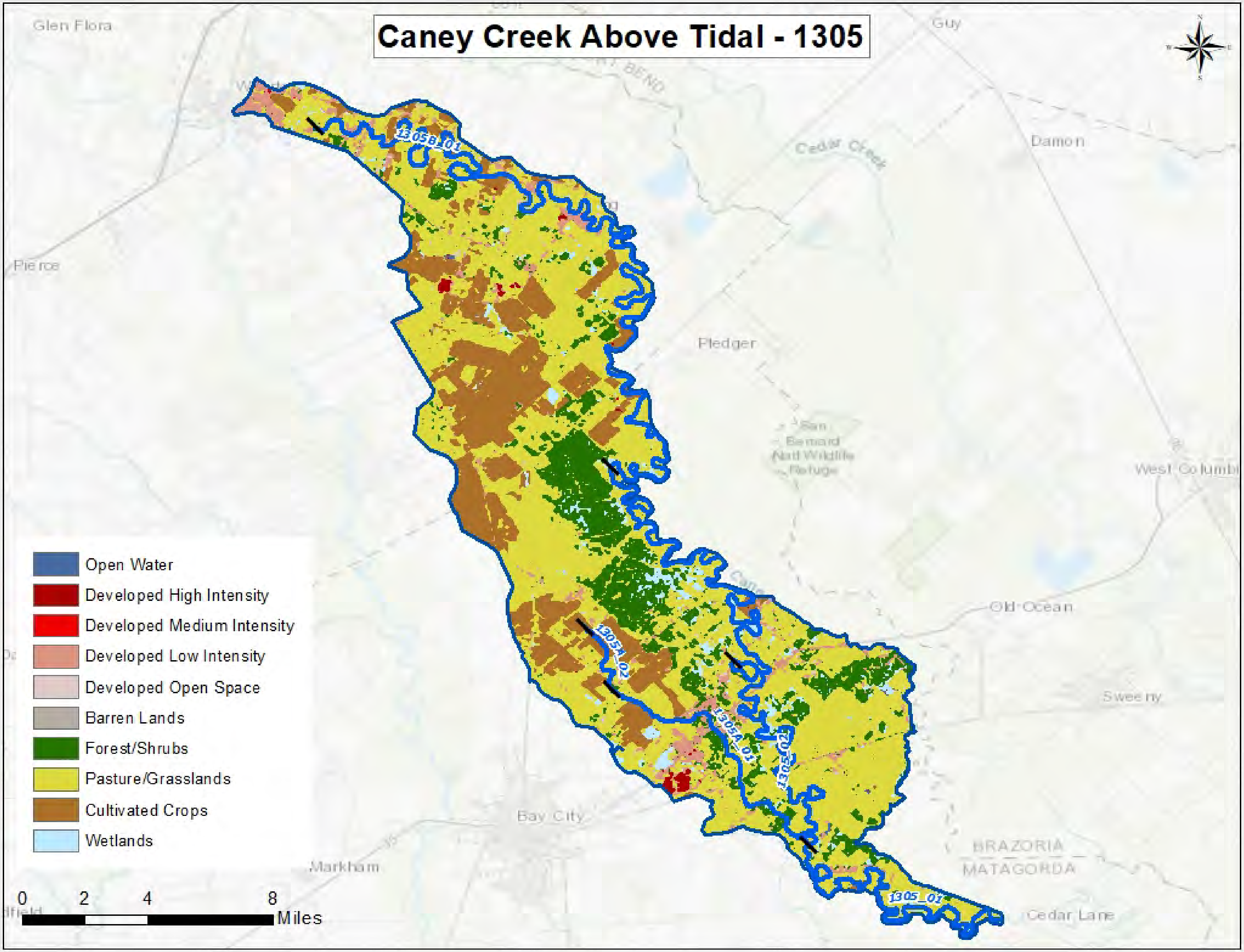


Segment 1305 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0 / 4.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0 / 3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	200		
Sulfate (mg/L as SO_4):	75		
Total Dissolved Solids (mg/L):	1,000		

Segment Discussion

Watershed Characteristics and Land Cover: The Caney Creek Above Tidal (1305) watershed is primarily rural with the majority of land (76.81 percent) used for agricultural purposes. The cities of Wharton, Boling-lago, and Van Vleck represent the only small developed portions of the watershed. A large area of undeveloped forested land and wetland is present in the south-central part of the watershed with other small plots scattered throughout the area. Major tributaries include Hardeman Slough, Quinine Slough, Water Hole Creek, Gardner Slough, and Snead Slough.

Segment 1305 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	50,155.09	59.38	66,467.34	76.81	32.52
Barren Lands	140.55	0.17	13.12	0.02	-90.66
Developed	1,182.69	1.40	5,485.16	6.34	363.79
Forest/Shrubs	1,340.14	1.59	10,318.04	11.92	669.92
Open Water	743.02	0.88	18.01	0.02	-97.58
Wetlands	30,906.25	36.59	4,234.86	4.89	-86.30
TOTAL	**84,467.74**	**100.00**	**86,536.53**	**100.00**	



Caney Creek Above Tidal - 1305
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
2
4
8
Miles
1305B_01
1305A_02
1305A_01
1305_02
1305_01
Glen Flora
Guy
Damon
Cedar Creek
Pierce
Pledger
West Columbi
Old Ocean
Sweeny
Bay City
Markham
BRAZORIA
MATAGORDA
Cedar Lane

Water Quality Issues:

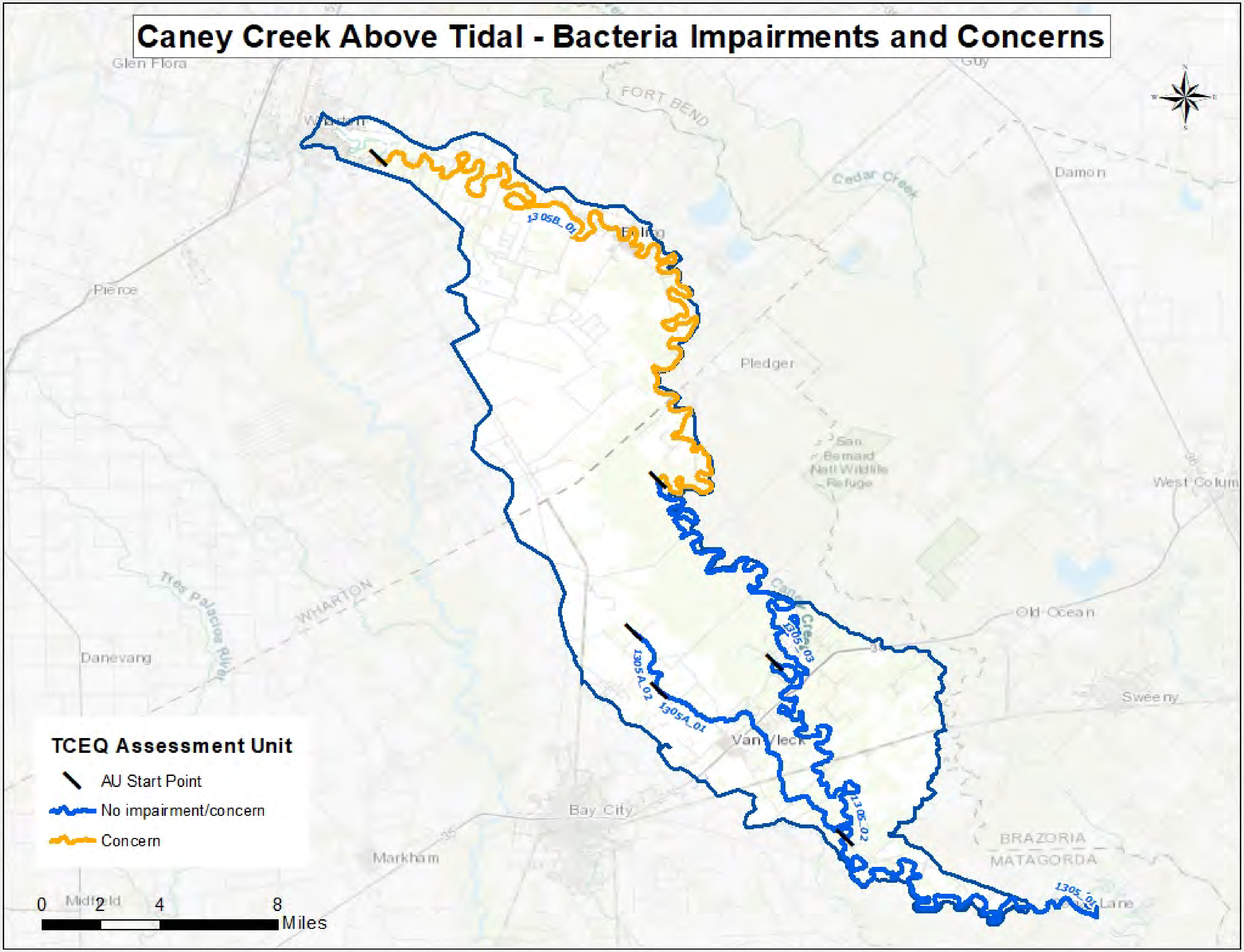
Bacteria Impairments and Concerns
The 2020 Integrated Report lists the unclassified assessment unit 1305B_01 as having a concern for recreation use due to an elevated *E. coli* geometric mean.

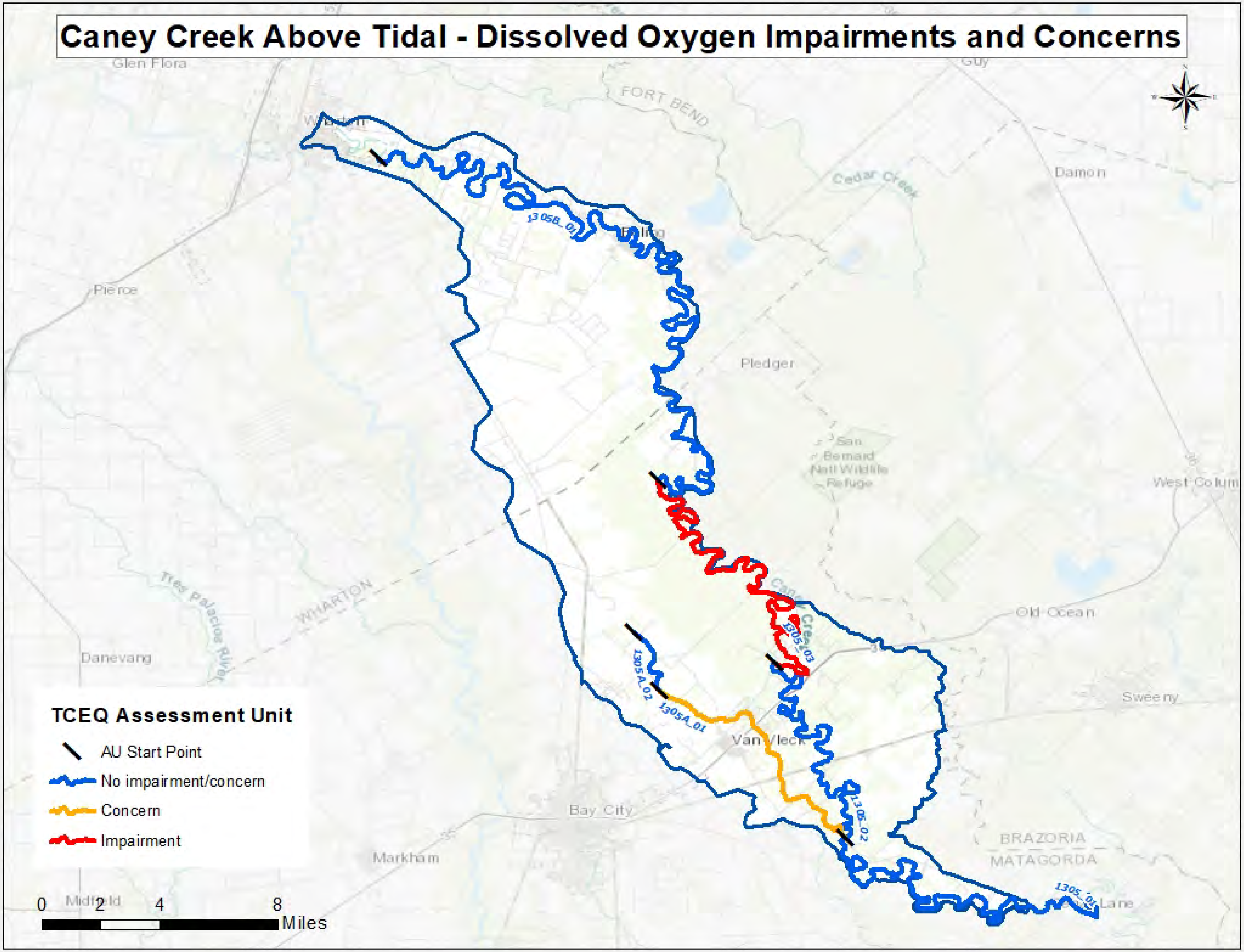
Dissolved Oxygen Impairments and Concerns
Assessment unit 1305_03 does not support its aquatic life use designation due to depressed dissolved oxygen. This impairment is based on 24-hour dissolved oxygen measurements. A concern was identified in 1305A based on dissolved oxygen grab screening levels.

Nutrient Concerns
Nutrient concerns for total phosphorus are present for 1305_03 and 1305B_01.

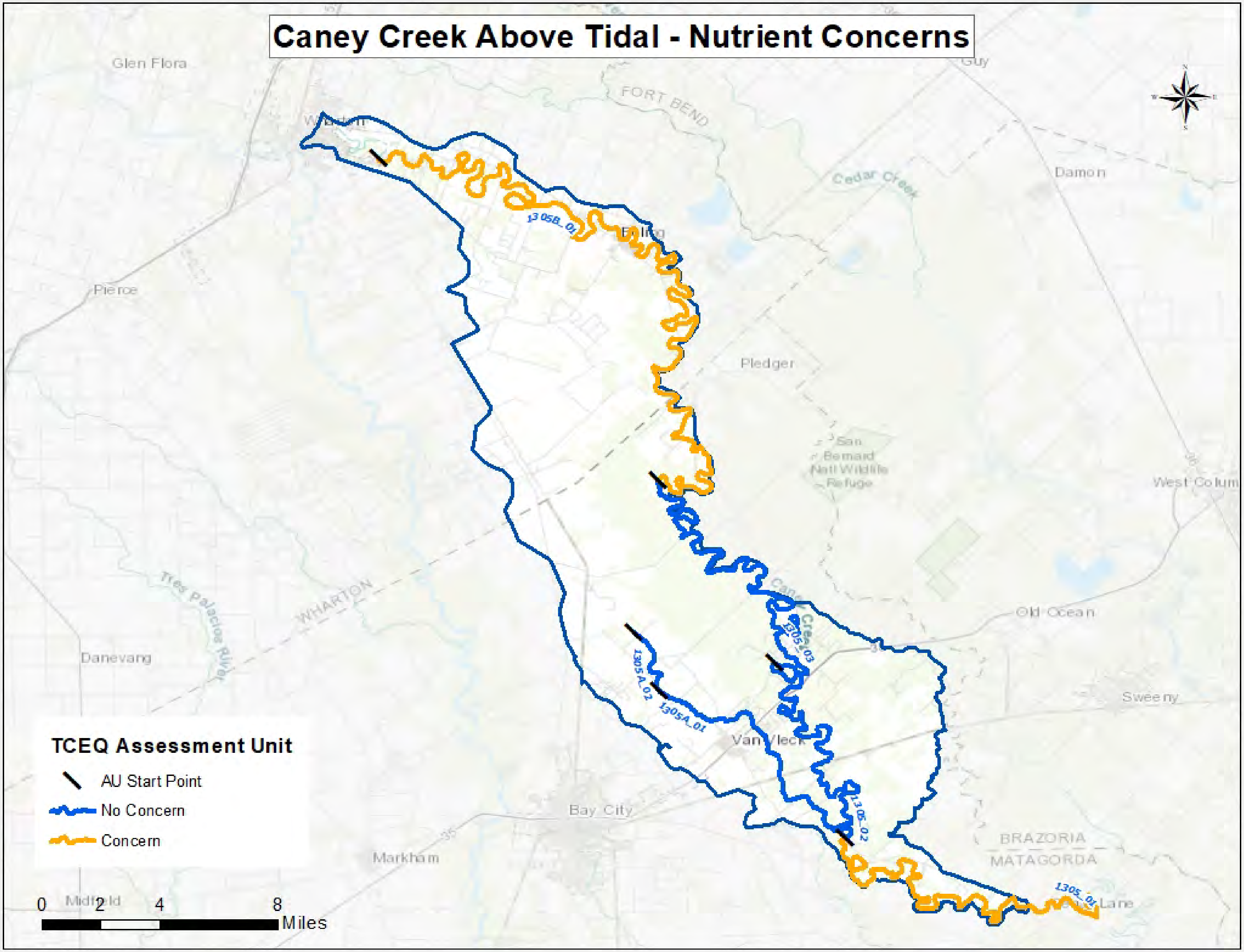
PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Habitat Impairments and Concerns
A concern for habitat is present in assessment unit 1305_02.

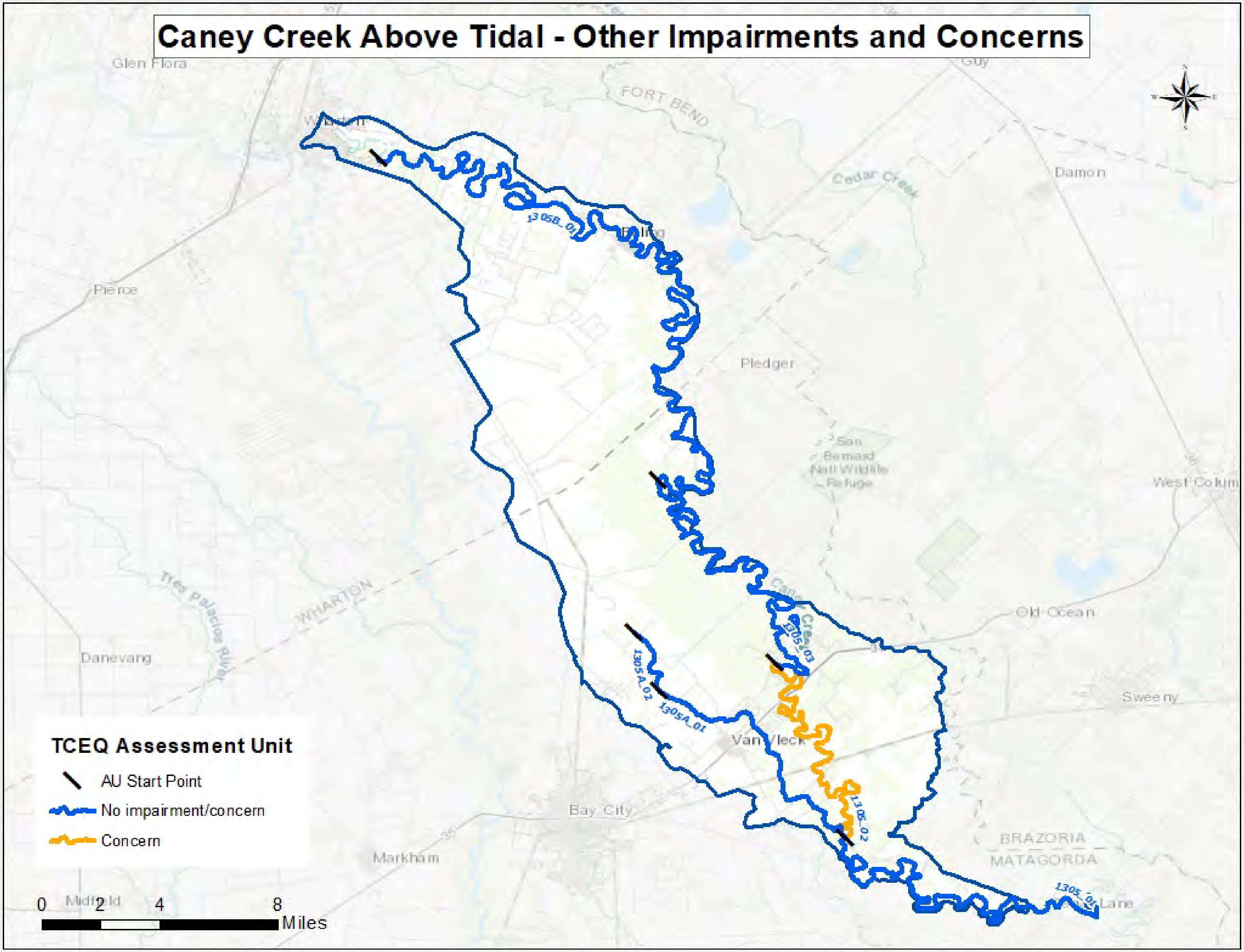

Caney Creek Above Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
0
2
4
8
Miles
1305B_01
1305A_02
1305A_01
1305_03
1305_02
1305_01
Glen Flora
Wharton
FORT BEND
Cedar Creek
Damon
Guy
Pierce
Pledger
San Bernard Nat'l Wildlife Refuge
West Colum
Old Ocean
Sweeny
Danevang
Tres Palacios River
WHARTON
Van Vleck
Bay City
Markham
Midfield
BRAZORIA
MATAGORDA
Lane
Caney Creek



Caney Creek Above Tidal - Dissolved Oxygen Impairments and Concerns
Glen Flora
FORT BEND
Cedar Creek
Damon
Pierce
Pledger
San Bernard Natl Wildlife Refuge
West Colum
1305B_01
1305_03
1305A_02
1305A_01
1305_02
1305_01
Old Ocean
Danevang
Tres Palacios River
WHARTON
Sweeny
Van Vleck
Bay City
Markham
BRAZORIA
MATAGORDA
Lane
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0 2 4 8
Miles



Caney Creek Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0 2 4 8
Miles
1305B_01
1305A_02
1305A_01
1305_03
1305_02
1305_01
Glen Flora
FORT BEND
Cedar Creek
Damon
Pierce
Pledger
San Bernard Nat'l Wildlife Refuge
West Columbia
Old Ocean
Danevang
Tres Palacios River
WHARTON
Van Vleck
Sweeny
Bay City
Markham
BRAZORIA
MATAGORDA
Guy
Boling
Caney Creek
Lane



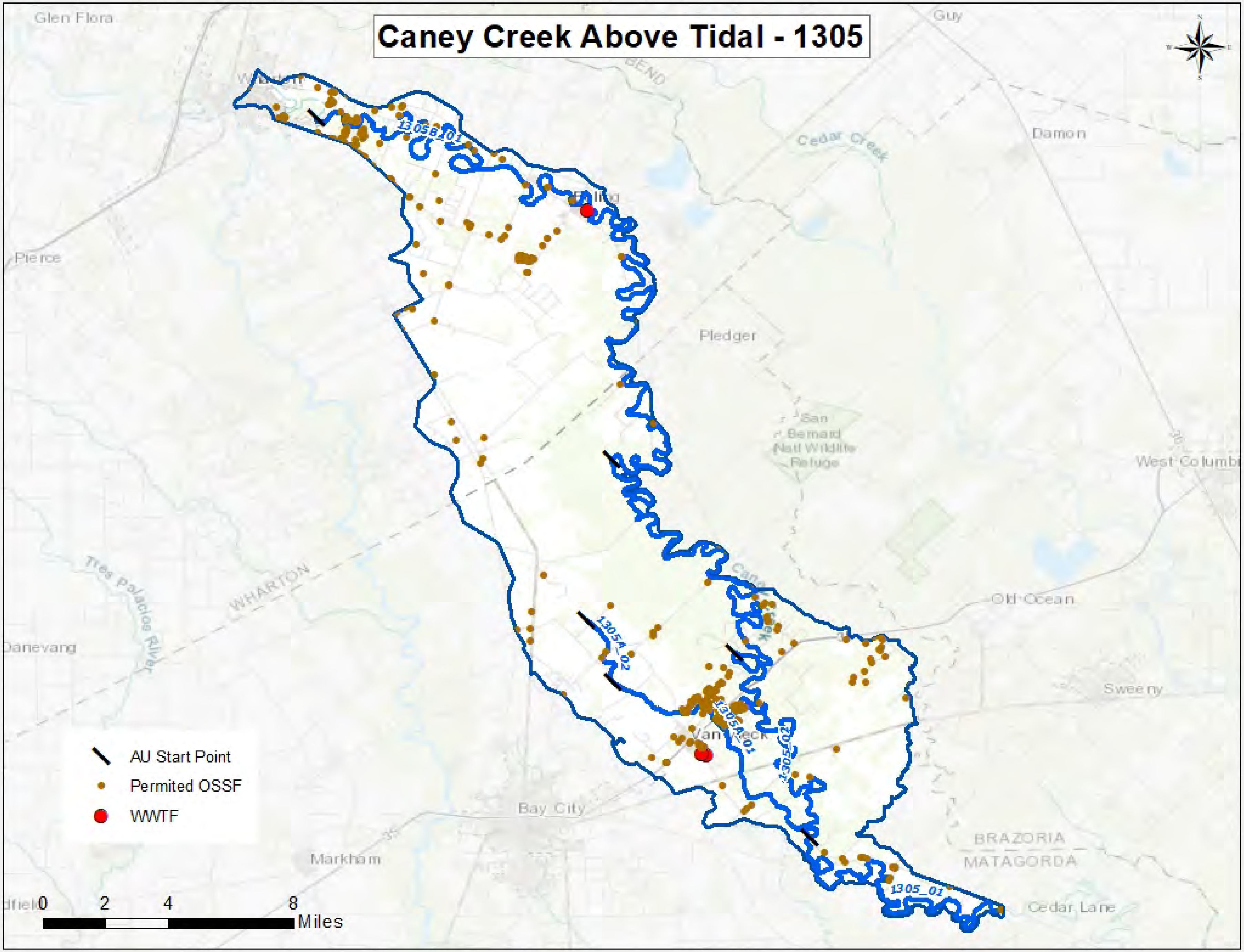
Caney Creek Above Tidal - Other Impairments and Concerns
Glen Flora
Guy
FORT BEND
Cedar Creek
Damon
Pierce
Pledger
San Bernard Nat'l Wildlife Refuge
West Colum
WHARTON
Tres Palacios River
Danevang
Old Ocean
Sweeny
Van Vleck
Bay City
Markham
BRAZORIA
MATAGORDA
Lane
1305B_01
1305_03
1305A_02
1305A_01
1305_02
1305_01
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
0
2
4
8
Miles

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Caney Creek Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, failing on-site sewage facilities, feral hogs, and animal waste.

There are 3 permitted wastewater outfalls in the Caney Creek Above Tidal watershed. In the majority of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 410 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Caney Creek Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Caney Creek Above Tidal watershed.



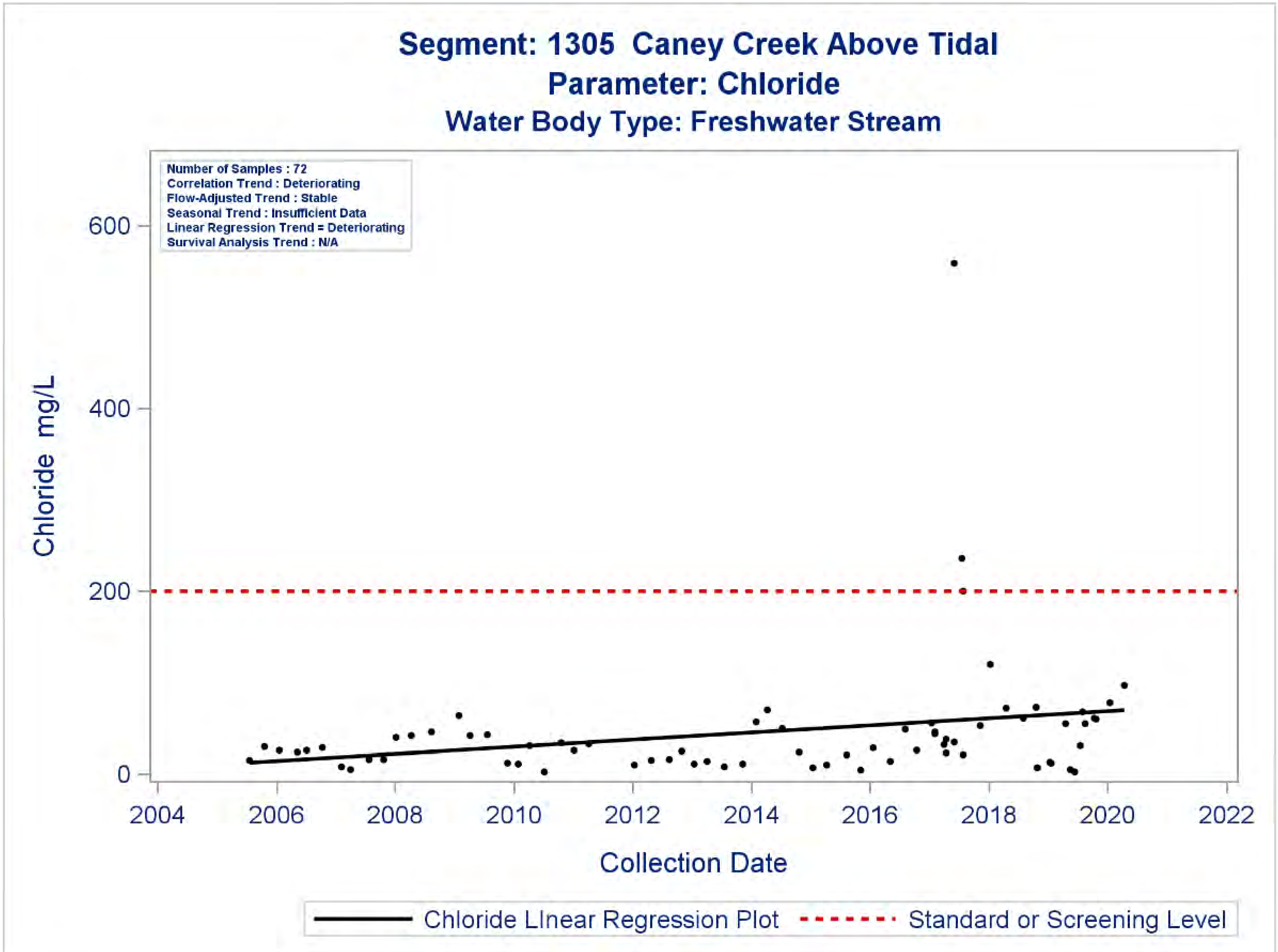
Caney Creek Above Tidal - 1305
Glen Flora
Guy
Damon
Cedar Creek
Pledger
Pierce
San Bernard Natl Wildlife Refuge
West Columbia
Tres Palacios River
WHARTON
Danevang
Old Ocean
Sweeny
Bay City
Markham
BRAZORIA
MATAGORDA
Cedar Lane
1305B_01
1305A_02
1305A_01
1305A_02
1305_01
AU Start Point
Permited OSSF
WWTF
0 2 4 8 Miles

Trend Analysis:

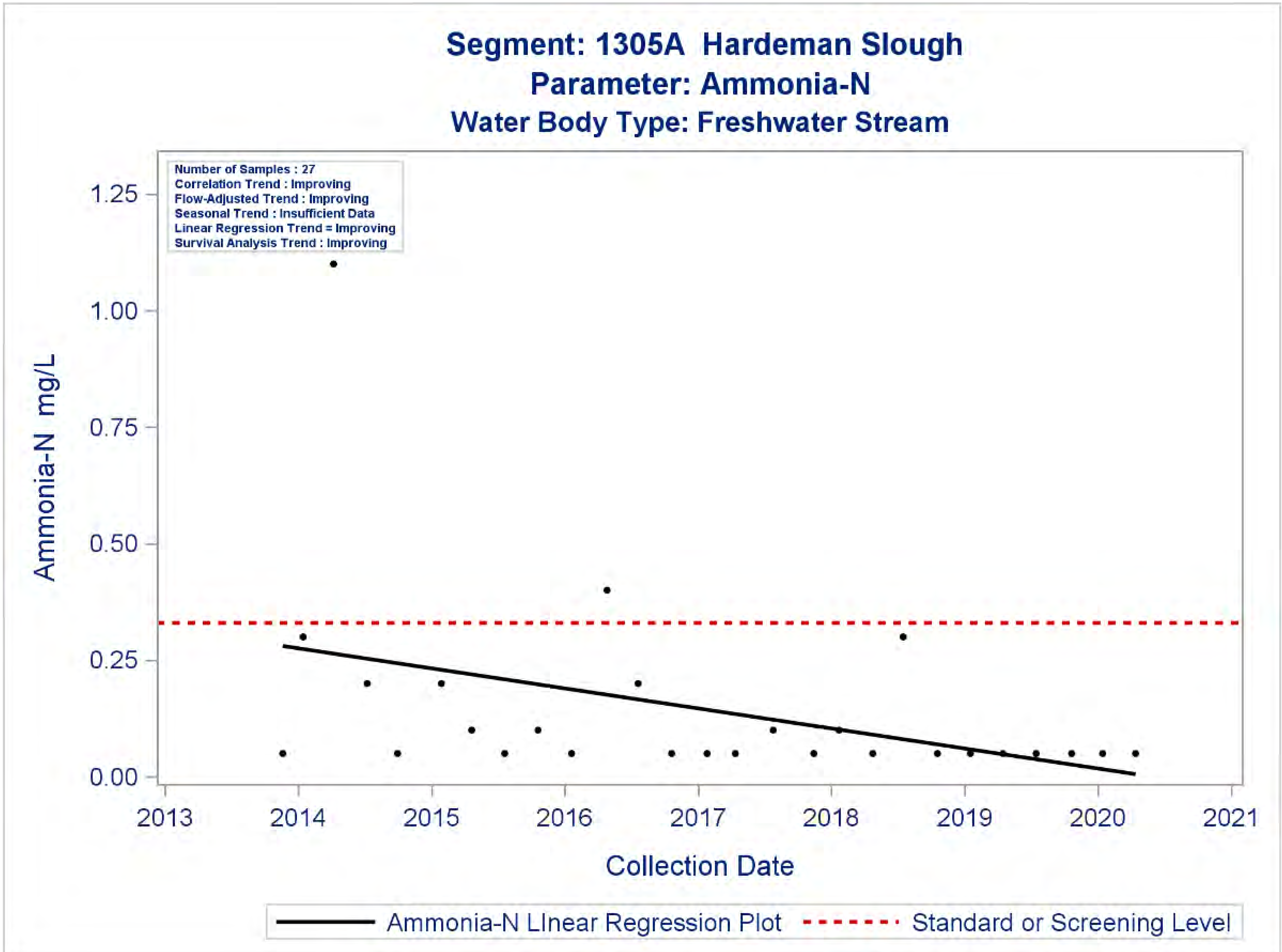
Analysis of Caney Creek Above Tidal data looked at 16 parameters of which 15 held sufficient data to perform analysis. All parameters appeared to be consistently stable through the period of record except for deteriorating trends with chloride and instantaneous flow in classified segment 1305. Simultaneously, three trends were identified in Hardeman Slough (unclassified segment 1305A). Ammonia and TSS concentrations were decreasing while Secchi Transparency was deteriorating or Secchi depths were increasing. When there is a trend with the TSS data, there is an inverse relationship to the Secchi transparency data. Where sediment loads are decreasing, the Secchi transparency depth is increasing. Increasing trends are typically categorized as 'deteriorating' trends, as seen in the graph legend, but the water is getting less turbid over time.

The only parameter listed in the 2020 Integrated Report (IR) for Hardeman Slough (1305A) was a concern for the dissolved oxygen grab screening level. A review of the dissolved oxygen trend shows one that is stable, though samples frequently are less than the 4 mg/L criterion for this segment.

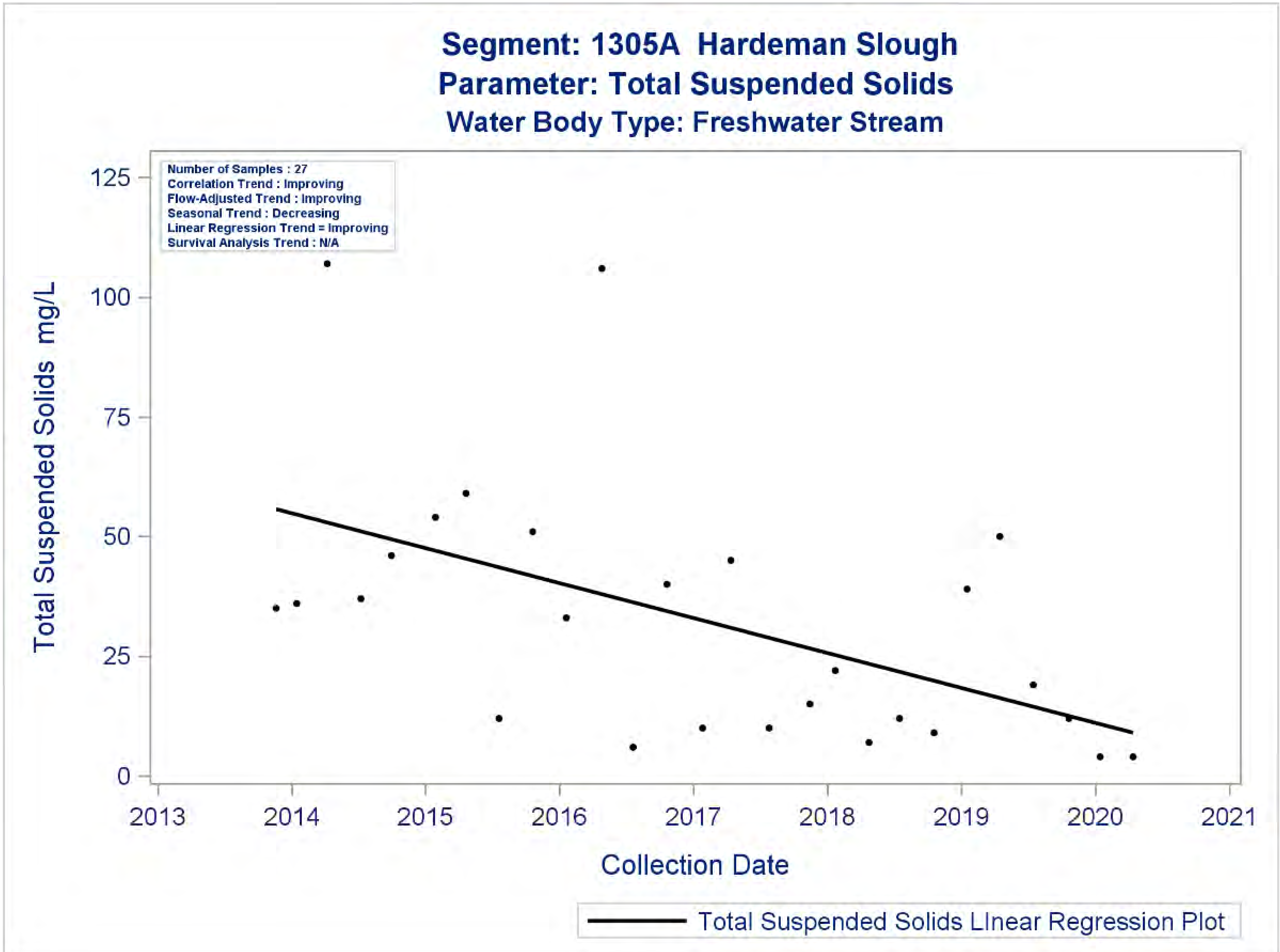
Caney Creek Above Water Hole Creek, unclassified segment 1305B, is listed in the 2020 IR for a contact recreation standard concern and a screening level concern for total phosphorus. Ambient monitoring has not been collected in this unclassified segment in recent years, so trends were not available due to insufficient data.



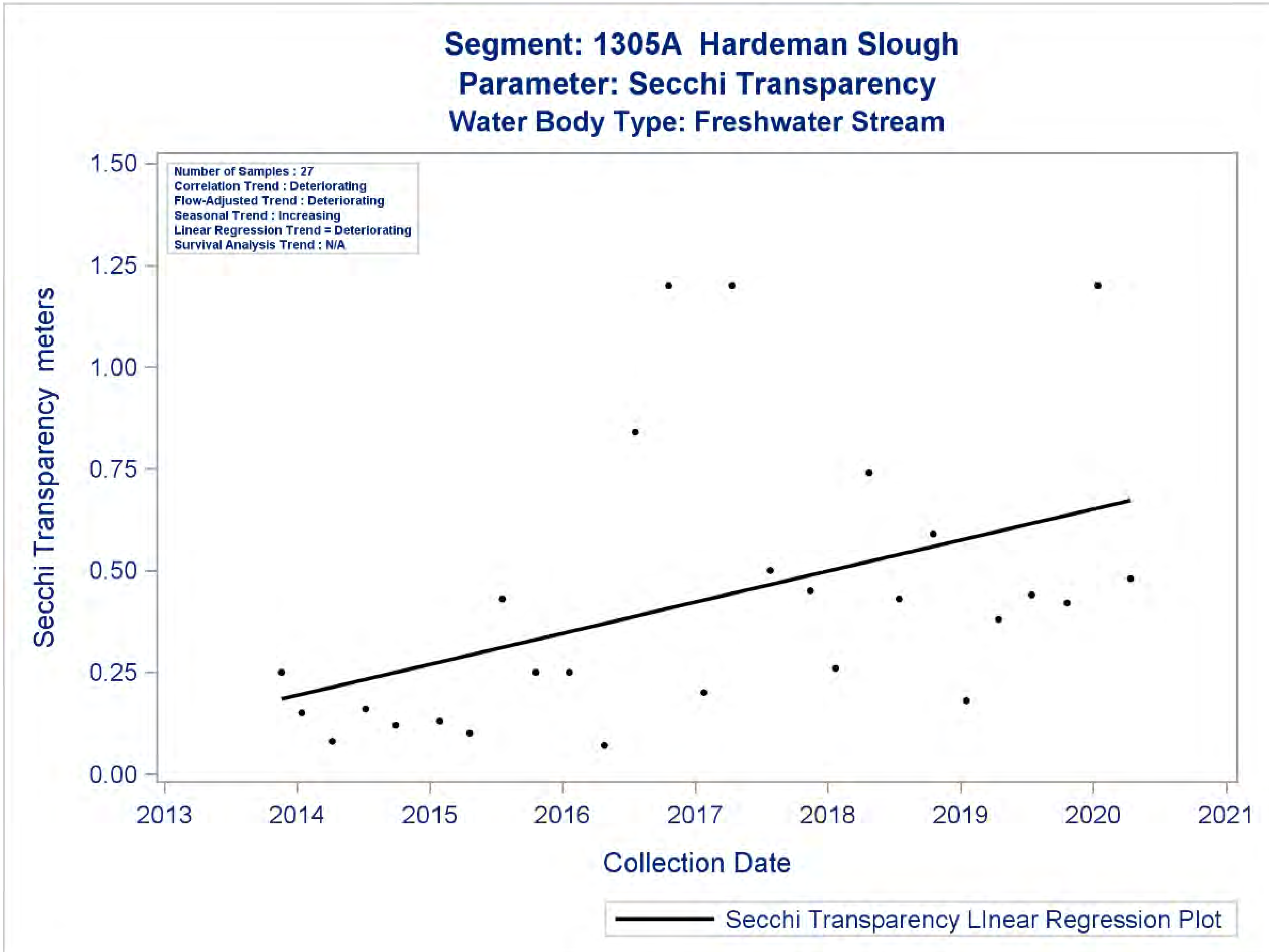
Segment: 1305 Caney Creek Above Tidal
Parameter: Chloride
Water Body Type: Freshwater Stream
Number of Samples : 72
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Chloride mg/L
600
400
200
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LInear Regression Plot
Standard or Screening Level



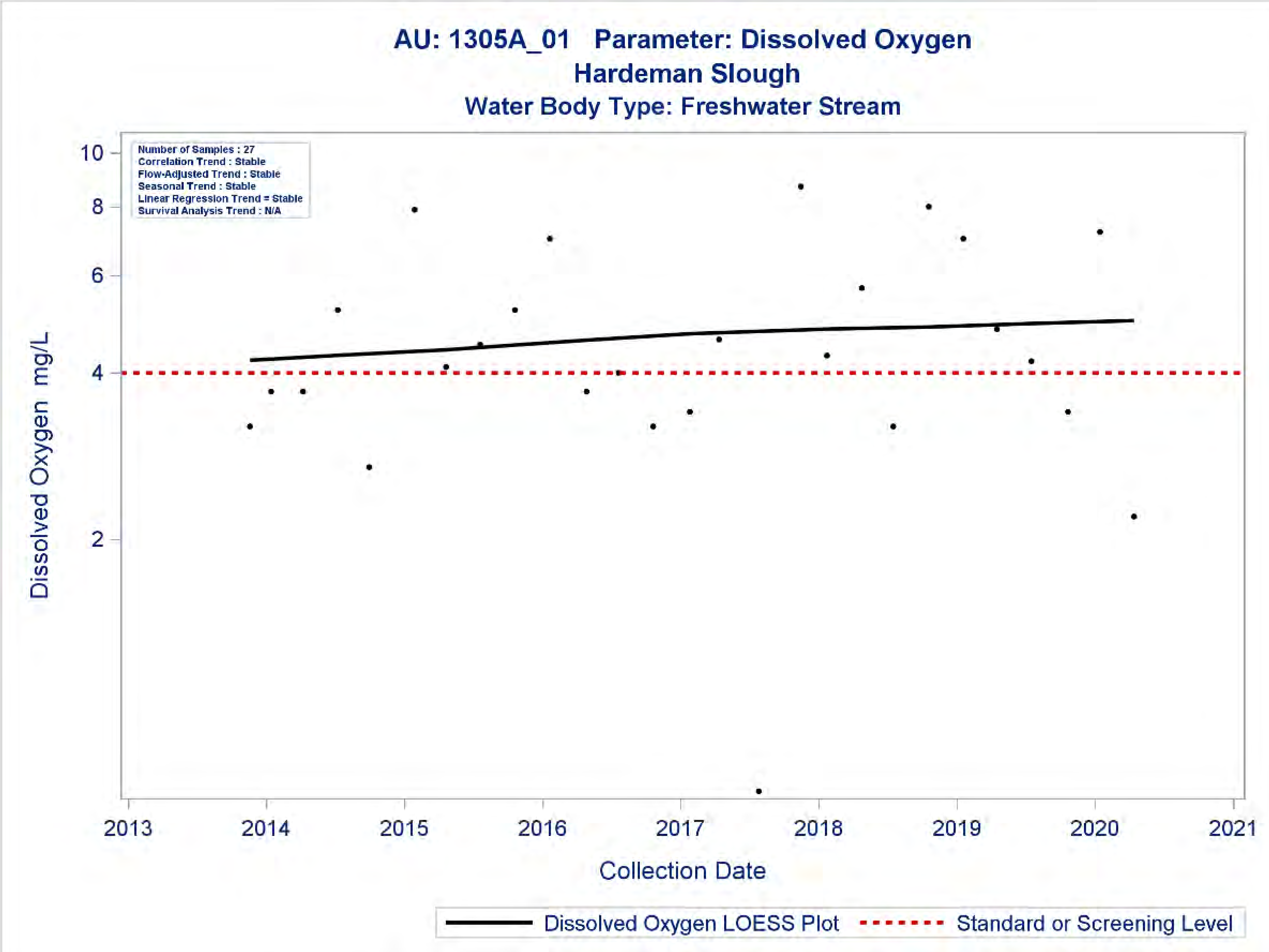
Segment: 1305A Hardeman Slough
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 27
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Insufficient Data
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
1.25
1.00
0.75
0.50
0.25
0.00
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



Segment: 1305A Hardeman Slough
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 27
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
125
100
75
50
25
0
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Suspended Solids LInear Regression Plot



Segment: 1305A Hardeman Slough
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 27
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Secchi Transparency meters
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Secchi Transparency LInear Regression Plot



AU: 1305A_01 Parameter: Dissolved Oxygen
Hardeman Slough
Water Body Type: Freshwater Stream
Number of Samples : 27
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
10
8
6
4
2
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1305B C	• Animal waste from agricultural production, hobby farms, and riding stables • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	***24-Hour Avg*** 1305_03 I ***24-Hour Min*** 1305_03 C ***Grab Screening Level*** 1305A_01 C	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve riparian buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • More public education on pet waste disposal

				• More public education regarding OSSF operation and maintenance • More public education regarding disposal of household fats, oils, and grease • Improve operation and maintenance of existing WWTF and collection systems • Regionalize chronically non-compliant WWTFs • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating
Elevated Nutrient Concentrations	***Phosphorus*** 1305_03 C 1305B_01 C	• WWTP effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Monitor phosphorus levels at WWTFs to determine if controls are needed. • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Impaired Habitat	1305_02 C	• Loss of habitat due to channelization of waterway • Ongoing maintenance of modified channel • Bank erosion and erosion at construction sites	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Re-connect oxbows and lost channels to augment water storage and retention • Work with drainage districts to install/construct habitat that doesn't interfere with water movement • Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat

Special Studies:

Bacteria impairments in Caney Creek Above Tidal are being addressed in the Basin 13 (Brazos-Colorado Coastal Basin) Bacteria Reduction Project. The Technical Support Document and the Total Maximum Daily Load document are currently undergoing TCEQ management review, with approval expected in Summer 2021.

For more information, please visit **http://h-gac.com/watershed-based-plans/brazos-colorado-coastal-basin-tmdl-and-implementation-plan.aspx.**

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number:	**1304**		**Name:**	**Caney Creek Tidal**	
Length:	36 miles	**Watershed Area:**	142 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	5	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	6

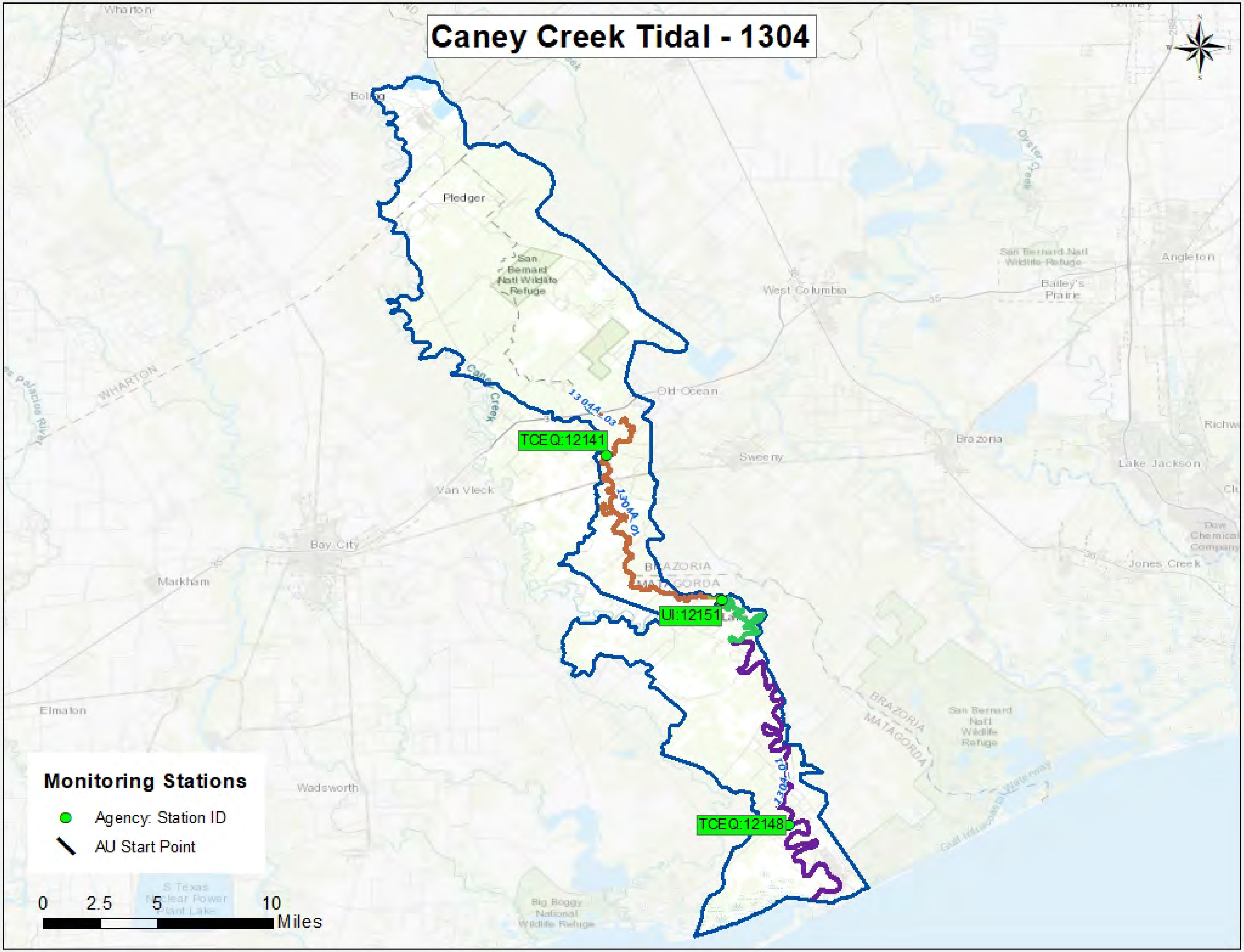
DESCRIPTION

- Segment 1304 (Tidal Stream w/ high ALU): **Caney Creek Tidal** (classified water body) – From the confluence with the Intracoastal Waterway in Matagorda County to a point 1.9 km (1.2) mi) upstream of the confluence of Linville Bayou in Matagorda County

- Segment 1304A (Intermittent Stream with Pools w/ limited ALU): **Linnville Bayou** (unclassified water body) – From the confluence with Caney Creek in Matagorda County upstream to a point 0.7 km above FH 35 in Brazoria/Matagorda Counties

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
12148	1304	CANEY CREEK TIDAL MID CHANNEL AT CHAMBLESS RD	FO	Quarterly	Field, Conventional, Bacteria
12151	1304	CANEY CREEK IMMEDIATELY UPSTREAM OF CONCRETE BRIDGE 210 M DOWNSTREAM OF LINVILLE BAYOU CONFLUENCE AND ADJACENT TO FM 521	UI	Quarterly	Field, Conventional, Bacteria
15951	1304	CANEY CREEK ABOVE TIDAL IMMEDIATELY UPSTREAM OF FM 457 IN CITY OF CEDAR LANE	UI	Quarterly	Field, Conventional, Bacteria, Flow
12138	1304A	LINVILLE BAYOU 35 M DOWNSTREAM OF SIMS ROAD APPROXIMATELY 5.20 KM UPSTREAM OF MOUTH	FO	Quarterly	Field, Conventional, Bacteria
12141	1304A	LINVILLE BAYOU 35 M UPSTREAM OF LITTLE LINVILLE ROAD/CR 324	FO	Quarterly One/Year	Field, Conventional, Bacteria, Flow Metals in Sediment, Organics in Sediment

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston


Caney Creek Tidal - 1304
Monitoring Stations
Agency: Station ID
AU Start Point
0
2.5
5
10
Miles
TCEQ:12141
UI:12151
TCEQ:12148
1304A_03
1304A_01
1304_01
Wharton
Boling
Pledger
San Bernard Natl Wildlife Refuge
West Columbia
Old Ocean
Sweeny
Van Vleck
Bay City
Markham
Elmaton
Wadsworth
Brazoria
Angleton
Bailey's Prairie
Lake Jackson
Jones Creek
Dow Chemical Company
BRAZORIA
MATAGORDA
WHARTON
Caney Creek
Oyster Creek
Big Boggy National Wildlife Refuge
S Texas Nuclear Power Plant Lake
Gulf Intracoastal Waterway

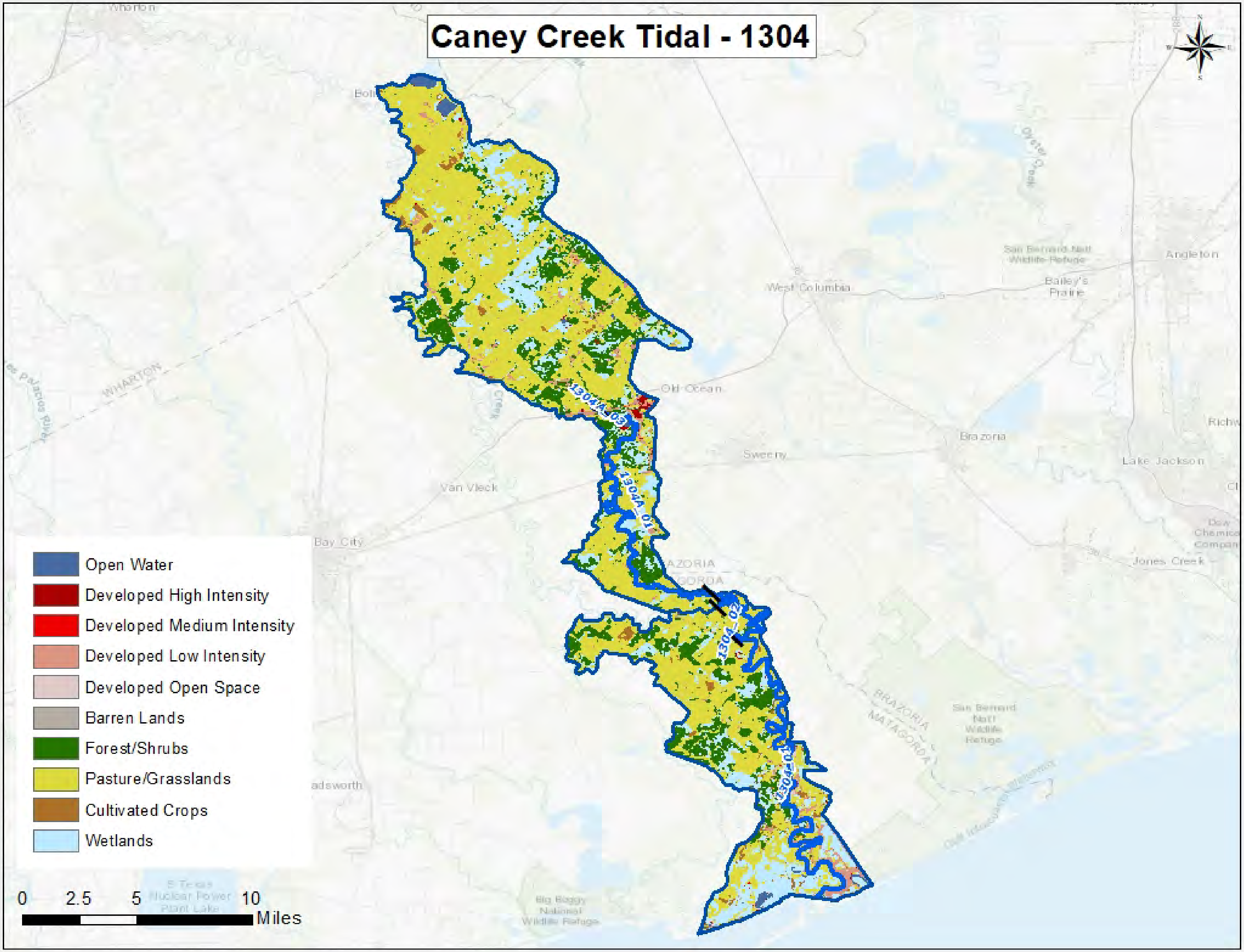
Segment 1304 Water Quality Standards and Screening Levels					
Standards	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia (mg/L):	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	3.0	Nitrate-N (mg/L):	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	2.0	Orthophosphate Phosphorus (mg/L):	0.46	0.37
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus (mg/L):	0.66	0.69
Enterococci (MPN/100mL) (grab):	104		Chlorophyll *a* (µg/L):	21	14.1
Enterococci (MPN/100mL) (geometric mean):	35				
E. coli (MPN/100 mL) (grab):		399			
E. coli (MPN/100 mL) (geometric mean):		126			

Segment Discussion

Watershed Characteristics and Land Cover: The Caney Creek Tidal (1304) watershed is predominantly rural and undeveloped with the exceptions of the communities of Old Ocean in the northeast and Sargent and Bay City near the mouth of the creek. Residential homes with dock access line Caney Creek Tidal in the southern reaches of the watershed, most of which are serviced by wastewater treatment facilities. The dominant land use in the area is agricultural (58.36 percent) with cattle grazing and horse farms commonly seen throughout. Small, scattered plots of wetland and forested lands are also present, especially in the southern portion of the watershed. The bulk of the agricultural activity consists of hay pastures which are concentrated along Linnville Bayou. Major tributaries to Caney Creek Tidal are Linnville Bayou, Red Bayou, Little Linnville Bayou, Dance Bayou, and Dead Slough.

Segment 1304 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	53,436.50	49.66	62,798.04	58.36	17.52
Barren Lands	635.82	0.59	137.66	0.13	-78.35
Developed	1,860.10	1.73	5,384.19	5.00	189.46
Forest/Shrubs	2,812.61	2.61	16,927.41	15.73	501.84
Open Water	1,142.44	1.06	1,036.81	0.96	-9.25
Wetlands	47,727.44	44.35	21,323.28	19.82	-55.32
TOTAL	**107,614.91**	**100.00**	**107,607.39**	**100.00**	

Caney Creek Tidal - 1304



Water Quality Issues:

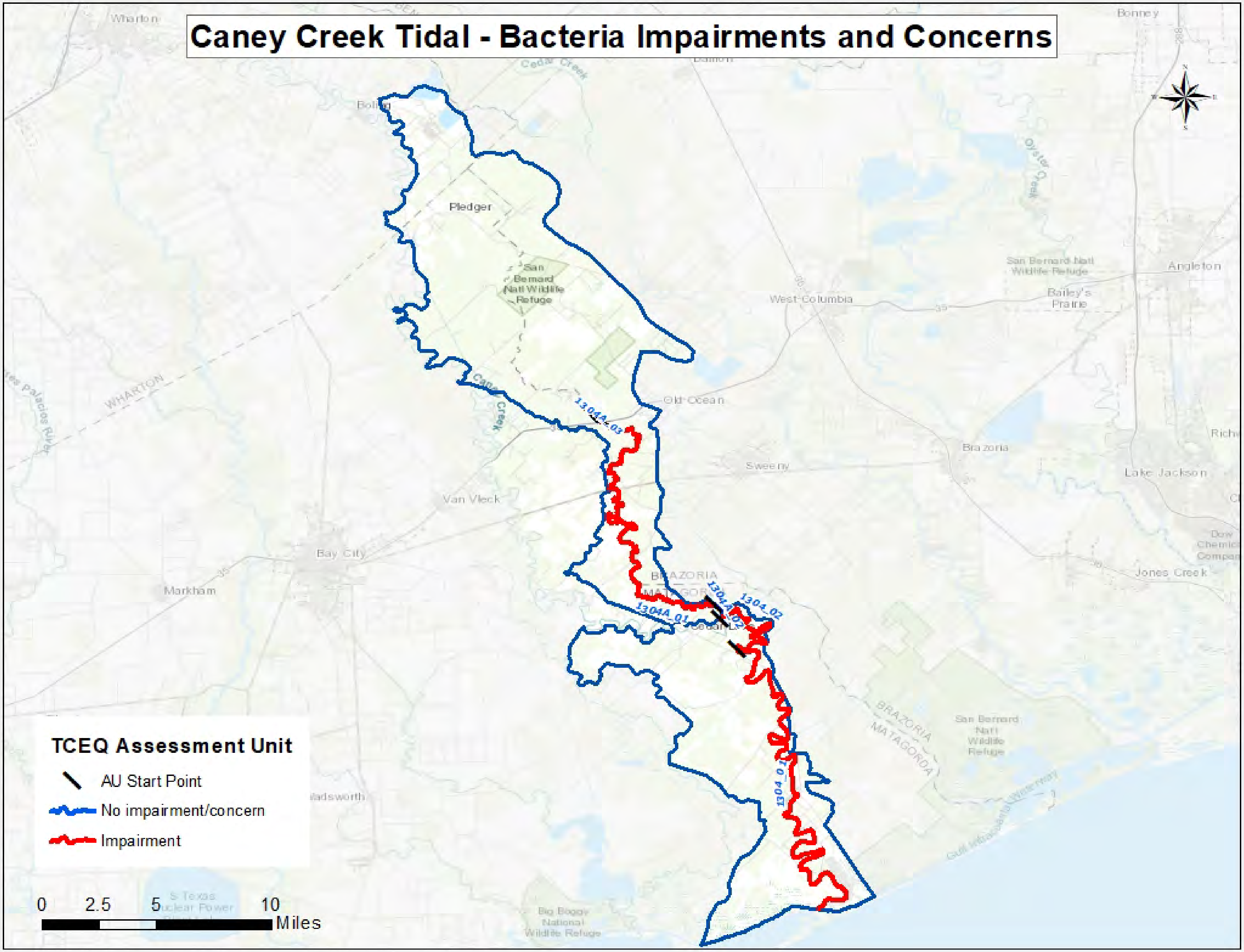
<u>Bacteria Impairments and Concerns</u>
Contact recreation use is not supported in this watershed. Both assessment units of Caney Creek Tidal (1304) are listed as impaired due to the Enterococcus geometric mean exceeding the water quality standard. Linnville Bayou (1304A) is impaired for elevated levels of *E. coli* bacteria.

<u>Dissolved Oxygen Impairments and Concerns</u>
Assessment unit 1304_01 has a concern for support of aquatic life use due to depressed dissolved oxygen in grab samples.

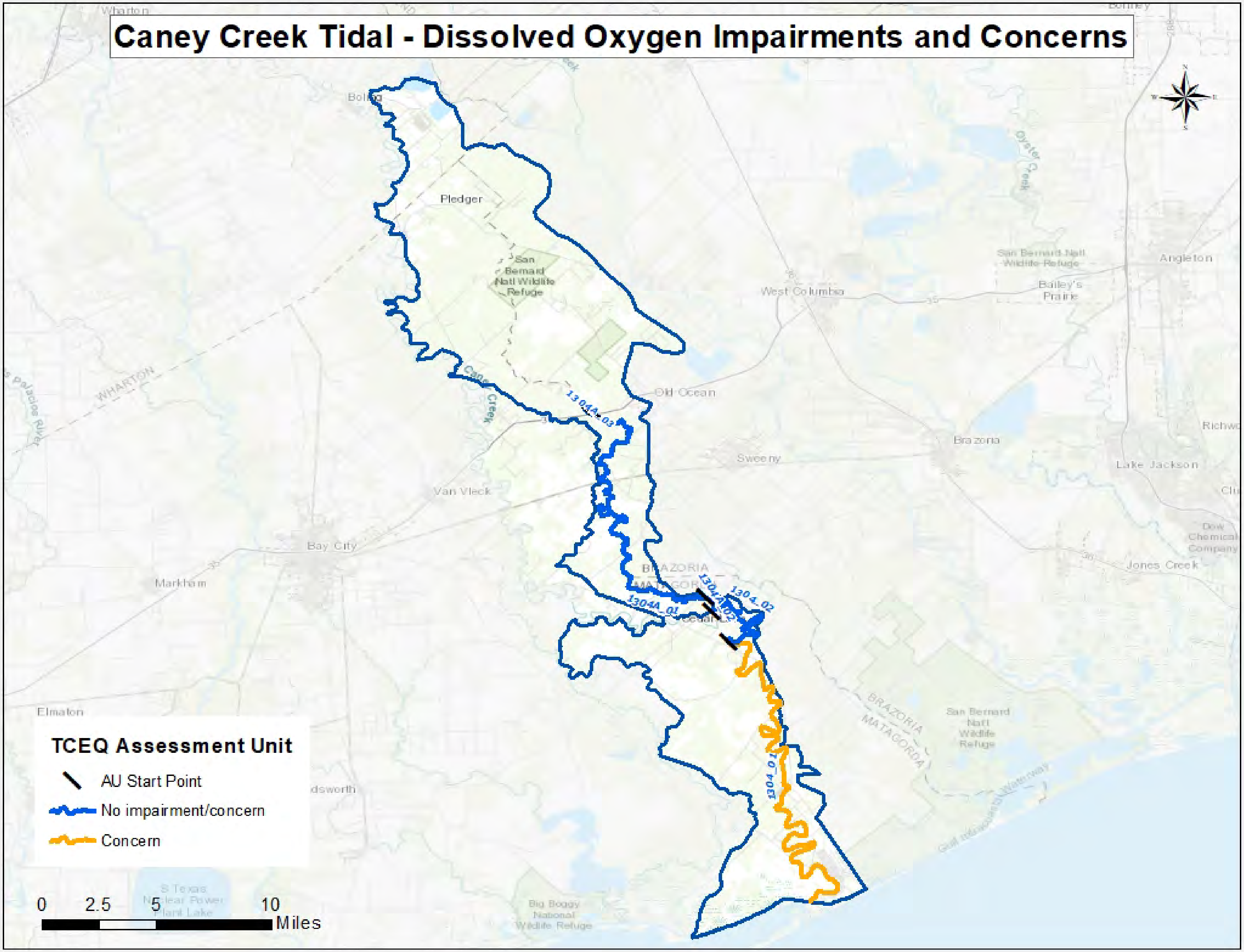
<u>Nutrient Concerns</u>
There are no nutrient concerns in this segment.

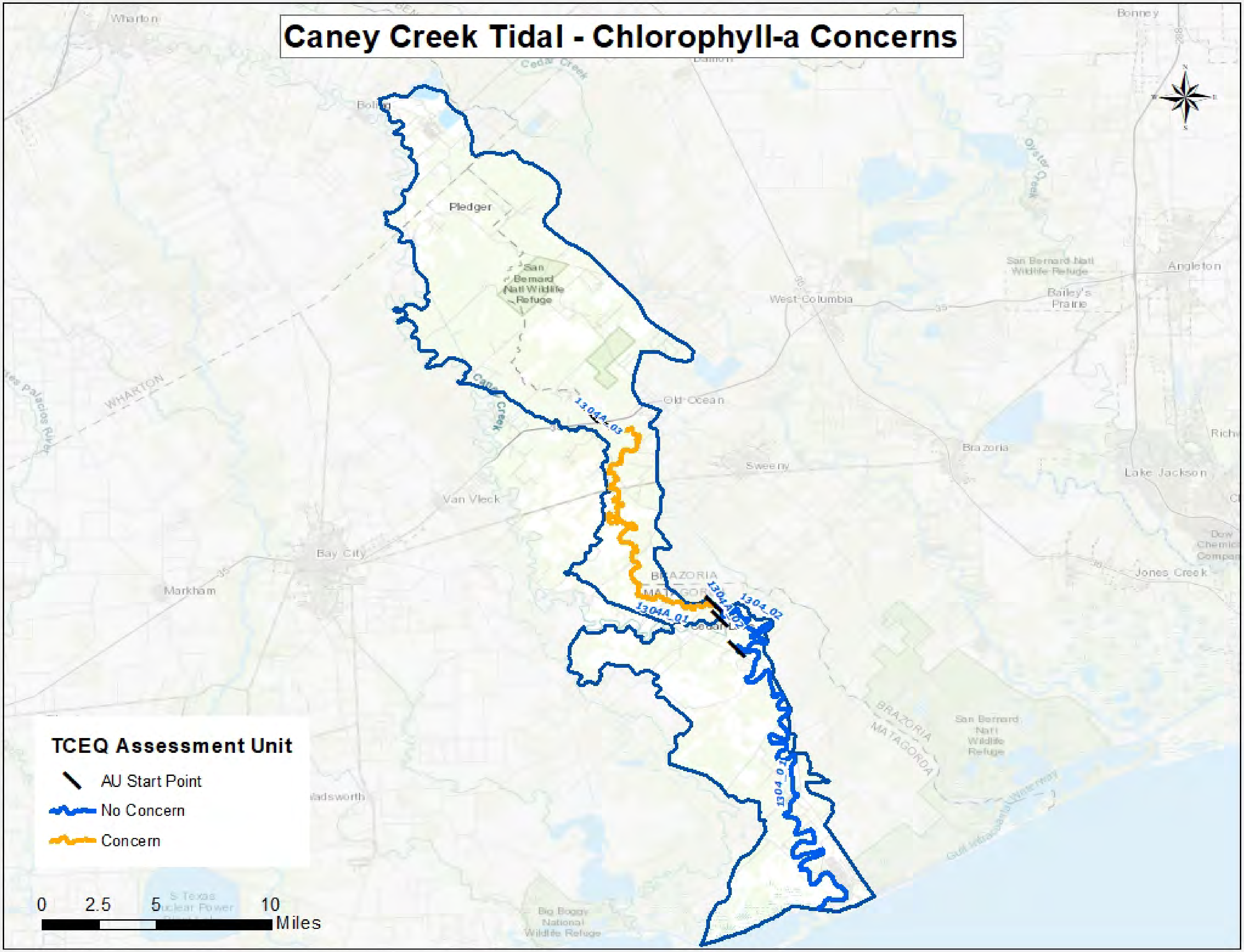
<u>PCBs and Dioxins Impairments</u>
There are no PCBs/Dioxins impairments in this segment.

<u>Chlorophyll-a Concerns</u>
A concern for chlorophyll-a exceeding screening levels was present in Linville Bayou (1304A_01)



Caney Creek Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
0
2.5
5
10
Miles
1304A_03
1304A_01
1304A_02
1304_02
1304_01
Pledger
Van Vleck
Bay City
Markham
West Columbia
Old Ocean
Sweeny
Brazoria
Angleton
Lake Jackson
Jones Creek
Wharton
Bonney
San Bernard Natl Wildlife Refuge
Bailey's Prairie
BRAZORIA
MATAGORDA
Wadsworth
Big Boggy National Wildlife Refuge


Caney Creek Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
0
2.5
5
10
Miles
Wharton
Bolling
Pledger
San Bernard Natl Wildlife Refuge
West Columbia
Angleton
Bailey's Prairie
Old Ocean
Brazoria
Sweeny
Van Vleck
Bay City
Markham
Lake Jackson
Jones Creek
Elmaton
Caney Creek
WHARTON
BRAZORIA
MATAGORDA
1304A_03
1304A_02
1304A_01
1304_02
1304_01
Big Boggy National Wildlife Refuge
Dow Chemical Company
Gulf Intracoastal Waterway



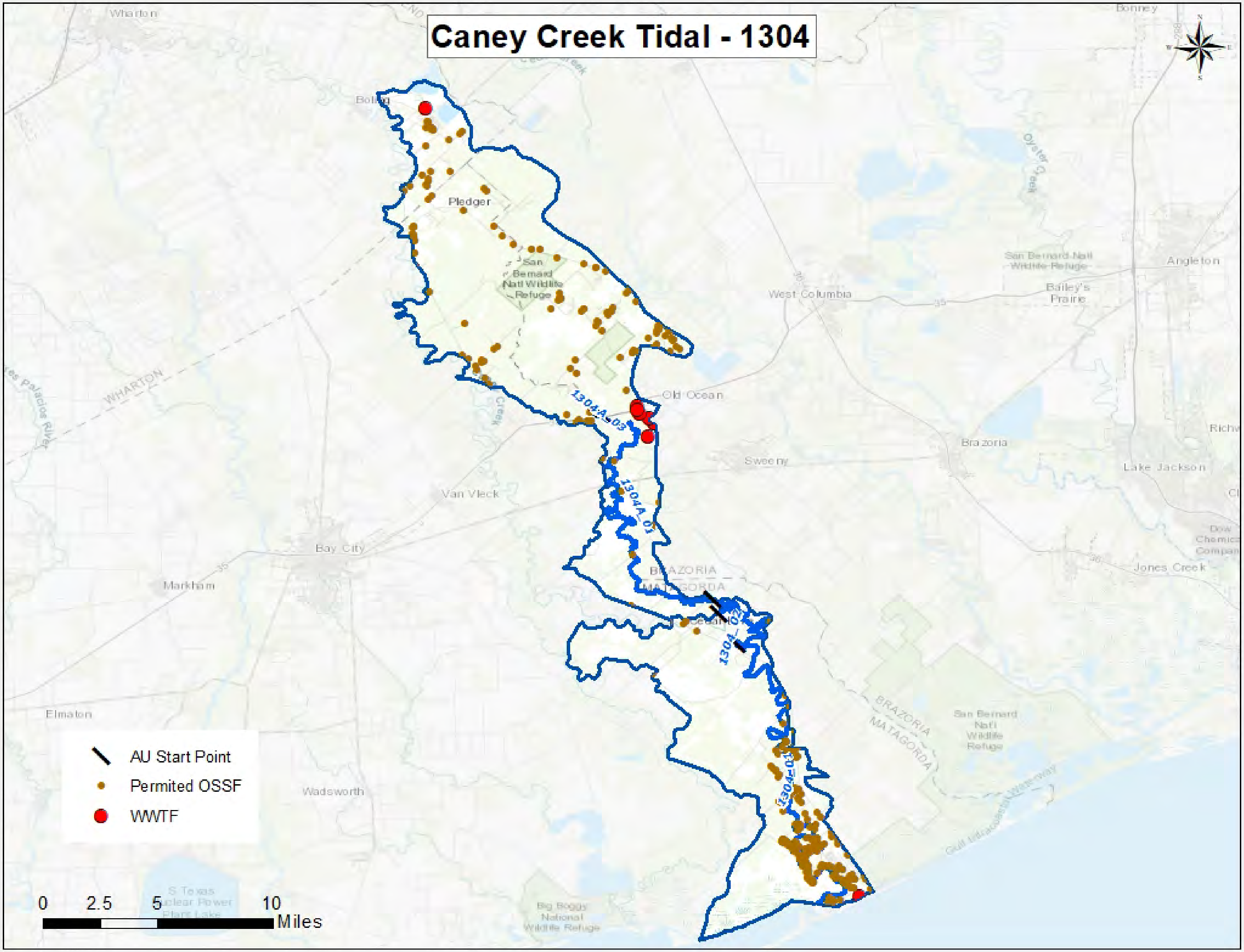
Caney Creek Tidal - Chlorophyll-a Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
2.5
5
10
Miles
1304A_03
1304A_01
1304A_02
1304_02
1304_01
Wharton
Bonney
Pledger
San Bernard Nat'l Wildlife Refuge
West Columbia
Angleton
Bailey's Prairie
Old Ocean
Brazoria
Sweeny
Lake Jackson
Van Vleck
Bay City
Markham
Jones Creek
BRAZORIA
MATAGORDA
Big Boggy National Wildlife Refuge

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Caney Creek Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, failing on-site sewage facilities, feral hogs, and animal waste.

There are 6 permitted wastewater outfalls in the Caney Creek Tidal watershed. In most areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 416 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Caney Creek Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Caney Creek Tidal watershed.

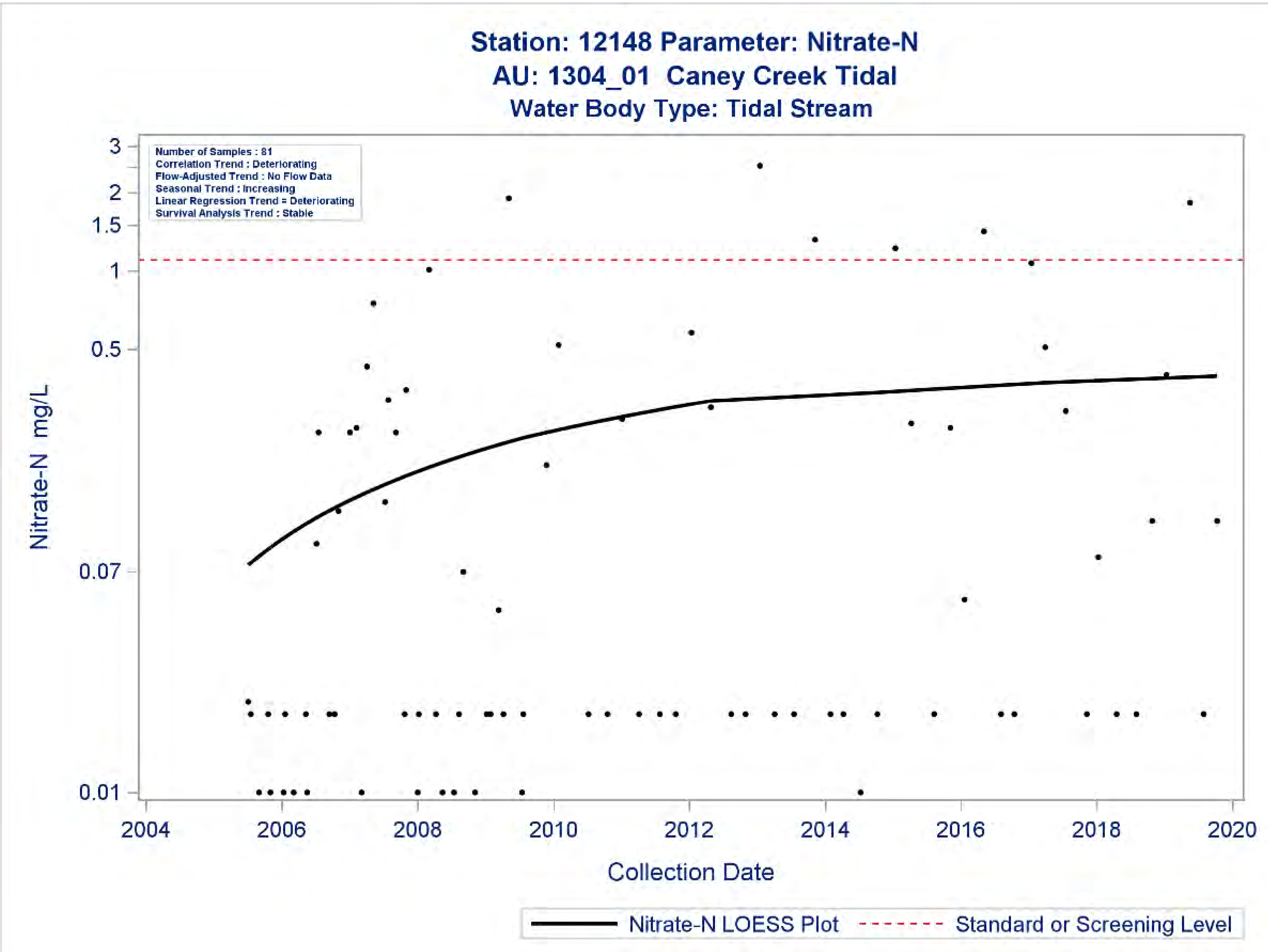


Caney Creek Tidal - 1304
AU Start Point
Permited OSSF
WWTF
0
2.5
5
10
Miles
Wharton
Boling
Pledger
San Bernard Nat'l Wildlife Refuge
West Columbia
Old Ocean
Sweeny
Van Vleck
Bay City
Markham
Elmaton
Wadsworth
Brazoria
Angleton
Bailey's Prairie
Lake Jackson
Jones Creek
Bonney
WHARTON
BRAZORIA
MATAGORDA
1304A_03
1304A_01
1304_02
1304_01
Oyster Creek
Big Boggy National Wildlife Refuge

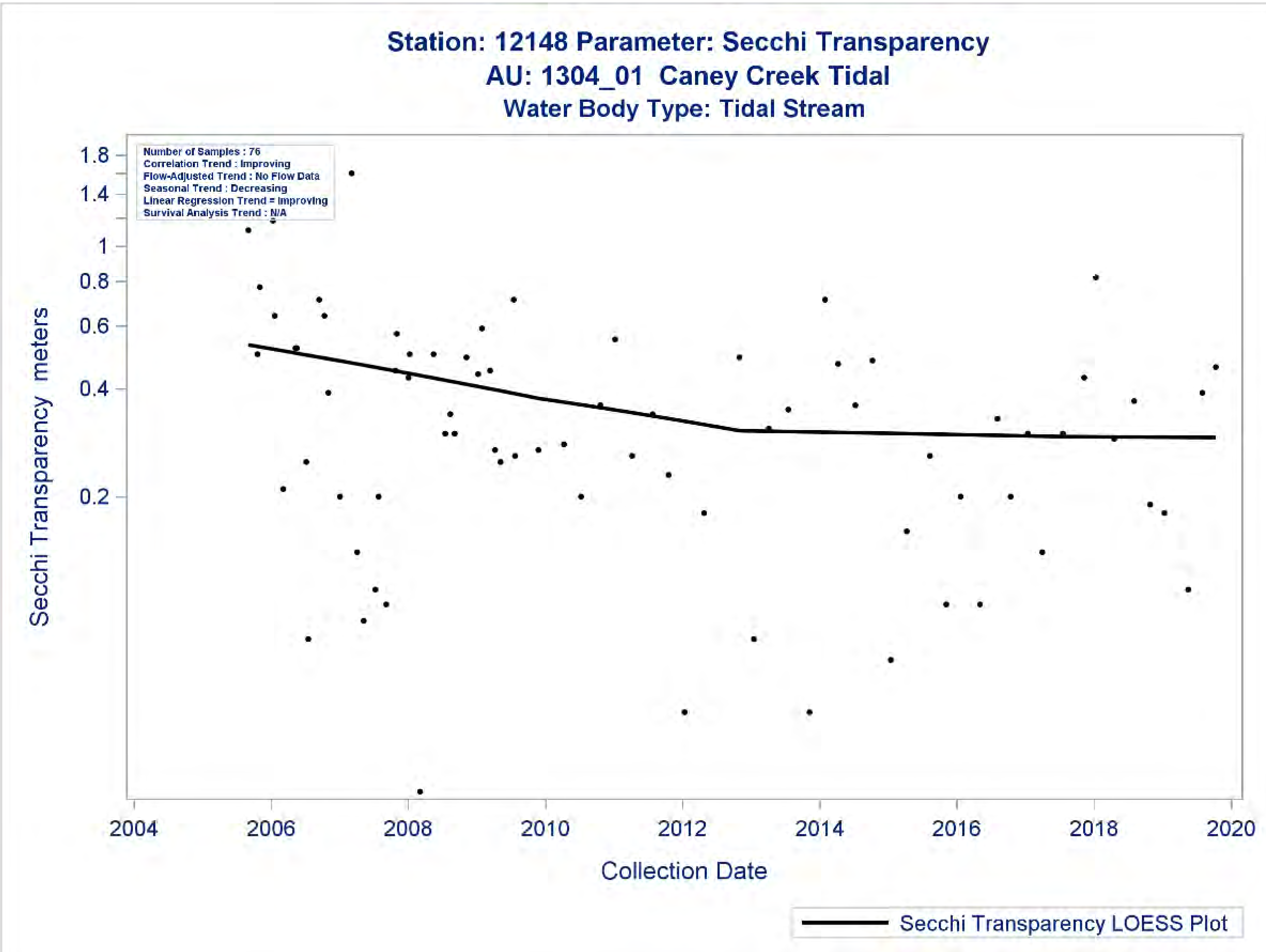
Trend Analysis:

Analysis of Caney Creek Tidal (1304) water quality data revealed parameter trends in three AUs within the entire watershed. Those trends included nitrate, Secchi transparency, and specific conductance. At site 12148 in AU 1304_01, the nitrate trend was deteriorating with increasing concentrations over time, with occasional results above the screening criteria. The Secchi transparency trend at the same site shows depths are decreasing due to more turbid water. Segment 1304 has an improving linear regression trend for specific conductance (decreasing concentrations) but a stable LOESS correlation trend. Conversely, at site 12151 in AU1304_02, the specific conductance was deteriorating with increasing concentrations. All other parameters were stable.

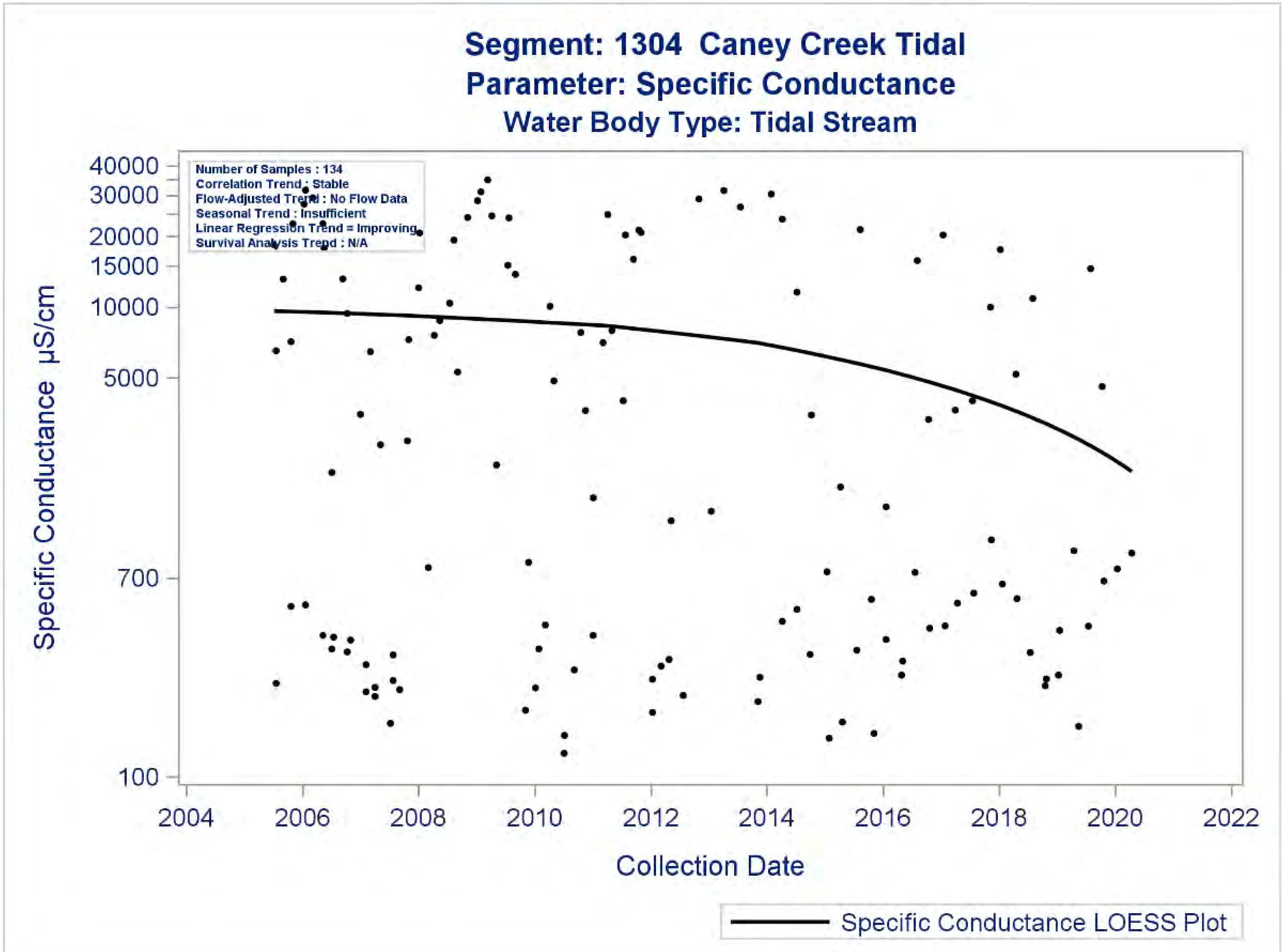
Enterococci continued to be above the contact recreation standard of 35 MPN/100 mL, though it remained stable through the reporting period. In the 2020 Integrated Report, AU 1304_02 was assessed as impaired for contact recreation for the first time, as sufficient data was collected to make this determination. In Linnville Bayou (1304A), *E.coli* bacteria concentrations were also stable but the majority of samples were greater than the 126 MPN/100 mL contact recreation standard for freshwater. A TMDL will be conducted in FY22.

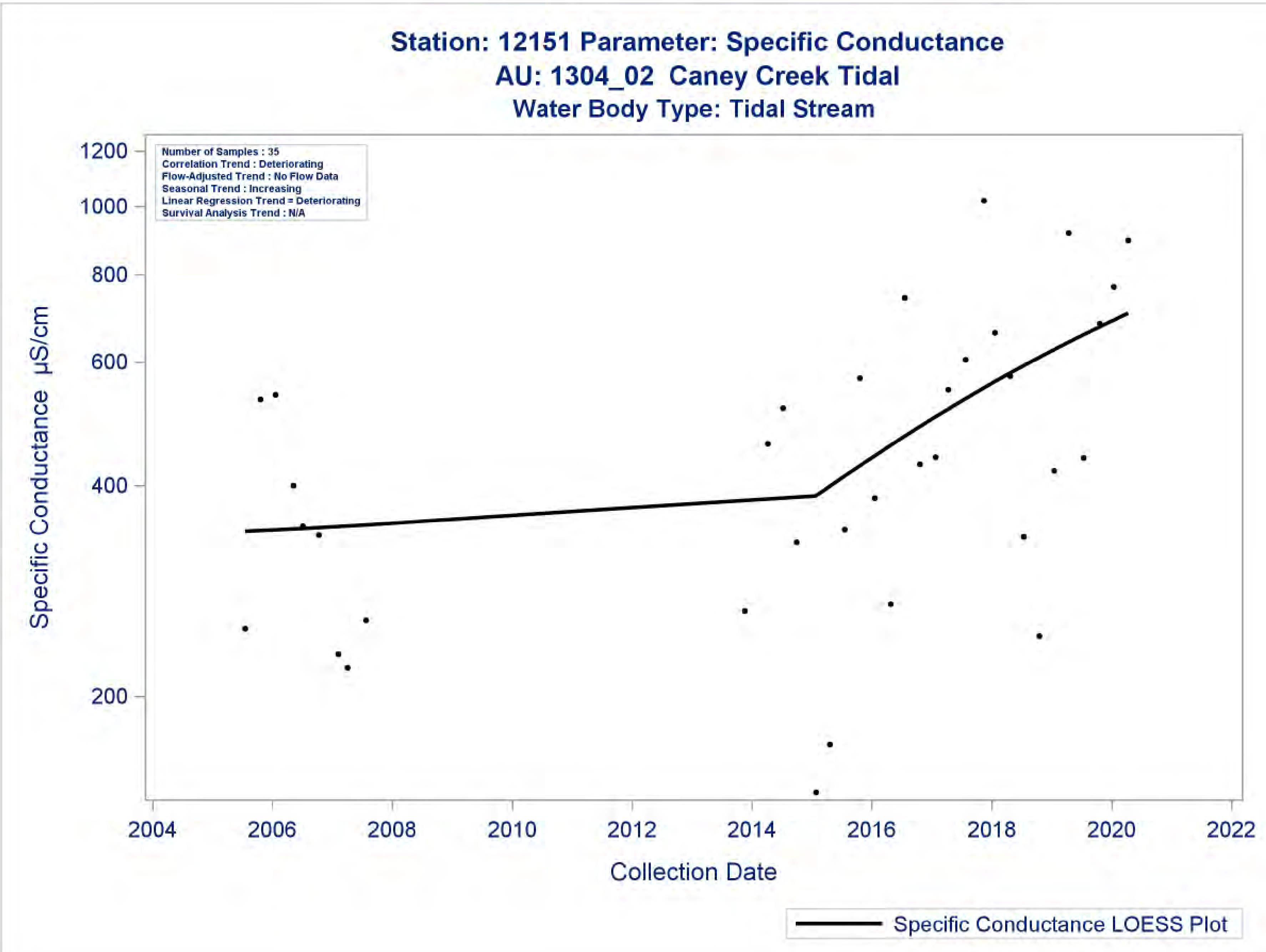


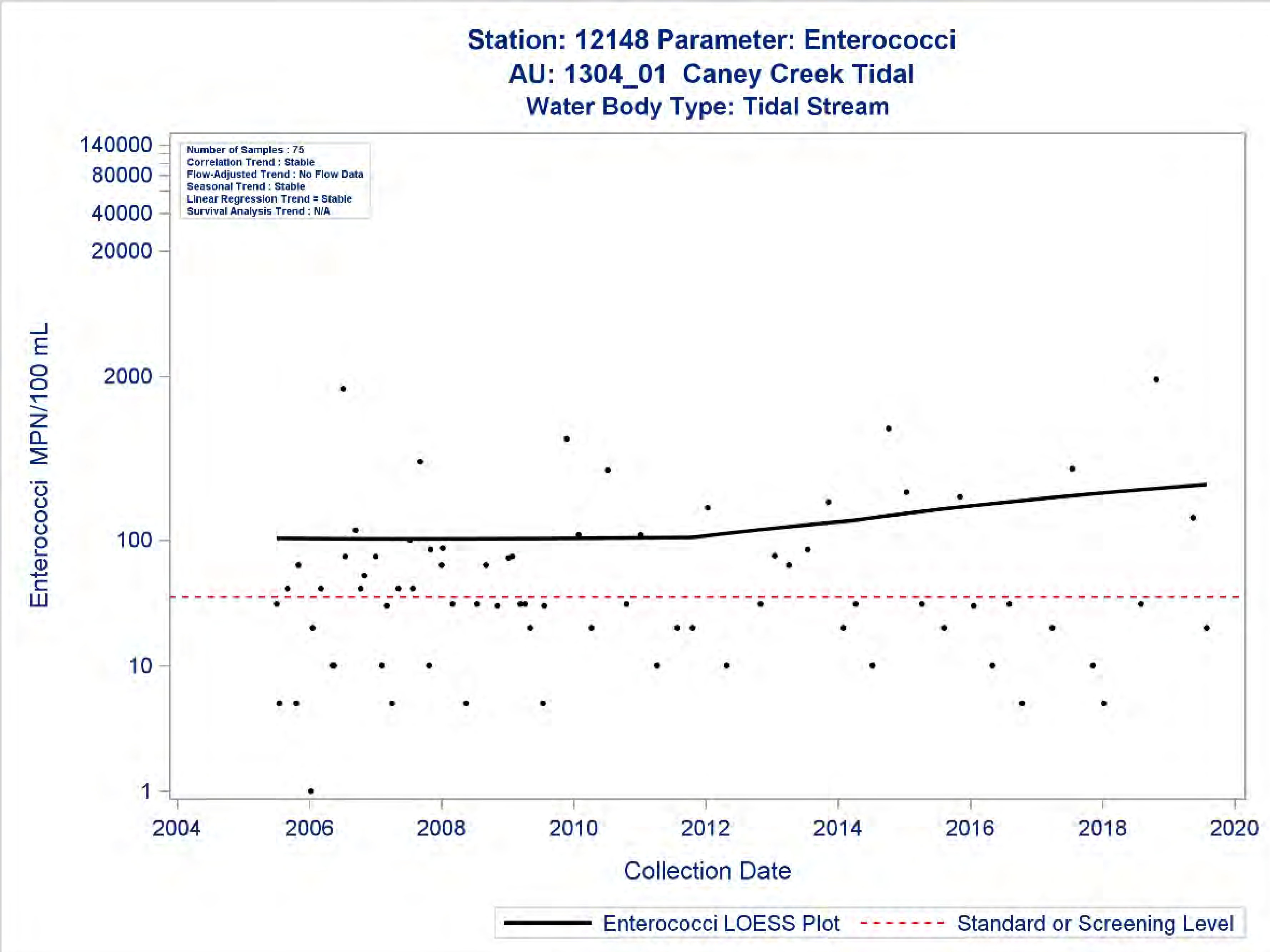
Station: 12148 Parameter: Nitrate-N
AU: 1304_01 Caney Creek Tidal
Water Body Type: Tidal Stream
Number of Samples : 81
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Stable
Nitrate-N mg/L
3
2
1.5
1
0.5
0.07
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

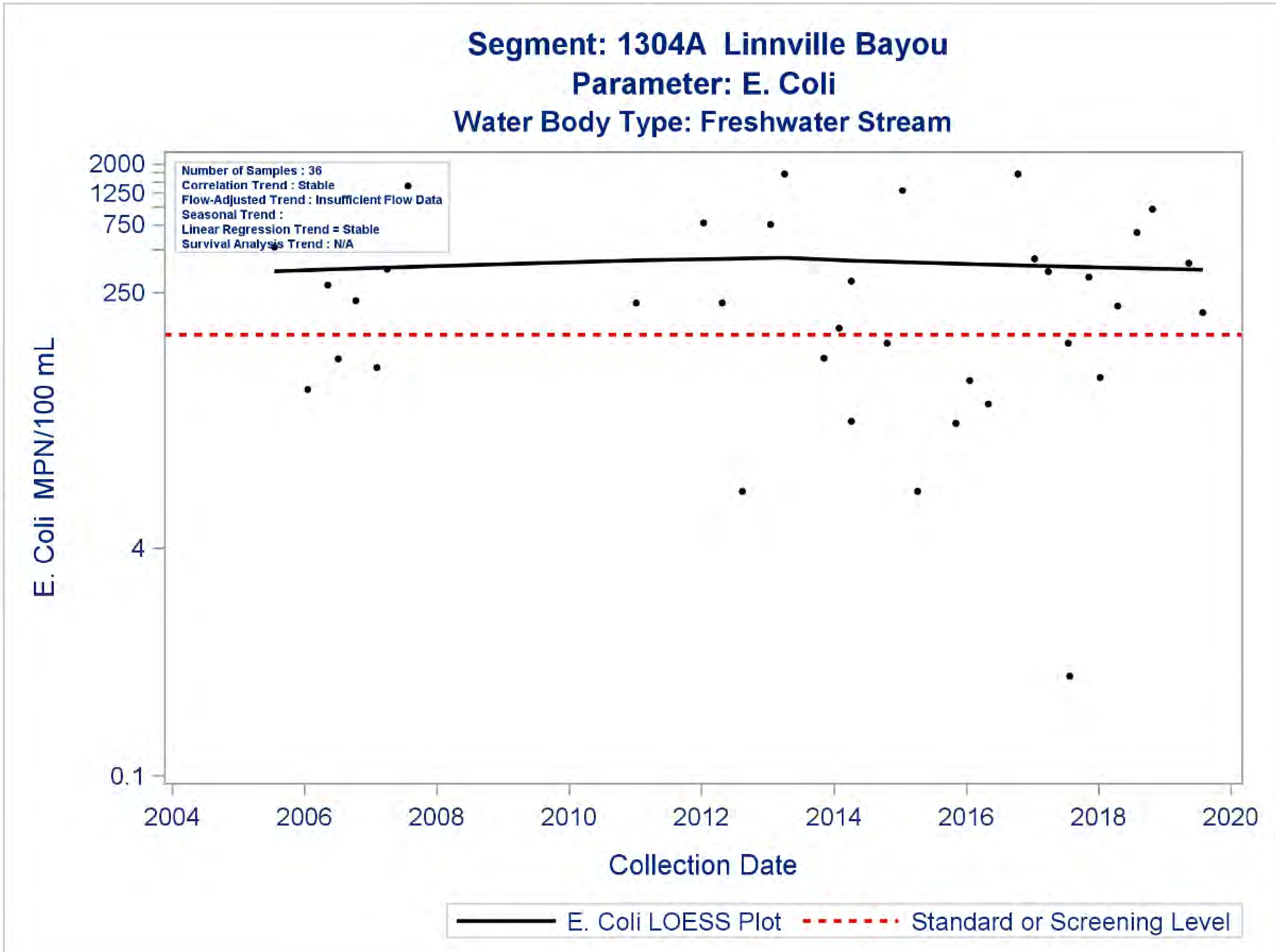


Station: 12148 Parameter: Secchi Transparency
AU: 1304_01 Caney Creek Tidal
Water Body Type: Tidal Stream
Number of Samples : 76
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.8
1.4
1
0.8
0.6
0.4
0.2
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Secchi Transparency LOESS Plot


Segment: 1304 Caney Creek Tidal
Parameter: Specific Conductance
Water Body Type: Tidal Stream
Number of Samples : 134
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
40000
30000
20000
15000
10000
5000
700
100
Specific Conductance µS/cm
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot


Station: 12151 Parameter: Specific Conductance
AU: 1304_02 Caney Creek Tidal
Water Body Type: Tidal Stream
Number of Samples : 35
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Specific Conductance µS/cm
1200
1000
800
600
400
200
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot


Station: 12148 Parameter: Enterococci
AU: 1304_01 Caney Creek Tidal
Water Body Type: Tidal Stream
Number of Samples : 75
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
140000
80000
40000
20000
2000
100
10
1
Enterococci MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Enterococci LOESS Plot
Standard or Screening Level



Segment: 1304A Linnville Bayou
Parameter: E. Coli
Water Body Type: Freshwater Stream
Number of Samples : 36
Correlation Trend : Stable
Flow-Adjusted Trend : Insufficient Flow Data
Seasonal Trend :
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
2000
1250
750
250
4
0.1
E. Coli MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
E. Coli LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1304 I 1304A_01 I	• Animal waste from agricultural production, hobby farms, and riding stables • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Direct and dry weather discharges • Waste haulers illegal discharges/improper disposal • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	1304_01 C	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Improve compliance and enforcement of existing stormwater quality permits • Install and/or conserve riparian buffer areas along all waterways • More public education about OSSF maintenance

				• More public education on pet waste disposal • More public education regarding disposal of household fats, oils, and grease • Regionalize chronically non-compliant WWTFs • Improve operation and maintenance of existing WWTF and collection systems • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating
Elevated Chlorophyll -*a* Concentrations	1304A_01 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas

Special Studies:

Bacteria impairments in Caney Creek Tidal are being addressed in the Basin 13 (Brazos-Colorado Coastal Basin) Bacteria Reduction Project. The Technical Support Document and the Total Maximum Daily Load document are currently undergoing TCEQ management review, with approval expected in Summer 2021.

For more information, please visit http://h-gac.com/watershed-based-plans/brazos-colorado-coastal-basin-tmdl-and-implementation-plan.aspx.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan of TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes

- 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 Total Maximum Daily Load program and future watershed protection plan development
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number:	1302	Name:	San Bernard River Above Tidal

Length:	110 miles	Watershed Area:	864 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Public Water Supply
Number of Active Monitoring Stations:	6	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	11

DESCRIPTION

- Segment 1302 (Perennial Stream w/ high ALU): **San Bernard River Above Tidal** (classified water body) – From a point 3.2 km (2.0 mi) upstream of SH 35 in Brazoria County to the county road southeast of New Ulm in Austin County

- Segment 1302A (Perennial Stream w/ high ALU): **Gum Tree Branch** (unclassified water body) – From the confluence with West Bernard Creek near Wharton CR 252 to the headwaters approximately 15 miles upstream near RR 102

- Segment 1302B (Perennial Stream w/ high ALU): **West Bernard Creek** (unclassified water body) – From the confluence with the San Bernard River Above Tidal downstream of US Highway 59 to the headwaters approximately 40 miles upstream near FM 1093

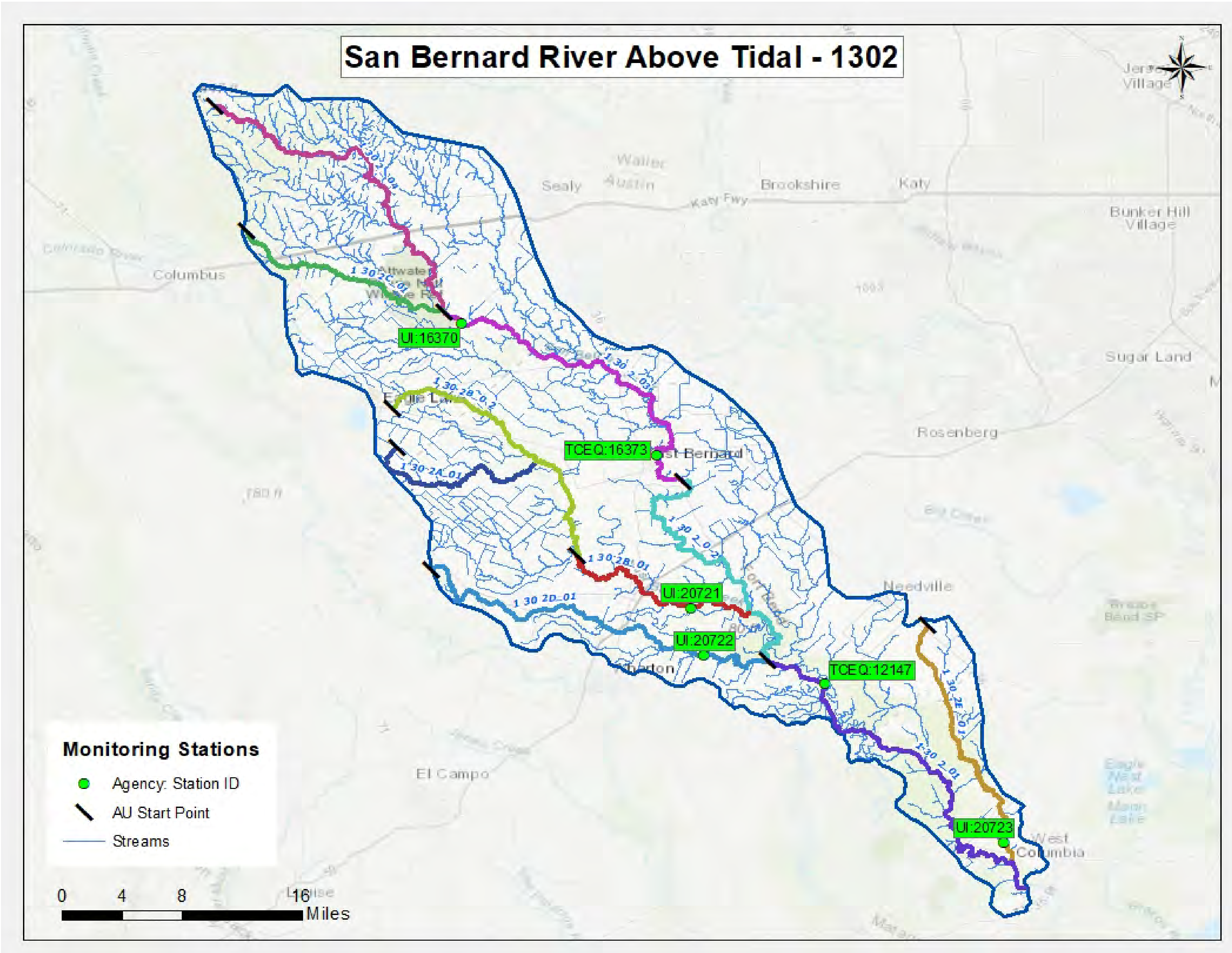
- Segment 1302C (Perennial Stream w/ high ALU): **Coushatta Creek** (unclassified water body) – From the confluence with the San Bernard River Above Tidal upstream to a point 4.6 km upstream of I-10

- Segment 1302D (Perennial Stream w/ high ALU): **Peach Creek** (unclassified water body) – From the confluence with the San Bernard River in Wharton County to the headwaters approximately 8 km upstream of FM 102 in Wharton County

- Segment 1302E (Perennial Stream w/ high ALU): **Mound Creek** (unclassified water body) – From the confluence with the San Bernard River in Brazoria Co. to the headwater approximately 400 m upstream of TS Hwy 36 in Fort Bend County

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
12147	1302	SAN BERNARD RIVER MID CHANNEL 60 M DOWNSTREAM OF FM 442 BRIDGE SW OF NEEDVILLE	FO	Quarterly	Field, Conventional, Bacteria, Flow
16370	1302	SAN BERNARD RIVER IMMEDIATELY DOWNSTREAM OF FM 3013 ON THE COLORADO-AUSTIN COUNTY LINE APPROXIMATELY 15KM SW OF SEALY	UI	Quarterly	Field, Conventional, Bacteria, Flow
16373	1302	SAN BERNARD RIVER IMMEDIATELY DOWNSTREAM OF US90A IN EAST BERNARD	FO	Quarterly	Field, Conventional, Bacteria, Flow
20721	1302B	WEST BERNARD CREEK AT WHARTON CR 225 IN EAST OF HUNGERFORD	UI	Quarterly	Field, Conventional, Bacteria, Flow
20722	1302D	PEACH CREEK AT WHARTON CR 117/CHUDALLA ROAD/ARCHER ROAD 89 METERS SOUTH OF THE INTERSECTION OF WHARTON CR 117/CHUDALLA ROAD/ARCHER ROAD AND WHARTON CR 121/ WHARTON CR 119/DONALDSON ROAD IN EAST OF WHARTON	UI	Quarterly	Field, Conventional, Bacteria, Flow
20723	1302E	MOUND CREEK AT BRAZORIA CR 450/JACKSON SETTLEMENT ROAD 1.22 KILOMETERS UPSTREAM OF FM 1301 IN WEST OF WEST COLUMBIA	UI	Quarterly	Field, Conventional, Bacteria, Flow

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston

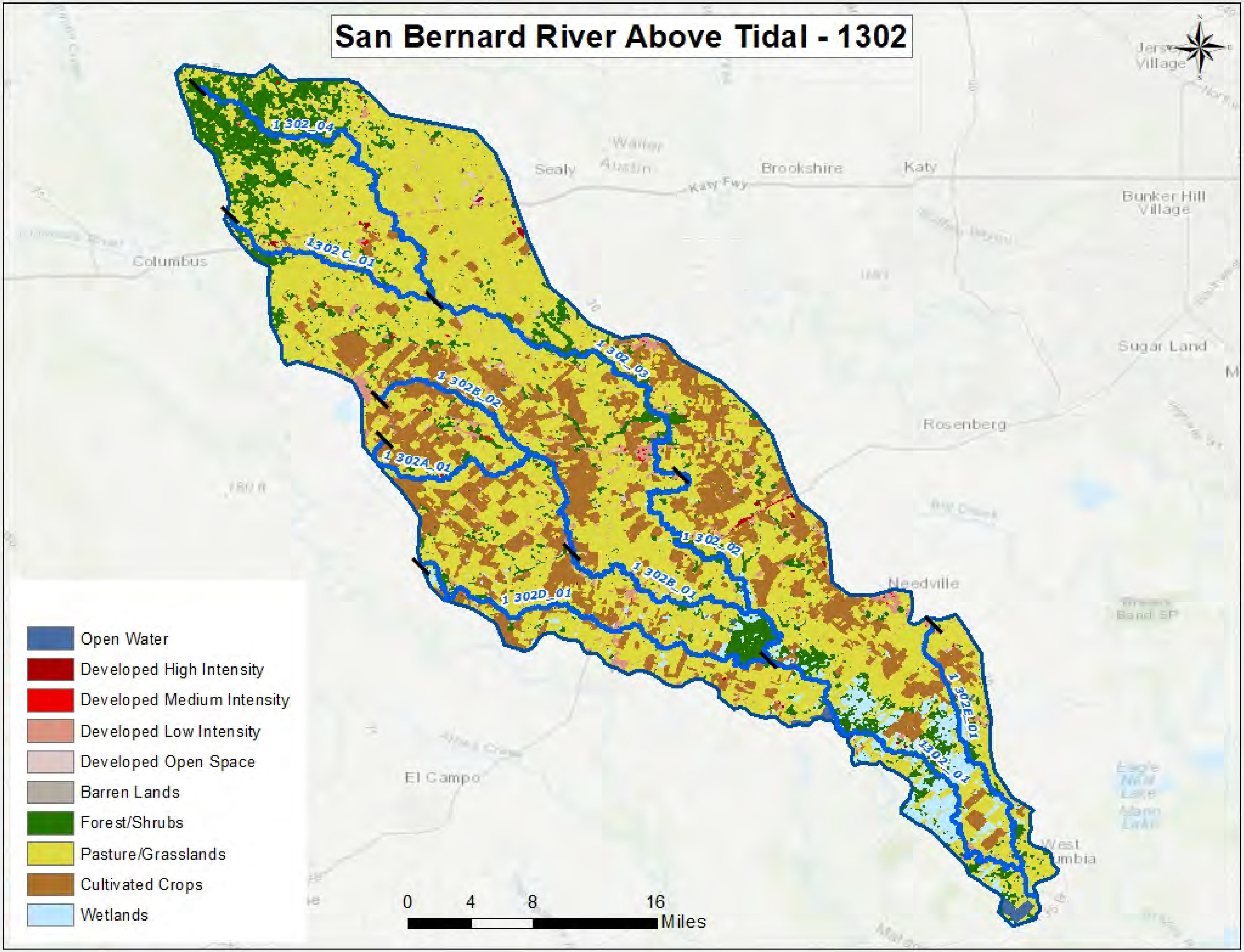

San Bernard River Above Tidal - 1302
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
UI:16370
TCEQ:16373
UI:20721
UI:20722
TCEQ:12147
UI:20723
1302_04
1302C_01
1302_03
1302B_02
1302A_01
1302_02
1302B_01
1302D_01
1302_01
1302E_01
Sealy
Brookshire
Katy
Columbus
Rosenberg
Needville
El Campo
Sugar Land
Bunker Hill Village
West Columbia
0 4 8 16
Miles

Segment 1302 Water Quality Standards and Screening Levels			
Standards	**Perennial Stream**	**Screening Levels**	**Perennial Stream**
Temperature (°C/°F):	32 / 90	Ammonia (mg/L):	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Nitrate-N (mg/L):	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.37
pH (standard units):	6.5-9.0	Total Phosphorus (mg/L):	0.69
E. coli (MPN/100 mL) (grab):	399	Chlorophyll *a* (µg/L):	14.1
E. coli (MPN/100 mL) (geometric mean):	126		
Chloride (mg/L as Cl):	200		
Sulfate (mg/L as SO_4):	100		
Total Dissolved Solids (mg/L):	500		

Segment Discussion

Watershed Characteristics and Land Cover: The San Bernard River Above Tidal (1302) watershed is sparsely populated and contains the small towns of East Bernard, Kendleton, Needville, Wallis, Hungerford, and Eagle Lake. The vast majority of the watershed is classified as agricultural with rice and cotton fields and grazing pastures dominating the landscape. There are plots of wetland and forested areas scattered throughout, especially in the northern and southern portions of the watershed. Major tributaries include Coushatta Creek, East Bernard Creek, Little San Bernard Creek, Peach Creek, West Bernard Creek, and Middle Bernard River.

Segment 1302 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	414,089.90	74.85	453,859.87	82.04	9.60
Barren Lands	91.63	0.02	551.09	0.10	501.46
Developed	34,941.59	6.32	9,914.53	1.79	-71.63
Forest/Shrubs	75,986.76	13.73	25,170.50	4.55	-66.88
Open Water	2,108.51	0.38	2,394.51	0.43	13.56
Wetlands	26,025.16	4.70	61,358.16	11.09	135.76
TOTAL	**553,243.54**	**100.00**	**553,248.66**	**100.00**	


San Bernard River Above Tidal - 1302
1302_04
1302C_01
1302_03
1302B_02
1302A_01
1302_02
1302B_01
1302D_01
1302E_01
1302_01
Sealy
Brookshire
Katy
Columbus
Rosenberg
Sugar Land
Bunker Hill Village
Needville
El Campo
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 4 8 16 Miles

Water Quality Issues:

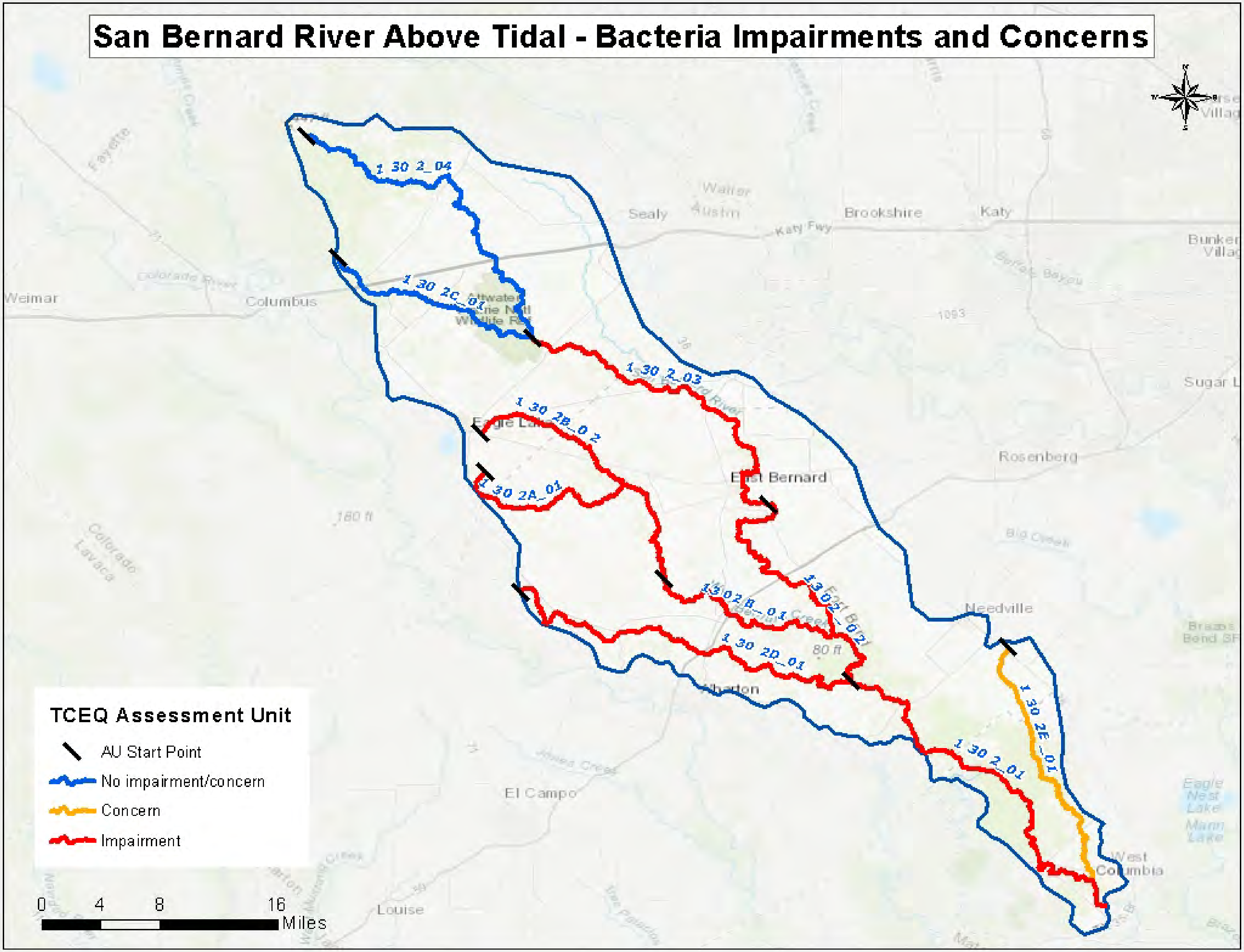
Bacteria Impairments and Concerns
Recreation use is not supported in San Bernard Tidal. Three assessment units in the segment (1302_01, 1302_02, and 1302_03) and three of the tributaries (1302A_01, 1302B_01, 1302B_02 and 1302D_01) were listed as impaired in the 2020 Integrated Report due to elevated levels of *E. coli*. A concern for bacteria was identified in 1302E.

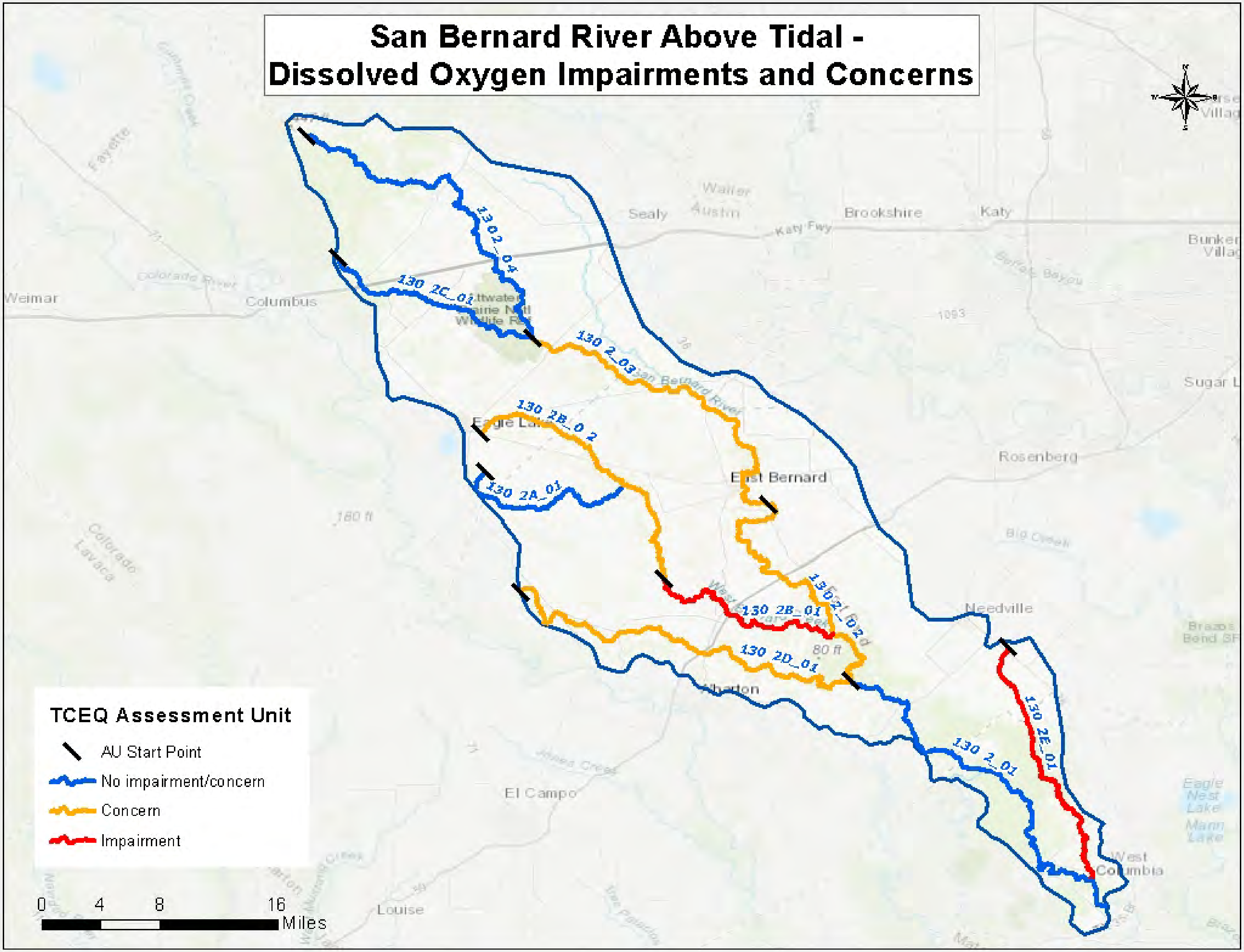
Dissolved Oxygen Impairments and Concerns
Unclassified segment 1302B_01 is impaired for 24-hour dissolved oxygen and 1302E_01 is impaired based on dissolved oxygen grab minimum values. There are also dissolved oxygen concerns for screening levels in AUs 1302_02, 1302_03, 1302B_02, 1302D_01, and 1302E_01.

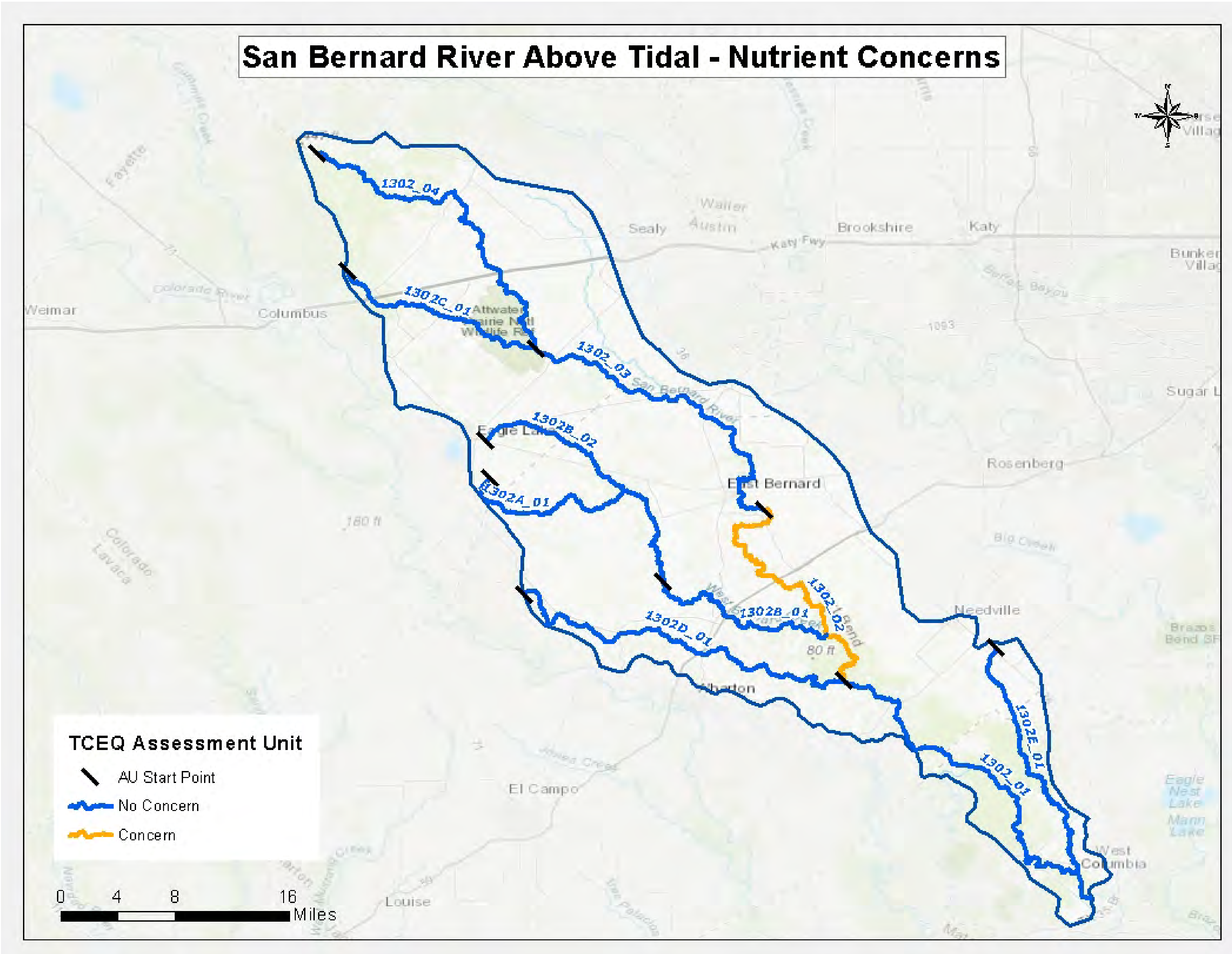
Nutrient Concerns
A concern for ammonia-nitrogen was identified for AU 1302B_02.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

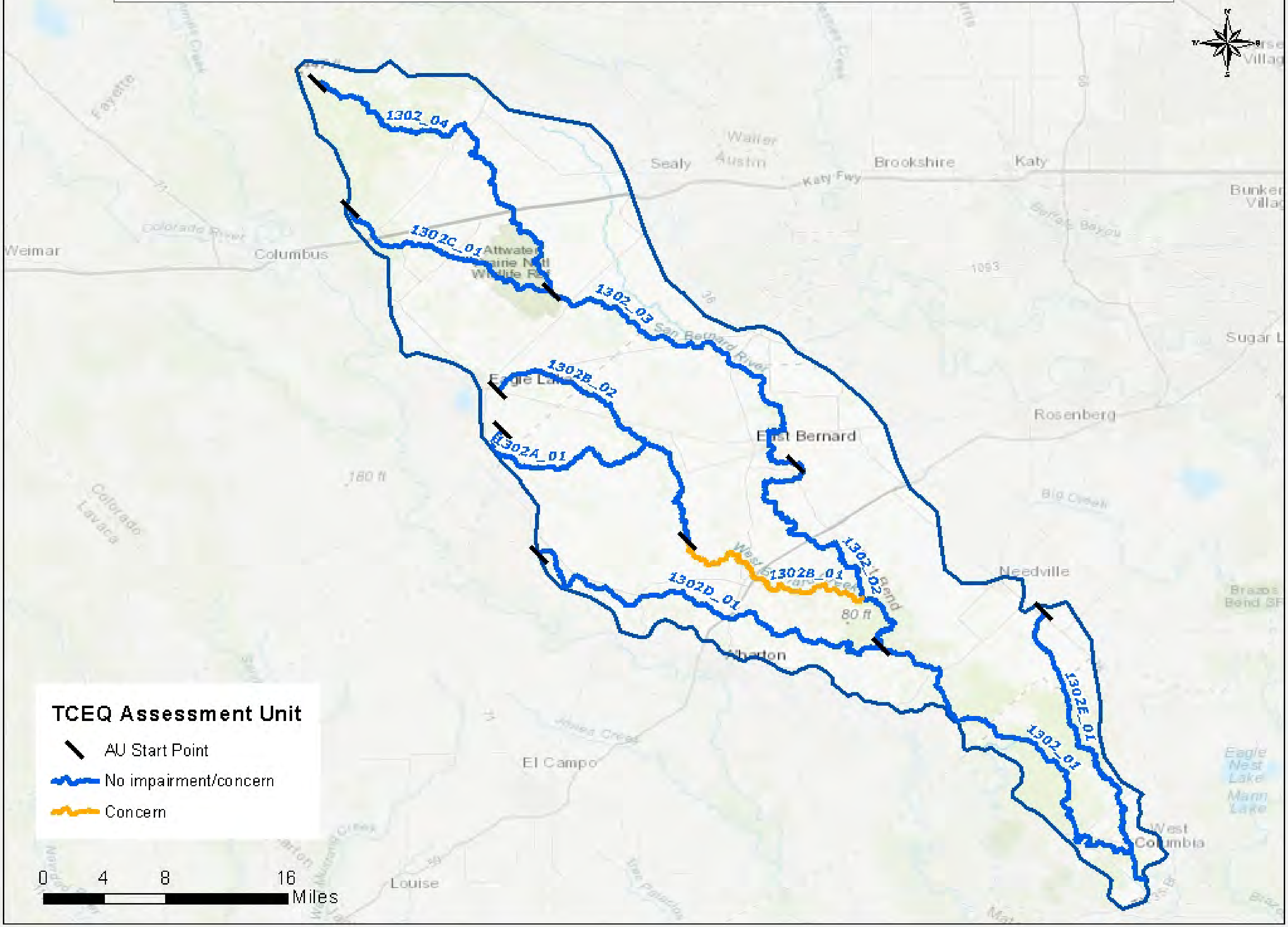
Habitat Concerns
A concern for habitat was identified for 1302B_01 (West Bernard Creek) in the 2020 Integrated Report. This assessment unit was fully supporting for fish and macrobenthic communities.


San Bernard River Above Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0
4
8
16
Miles
1 30 2_04
1 30 2C_01
1 30 2_03
1 30 2B_0 2
1 30 2A_01
1 30 2D_01
1 30 2_01
1 30 2E_01
Sealy
Brookshire
Katy
Columbus
Weimar
East Bernard
Rosenberg
Needville
Wharton
El Campo
Louise
West Columbia
Katy Fwy
180 ft
80 ft


San Bernard River Above Tidal -
Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
0 4 8 16
Miles
1302_04
1302C_01
1302_03
1302B_02
1302A_01
1302B_01
1302_02
1302D_01
1302_01
1302E_01
Sealy
Brookshire
Katy
Columbus
Weimar
East Bernard
Rosenberg
Needville
Wharton
El Campo
Louise
West Columbia


San Bernard River Above Tidal - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0
4
8
16
Miles
1302_04
1302C_01
1302_03
1302B_02
1302A_01
1302D_01
1302B_01
1302_02
1302E_01
1302_01
Sealy
Brookshire
Katy
Columbus
Weimar
Eagle Lake
East Bernard
Rosenberg
Needville
Wharton
El Campo
Louise
West Columbia
San Bernard River

San Bernard River Above Tidal - Other Impairments and Concerns

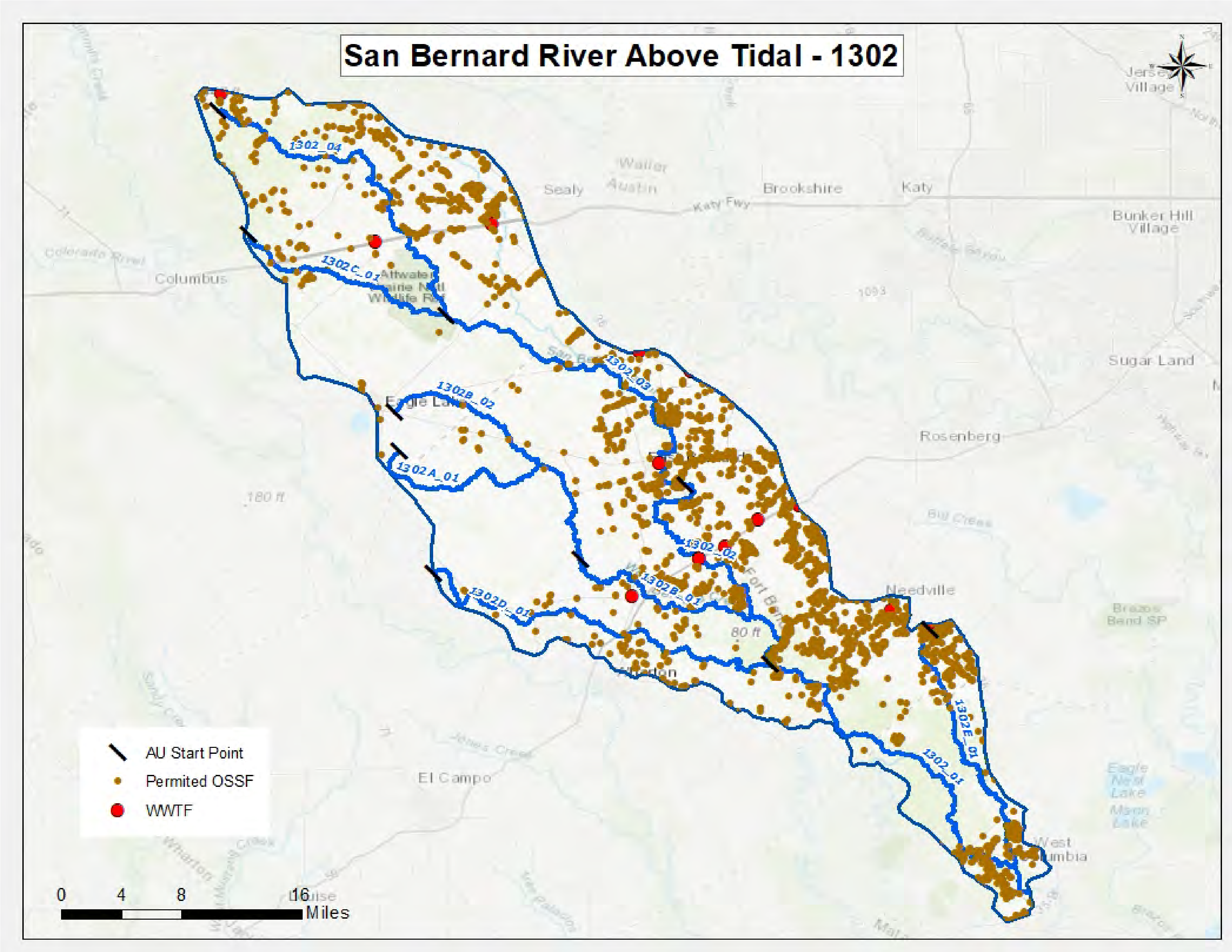


Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients) in the San Bernard River Above Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, feral hogs, and animal waste.

There are 11 permitted wastewater outfalls in the San Bernard River Above Tidal watershed. In the majority of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 2.737 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the San Bernard River Above Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 9 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the San Bernard River Above Tidal watershed.

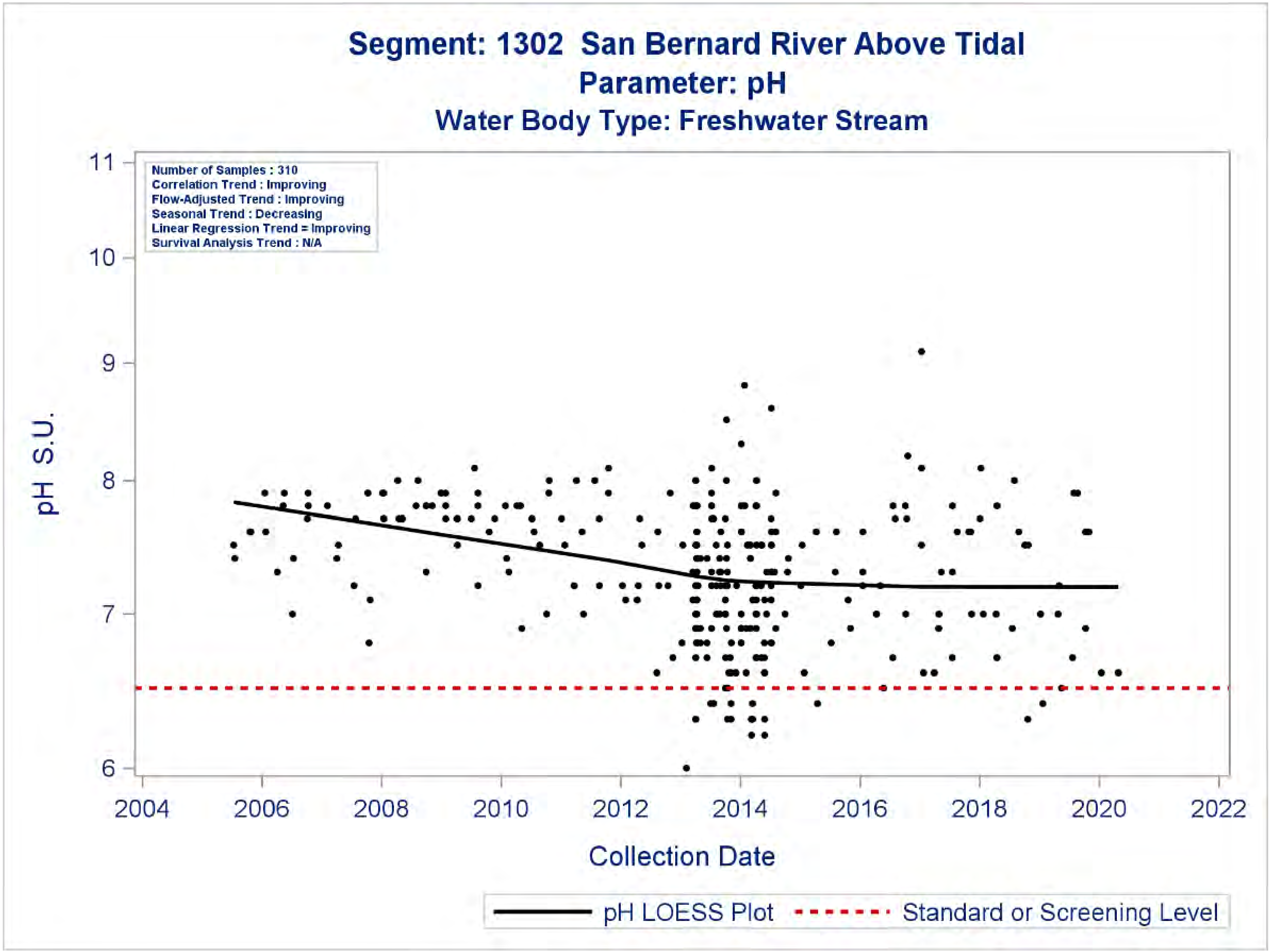

San Bernard River Above Tidal - 1302
AU Start Point
Permited OSSF
WWTF
1302_04
1302C_01
1302_03
1302B_02
1302A_01
1302_02
1302B_01
1302D_01
1302E_01
1302_01
Sealy
Brookshire
Katy
Columbus
Eagle Lake
Needville
Rosenberg
Sugar Land
Bunker Hill Village
Jersey Village
El Campo
West Columbia
0
4
8
16
Miles

Trend Analysis:

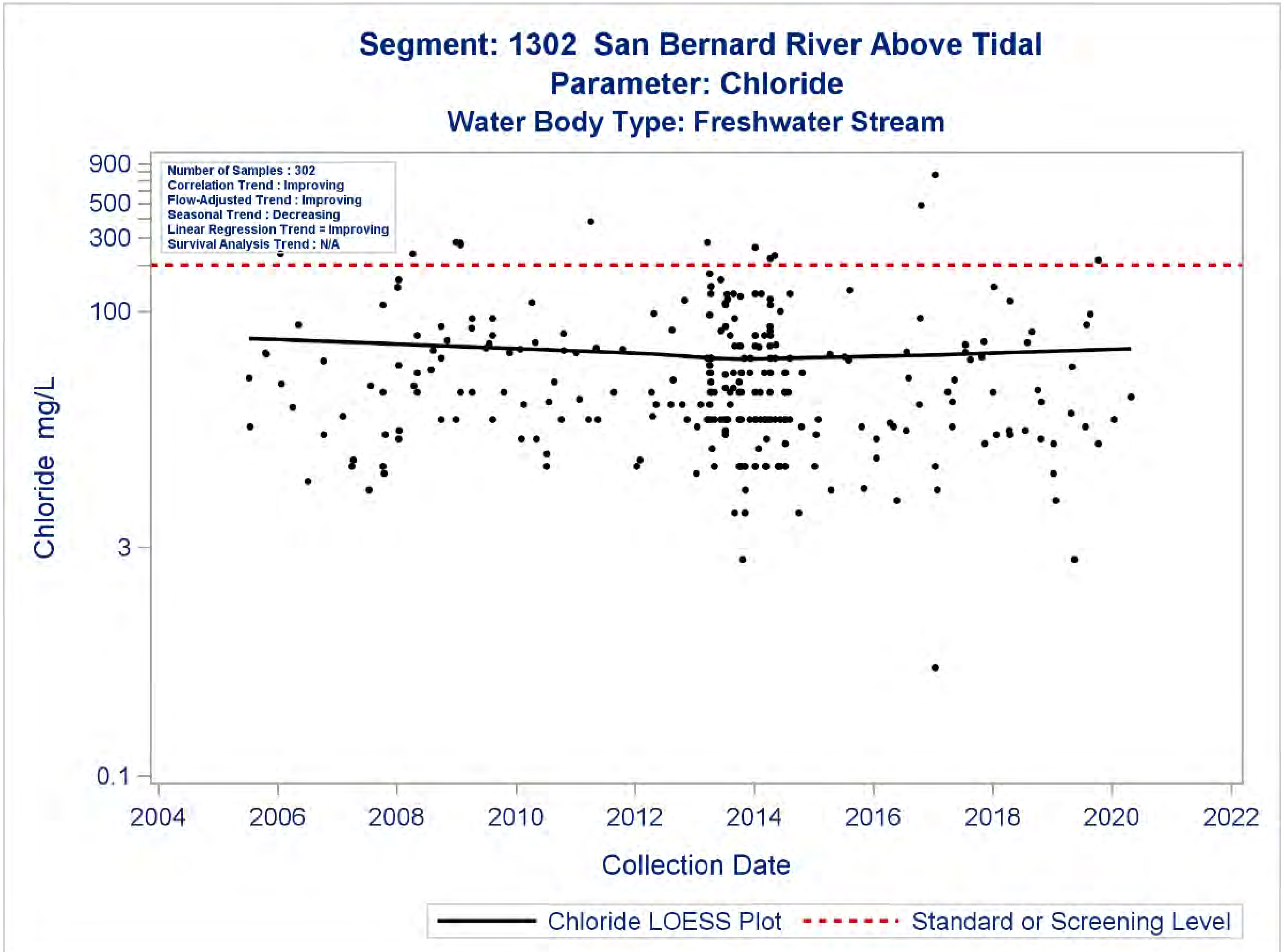
Analysis of San Bernard Above Tidal segment (1302) data revealed trends for pH, chloride, and specific conductance in the classified segment. The dataset for pH from 2005 through 2014 was decreasing with quite a few samples from 2013-2014 dipping below the water quality standard of 6.5 standard units. From 2015 forward the decreasing trend may be stabilizing with only a few measurements falling below the standard. Chloride concentrations decreased between 2005 and 2014, then leveled off or began to slightly increase after 2016. It is possible that the opening of the San Bernard River mouth in 2009 may have influenced the chloride concentrations decreasing. Otherwise, there is no obvious explanation for it. Specific conductance also revealed only a slight decreasing trend from 2005 through 2014 and then concentrations began to trend upwards.

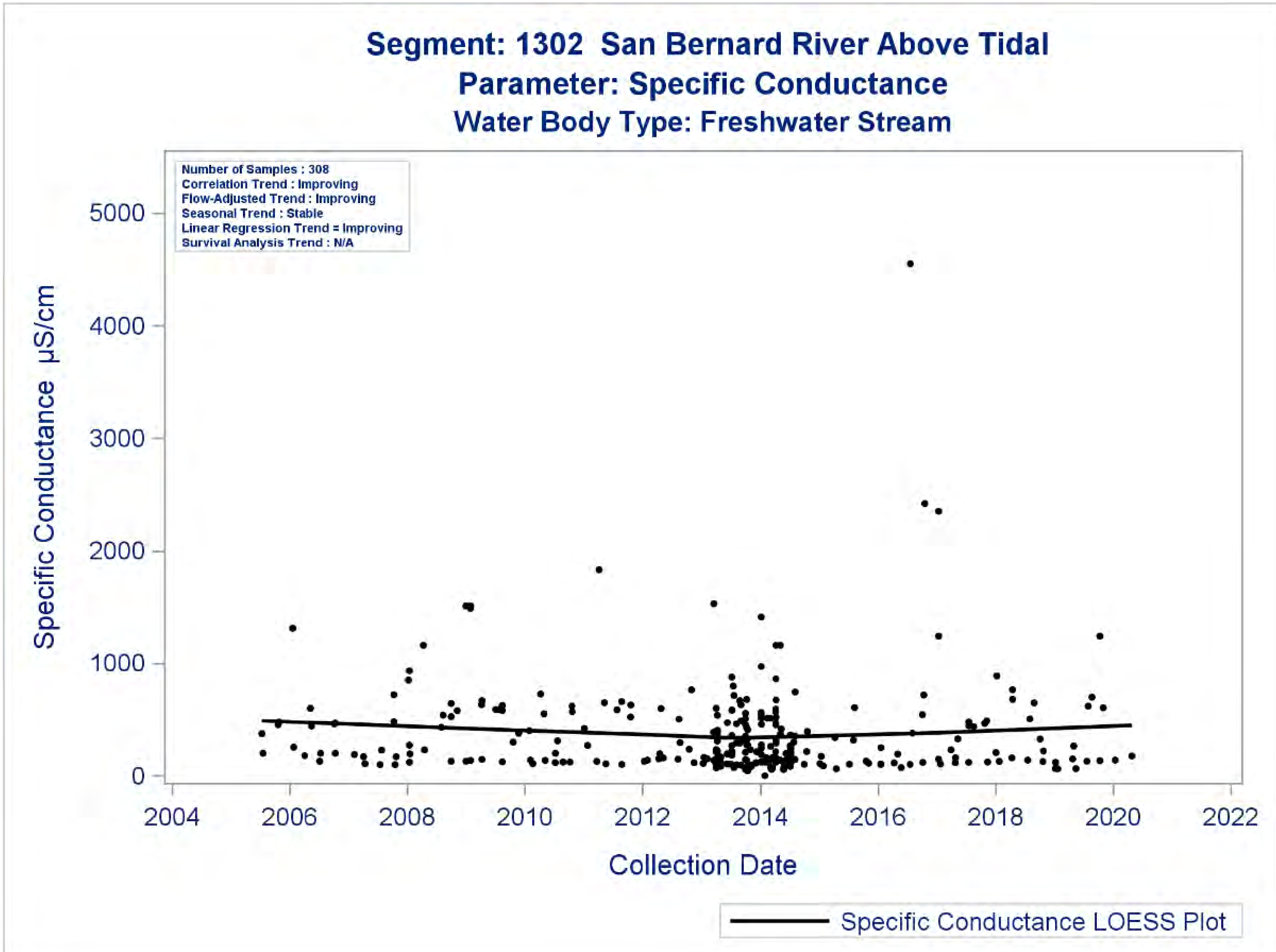
Only two other parameter trends were observed in three unclassified segments. First, DO concentrations in West Bernard Creek (1302B) were improving since 2015 with all but one measurement being greater than the standard of 5.0 mg/L. Second, TKN improving trends (decreasing concentrations) were identified in West Bernard Creek (1302B), Peach Creek (1302D), and Mound Creek (1302E). Currently, there is no screening criteria for TKN so the downward trend is positive for this nutrient for which the majority of sample results measured less than 4 mg/L and were decreasing.

E. coli concentrations have remained stable with a majority of samples still measuring well above the water quality standard of 126 MPN/100 mL for this segment.

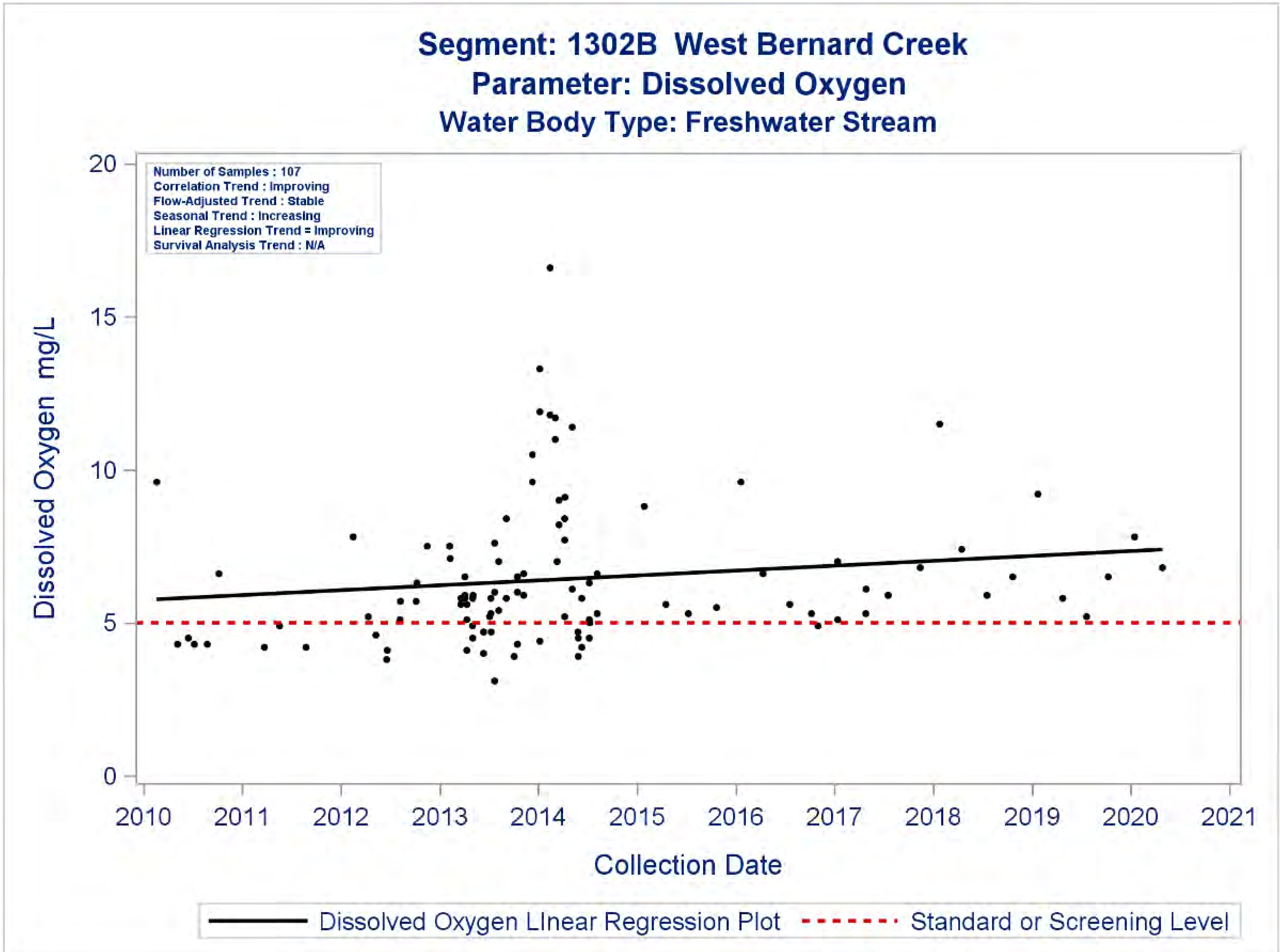


Segment: 1302 San Bernard River Above Tidal
Parameter: pH
Water Body Type: Freshwater Stream
Number of Samples : 310
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
pH S.U.
11
10
9
8
7
6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
pH LOESS Plot
Standard or Screening Level

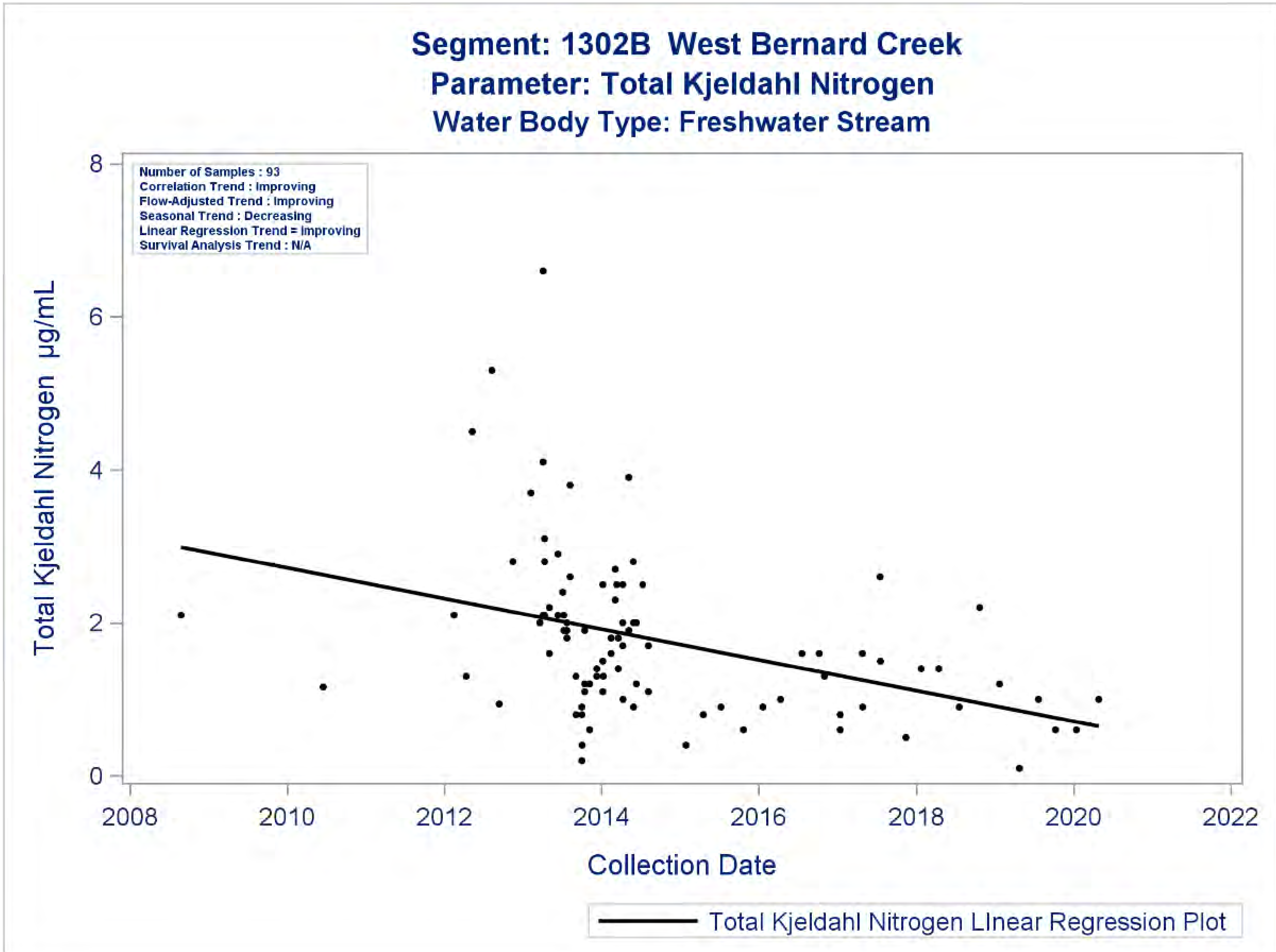

Segment: 1302 San Bernard River Above Tidal
Parameter: Chloride
Water Body Type: Freshwater Stream
Number of Samples : 302
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
900
500
300
100
3
0.1
Chloride mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chloride LOESS Plot
Standard or Screening Level



Segment: 1302 San Bernard River Above Tidal
Parameter: Specific Conductance
Water Body Type: Freshwater Stream
Number of Samples : 308
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Specific Conductance µS/cm
0
1000
2000
3000
4000
5000
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LOESS Plot



Segment: 1302B West Bernard Creek
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 107
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
20
15
10
5
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level


Segment: 1302B West Bernard Creek
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Freshwater Stream
Number of Samples : 93
Correlation Trend : Improving
Flow-Adjusted Trend : Improving
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
8
6
4
2
0
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Kjeldahl Nitrogen Linear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1302_01 I 1302_02 I 1302_03 I 1302A I 1302B I 1302D I 1302E C	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Constructed stormwater controls failing • Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Direct and dry weather discharges • Improper or no pet waste disposal • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Improve compliance and enforcement of existing stormwater quality permits • Improve storm water controls in new developments by adding bacteria reduction measures • Improve construction oversight to minimize TSS discharges to waterways • More public education on pet waste disposal • Promote and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing and alternative water supplies to keep livestock out of or away from waterways
Low Dissolved Oxygen Concentrations	***DO Grab Screening Level*** 1302_02 C 1302_03 C 1302B_02 C 1302D_01 C 1302E_01 C ***DO 24-hr Avg*** 1302B_01 I ***DO 24-hr Min***	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, and grease disposal; and OSSF maintenance • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Work with drainage districts and agencies to change practices of clear-cutting and

	1302E_01 I			channelizing waterways to protect from solar heating • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water.
Elevated Nutrient Concentrations	***Ammonia*** 1302B_02 C	• Agricultural runoff from row crops, fallow fields, and animal operations • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs	• Detrimental effect on aquatic biological community	• Agricultural runoff from row crops, fallow fields, and animal operations • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs
Impaired Habitat	1302B_01 C	• Ongoing maintenance of modified channel • Loss of habitat due to channelization of waterway • Bank erosion and erosion at construction sites	• Detrimental effect on aquatic biological community	• Re-connect oxbows and lost channels to augment water storage and retention • Work with drainage districts to install/construct habitat that doesn't interfere with water movement • Strategically plant vegetation to enhance tree canopy and slow bank erosion to create more habitat

Special Studies:

The San Bernard Watershed Protection Plan to address bacteria impairments was initiated in 2009 and approved in 2017. This project was facilitated by H-GAC and TCEQ. H-GAC supports stakeholder engagement in the watershed and implementation of the San Bernard Watershed Protection Plan. Elements of the WPP are currently in implementation through coordination between H-GAC and local partners. For more information, please refer to the discussion in the Public Involvement and Outreach section.

Recommendations:

The WPP identified best management practices to address contributions from livestock, domestic pets, wildlife, OSSFs, and other sources.

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to evaluate the effectiveness of the watershed protection plan
- Continue to implement the watershed protection plan recommendations for bacteria reduction.
- Continue collecting water quality data to evaluate the effectiveness of the watershed protection plan.
- Continue to implement the watershed protection plan recommendations

- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, and grease
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Promote voluntary conservation and forestry projects

Segment Number:	1301	Name:	San Bernard River Tidal

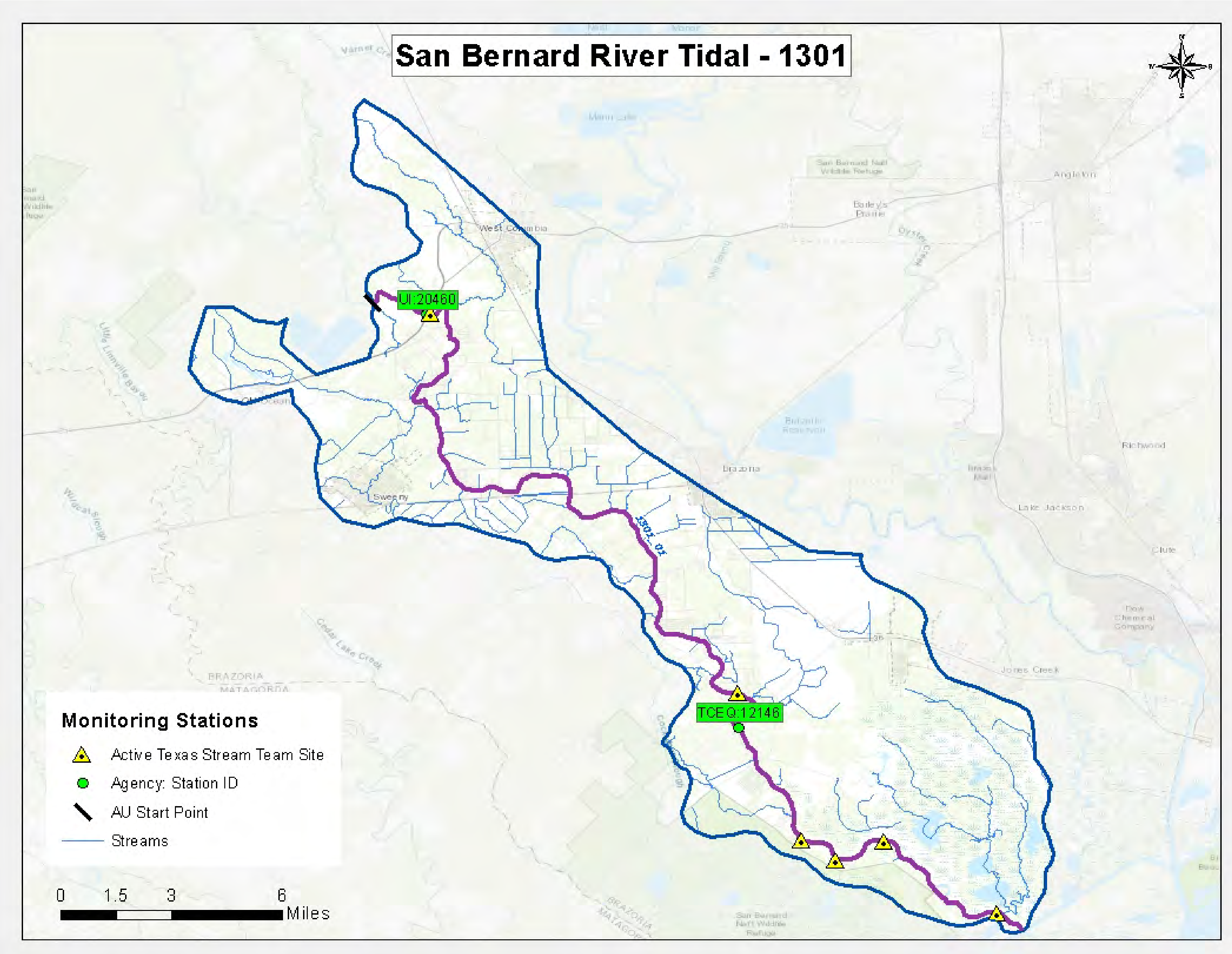
Length:	34 miles	Watershed Area:	131 square miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	2	Texas Stream Team Monitoring Stations:	6	Permitted WWTF Outfalls:	6

DESCRIPTION

- Segment 1301 (Tidal Stream w/ high ALU): **San Bernard River Tidal** (classified water body) – From the confluence with the Intracoastal Waterway in Brazoria County to a point 3.2 km (2.0 mi) upstream of SH 35 in Brazoria County

FY 2021 Routine Active Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
12146	1301	SAN BERNARD RIVER TIDAL EAST BANK IMMEDIATELY UPSTREAM OF FM 2611	FO	Quarterly	Field, Conventional, Bacteria
20460	1301	SAN BERNARD RIVER TIDAL AT SH 35 SOUTHWEST OF WEST COLUMBIA	UI	Quarterly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston

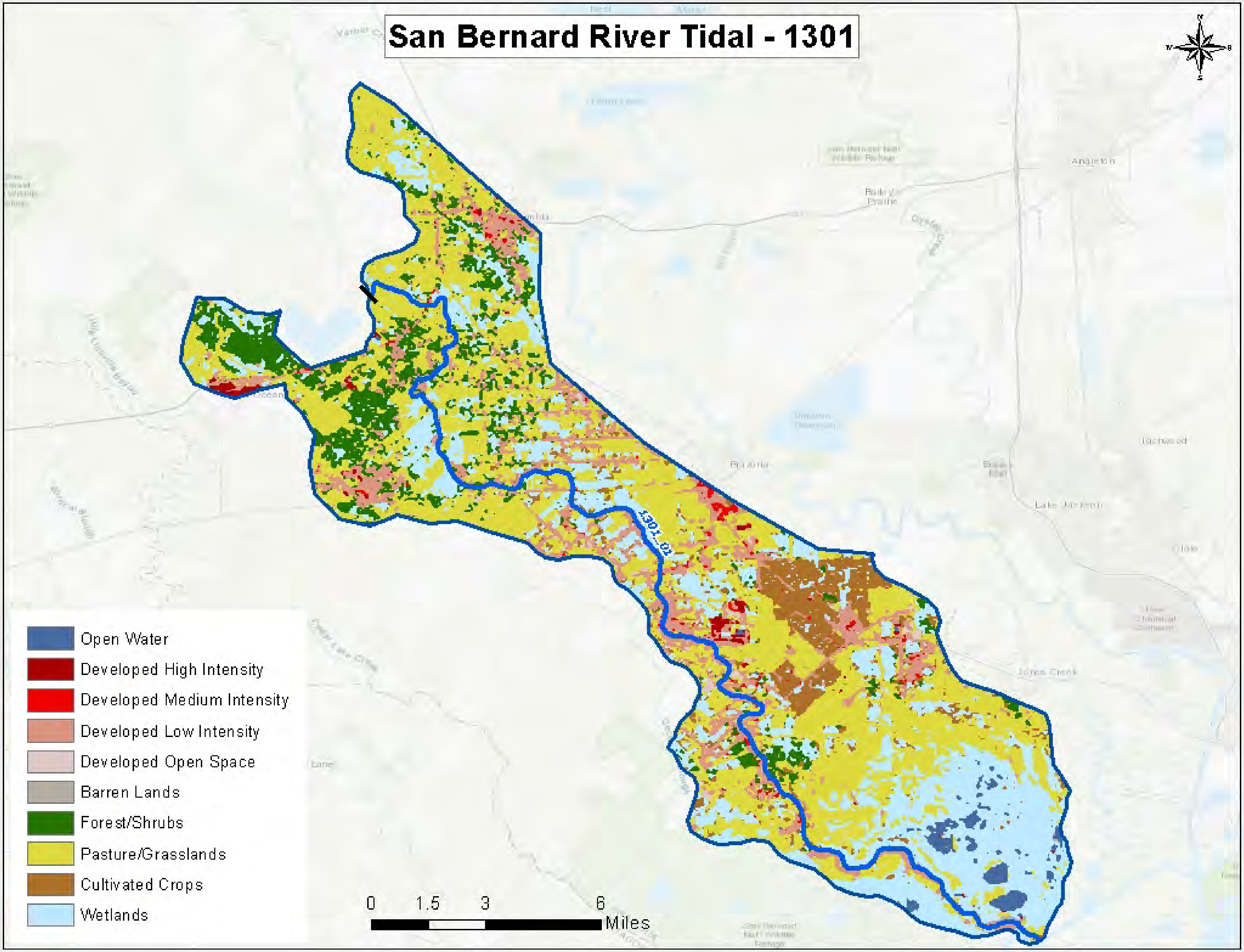

San Bernard River Tidal - 1301
UI:20460
TCEQ:12146
1301_01
West Columbia
Sweeny
Brazoria
Angleton
Bailey's Prairie
Richwood
Lake Jackson
Clute
Jones Creek
Dow Chemical Company
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
1.5
3
6
Miles

Segment 1301 Water Quality Standards and Screening Levels			
Standards	**Tidal Stream**	**Screening Levels**	**Tidal Stream**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.46
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.66
Enterococci (MPN/100mL) (grab):	104	Chlorophyll *a* (µg/L):	21
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The San Bernard River Tidal (1301) watershed is predominantly undeveloped with the exception of a few small towns including West Columbia, Wild Peach Village, Sweeny, Brazoria, and Jones Creek. Although there has not been a lot of development in the watershed, land that was previously grassland is now cultivated land, and some areas that were previously classified as forested land are now classified as woody wetlands. A large portion of the lower watershed by the mouth of the river is wetlands, including the San Bernard National Wildlife Refuge. The predominant land cover types are Wetlands (45.66 percent) and Agriculture (40.01 percent). The closure of the San Bernard River mouth with silt continues to pose problems for tidal exchange and removal of pollutants and sediments, DO levels, barge traffic on the connected intercoastal waterway, and transit of species back and forth between the waterway and the Gulf.

Segment 1301 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	40,827.45	48.58	33,615.68	40.01	-17.66
Barren Lands	132.10	0.16	340.71	0.41	157.91
Developed	11,207.52	13.34	5,424.18	6.46	-51.60
Forest/Shrubs	7,680.36	9.14	4,264.84	5.08	-44.47
Open Water	1,607.91	1.91	2,007.55	2.39	24.85
Wetlands	22,585.18	26.87	38,367.11	45.66	69.88
TOTAL	**84,040.52**	**100.00**	**84,020.06**	**100.00**	


San Bernard River Tidal - 1301
1301_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1.5 3 6
Miles
Angleton
Lake Jackson
Jones Creek

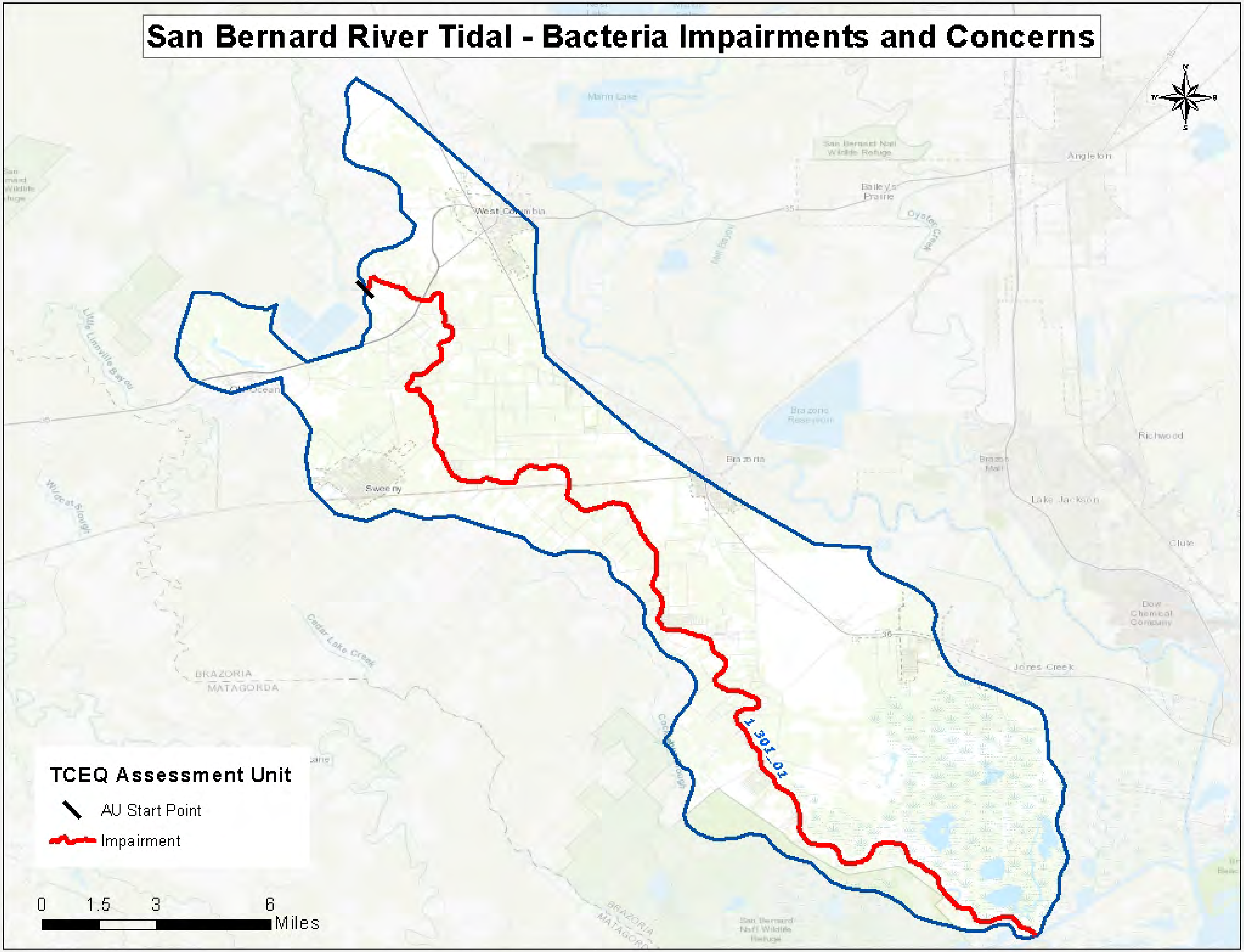
Water Quality Issues:

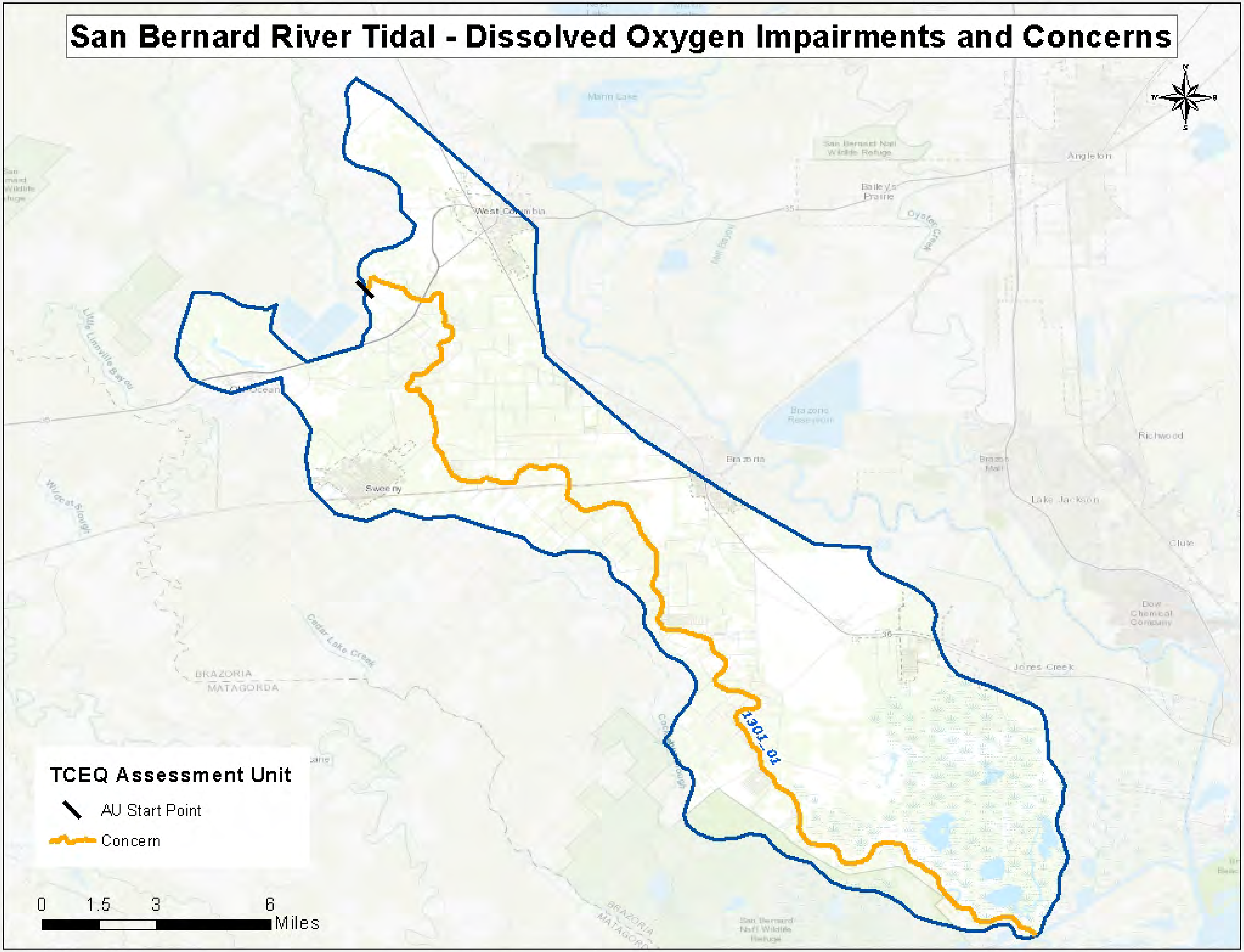
Bacteria Impairments and Concerns
Contact recreation use in the San Bernard Tidal (1301) segment is impaired due to elevated levels of Enterococcus. For the assessment period of 12/01/11 – 11/30/18 in the 2020 Integrated Report, the geometric mean was 61.38 MPN/100 mL. This is much higher than the standard of 35 MPN/100 mL.

Dissolved Oxygen Impairments and Concerns
A concern for depressed dissolved oxygen is present in San Bernard Tidal. In the 2020 Integrated Report, 11 of 79 samples (13.9 percent) were below the dissolved oxygen screening level of 4.0 mg/L.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.


San Bernard River Tidal - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
Impairment
0
1.5
3
6
Miles
1301_01
West Columbia
Angleton
Bailey's Prairie
Oyster Creek
Brazoria
Brazoria Reservoir
Richwood
Lake Jackson
Clute
Sweeny
Old Ocean
Jones Creek
Cedar Lake Creek
Little Linnville Bayou
Wildcat Slough
BRAZORIA
MATAGORDA
Dow Chemical Company
San Bernard Nat'l Wildlife Refuge
Mann Lake



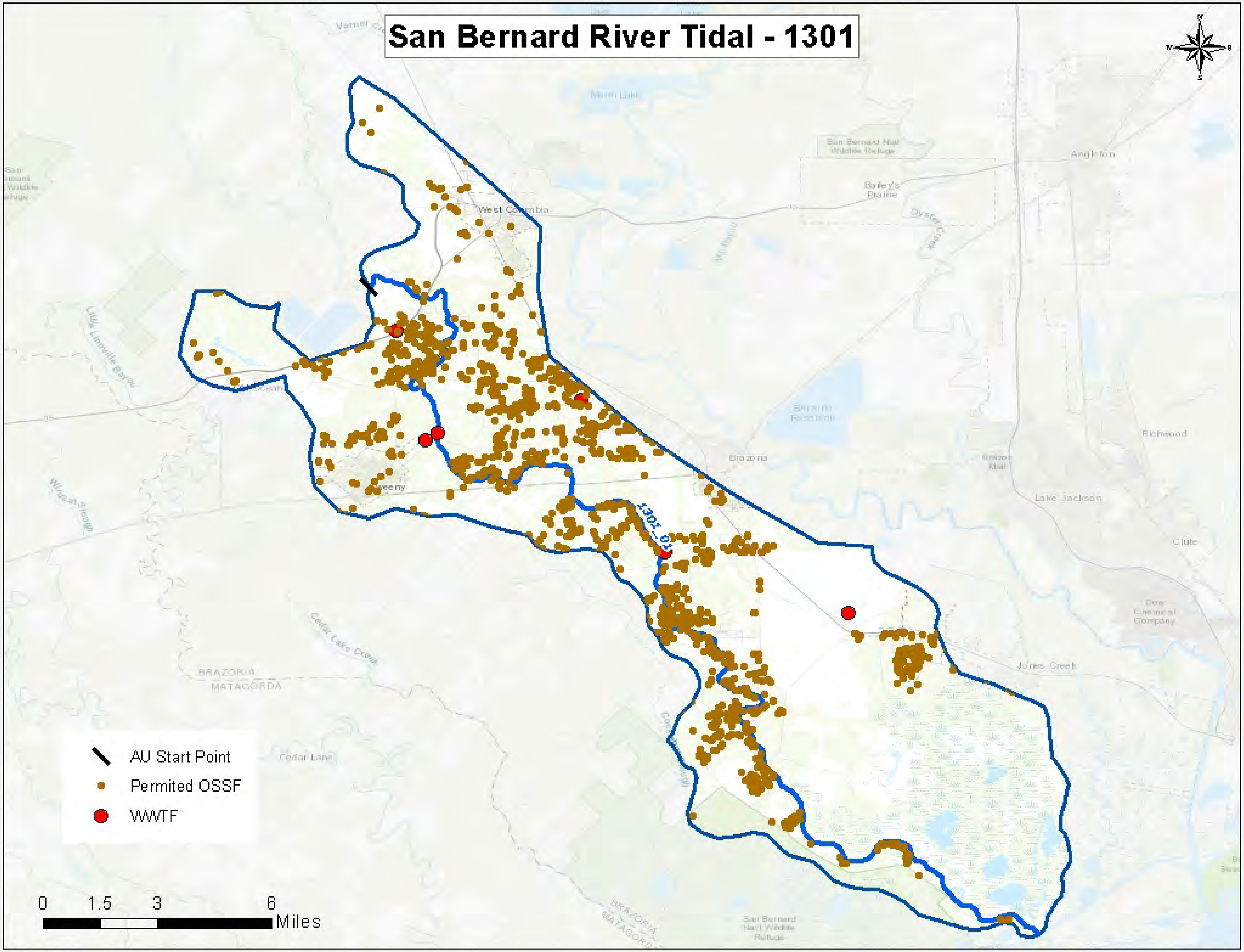
San Bernard River Tidal - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
Concern
0
1.5
3
6
Miles
1301_01
West Columbia
Angleton
Sweeny
Brazoria
Richwood
Lake Jackson
Clute
Jones Creek
Bailey's Prairie
Brazoria Reservoir
Little Linnville Bayou
Wildcat Slough
Cedar Lake Creek
Oyster Creek
BRAZORIA
MATAGORDA
Dow Chemical Company
San Bernard Nat'l Wildlife Refuge
Mann Lake

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria in the San Bernard River Tidal watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, feral hogs, and animal waste.

There are 6 permitted wastewater outfalls in the San Bernard River Tidal watershed. In the majority of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 1,415 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the San Bernard River Tidal watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 124 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the San Bernard River Tidal watershed.



San Bernard River Tidal - 1301
AU Start Point
Permited OSSF
WWTF
0
1.5
3
6
Miles
1301_01
West Columbia
Angleton
Brazoria
Lake Jackson
Clute
Richwood
Jones Creek
Sweeny
Bailey's Prairie
BRAZORIA
MATAGORDA
Cedar Lake Creek
Little Linnville Bayou

Trend Analysis:

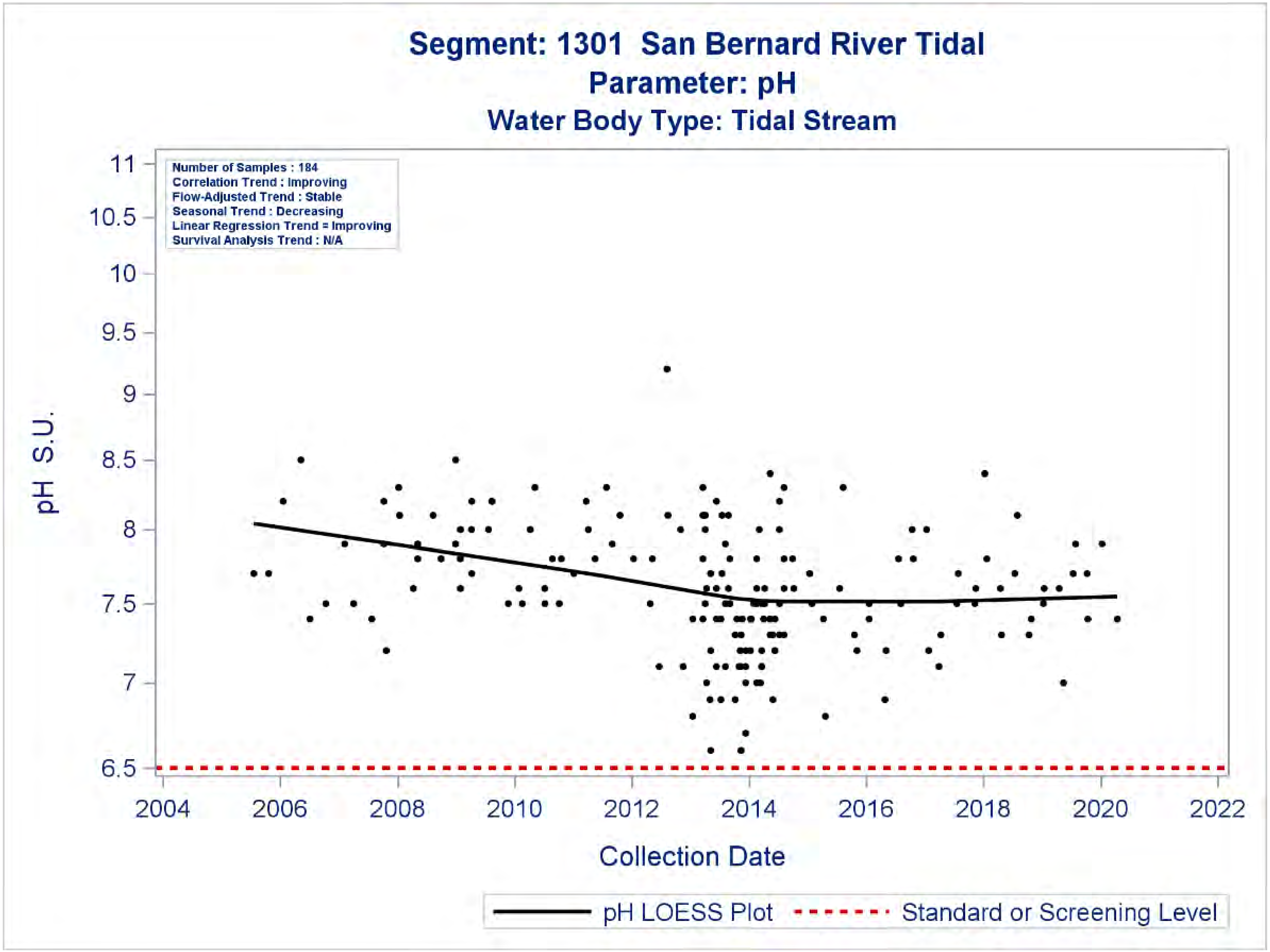
Analysis of data from the San Bernard River Tidal segment revealed parameter trends for three water quality parameters. These include decreasing trends for pH and specific conductance. Even with a decreasing tread, all pH measurements are above the water quality standard of 6.5 standard units.

A major influence on specific conductance in the tidal portion of the San Bernard River is whether the 'mouth' is open to the Gulf of Mexico or whether it has tidal exchange with the intracoastal waterway only. When the mouth of the river closed due to sand and sediment deposition (influenced by the relocated Brazos River channel down the coast), salinity began to decrease in the river and the tidal portion of the river became less saline. While not so much a water quality issue on its own, the blockage of the mouth affects the abundance of crab and fish in the lower riverine system. Several populations of marine species require a migration between the Gulf of Mexico and the river to maintain historical population levels in the river. In the spring of 2005, the mouth of the river had completely silted closed and those migratory marine populations were decimated. When the mouth of the river was dredged open back in 2009, those same migratory marine species returned to the river. Since that time, the mouth has slowly silted closed, salinity has decreased, and the migratory marine population with it. In July 2020, a joint federal, state, and county dredging operation was set to begin opening the river's mouth and the Port of Freeport and the U.S. Army Corp of Engineers agreed to maintain it afterwards.

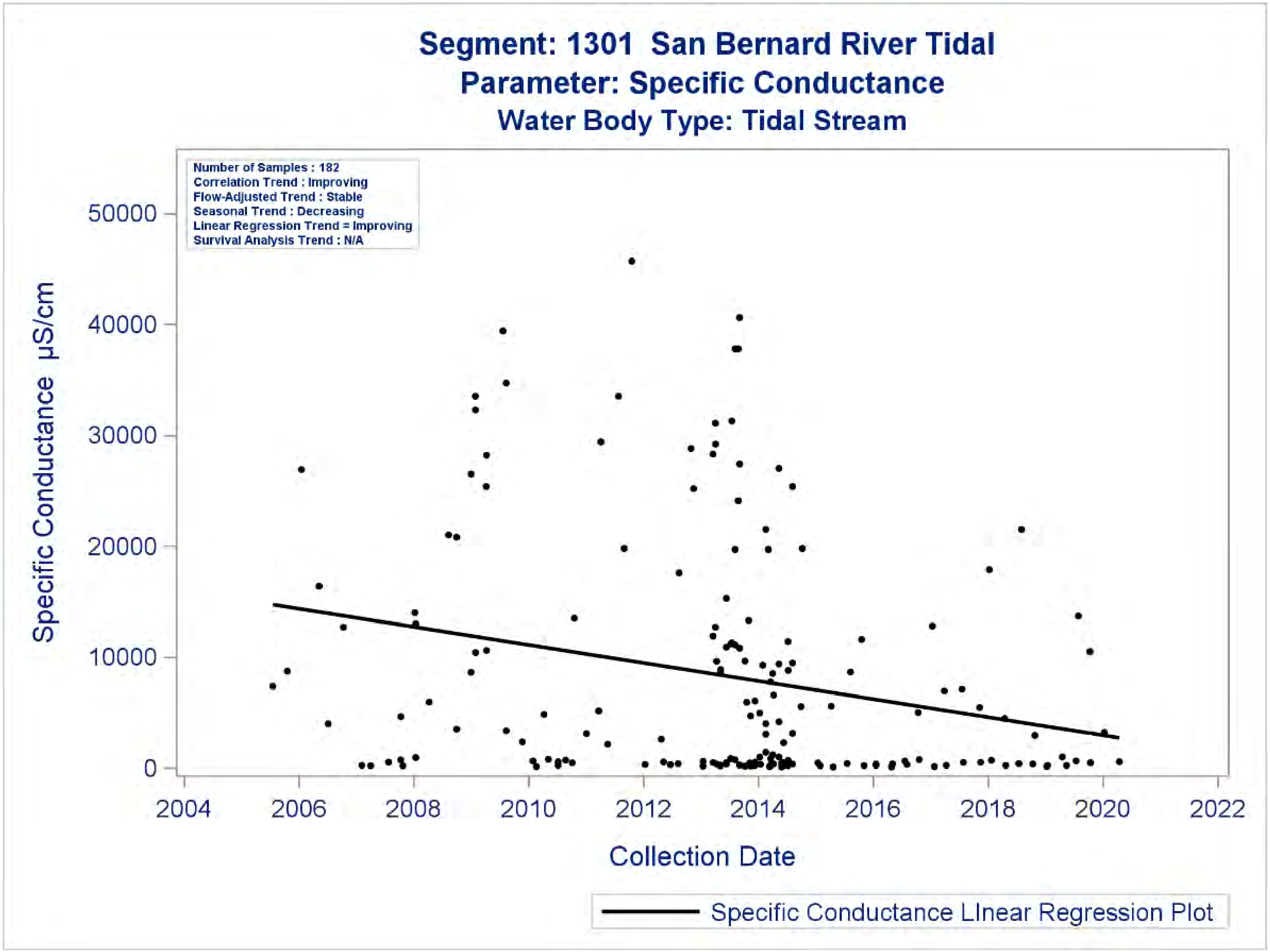
There is also a deteriorating trend in total phosphorus which means the concentrations are increasing. Concentrations of ammonia are also beginning to increase according to the LOESS analysis but are still considered stable with no linear regression trend found in the data. Since 2015, all ammonia results have been less than the screening criteria 0.46 mg/L, so the trend may remain stable.

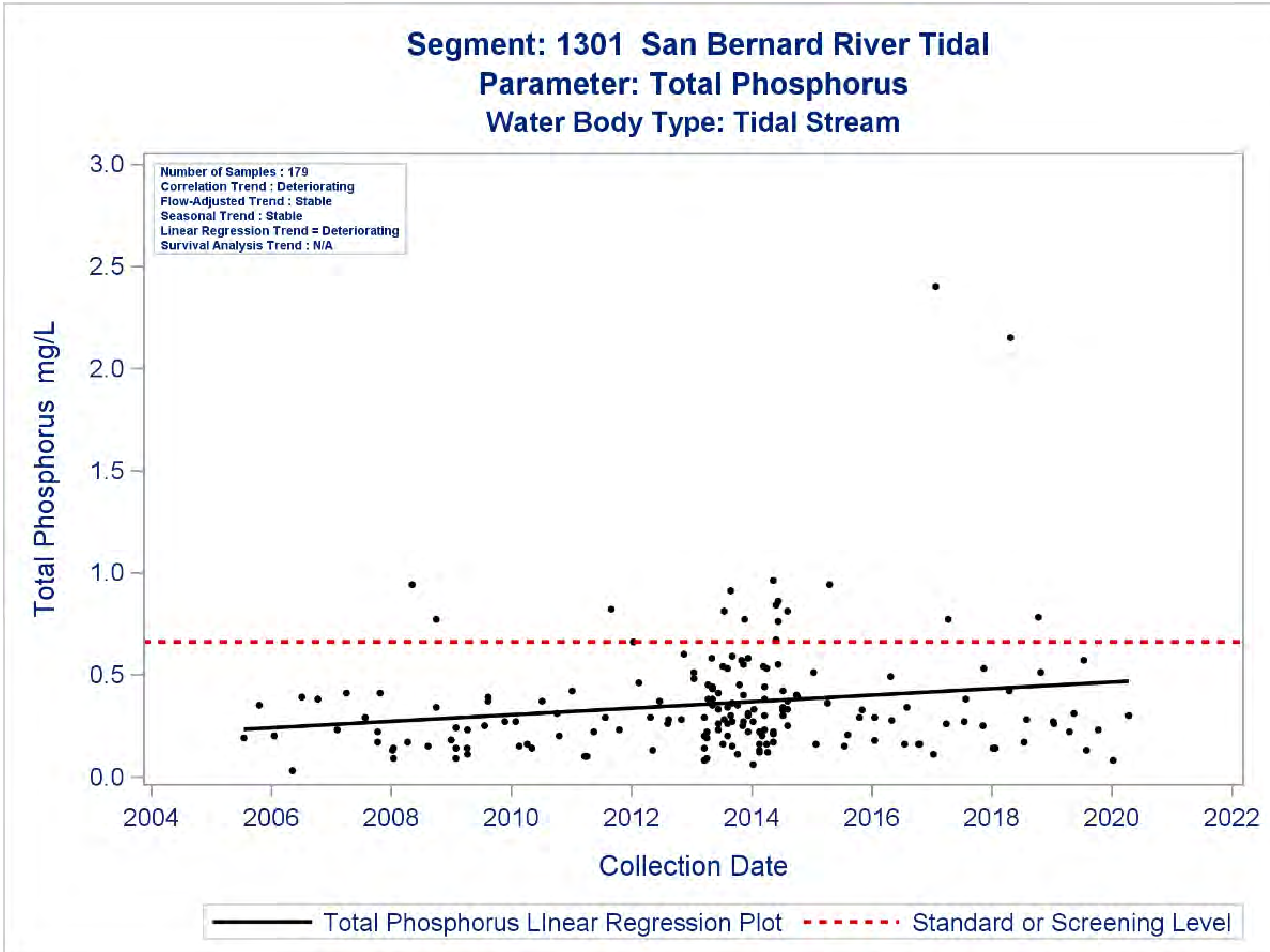
Other than occasional spikes, the majority of total phosphorus and ammonia sample results have concentrations falling below the screening criteria. These occasional spikes in total phosphorus and ammonia, as well as elevated bacteria levels, are likely related to rain events when natural and man-made causes such as wildlife, livestock fields and enclosures, collection systems overflow, WWTFs and OSSFs malfunction, and pet waste in stormwater enter the water way. Bacteria is still a major issue in this segment as Enterococci concentrations remain stable throughout the watershed, with the majority of samples exceeding the 35 MPN/100 mL standard.

With the exception of a few samples collected in 2006, the Chlorophyll *a* dataset includes only data collected between 2013-2015. There is not a long enough period of record for adequate trend analysis, but it should be noted that only a few sample results were measured above the 21 µg/L screening level.

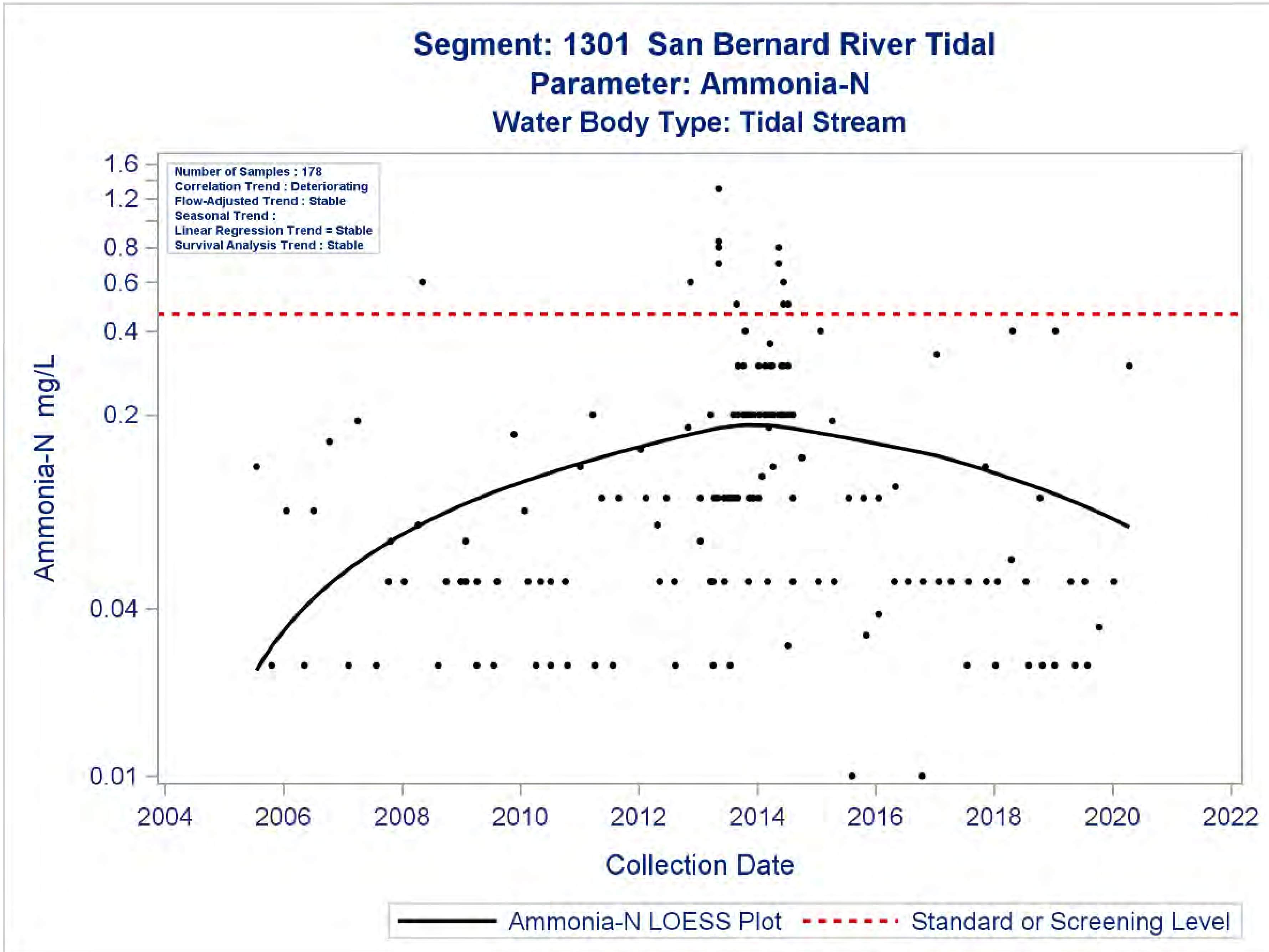


Segment: 1301 San Bernard River Tidal
Parameter: pH
Water Body Type: Tidal Stream
Number of Samples : 184
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
pH S.U.
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
pH LOESS Plot
Standard or Screening Level


Segment: 1301 San Bernard River Tidal
Parameter: Specific Conductance
Water Body Type: Tidal Stream
Number of Samples : 182
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Specific Conductance µS/cm
50000
40000
30000
20000
10000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance LInear Regression Plot



Segment: 1301 San Bernard River Tidal
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 179
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level


Segment: 1301 San Bernard River Tidal
Parameter: Ammonia-N
Water Body Type: Tidal Stream
Number of Samples : 178
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend :
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Ammonia-N mg/L
1.6
1.2
0.8
0.6
0.4
0.2
0.04
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	1301 I	• Animal waste from agricultural production, hobby farms, and riding stables • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • Waste haulers illegal discharges/improper disposal • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	***DO Grab Screening*** 1301 C	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Excessive nutrients and organic matter from agricultural production, and related activities	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, and grease disposal; and OSSF maintenance • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties

		▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Vegetative canopy removed		• Work with drainage districts and agencies to change practices of clear-cutting and channelizing waterways to protect from solar heating • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water.

Special Studies:

The San Bernard Watershed Protection Plan to address bacteria impairments was initiated in 2009 and approved in 2017. This project was facilitated by H-GAC and TCEQ. H-GAC supports stakeholder engagement in the watershed and implementation of the San Bernard Watershed Protection Plan. Elements of the WPP are currently in implementation through coordination between H-GAC and local partners. For more information, please refer to the discussion in the Public Involvement and Outreach section.

Recommendations:

The WPP identified best management practices to address contributions from livestock, domestic pets, wildlife, OSSFs, and other sources.

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to evaluate the effectiveness of the watershed protection plan.
- Continue to implement the watershed protection plan recommendations
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, and grease
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal and installation of pet waste stations
- Promote voluntary conservation and forestry projects
- Coordinate with flood mitigation planning and navigation channel improvements to emphasize water quality elements.

BASIN 24 (Upper Portion)

Upper Bays and Estuaries

2436 – Barbours Cut

2438 – Bayport Channel

2428 – Black Duck Bay

2430 – Burnet Bay

2425 – Clear Lake

2427 – San Jacinto Bay

2429 – Scott Bay

2426 – Tabbs Bay

2422 – Trinity Bay

2421 – Upper Galveston Bay

Segment Number: 2436	Name: Barbours Cut

Area:	0.4 square miles	Miles of Shoreline:	4 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	1	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	3

DESCRIPTION

- Segment 2436: **Barbours Cut** (classified water body) – A side waterbody located on west side of Houston Ship Channel/tidal San Jacinto River immediately north of Morgan's Point in the City of La Porte

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
17925	2436	BARBOUR'S CUT NEAR NORTH BANK 0.5 KM NNW OF THE INTERSECTION OF BARBOURS CUT BLVD AND MAPLE ST	HC	Bimonthly	Field, Conventional, Bacteria

HC = Harris County Pollution Control


Barbours Cut - 2436
HC:17925
2436_01
Houston Ship Channel
Southern Pacific
Southern Pacific
N L St
Barbours Cut Intermodal
E Barbours Cut Blvd
Cut Blvd
Morgans Point
S Jamison St
S Oak St
S Maple St
S C St
N Lobit St
S Wilson St
S Donaldson
S Blackwell St
S Lobit St
Bayridge Rd
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
Streams
0 0.1 0.2 0.4
Miles

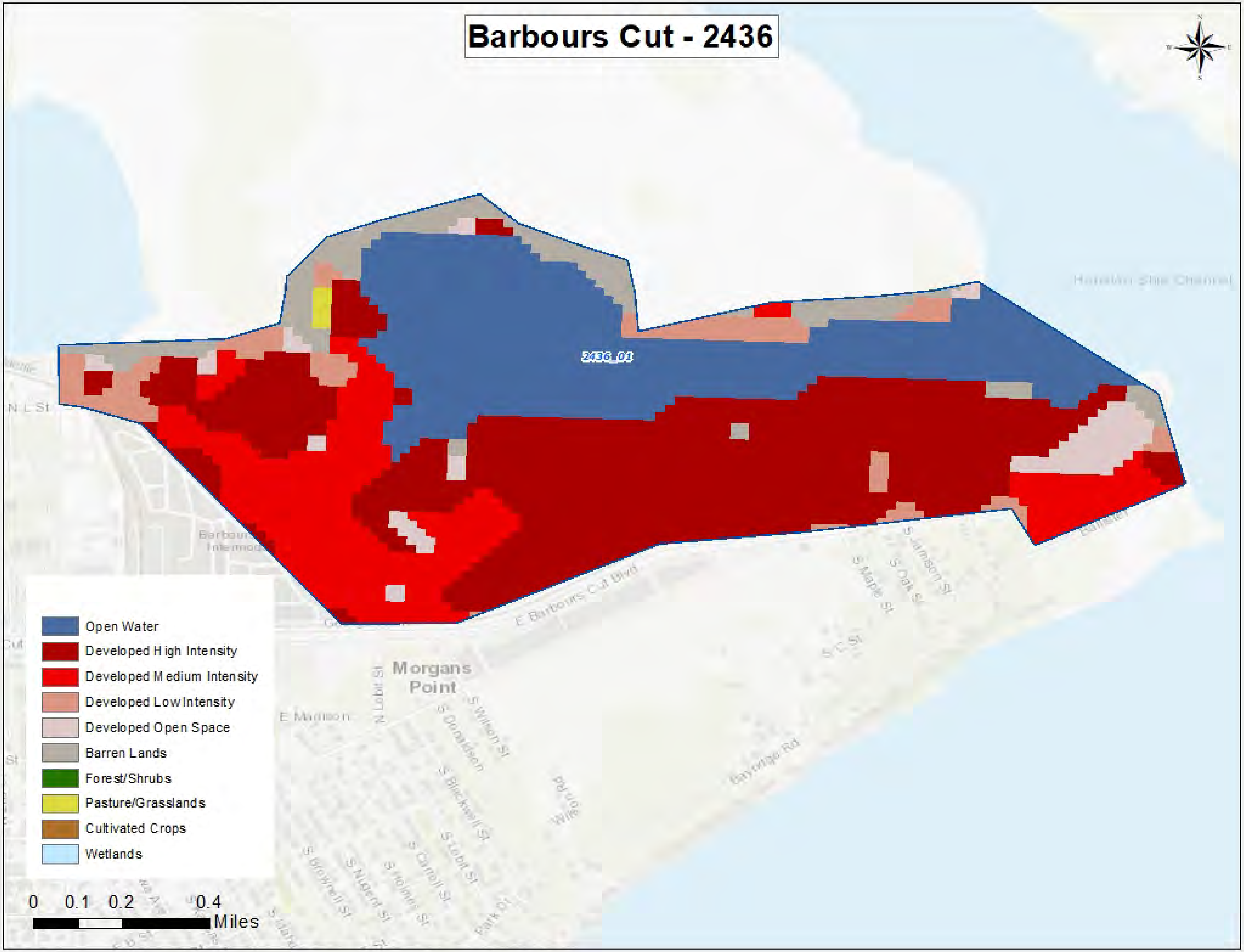
Segment 2436 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Barbours Cut watershed is at the south end of the Houston Ship Channel (HSC) at Morgan's Point. The area is surrounded by some wetlands, sparsely populated residential areas, and the Port of Houston container yard. The Houston Ship Channel provides heavy boat and barge traffic on a consistent basis.

Developed lands are the largest land cover class at 65.93 percent. The next largest land cover class is Open Water, which covers 25.82 percent of the area. Although covering a small percentage of the watershed in 2008 (0.69%), by 2018 agricultural lands diminished to 0% land cover.

Segment 2436 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	5.34	0.69	0.00	0.00	-100.00
Barren Lands	39.36	5.06	59.16	7.62	50.30
Developed	437.01	56.22	511.73	65.93	17.10
Forest/Shrubs	1.33	0.17	4.23	0.54	218.05
Open Water	228.84	29.44	200.38	25.82	-12.44
Wetlands	65.38	8.41	0.67	0.09	-98.98
TOTAL	**777.27**	**100.00**	**776.16**	**100.00**	


Barbours Cut - 2436
2436_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.1 0.2 0.4
Miles
Morgans Point
E Barbours Cut Blvd
Bayridge Rd
N L St

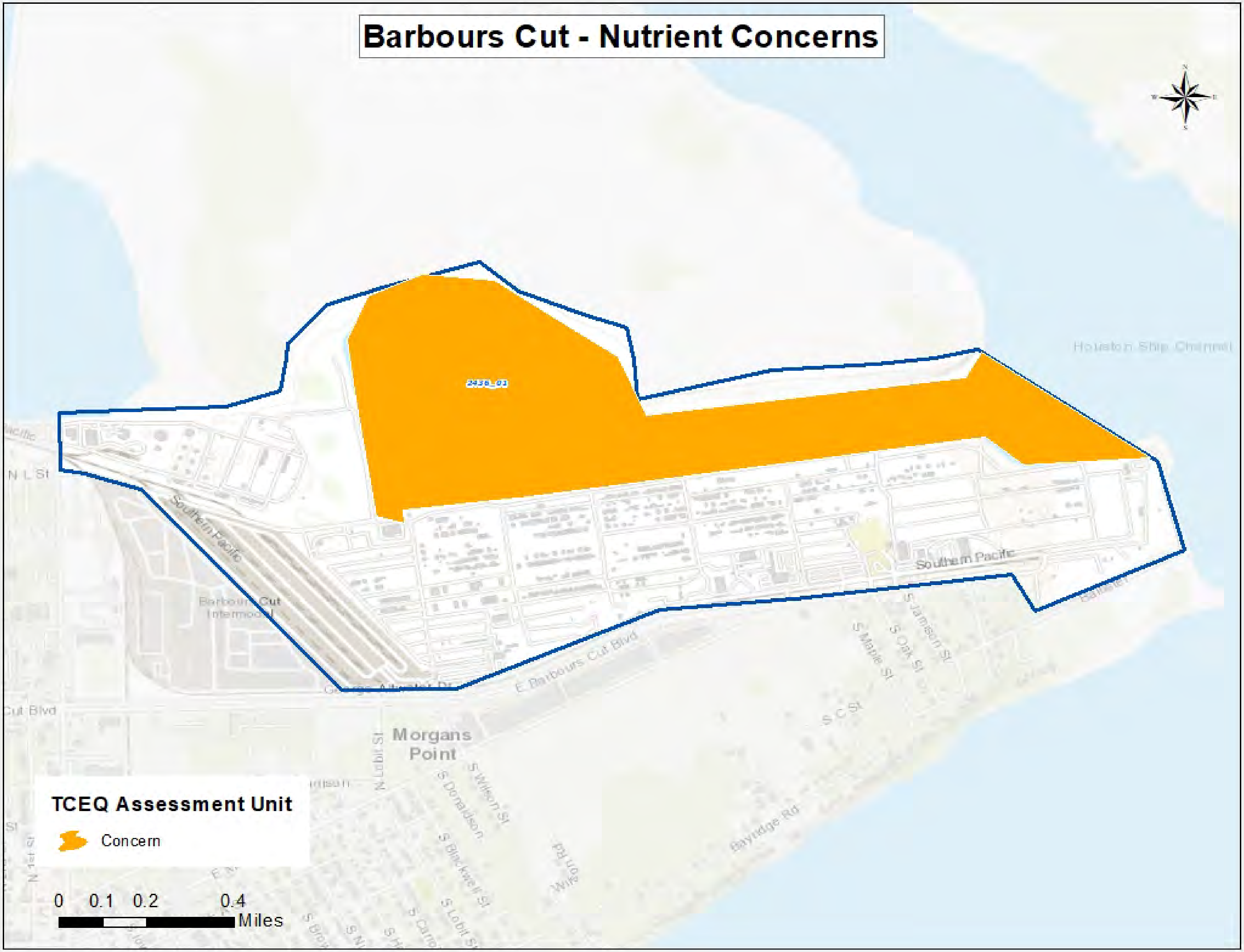
Water Quality Issues:

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

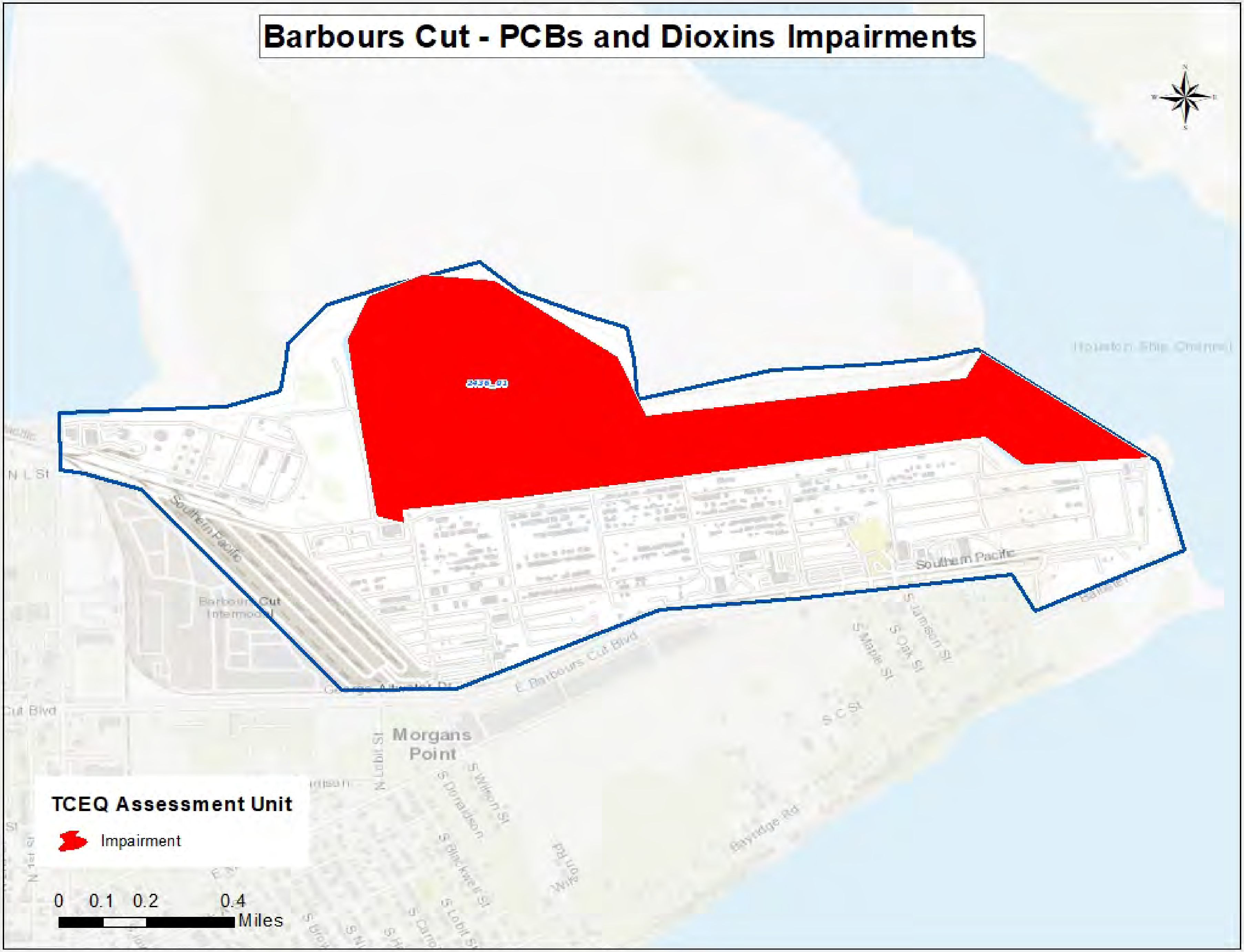
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
Barbours Cut (2436) is listed in the 2020 Integrated Report for having water quality screening level concerns for ammonia-nitrogen, nitrate-nitrogen, and total phosphorus. For samples collected between 12/1/11 – 11/30/18, 45.2 percent of ammonia-nitrogen, 95.1 percent of nitrate-nitrogen, and 69.0 percent of total phosphorus samples exceed the nutrient screening levels.

PCBs and Dioxin Impairments
Barbours Cut is listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from this segment indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.



Barbours Cut - Nutrient Concerns
Houston Ship Channel
2436_01
Southern Pacific
Barbours Cut Intermodal
E Barbours Cut Blvd
Morgans Point
N Lobit St
S Wilson St
S Donaldson
S Blackwell St
S Lobit St
S Jamison St
S Oak St
S Maple St
S C St
Bayridge Rd
N L St
Cut Blvd
TCEQ Assessment Unit
Concern
0 0.1 0.2 0.4
Miles



Barbours Cut - PCBs and Dioxins Impairments
Houston Ship Channel
N L St
Southern Pacific
Barbours Cut Intermodal
E Barbours Cut Blvd
Cut Blvd
S Jamison St
S Oak St
S Maple St
S C St
Morgans Point
N Lobit St
S Donaldson
S Wilson St
S Blackwell St
S Lobit St
Bayridge Rd
TCEQ Assessment Unit
Impairment
0 0.1 0.2 0.4
Miles

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Barbours Cut watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, stormwater runoff, and animal waste.

There are 3 permitted wastewater outfalls in the Barbours Cut watershed. There are no permitted on-site sewage facilities in the watershed. The wastewater treatment facilities in the watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a no sanitary sewer overflows reported in the sewer collection systems.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

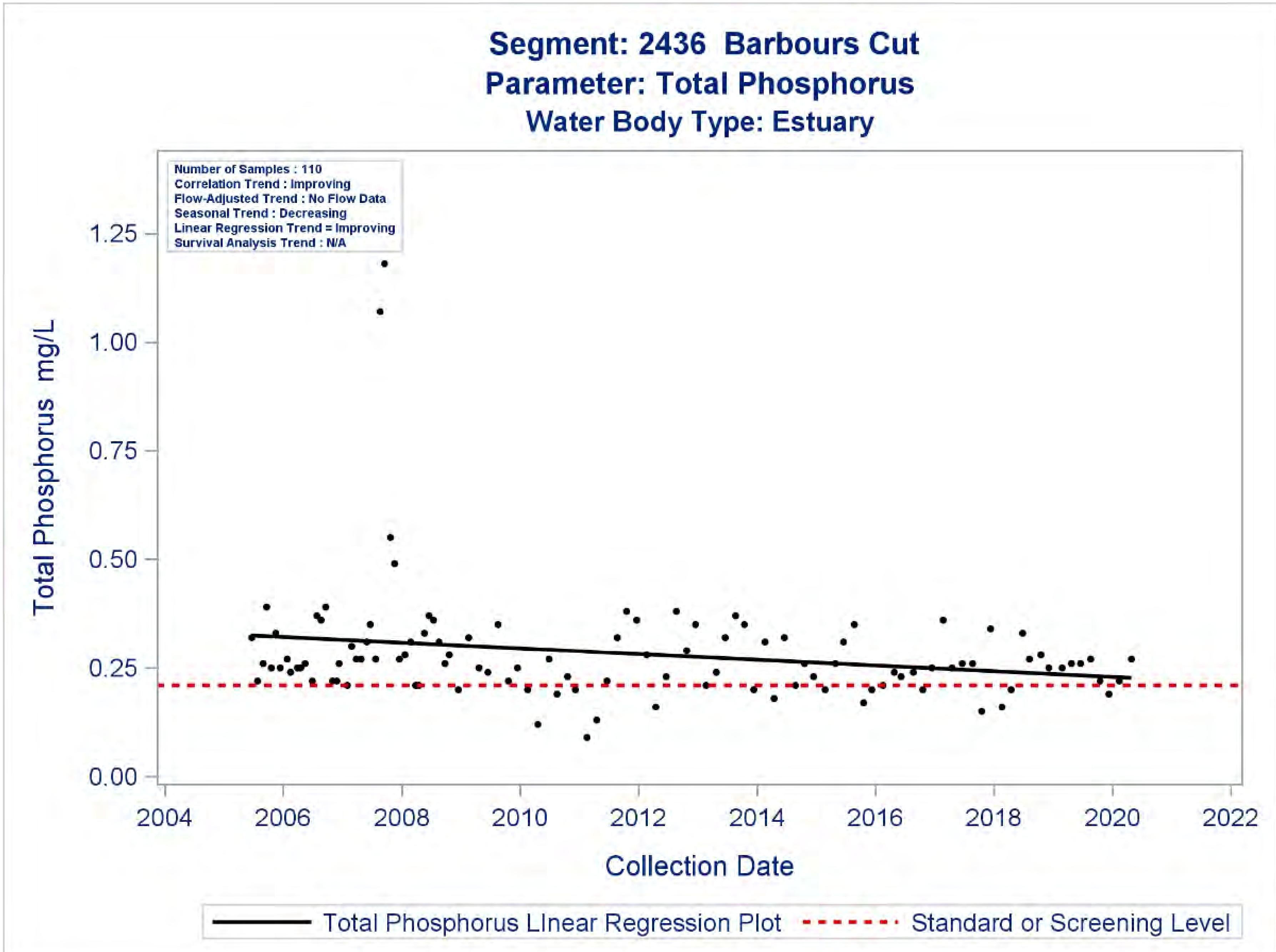
For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Barbours Cut watershed.

Barbours Cut - 2436

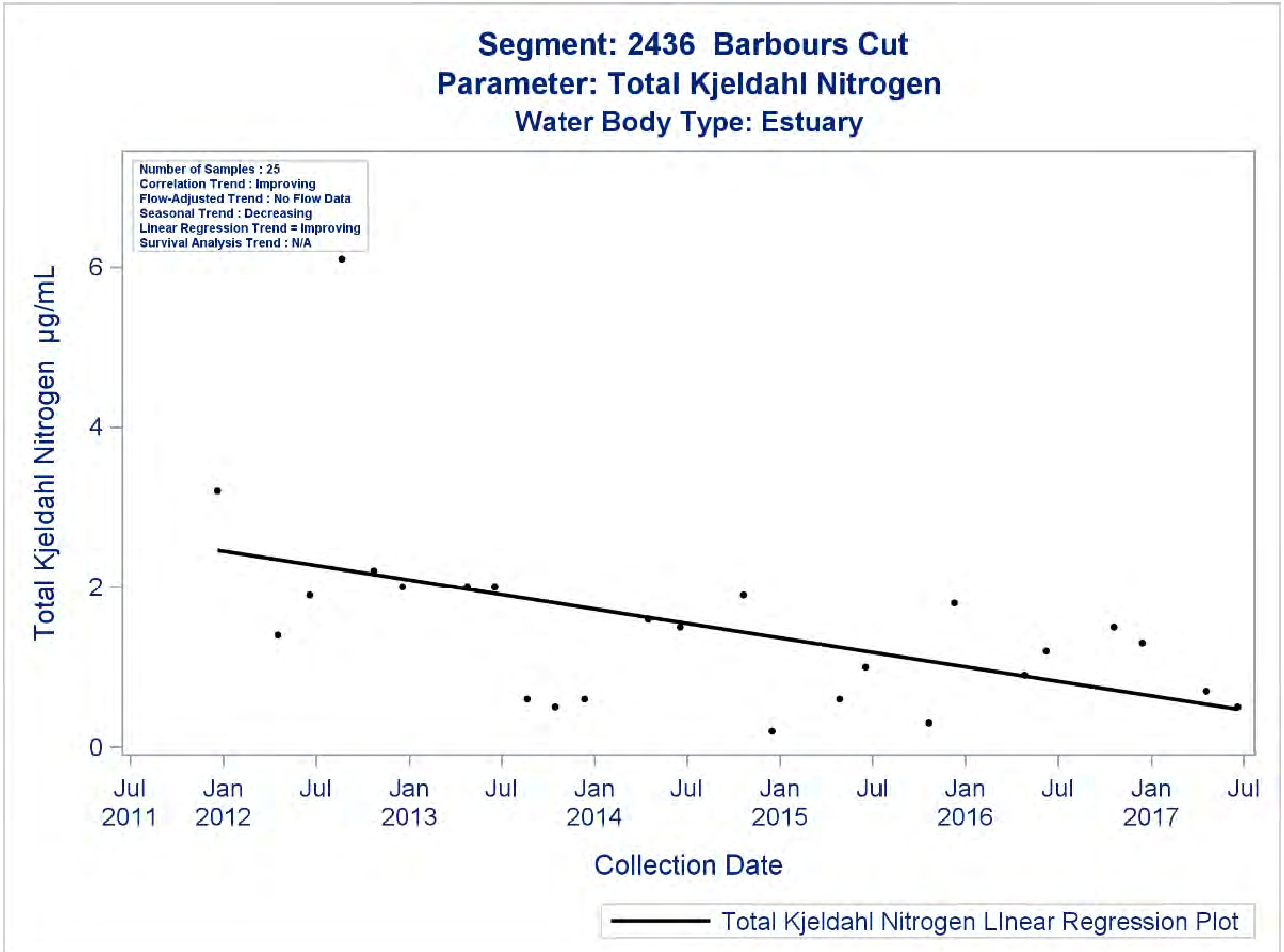
Trend Analysis:

Analysis of the water quality data set for Barbours Cut (segment 2436) identified one parameter trend and a second possible trend – total phosphorus and TKN respectively. While the trend is improving and concentrations are decreasing, of 110 data points in the data set, total phosphorus exceeded the screening criteria of 0.21 mg/L in more than 75% of the samples. TKN samples were only collected for this site for six years instead of the seven required to confirm a valid trend. With 25 samples, analysis shows what appears to be an improving trend with decreasing TKN concentrations over time. Additional sampling must be conducted to prove or disprove a trend.

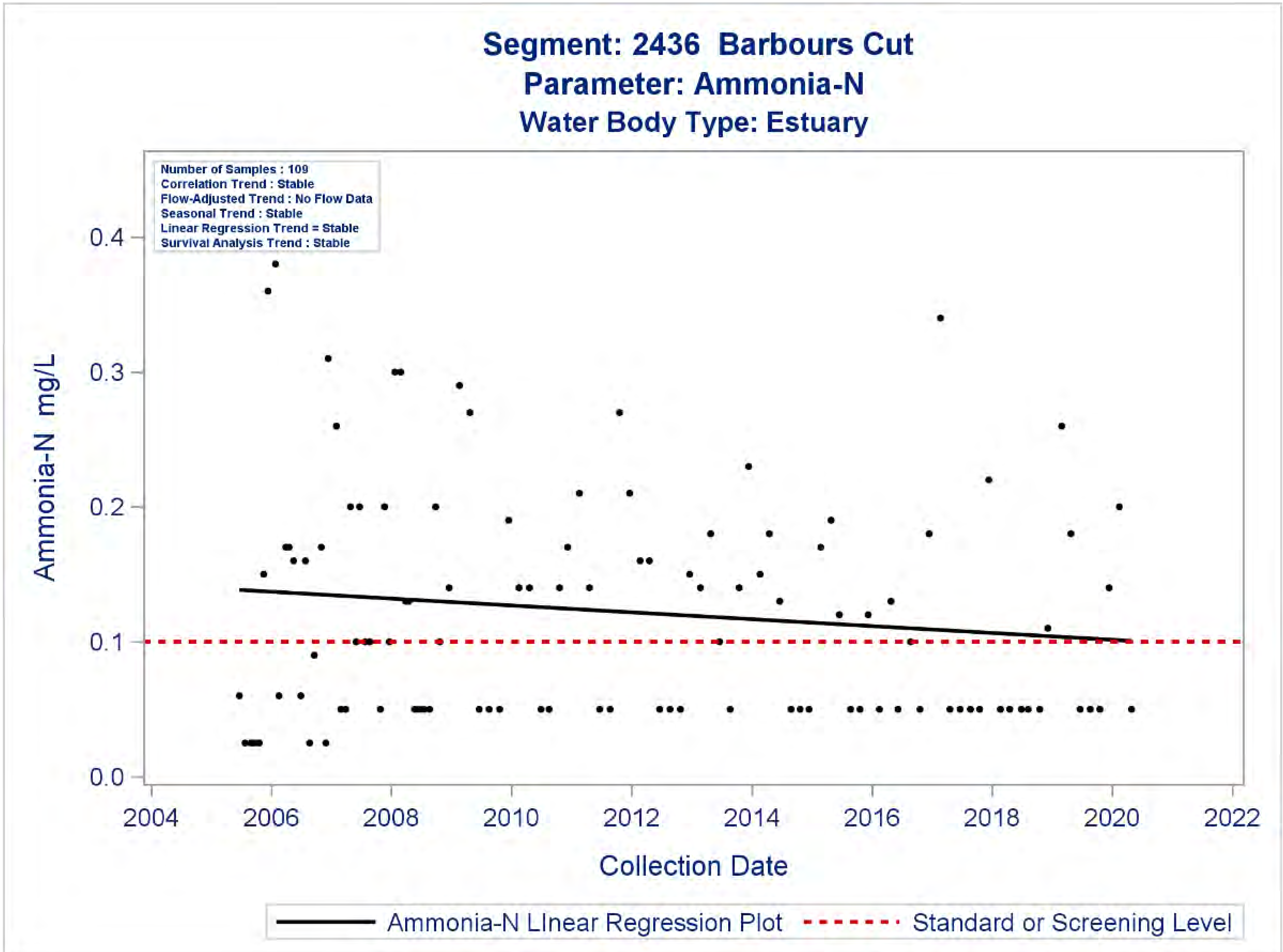
The 2020 Texas Integrated Report lists this segment as having a concern for elevated nutrient levels. Trend analysis of ammonia and nitrate data for segment 2436 showed that concentrations have remained relatively stable over time with a majority of samples exceeding the set screening criteria for each parameter. The elevated nutrient concentrations in Barbours Cut are likely originating from urban runoff or from wastewater treatment facility (WWTF) outfalls.



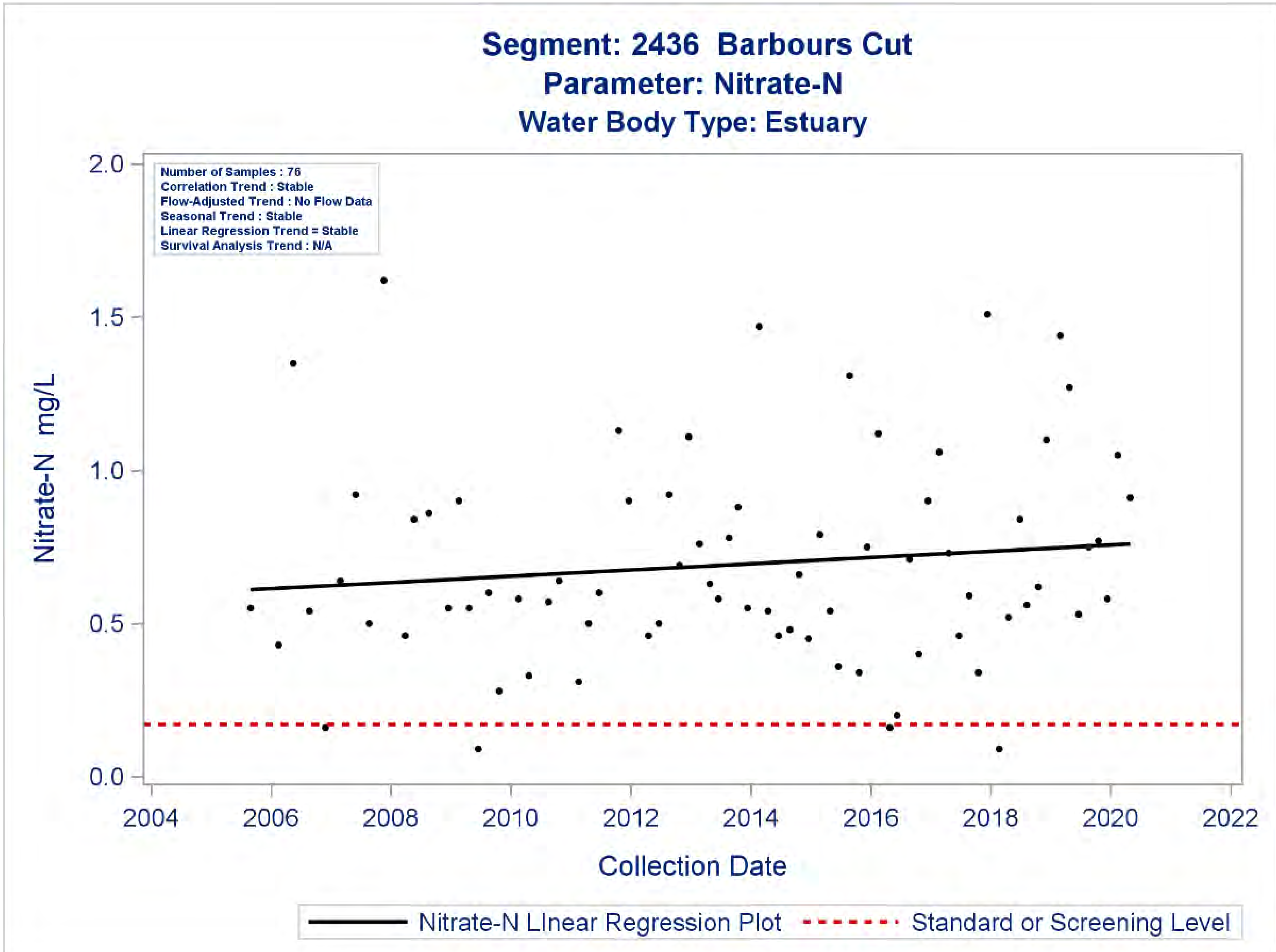
Segment: 2436 Barbours Cut
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



Segment: 2436 Barbours Cut
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 25
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
2
4
6
Jul 2011
Jan 2012
Jul
Jan 2013
Jul
Jan 2014
Jul
Jan 2015
Jul
Jan 2016
Jul
Jan 2017
Jul
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 2436 Barbours Cut
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 109
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Ammonia-N mg/L
0.0
0.1
0.2
0.3
0.4
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



Segment: 2436 Barbours Cut
Parameter: Nitrate-N
Water Body Type: Estuary
Number of Samples : 76
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Nitrate-N mg/L
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nutrient Concentrations	***Ammonia*** ***Nitrate*** ***Phosphorus*** 2436 C	• WWTF effluent and sanitary sewer overflows • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Dioxin/PCBs in Fish Tissue	2436 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue. This segment was included in the Houston Ship Channel TMDL for Dioxin.

Barbours Cut was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2438	Name: Bayport Ship Channel

Area:	0.3 square miles	Miles of Shoreline:	5 miles	Designated Uses:	Noncontact Recreation; High Aquatic Life

Number of Active Monitoring Stations:	1	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	7

DESCRIPTION

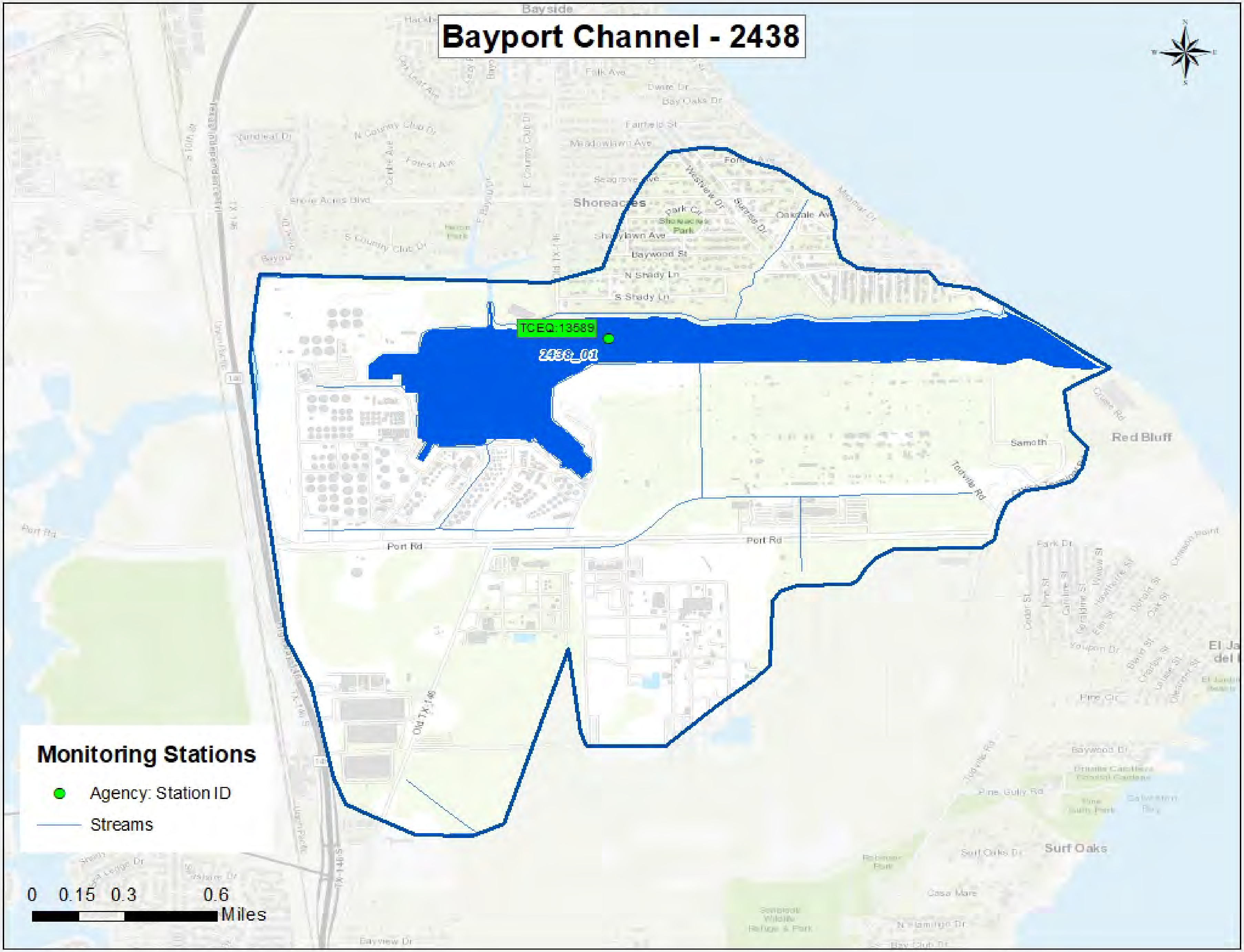
- Segment 2438: **Bayport Ship Channel** – Located on the western shore of Upper Galveston Bay from confluence with Galveston Bay extending west approximately 2 miles to the terminus in the turning basin immediately south of the Cities of La Porte and Shoreacres

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
13589	2438	BAYPORT CHANNEL MID CHANNEL SOUTH OF S SHADY LN AT PINE TRL IMMEDIATELY EAST OF TURNING BASIN	FO	Quarterly Two/Year One/Year	Field, Conventional, Bacteria Metals in Water Metals in Sediment, Organics in Sediment

FO = TCEQ Regional Office

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.



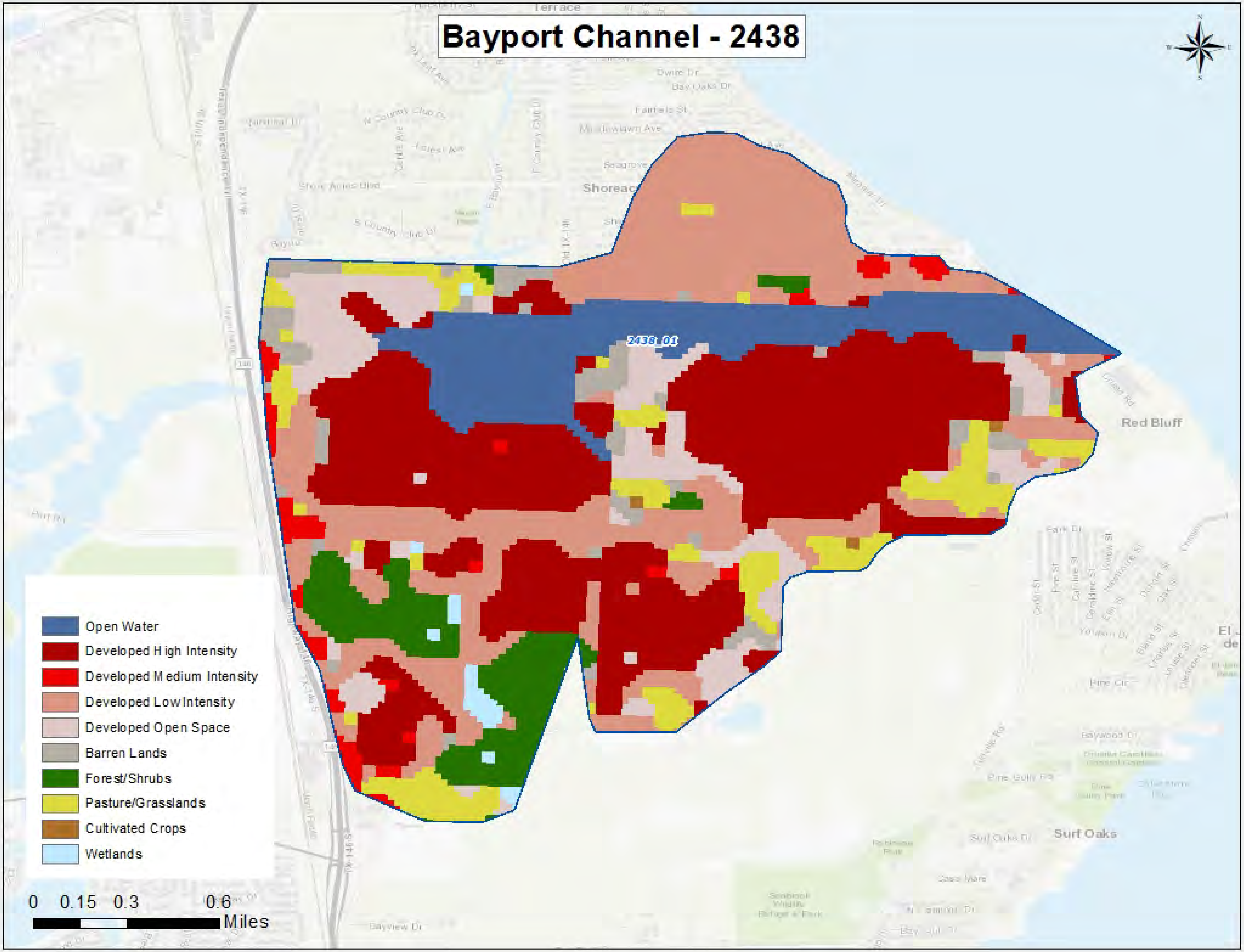
Bayport Channel - 2438
TCEQ:13589
2438_01
Monitoring Stations
Agency: Station ID
Streams
0 0.15 0.3 0.6
Miles
Shoreacres
Red Bluff
Surf Oaks
Port Rd
Old TX-146

Segment 2438 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Bayport Channel is located on the western shore of Upper Galveston Bay from the confluence with Galveston Bay extending west approximately two miles to the terminus in the turning basin. The Channel is used primarily by barges transporting petrochemical feed stocks and related products. The surrounding watershed is heavily developed with industrial activities and residential and commercial uses, with Developed land cover being 67.78 percent of the area. A cruise ship terminal sits at the mouth of the channel but is considered upper Galveston Bay.

Segment 2438 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	27.13	1.35	167.24	8.32	516.39
Barren Lands	2.00	0.10	105.64	5.26	5,182.00
Developed	1,407.32	70.06	1,361.73	67.78	-3.24
Forest/Shrubs	2.89	0.14	128.99	6.42	4,363.32
Open Water	298.68	14.87	221.28	11.01	-25.91
Wetlands	270.66	13.47	24.24	1.21	-91.04
TOTAL	**2,008.68**	**100.00**	**2,009.12**	**100.00**	



Bayport Channel - 2438
2438_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.15 0.3 0.6
Miles
Red Bluff
Surf Oaks

Water Quality Issues:

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

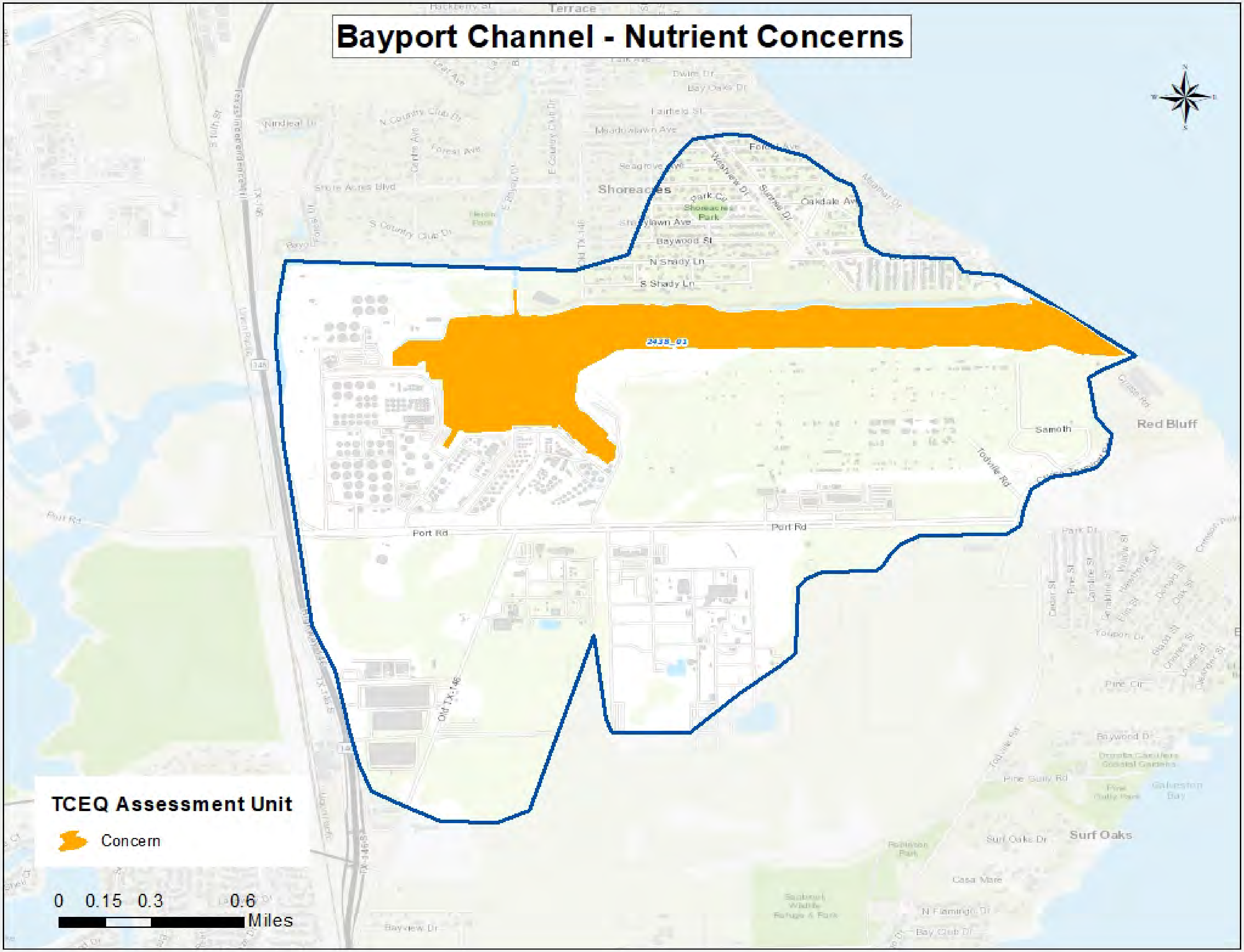
Nutrient Concerns
Bayport Channel (2438) is listed in the 2020 Integrated Report as having nutrient screening level concerns for ammonia-nitrogen, nitrate-nitrogen, and total phosphorus. For the segment, 48.1 percent of ammonia-nitrogen samples, 54.8 percent of nitrate-nitrogen samples, 81.5 percent of total phosphorus samples, and 66.7 percent of chlorophyll-*a* samples exceeded the nutrient screening levels.

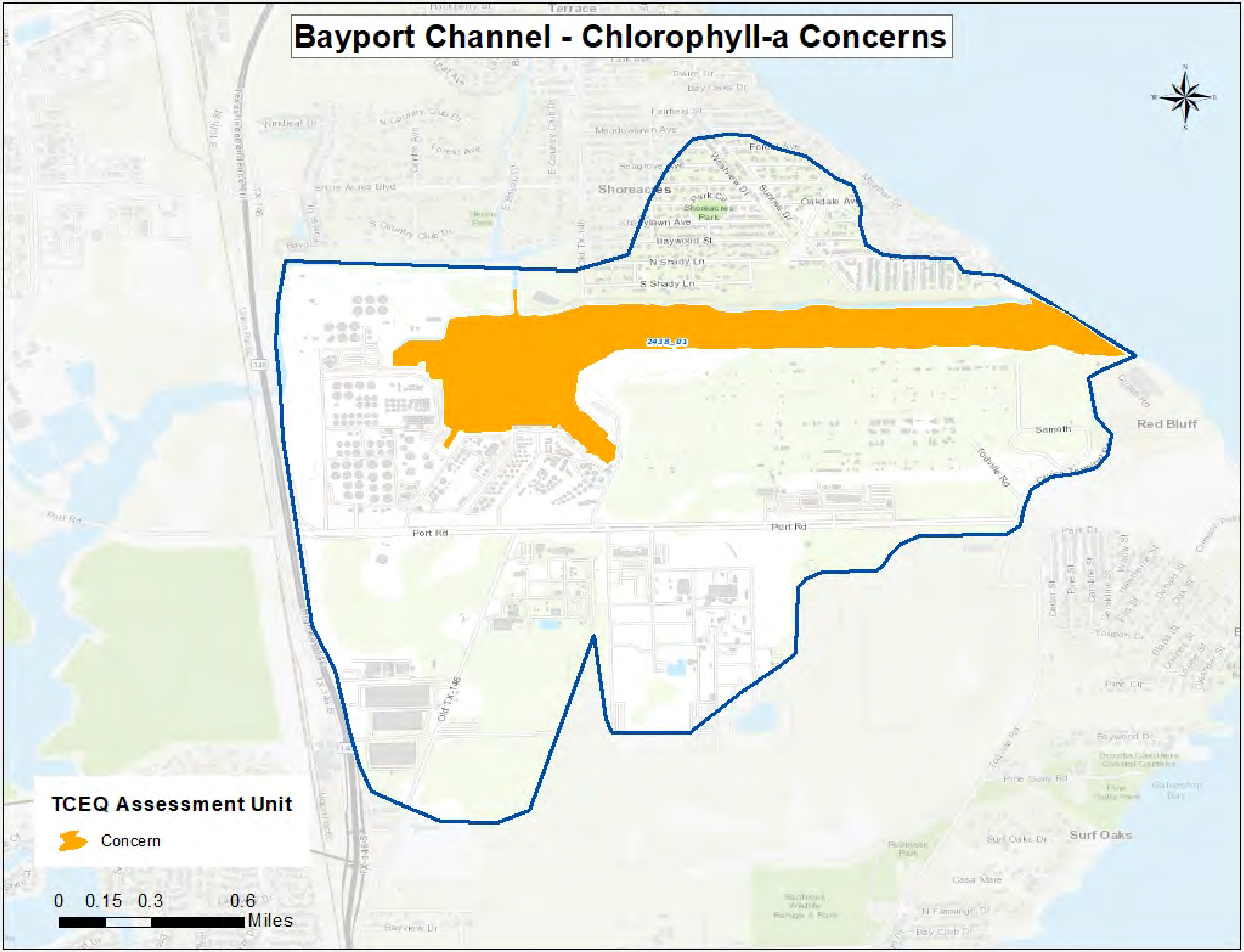
Chlorophyll-a Concerns
Bayport Channel has a screening level concern for chlorophyll-a, with 20 of 30 samples exceeding the screening level criteria.

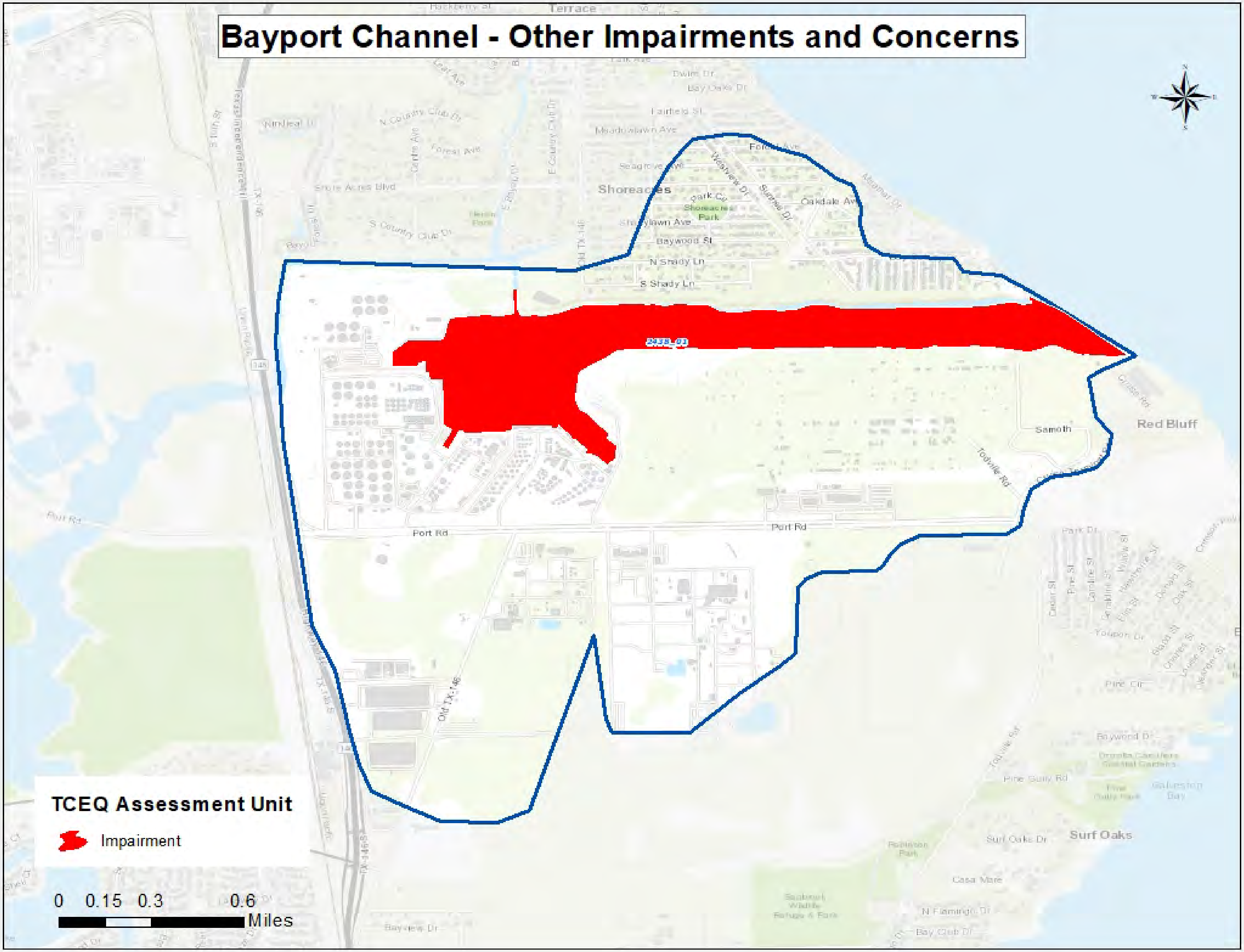
Chronic Toxic Substances in Water
In the 2020 Integrated Report, a concern for chronic toxic substances in water is identified for AU 2438_01. This concern is based upon elevated levels of dissolved copper.

PCBs and Dioxin Impairments
Bayport Channel is listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from this segment indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory in in effect.

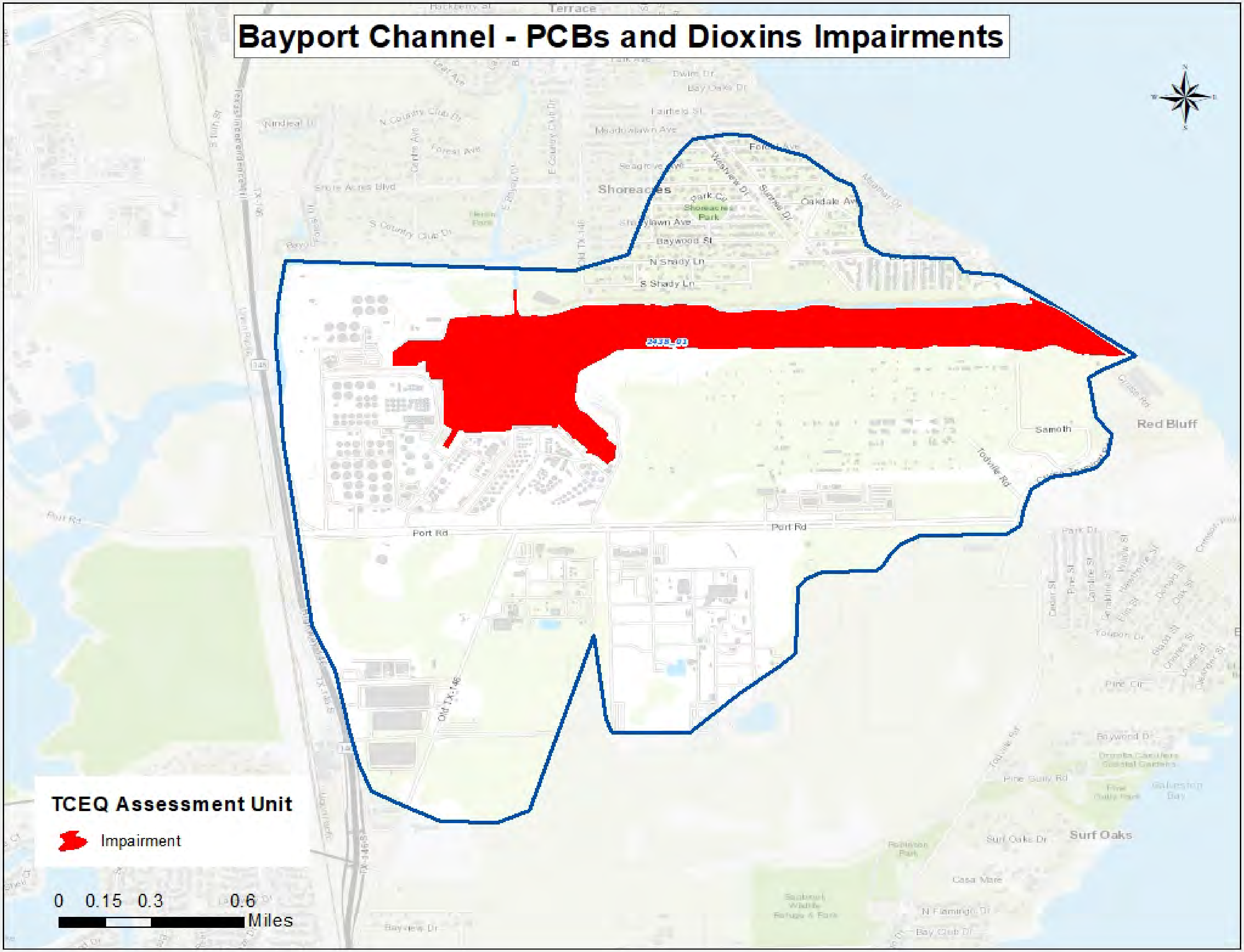
Bayport Channel - Nutrient Concerns




Bayport Channel - Chlorophyll-a Concerns
2438_01
TCEQ Assessment Unit
Concern
0 0.15 0.3 0.6
Miles
Shoreacres
Red Bluff
Surf Oaks
Port Rd
Samoth
Todville Rd
Old TX-146
Shoreacres Park
Baywood St
N Shady Ln
S Shady Ln
Oakdale Ave
Meadowlawn Ave
Fairfield St
Shore Acres Blvd
S Country Club Dr
N Country Club Dr
Forest Ave
Park Cir
Westview Dr
Sunrise Dr
Seagrove Ave
Shadylawn Ave
Terrace
Pine Gully Rd
Surf Oaks Dr
Casa Mare
N Flamingo Dr
Bay Club Dr
Bayview Dr
Pine Cir
Yaupon Dr


Bayport Channel - Other Impairments and Concerns
TCEQ Assessment Unit
Impairment
0 0.15 0.3 0.6
Miles
2438_01
Shoreacres
Red Bluff
Surf Oaks
Port Rd
Old TX-146
Todville Rd

Bayport Channel - PCBs and Dioxins Impairments



Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Bayport Channel watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, stormwater runoff, and animal waste.

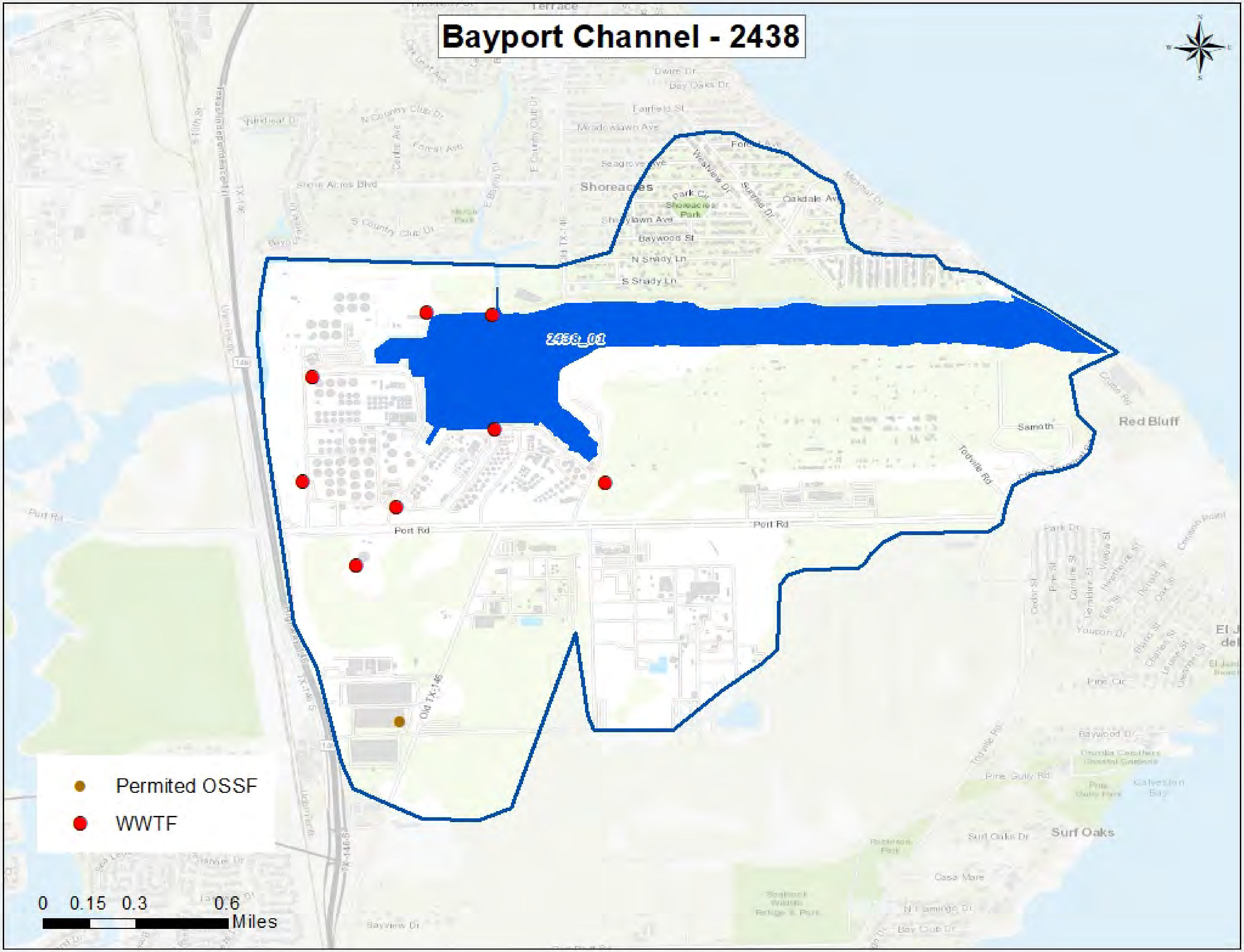
There are 7 permitted wastewater outfalls and 1 permitted on-site sewage facility in the Bayport Channel watershed. The wastewater treatment facilities and on-site sewage facilities in the Bayport Channel watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

An impairment for chronic toxic substances is due to the presence of dissolved copper in water. Copper typically enters water bodies from domestic, agricultural, or industrial sources, as well as the dissolution of natural deposits. Copper can also be resuspended from deposits in sediment through dredging or tidal movements. There is no known point source for copper in this watershed.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Bayport Channel watershed.

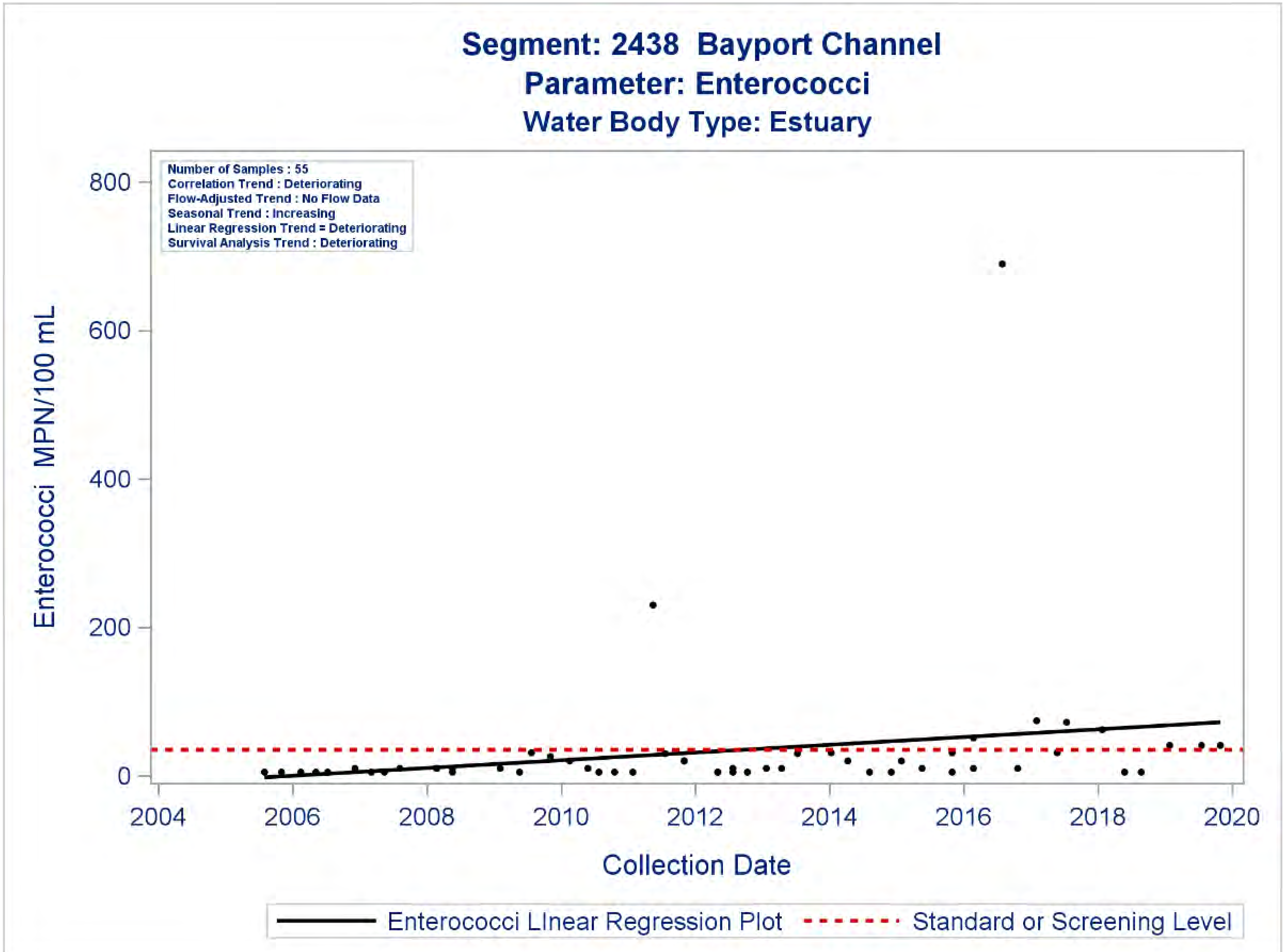


Bayport Channel - 2438
2438_01
Permited OSSF
WWTF
0 0.15 0.3 0.6
Miles
Port Rd
Shoreacres
Red Bluff
Surf Oaks

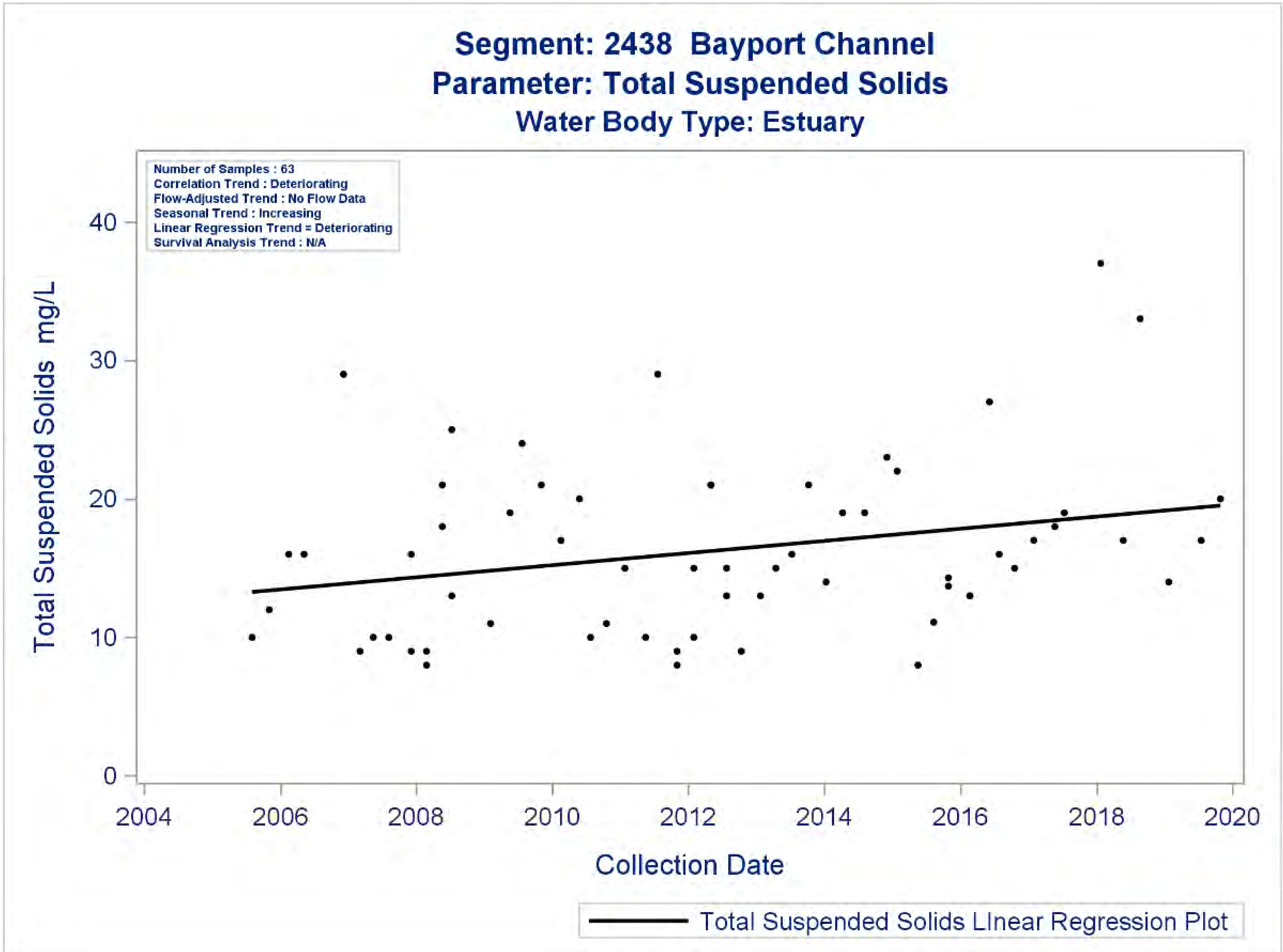
Trend Analysis:

Analysis of water quality data for the Bayport Ship Channel (segment 2438) watershed revealed three parameter trends including increasing enterococci and TSS and decreasing or improving total phosphorus concentrations. With the exception of a few data points, bacteria began exceeding the standard more frequently begin in 2016. While not problematic at this time, TSS concentrations are increasing but values still fall below 40 mg/L which is less than the grab sample limit for most WWTF discharges. Total phosphorus concentrations in the Bayport Channel are decreasing with samples being measured below the screening criteria of 0.21 mg/L more frequently beginning in 2016.

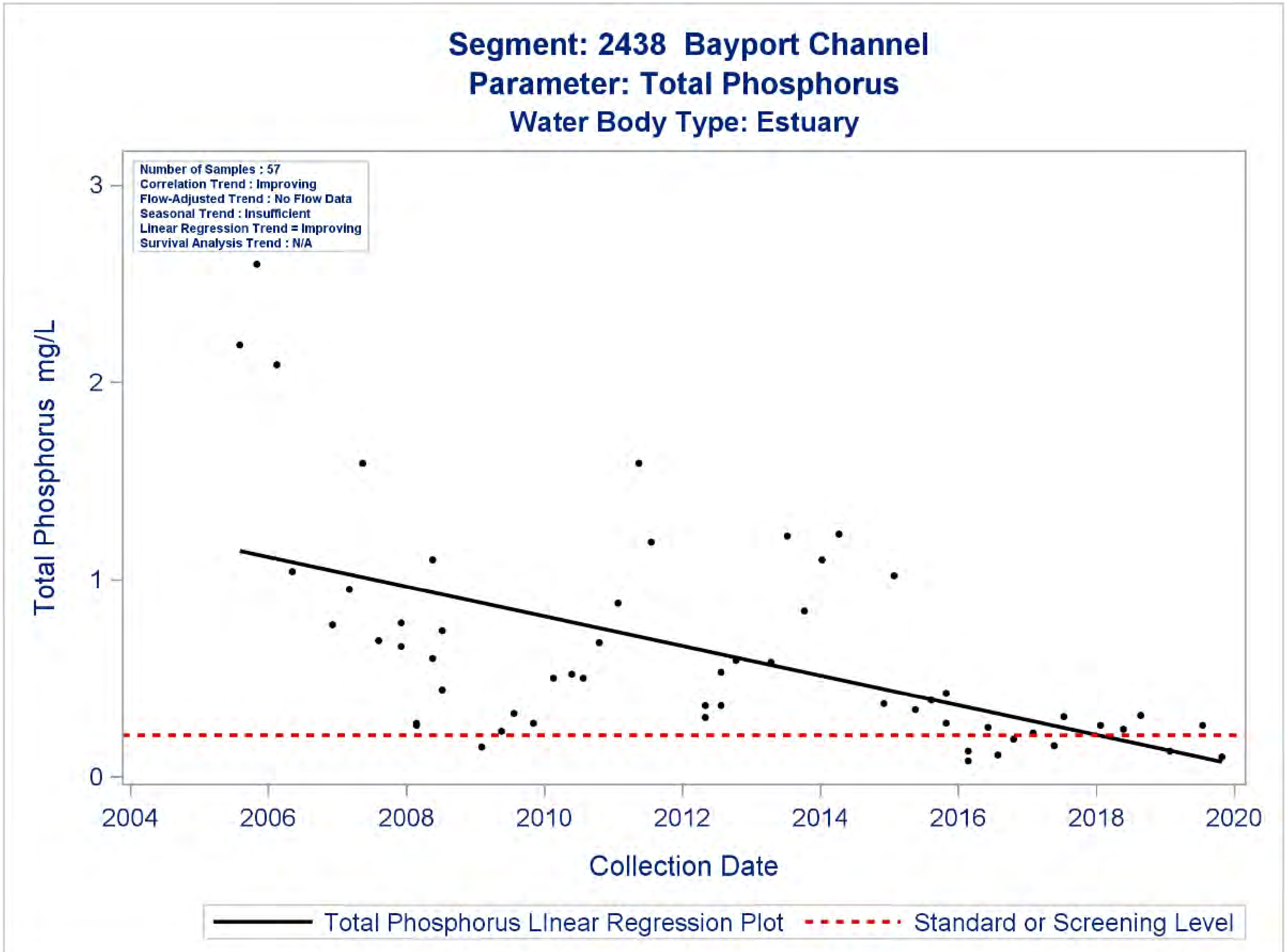
The 2020 Texas Integrated Report lists this segment as having a concern for elevated nutrient levels. Analysis of Bayport Channel ammonia and nitrate data revealed stable trends, but the majority of samples collected during the period of record exceeded the recommended screening criteria for each parameter more than 50% of the time. A concern for chlorophyll *a* levels also exists for this segment, but there is no trend found in the data. However, more than half of the samples collected since 2000 have exceeded the 11.6 µg/L screening criteria.

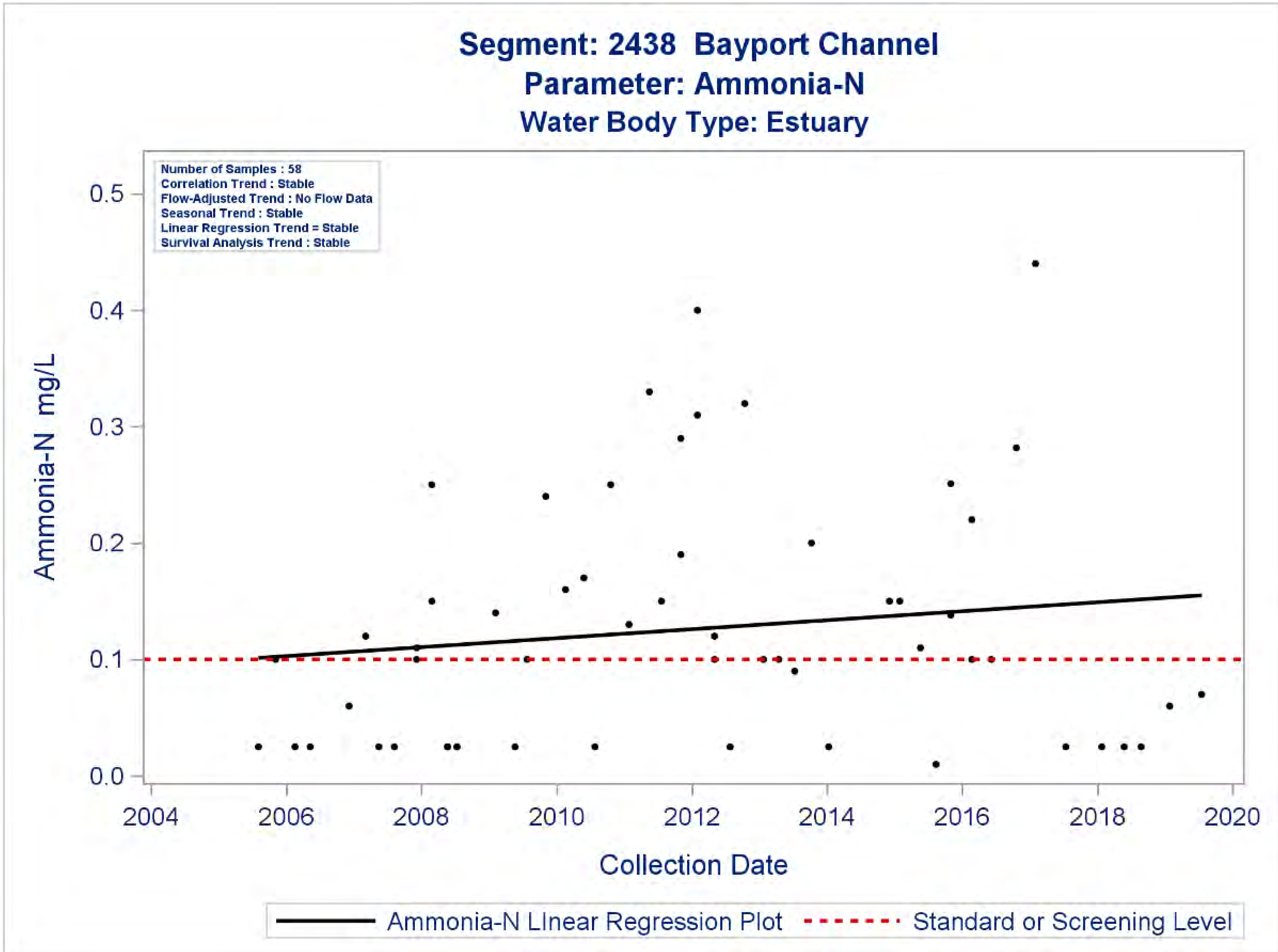


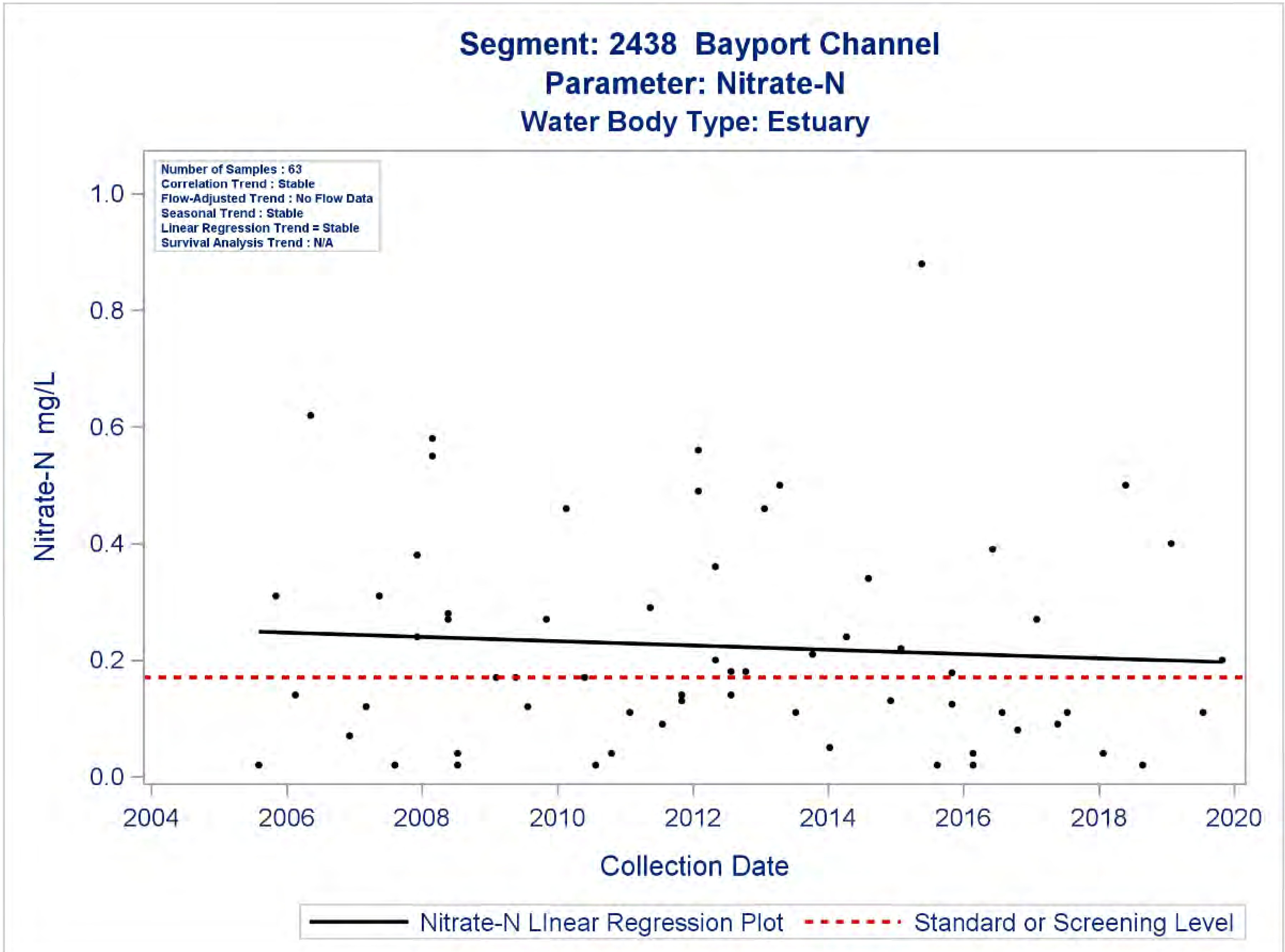
Segment: 2438 Bayport Channel
Parameter: Enterococci
Water Body Type: Estuary
Number of Samples : 55
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Enterococci MPN/100 mL
800
600
400
200
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Enterococci LInear Regression Plot
Standard or Screening Level



Segment: 2438 Bayport Channel
Parameter: Total Suspended Solids
Water Body Type: Estuary
Number of Samples : 63
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
10
20
30
40
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Suspended Solids LInear Regression Plot


Segment: 2438 Bayport Channel
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 57
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
3
2
1
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level


Segment: 2438 Bayport Channel
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 58
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Ammonia-N mg/L
0.0
0.1
0.2
0.3
0.4
0.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



Segment: 2438 Bayport Channel
Parameter: Nitrate-N
Water Body Type: Estuary
Number of Samples : 63
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Nitrate-N mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nutrient Concentrations	***Ammonia*** ***Nitrate*** ***Phosphorus*** 2438 C	• Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Nutrient loading from WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs	• Detrimental effect on aquatic biological community	• Add water quality features to stormwater systems • Restore habitat to riparian areas, ditches and swales. • Educate residents about excessive fertilizer use • Monitor phosphorus levels at WWTFs to determine if controls are needed
Elevated Chlorophyll -*a* Concentrations	2438 C	• Excess nutrients from residential lawns • Fertilizer runoff from surrounding watershed promotes algal growth in waterways • Nutrient loading from WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs promotes algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Educate residents about excessive fertilizer use • Reduce or manage fertilizer runoff from agricultural areas • Improve compliance and enforcement of existing stormwater quality permits • Add water quality features to stormwater systems • More public education regarding nutrients
Chronic Toxic Substances in Water (Copper)	2438 I	• Discharges from domestic, agricultural, or industrial sources • Build-up in pipelines, pressure tanks, water heaters, and water softeners from industrial point sources • Dissolution from natural deposits • Particle deposition and re-suspension processes from dredging or tidal movements	• Copper is a toxic heavy metal • Copper causes many health hazards and harmful biochemical effects on living beings	• Increase monitoring and enforcement efforts to identify and control industrial point sources • Encourage additional testing to locate all unknown sources/deposits
Dioxin/PCBs in Fish Tissue	2438 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue. This segment was included in the Houston Ship Channel TMDL for Dioxin and the Galveston Bay System Survey of Dioxin and PCBs.

Bayport Channel was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Restore riparian habitats
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2428	Name: Black Duck Bay

Area:	1 square miles	Miles of Shoreline:	5.1 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	1	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	0

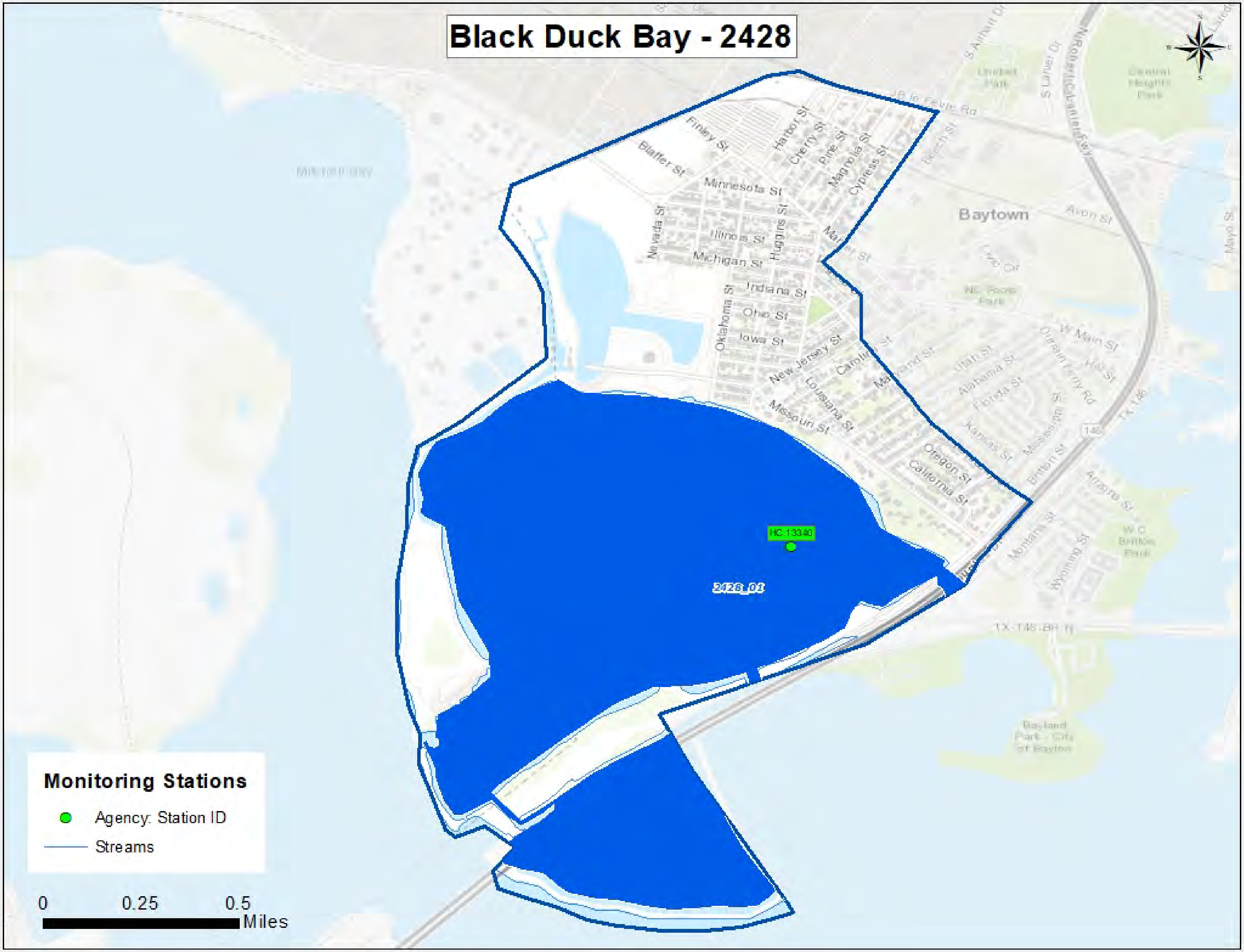
DESCRIPTION

- Segment 2428: **Black Duck Bay** (classified water body) – A side bay located east of the Houston Ship Channel/tidal San Jacinto River intersected by the Highway 146 bridge crossing into the City of Baytown.

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
13340	2428	BLACK DUCK BAY AT MID BAY 0.6 KM NE OF SH 146 BRIDGE AND 0.6 KM SE OF END OF OKLAHOMA ST IN BAYTOWN	HC	BIMONTHLY	Field, Conventional, Bacteria

HC = Harris County Pollution Control



Black Duck Bay - 2428
HC:13340
2428_01
Baytown
Monitoring Stations
Agency: Station ID
Streams
0
0.25
0.5
Miles

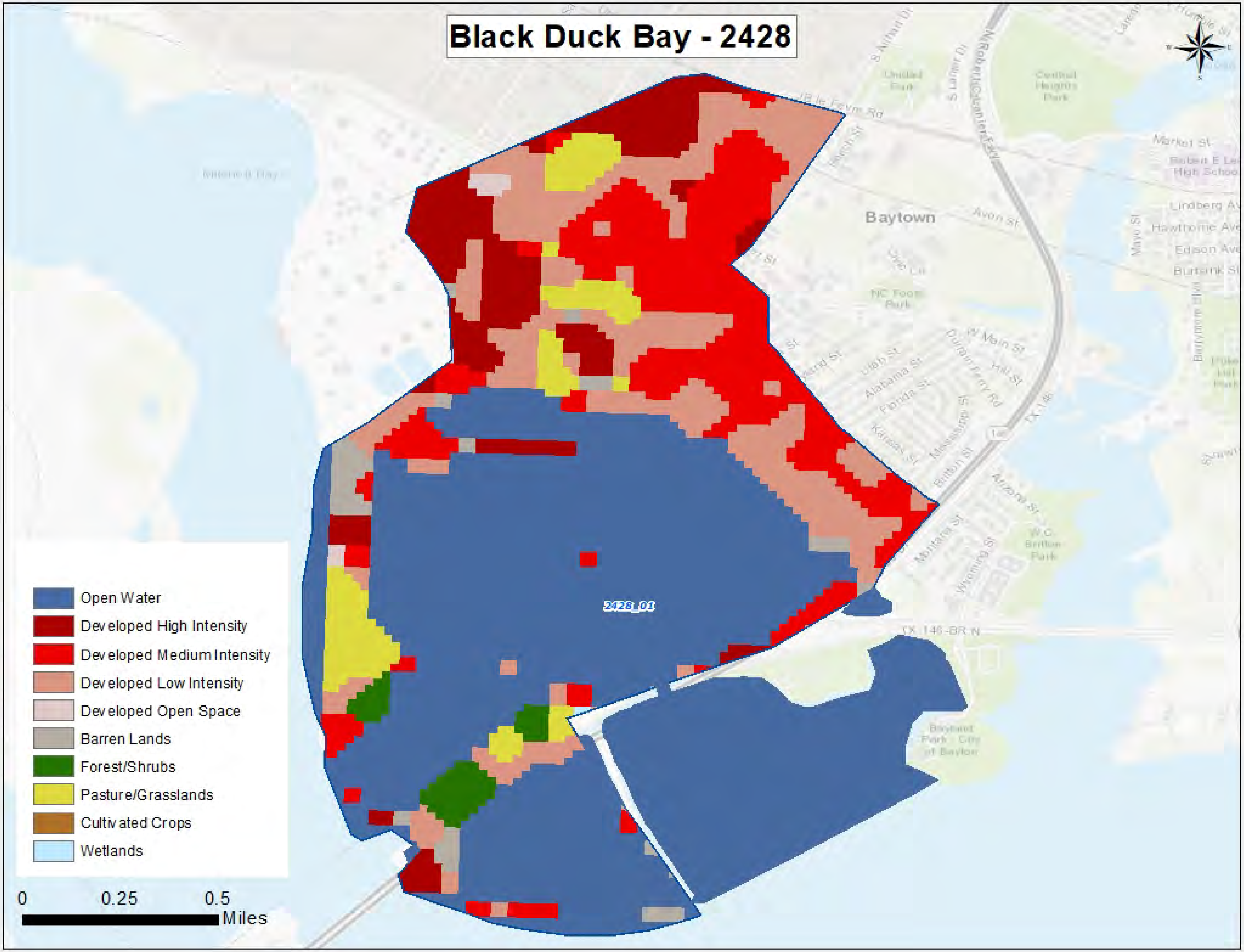
Segment 2428 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Black Duck Bay watershed is just south of the City of Baytown which is highly developed with mixed residential, commercial, and industrial land uses scattered throughout. Small plots of undeveloped wetland and forested land are present in areas adjacent to the Black Duck Bay shoreline. The Houston Ship Channel (HSC) also supports heavy boat and barge traffic on a consistent basis throughout the year.

The watershed area for Black Duck Bay is small, at only 1,134 acres. Open Water makes up 45.07 percent of the area, while 43.68 percent is developed.

Segment 2428 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	16.01	1.41	68.05	6.00	325.05
Barren Lands	0	0.00	36.70	3.24	N/A
Developed	481.26	42.43	495.27	43.68	2.91
Forest/Shrubs	2.67	0.24	22.02	1.94	724.72
Open Water	531.97	46.90	511.06	45.07	-3.93
Wetlands	102.30	9.02	0.89	0.08	-99.13
TOTAL	**1,134.21**	**100.00**	**1,133.99**	**100.00**	



Black Duck Bay - 2428
2428_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
0.25
0.5
Miles
Baytown

Water Quality Issues:

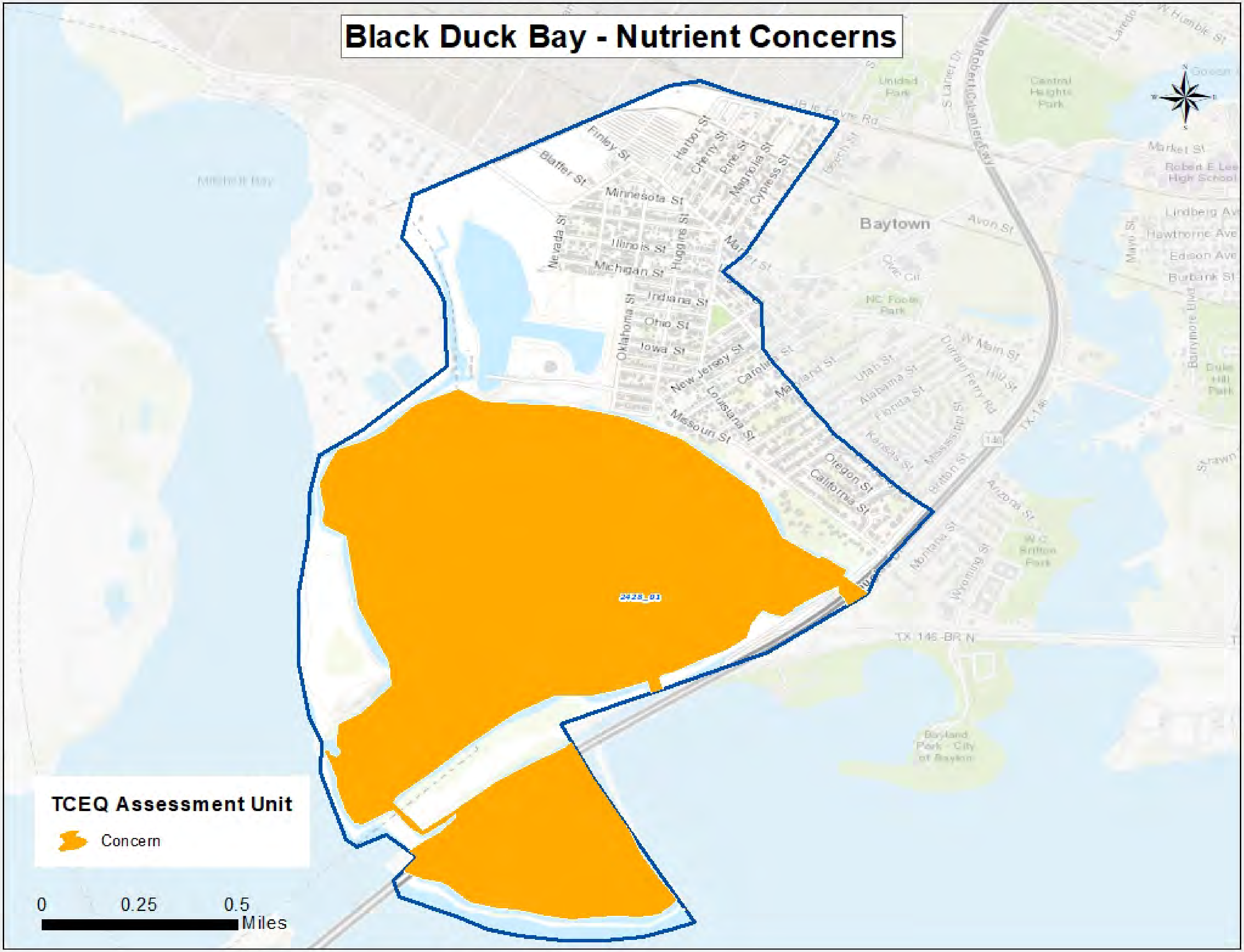
Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

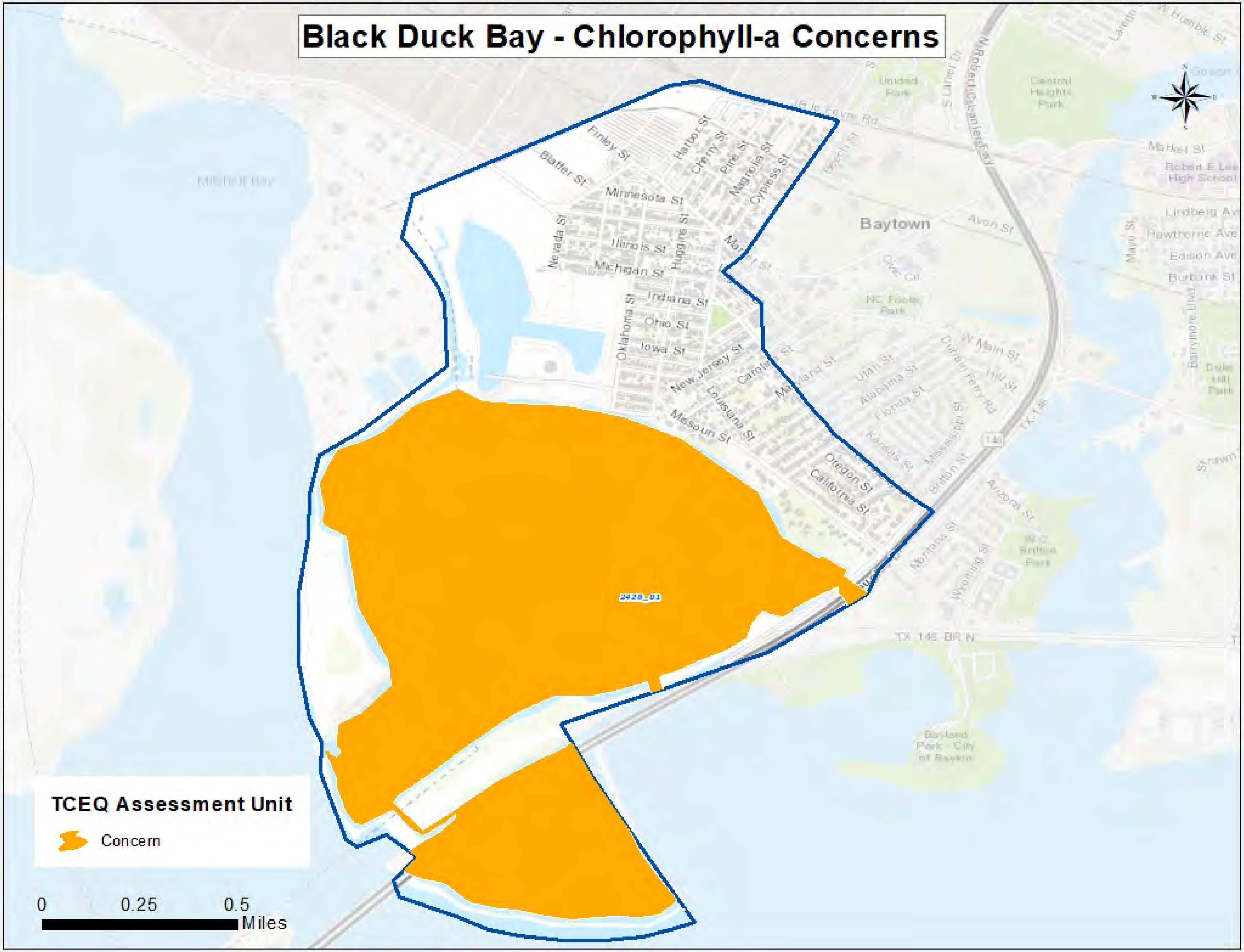
Nutrient Concerns
Black Duck Bay (2428) is listed in the 2020 Integrated Report for concerns for water quality based on screening level criteria for nitrate-nitrogen and total phosphorus. Based on samples collected from 12/1/11 – 11/30/18, 52.4 percent of nitrate-nitrogen and 66.7 percent of total phosphorus samples exceeded the nutrient screening levels.

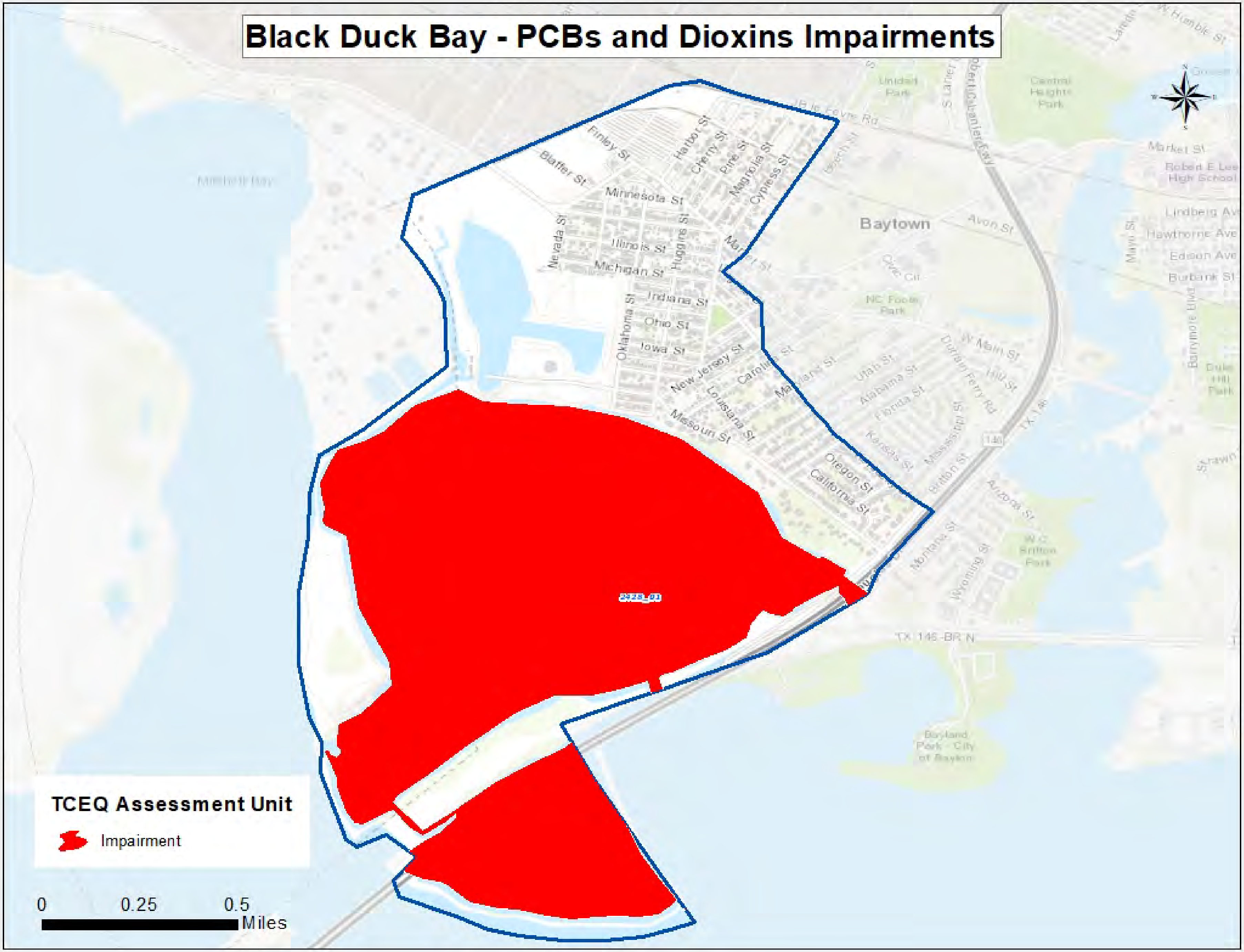
Chlorophyll-a Concerns
Black Duck Bay has a concern for chlorophyll-a, with 14 of 30 samples exceeding the screening level of 11.60 µg/L.

PCBs and Dioxin Impairments
Black Duck Bay is listed as impaired for PCBs and Dioxins in all finfish and blue crab. Fish samples collected from this segment indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.


Black Duck Bay - Nutrient Concerns
TCEQ Assessment Unit
Concern
0
0.25
0.5
Miles
2428_01
Mitchell Bay
Baytown
Minnesota St
Illinois St
Michigan St
Indiana St
Ohio St
Iowa St
New Jersey St
Missouri St
Louisiana St
Oregon St
California St
Nevada St
Oklahoma St
Huggins St
Finley St
Blaffer St
Harbor St
Cherry St
Pine St
Magnolia St
Cypress St
Market St
Avon St
W Main St
Utah St
Alabama St
Florida St
Kansas St
Mississippi St
Britton St
Arizona St
Montana St
Wyoming St
Durham Ferry Rd
N Robert C Lanier Fwy
TX 146
TX 146-BR N
Lindberg Ave
Hawthorne Ave
Edison Ave
Burbank St
Barrymore Blvd
Robert E Lee High School
Central Heights Park
W.C. Britton Park
Bayland Park - City of Baytown

Black Duck Bay - Chlorophyll-a Concerns




Black Duck Bay - PCBs and Dioxins Impairments
TCEQ Assessment Unit
Impairment
0
0.25
0.5
Miles
2428_01
Baytown
Minnesota St
Illinois St
Michigan St
Indiana St
Ohio St
Iowa St
New Jersey St
Missouri St
Oregon St
California St
TX 146-BR N

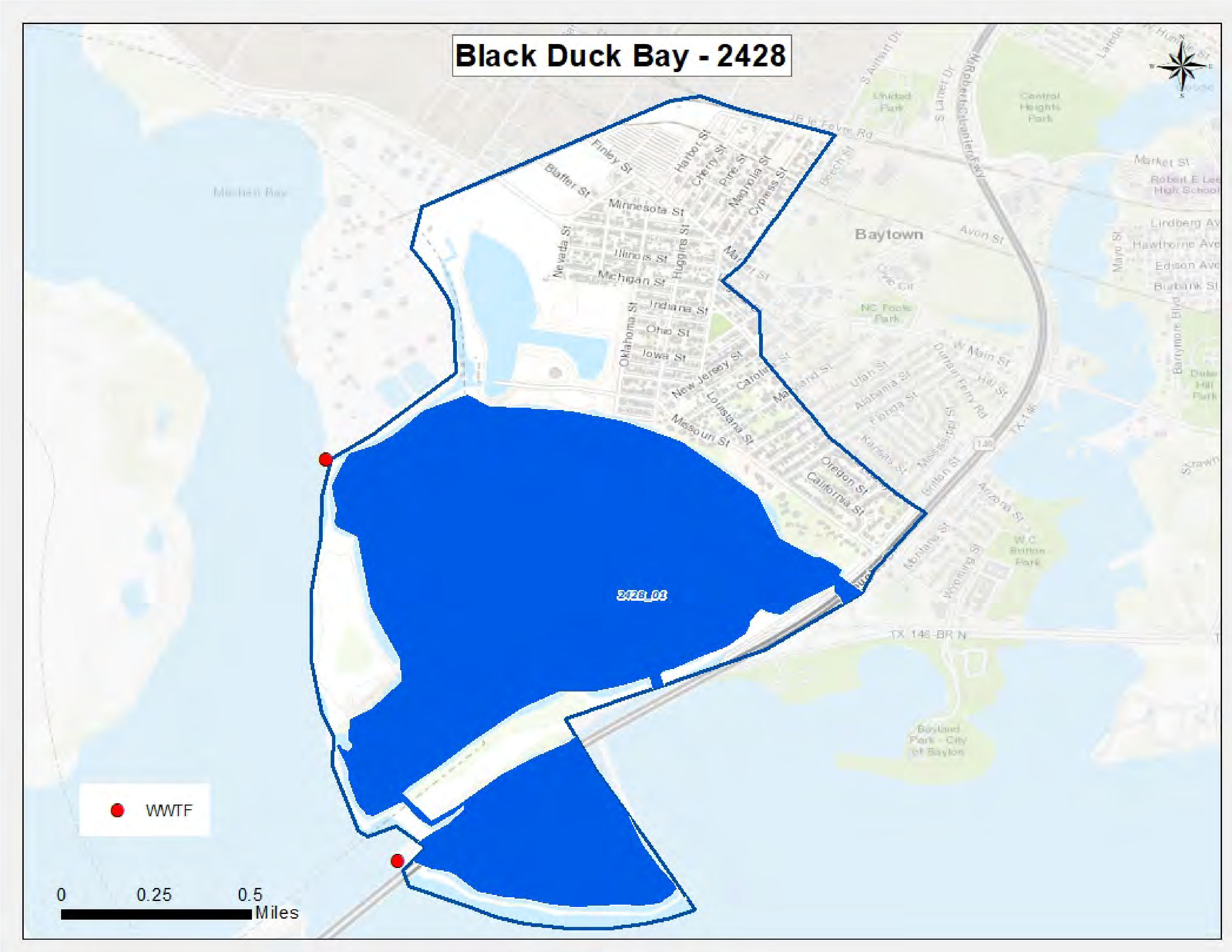
Potential Sources of Water Quality Issues: Potential sources of nutrients in the Black Duck Bay watershed include stormwater runoff and animal waste.

There are no permitted wastewater outfalls in the watershed, although outfalls are present just outside the watershed boundaries. There is only one permitted on-site sewage facility in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Black Duck Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

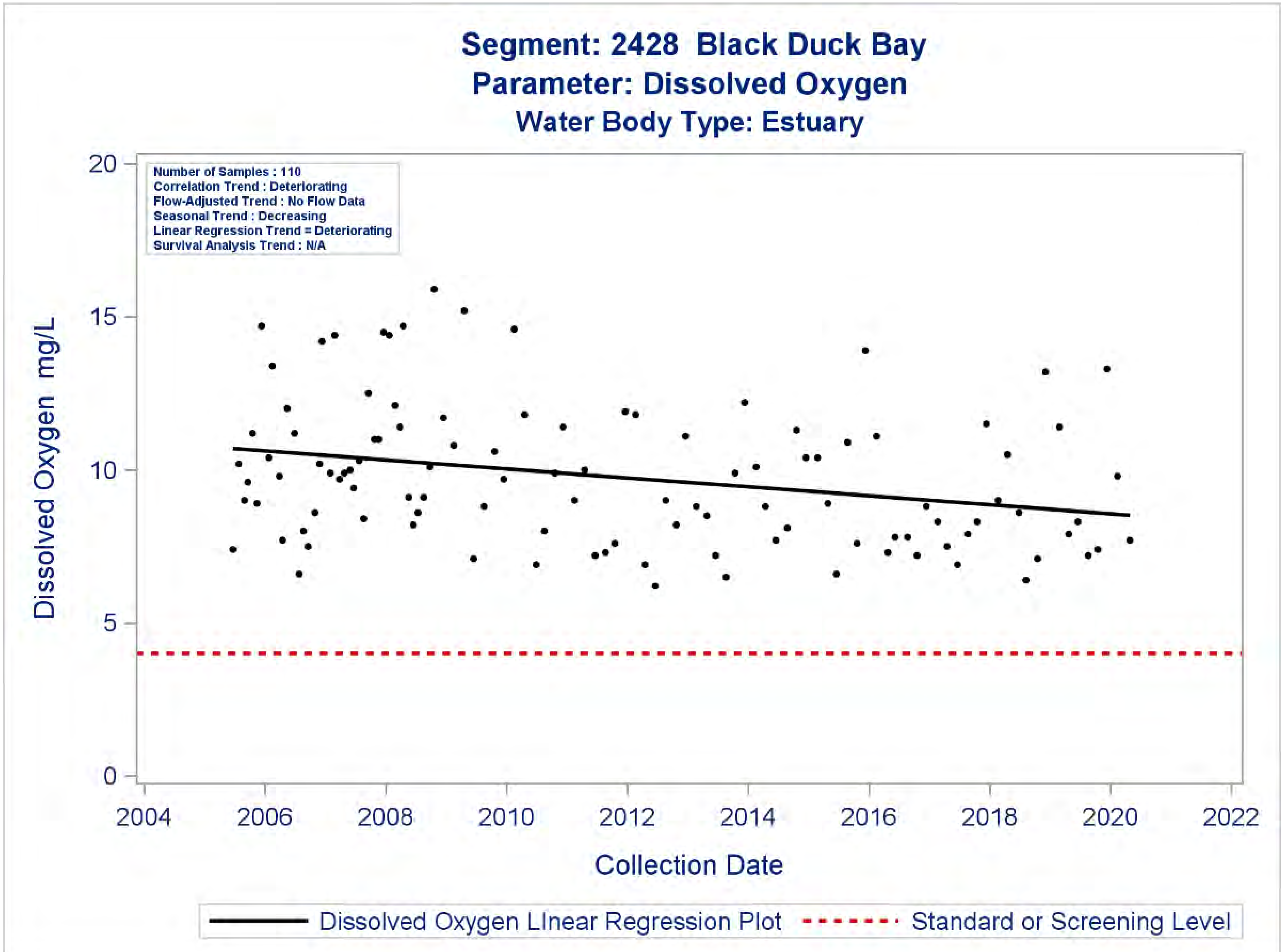
For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Black Duck Bay watershed.

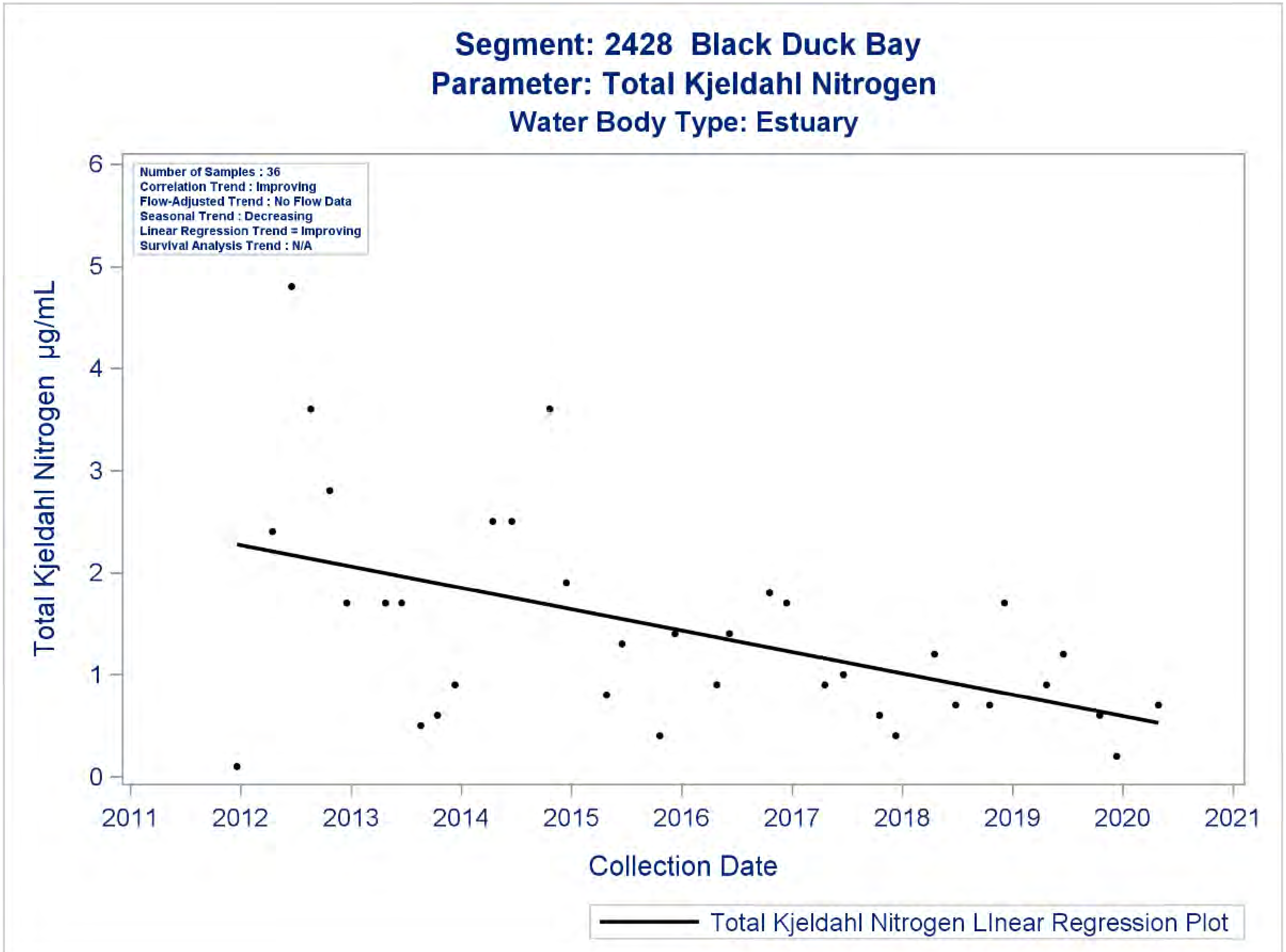

Black Duck Bay - 2428
Baytown
2428_01
WWTF
0
0.25
0.5
Miles
Minnesota St
Michigan St
Indiana St
Ohio St
Iowa St
Illinois St
Missouri St
Oregon St
California St
Market St
Avon St
TX 146-BR N

Trend Analysis:

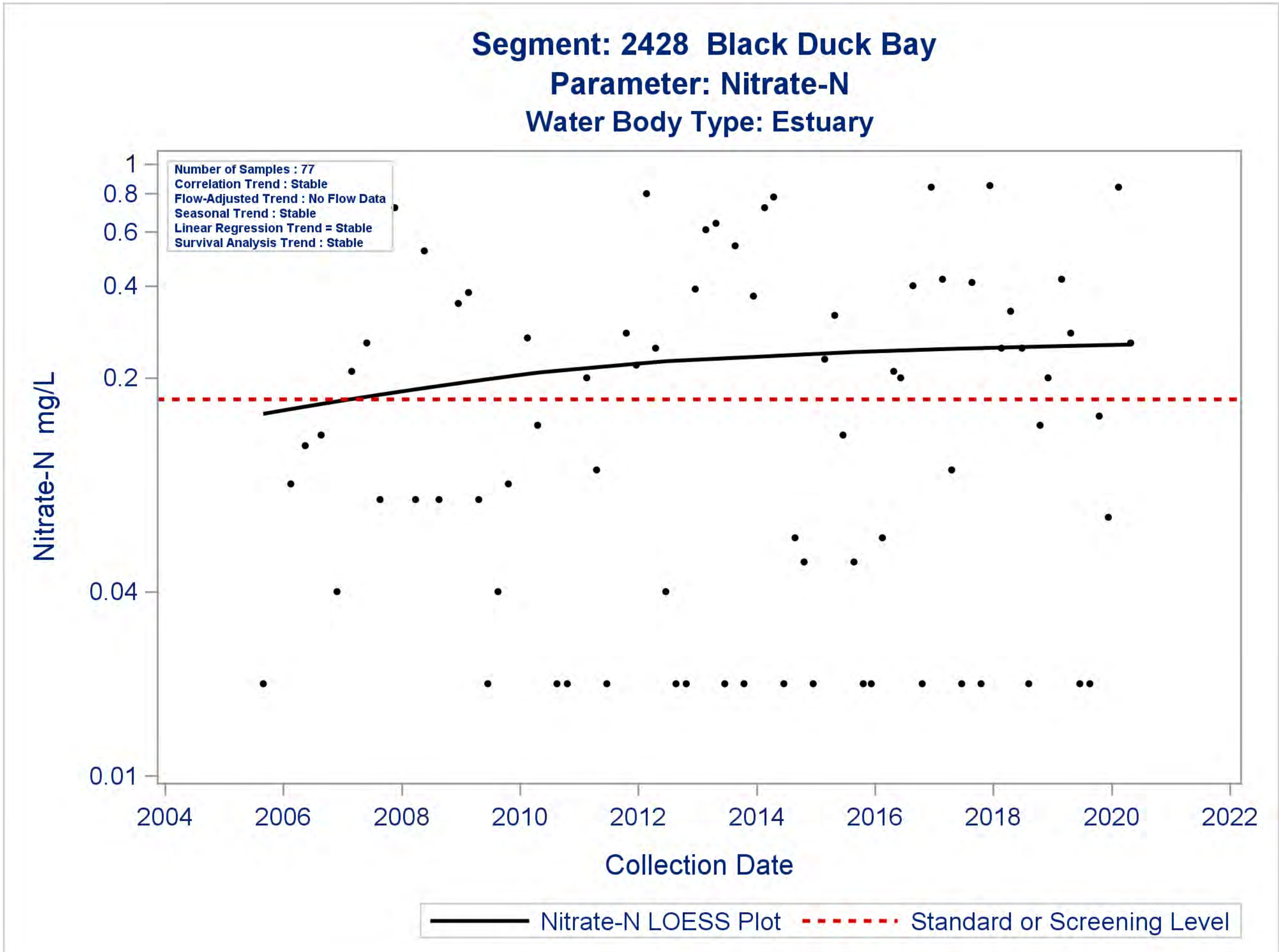
Analysis of Black Duck Bay (segment 2428) water quality data revealed three parameter trends with decreasing concentrations of DO, specific conductance, and TKN over time. There is no concern for any of the trends. All of the DO measurements were above the minimum standard. Black Duck Bay is tidal and therefore the specific conductance is affected by tide and rainfall. TKN has only been collected since 2012 and TCEQ has no established screening criteria for that nutrient.

The 2020 Texas Integrated Report lists this segment as impaired for PCB/dioxin in edible fish tissue and having a concern for elevated nutrient and chlorophyll *a* concentrations. Ammonia and nitrate have shown relatively stable trends over time. Total phosphorus has shown a decreasing trend over time. Many of the nutrient samples collected during the period of record are greater than the screening criteria for each parameter. Chlorophyll *a* levels appear to be improving but concentrations greater than the 11.6 μg/L screening criteria are still common.

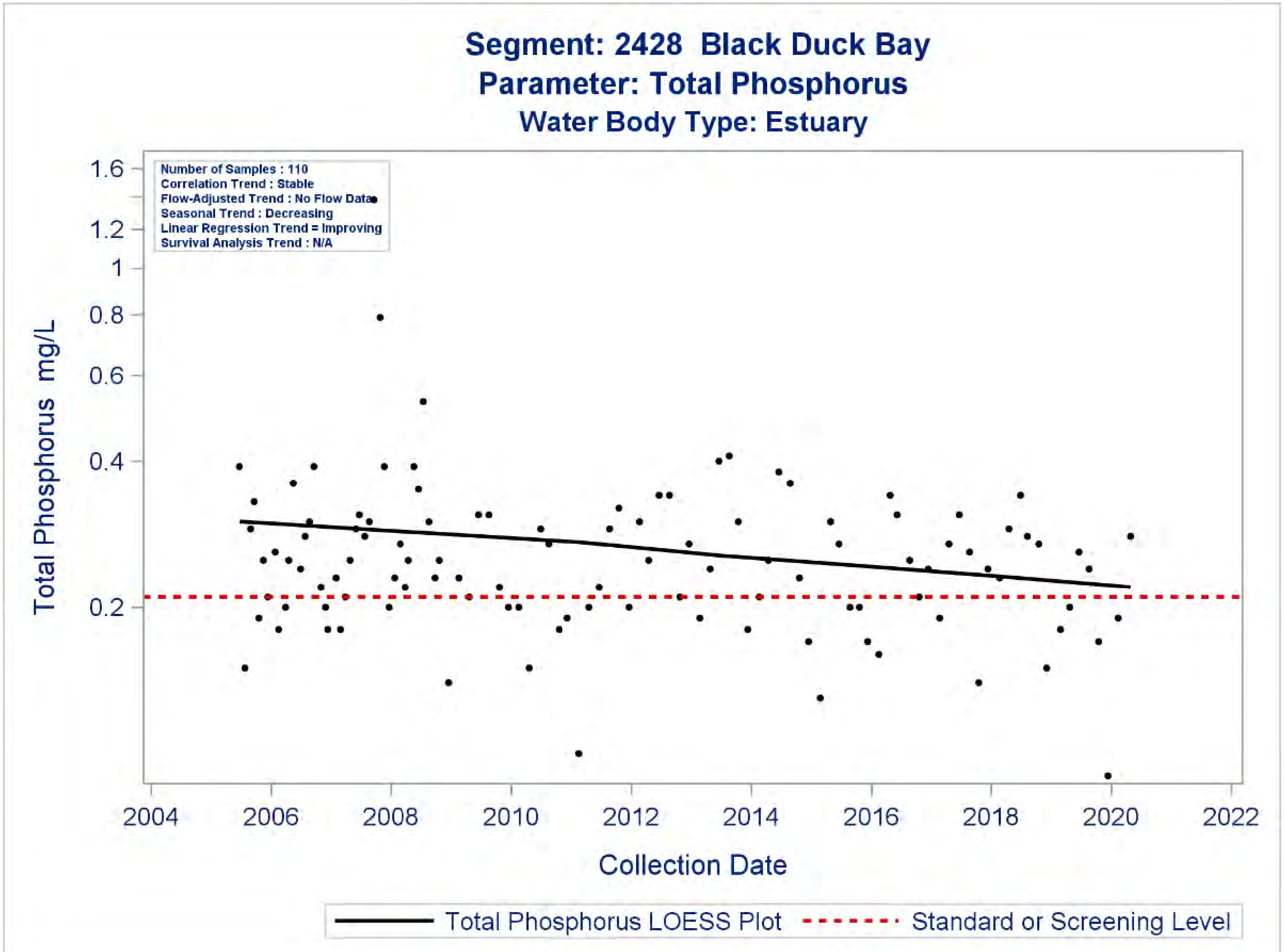

Segment: 2428 Black Duck Bay
Parameter: Dissolved Oxygen
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
20
15
10
5
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen Linear Regression Plot
Standard or Screening Level

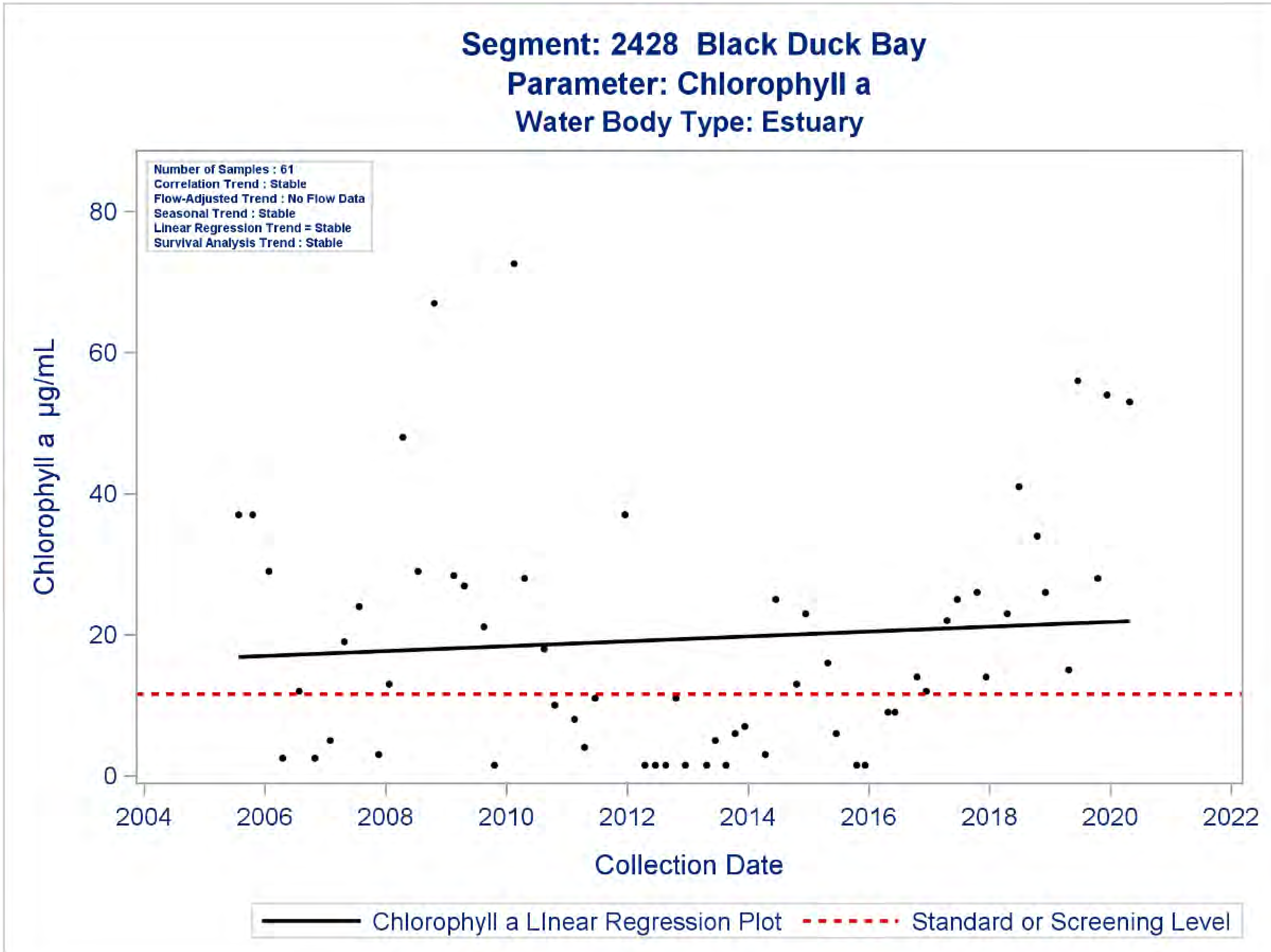


Segment: 2428 Black Duck Bay
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 36
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
6
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 2428 Black Duck Bay
Parameter: Nitrate-N
Water Body Type: Estuary
Number of Samples : 77
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Nitrate-N mg/L
1
0.8
0.6
0.4
0.2
0.04
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level


Segment: 2428 Black Duck Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1.6
1.2
1
0.8
0.6
0.4
0.2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


Segment: 2428 Black Duck Bay
Parameter: Chlorophyll a
Water Body Type: Estuary
Number of Samples : 61
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Chlorophyll a µg/mL
0
20
40
60
80
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nutrient Concentrations	***Nitrate*** ***Phosphorus*** 2428 C	• Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields, and animal operations • Nutrient loading from WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Expand use of LID and green infrastructure practices • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed
Elevated Chlorophyll -*a* Concentrations	2428 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	2428 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2430		Name: Burnet Bay			
Area:	2 square miles	Miles of Shoreline:	8.6 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	2	Texas Stream Team Monitoring Stations:	1	Permitted WWTF Outfalls:	8

Please note that historically, this water body has been spelled as both Burnet Bay and Burnett Bay.

DESCRIPTION

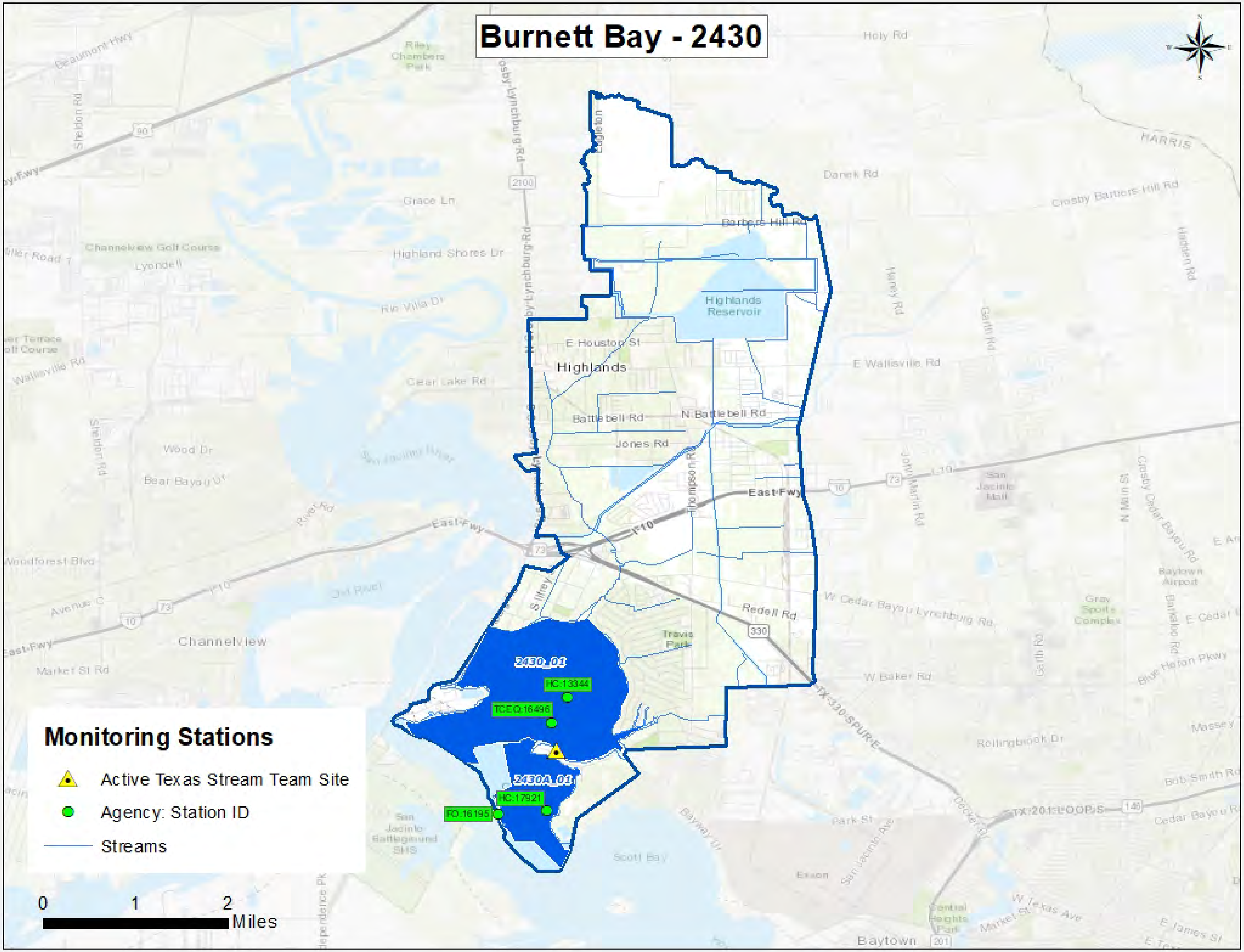
- Segment 2430: **Burnet Bay** (classified water body) – A side bay located to the east of the Houston Ship Channel/tidal San Jacinto River south of Interstate-10 immediately north of the Baytown Nature Center and southeast of the Lynchburg Ferry Road
- Segment 2430A (Estuary w/ high ALU): **Crystal Bay** (unclassified water body) – Crystal Bay, a side bay of Burnet Bay, is located between Burnett Bay and Scott Bay (Segment 2429) due east of the San Jacinto Monument and lying on the east side and adjacent to the Houston Ship Channel (Segment 1005)

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
13334	2430	BURNET BAY AT MID BAY 1.3 KM SSW OF CONFLUENCE WITH SPRING GULLY AND 1.6 KM SE OF LYNCHBURG ROAD	HC	Bimonthly	Field, Conventional, Bacteria
17921	2430A	CRYSTAL BAY IN BAYTOWN 383 METERS WEST AND 137 METERS SOUTH OF THE INTERSECTION OF BAYSHORE DRIVE AND CROW ROAD	HC	Bimonthly	Field, Conventional, Bacteria

HC = Harris County Pollution Control

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.

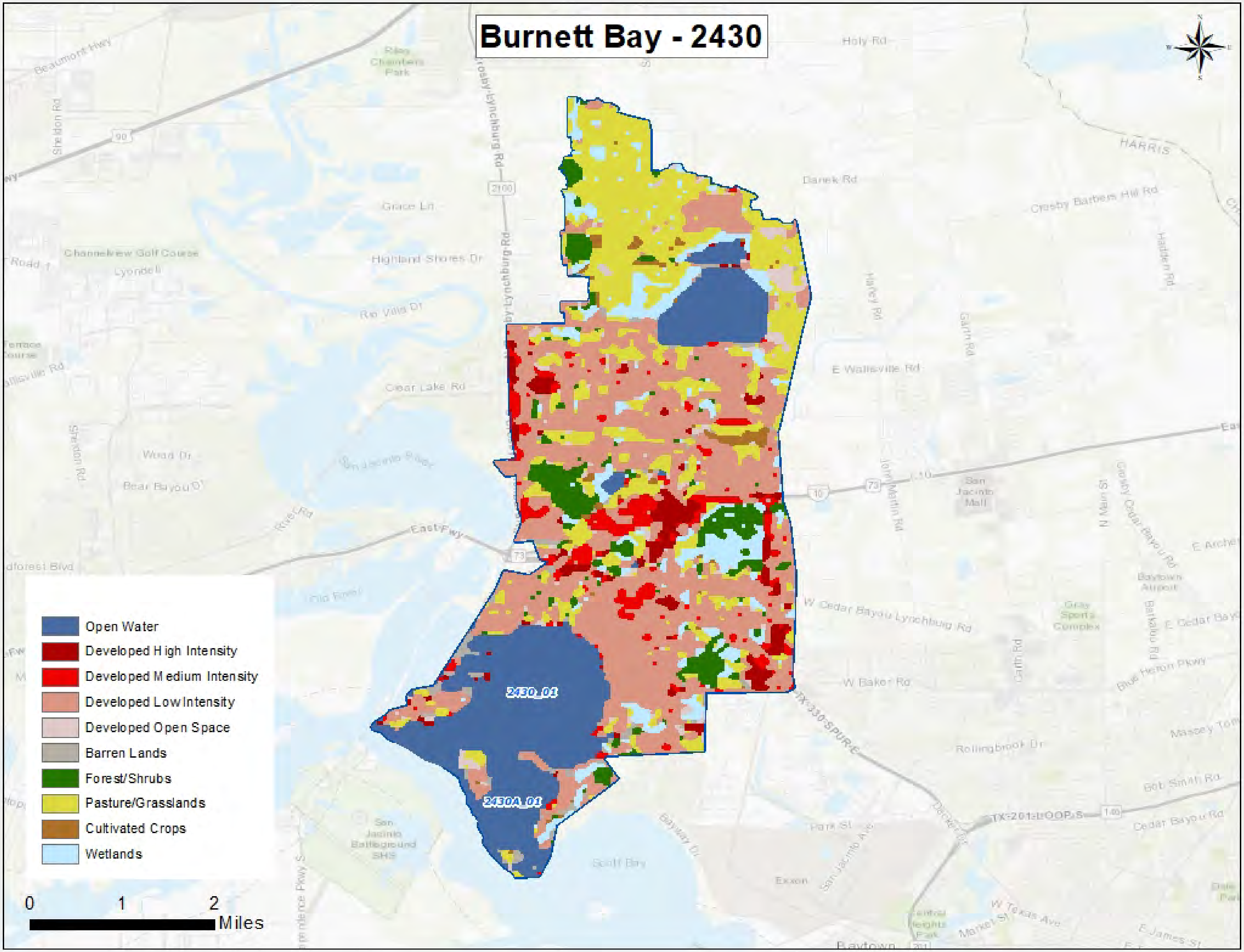

Burnett Bay - 2430
2430_01
2430A_01
HC:13344
TCEQ:16496
HC:17921
FO:16195
Highlands
Highlands Reservoir
Channelview
Baytown
Scott Bay
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
Streams
0
1
2
Miles

Segment 2430 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Burnet Bay watershed is located west of the City of Baytown and south of the cities of Highlands and Lynchburg. The area is highly developed (43.25 percent of the watershed area) with residential and commercial uses. Agricultural land covers 21.79 percent of the watershed and is most commonly present in the northern reaches of this watershed. Undeveloped forested land and wetland areas are scattered throughout. Additionally, the Houston Ship Channel (HSC) supports heavy boat and barge traffic on a consistent basis.

Segment 2430 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	2,187.93	19.18	2,485.49	21.79	13.60
Barren Lands	66.05	0.58	212.17	1.86	221.21
Developed	4,737.91	41.53	4,933.40	43.25	4.13
Forest/Shrubs	484.82	4.25	609.59	5.34	25.73
Open Water	2,261.98	19.83	2,218.39	19.45	-1.93
Wetlands	1,668.63	14.63	948.74	8.32	-43.14
TOTAL	**11,407.33**	**100.00**	**11,407.78**	**100.00**	



Burnett Bay - 2430
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1
2
Miles
2430_01
2430A_01

Water Quality Issues:

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

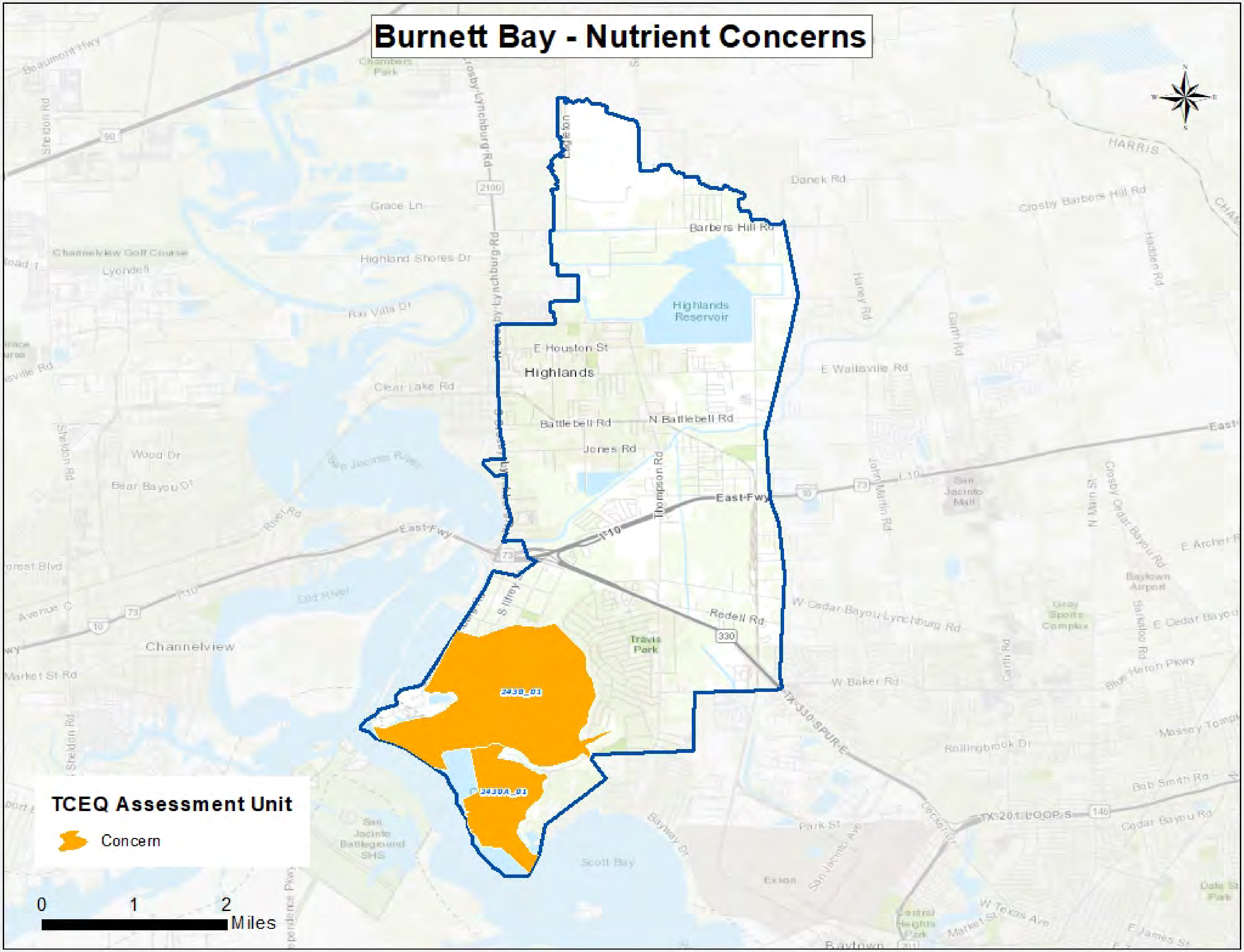
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
Burnet Bay (2430) is listed in the 2020 Integrated Report for concerns for water quality based upon screening level criteria for nitrate-nitrogen and total phosphorus. Crystal Bay (2430A) has nutrient screening level concerns for ammonia-nitrogen, nitrate-nitrogen, and total phosphorus.

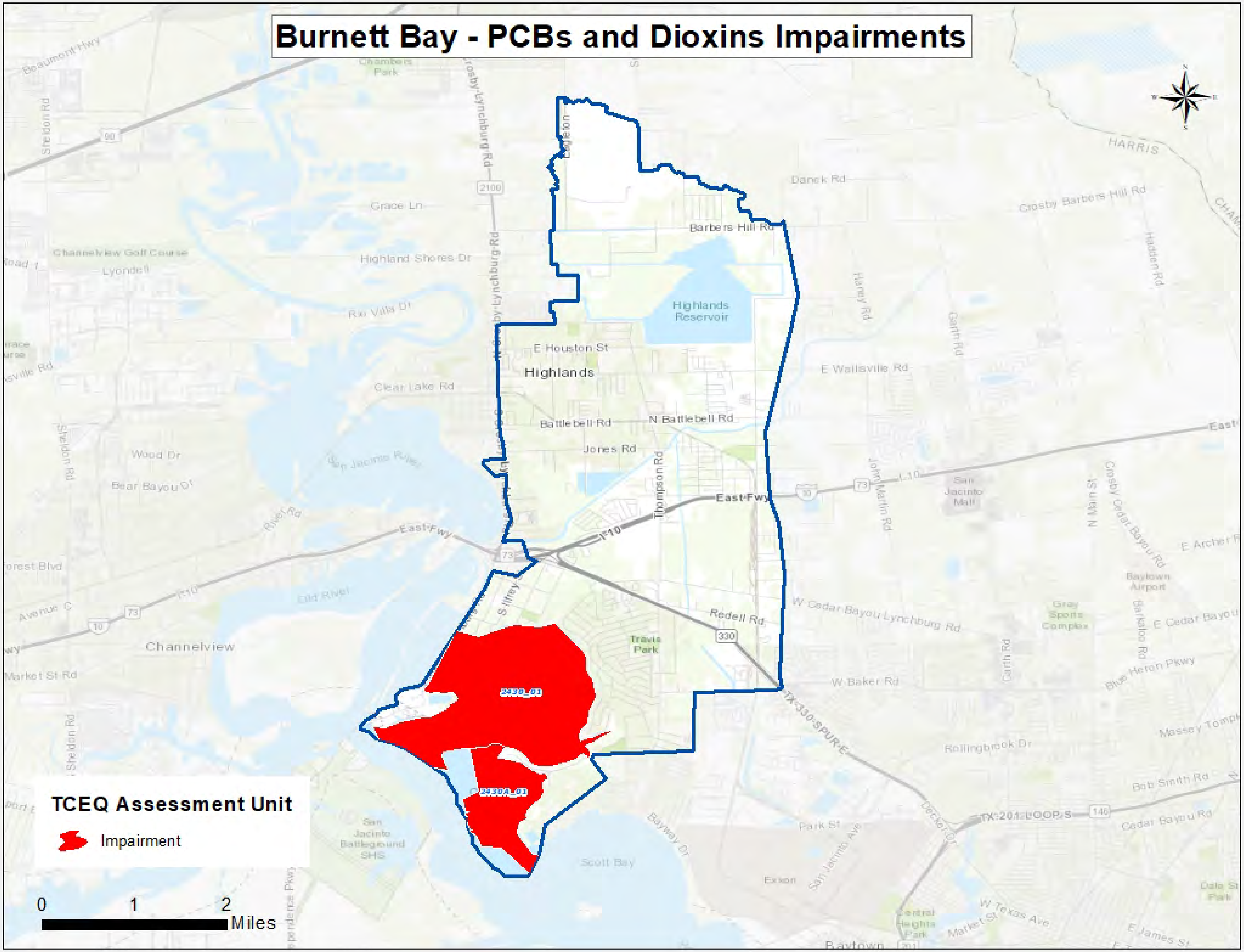
Chlorophyll-a Concerns
Burnet Bay has a concern for chlorophyll-a, with 17 of 36 samples exceeding the nutrient screening level.

PCBs and Dioxin Impairments
Burnet Bay and Crystal Bay are listed as impaired for PCBs and Dioxins in all finfish and blue crab. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.

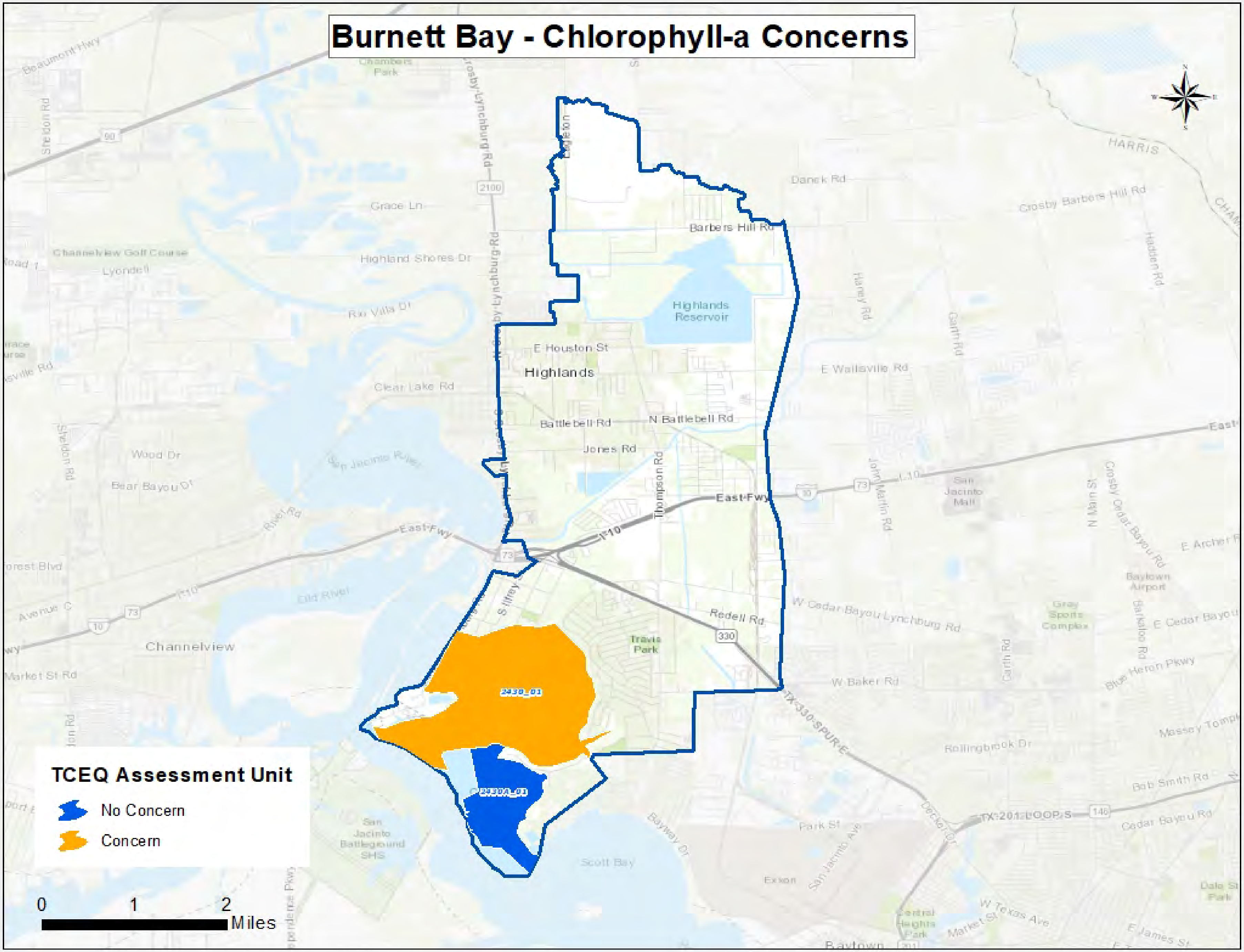
Burnett Bay - Nutrient Concerns



Burnett Bay - PCBs and Dioxins Impairments



Burnett Bay - Chlorophyll-a Concerns



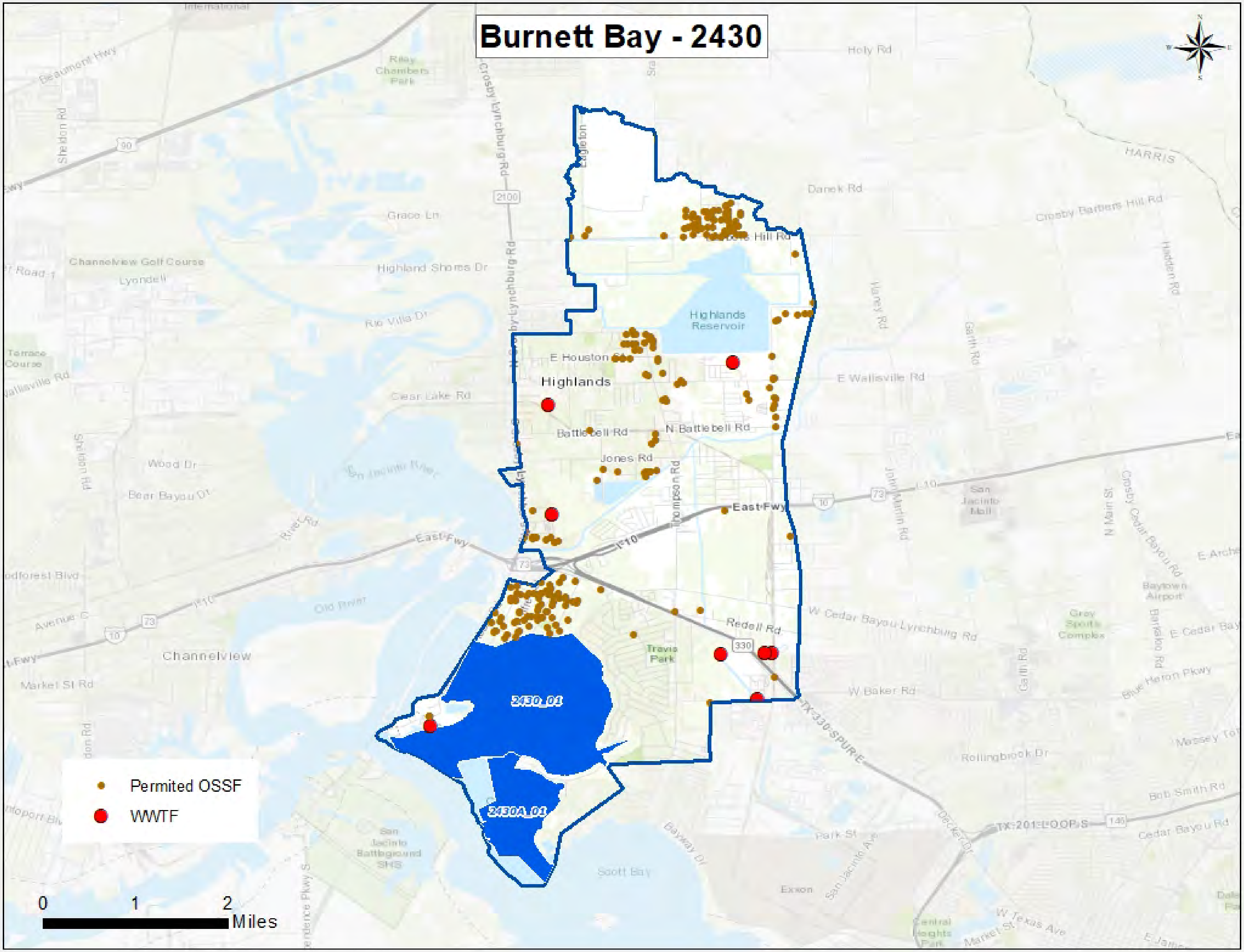
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Burnet Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 8 permitted wastewater outfalls in the Burnet Bay watershed. In many areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 240 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Burnet Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of no sanitary sewer overflows reported in the sewer collection systems.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Burnet Bay watershed.

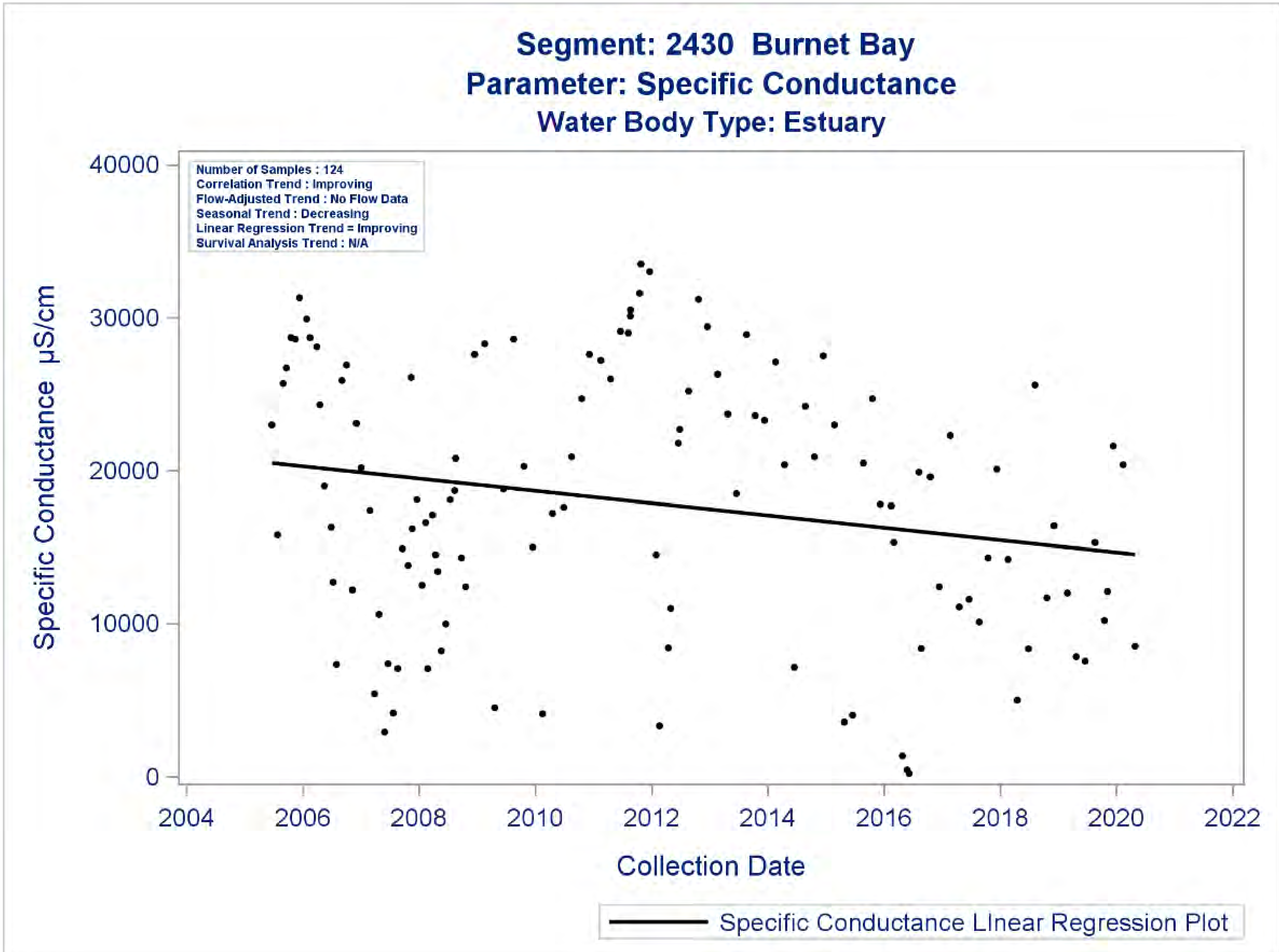

Burnett Bay - 2430
Permited OSSF
WWTF
0
1
2
Miles
2430_01
2430A_01
Highlands
Highlands Reservoir
Channelview
E Houston
Battlebell Rd
N Battlebell Rd
Jones Rd
East Fwy
Redell Rd
E Wallisville Rd
Travis Park
Scott Bay
Exxon
HARRIS

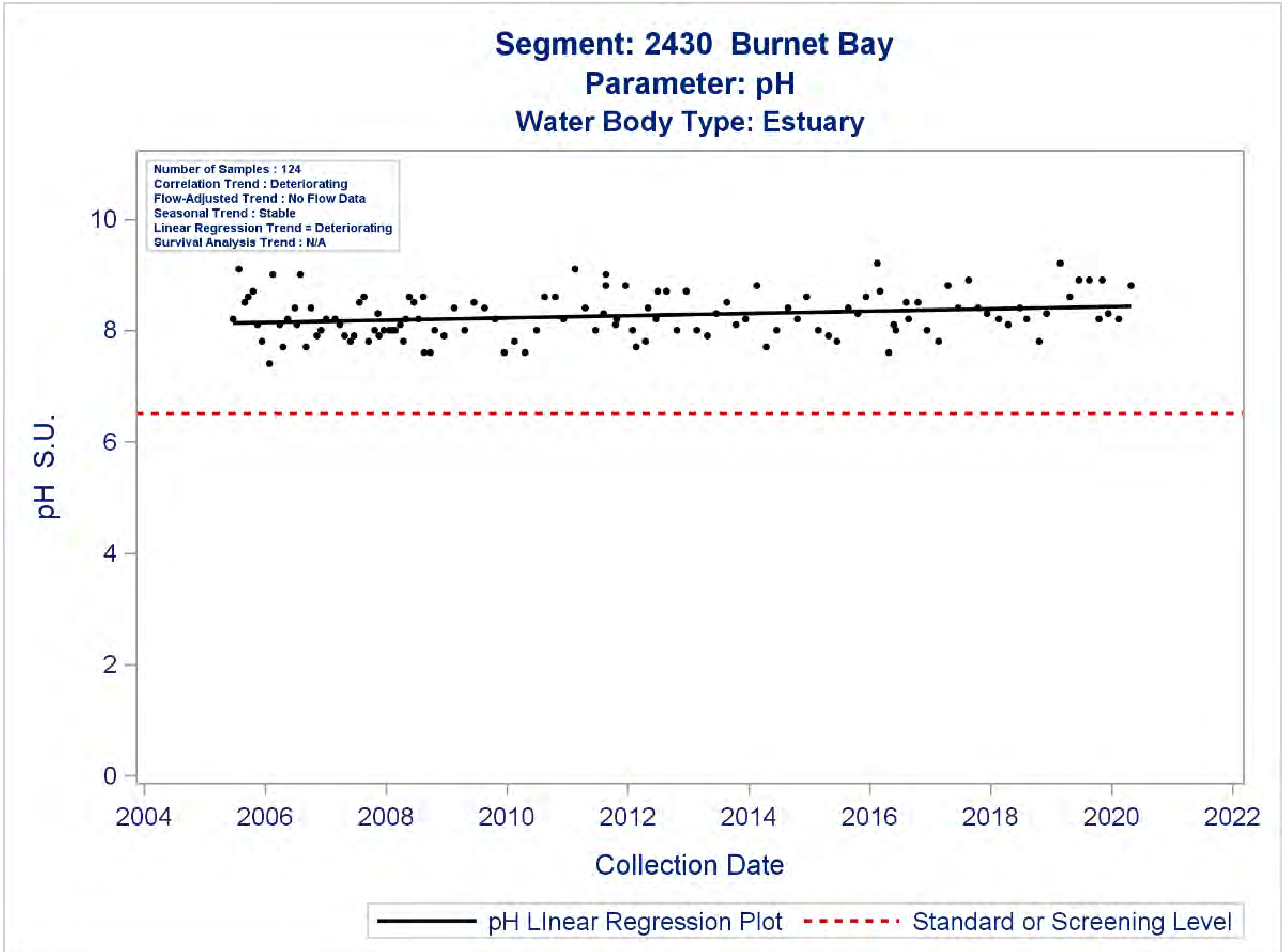
Trend Analysis:

Analysis of water quality data revealed four parameter trends for the two assessment units which make up the Burnet Bay (2430) watershed. The main segment of Burnet Bay had two parameter trends – specific conductance concentrations are decreasing over time and pH is increasing. The specific conductance is not problematic in that Burnett Bay is tidal and therefore under the influence of both the tides and rainfall events which affect the salinity of the bay. However, of the 124 pH measurements collected in the bay, there were six points found to be equal to or greater than the maximum range of 6.5 to 9.0 standard units. Those pH exceedances were measured in 2006, again in 2011, then again in 2016 and 2019.

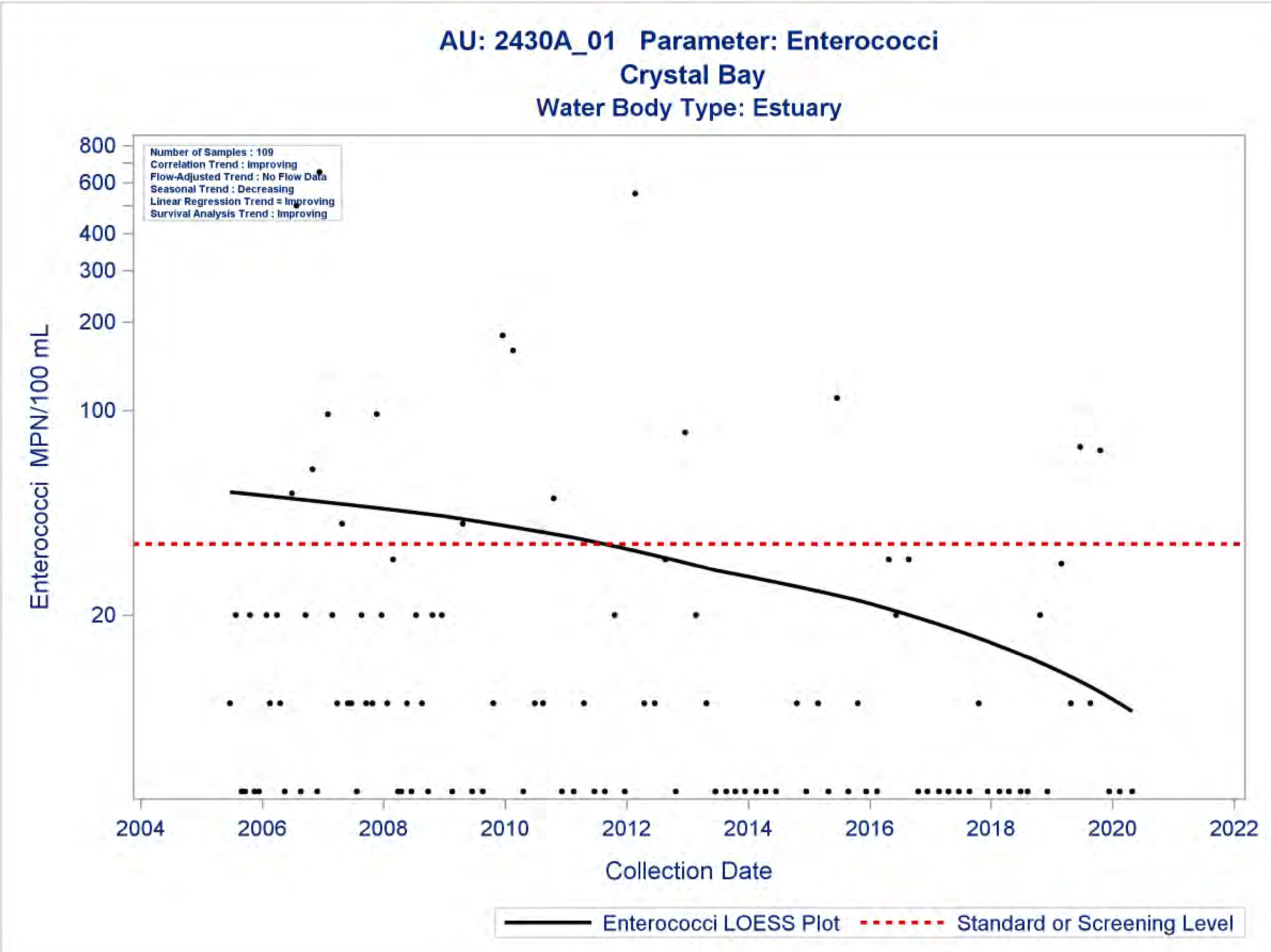
Unclassified segment 2430A (Crystal Bay) had two parameter trends with enterococci and ammonia concentrations decreasing over time. Since 2012, only five bacteria tests have exceeded the standard of 35 MPN/100 mL. In the ammonia trend, not only is the ammonia concentration decreasing, but the number of samples exceeding the screening criteria dropped in half after 2012.

The 2020 Texas Integrated Report lists both Burnet Bay and Crystal Bay as having concerns for elevated nutrients concentrations, with Burnet Bay also having a concern for chlorophyll *a*. In addition to the ammonia trend found in Crystal Bay, there was an improving linear regression trend found in Burnet Bay but not a LOESS correlation trend. It should be noted that for both water bodies, an appreciable portion of the ammonia data was censored (reported at or below the limit of quantitation). The trends for nitrate, total phosphorus, and chlorophyll *a* are all stable. Graphing Burnet Bay (2430) data shows 89% of nitrate samples and 96% of total phosphorus samples exceed the screening criteria respectively and approximately 50% of chlorophyll *a* samples exceed the screening criteria. For Crystal Bay (2430A), nearly 100% of nitrate and total phosphorus samples exceeded the screening criteria while only 25% of the chlorophyll *a* samples exceeded the screening criteria.

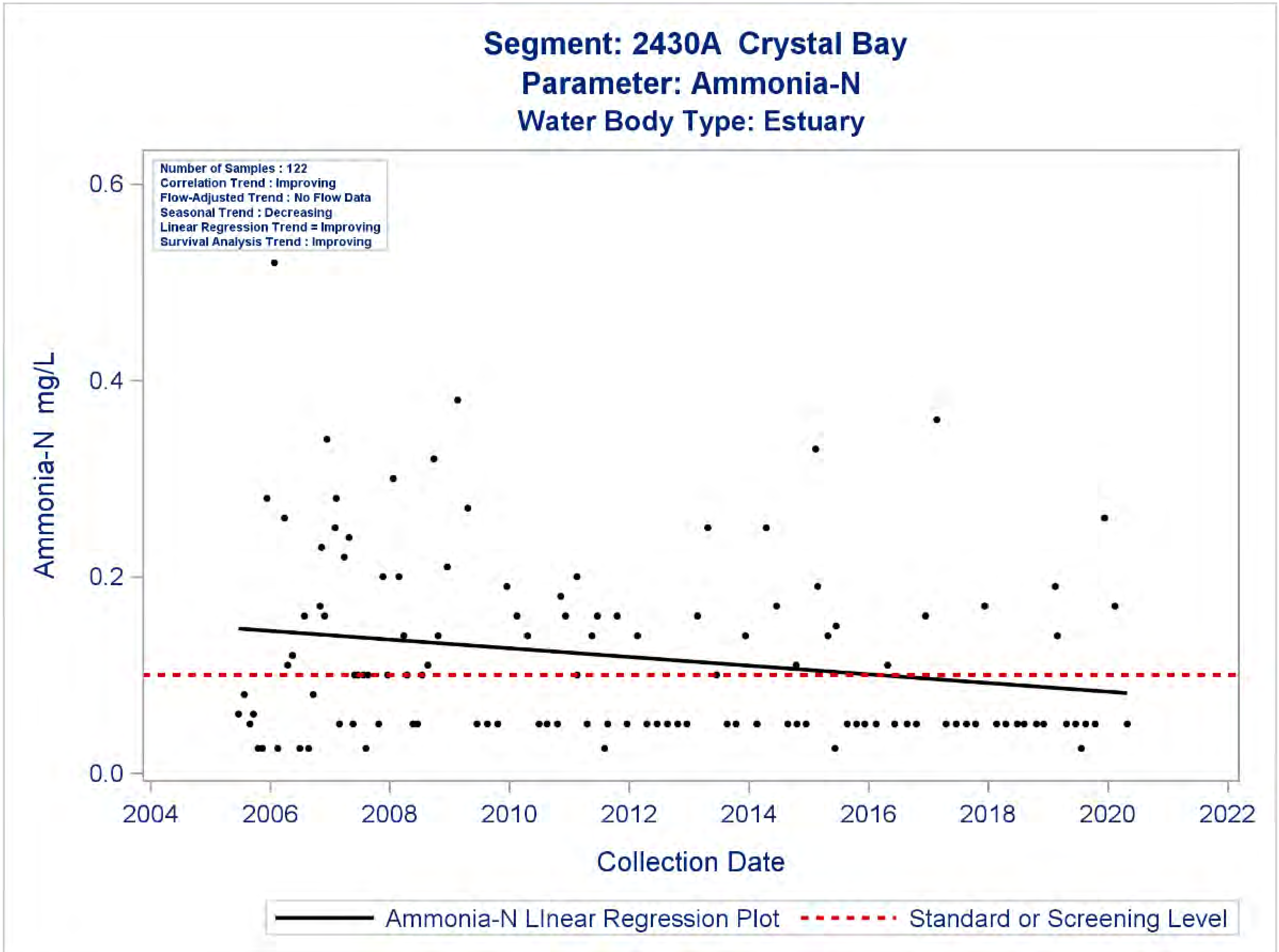

Segment: 2430 Burnet Bay
Parameter: Specific Conductance
Water Body Type: Estuary
Number of Samples : 124
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Specific Conductance µS/cm
40000
30000
20000
10000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Specific Conductance Linear Regression Plot



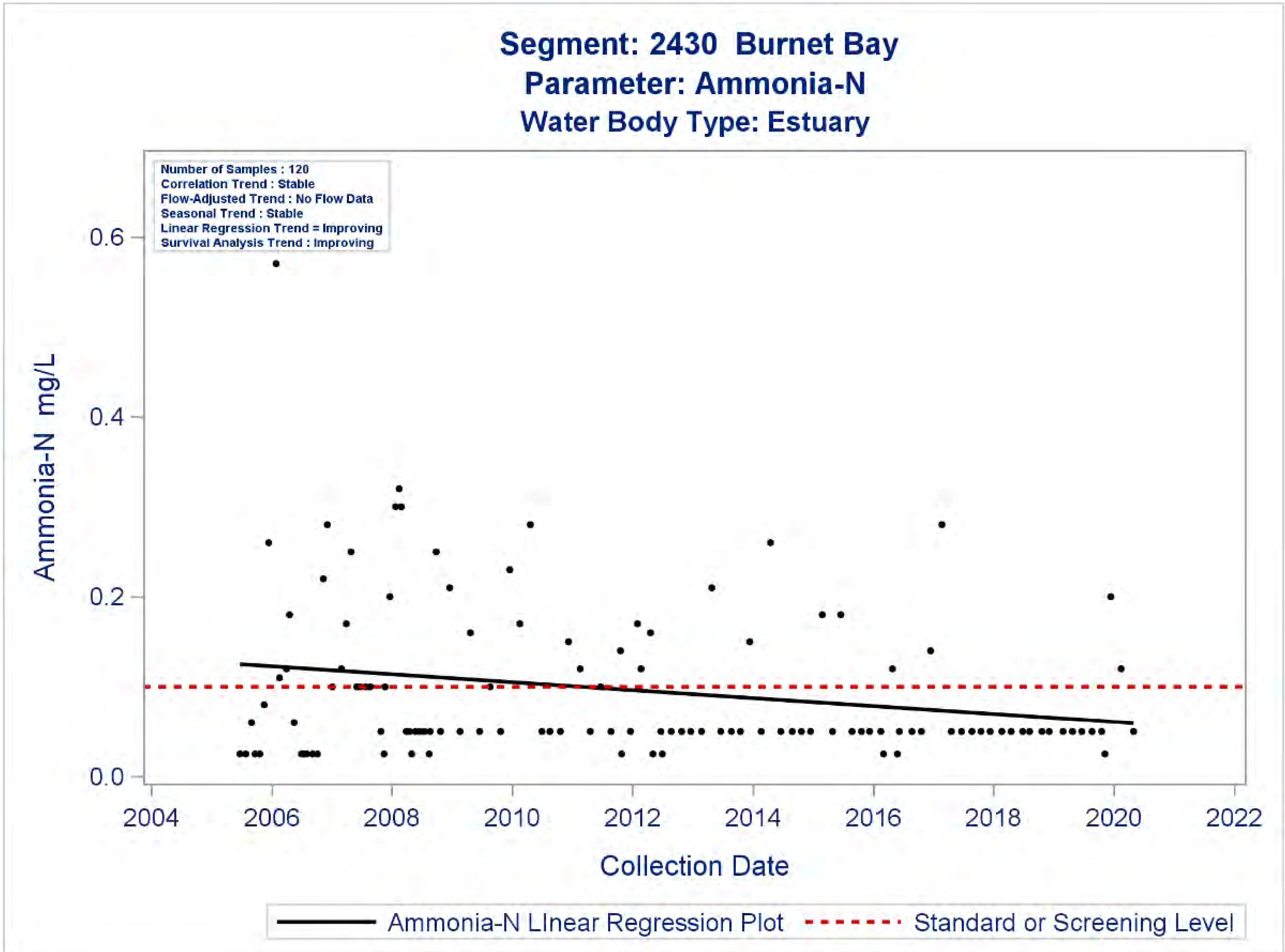
Segment: 2430 Burnet Bay
Parameter: pH
Water Body Type: Estuary
Number of Samples : 124
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
pH S.U.
0
2
4
6
8
10
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
pH LInear Regression Plot
Standard or Screening Level



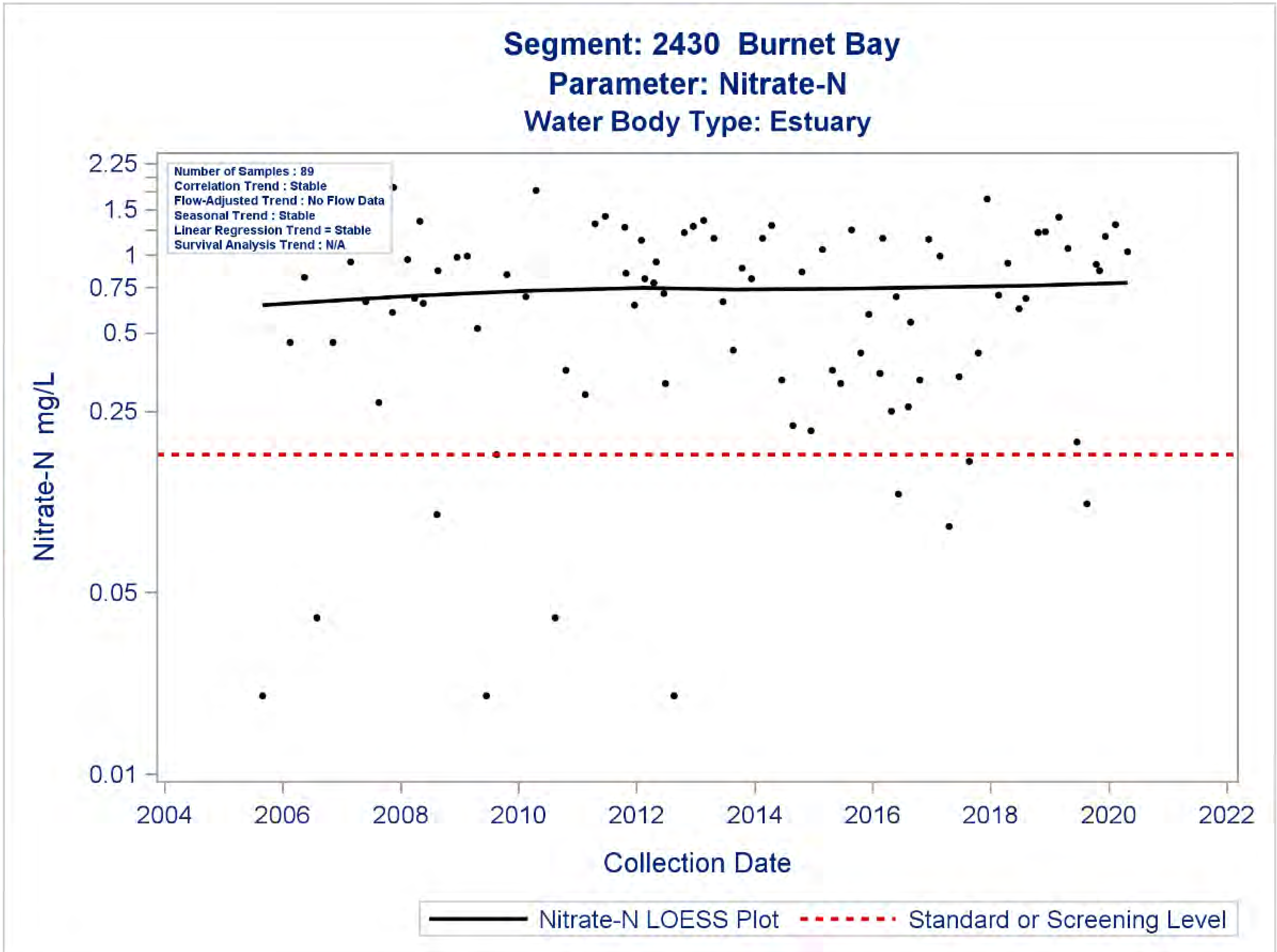
AU: 2430A_01 Parameter: Enterococci
Crystal Bay
Water Body Type: Estuary
Number of Samples : 109
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Enterococci MPN/100 mL
800
600
400
300
200
100
20
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Enterococci LOESS Plot
Standard or Screening Level



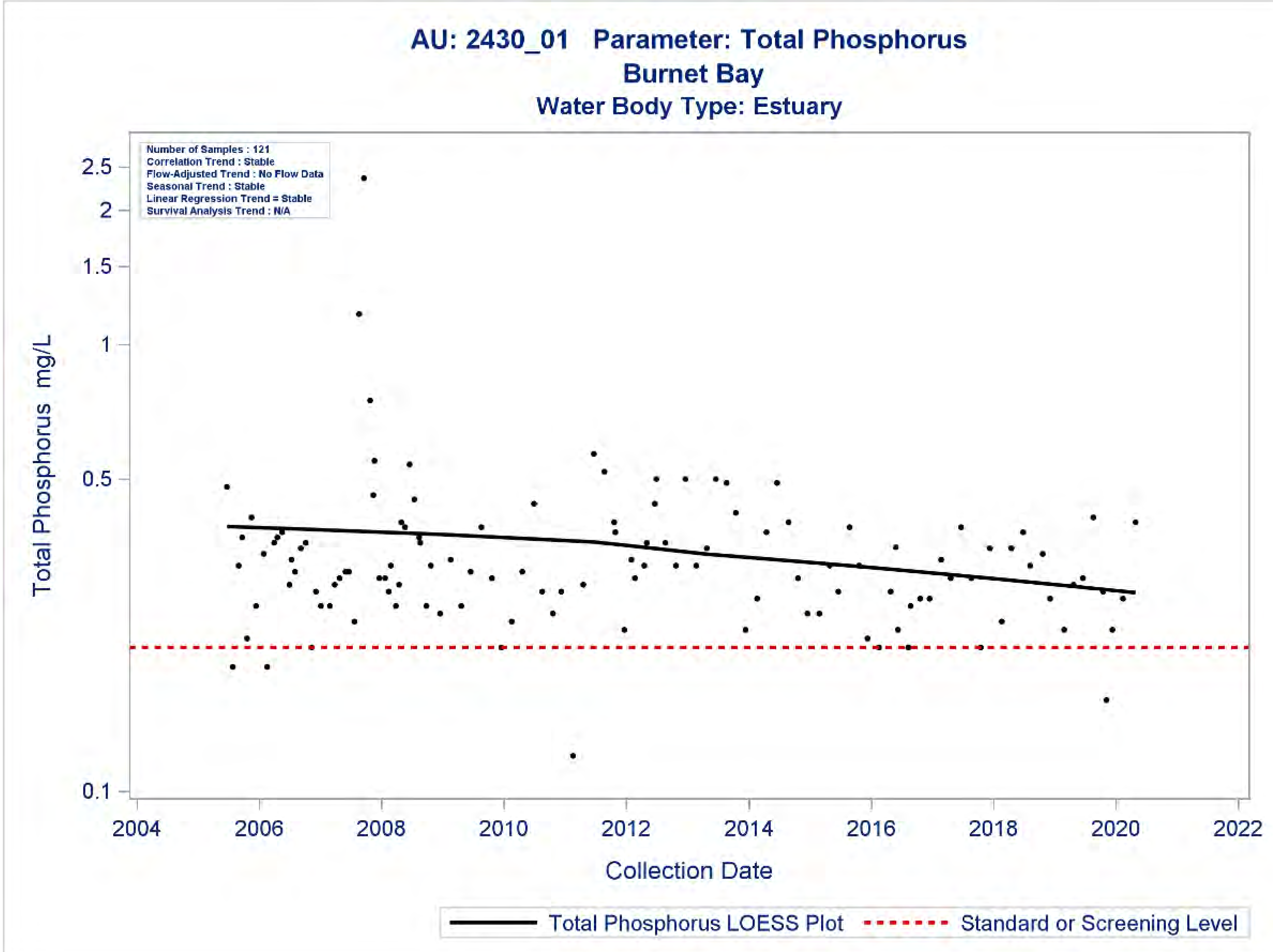
Segment: 2430A Crystal Bay
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 122
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
0.0
0.2
0.4
0.6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

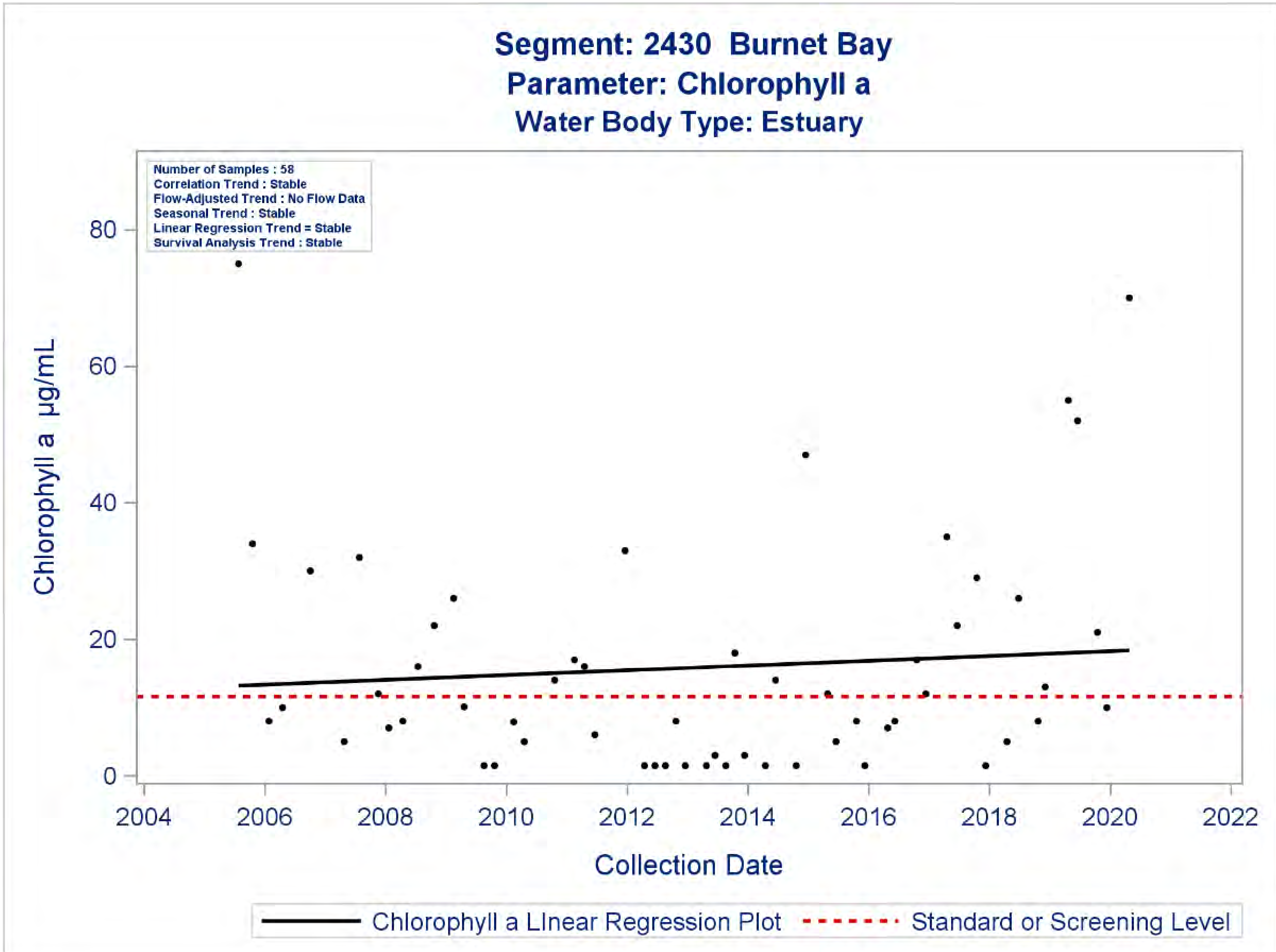


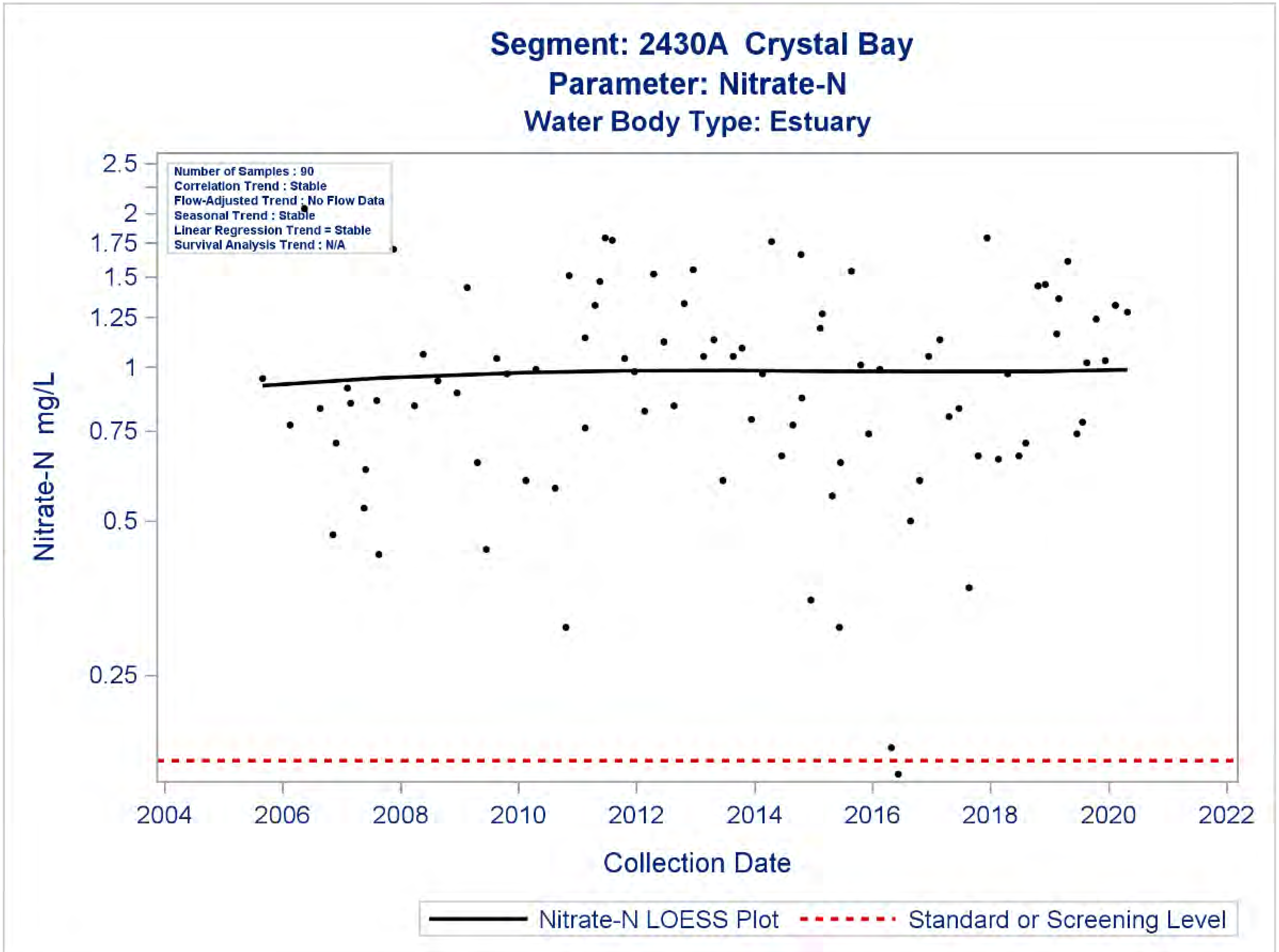
Segment: 2430 Burnet Bay
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 120
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
0.0
0.2
0.4
0.6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



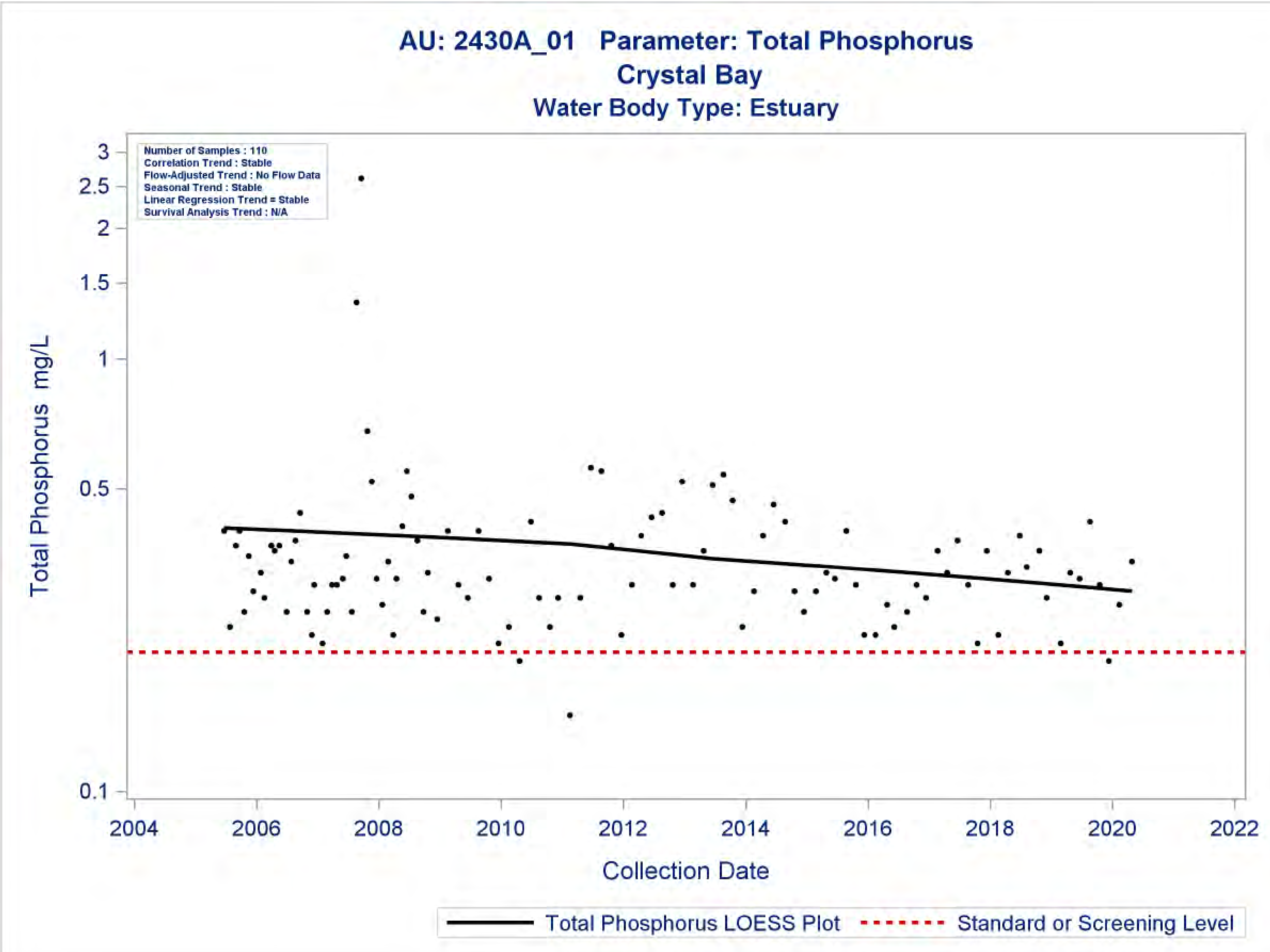
Segment: 2430 Burnet Bay
Parameter: Nitrate-N
Water Body Type: Estuary
Number of Samples : 89
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Nitrate-N mg/L
2.25
1.5
1
0.75
0.5
0.25
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

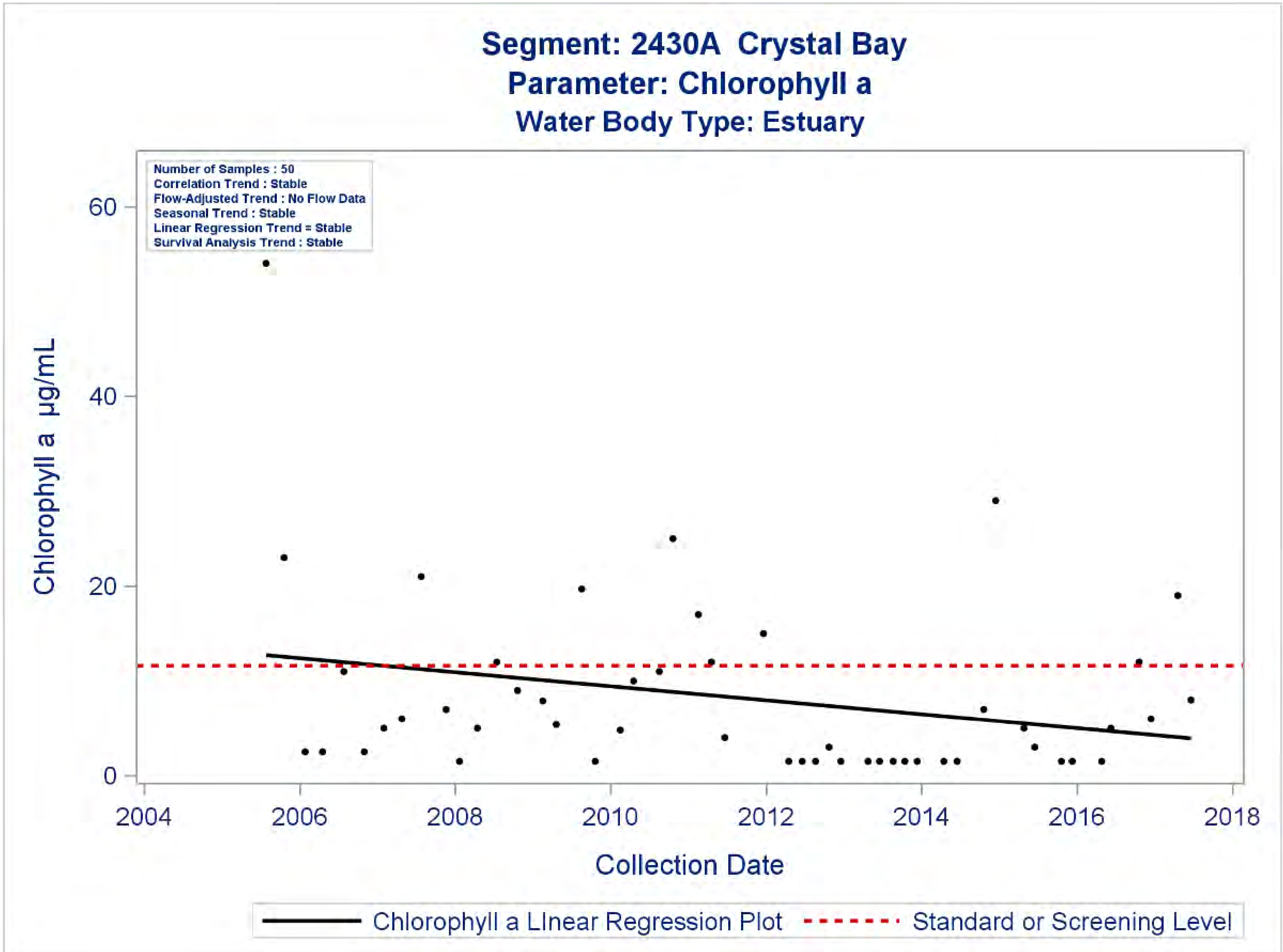

AU: 2430_01 Parameter: Total Phosphorus
Burnet Bay
Water Body Type: Estuary
Number of Samples : 121
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.1
0.5
1
1.5
2
2.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


Segment: 2430 Burnet Bay
Parameter: Chlorophyll a
Water Body Type: Estuary
Number of Samples : 58
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Chlorophyll a µg/mL
0
20
40
60
80
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level



Segment: 2430A Crystal Bay
Parameter: Nitrate-N
Water Body Type: Estuary
Number of Samples : 90
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Nitrate-N mg/L
2.5
2
1.75
1.5
1.25
1
0.75
0.5
0.25
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level


AU: 2430A_01 Parameter: Total Phosphorus
Crystal Bay
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Phosphorus mg/L
3
2.5
2
1.5
1
0.5
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



Segment: 2430A Crystal Bay
Parameter: Chlorophyll a
Water Body Type: Estuary
Number of Samples : 50
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Chlorophyll a µg/mL
60
40
20
0
2004
2006
2008
2010
2012
2014
2016
2018
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nutrient Concentrations	***Ammonia*** ***Nitrate*** ***Phosphorus*** 2430_01 C 2430A_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Expand use of LID and green infrastructure practices • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed
Elevated Chlorophyll -*a* Concentrations	2430_01 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	2430_01 I 2430A_01 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2425 — Name: Clear Lake

Area:	3 square miles	Miles of Shoreline:	31.6 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	9	Texas Stream Team Monitoring Stations:	16	Permitted WWTF Outfalls:	12

DESCRIPTION

- Segment 2425: **Clear Lake** (classified water body) – A 5.2 square kilometer (2.0 square mile) brackish, tidally influenced water body on the western shore of Upper Galveston Bay that receives inflows from Clear Creek, Jarbo Bayou, Armand Bayou, and Taylor Lake, and also serves as the boundary between Galveston and Harris Counties.

- Segment 2425A (Estuary w/ high ALU): **Taylor Lake** (unclassified water body) — From the confluence with Clear Lake upstream to the terminus of Taylor Bayou south of Bay Forest Golf Club in La Porte in Harris County

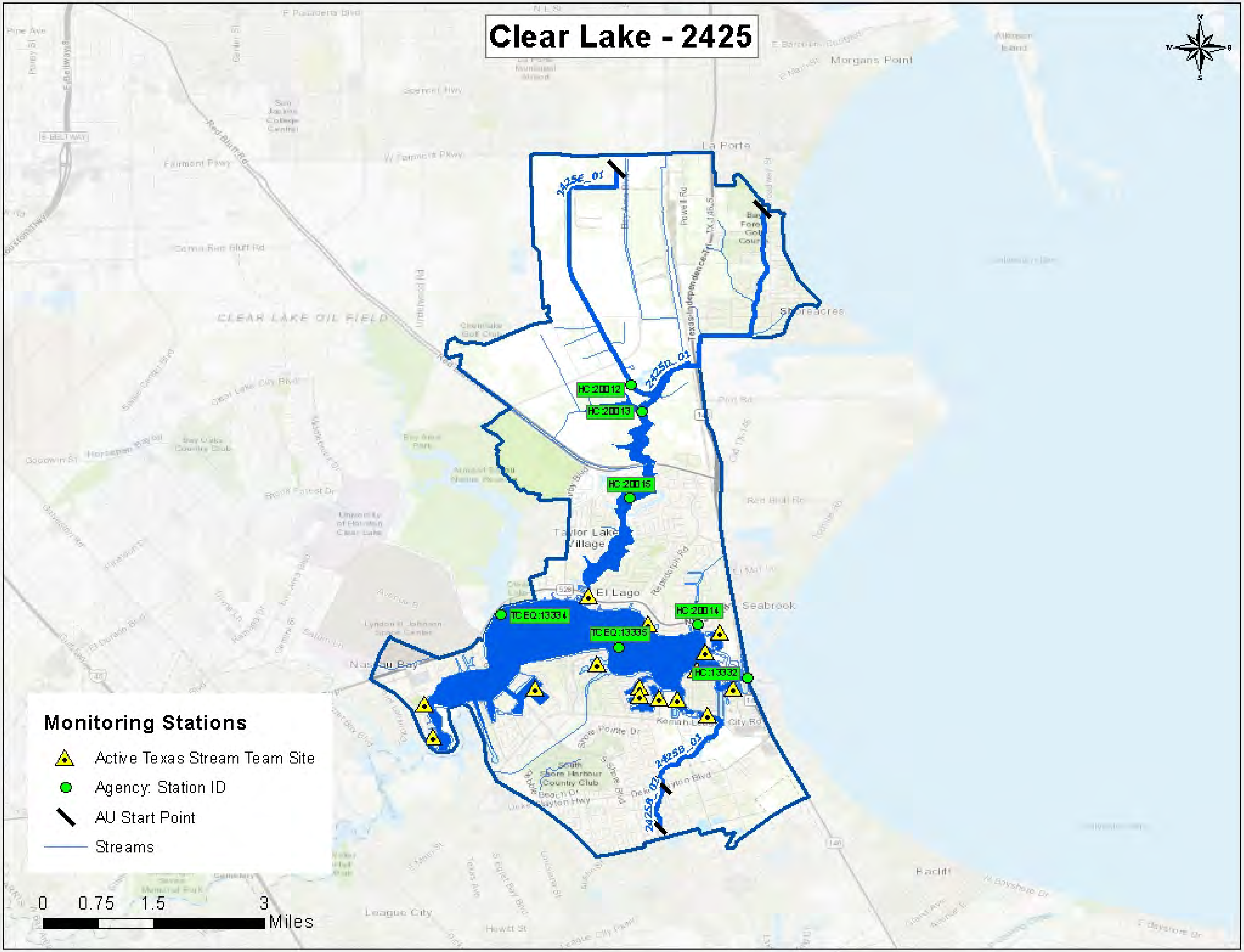
- Segment 2425B (Tidal Stream w/ high ALU): **Jarbo Bayou** (unclassified water body) — From Clear Lake confluence with Clear Lake to 1.1 km (0.67 mi) upstream of FM 518 in Galveston County

- Segment 2425D (Tidal Stream w/ high ALU): **Taylor Bayou** (unclassified water body) — From the Taylor Lake confluence to a point 4.6 km (2.8 mi) upstream of State Hwy 146

- Segment 2425E (Tidal Stream w/ high ALU): **Harris County Flood Control Ditch A** (unclassified water body) – From the Taylor Bayou confluence to a point 0.28 km (0.17 mi) downstream of Fairmont Parkway

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
13332	2425	CLEAR LAKE AT SH 146 DRAWBRIDGE	HC	Bimonthly	Field, Conventional, Bacteria
13334	2425	CLEAR LAKE 120 METERS SE OF CENTER OF NASA 1 BRIDGE	FO	Quarterly	Field, Conventional, Bacteria
13335	2425	CLEAR LAKE AT CM 17	FO	Quarterly Two/Year One/Year	Field, Conventional, Bacteria Metals in Water Metals in Sediment, Organics in Sediment
20014	2425	CLEAR LAKE UNNAMED INLET 115 M SOUTHWEST OF THE INTERSECTION OF NASA ROAD 1 AND OCEANVIEW DRIVE IN SEABROOK IN HARRIS COUNTY	HC	Bimonthly	Field, Conventional, Bacteria
20013	2425A	TAYLOR BAYOU MID CHANNEL 400 M DOWNSTREAM OF PORT ROAD BRIDGE IN HARRIS COUNTY	HC	Bimonthly	Field, Conventional, Bacteria
20015	2425A	TAYLOR LAKE MID LAKE AT BLUE WINDOWS 230 M SOUTH OF LAKEWAY DRIVE AT RAY SHELL COURT/HARBOR COVE CIRCLE IN HARRIS COUNTY	HC	Bimonthly	Field, Conventional, Bacteria
16476	2425B	JARBO BAYOU AT FM2094 APPROX 0.3MI UPSTREAM OF CLEAR LAKE CONFLUENCE IN KEMAH	FO	Quarterly	Field, Conventional, Bacteria
16485	2425B	JARBO BAYOU AT LAWRENCE ROAD IN KEMAH	FO	Quarterly	Field, Conventional, Bacteria
20012	2425E	HARRIS COUNTY FLOOD CONTROL DITCH A TRIBUTARY TO TAYLOR BAYOU 385 M UPSTREAM OF CONFLUENCE WEST OF SH 146 AT PORT ROAD IN HARRIS COUNTY	HC	Bimonthly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
HC = Harris County Pollution Control


Clear Lake - 2425
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0
0.75
1.5
3
Miles
2425E_01
2425D_01
2425B_01
2425A_01
HC:20012
HC:20013
HC:20015
HC:20014
HC:13332
TCEQ:13334
TCEQ:13335
La Porte
Morgans Point
Shoreacres
Taylor Lake Village
El Lago
Seabrook
Nassau Bay
Kemah
League City
Bacliff
CLEAR LAKE OIL FIELD

Segment 2425 Water Quality Standards and Screening Levels					
Standards	**Bays & Estuaries**	**Tidal Stream**	**Screening Levels**	**Bays & Estuaries**	**Tidal Stream**
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia-N (mg/L):	0.10	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	4.0	Nitrate-N (mg/L):	0.17	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66
Enterococci (MPN/100mL) (grab):	130	130	Chlorophyll *a* (µg/L):	11.6	21
Enterococci (MPN/100mL) (geometric mean):	35	35			

Segment Discussion

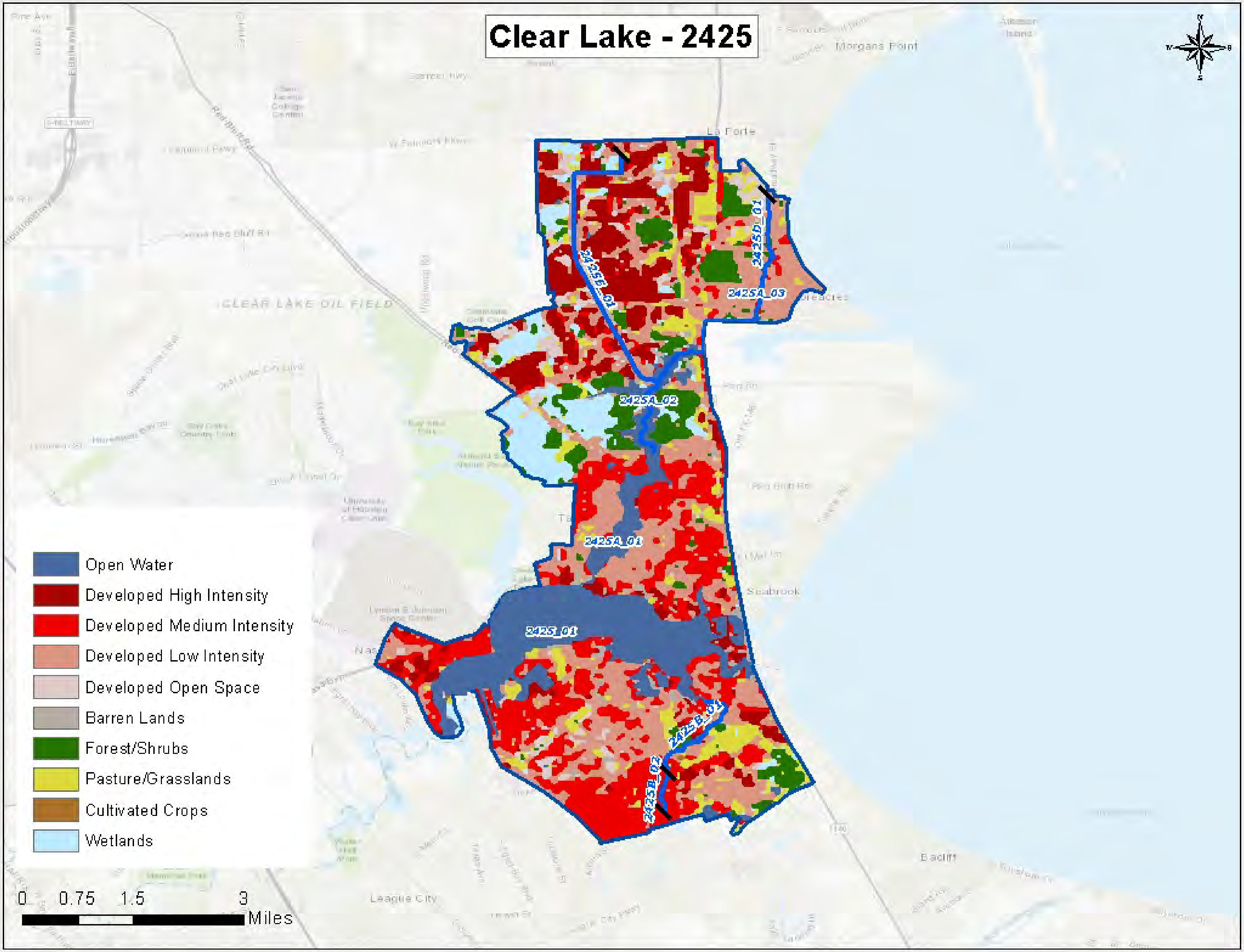
Watershed Characteristics and Land Cover: Clear Lake, including tributaries Taylor and Jarbo Bayous, is the terminus for Clear Creek and Armand Bayou and empties into Upper Galveston Bay. It is home to one of the most concentrated fleets of recreational boats in Texas and the United States. Numerous marinas are located around the lake providing easy access to Upper Galveston Bay.

On the south shore of Clear Lake, the watershed encompasses the cities of League City, Clear Lake Shores and Kemah. High and low intensity residential and mixed commercial developments are the prominent land use for the majority of the southern shore. The exception is an area of homes and businesses on small acreages in the southeast portion of the watershed. The cities of Nassau Bay, Pasadena, Taylor Lake Village, El Lago and Seabrook border the lake on the north shore. These cities are heavily urbanized with high and low intensity developments.

Upstream of Red Bluff Road, the Taylor Lake (2425A) sub-watershed is mostly undeveloped with large tracts of wetlands, grasslands and forested land. Large industrial facilities are located along the major highway corridors of Bay Area Boulevard and Port Road in the upper reaches of the sub-watershed. The majority of the watershed developments are serviced by municipal wastewater collection and treatment systems.

The largest land cover class in this watershed is Developed land, which covers 63.02 percent of the area.

Segment 2425 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	1,220.06	7.19	1,356.17	7.99	11.16
Barren Lands	95.41	0.56	478.15	2.82	401.17
Developed	10,695.67	63.05	10,690.11	63.02	-0.05
Forest/Shrubs	224.17	1.32	1,226.73	7.23	447.22
Open Water	2,619.15	15.44	2,093.85	12.34	-20.06
Wetlands	2,110.31	12.44	1,118.87	6.60	-46.98
TOTAL	**16,964.77**	**100.00**	**16,963.88**	**100.00**	



Clear Lake - 2425
2425EE_01
2425D_01
2425A_03
2425A_02
2425A_01
2425_01
2425B_01
2425B_02
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.75 1.5 3
Miles
La Porte
Morgans Point
Seabrook
CLEAR LAKE OIL FIELD
Bacliff
League City

Water Quality Issues:

Bacteria Impairments and Concerns
Jarbo Bayou (2425B) is impaired for contact recreation due to elevated levels of enterococci bacteria. In the 2020 assessment, the bacteria geometric mean was 81.11 MPN/100 mL for AU 2425B_01, which exceeds the water quality standard of 35 MPN/100 mL. AU 2425B_02 was not assessed in 2020 due to insufficient data, but is listed as a concern, which is a carry-forward from a previous assessment.

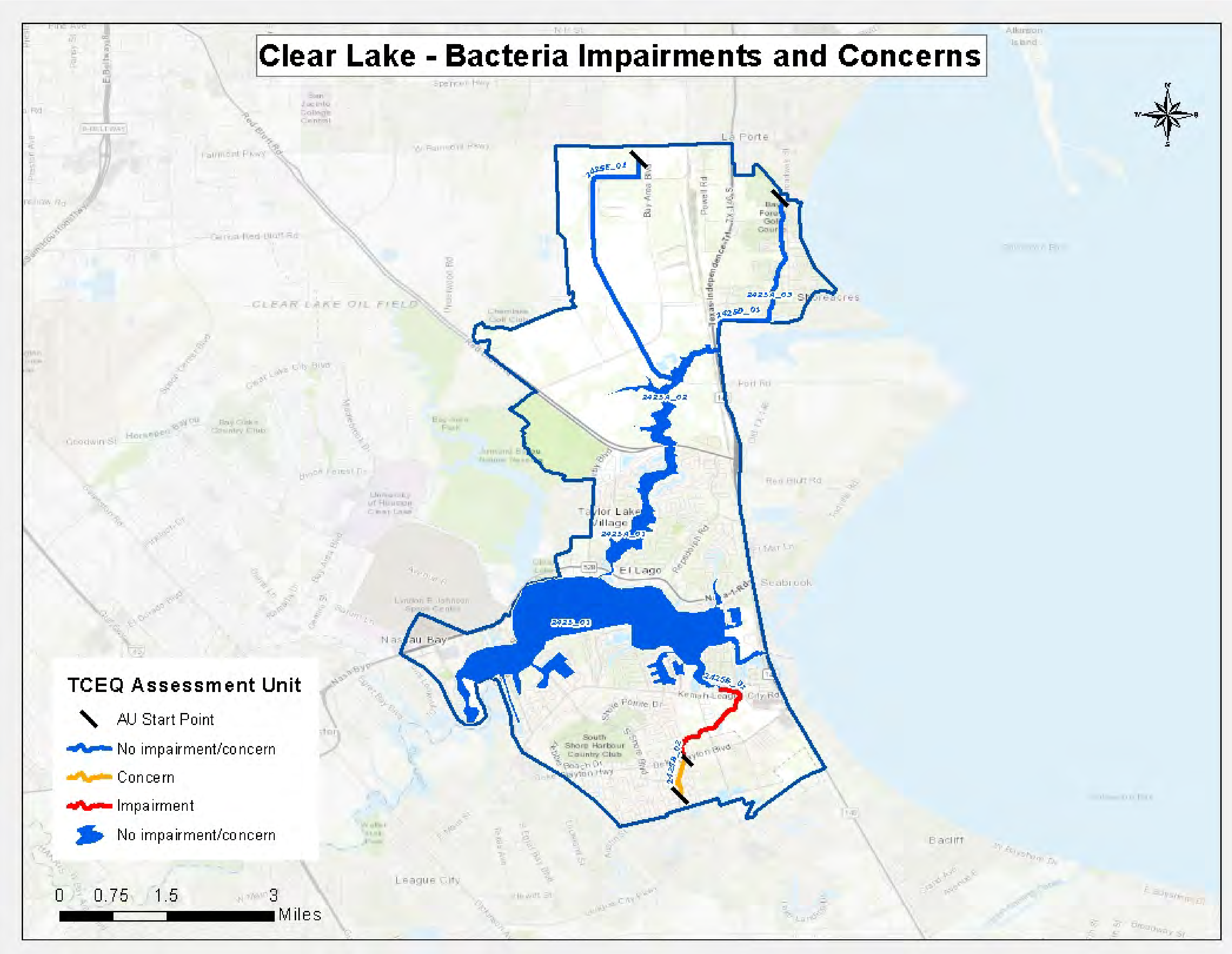
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

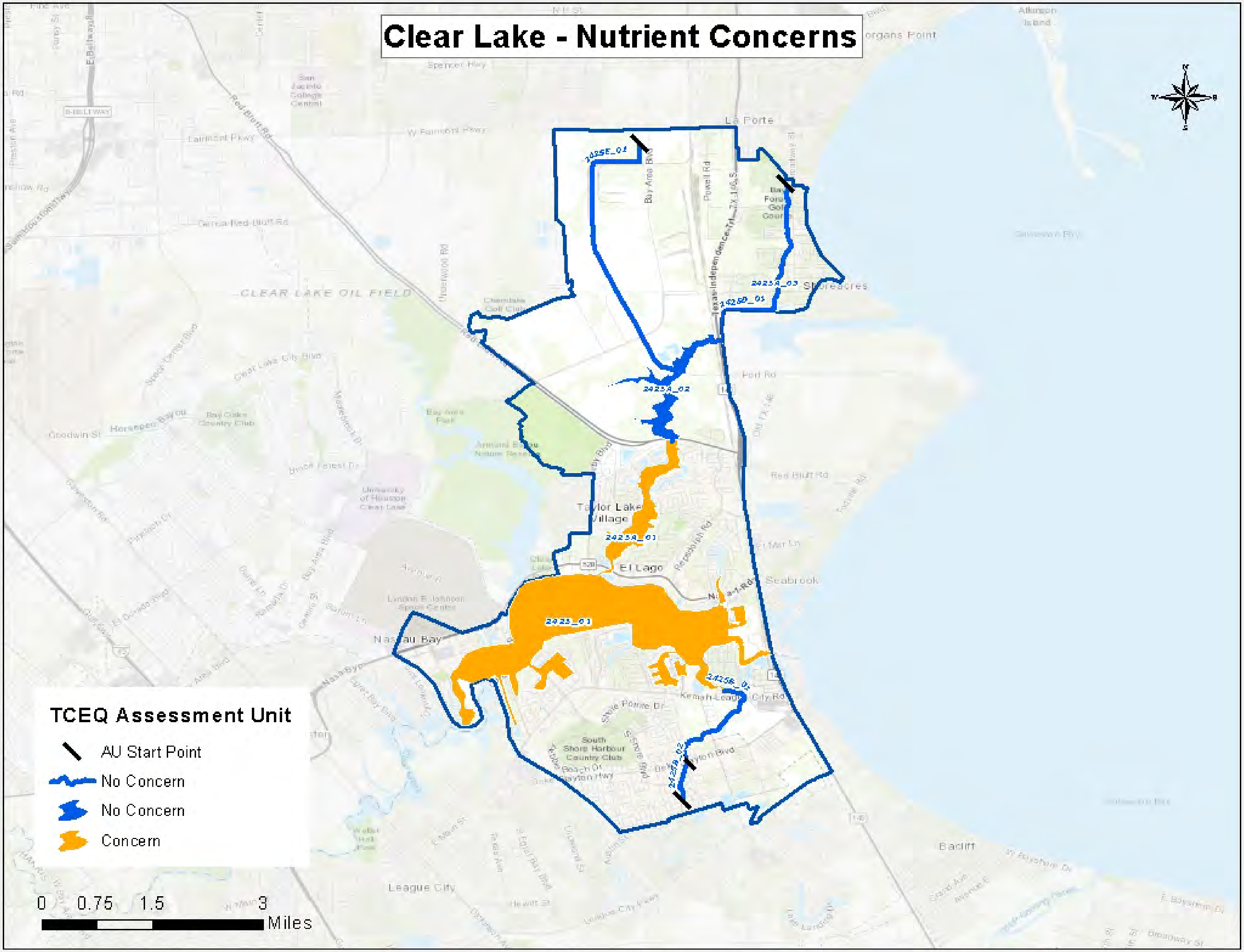
Nutrient Concerns
Nutrient concerns for nitrate-nitrogen and total phosphorus are present in Clear Lake and in assessment unit 2425A_01 of Taylor Lake. A total phosphorus concern is also present in assessment unit 2425A_02 of Taylor Lake.

Chlorophyll-a Concerns
Screening level concerns for chlorophyll-*a* are present in Clear Lake (2425) and a portion of Taylor Lake (2425A_01).

PCBs and Dioxin Impairments
Clear Lake (2425), Taylor Lake (2425A), and Jarbo Bayou (2425B) are listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services is in effect.

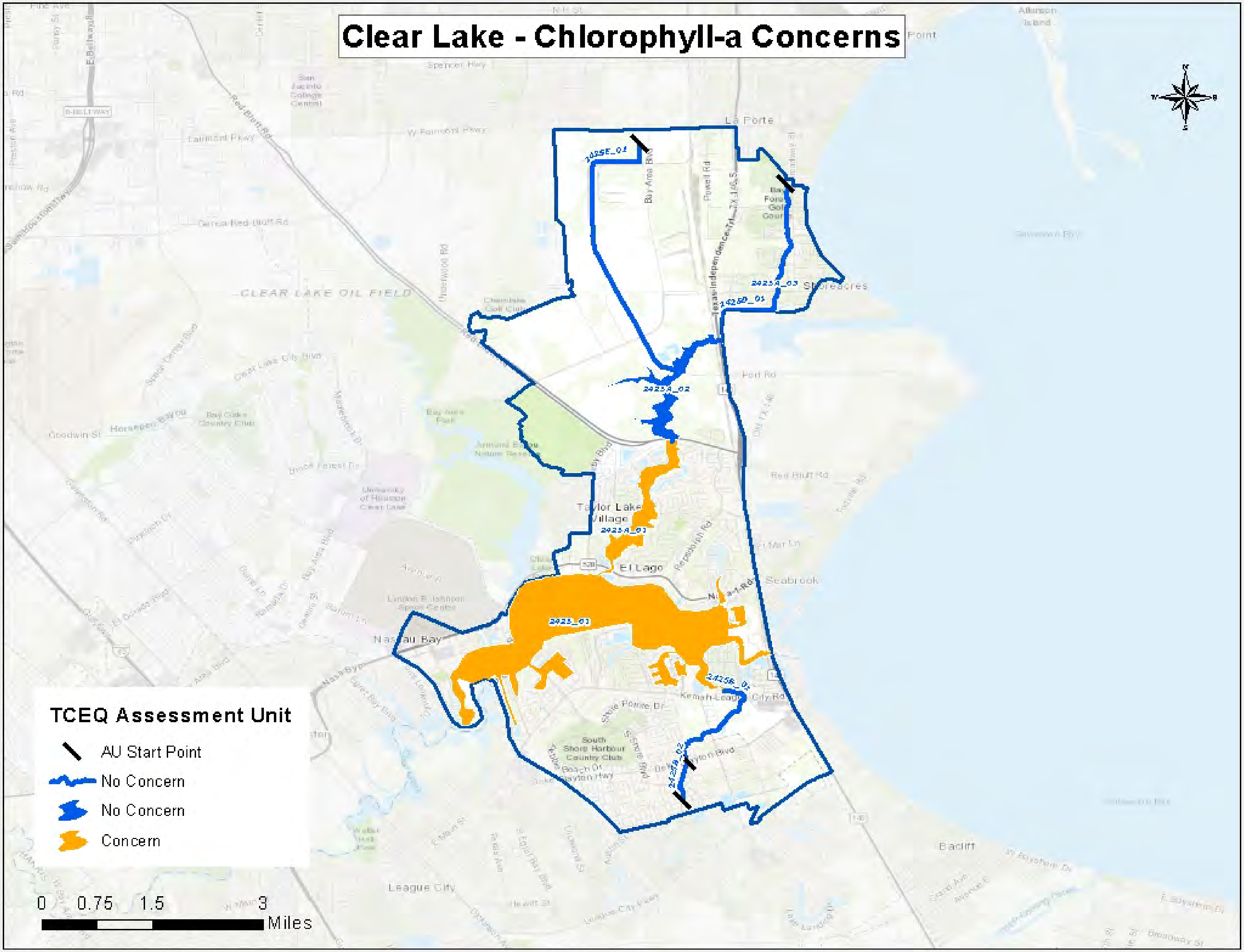
Chronic Toxic Substances in Water
An impairment for chronic toxic substances in water for Clear Lake was identified in the 2020 Integrated Report. This impairment is for the presence of dissolved copper in water. The exact source is not known, but runoff from ship yards where boats are serviced, cleaned, and repainted could be a potential source.

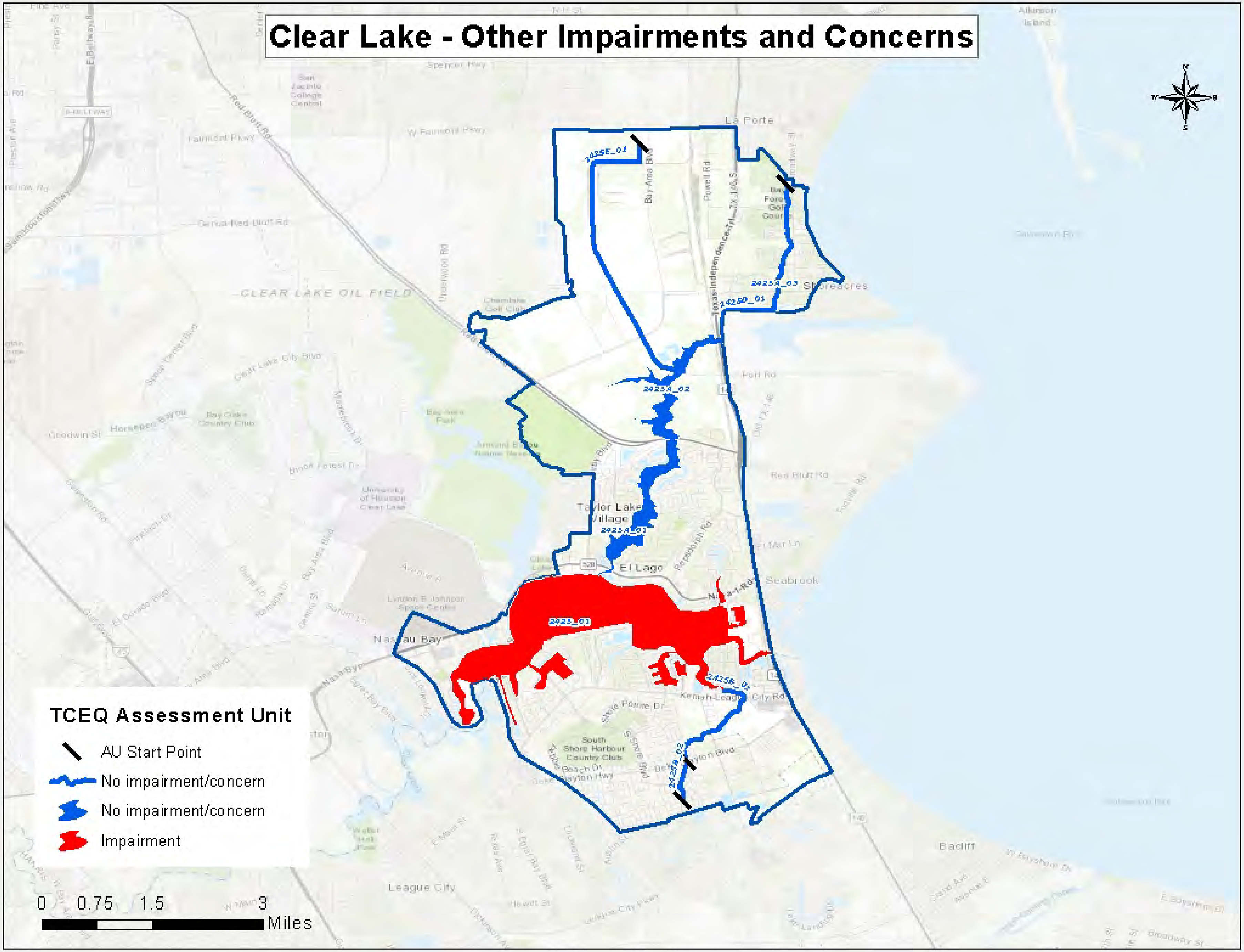

Clear Lake - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
No impairment/concern
0 0.75 1.5 3
Miles
2425_01
2425A_01
2425A_02
2425A_03
2425B_01
2425B_02
2425D_01
2425E_01
La Porte
Taylor Lake Village
El Lago
Seabrook
Nassau Bay
League City
Bacliff
Shoreacres

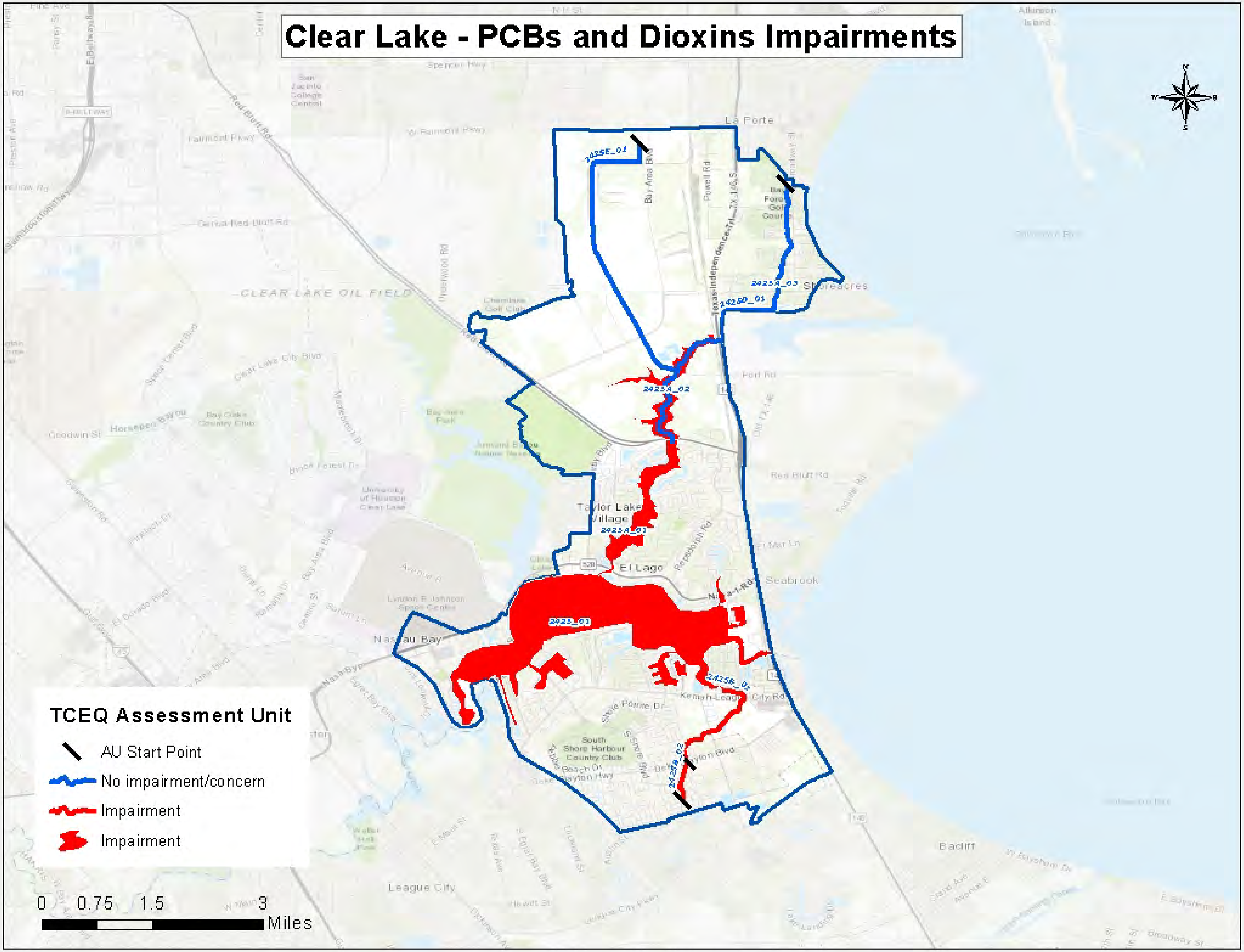


Clear Lake - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
No Concern
Concern
0 0.75 1.5 3
Miles
2425_01
2425A_01
2425A_02
2425A_03
2425B_01
2425B_02
2425D_01
2425E_01
La Porte
Shoreacres
Taylor Lake Village
El Lago
Seabrook
Nassau Bay
League City
Bacliff
CLEAR LAKE OIL FIELD

Clear Lake - Chlorophyll-a Concerns




Clear Lake - Other Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
No impairment/concern
Impairment
0 0.75 1.5 3
Miles
2425_01
2425A_01
2425A_02
2425A_03
2425B_01
2425B_02
2425D_01
2425E_01
La Porte
Shoreacres
Taylor Lake Village
El Lago
Seabrook
Nassau Bay
League City
Bacliff



Clear Lake - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
Impairment
0 0.75 1.5 3
Miles
2425E_01
2425A_03
2425D_01
2425A_02
2425A_01
2425_01
2425B_01
2425B_02
La Porte
Shoreacres
Taylor Lake Village
El Lago
Seabrook
Nassau Bay
League City
Bacliff
CLEAR LAKE OIL FIELD

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Clear Lake watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

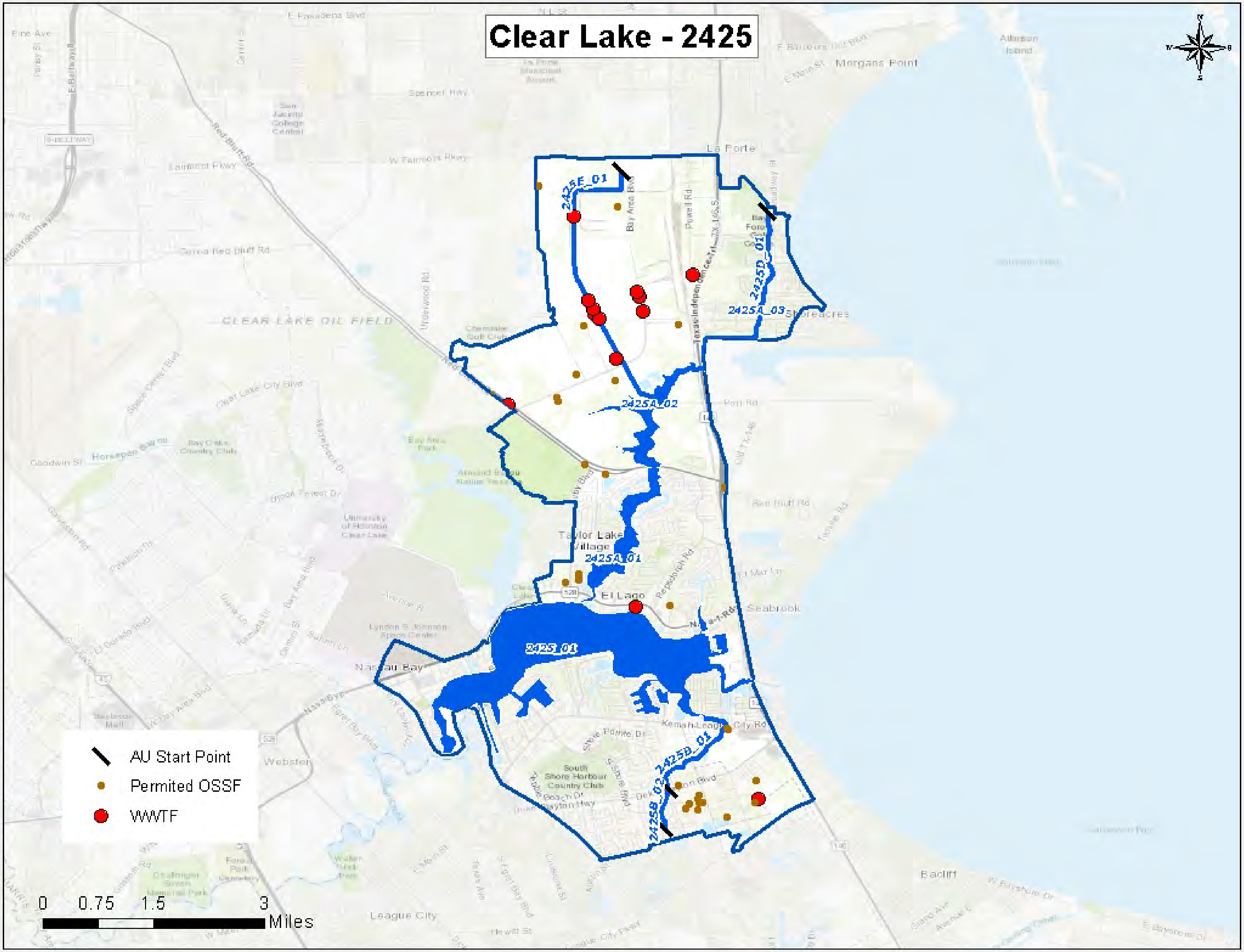
There are 12 permitted wastewater outfalls and 29 permitted on-site sewage facilities in the Clear Lake watershed. The wastewater treatment facilities and on-site sewage facilities in the Clear Lake watershed are shown in the accompanying map.

For the period of 2010 – 2019, there was only 1 sanitary sewer overflow reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

A concern for chronic toxic substances is due to the presence of dissolved copper in water. Copper typically enters water bodies from domestic, agricultural, or industrial sources, as well as the dissolution of natural deposits. Runoff from shipyards may be a potential source. Copper can also be resuspended from deposits in sediment through dredging.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Clear Lake watershed.



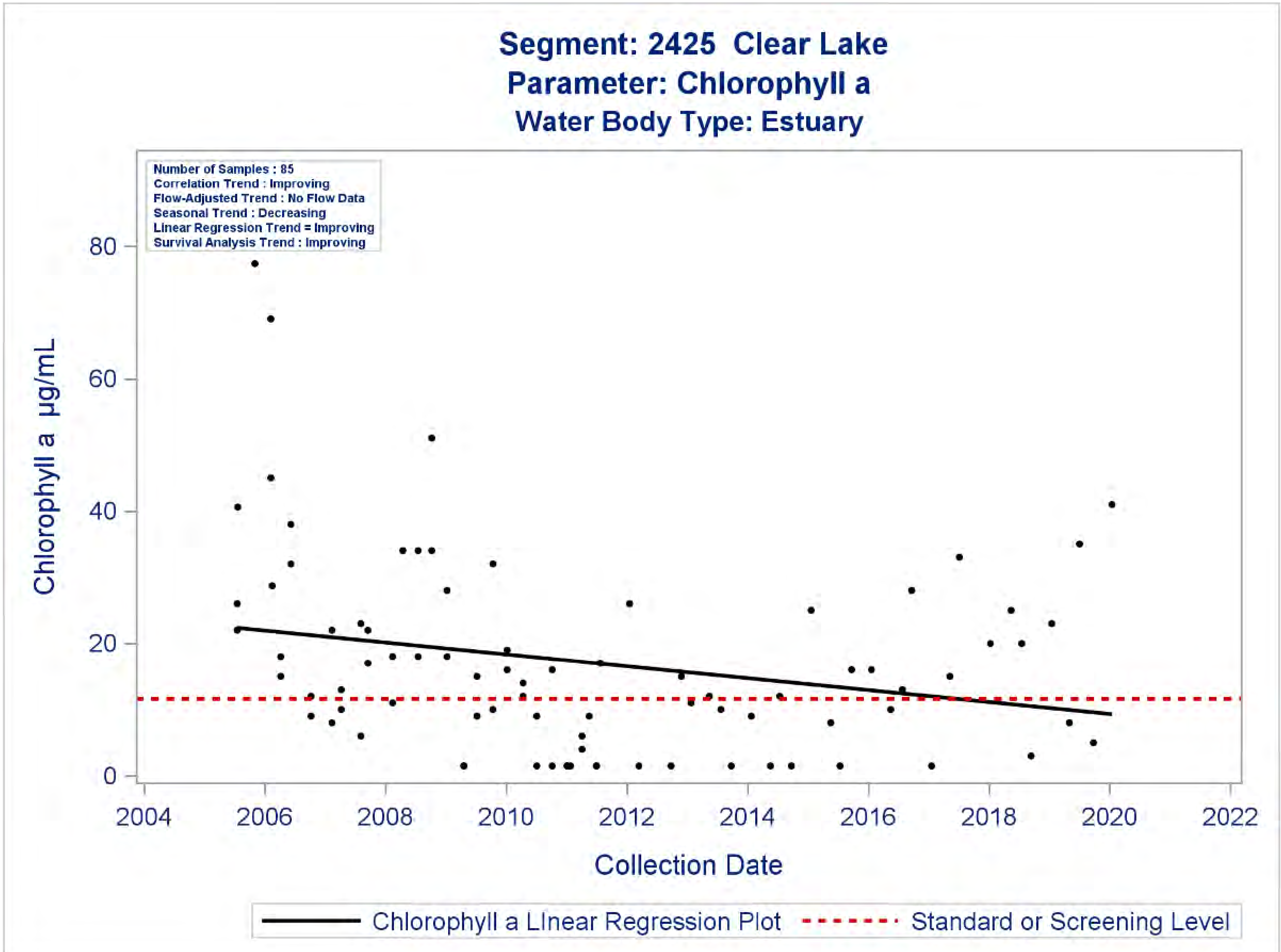
Clear Lake - 2425
2425E_01
2425D_01
2425A_03
2425A_02
2425A_01
2425_01
2425B_01
2425B_02
AU Start Point
Permited OSSF
WWTF
0 0.75 1.5 3
Miles
La Porte
Morgans Point
Shoreacres
Taylor Lake Village
El Lago
Seabrook
Nassau Bay
Webster
League City
Bacliff
CLEAR LAKE OIL FIELD

Trend Analysis:

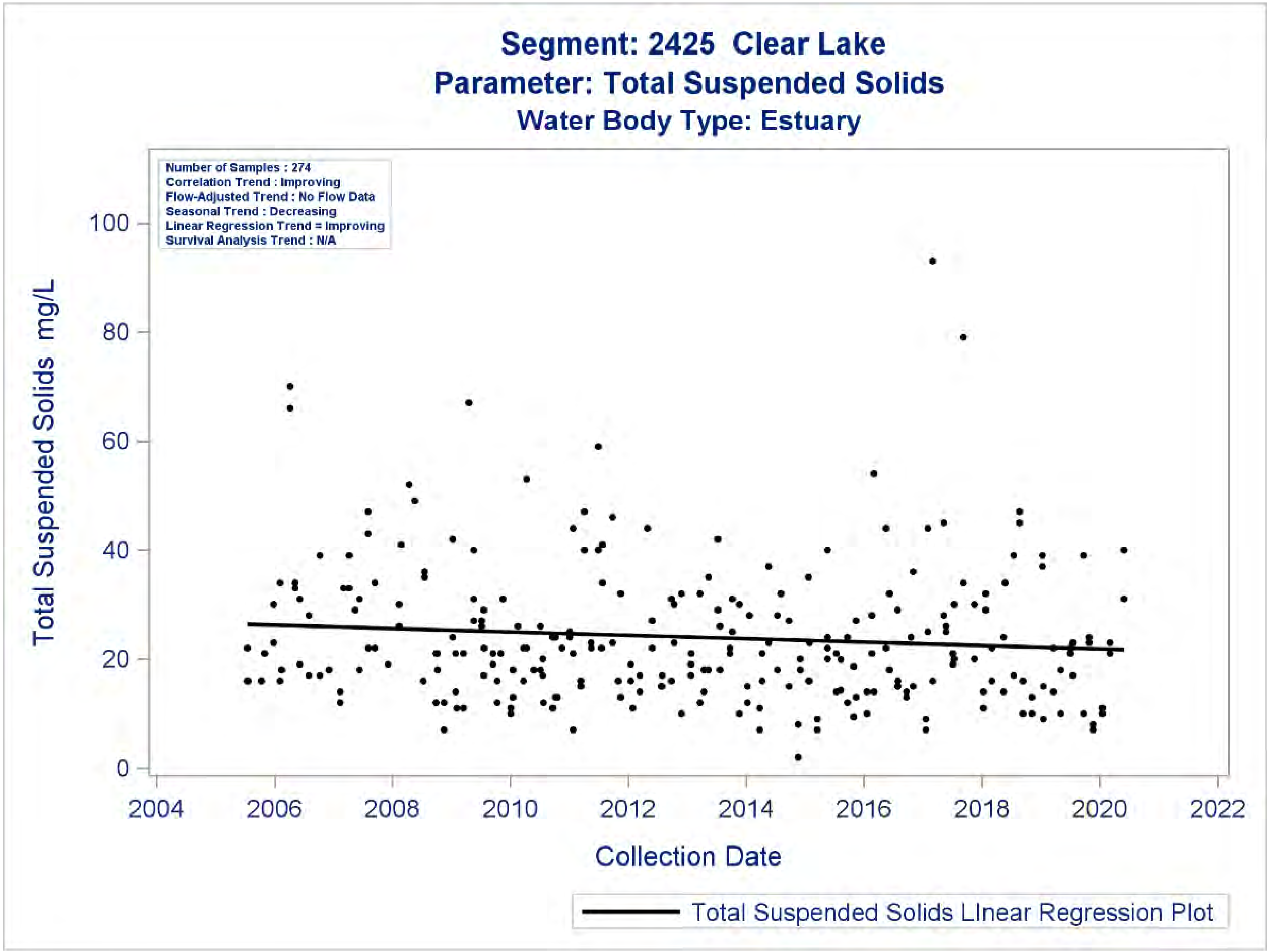
Analysis of water quality data revealed a total of nine parameter trends in the classified and unclassified AUs located in the Clear Lake (2425) watershed. The main Clear Lake AU had six significant parameter trends including increasing Secchi transparency depths, while concentrations of chloride, chlorophyll *a*, TSS, sulfate, and specific conductance are decreasing over time. When there is a trend with the TSS data, there is usually an inverse relationship to the Secchi transparency data. Where sediment loads are decreasing the Secchi transparency depth is increasing. Increasing trends are typically categorized as 'deteriorating trends' as seen in the graph legend, but the water is actually getting less turbid. Linear regression analysis shows an improving trend for ammonia, with decreasing values over time.

Taylor Lake (2425A) also revealed six parameter trends with increasing chlorophyll *a* concentrations and decreasing concentrations of DO, TKN, total phosphorus, and specific conductance. Decreasing Secchi transparency depths were also observed. All total phosphorus results are less than the screening criteria except for two values collected in 2011 and 2016. While DO concentrations are decreasing, there was still only one value measured at less than the standard of 4.0 mg/L. Unclassified segment 2425B (Jarbo Bayou), revealed two parameter trends –decreasing specific conductance and TKN concentrations. Harris County Flood Control Ditch A (unclassified segment 2425E) revealed four parameter trends – milligrams per liter of DO is decreasing but only one value has dipped below the standard and concentrations of total phosphorus, TKN, and specific conductance are all decreasing or showing improving trends.

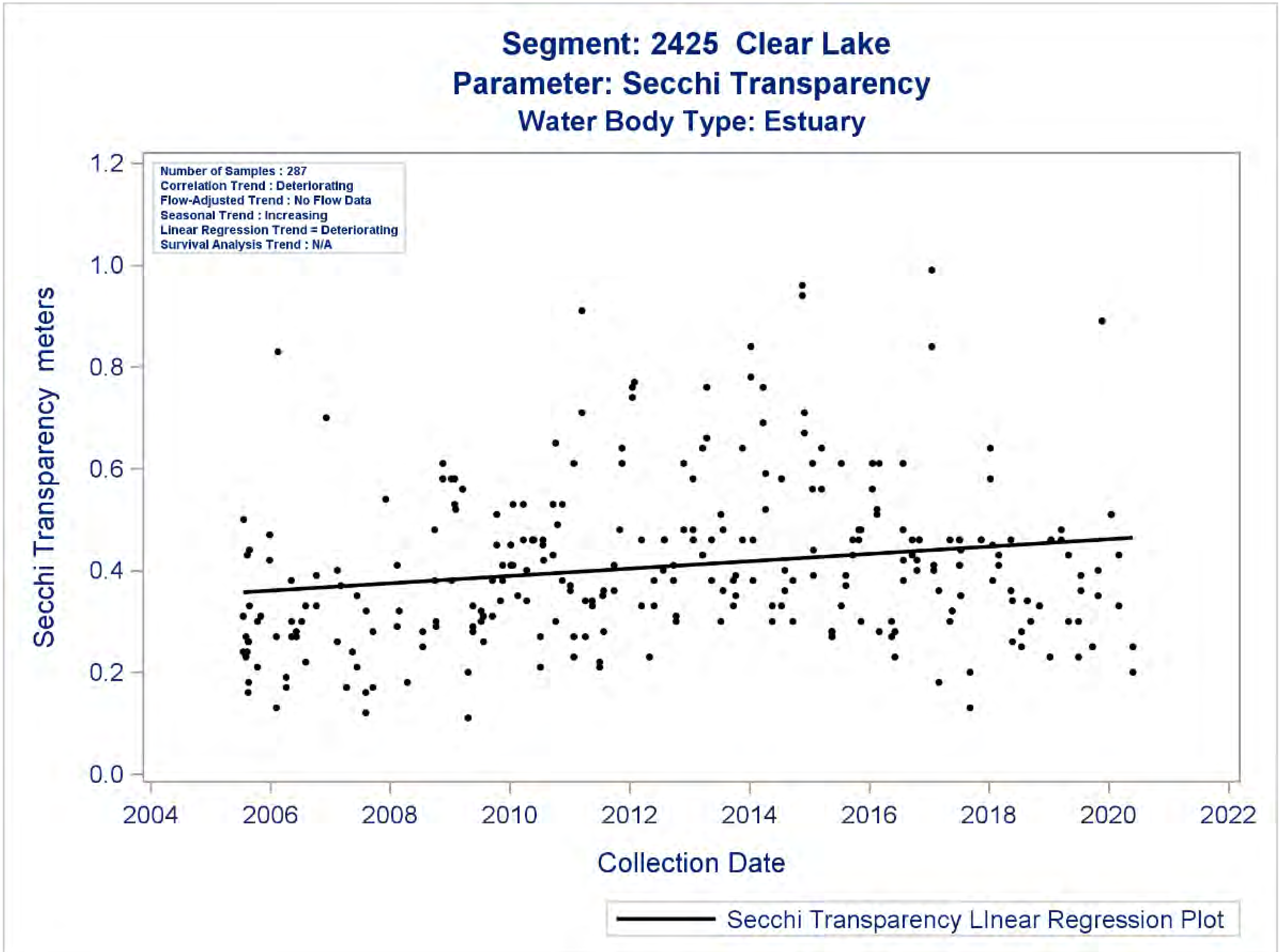
The 2020 Texas Integrated Report lists only unclassified segment 2425B (Jarbo Bayou) as impaired for elevated levels of indicator bacteria. Regression analysis identified a relatively stable trend in enterococci concentrations in Jarbo Bayou. However, the majority of bacteria values have remained significantly greater than the 35 MPN/100 standard during the period of record.



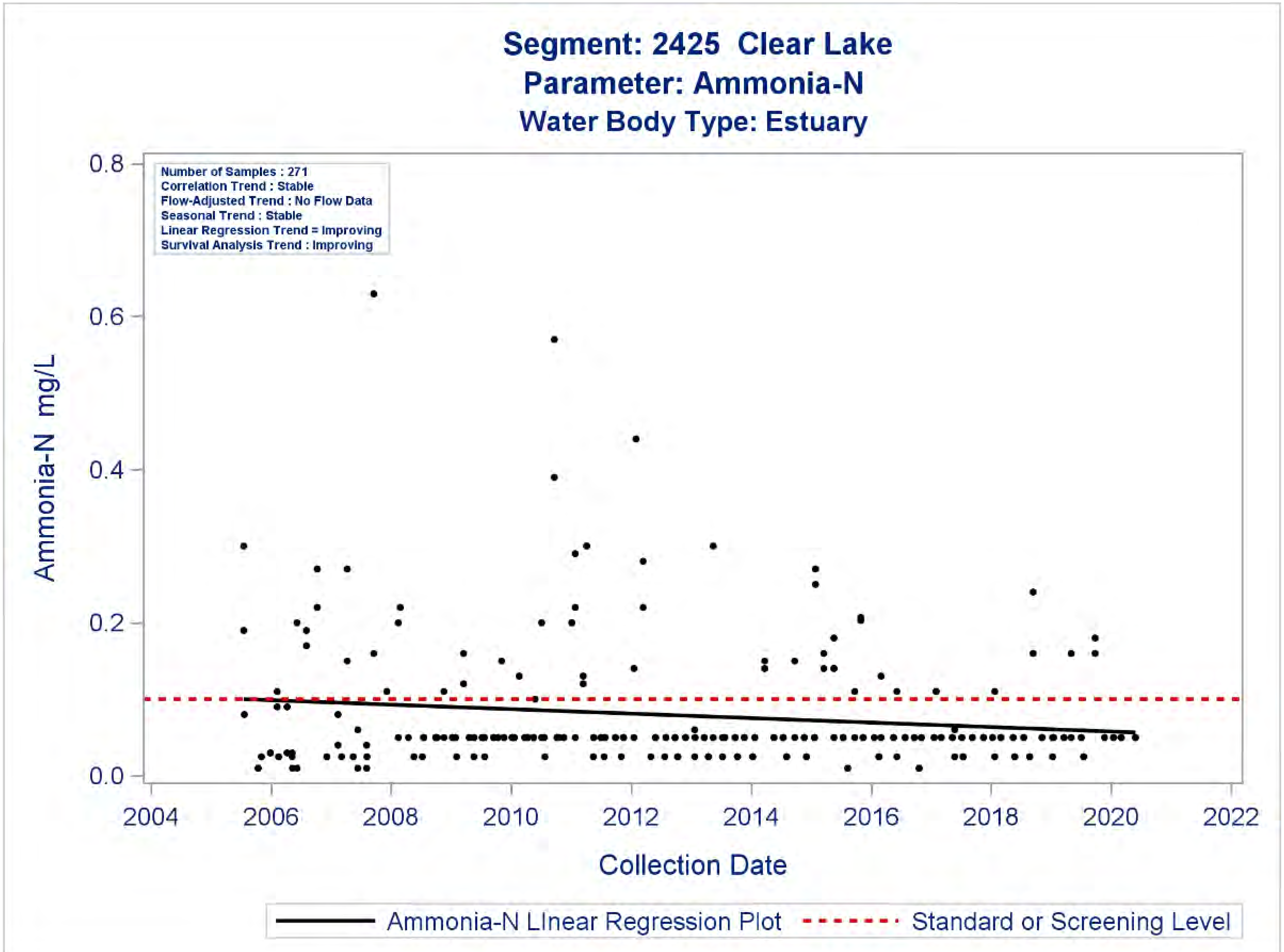
Segment: 2425 Clear Lake
Parameter: Chlorophyll a
Water Body Type: Estuary
Number of Samples : 85
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Chlorophyll a µg/mL
0
20
40
60
80
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level

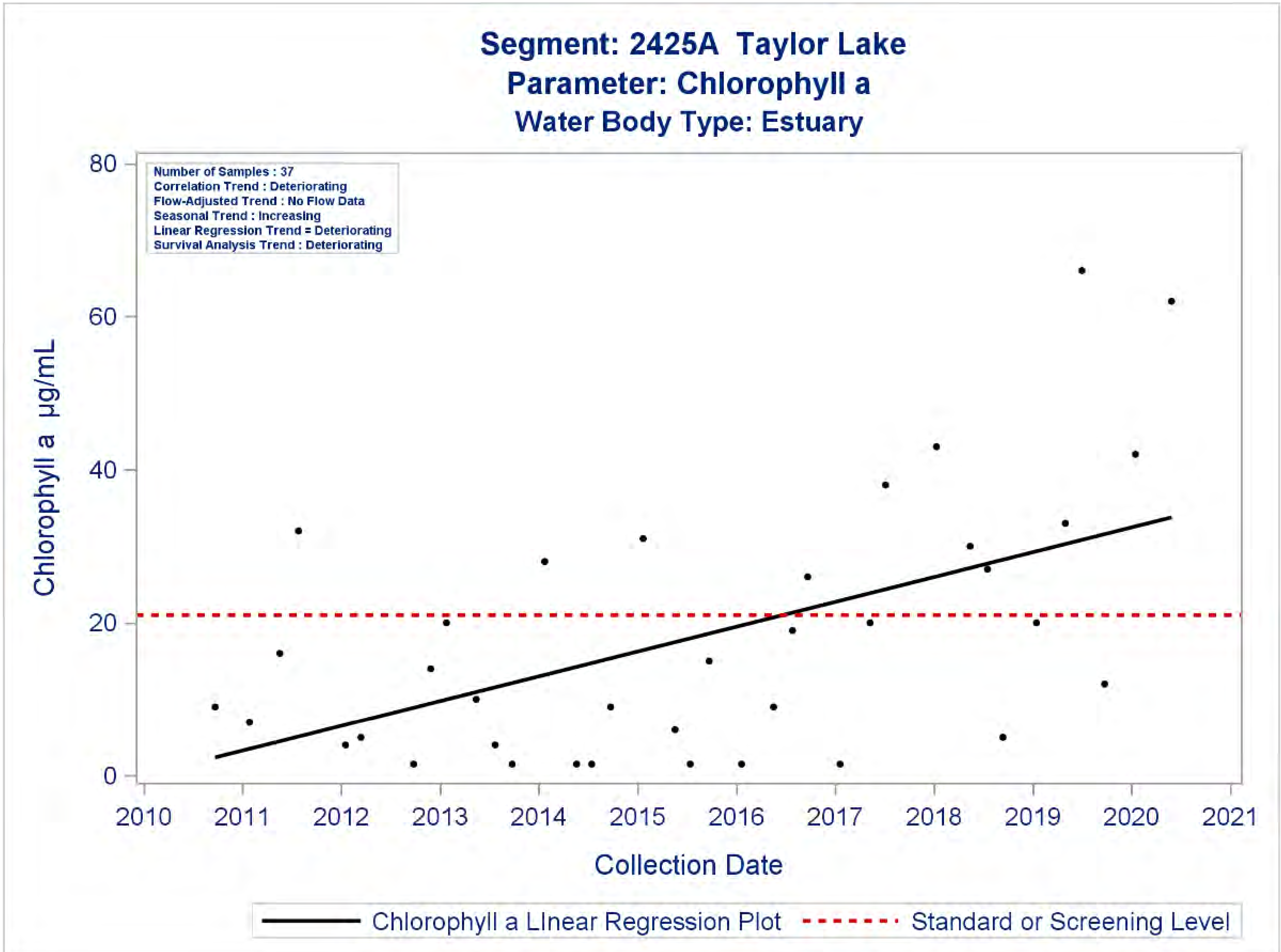


Segment: 2425 Clear Lake
Parameter: Total Suspended Solids
Water Body Type: Estuary
Number of Samples : 274
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
20
40
60
80
100
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot

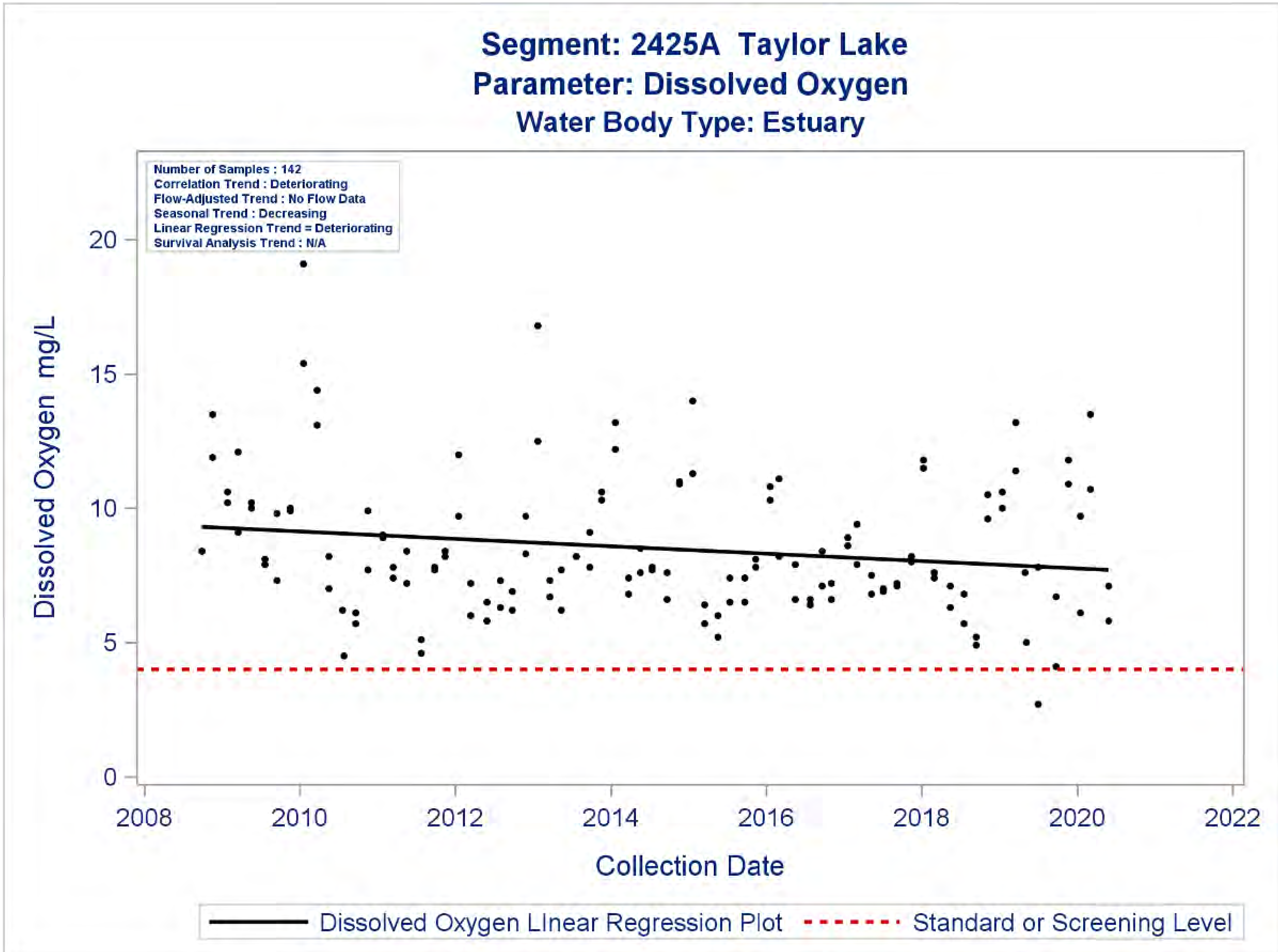


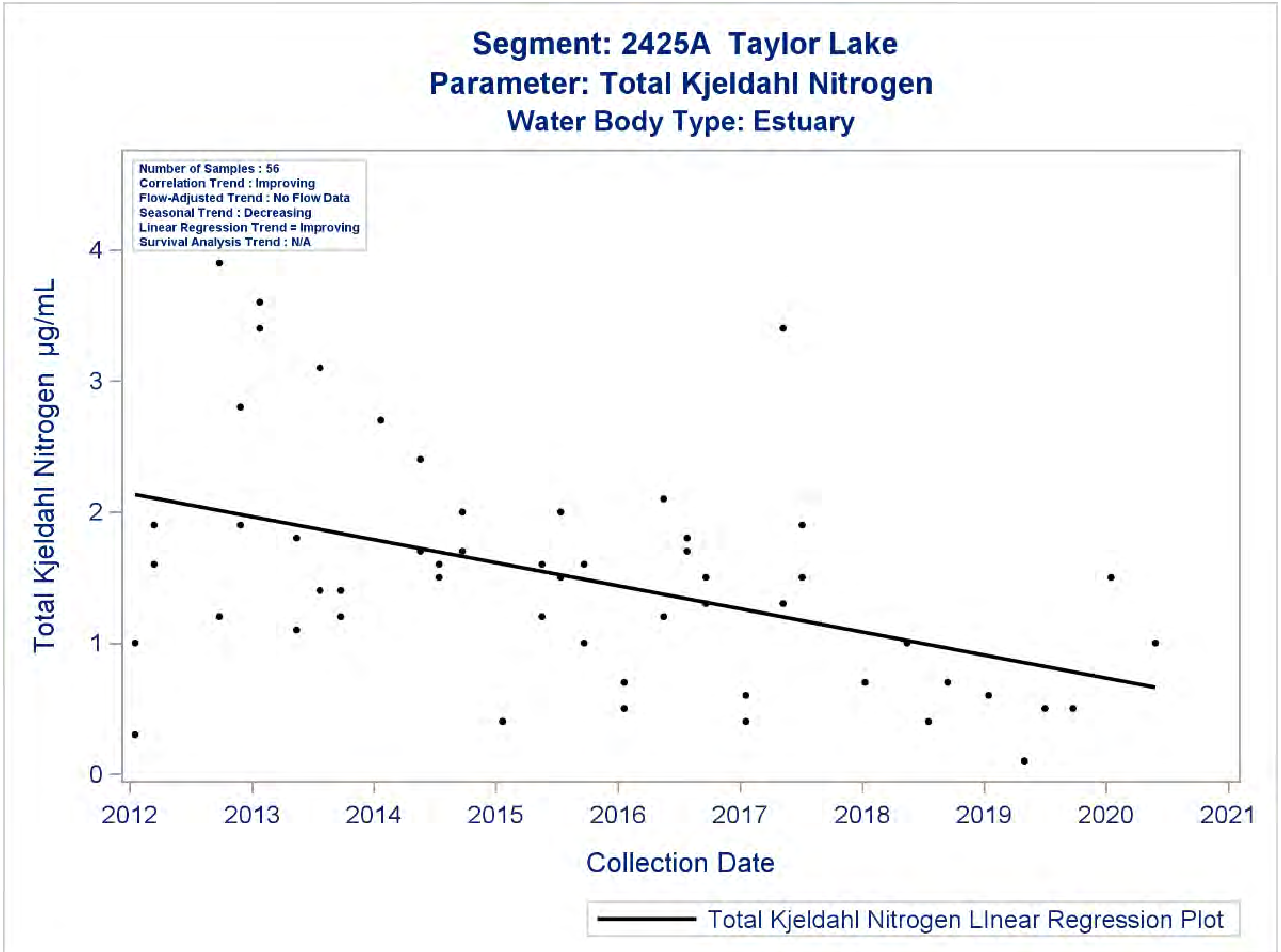
Segment: 2425 Clear Lake
Parameter: Secchi Transparency
Water Body Type: Estuary
Number of Samples : 287
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Secchi Transparency meters
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency Linear Regression Plot

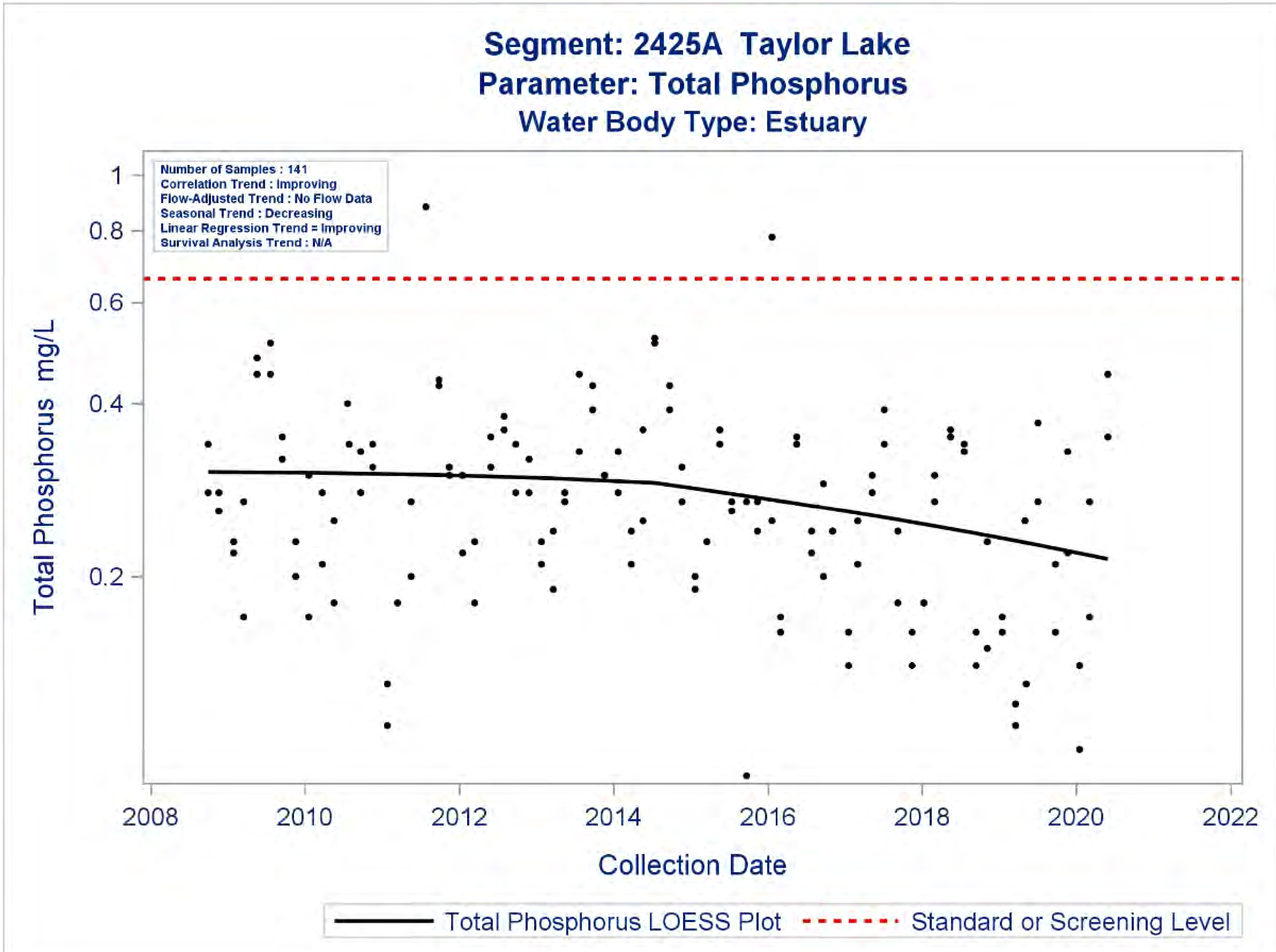

Segment: 2425 Clear Lake
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 271
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
0.0
0.2
0.4
0.6
0.8
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level



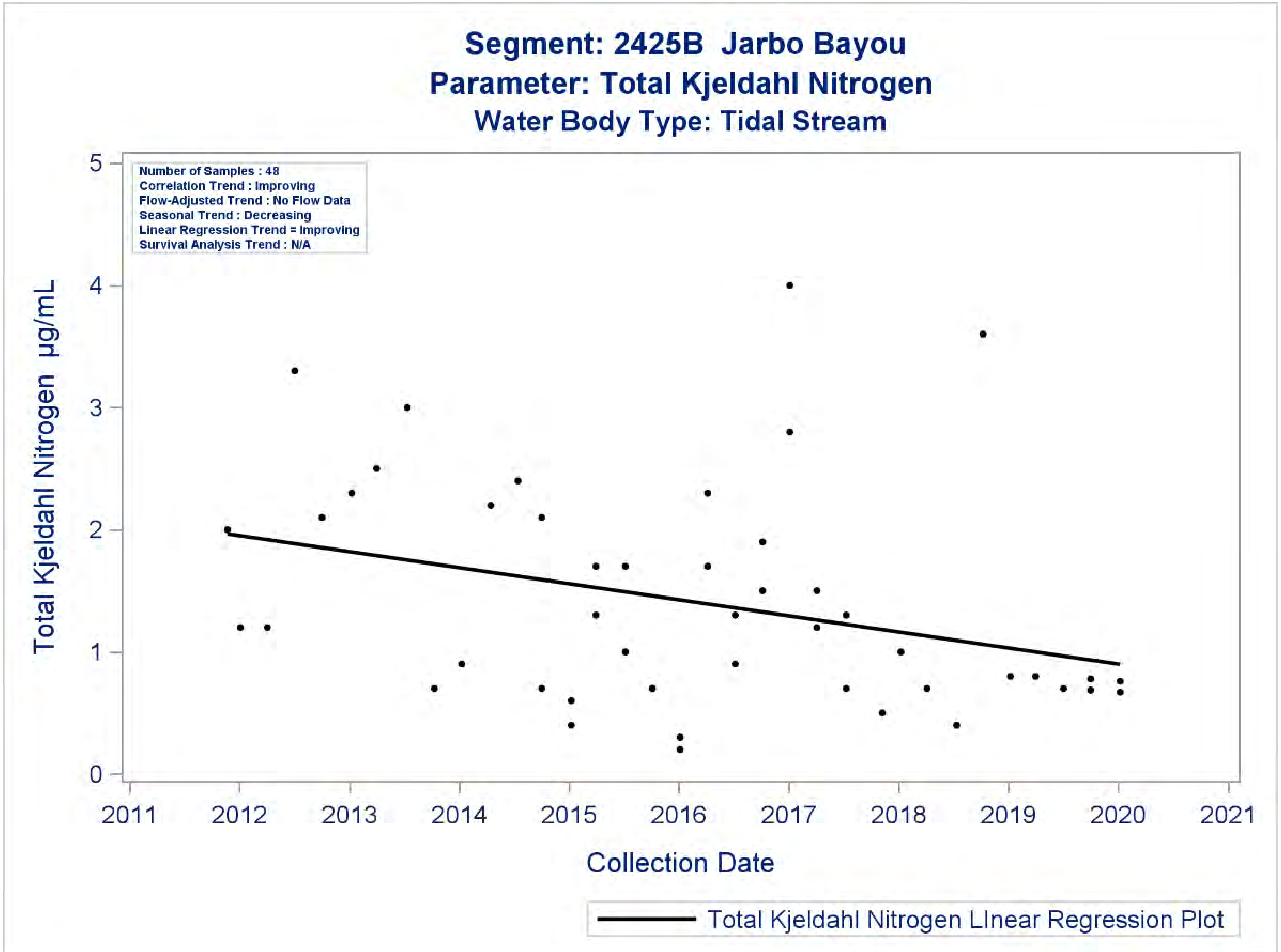
Segment: 2425A Taylor Lake
Parameter: Chlorophyll a
Water Body Type: Estuary
Number of Samples : 37
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Chlorophyll a µg/mL
80
60
40
20
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level


Segment: 2425A Taylor Lake
Parameter: Dissolved Oxygen
Water Body Type: Estuary
Number of Samples : 142
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
20
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen Linear Regression Plot
Standard or Screening Level

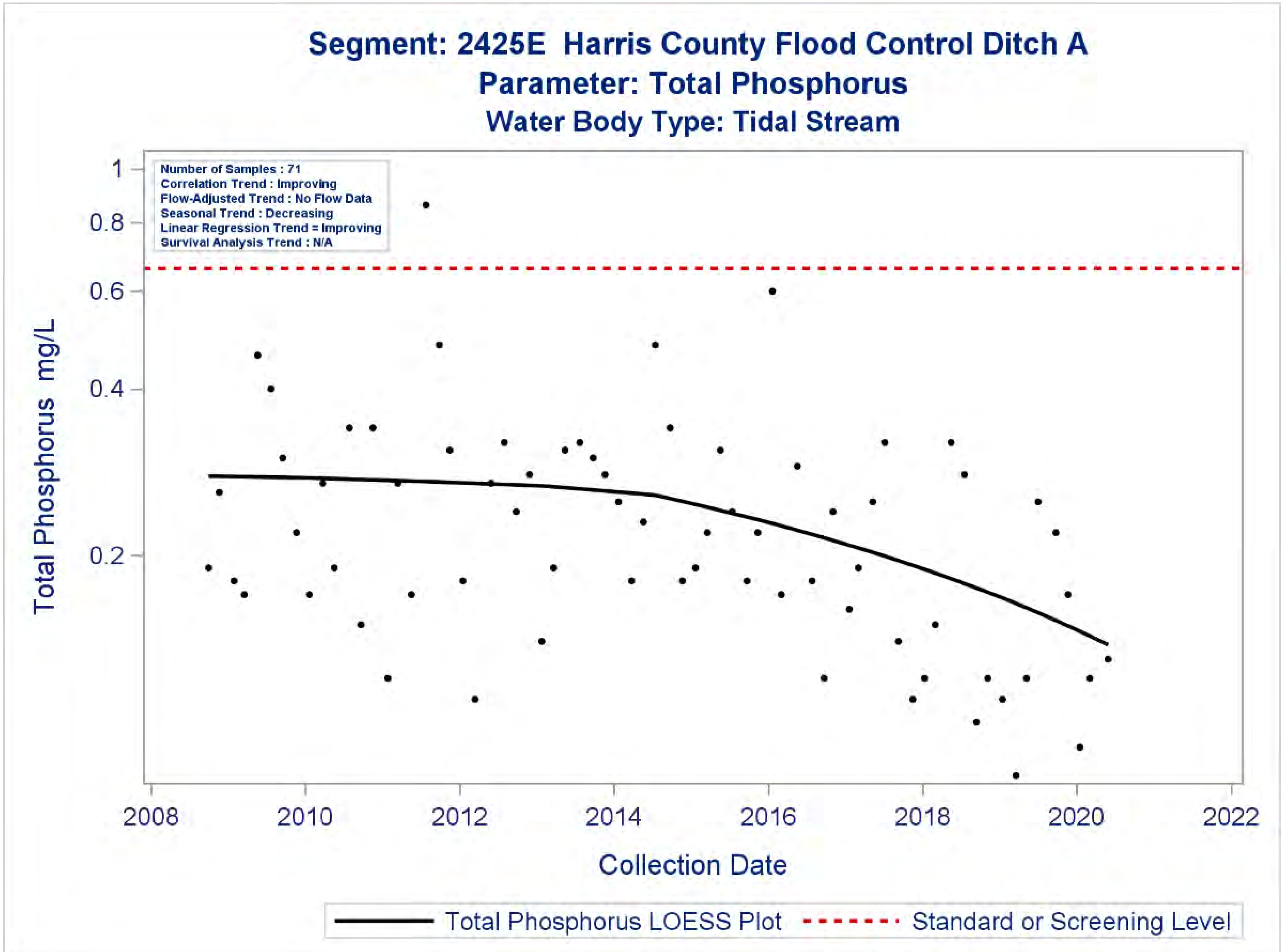

Segment: 2425A Taylor Lake
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 56
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 2425A Taylor Lake
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 141
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1
0.8
0.6
0.4
0.2
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



Segment: 2425B Jarbo Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 48
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 2425E Harris County Flood Control Ditch A
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 71
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1
0.8
0.6
0.4
0.2
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	2425B_01 I 2425B_02 C	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Animal waste from agricultural production, hobby farms, and riding stables • Improper or no pet waste disposal • Developments with malfunctioning OSSFs • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • More public education on pet waste disposal • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Elevated Nutrient Concentrations	***Nitrate*** 2425_01 C 2425A_01 C ***Phosphorus*** 2425_01 C 2425A_01 C 2425A_02 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties

					• Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Elevated Chlorophyll -*a* Concentrations	2425 2425A_01	C C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Chronic Toxic Substances in Water (Copper)	2425	I	• Discharges from domestic, agricultural, or industrial sources • Build-up in pipelines, pressure tanks, water heaters, and water softeners from industrial point sources • Dissolution from natural deposits • Particle deposition and re-suspension processes from dredging or tidal movements	• Copper is a toxic heavy metal • Copper causes many health hazards and harmful biochemical effects on living beings	• Increase monitoring and enforcement efforts to identify and control industrial point sources • Encourage additional testing to locate all unknown sources/deposits
Dioxin/PCBs in Fish Tissue	2425 2425A 2425B	I I I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

Clear Lake was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

Jarbo Bayou is included in the Bacteria Implementation Group project area.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2427	Name: San Jacinto Bay

Area:	2 square miles	Miles of Shoreline:	4.9 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	2	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	39

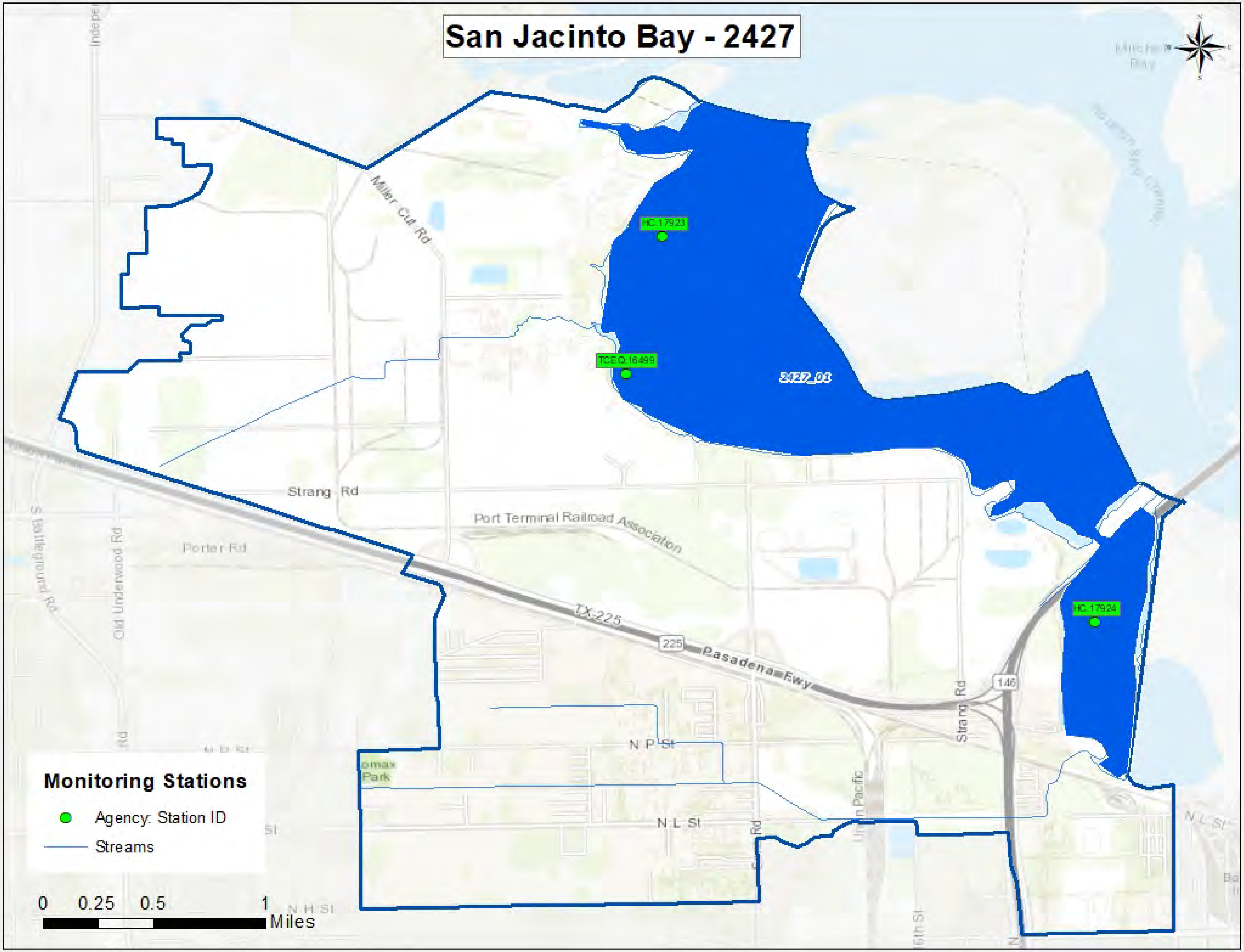
DESCRIPTION

- Segment 2427: **San Jacinto Bay** (classified water body) – A side bay located on the west side of the Houston Ship Channel/tidal San Jacinto River near Highway 146 bridge to the City of Baytown

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
17923	2427	UPPER SAN JACINTO BAY UNDERNEATH ELECTRICAL TRANSMISSION LINES 2.1 KM E/NE OF INTERSECTION OF MILLER CUTOFF RD AND OLD CLARK RD	HC	Bimonthly	Field, Conventional, Bacteria
17924	2427	LOWER SAN JACINTO BAY MID CHANNEL SOUTH OF SH 146 1 KM NE OF INTERSECTION OF SH 225 AND STRANG ROAD IN LAPORTE	HC	Bimonthly	Field, Conventional, Bacteria

HC = Harris County Pollution Control

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.

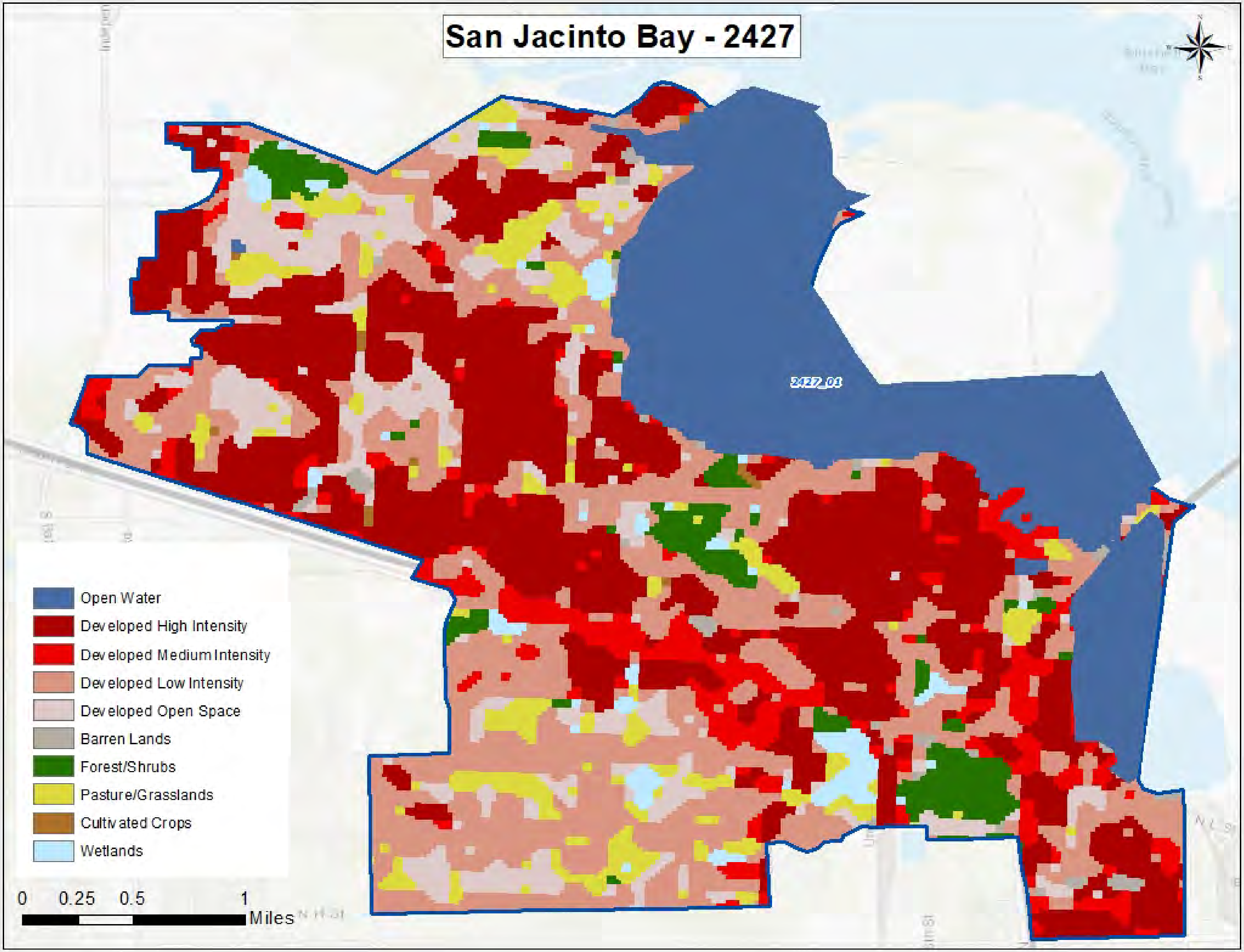

San Jacinto Bay - 2427
HC.17923
TCEQ.16499
2427_01
HC.17924
Miller Cut Rd
Strang Rd
Port Terminal Railroad Association
Porter Rd
S Battleground Rd
Old Underwood Rd
TX-225
225
Pasadena Fwy
146
Strang Rd
N P St
N L St
Union Pacific
Lomax Park
Monitoring Stations
Agency: Station ID
Streams
0
0.25
0.5
1
Miles

Segment 2427 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: This watershed is predominantly developed (67.99 percent of the watershed area) with mixed residential, commercial, and industrial land uses. The cities of La Porte and Morgan Point make up the majority of development in the area, but small plots of undeveloped and agricultural lands are scattered throughout. Additionally, the Houston Ship Channel supports heavy boat and barge traffic on a consistent basis throughout the year. The amount of Barren Lands in the watershed increased from 1.11 acres in 2008 to 110.31 acres in 2018. Although the amount of Barren Land cover is still a small percentage of the watershed area (1.68 percent), there was an increase of 9,837 percent over the 10-year period.

Segment 2427 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	431.00	6.55	469.92	7.14	9.03
Barren Lands	1.11	0.02	110.31	1.68	9,837.84
Developed	4,572.45	69.45	4,473.93	67.99	-2.15
Forest/Shrubs	59.82	0.91	235.96	3.59	294.42
Open Water	1,184.70	17.99	1,128.88	17.15	-4.71
Wetlands	335.15	5.09	161.68	2.46	-51.76
TOTAL	**6,584.24**	**100.00**	**6,580.68**	**100.00**	


San Jacinto Bay - 2427
2427_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.25 0.5 1
Miles

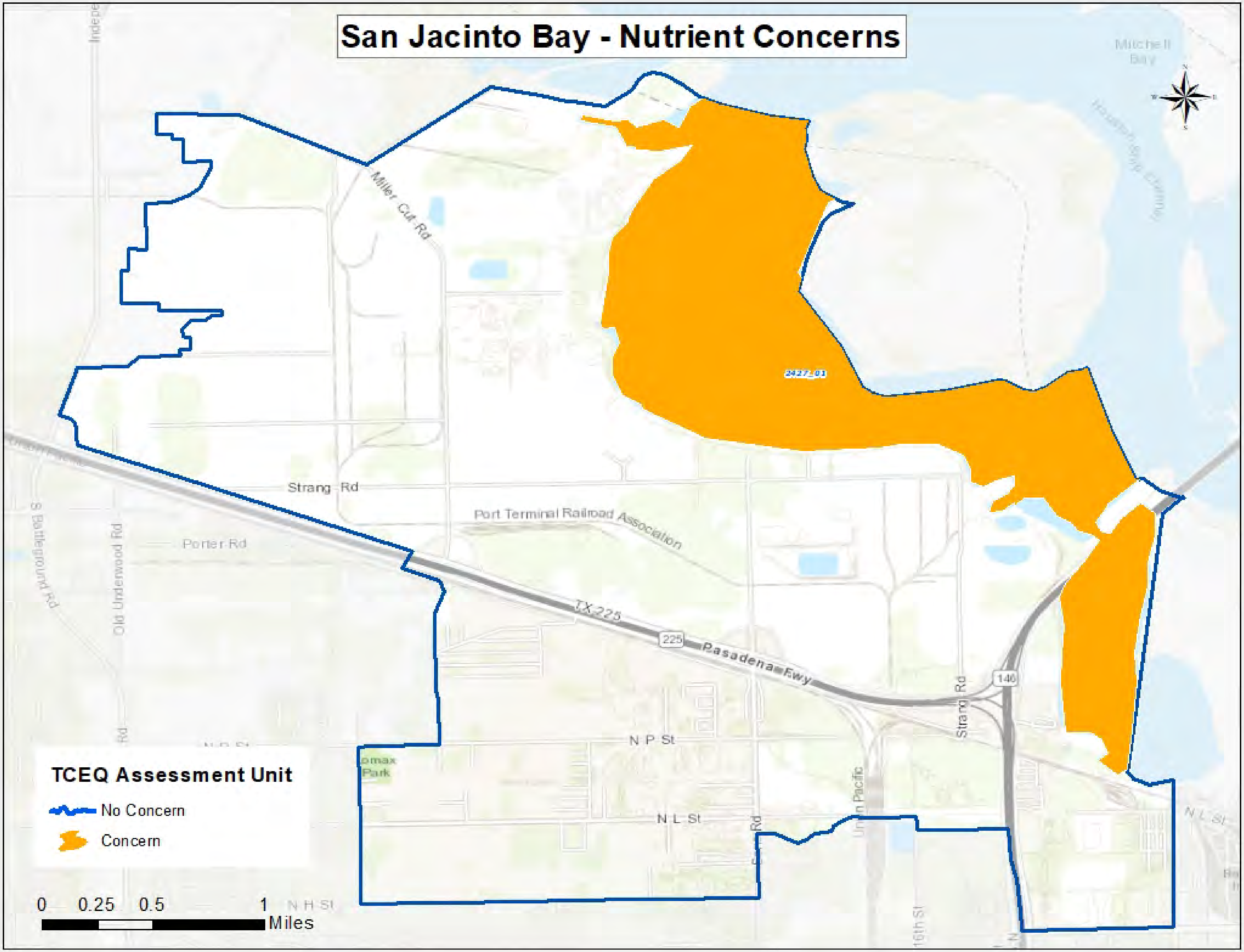
Water Quality Issues:

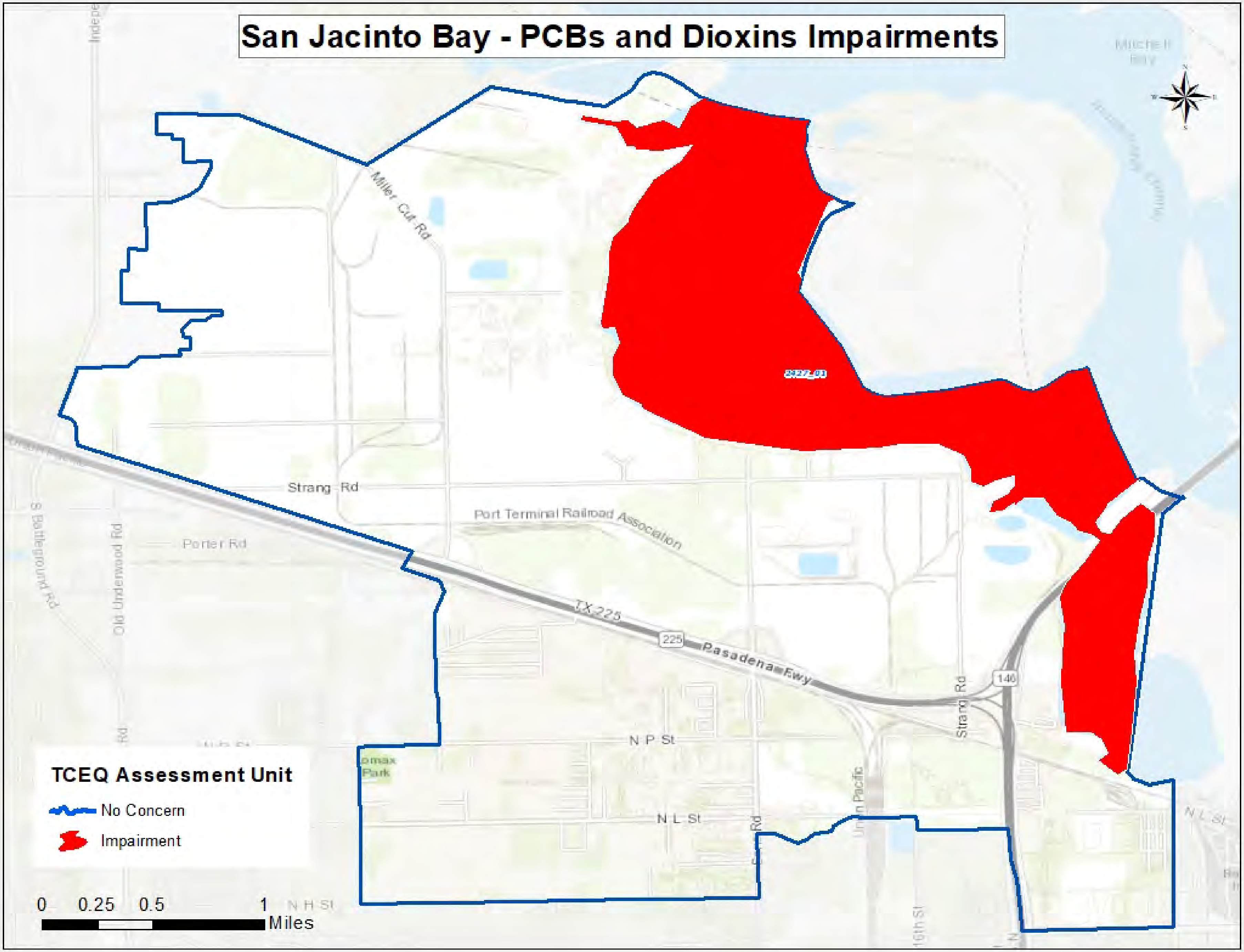
Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
San Jacinto Bay is listed in the 2020 Integrated Report for concerns for water quality based upon screening level criteria for ammonia-nitrogen, nitrate-nitrogen, and total phosphorus. For samples assessed from 12/01/11 – 11/30/18, 40.4 percent of ammonia-nitrogen samples, 92.2 percent of nitrate-nitrogen samples, and 95.6 percent of total phosphorus samples exceed the nutrient screening levels.

PCBs and Dioxin Impairments
San Jacinto Bay is listed as impaired for PCBs and Dioxins in all finfish and blue crab. Fish samples collected from this segment indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.


San Jacinto Bay - Nutrient Concerns
Mitchell Bay
Houston Ship Channel
Miller Cut Rd
2427_01
Strang Rd
Port Terminal Railroad Association
Porter Rd
S Battleground Rd
Old Underwood Rd
TX 225
225
Pasadena Fwy
146
Strang Rd
N P St
N L St
Union Pacific
16th St
N H St
Lomax Park
TCEQ Assessment Unit
No Concern
Concern
0 0.25 0.5 1
Miles


San Jacinto Bay - PCBs and Dioxins Impairments
Miller Cut Rd
Strang Rd
Port Terminal Railroad Association
Porter Rd
S Battleground Rd
Old Underwood Rd
TX 225
225
Pasadena Fwy
146
Strang Rd
N P St
N L St
Union Pacific
16th St
2427_01
TCEQ Assessment Unit
No Concern
Impairment
0
0.25
0.5
1
Miles

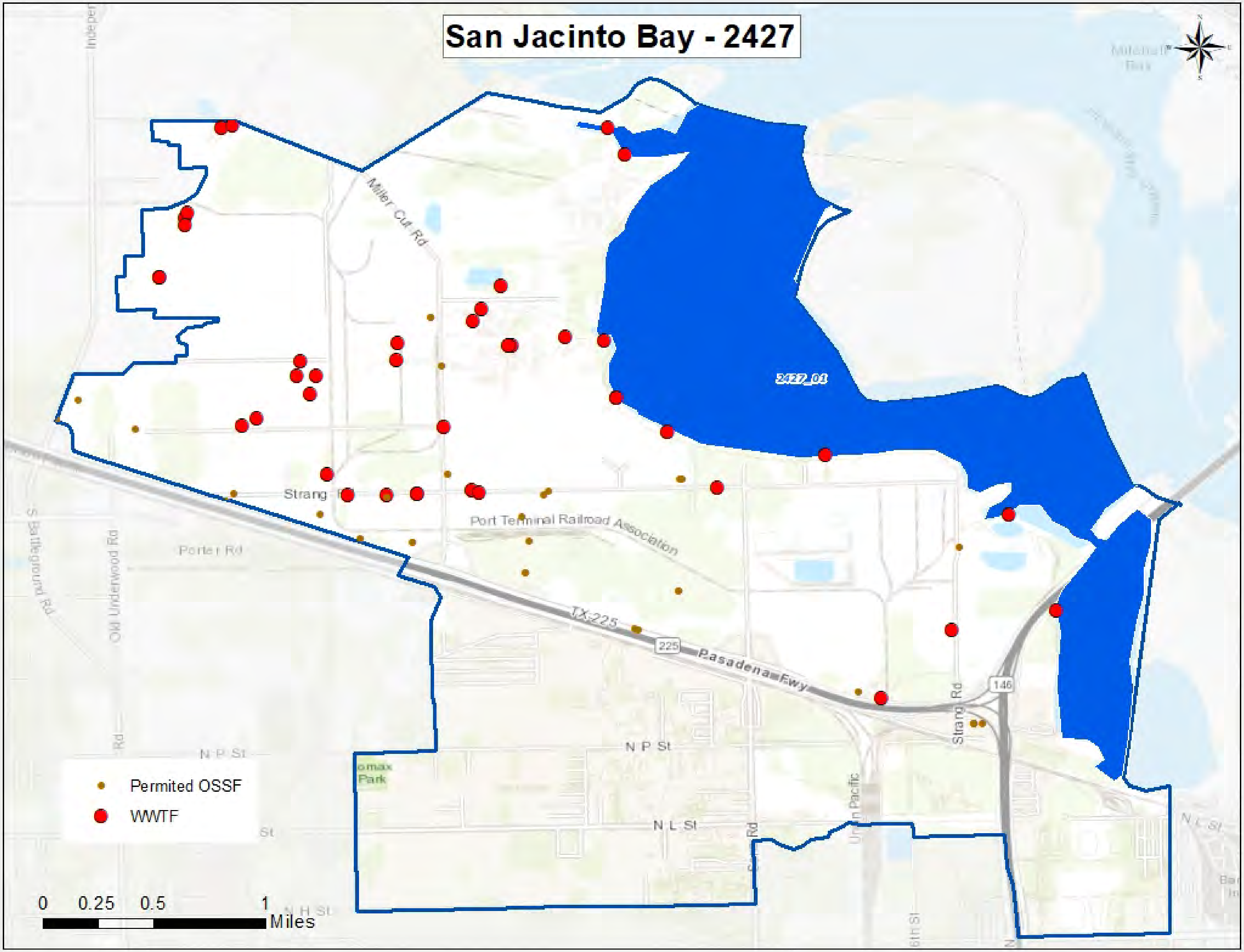
Potential Sources of Water Quality Issues: Potential sources of nutrients in the San Jacinto Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste. Bacteria is not an issue in this watershed at this time.

There are 39 permitted wastewater outfalls and 31 permitted on-site sewage facilities in the San Jacinto Bay watershed. The wastewater treatment facilities and on-site sewage facilities in the San Jacinto Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

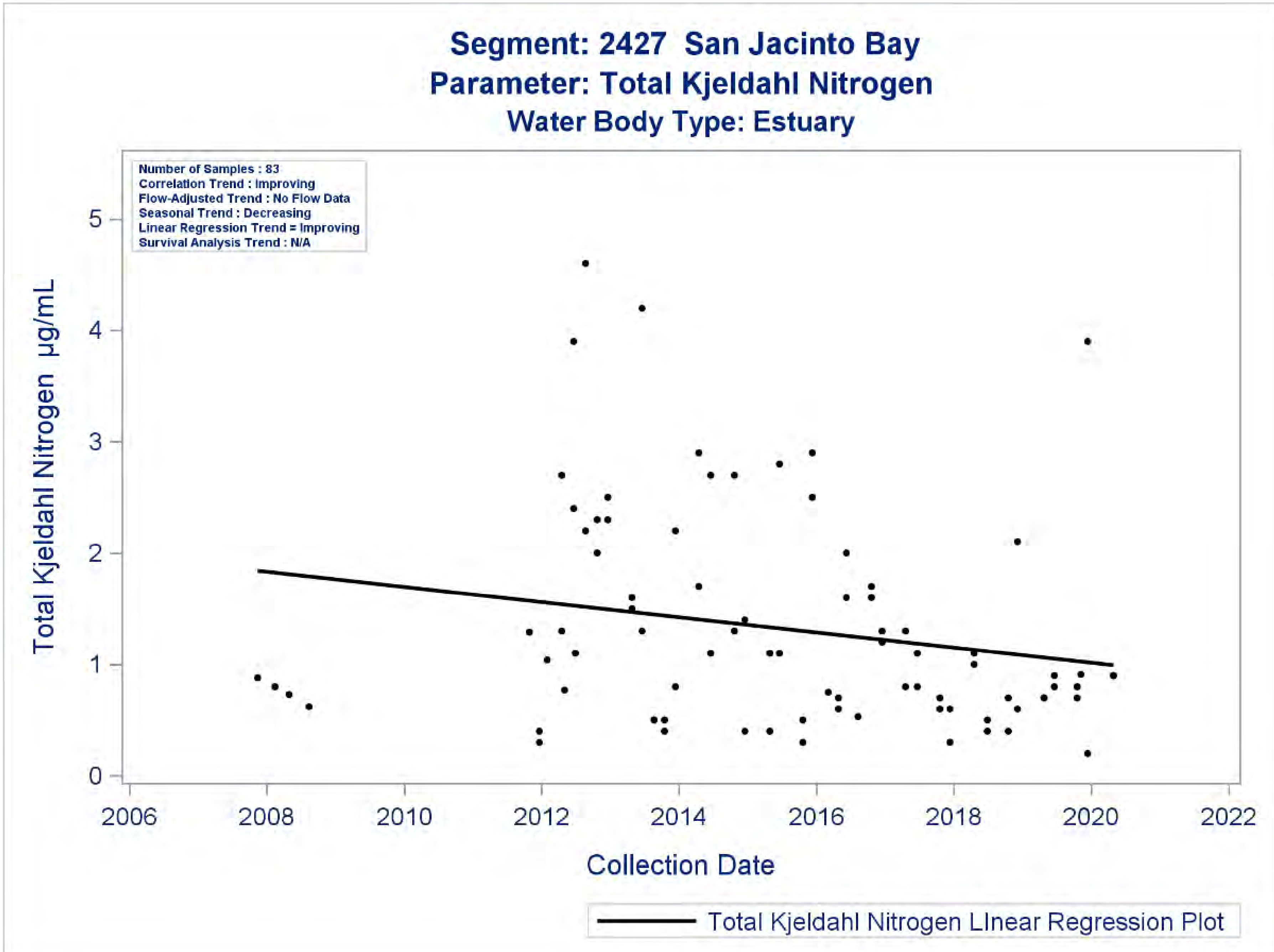
For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the San Jacinto Bay watershed.

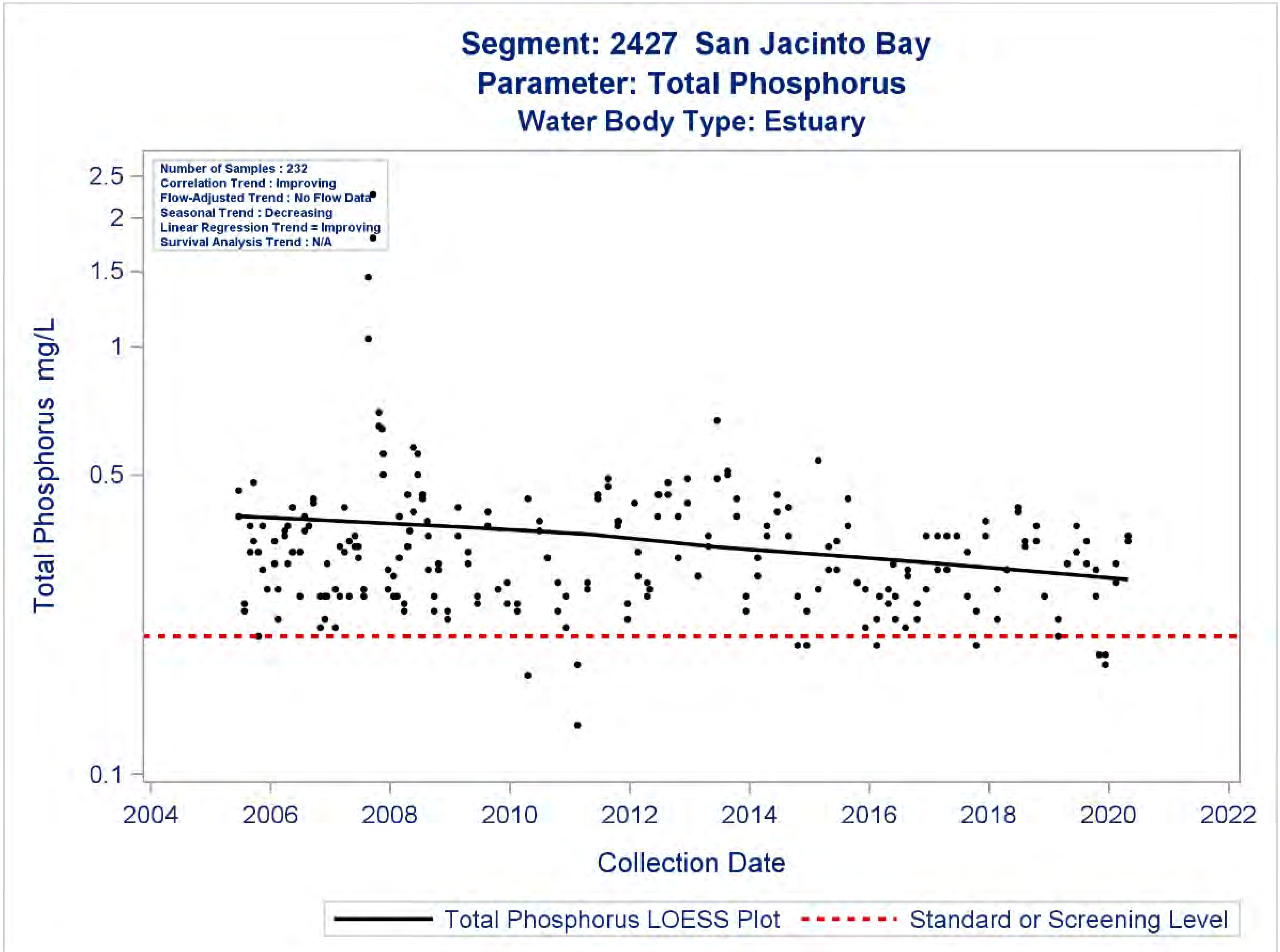


San Jacinto Bay - 2427
2427_01
Miller Cut Rd
Strang Rd
Port Terminal Railroad Association
Porter Rd
TX-225
225
Pasadena Fwy
146
N P St
N L St
Union Pacific
Old Underwood Rd
S Battleground Rd
Permited OSSF
WWTF
0 0.25 0.5 1 Miles

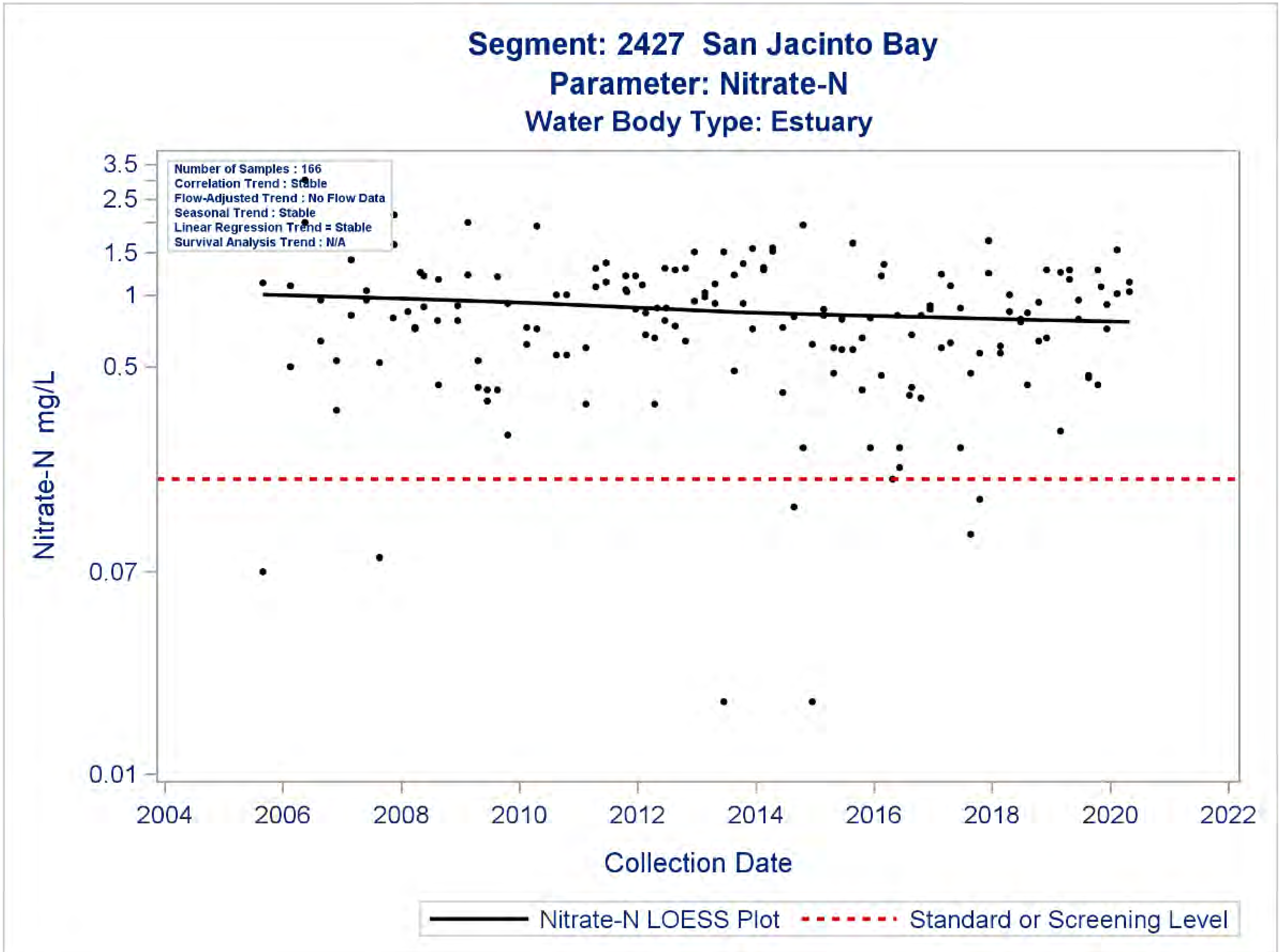
Trend Analysis:

Analysis of water quality data revealed three parameter trends for the San Jacinto Bay (2427) watershed including decreasing specific conductance, TKN, and total phosphorous concentrations over time. Specific conductance is not of concern because it is a tidal bay. TKN and total phosphorus concentrations are decreasing over time, but most of the total phosphorus samples collected over the period of record exceeded the screening criteria for that parameters. This segment is listed as having a concern for elevated nutrient concentrations. Regression analysis of nutrient data for San Jacinto Bay revealed nitrate concentrations have remained relatively stable during the period of record. However, a majority of nutrient samples collected since 2002 remain well above the set screening criteria for each parameter. The same is true for ammonia concentrations in this segment.


Segment: 2427 San Jacinto Bay
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 83
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 2427 San Jacinto Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 232
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
2.5
2
1.5
1
0.5
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


Segment: 2427 San Jacinto Bay
Parameter: Nitrate-N
Water Body Type: Estuary
Number of Samples : 166
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
3.5
2.5
1.5
1
0.5
0.07
0.01
Nitrate-N mg/L
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nutrient Concentrations	***Ammonia, Nitrate, Phosphorus*** 2427 C	• Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields, and animal operations • Nutrient loading from WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Expand use of LID and green infrastructure practices • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed
Dioxin/PCBs in Fish Tissue	2427 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue. This segment was also included in the Houston Ship Channel TMDL for Dioxin.

San Jacinto Bay was also included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2429 Name: Scott Bay

Area:	1.5 square miles	**Miles of Shoreline:**	3.5 miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	1	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	1

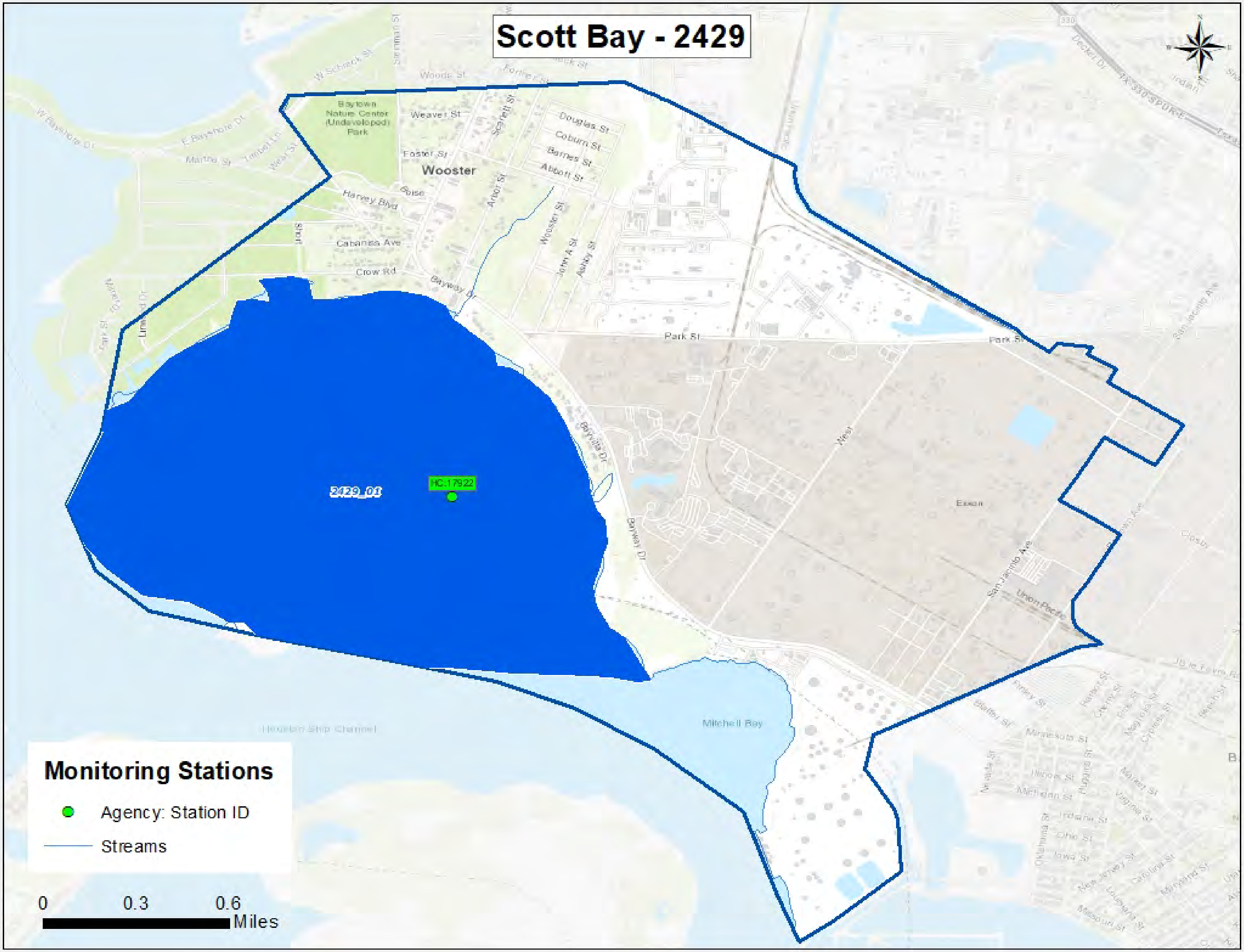
DESCRIPTION

- Segment 2429: **Scott Bay** (classified water body) – A side bay located east of the Houston Ship Channel/tidal San Jacinto River north of Highway 146 on the west side of the City of Baytown

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
17922	2429	SCOTT BAY 1.2 KM SW OF INTERSECTION OF BAYWAY DRIVE AND PARK STREET IN BAYTOWN	HC	BIMONTHLY	Field, Conventional, Bacteria

HC = Harris County Pollution Control

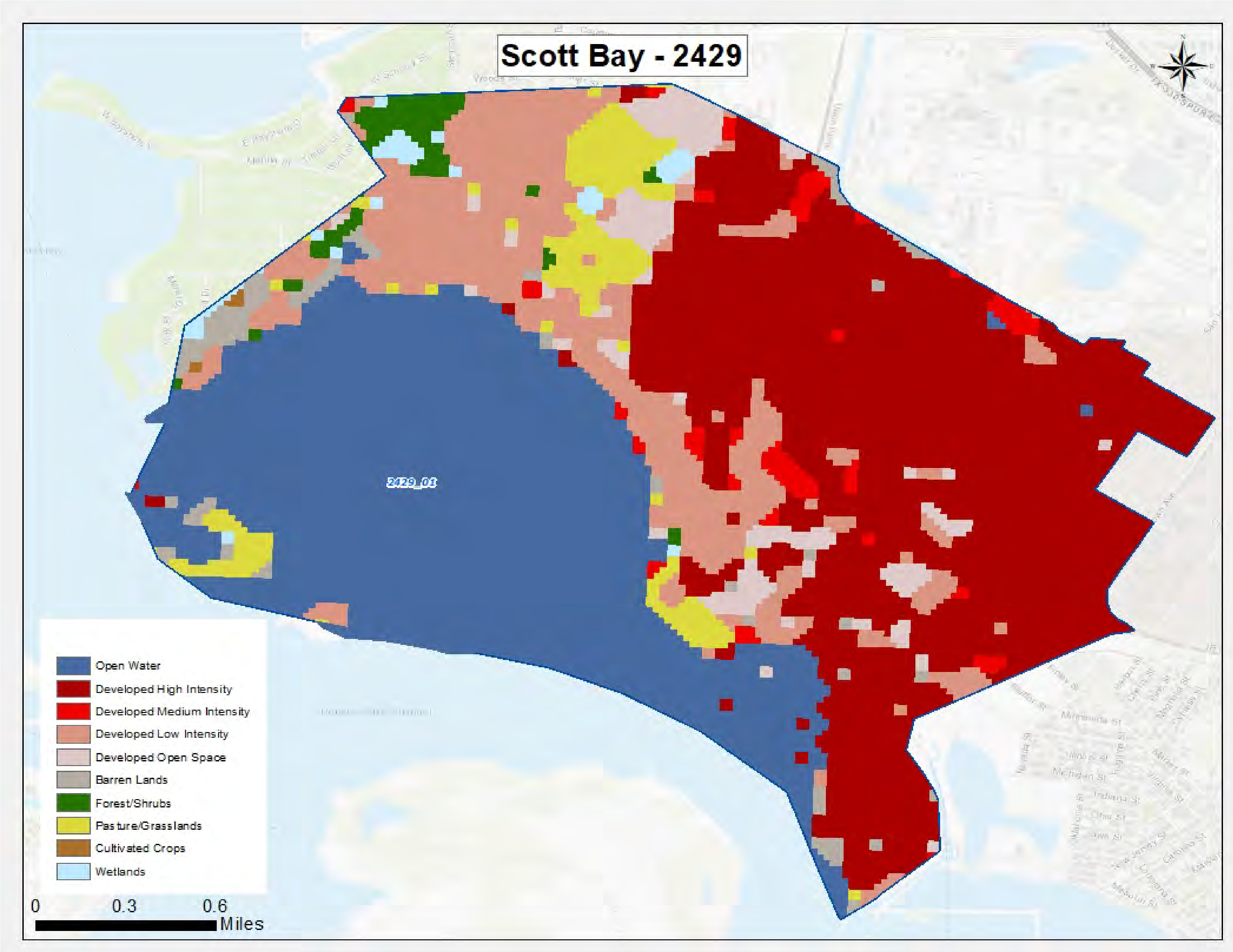

Scott Bay - 2429
2429_01
HC:17922
Monitoring Stations
Agency: Station ID
Streams
0
0.3
0.6
Miles
Wooster
Mitchell Bay
Houston Ship Channel
Baytown Nature Center (Undeveloped) Park
Exxon
Park St
Bayway Dr
Harvey Blvd
Cabaniss Ave
Crow Rd

Segment 2429 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Scott Bay watershed is south of the city of Baytown in an area that is characterized by heavy development – residential development to the north and industrial and commercial development to the east. Developed land cover Is 56.69 percent of the watershed area, with 32.78 percent of the area being Open Water. The Houston Ship Channel (HSC) supports heavy boat and barge traffic on a consistent basis.

Segment 2429 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	24.91	0.84	149.00	5.00	498.15
Barren Lands	21.35	0.72	78.51	2.63	267.71
Developed	1,788.95	60.04	1,690.87	56.69	-5.48
Forest/Shrubs	44.70	1.50	47.59	1.60	6.47
Open Water	975.43	32.74	977.65	32.78	0.23
Wetlands	124.32	4.17	38.92	1.30	-68.69
TOTAL	**2,979.65**	**100.00**	**2,982.55**	**100.00**	



Scott Bay - 2429
2429_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
0.3
0.6
Miles

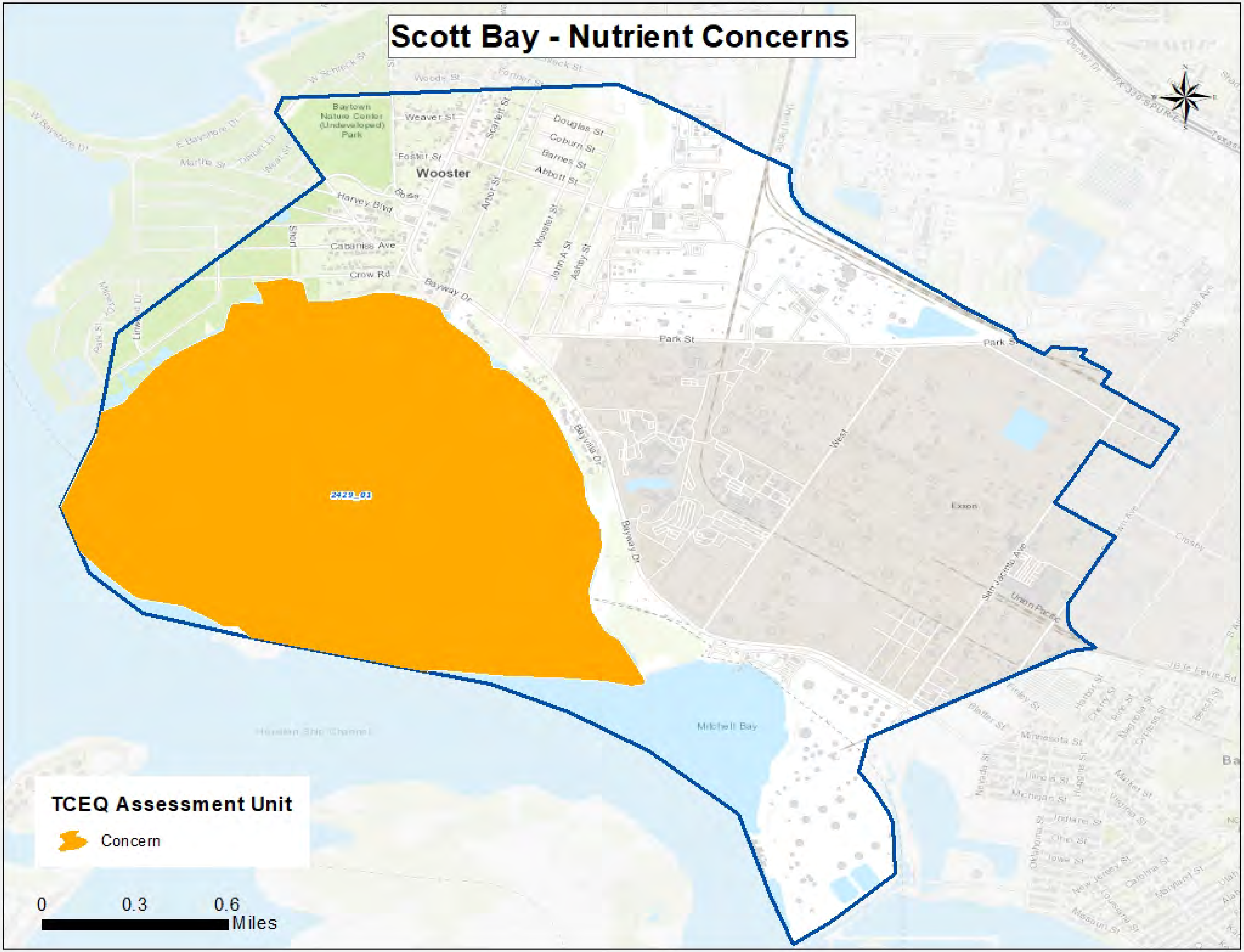
Water Quality Issues:

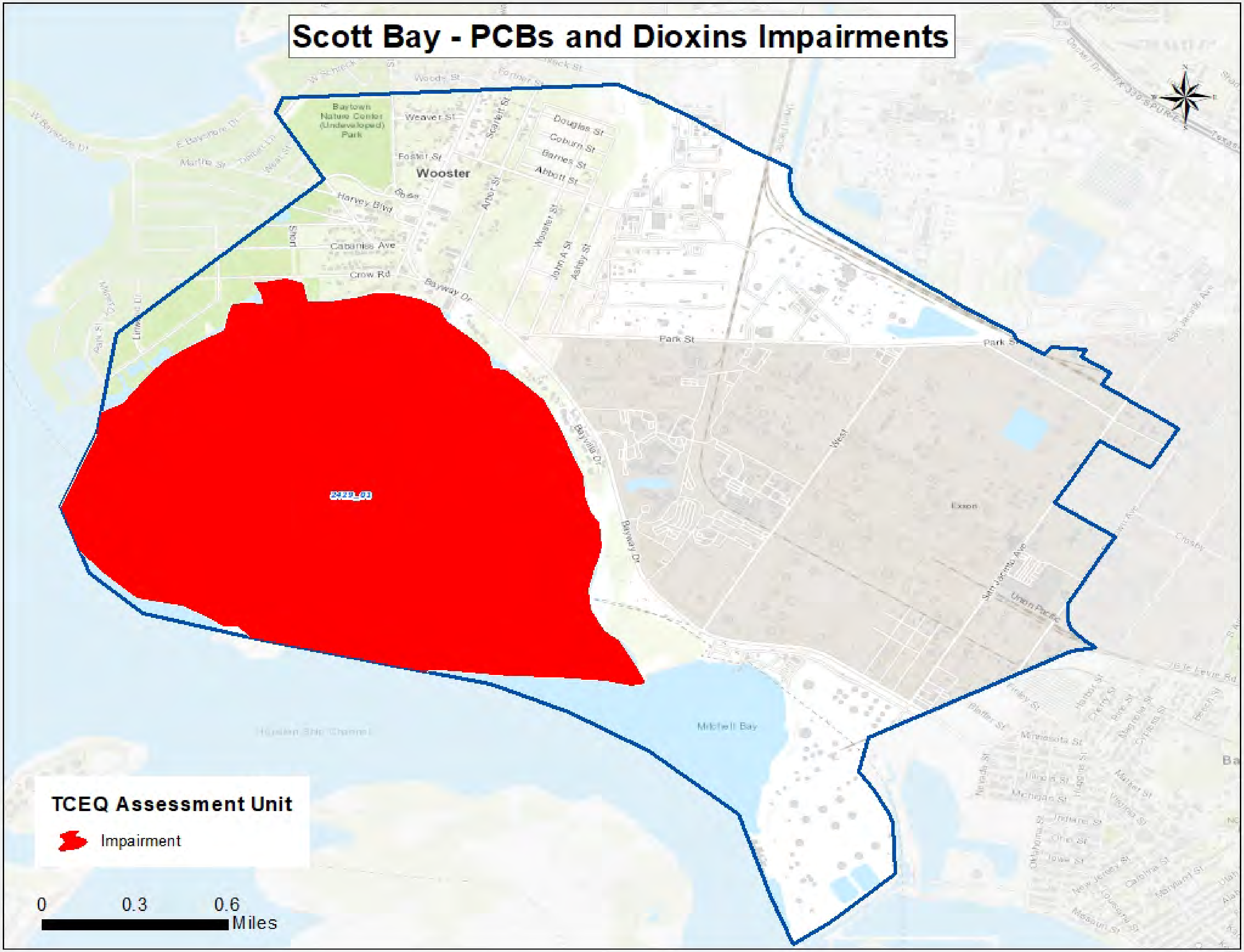
Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
Scott Bay is listed in the 2020 Integrated Report for concerns for water quality based on screening level criteria for ammonia-nitrogen, nitrate-nitrogen and total phosphorus. Based on samples collected from 12/1/11 – 11/30/18, 35.7 percent of ammonia-nitrogen, 100 percent of nitrate-nitrogen and 95.2 percent of total phosphorus samples exceeded the nutrient screening levels.

PCBs and Dioxin Impairments
Scott Bay is listed as impaired for PCBs and Dioxins in all finfish and blue crab. Fish samples collected from this segment indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.


Scott Bay - Nutrient Concerns
TCEQ Assessment Unit
Concern
2429_01
0
0.3
0.6
Miles
Wooster
Baytown Nature Center (Undeveloped) Park
Mitchell Bay
Houston Ship Channel
Exxon
Park St
Bayway Dr
Crow Rd
Cabaniss Ave
Harvey Blvd
Weaver St
Foster St
Douglas St
Coburn St
Barnes St
Abbott St
West
San Jacinto Ave
Union Pacific
Minnesota St
Michigan St
Illinois St
Indiana St
Ohio St
Iowa St



Scott Bay - PCBs and Dioxins Impairments
TCEQ Assessment Unit
Impairment
0
0.3
0.6
Miles
2429_01
Wooster
Baytown Nature Center (Undeveloped) Park
Mitchell Bay
Houston Ship Channel
Exxon
Park St
Bayway Dr
Harvey Blvd
Cabaniss Ave
Crow Rd

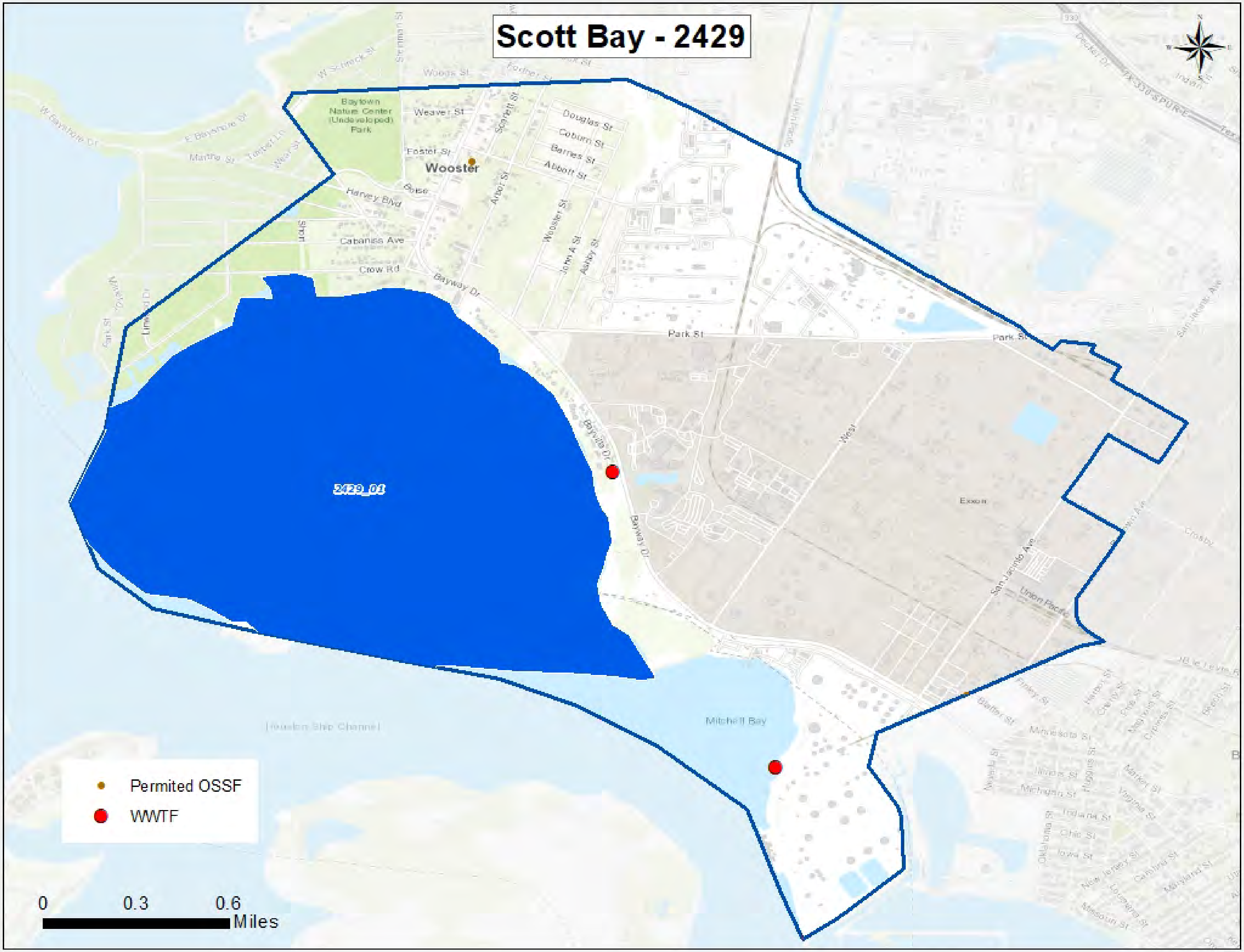
Potential Sources of Water Quality Issues: Potential sources of nutrients in the Scott Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, stormwater runoff, and animal waste.

There is 1 permitted wastewater outfall that discharges to Scott Bay, as well as 1 permitted on-site sewage facility. An additional wastewater treatment facility discharges to Mitchell Bay.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Scott Bay watershed.

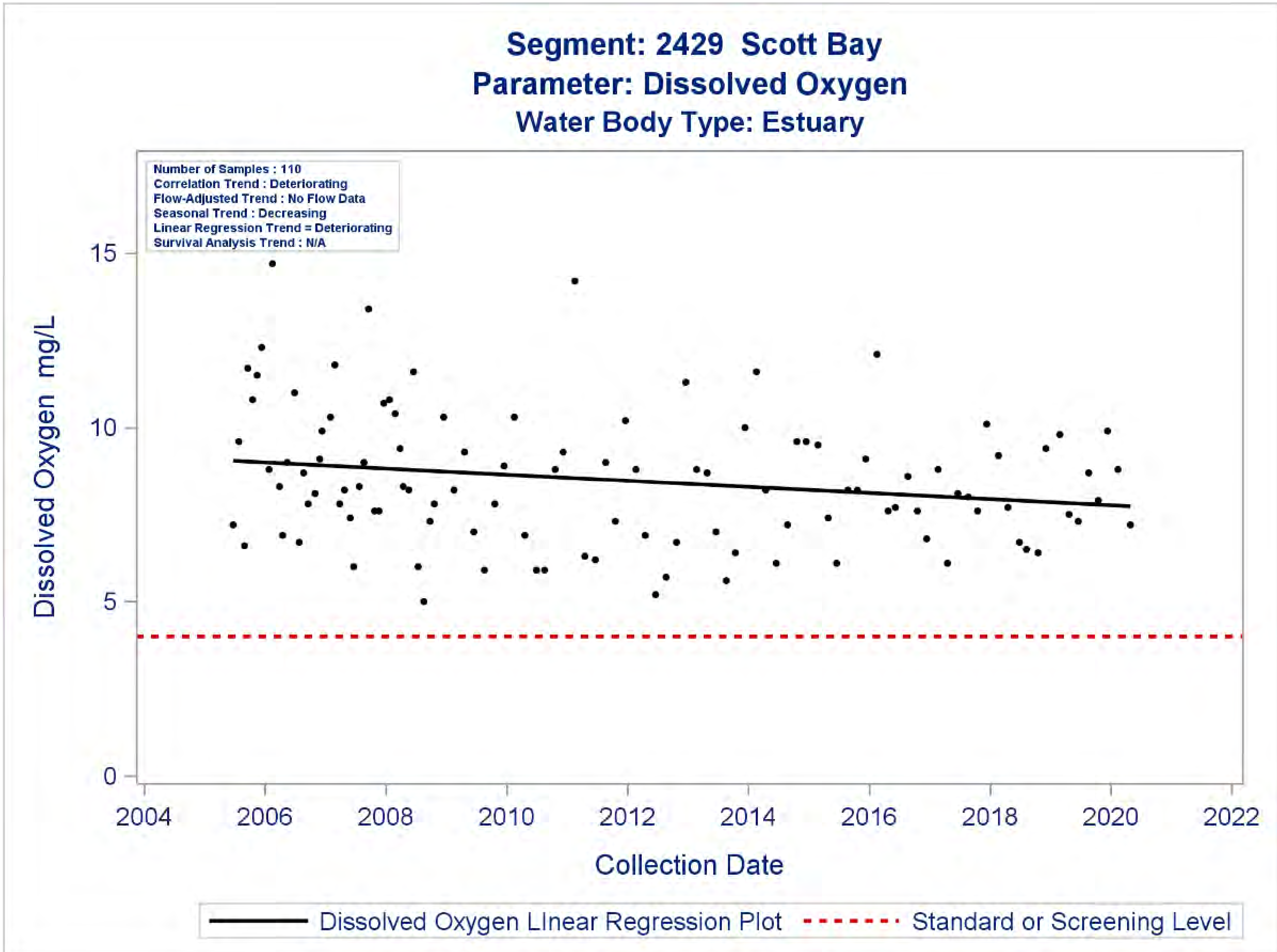


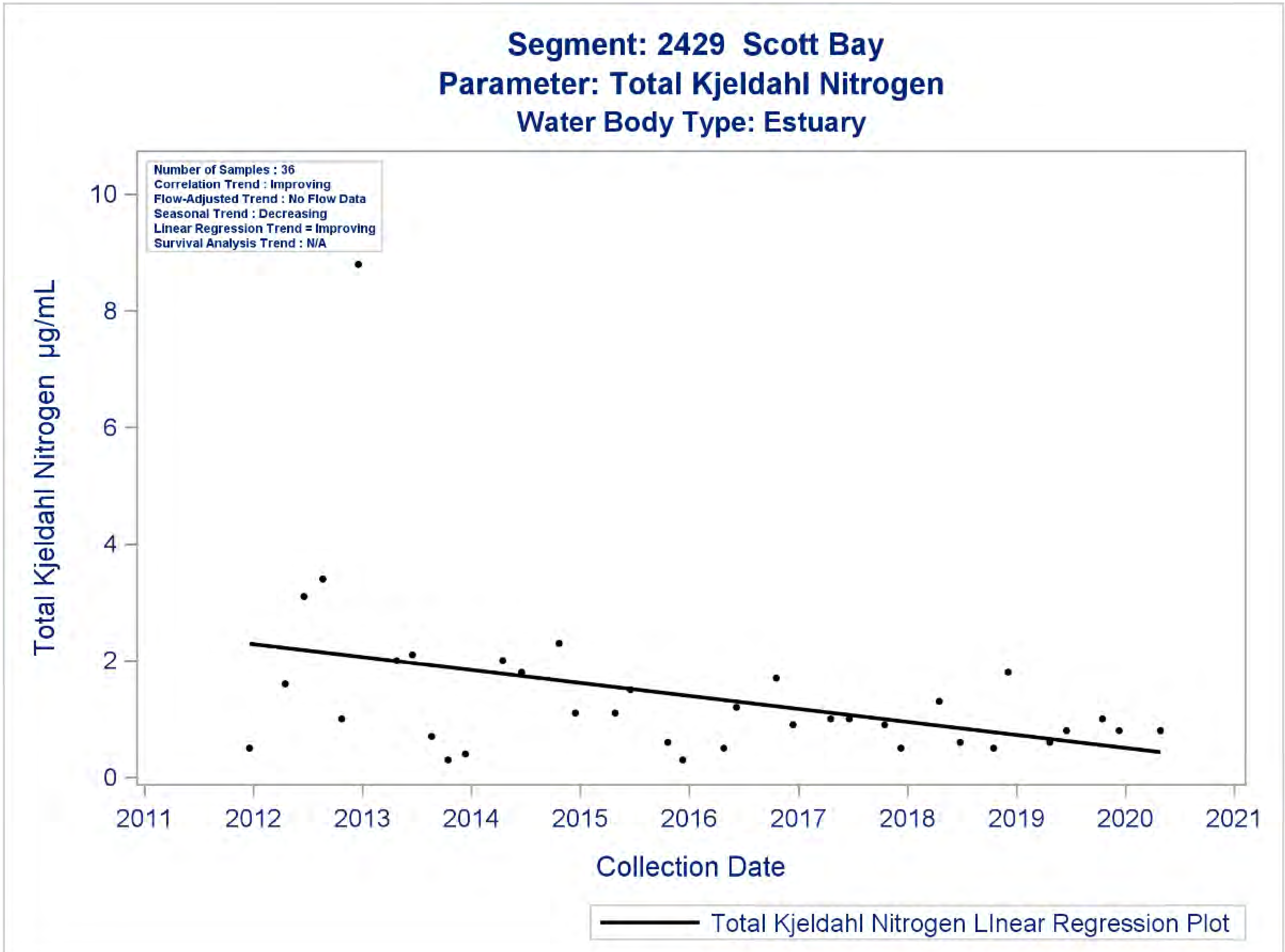
Scott Bay - 2429
2429_01
Mitchell Bay
Wooster
Baytown Nature Center (Undeveloped) Park
Park St
Bayway Dr
Exxon
Permited OSSF
WWTF
0
0.3
0.6
Miles

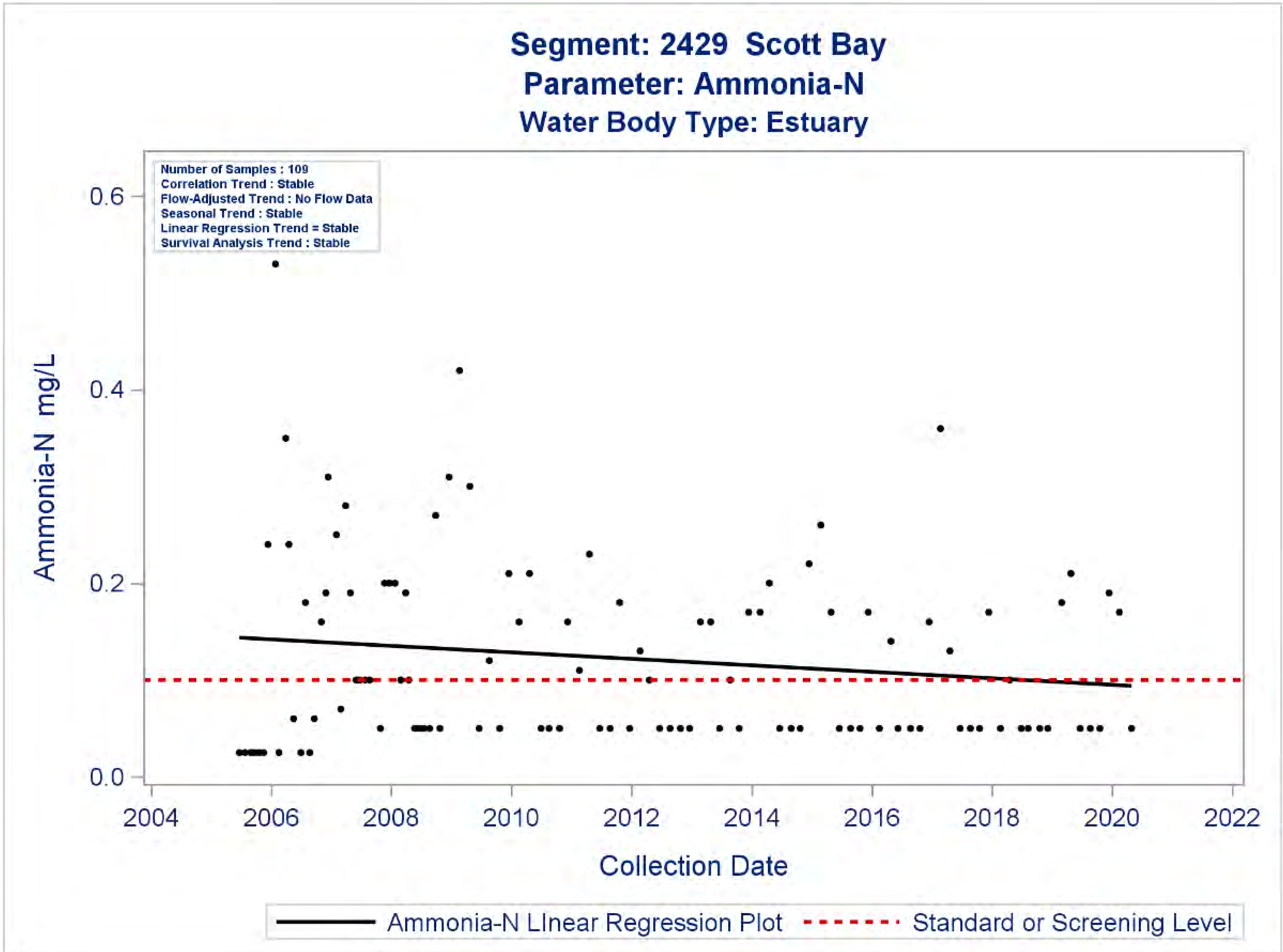
Trend Analysis:

Analysis of water quality data revealed two parameter trends for the Scott Bay (segment 2429) watershed including decreasing DO and TKN concentrations over time. There is no concern for either of these trends. All of the DO measurements were above the minimum standard. TKN has only been collected since 2012 and TCEQ has no established screening criteria for that nutrient.

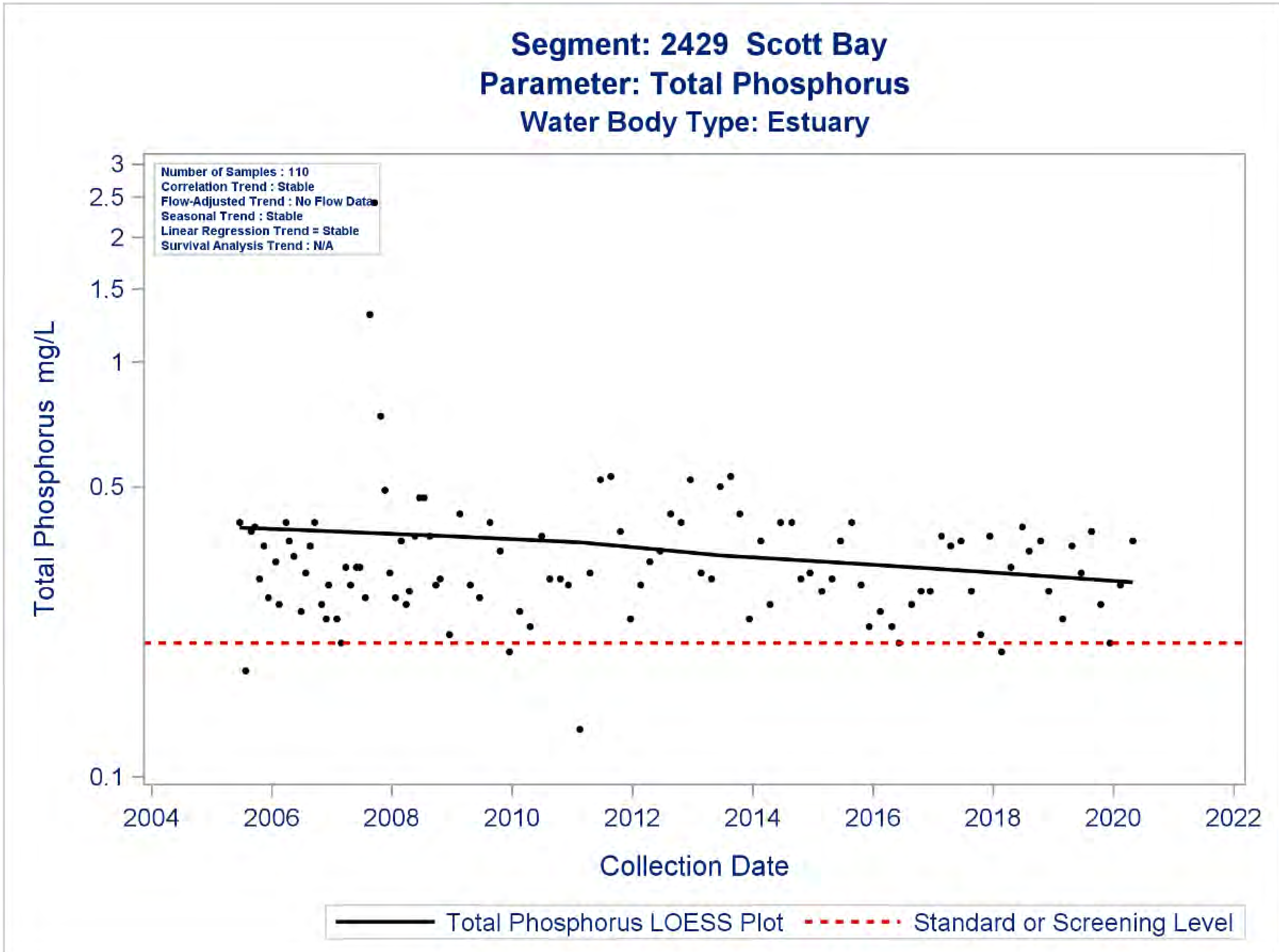
The 2020 Integrated Report lists this segment as having a concern for elevated nutrient concentrations. At this time, all nutrients except TKN have stable trends. Analysis of ammonia data revealed about half of all samples exceeded the screening criteria of 0.10 mg/L, but a downward trend may be seen in the future if samples results continue to decrease. Simultaneously, nearly all the total phosphorus samples were greater than the screening criteria of 0.21 mg/L but an improving or deteriorating trend cannot be predicted.


Segment: 2429 Scott Bay
Parameter: Dissolved Oxygen
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
0
5
10
15
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen Linear Regression Plot
Standard or Screening Level


Segment: 2429 Scott Bay
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 36
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
10
8
6
4
2
0
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 2429 Scott Bay
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 109
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Ammonia-N mg/L
0.0
0.2
0.4
0.6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level



Segment: 2429 Scott Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Phosphorus mg/L
3
2.5
2
1.5
1
0.5
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nutrient Concentrations	***Ammonia*** ***Nitrate*** ***Phosphorus*** 2429 C	• Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields, and animal operations • Nutrient loading from WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Expand use of LID and green infrastructure practices • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed
Dioxin/PCBs in Fish Tissue	2429 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2426	Name: Tabbs Bay

Area	0.36 square miles	**Miles of Shoreline:**	4.9 miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	2	**Texas Stream Team Monitoring Stations:**	1	**Permitted WWTF Outfalls:**	7

DESCRIPTION

- Segment 2426: **Tabbs Bay** (classified water body) – A side bay located east of the Houston Ship Channel/tidal San Jacinto River across from Morgan's Point and south of the City of Baytown

- Segment 2426A (Perennial Stream w/ intermediate ALU): **Goose Creek** (unclassified water body) – From the confluence of East Fork Goose Creek upstream to the confluence of an unnamed tributary from Highland Reservoir

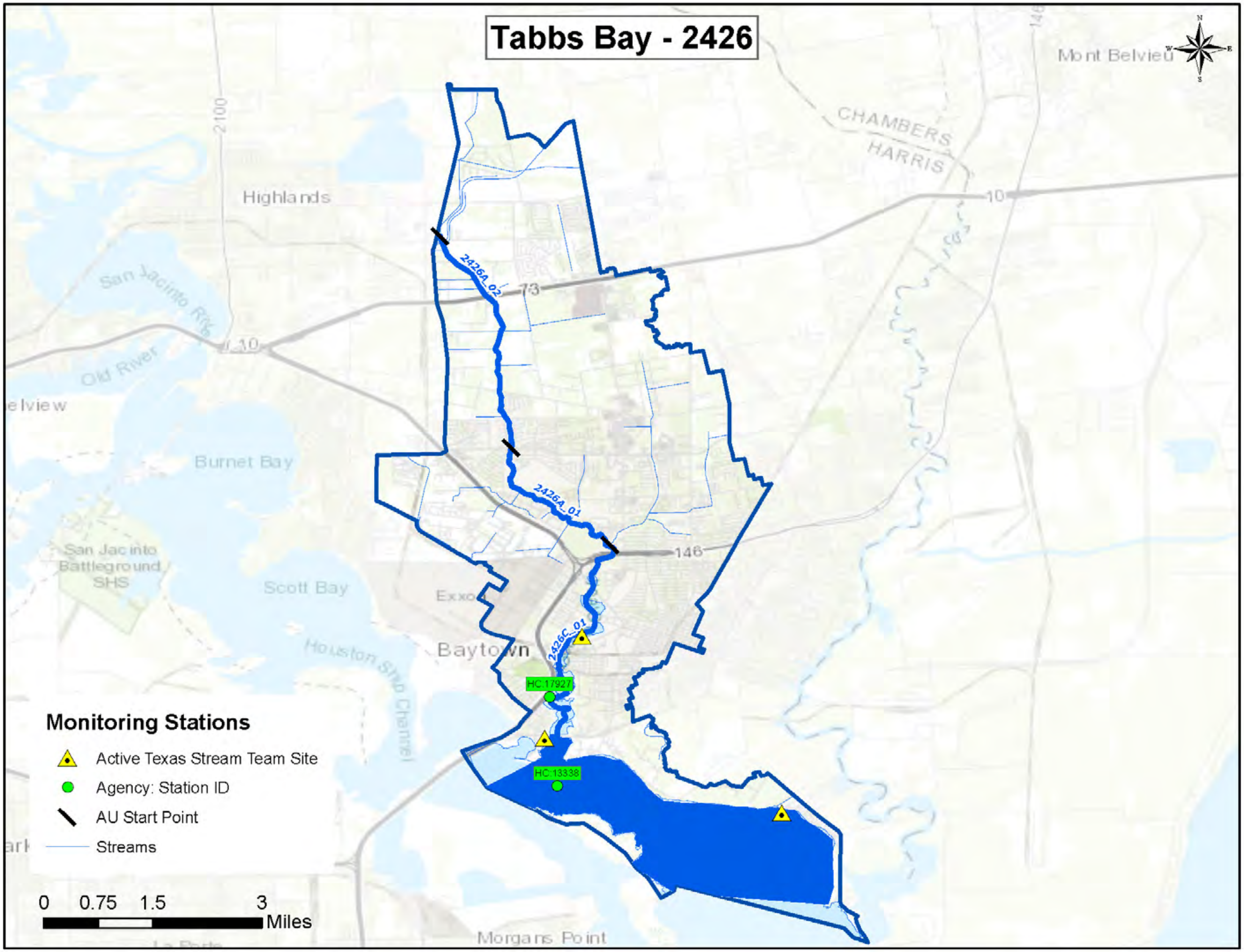
- Segment 2426B: **Goose Creek** (Unclassified water body) – Segment description retired

- Segment 2426C (Tidal Stream w/ high ALU): **Goose Creek Tidal** (unclassified water body) – From the Tabbs Bay confluence upstream to the East Fork of Goose Creek confluence

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
13338	2426	TABBS BAY MIDWAY BETWEEN GOOSE CREEK AND UPPER HOG ISLAND	HC	Bimonthly	Field, Conventional, Bacteria
17927	2426C	GOOSE CREEK NEAR SH 146 340 M SOUTH OF THE INTERSECTION OF SH 146 AND WEST MAIN IN BAYTOWN	HC	Bimonthly	Field, Conventional, Bacteria

HC = Harris County Pollution Control



Tabbs Bay - 2426
Mont Belvieu
CHAMBERS
HARRIS
Highlands
San Jacinto River
Old River
Burnet Bay
San Jacinto Battleground SHS
Scott Bay
Houston Ship Channel
Baytown
Morgans Point
2426A_02
2426A_01
2426C_01
HC:17927
HC:13338
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
Streams
0 0.75 1.5 3
Miles

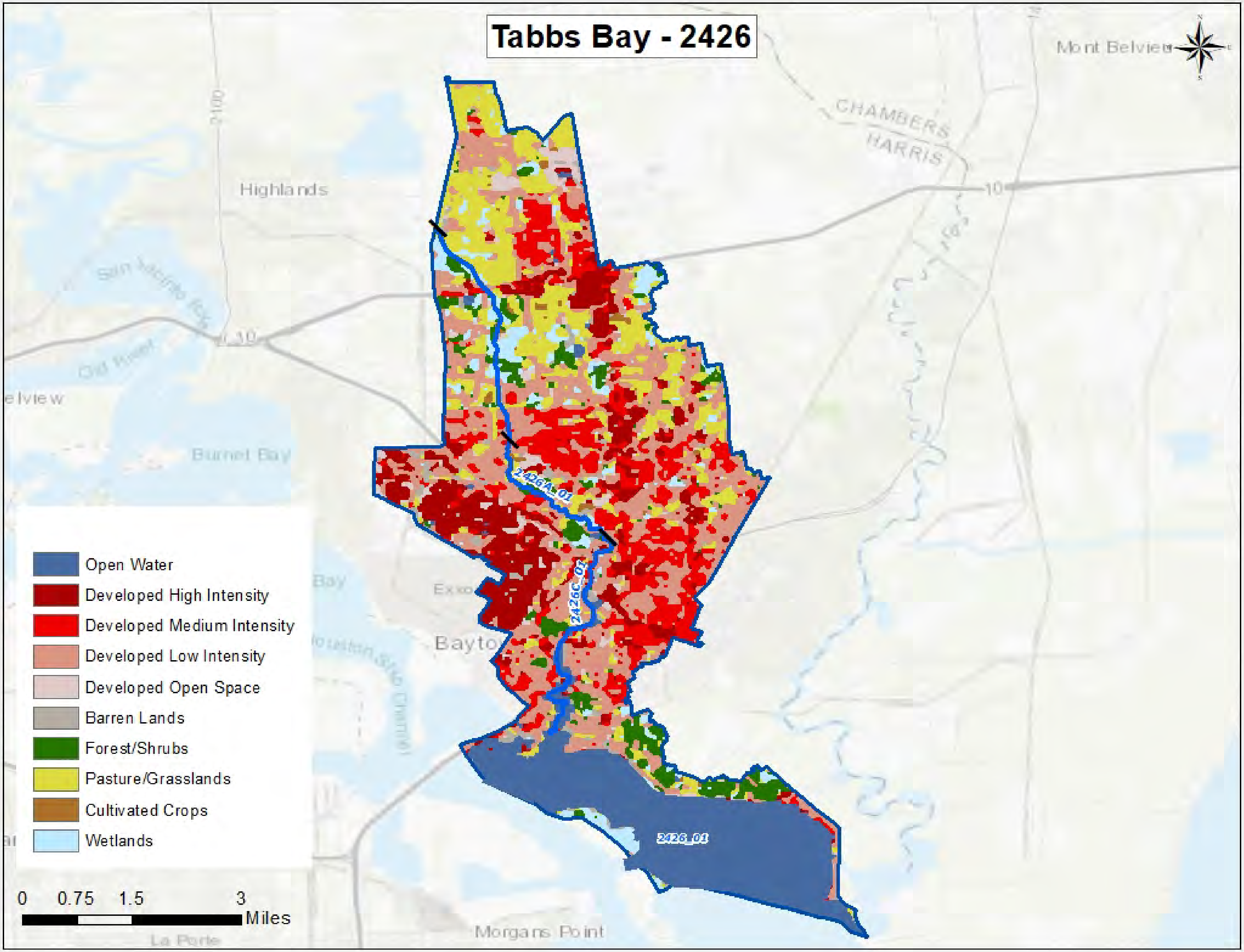
Segment 2426 Water Quality Standards and Screening Levels							
Standards	**Bays & Estuaries**	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Bays & Estuaries**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	35 / 95	35 / 95	Ammonia-N (mg/L):	0.10	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	4.0	4.0	Nitrate-N (mg/L):	0.17	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46	0.37
pH (standard units):	6.5-9.0	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66	0.69
Enterococci (MPN/100mL) (grab):	130	130	130	Chlorophyll *a* (µg/L):	11.6	21	14.1
Enterococci (MPN/100mL) (geometric mean):	35	35	35				

Segment Discussion

Watershed Characteristics and Land Cover: This watershed includes part of the City of Baytown and drains a large unclassified water body that extends north into the city. The southern part of the watershed is heavily developed with dense residential, commercial and industrial uses. The northern portion of the watershed is more undeveloped and rural with plots of agricultural lands present in the area.

The predominant land cover class is Developed land, at 53.19 percent of the watershed area. Open Water makes up 16.59 percent of the area, while Agriculture is 16.37 percent of the area.

Segment 2426 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	2,990.77	16.39	2,988.33	16.37	-0.08
Barren Lands	86.07	0.47	562.22	3.08	553.23
Developed	9,608.82	52.64	9,710.23	53.19	1.06
Forest/Shrubs	490.83	2.69	933.84	5.12	90.26
Open Water	3,058.61	16.76	3,028.14	16.59	-1.01
Wetlands	2,017.57	11.05	1,032.80	5.66	-48.81
TOTAL	**18,252.66**	**100.00**	**18,255.56**	**100.00**	


Tabbs Bay - 2426
Mont Belvieu
CHAMBERS
HARRIS
Highlands
San Jacinto River
Old River
Burnet Bay
Baytown
Morgans Point
La Porte
2426A_01
2426C_01
2426_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.75 1.5 3
Miles

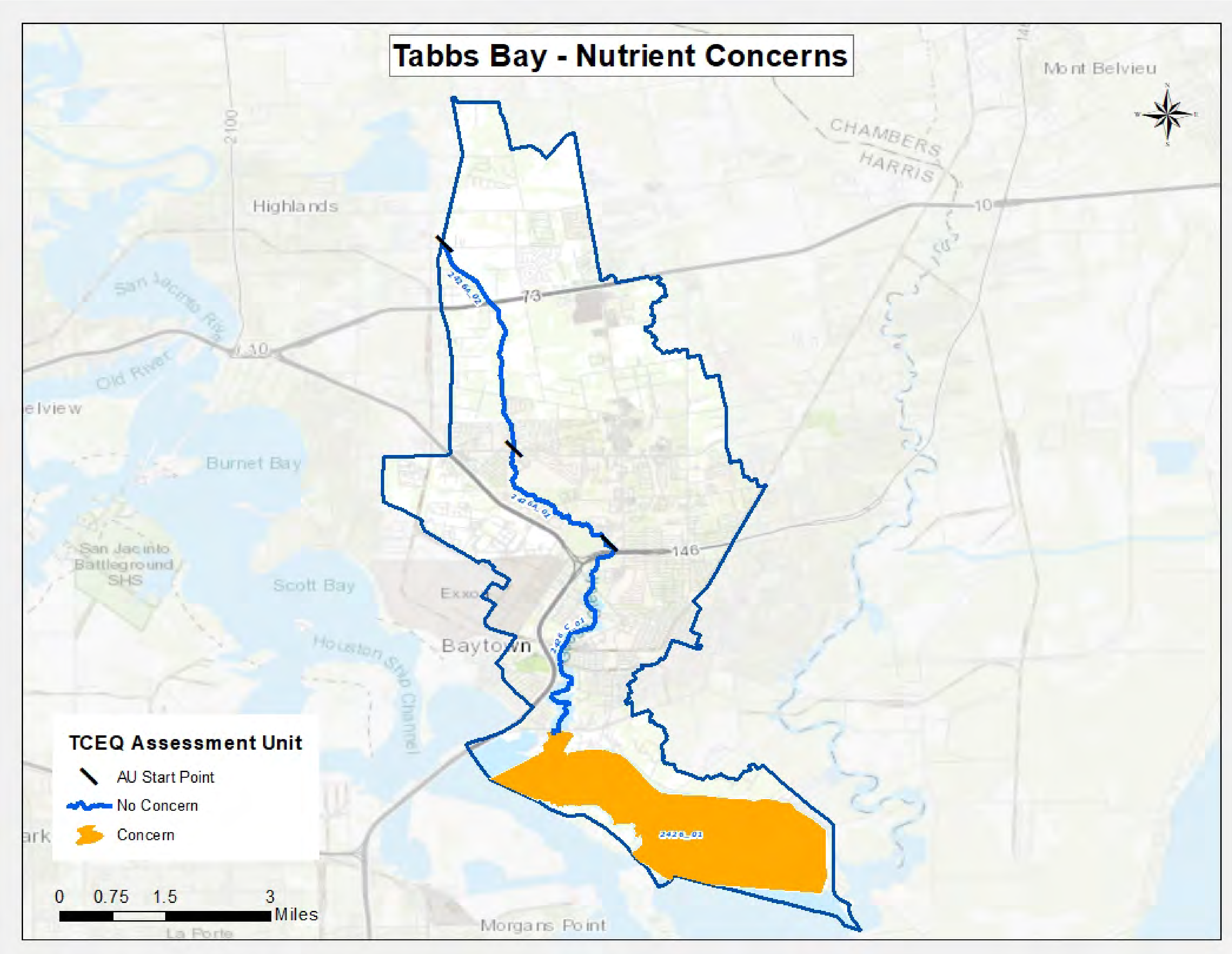
Water Quality Issues:

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

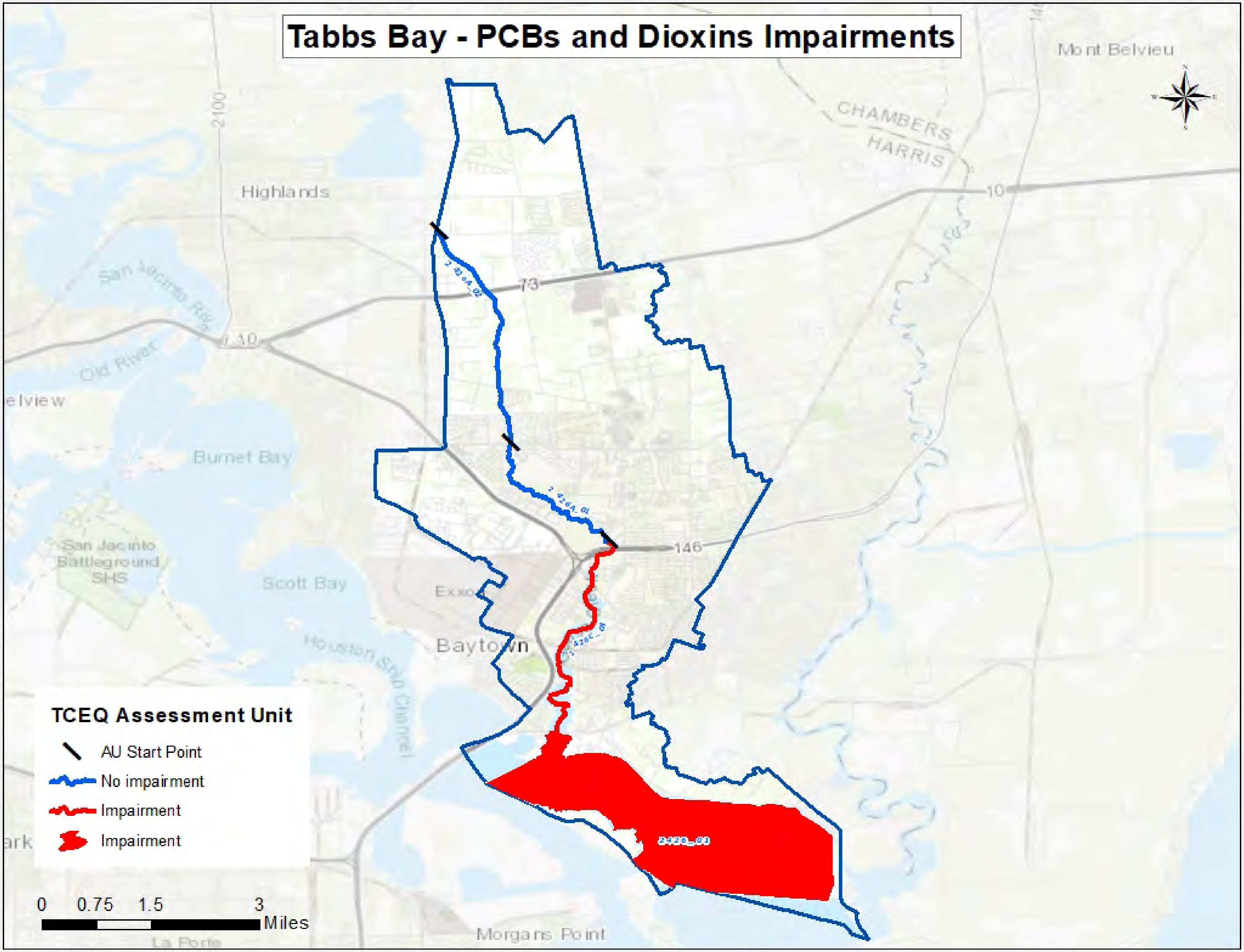
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
Tabbs Bay (2426) is listed in the 2020 Integrated Report for concerns for water quality based upon screening level criteria for ammonia-nitrogen, nitrate-nitrogen, and total phosphorus. According to the sampling data collected from between 12/01/11 – 11/30/18, 42.8 percent of ammonia samples, 78.6 percent of nitrate samples, and 71.4 percent of total phosphorus samples exceeded the nutrient screening levels.

PCBs and Dioxin Impairments
Tabbs Bay (2426) and Goose Creek Tidal (2426C) are listed as impaired for PCBs and Dioxins in all species of catfish, spotted seatrout and blue crab. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.



Tabbs Bay - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
0 0.75 1.5 3
Miles
Mont Belvieu
CHAMBERS
HARRIS
Highlands
San Jacinto River
Old River
Burnet Bay
San Jacinto Battleground SHS
Scott Bay
Houston Ship Channel
Baytown
Morgans Point
La Porte
2426_01


Tabbs Bay - PCBs and Dioxins Impairments
Mont Belvieu
CHAMBERS
HARRIS
Highlands
San Jacinto River
Old River
Burnet Bay
San Jacinto Battleground SHS
Scott Bay
Exxon
Baytown
Houston Ship Channel
Morgans Point
La Porte
73
146
10
2100
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
Impairment
0 0.75 1.5 3
Miles

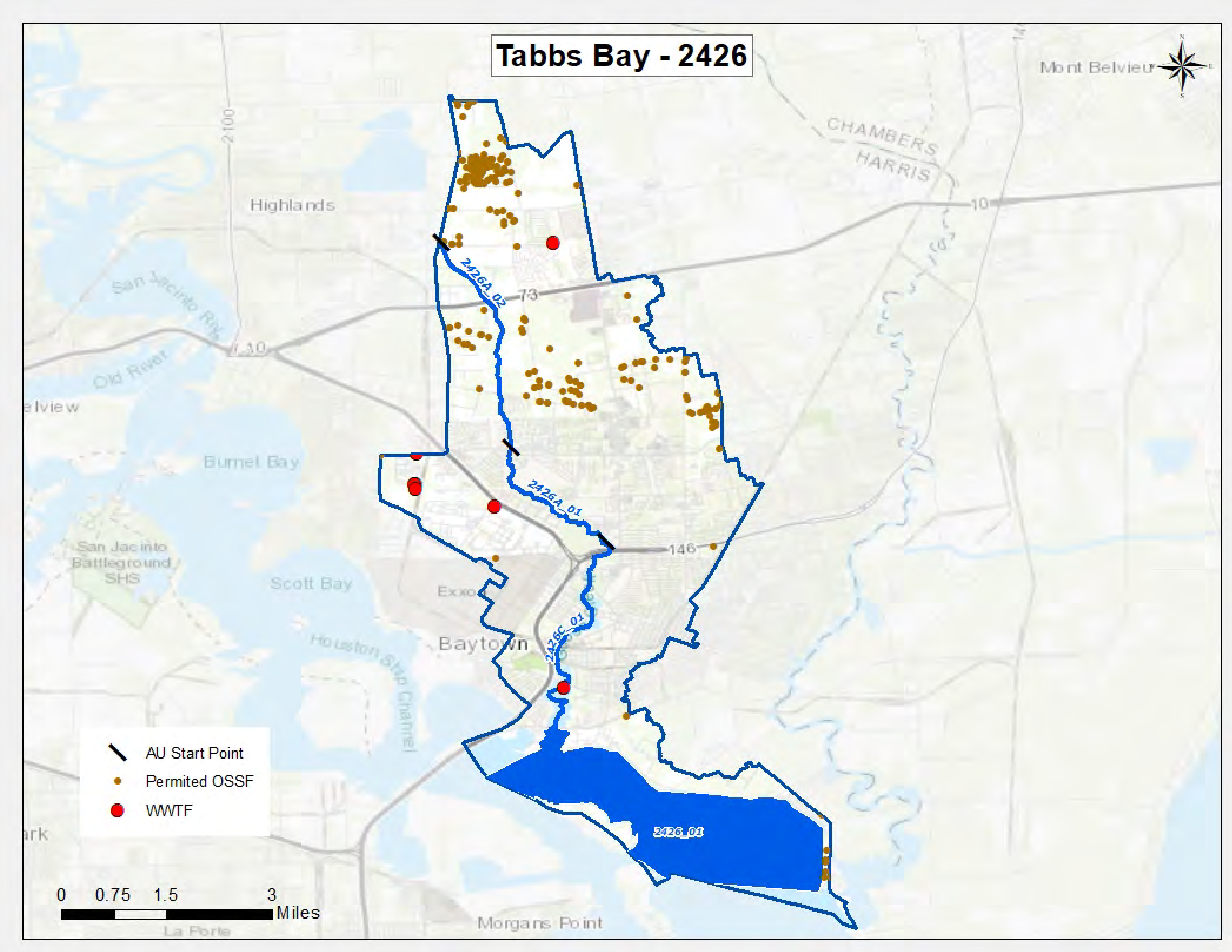
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Tabbs Bayou watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 7 permitted wastewater outfalls in the Tabbs Bayou watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 202 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Tabbs Bayou watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 160 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Volatile Organic Compounds (VOCs), Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. VOCs are chemicals found in industry, agriculture, transportation, and day-to-day activities around the home that both vaporize into the air and dissolve into water. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source for PCBs and Dioxins.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Tabbs Bayou watershed.

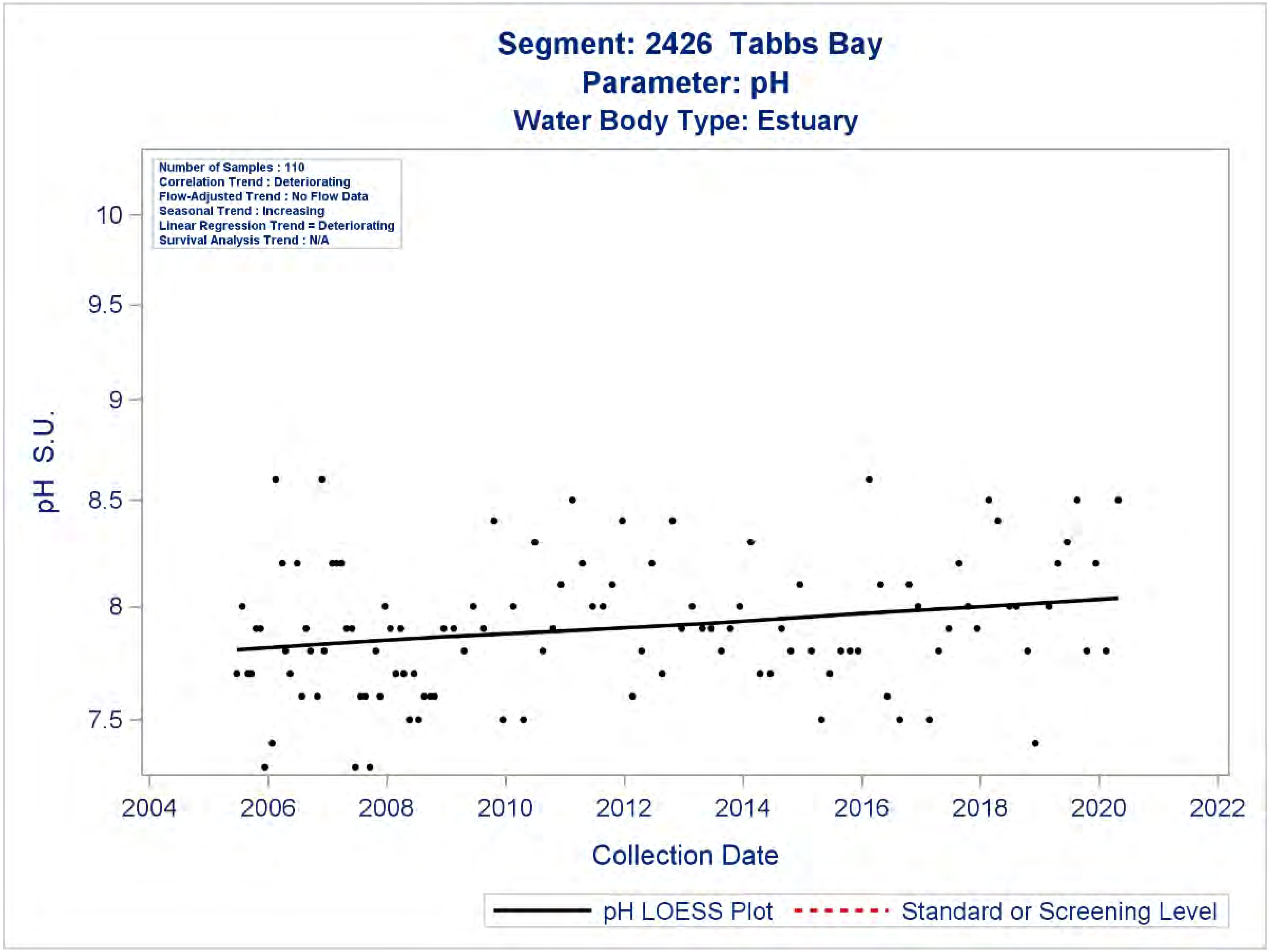


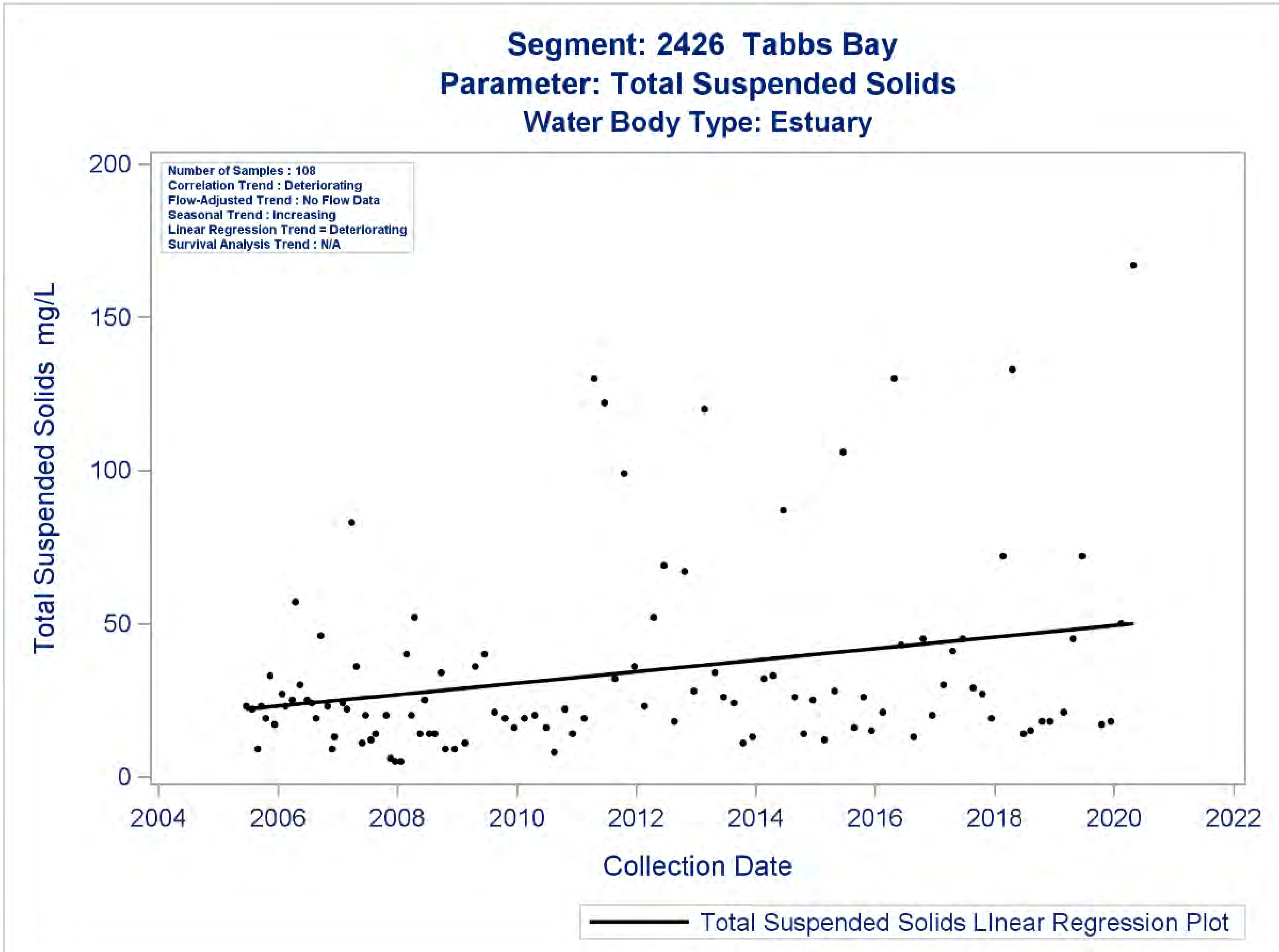
Tabbs Bay - 2426
Mont Belvieu
CHAMBERS
HARRIS
Highlands
San Jacinto Riv
Old River
Burnet Bay
San Jacinto Battleground SHS
Scott Bay
Houston Ship Channel
Baytown
Exxo
Morgans Point
La Porte
2426A_02
2426A_01
2426C_01
2426_01
10
73
146
2100
AU Start Point
Permited OSSF
WWTF
0
0.75
1.5
3
Miles

Trend Analysis:

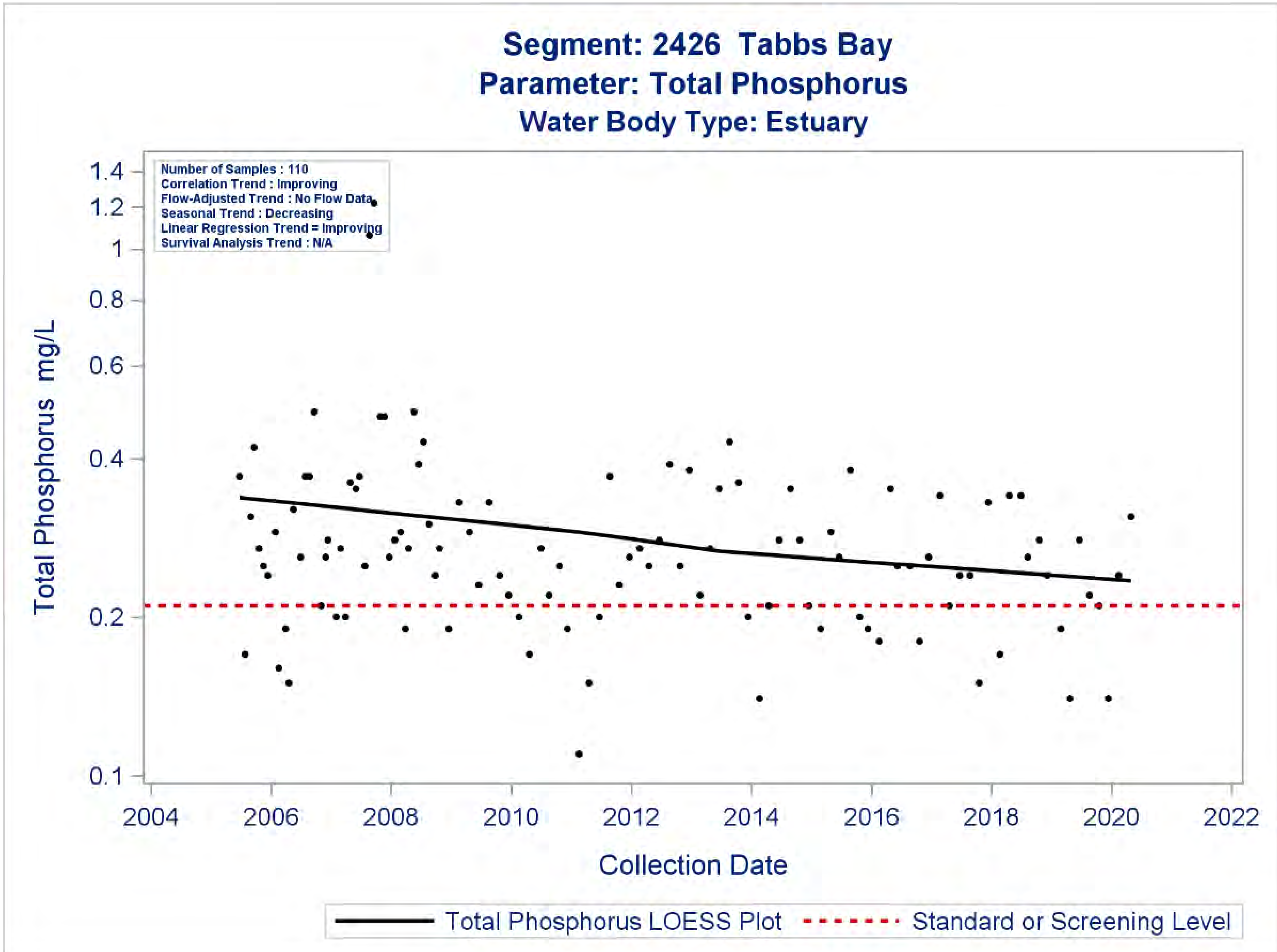
Analysis of water quality data revealed five parameter trends for two of the four assessment units located in Tabbs Bay (2426) watershed. Three trends were detected for the classified Tabbs Bay segment including increasing pH which is still within the acceptable range of 6.5 – 9.0 standard units and TSS. Suspended solids in the water column are increasing with the spikes getting more turbid with higher concentrations of TSS. Conversely, total phosphorus concentrations are decreasing over time. However, a majority of sample results have been greater than the screening criteria. Unclassified segment 2426C (Goose Creek Tidal), revealed two parameter trends with ammonia concentrations increasing and nitrate concentrations decreasing.

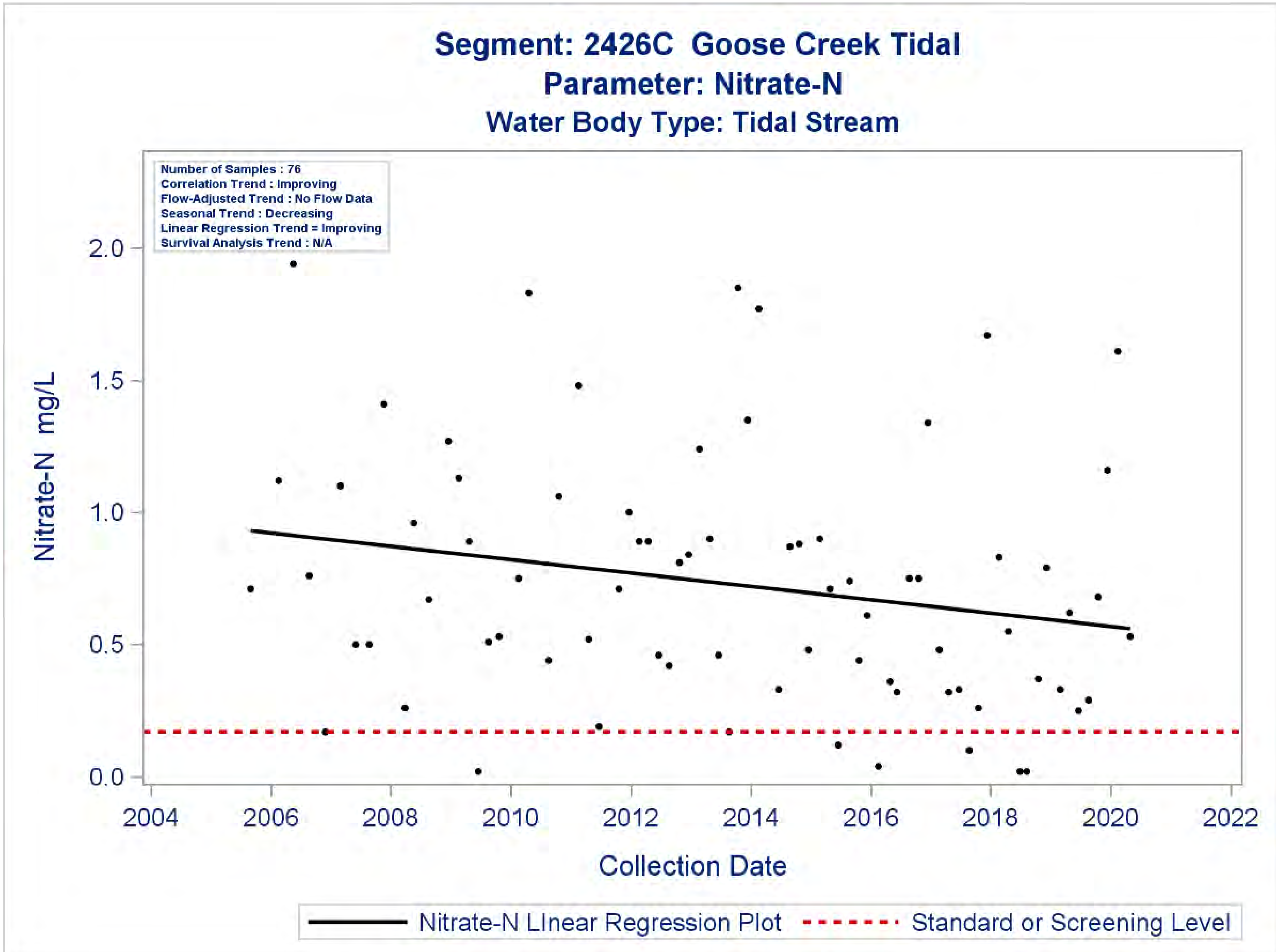
Segment 2426 is currently listed as having a nutrient concern in the 2020 Texas Integrated Report. Data collection in Tabbs Bay reveals nitrate levels are improving but still show the majority of samples being well above the screening criteria. Nitrate values have been measured below the screening criteria only a few times during the period of record. Likewise, ammonia data shows an increasing trend with concentrations increasing over time. Ammonia sample values are distributed with about half of the results above and half below the screening criteria.


Segment: 2426 Tabbs Bay
Parameter: pH
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
pH S.U.
10
9.5
9
8.5
8
7.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
pH LOESS Plot
Standard or Screening Level

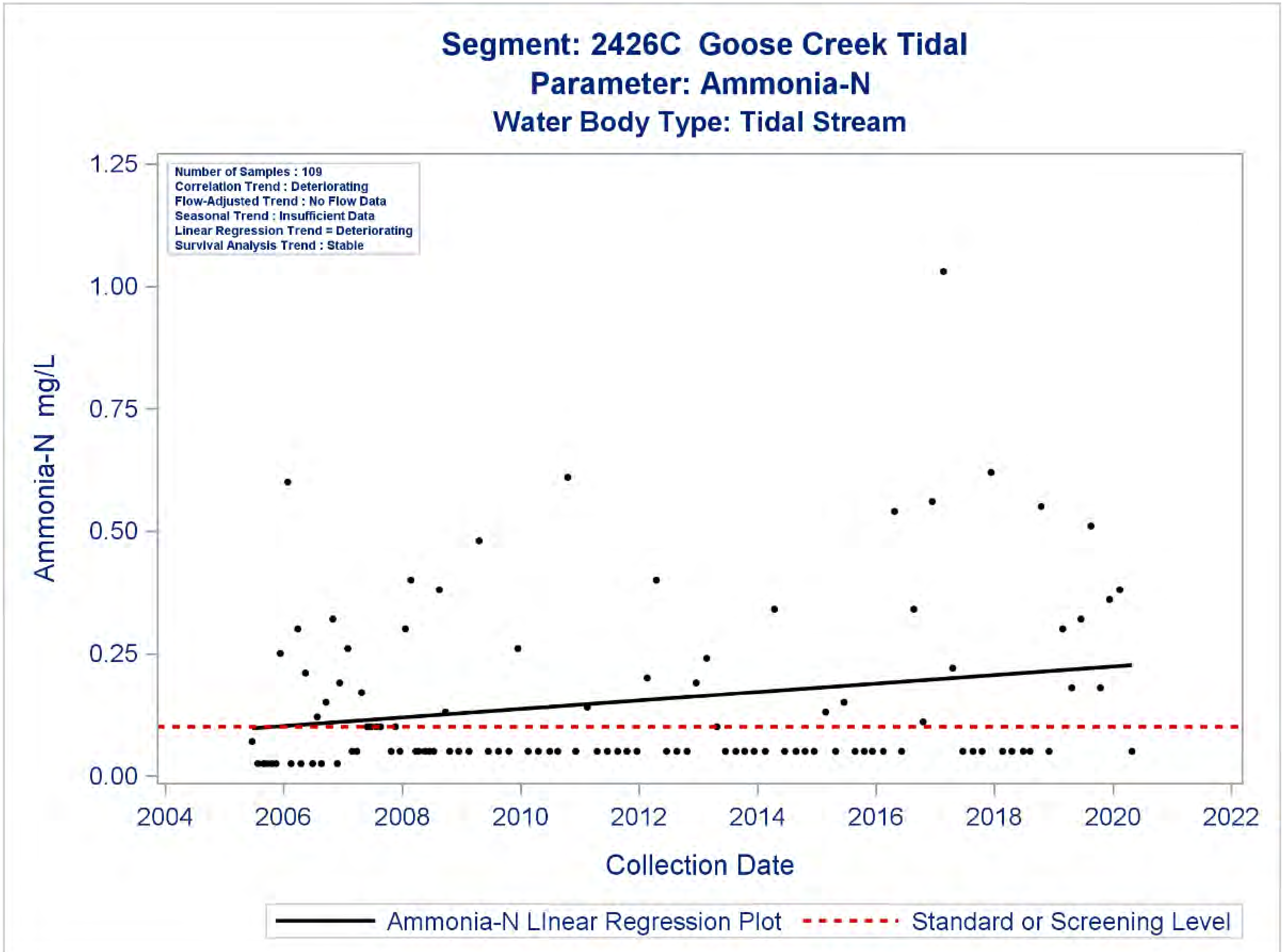


Segment: 2426 Tabbs Bay
Parameter: Total Suspended Solids
Water Body Type: Estuary
Number of Samples : 108
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
200
150
100
50
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot


Segment: 2426 Tabbs Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 110
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1.4
1.2
1
0.8
0.6
0.4
0.2
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



Segment: 2426C Goose Creek Tidal
Parameter: Nitrate-N
Water Body Type: Tidal Stream
Number of Samples : 76
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Nitrate-N mg/L
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level



Segment: 2426C Goose Creek Tidal
Parameter: Ammonia-N
Water Body Type: Tidal Stream
Number of Samples : 109
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Stable
Ammonia-N mg/L
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nutrient Concentrations	***Ammonia, Nitrate, and Phosphorus*** 2426 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Expand use of LID and green infrastructure practices • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed
Dioxin/PCBs in Fish Tissue	2426 I 2426C I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/ADV-55_Modification_Galveston-Bay-Map.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.

- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2422 Name: Trinity Bay

Area:	123 square miles	**Miles of Shoreline:**	80 miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	11	**Texas Stream Team Monitoring Stations:**	5	**Permitted WWTF Outfalls:**	6

DESCRIPTION

- Segment 2422: **Trinity** Bay (classified water body) – A 280.2 square kilometer (108.2 square mile) portion of the Galveston Bay complex located east of Upper Galveston Bay and entirely within Chambers County extending east/northeast from an imaginary north-south line extending from Beach City to Smith Point in Chambers County

- Segment 2422A (Perennial Stream w/ high ALU): **Anahuac Ditch** (unclassified water body) – Perennial Stream from the confluence with the West Fork Double Bayou upstream to FM 563 near the City of Anahuac

- Segment 2422B (Tidal Stream w/ high ALU): **Double Bayou West Fork** (unclassified water body) – From the Trinity Bayou confluence to Belton Road in Chambers County

- Segment 2422C (Tidal Stream w/ high ALU): **Cotton Bayou** (unclassified water body) – Retired segment description. Reassigned to segment 0801C

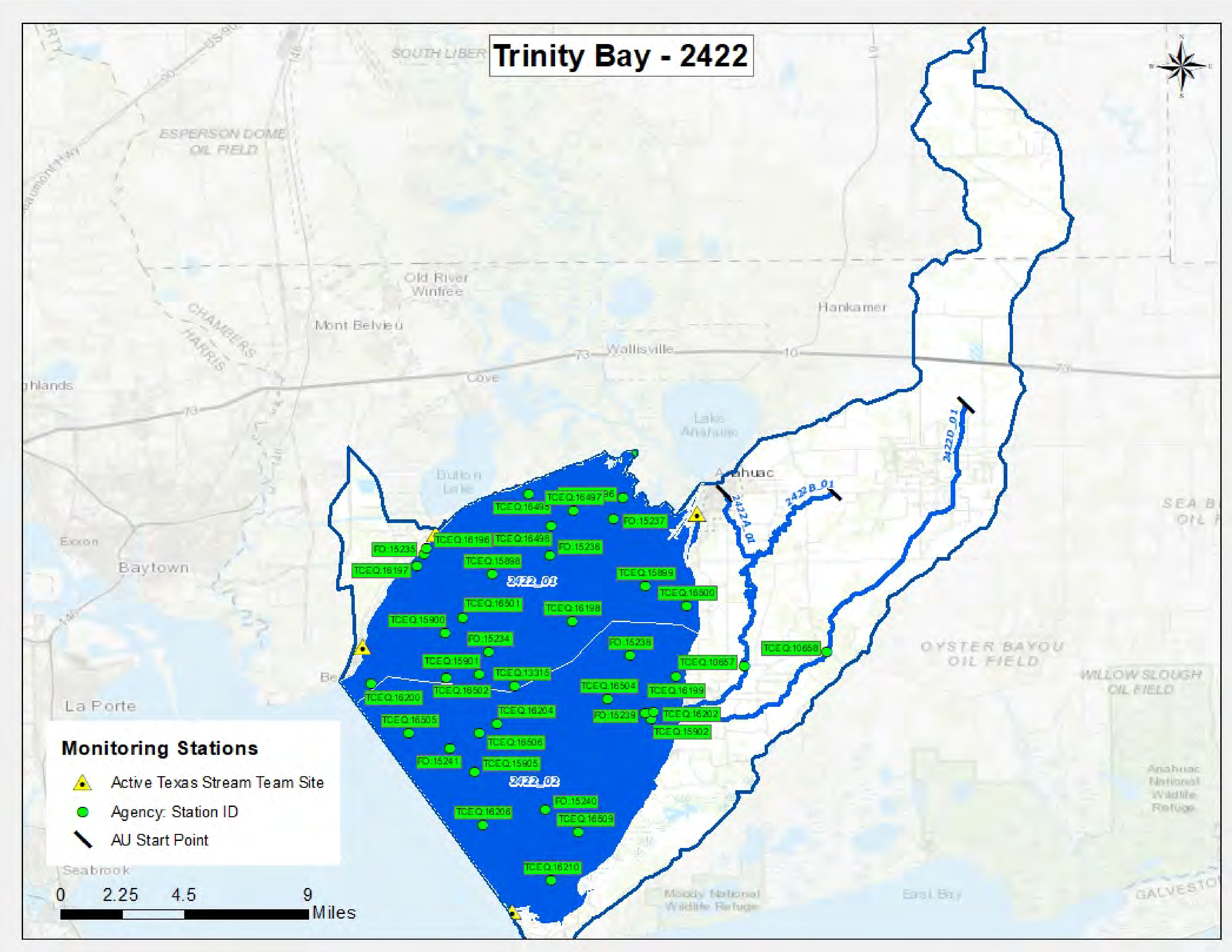
- Segment 2422D (Tidal Stream w/ high ALU): **Double Bayou East Fork** (unclassified water body) – From the Trinity Bayou confluence to a point 2.6 km (1.6 mi) upstream of SH 65

- Segment 2422OW (Oyster Waters)

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
13315	2422	TRINITY BAY 200 YDS NORTH OF EXXON C-1 PLATFORM	FO	QUARTERLY ONE/YEAR	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment
15234	2422	TRINITY BAY AT 95GB005	FO	QUARTERLY	Field, Conventional, Bacteria
15235	2422	TRINITY BAY AT 95GB003	FO	QUARTERLY	Field, Conventional, Bacteria
15236	2422	TRINITY BAY AT 95GB002	FO	QUARTERLY	Field, Conventional, Bacteria
15238	2422	TRINITY BAY AT 95GB004	FO	QUARTERLY	Field, Conventional, Bacteria
15239	2422	TRINITY BAY AT 95GB007	FO	QUARTERLY	Field, Conventional, Bacteria
15240	2422	TRINITY BAY AT 95GB010	FO	QUARTERLY	Field, Conventional, Bacteria
15241	2422	TRINITY BAY AT 95GB008	FO	QUARTERLY	Field, Conventional, Bacteria
10657	2422B	DOUBLE BAYOU WEST FORK AT EAGLE ROAD SOUTH OF ANAHUAC	FO	QUARTERLY	Field, Conventional, Bacteria
18361	2422B	DOUBLE BAYOU WEST FORK AT FM 2936 SOUTHEAST OF ANAHUAC	LL	TWO/YEAR	Field, Conventional
10658	2422D	DOUBLE BAYOU EAST FORK AT FM 562 SOUTHEAST OF ANAHUAC	LL	TWO/YEAR	Field, Conventional
10658	2422D	DOUBLE BAYOU EAST FORK AT FM 562 SOUTHEAST OF ANAHUAC	FO	QUARTERLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office
LL = Trinity River Authority Lake Livingston Project

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.



Trinity Bay - 2422
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
0
2.25
4.5
9
Miles
2422_01
2422_02
2422A_01
2422B_01
2422D_01

Segment 2422 Water Quality Standards and Screening Levels					
Standards	**Bays & Estuaries**	**Perennial Stream**	**Screening Levels**	**Bays & Estuaries**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia-N (mg/L):	0.10	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	4.0	Nitrate-N (mg/L):	0.17	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66
Enterococci (MPN/100mL) (grab):	130	130	Chlorophyll *a* (µg/L):	11.6	21
Enterococci (MPN/100mL) (geometric mean):	35	35			
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43				

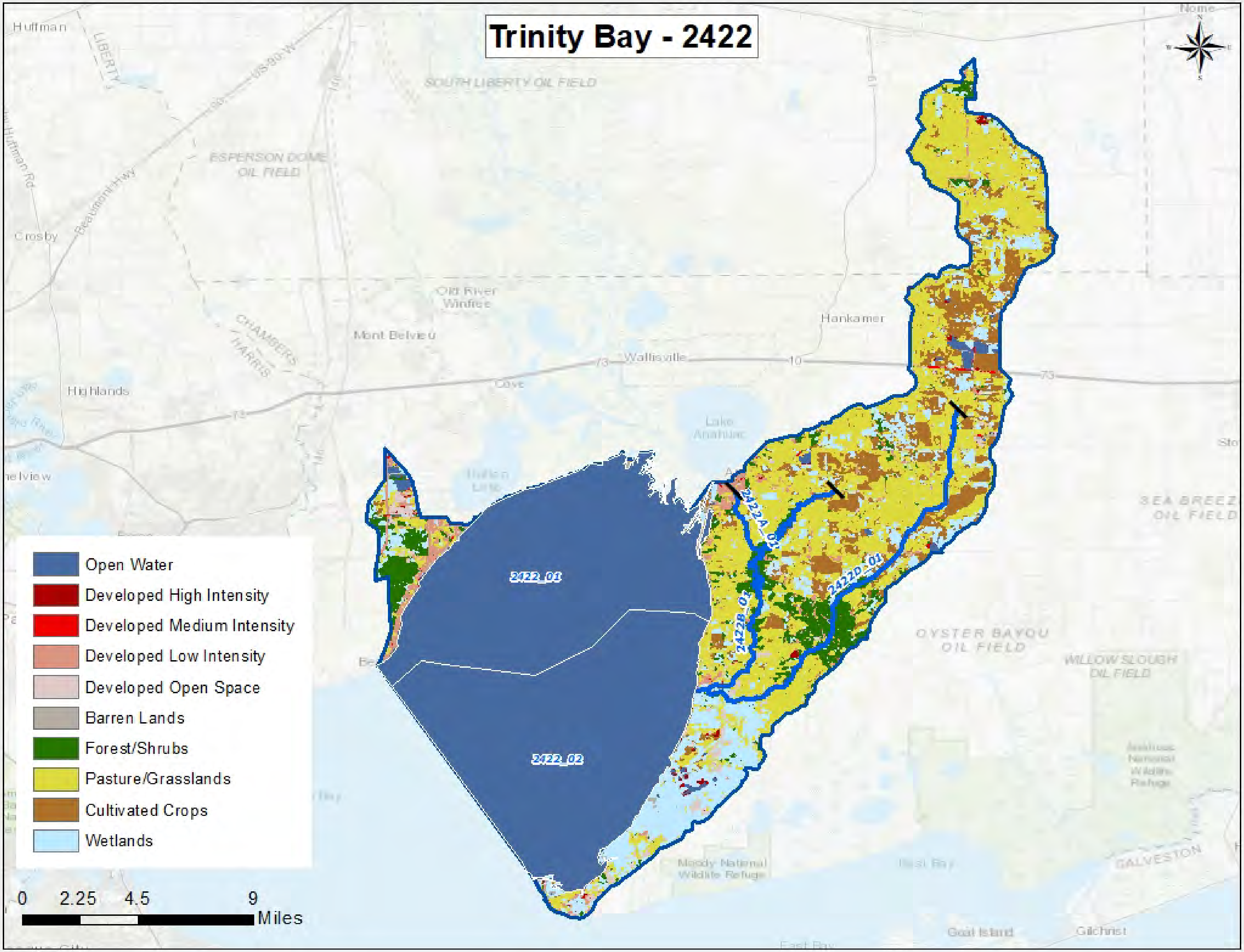
Segment Discussion

Watershed Characteristics and Land Cover: Trinity Bay (2422) lies within Chambers County. An imaginary line drawn from the north shore Houston Point area near Tri City Beach Rd to Smith Point on the southern shore separates Trinity Bay from Upper Galveston Bay. East Bay and Lower Galveston Bay lie south and southwest of Smith Point respectively. Coastal wetlands dominate the near shore landscape while cattle grazing, rice farming, and oil production are found throughout the county on the east side of the Bay. Anahuac is the major city in close proximity of the Bay situated on the northeast shore. The Double Bayou sub-watershed is located on the east side of the bay. Located in Liberty County, the headwaters of East Fork Double Bayou flow south before merging with West Fork Double Bayou and then draining to Trinity Bay at the community of Oak Island.

Open Water is the largest land cover category at 44.56 percent, followed by Agriculture at 33.63 percent.

Segment 2422 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	67,766.57	38.96	58,494.24	33.63	-13.68
Barren Lands	249.31	0.14	3,075.73	1.77	1,133.72
Developed	4,028.69	2.32	6,677.20	3.84	65.74
Forest/Shrubs	216.84	0.12	8,099.42	4.66	3,635.28
Open Water	77,455.46	44.53	77,508.61	44.56	0.07
Wetlands	24,240.44	13.93	20,102.11	11.56	-17.07
TOTAL	**173,957.31**	**100.00**	**173,957.31**	**100.00**	

Trinity Bay - 2422



Water Quality Issues:

Bacteria Impairments and Concerns
The 2020 Integrated Report lists Double Bayou West Fork (2422B) and Double Bayou East Fork (2422D) as impaired for contact recreation due to elevated levels of enterococci bacteria.

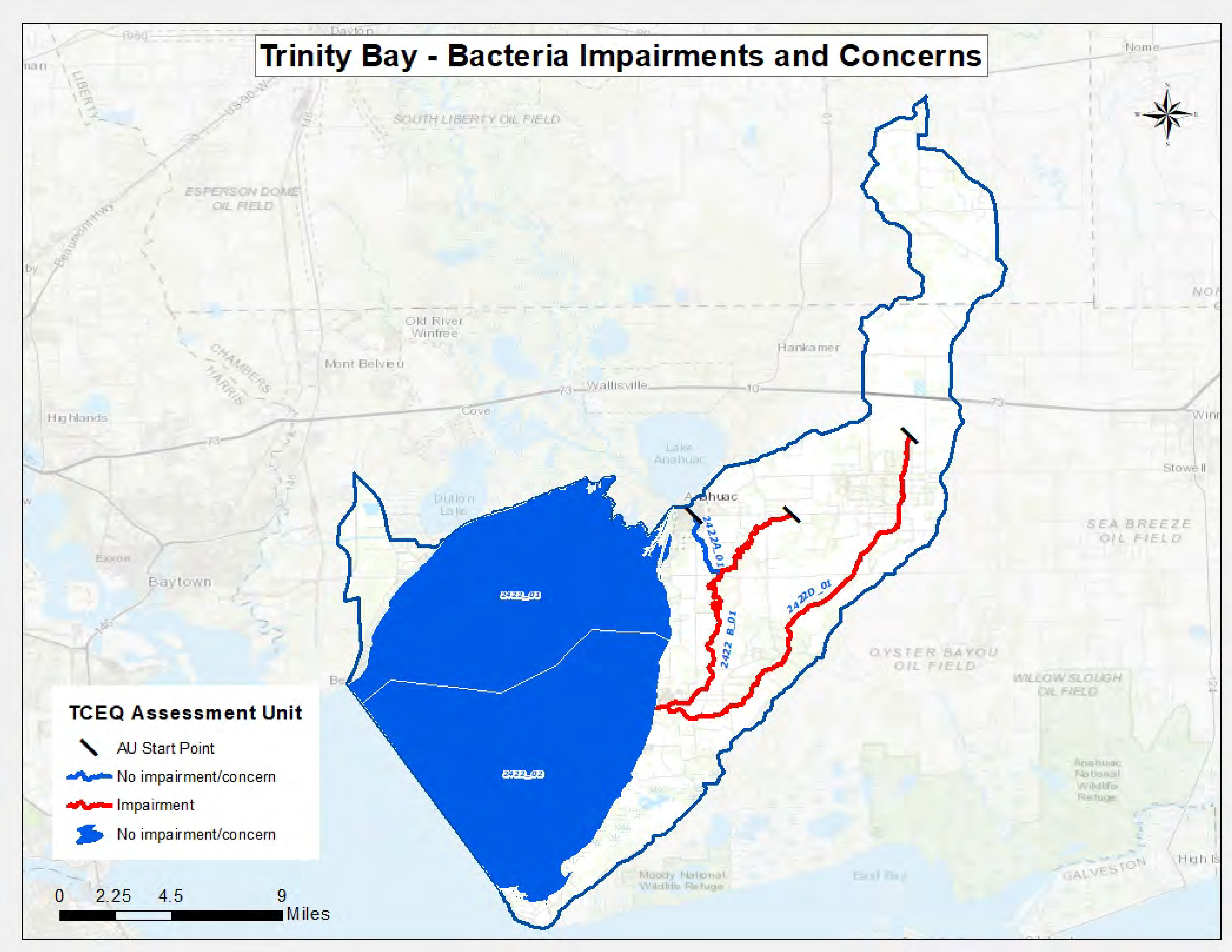
Assessment unit 2422OW_01 is included in a Texas Department of State Health Services shellfish harvesting restriction due to bacteria in oyster waters.

Dissolved Oxygen Impairments and Concerns
Double Bayou West Fork is listed for depressed dissolved oxygen. This listing is a carry-forward from a previous assessment.

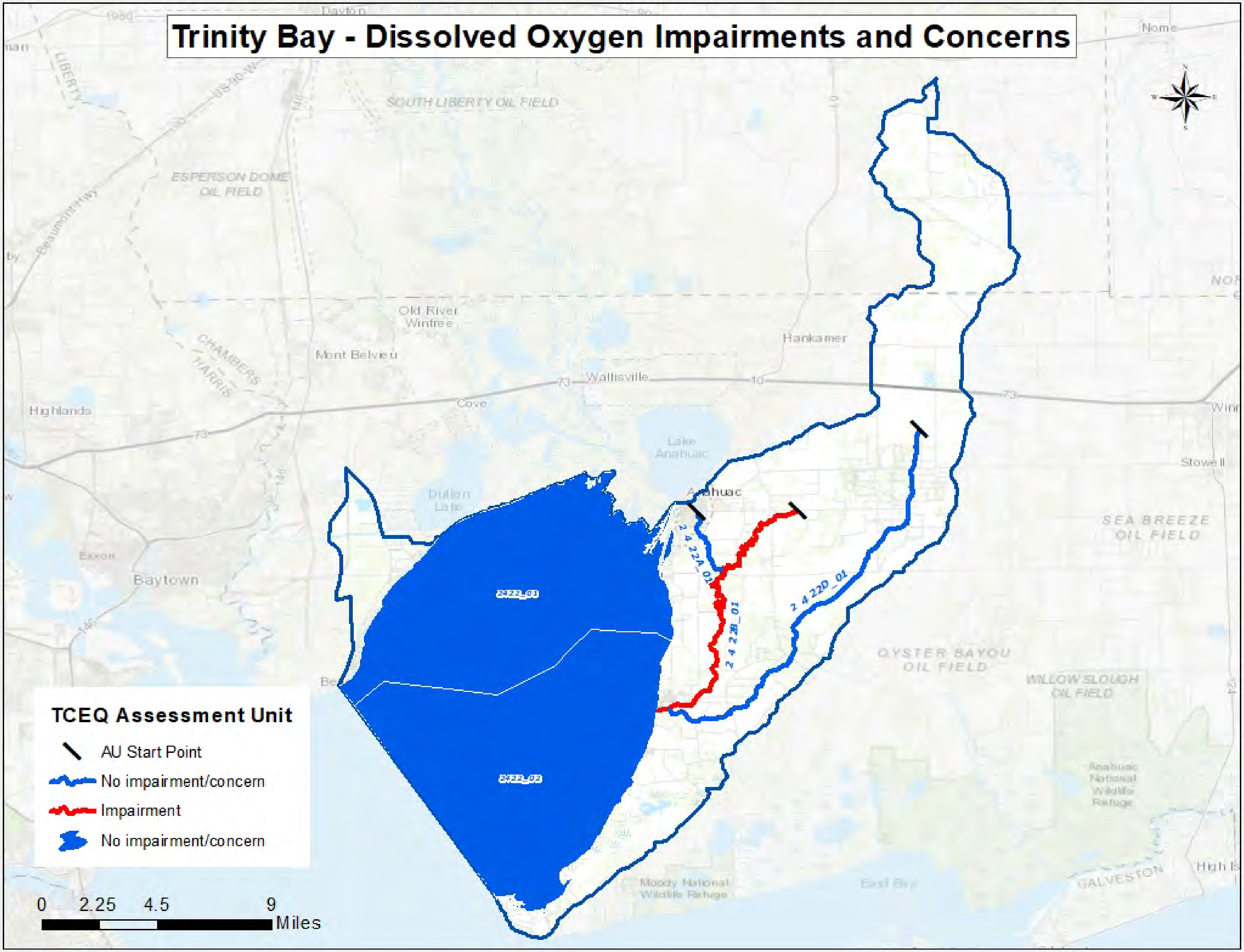
Nutrient Concerns
There are no nutrient concerns in this segment.

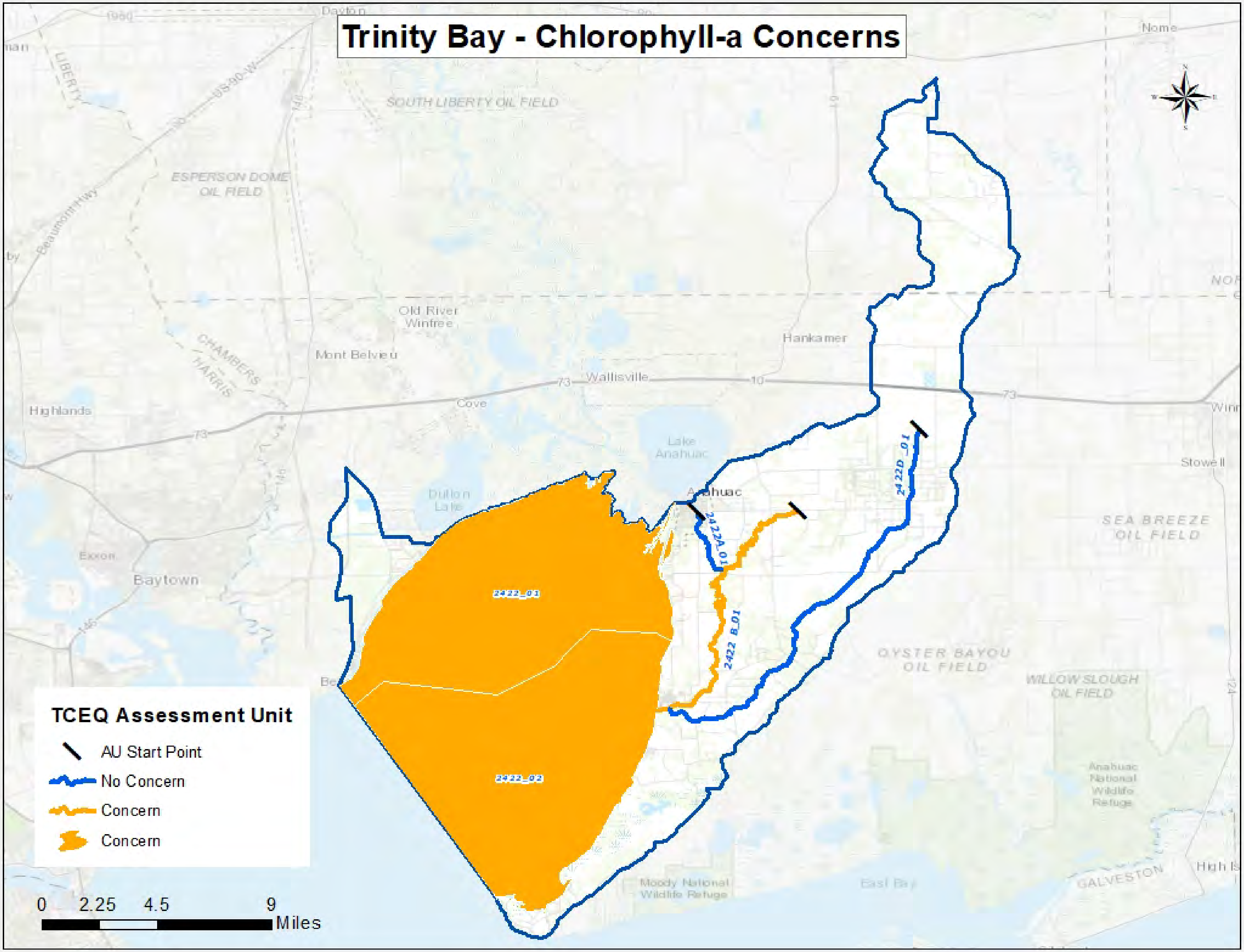
Chlorophyll-a Concerns
The East and West Forks of Double Bayou as well as Trinity Bay have chlorophyll-*a* concerns based upon water quality screening criteria levels. In AU 2422_01, 80.3 percent of samples exceeded the 11.6 micrograms per liter screening level, with 80.7 percent of samples exceeding the screening level in 2422_02.

PCBs and Dioxin Impairments
Trinity Bay and both forks of Double Bayou are listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. The Texas Department of State Health Services has issued a Limited Fish Consumption Advisory for these segments.

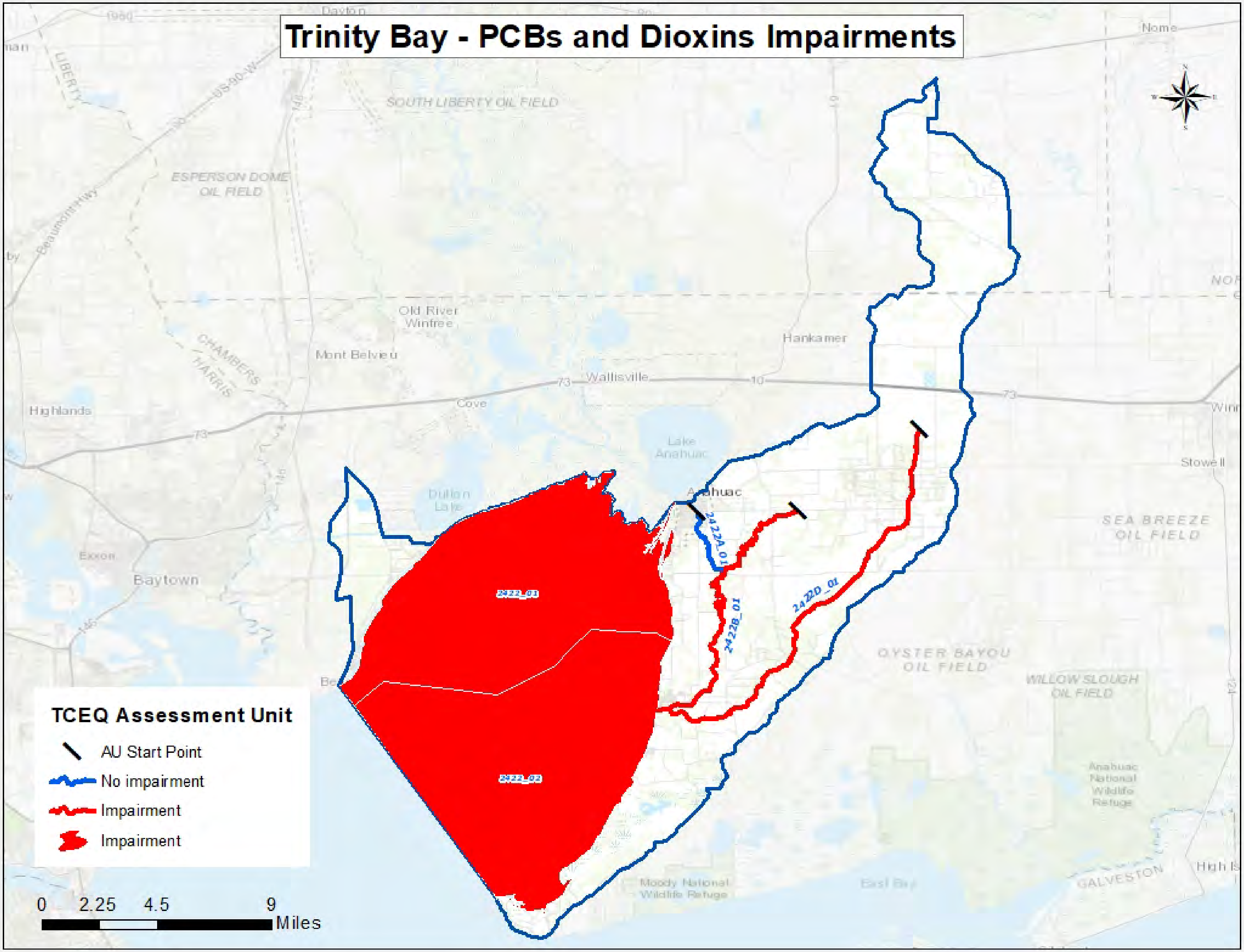


Trinity Bay - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
No impairment/concern
0 2.25 4.5 9
Miles
2422_01
2422_02
2422A_01
2422B_01
2422D_01
Anahuac
Wallisville
Hankamer
Mont Belvieu
Old River Winfree
Cove
Highlands
Baytown
Dayton
Nome
Stowell
SOUTH LIBERTY OIL FIELD
ESPERSON DOME OIL FIELD
SEA BREEZE OIL FIELD
OYSTER BAYOU OIL FIELD
WILLOW SLOUGH OIL FIELD
Lake Anahuac
Dutton Lake
Moody National Wildlife Refuge
Anahuac National Wildlife Refuge
East Bay
GALVESTON
CHAMBERS
HARRIS
LIBERTY


Trinity Bay - Dissolved Oxygen Impairments and Concerns
SOUTH LIBERTY OIL FIELD
ESPERSON DOME OIL FIELD
LIBERTY
CHAMBERS
HARRIS
Dayton
Nome
Old River Winfree
Mont Belvieu
Hankamer
Wallisville
Cove
Highlands
Lake Anahuac
Anahuac
Dutton Lake
Exxon
Baytown
Stowell
SEA BREEZE OIL FIELD
OYSTER BAYOU OIL FIELD
WILLOW SLOUGH OIL FIELD
Anahuac National Wildlife Refuge
Moody National Wildlife Refuge
East Bay
GALVESTON
2422A_01
2422B_01
2422D_01
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
No impairment/concern
0 2.25 4.5 9
Miles



Trinity Bay - Chlorophyll-a Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
Concern
0 2.25 4.5 9
Miles
2422_01
2422_02
2422A_01
2422B_01
2422D_01
SOUTH LIBERTY OIL FIELD
ESPERSON DOME OIL FIELD
Old River Winfree
Mont Belvieu
Hankamer
Wallisville
Cove
Highlands
Lake Anahuac
Anahuac
Dutton Lake
Baytown
Exxon
CHAMBERS
HARRIS
LIBERTY
Dayton
Nome
Stowell
SEA BREEZE OIL FIELD
OYSTER BAYOU OIL FIELD
WILLOW SLOUGH OIL FIELD
Anahuac National Wildlife Refuge
Moody National Wildlife Refuge
East Bay
GALVESTON
Beaumont Hwy
US-90-W


Trinity Bay - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
Impairment
0 2.25 4.5 9
Miles
2422_01
2422_02
2422A_01
2422B_01
2422D_01
Dayton
Nome
SOUTH LIBERTY OIL FIELD
ESPERSON DOME OIL FIELD
Old River Winfree
Mont Belvieu
Hankamer
Wallisville
Cove
Highlands
Lake Anahuac
Anahuac
Dutton Lake
Exxon
Baytown
Stowell
SEA BREEZE OIL FIELD
OYSTER BAYOU OIL FIELD
WILLOW SLOUGH OIL FIELD
Anahuac National Wildlife Refuge
Moody National Wildlife Refuge
East Bay
GALVESTON
CHAMBERS
HARRIS
LIBERTY

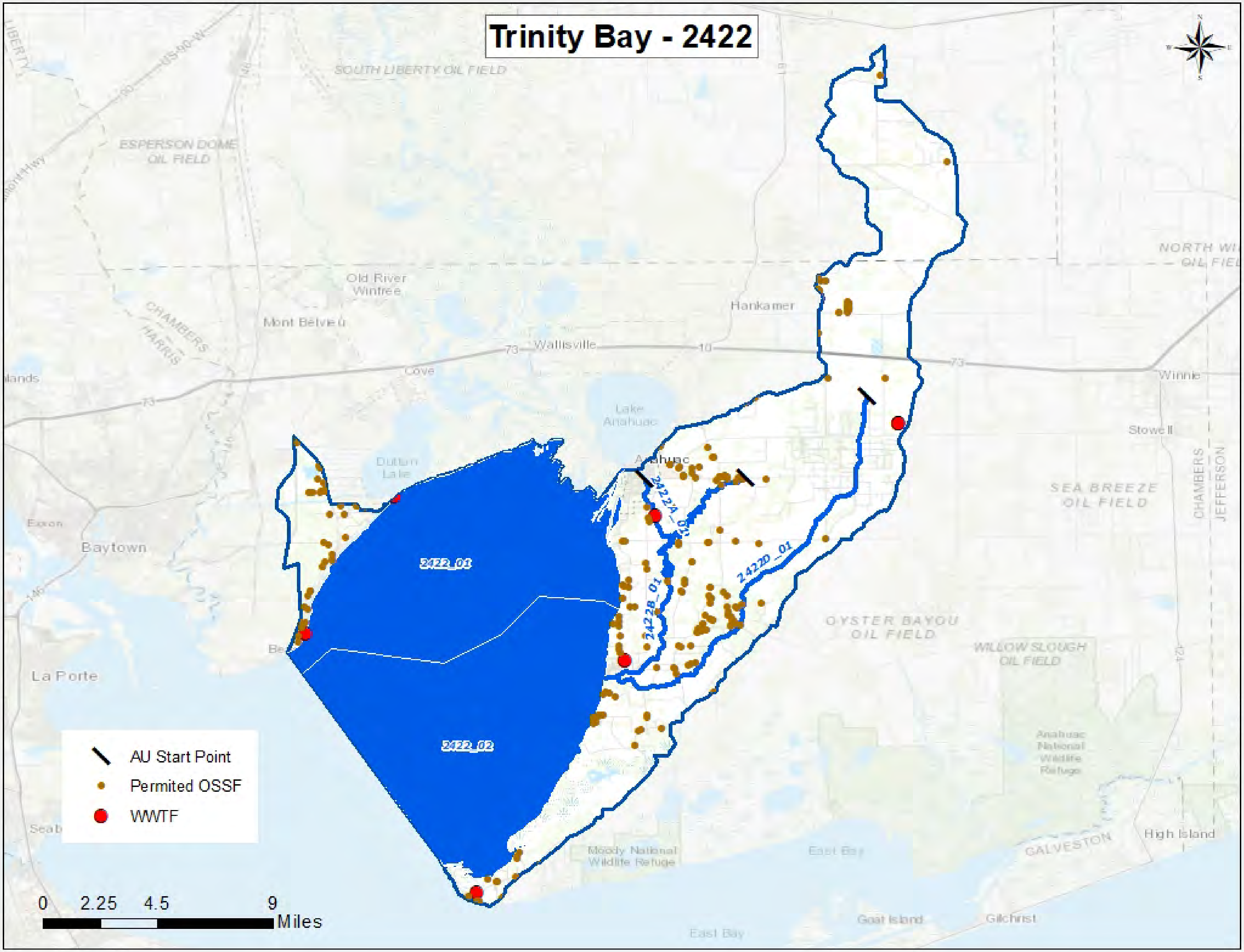
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Trinity Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 6 permitted wastewater outfalls in the Trinity Bay watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 244 of these on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Trinity Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 61 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Trinity Bay watershed.



Trinity Bay - 2422
2422_01
2422_02
2422A_01
2422B_01
2422D_01
AU Start Point
Permited OSSF
WWTF
0 2.25 4.5 9
Miles
SOUTH LIBERTY OIL FIELD
ESPERSON DOME OIL FIELD
Old River Wintree
Mont Belvieu
Hankamer
Wallisville
Cove
Lake Anahuac
Dutton Lake
Anahuac
Baytown
La Porte
Stowell
Winnie
SEA BREEZE OIL FIELD
OYSTER BAYOU OIL FIELD
WILLOW SLOUGH OIL FIELD
Moody National Wildlife Refuge
East Bay
Goat Island
Gilchrist
High Island
GALVESTON
CHAMBERS
HARRIS
JEFFERSON
Exxon

Trend Analysis:

Analysis of water quality data detected 10 parameters trends for Trinity Bay (2422) and its two unclassified segments –Double Bayou West Fork (2422B) and Double Bayou East Fork (2422D). The 2020 Texas Integrated Report lists Trinity Bay as having a concern for elevated levels of bacteria and chlorophyll *a* in water.

Seven trends were detected in Trinity Bay including increasing TSS concentrations and pH values. The majority of the TSS results fall below 50 mg/L, with a few TSS spikes throughout the period of record. Likewise, pH values are still within the acceptable range of 6.5 to 9.0 standard units.

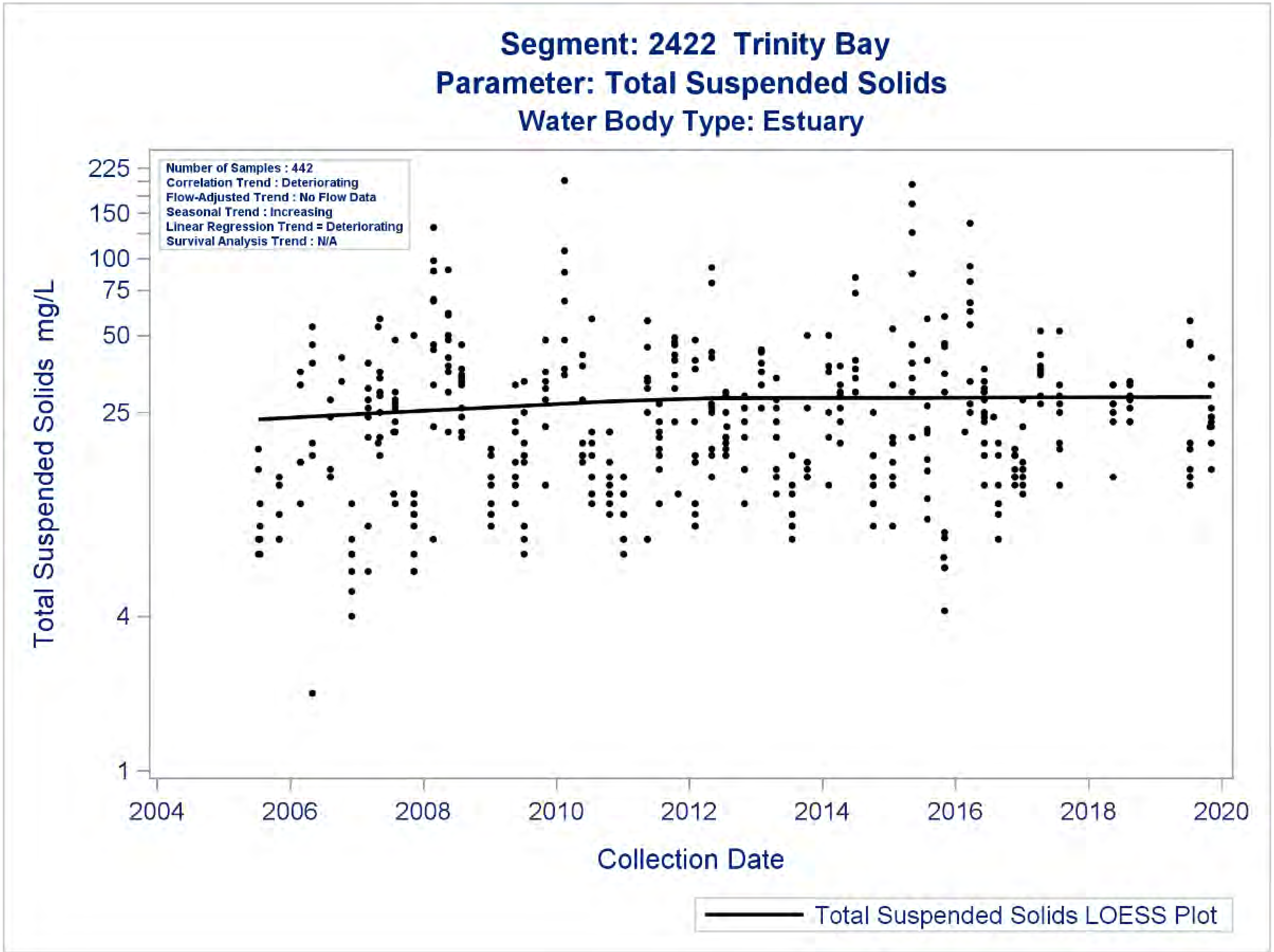
Regression analysis of nutrient data for Trinity Bay reveals decreasing concentrations of ammonia, total phosphorus, chloride, specific conductance and sulfate were seen over time. For ammonia, the trend indicates decreasing concentrations, with no sample results exceeding the screening criteria of 0.10 mg/L since mid-2012. Simultaneously, concentrations of total phosphorus have shown a decreasing trend since 2005. There are still instances where sample results exceed the screening criteria but again, the majority of total phosphorus sample results fall under the 0.21 mg/L screening criteria. Nitrate concentrations during the period of record are stable.

Analysis of enterococci data for Trinity Bay revealed no trend.

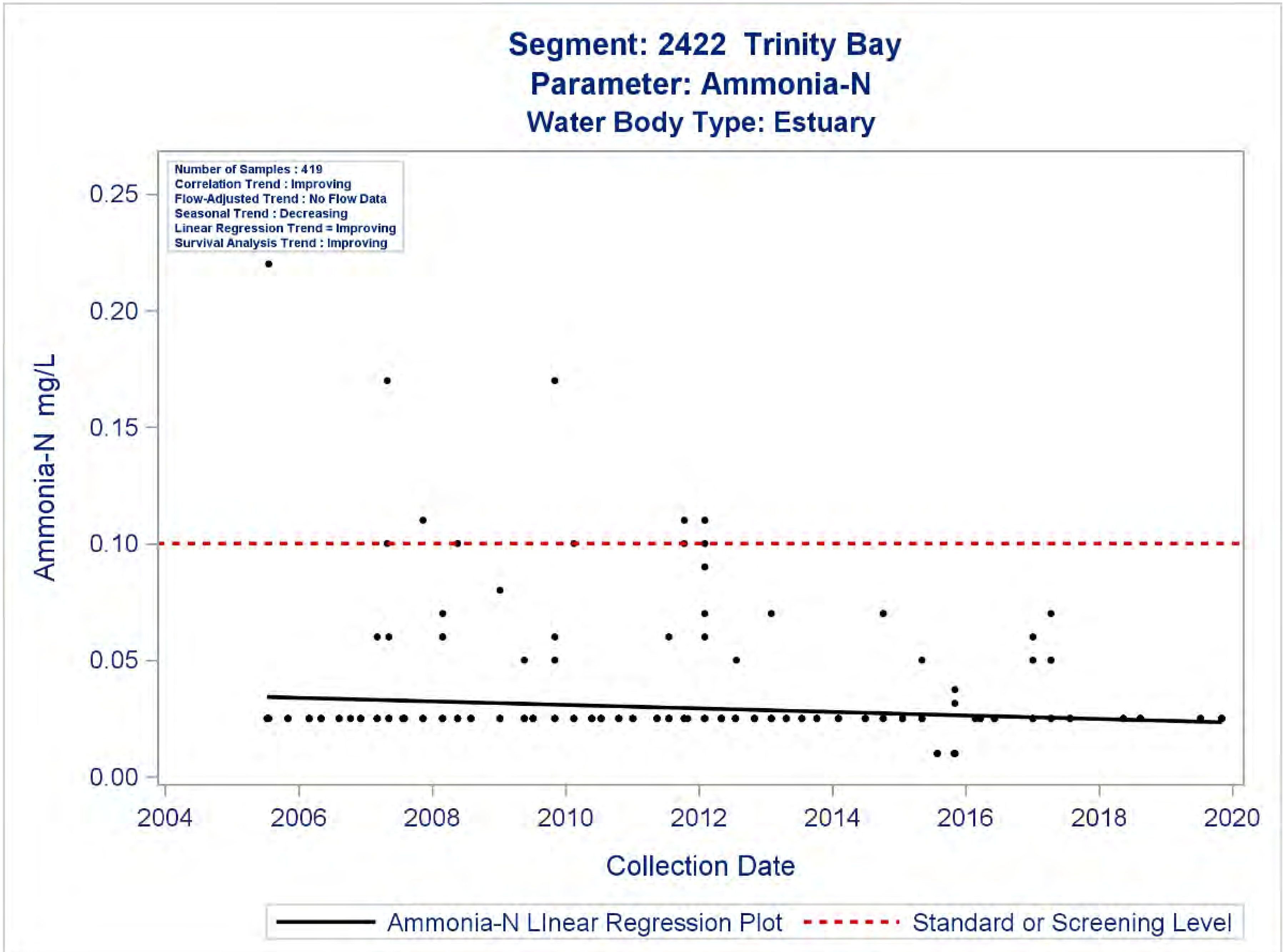
Analysis of Double Bayou West Fork (2422B) data revealed five trends with increasing concentrations of chloride, chlorophyll *a*, specific conductance, and temperature. While most analyses show enterococci as stable, linear regression shows a deteriorating trend. pH trends were stable for Segment 2422B. Simultaneously, Double Bayou East Fork (2422D) showed four parameter trends during the period of record with increasing concentrations of chlorophyll *a* and TKN and decreasing concentrations of total phosphorus and sulfate.

Increasing chlorophyll *a* concentrations is the most important trend identified for Double Bayou West Fork (2422B). Beginning in 2006, concentrations of chlorophyll *a* frequently exceeded the screening criteria of 21 mg/L. In late 2007, the graph shows a noticeable rise in chlorophyll *a* levels with many results being measured between 50 – 100 mg/L. Since the Double Bayou West Fork is a tidal stream, the trends for chloride, specific conductance, and temperature can potentially be affected by rain and, therefore, are not a great concern at this time. Unclassified segment 2422B is also listed as being impaired for elevated levels of bacteria. Enterococci data for this AU has hovered at or near the 35 MPN/100 mL geometric mean standard during the period of record, with extreme spikes detected several times since 2006 with levels approaching as high as 25,000 MPN/100 mL. Spikes of this magnitude are likely related to illicit discharges or sanitary sewer overflows (SSOs) that introduce large volumes of raw sewage into waterways or rainfall events washing bacteria from pastures, OSSFs, and pet waste into the bayou.

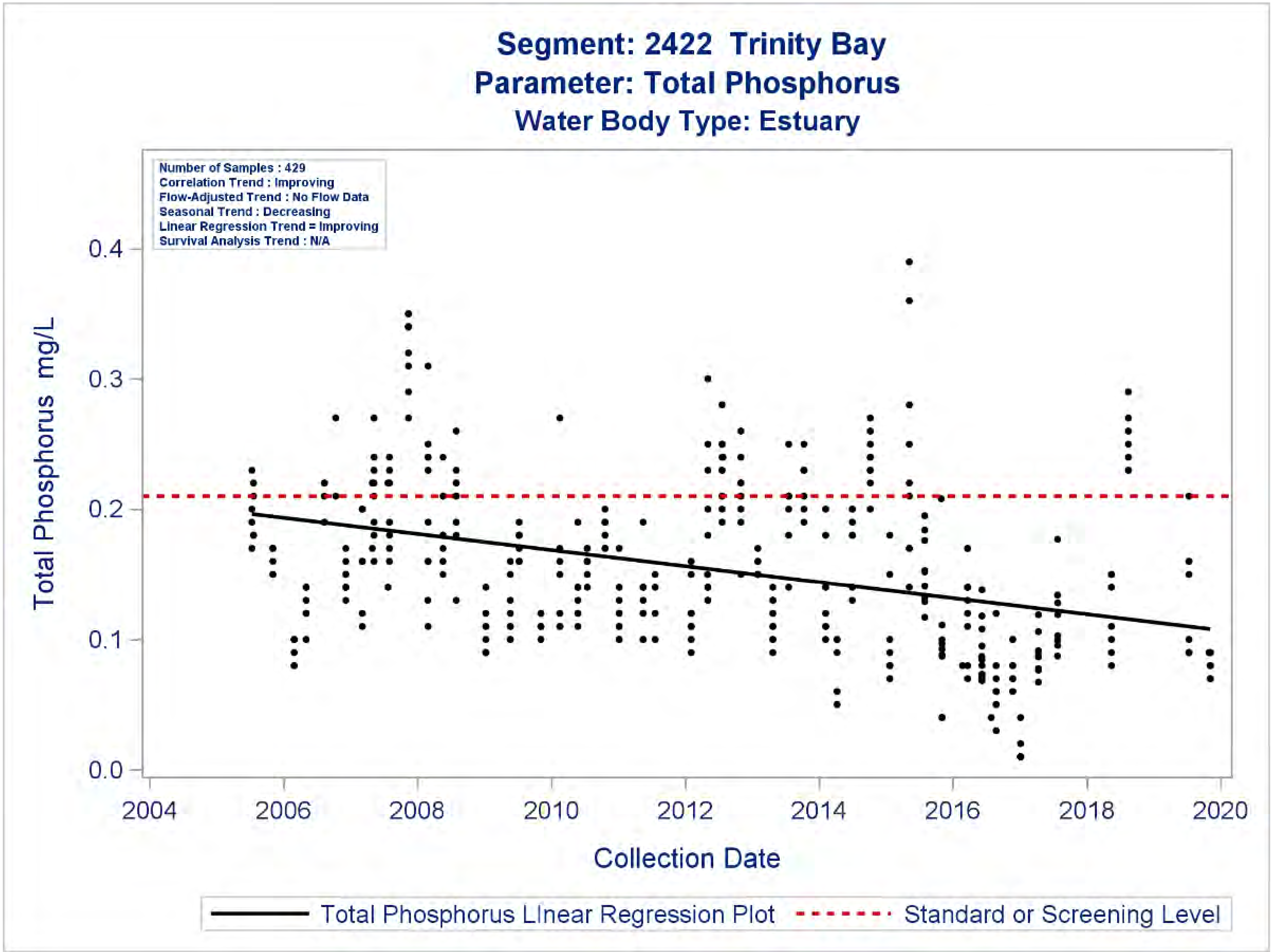
Unclassified segment 2422D (Double Bayou East Fork) showed deteriorating trends for chlorophyll *a* and TKN with increasing concentrations. Conversely, concentrations of total phosphorus in the East Fork are decreasing. Double Bayou East Fork is also impaired for elevated levels of bacteria. Routine monitoring of this segment began in 2002 but analysis detected no trend in enterococci levels over time. Nearly half of the samples exceed the enterococci geometric mean water quality contact recreation standard for bays and estuaries during the period of record.



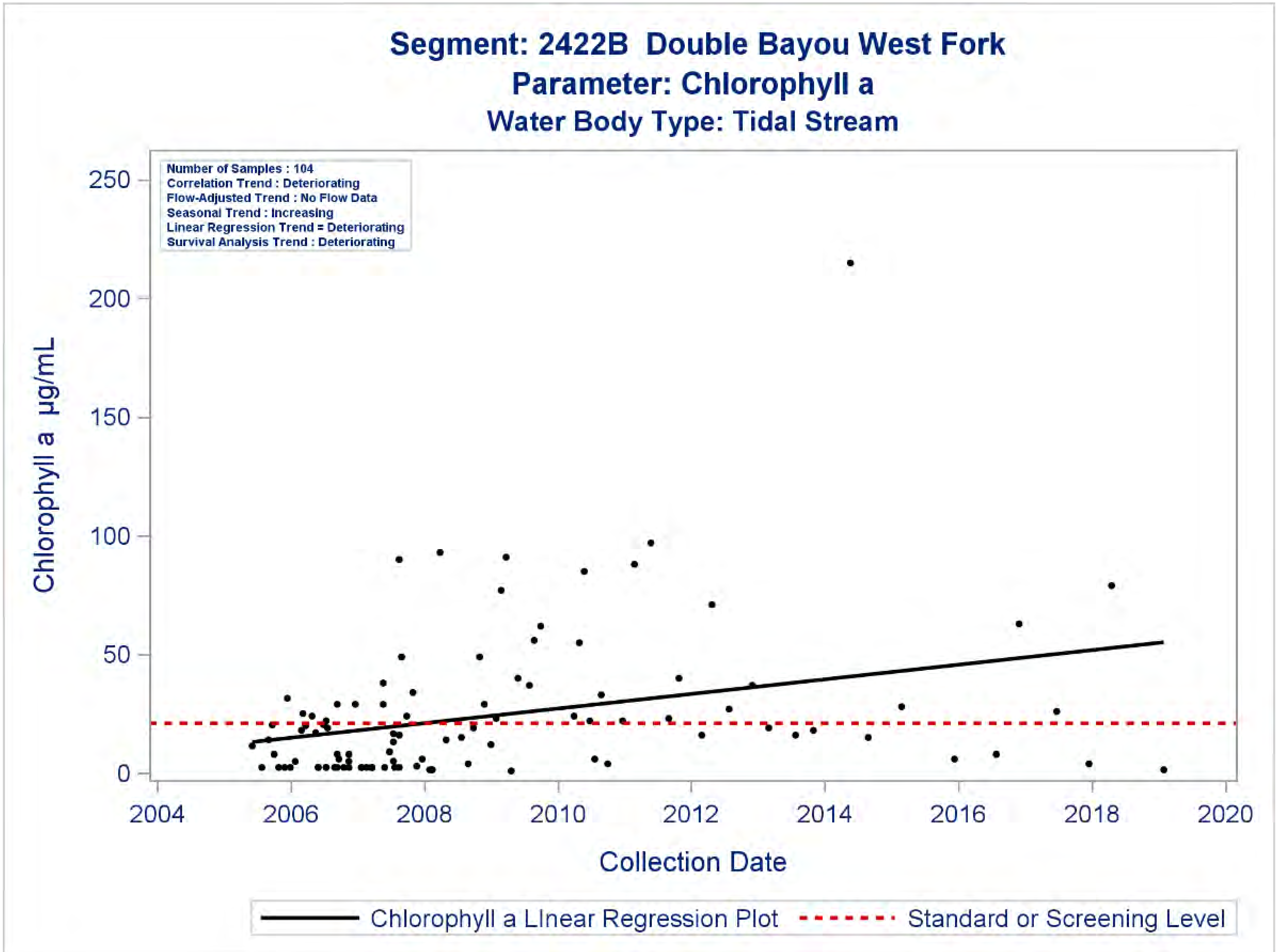
Segment: 2422 Trinity Bay
Parameter: Total Suspended Solids
Water Body Type: Estuary
Number of Samples : 442
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
225
150
100
75
50
25
4
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Suspended Solids LOESS Plot



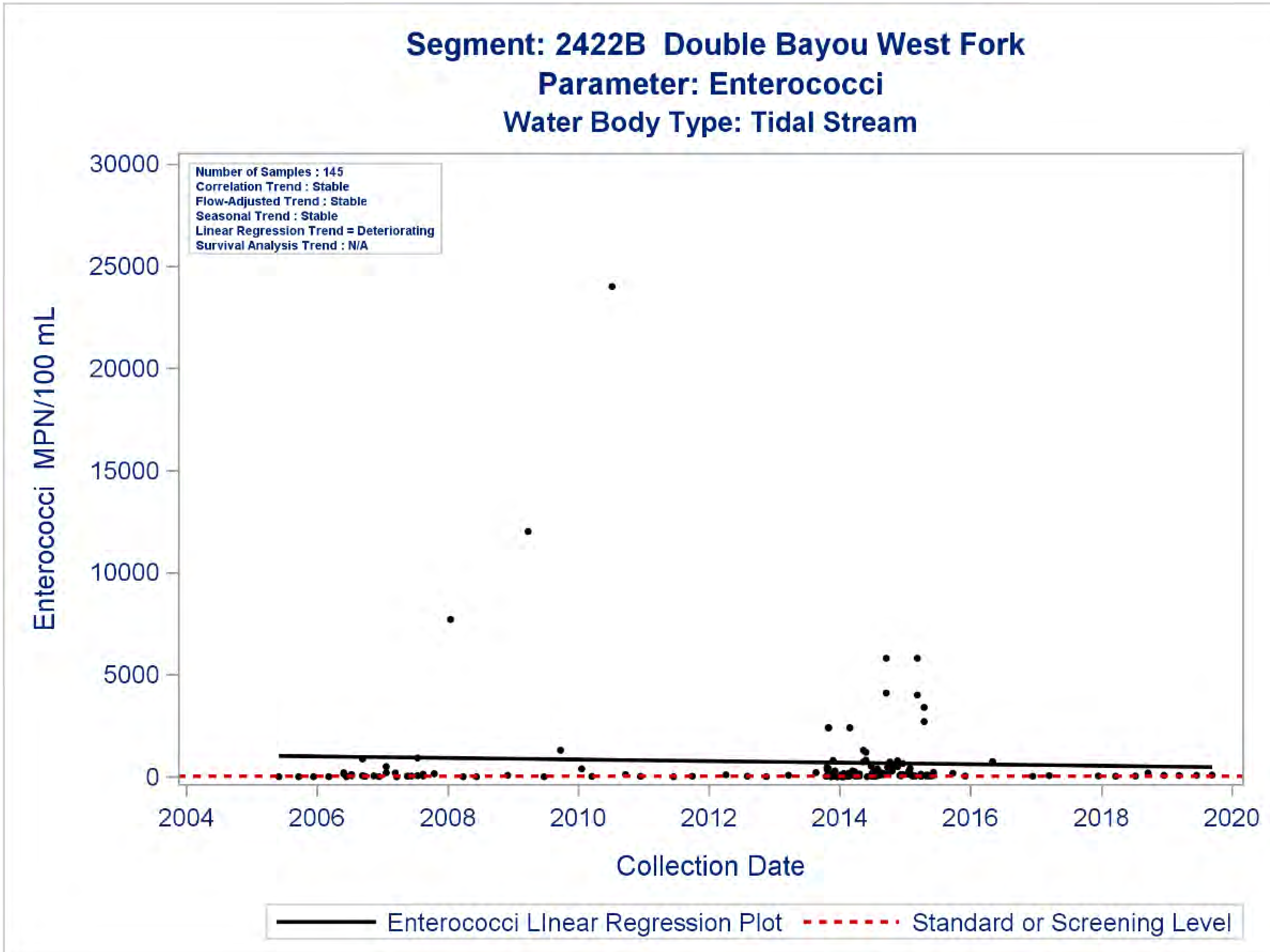
Segment: 2422 Trinity Bay
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 419
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Ammonia-N mg/L
0.25
0.20
0.15
0.10
0.05
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

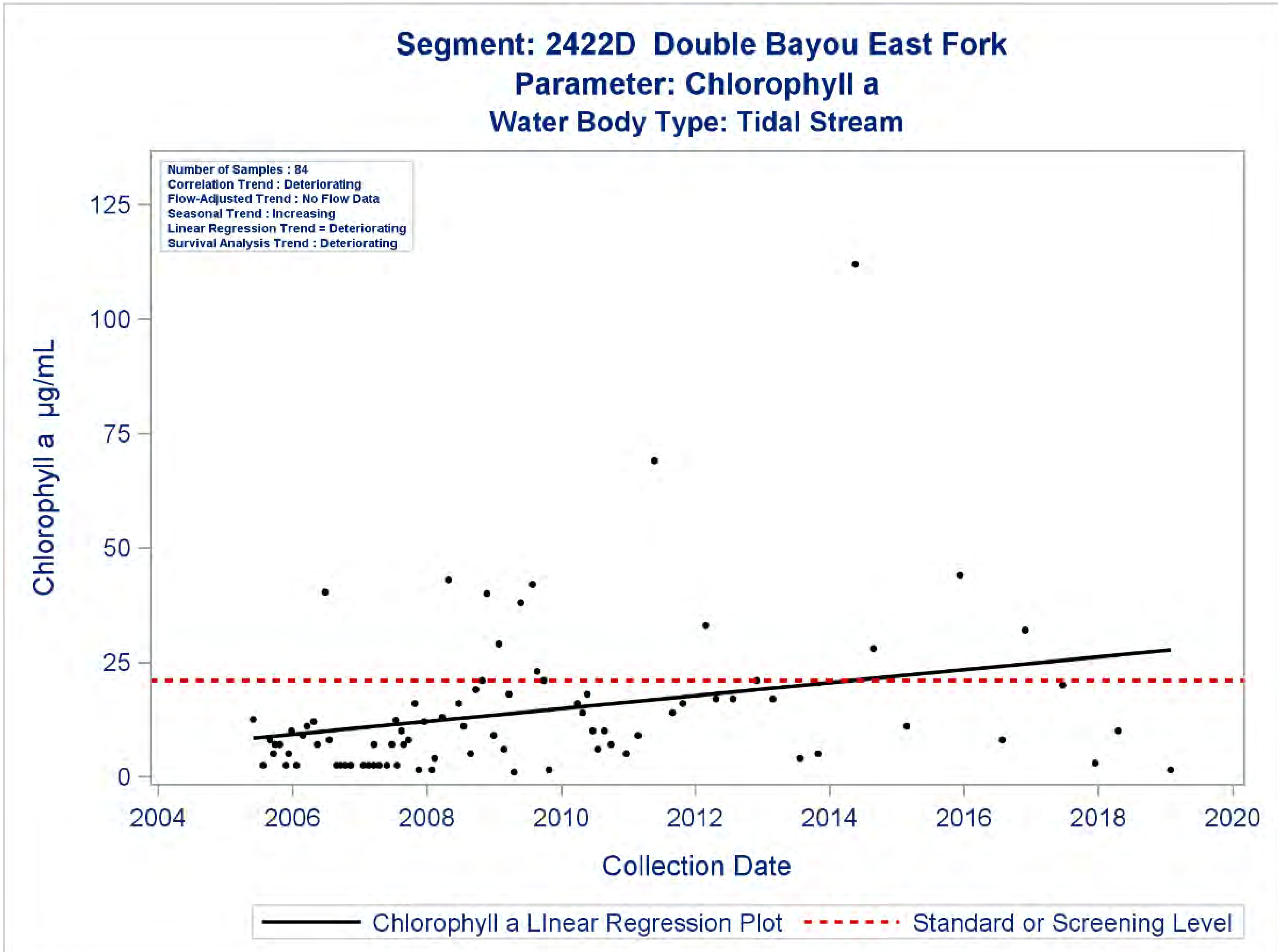


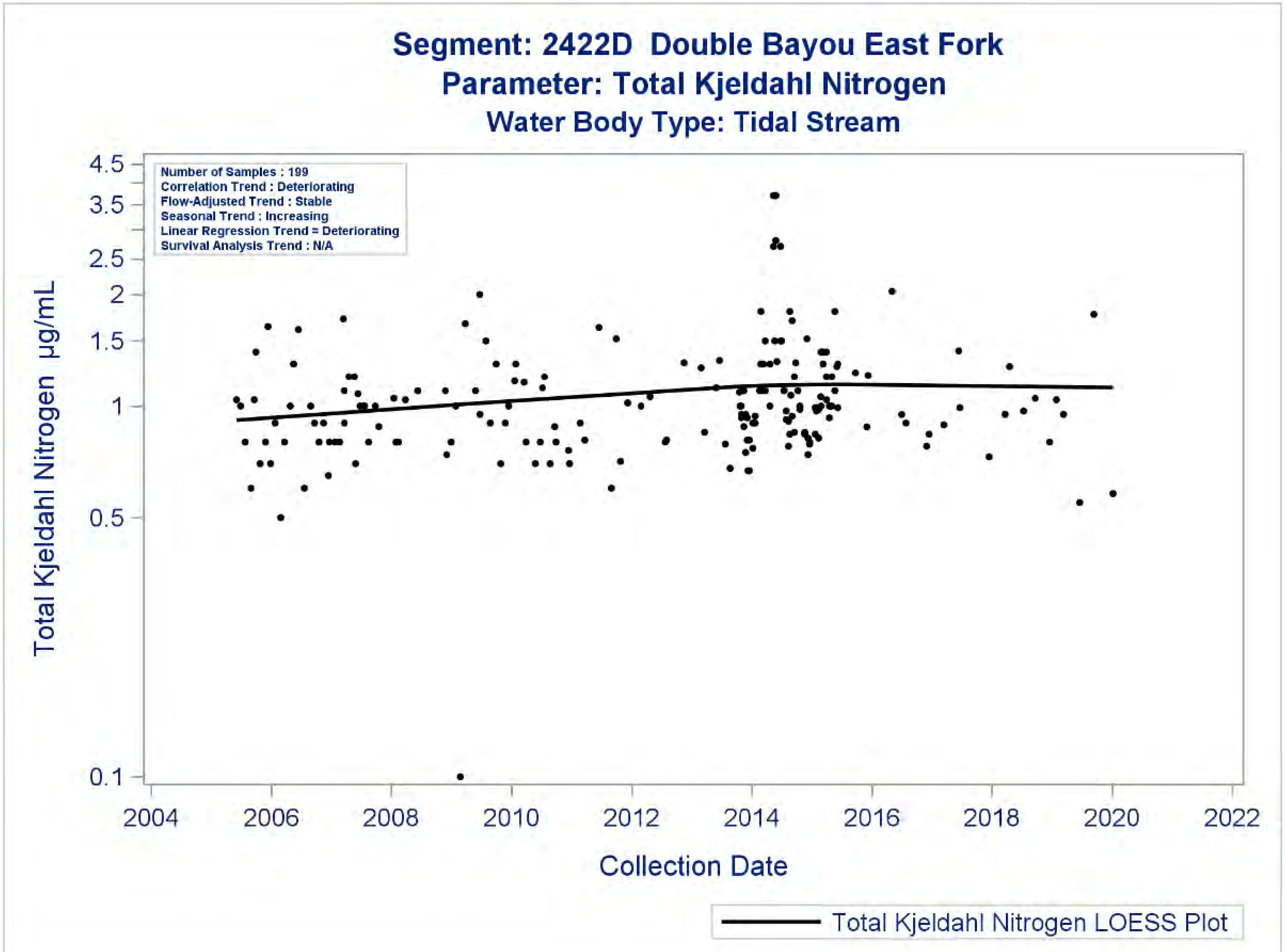
Segment: 2422 Trinity Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 429
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.1
0.2
0.3
0.4
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level



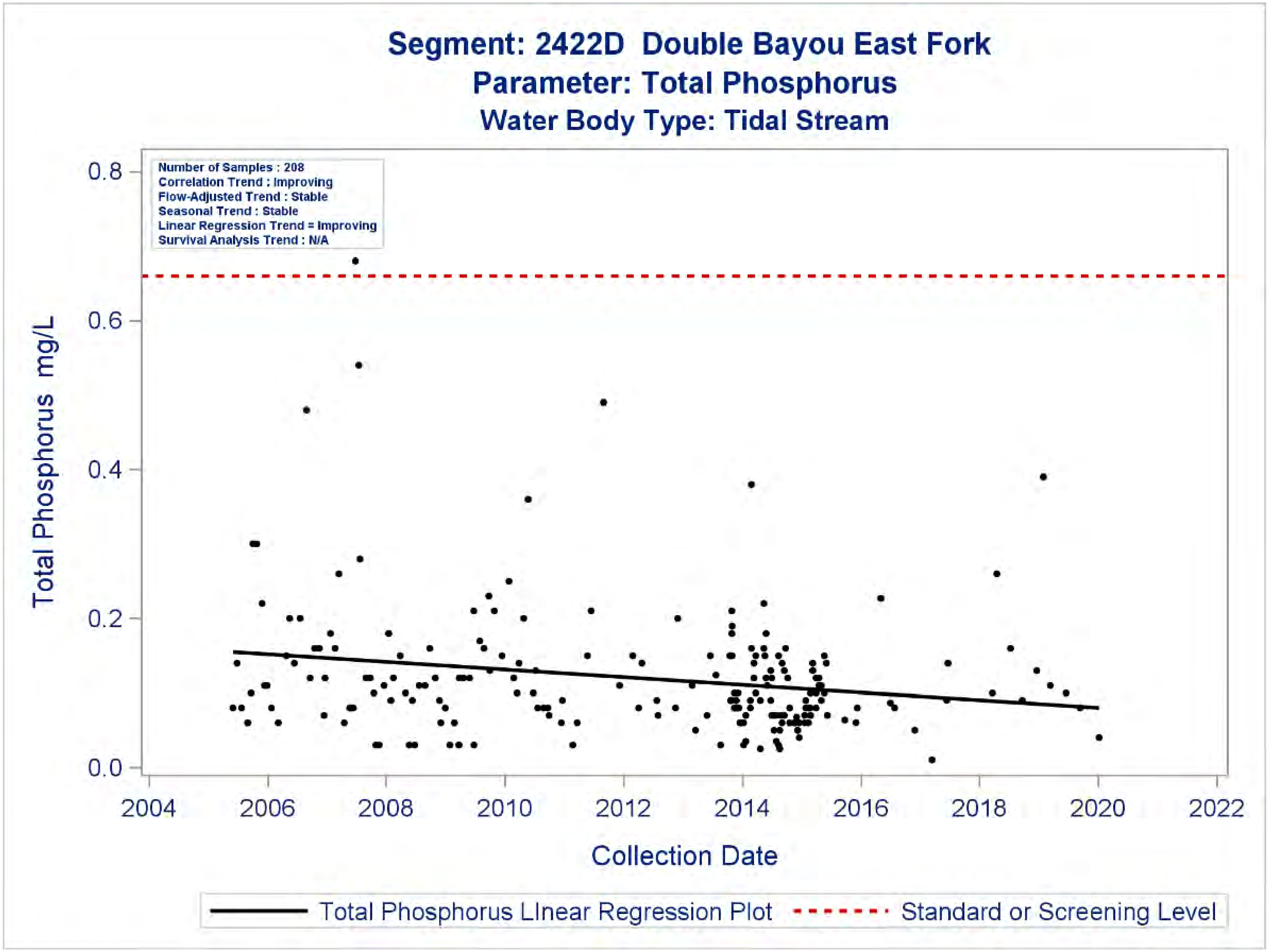
Segment: 2422B Double Bayou West Fork
Parameter: Chlorophyll a
Water Body Type: Tidal Stream
Number of Samples : 104
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Chlorophyll a µg/mL
250
200
150
100
50
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level


Segment: 2422B Double Bayou West Fork
Parameter: Enterococci
Water Body Type: Tidal Stream
Number of Samples : 145
Correlation Trend : Stable
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Enterococci MPN/100 mL
30000
25000
20000
15000
10000
5000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Enterococci LInear Regression Plot
Standard or Screening Level


Segment: 2422D Double Bayou East Fork
Parameter: Chlorophyll a
Water Body Type: Tidal Stream
Number of Samples : 84
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Chlorophyll a µg/mL
125
100
75
50
25
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level



Segment: 2422D Double Bayou East Fork
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 199
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
4.5
3.5
2.5
2
1.5
1
0.5
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Kjeldahl Nitrogen LOESS Plot


Segment: 2422D Double Bayou East Fork
Parameter: Total Phosphorus
Water Body Type: Tidal Stream
Number of Samples : 208
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.2
0.4
0.6
0.8
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria **Bacteria in Oyster Waters**	2422B I 2422D I 2422OW I	• Agricultural runoff from row crops, pastures, and fallow fields • Urbanization and increased impervious cover • Constructed stormwater controls failing • Bird rookeries on islands throughout the bay and along the shoreline • Improper disposal of waste from boats • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • Waste haulers illegal discharges/improper disposal • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact • recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Create and implement Water Quality Management Plans for individual agricultural properties • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education on proper boat waste disposal • More public education regarding OSSF operations and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	***DO 24hr Avg*** 2422B I ***DO 24hr Min*** I	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields	• Detrimental effect on aquatic biological community	• Educate agricultural community about riparian buffers and other conservation practices that reduce nutrient loads from fertilizer runoff. • Conserve or restore trees and habitat along waterways to maintain/create vegetated riparian buffer zones • More public education regarding OSSF operation and maintenance • Regionalize chronically non-compliant WWTFs

			▪ Vegetative canopy removed		
Elevated Chlorophyll -*a* Concentrations	2422 2422B	C C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	2422 2422B 2422D	I I I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health https:/dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

This segment was included in the Houston Ship Channel TMDL for Dioxin and the Galveston Bay System Survey of Dioxin and PCBs. This segment is also included in the Oyster Waters I-Plan for bacteria (approved in 2015).

The Double Bayou Watershed Protection Plan was approved in 2016. More information on this project can be found at www.doublebayou.org.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes

- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2421				Name: Upper Galveston Bay	
Area:	114 square miles	**Miles of Shoreline:**	35.2 miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	8	**Texas Stream Team Monitoring Stations:**	11	**Permitted WWTF Outfalls:**	3

DESCRIPTION

- Segment 2421: **Upper Galveston Bay** (classified water body) – A 280.2 square kilometer (108.2 square mile) portion of Galveston Bay located entirely between Chambers and Harris Counties extending southward from the vicinity of Morgan's Point to an imaginary east-west line in the area of Redfish Island off Eagle Point and extending eastward to Smith Point in Chambers County, then north on an imaginary north-south line extending to Beach City

- Segment 2421A (Estuary w/ high ALU): **Clear Lake Channel** (unclassified water body)—From the Lower Galveston Bay confluence to SH 146

- Segment 2421B (Tidal Stream w/ high ALU): **Little Cedar Bayou** (unclassified water body) – From the confluence with Upper Galveston Bay to appoint immediately upstream of Barbours Cut Blvd in La Porte

- Segment 2421C (Tidal Stream w/ high ALU): **Pine Gully** (unclassified water body) – From the confluence with Upper Galveston Bay upstream to the terminus approximately 875 meters east of the intersection of Old Highway 146 and Red Bluff Rd in Seabrook

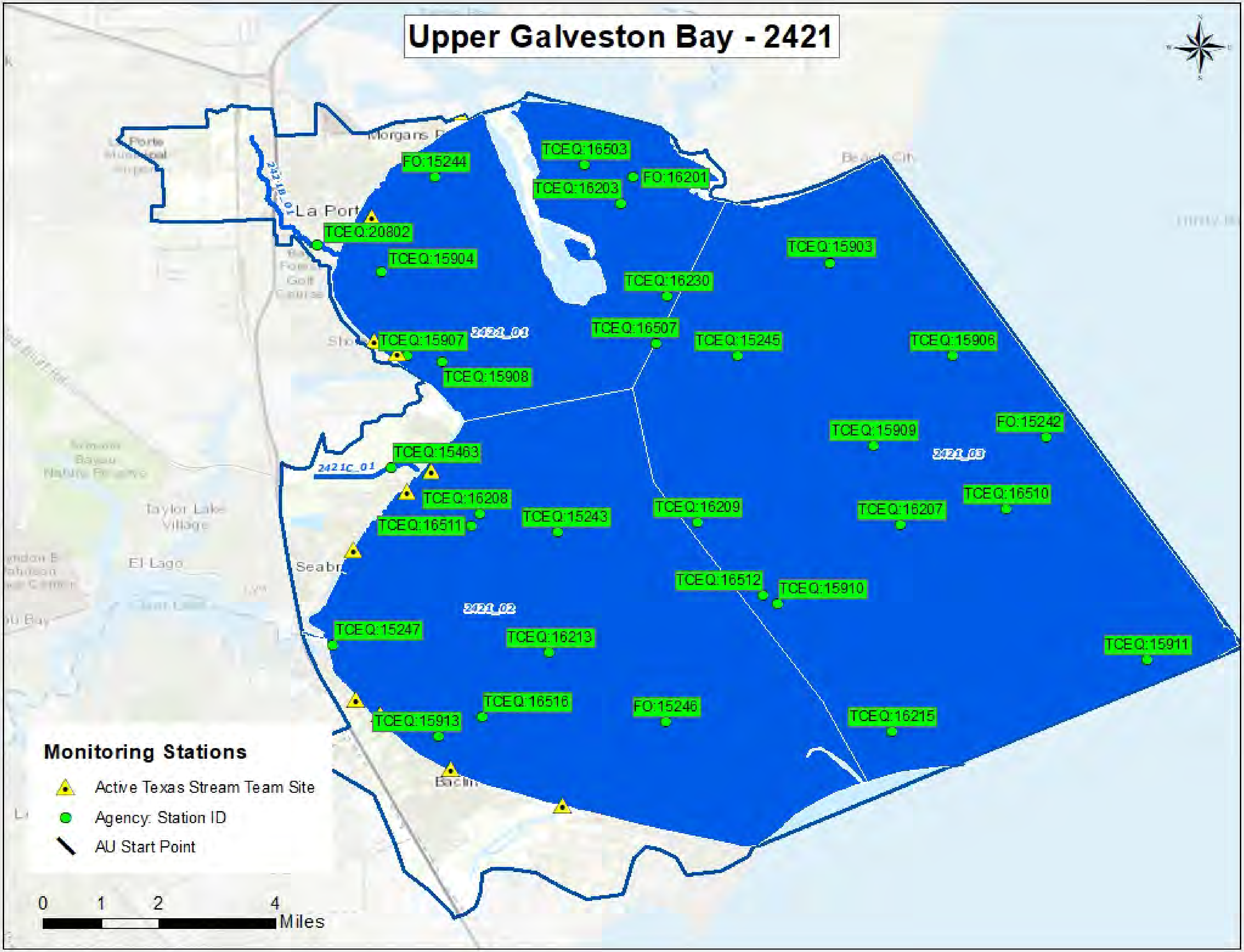
- Segment 2421HC (Recreational beaches)

- Segment 2421OW (Oyster Waters)

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
15242	2421	UPPER GALVESTON BAY AT 95GB011 HALFWAY BETWEEN SMITH POINT AND HOUSTON POINT	FO	QUARTERLY	Field, Conventional, Bacteria
15244	2421	UPPER GALVESTON BAY AT 95GB006 0.75 MI EAST OF BAYRIDGE PARK	FO	QUARTERLY	Field, Conventional, Bacteria
15245	2421	UPPER GALVESTON BAY AT 95GB009 2.5 MI SOUTH OF HOUSTON POINT	FO	QUARTERLY	Field, Conventional, Bacteria
15246	2421	UPPER GALVESTON BAY AT 95GB016 0.23 MI NE OF REDFISH REEF	FO	QUARTERLY	Field, Conventional, Bacteria
15247	2421	UPPER GALVESTON BAY AT 95GB014 JUST SOUTH OF ENTRANCE TO SEABROOK CHANNEL	FO	QUARTERLY	Field, Conventional, Bacteria
16209	2421	UPPER GALVESTON BAY AT 97GB015 0.2MI SE OF HSC CM70 4.93 MI EAST OF PARFUN RD END OF PAVEMENT	FO	ONE/YEAR QUARTERLY	Metal in Sediment, Organics in Sediment Field, Conventional, Bacteria
20802	2421	LITTLE CEDAR BAYOU AT SOUTH BROADWAY STREET / OLD SH 146 / SH LOOP 410 IN LA PORTE	FO	QUARTERLY	Field, Conventional, Bacteria
15463	2421	PINE GULLY AT TODVILLE RD NE OF SEABROOK	FO	QUARTERLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.


Upper Galveston Bay - 2421
TCEQ:16503
FO:15244
FO:16201
TCEQ:16203
TCEQ:20802
TCEQ:15904
TCEQ:15903
TCEQ:16230
TCEQ:16507
TCEQ:15907
2421_01
TCEQ:15245
TCEQ:15906
TCEQ:15908
TCEQ:15909
FO:15242
2421_03
TCEQ:15463
2421C_01
TCEQ:16208
TCEQ:16511
TCEQ:15243
TCEQ:16209
TCEQ:16207
TCEQ:16510
TCEQ:16512
TCEQ:15910
2421_02
TCEQ:15247
TCEQ:16213
TCEQ:15911
TCEQ:16516
TCEQ:15913
FO:15246
TCEQ:16215
2421B_01
La Port
Morgans P
Taylor Lake Village
El Lago
Seabr
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
0
1
2
4
Miles

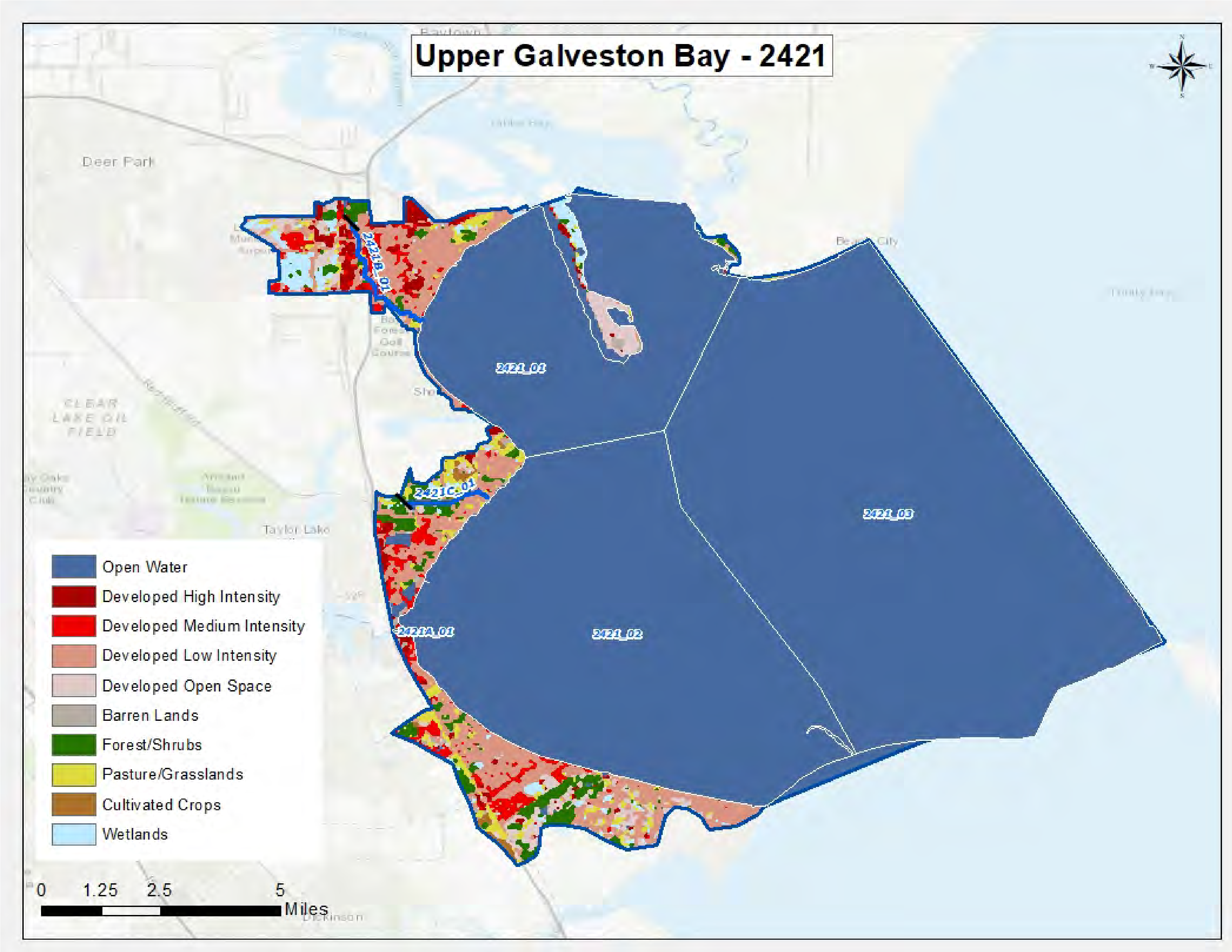
Segment 2421 Water Quality Standards and Screening Levels					
Standards	**Bays & Estuaries**	**Perennial Stream**	**Screening Levels**	**Bays & Estuaries**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia-N (mg/L):	0.10	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	4.0	Nitrate-N (mg/L):	0.17	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66
Enterococci (MPN/100mL) (grab):	130	130	Chlorophyll *a* (µg/L):	11.6	21
Enterococci (MPN/100mL) (geometric mean):	35	35			
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43				

Segment Discussion

Watershed Characteristics and Land Cover: Upper Galveston Bay (2421) is located in southeastern Harris County. It has several tributaries, including Little Cedar Bayou and Pine Gully. Much of Harris County drains to Galveston Bay.

Land use in the northern portion of this watershed is primarily industrial (including petrochemical facilities) with mixed residential and commercial uses present in the cities of La Porte, Shore Acres, and Pasadena. However, residential and commercial land use is more common in the southern reaches of the watershed in the cities of Seabrook and Kemah and in unincorporated Harris and Galveston counties. The watershed area is 81.42 percent Open Water, with 11.18 percent Developed lands. Recreational uses such as fishing and boating are very common throughout the Upper Galveston Bay waters.

Segment 2421 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	2,106.09	2.41	1,706.44	1.96	-18.98
Barren Lands	1,133.33	1.30	1,448.24	1.66	27.79
Developed	8,838.22	10.13	9,755.82	11.18	10.38
Forest/Shrubs	354.72	0.41	1,553.88	1.78	338.06
Open Water	71,558.20	82.03	71,024.67	81.42	-0.75
Wetlands	3,248.75	3.72	1,747.36	2.00	-46.21
TOTAL	**87,239.30**	**100.00**	**87,236.41**	**100.00**	


Upper Galveston Bay - 2421
Deer Park
CLEAR LAKE OIL FIELD
Taylor Lake
Baytown
Beach City
Dickinson
2421B_01
2421_01
2421C_01
2421_03
2421_02
2421A_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1.25 2.5 5
Miles

Water Quality Issues:

Bacteria Impairments and Concerns

The 2020 Integrated Report lists AU 2421OW_01 as impaired for oyster waters due to elevated levels of fecal coliform bacteria. This assessment unit covers the entire western portion of Upper Galveston Bay. This assessment unit is closed by the Seafood Safety Division of the Texas Department of State Health Services for the harvesting of oysters and other shellfish for direct marketing. Little Cedar Bayou (2421B) is also impaired for contact recreation due to elevated levels of bacteria. The remainder of the watershed meets the designated use for primary contact recreation.

Dissolved Oxygen Impairments or Concerns

There are no dissolved oxygen impairments in this segment.

Nutrient Concerns

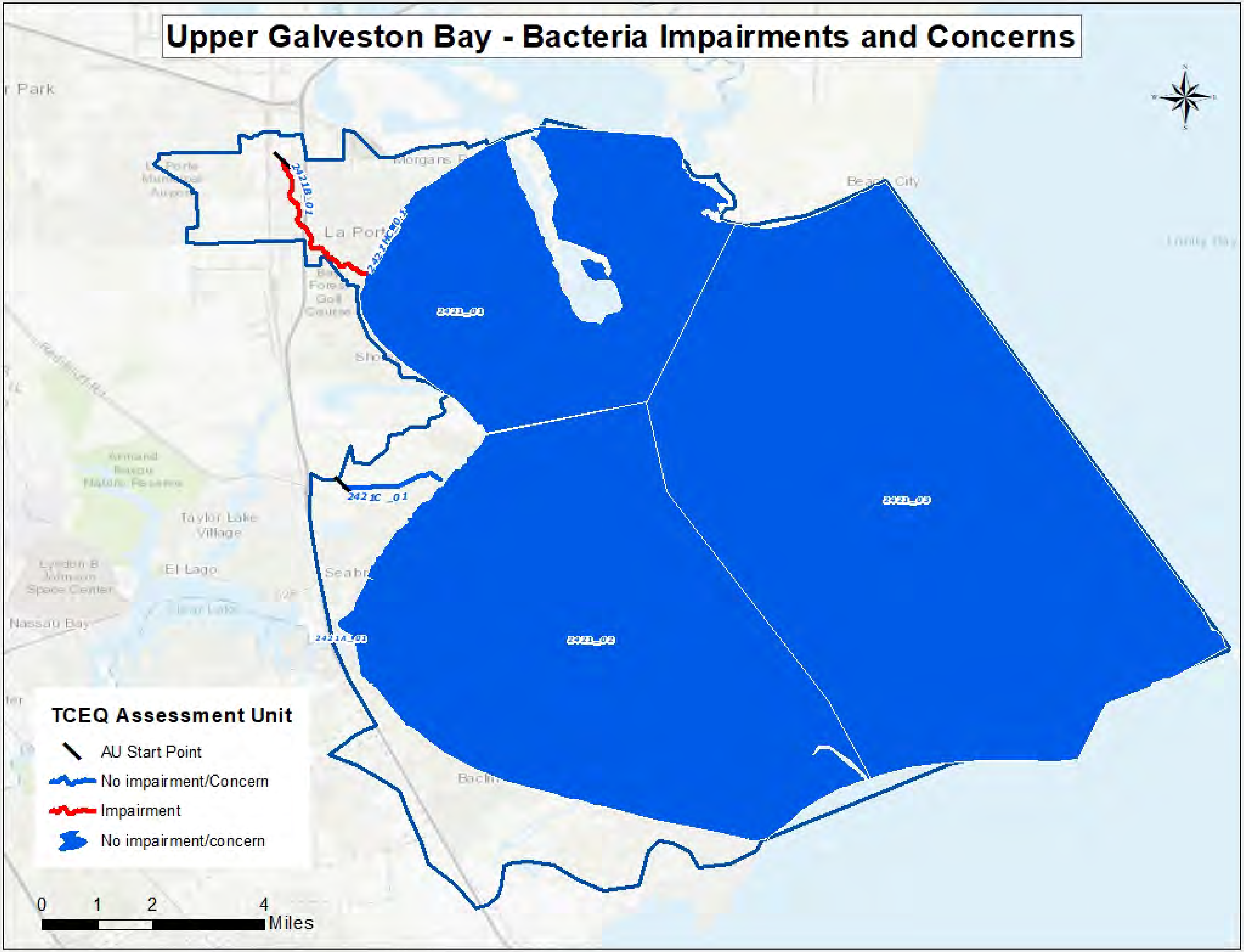
Assessment units within the Upper Galveston Bay system have numerous concerns for water quality based upon screening criteria levels for nutrients. In Upper Galveston Bay (2421) concerns for nitrate-nitrogen and total phosphorus are listed for AUs 2421_01 and 2421_02. Clear Lake Channel (2421A) has a concern for total phosphorus and ammonia-nitrogen, and Little Cedar Bayou (2421B) has concerns for nitrate-nitrogen and total phosphorus.

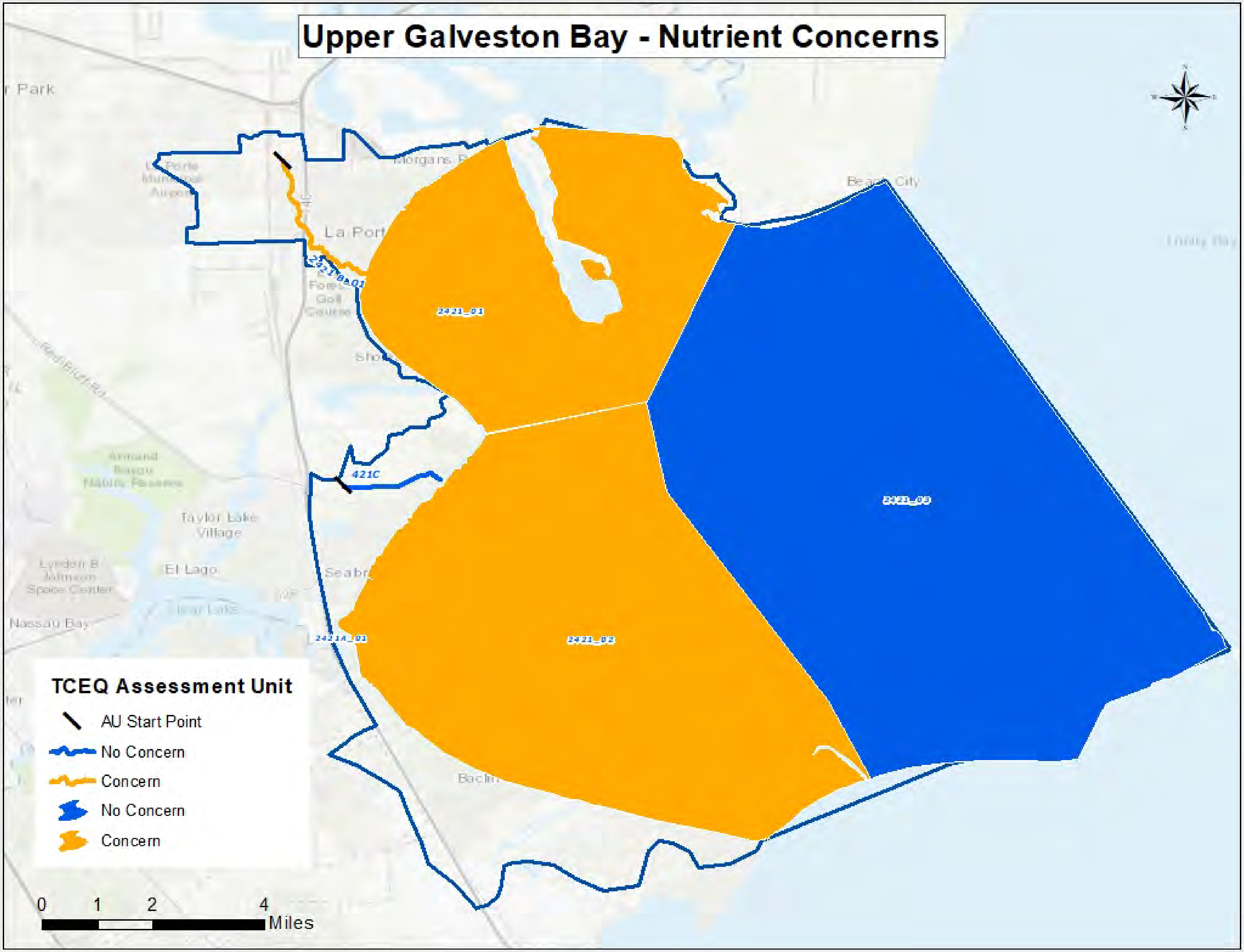
Chlorophyll a Concerns

Three assessment units in Upper Galveston Bay have water quality screening criteria concerns for chlorophyll-a. Concerns for chlorophyll-a screening levels are also present in Little Cedar Bayou and Pine Gully (2421C).

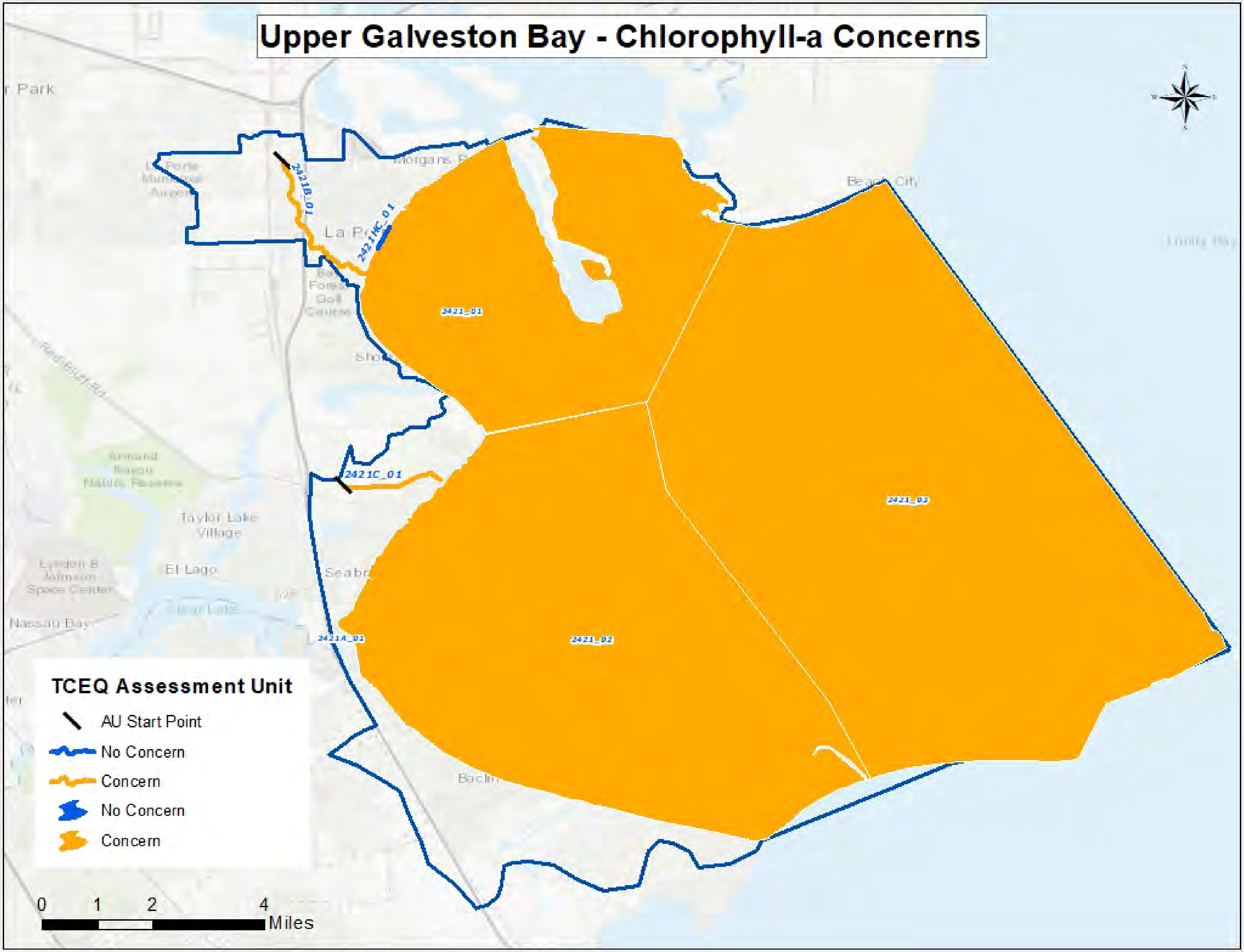
PCBs and Dioxin Impairments

Upper Galveston Bay (2421) and Clear Lake Channel (2421A) are listed as impaired for fish consumption due to elevated levels of dioxin and PCBs found in all species of catfish. The Texas Department of State Health Services as issued a Limited Fish Consumption Advisory for these segments.

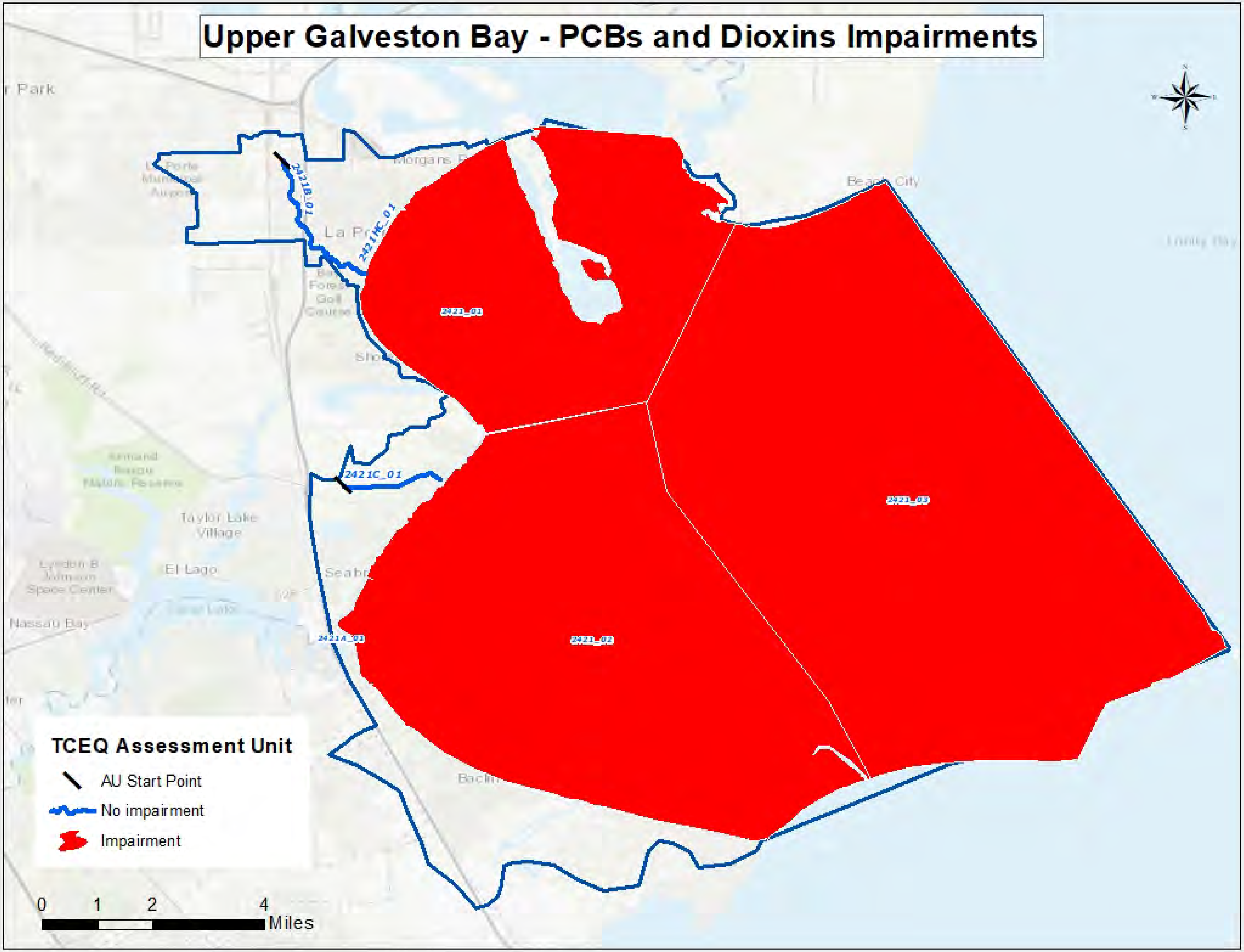

Upper Galveston Bay - Bacteria Impairments and Concerns
2421B_01
2421_01
2421_02
2421_03
2421A_01
La Porte
Beach City
Taylor Lake Village
El Lago
Nassau Bay
Lyndon B Johnson Space Center
Armand Bayou Nature Preserve
TCEQ Assessment Unit
AU Start Point
No impairment/Concern
Impairment
No impairment/concern
0
1
2
4
Miles



Upper Galveston Bay - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
No Concern
Concern
0 1 2 4
Miles
2421_01
2421_02
2421A_01
421C
Taylor Lake Village
El Lago
Nassau Bay



Upper Galveston Bay - Chlorophyll-a Concerns
2421B_01
2421C_01
2421_01
2421_02
2421_03
2421A_01
Taylor Lake Village
El Lago
Nassau Bay
Lyndon B Johnson Space Center
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
No Concern
Concern
0 1 2 4
Miles


Upper Galveston Bay - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
0
1
2
4
Miles
2421_01
2421_02
2421_03
2421B_01
2421HC_01
2421C_01
2421A_01
Morgans P
La Po
Beach City
Taylor Lake Village
El Lago
Nassau Bay
Seabr
Bacli

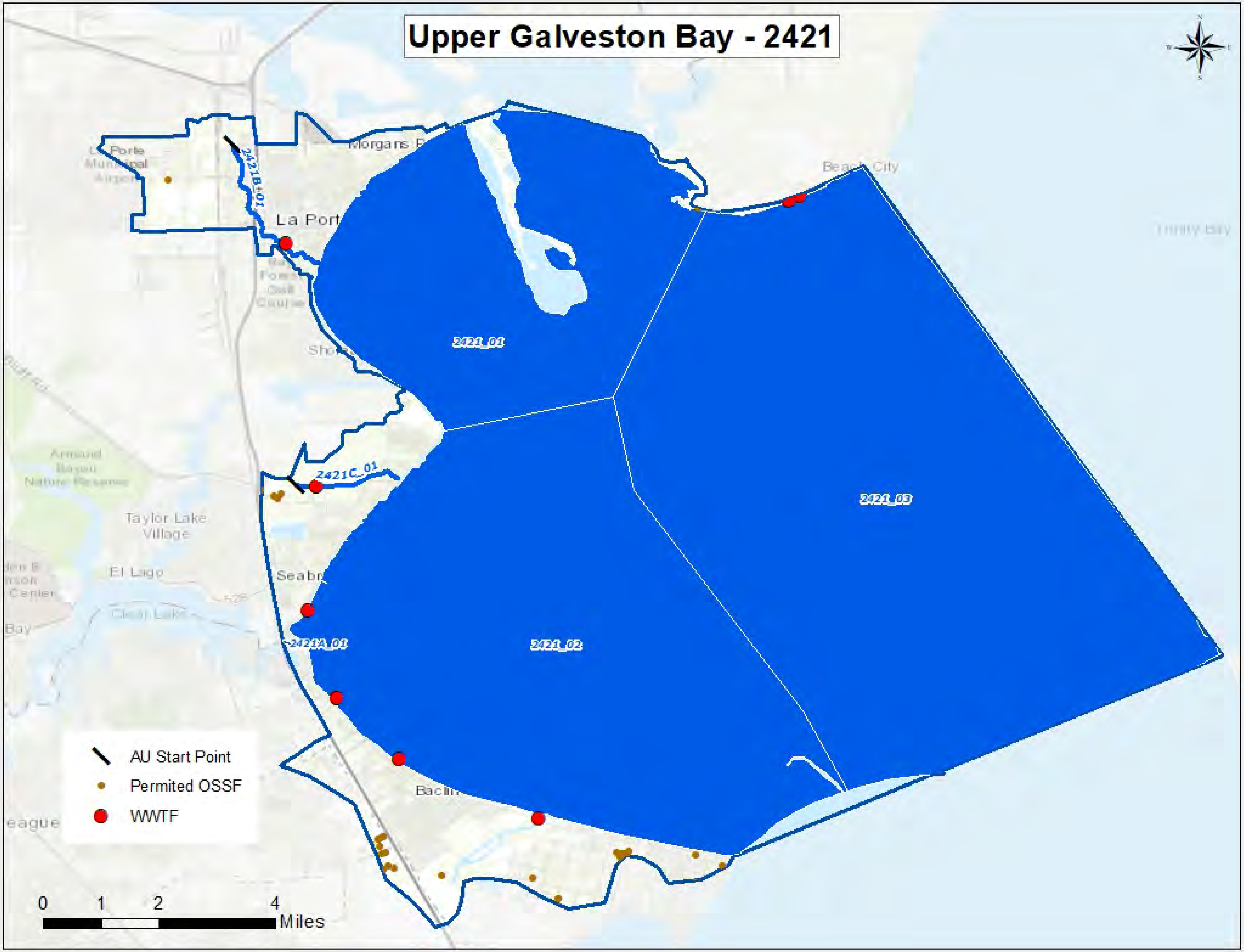
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Upper Galveston Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 3 permitted wastewater outfalls in the Upper Galveston Bay watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 31 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Upper Galveston Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 84 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Upper Galveston Bay watershed.



Upper Galveston Bay - 2421
2421B_01
2421C_01
2421A_01
2421_01
2421_02
2421_03
La Porte
Seabrook
Taylor Lake Village
El Lago
Beach City
AU Start Point
Permited OSSF
WWTF
0
1
2
4
Miles

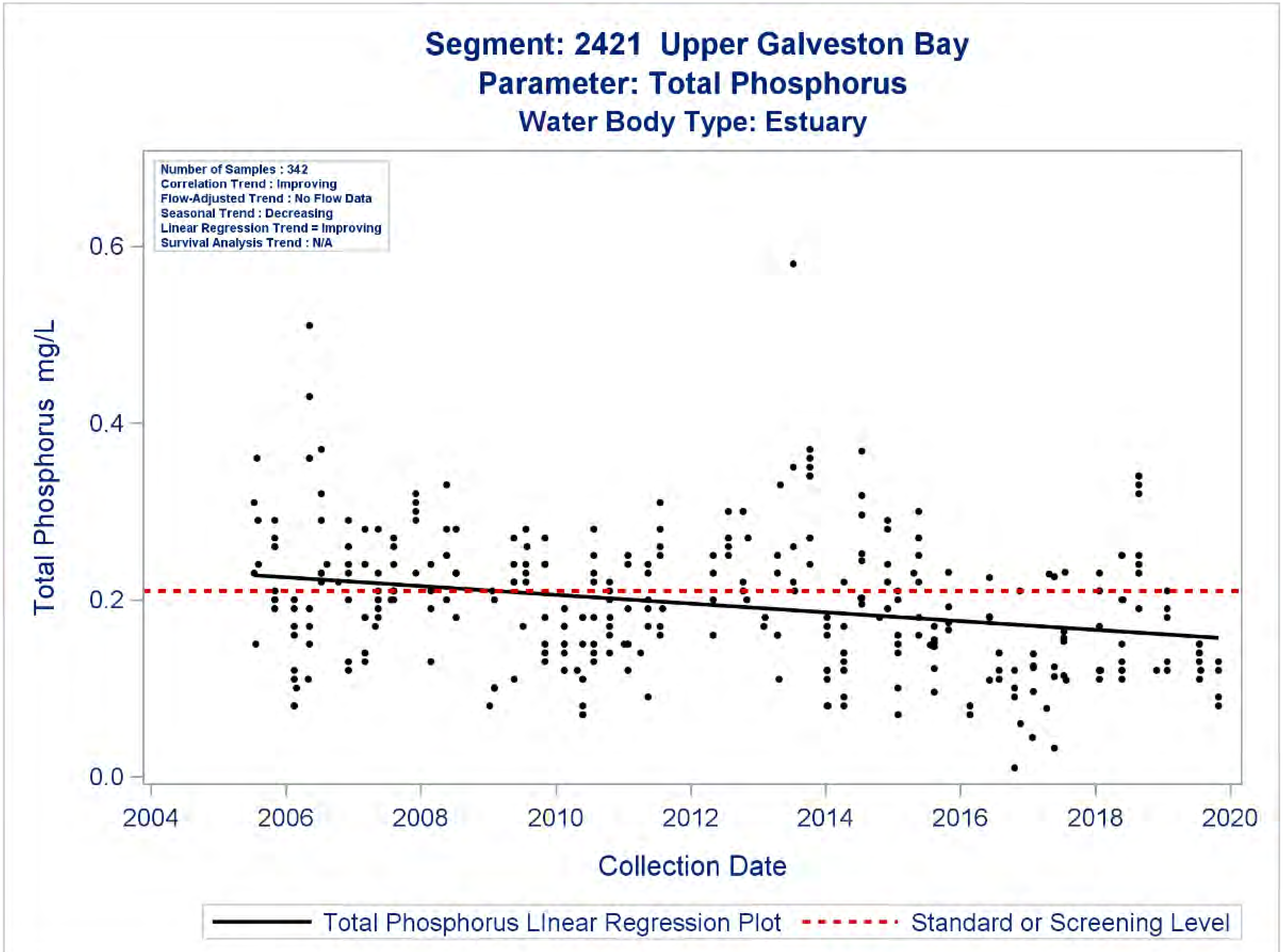
Trend Analysis:

Regression analysis of water quality data identified four parameter trends for Upper Galveston Bay (2421) and four parameter trends in Pine Gully (2421C) including decreasing total phosphorous and TKN. Clear Lake Channel (2421A) and Little Cedar Bayou (2421B), the other two AUs related to Upper Galveston Bay, have no parameter trends identified in their datasets.

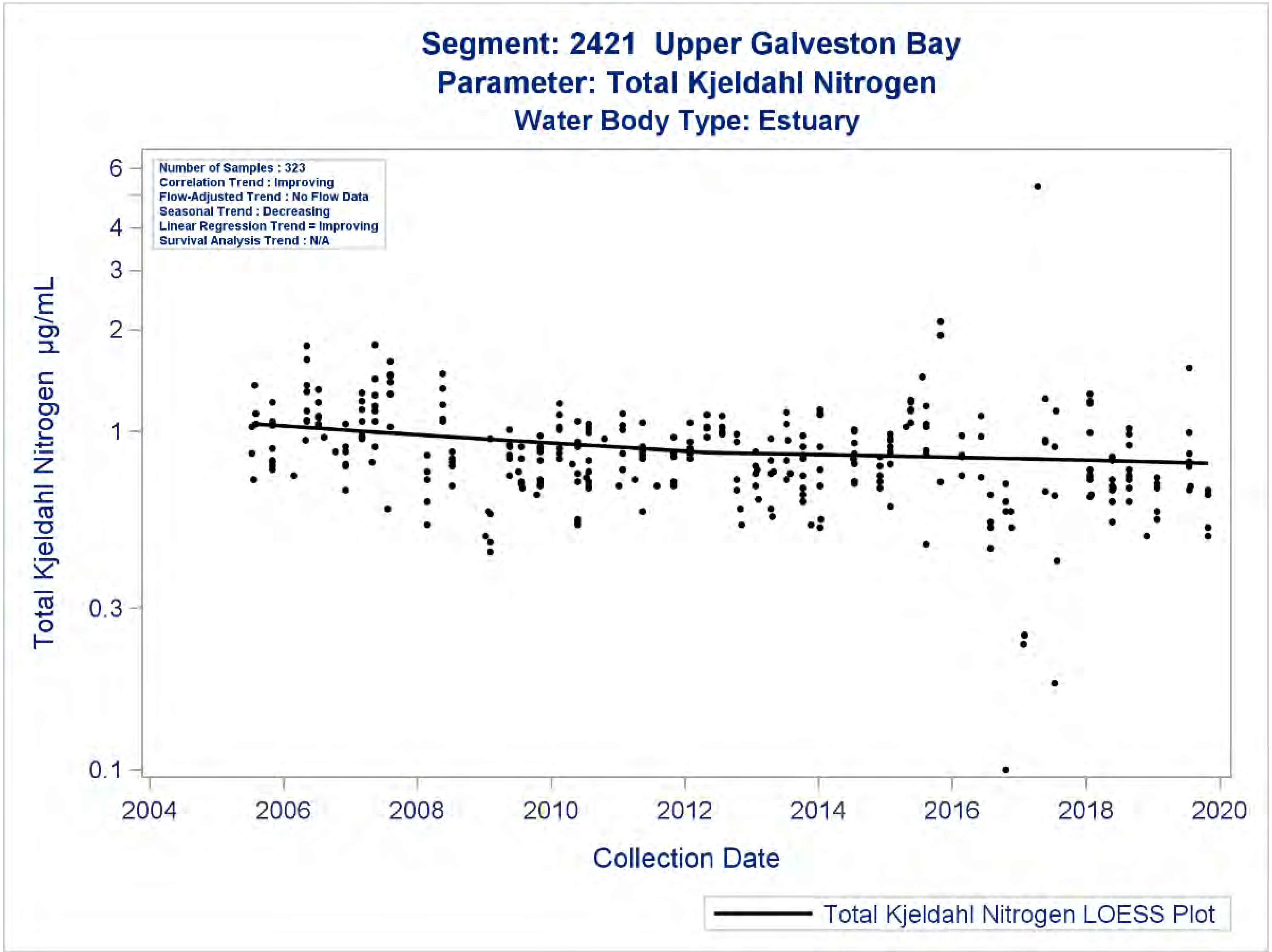
The 2020 Integrated Report (IR) lists the majority of AUs in Upper Galveston Bay as having a concern for nutrients. Although regression analysis show nitrate levels in Upper Bay have been relatively stable since 2000, a decreasing trend was detected for total phosphorus levels in Upper Galveston Bay with concentrations decreasing but many results still exceeded the screening criteria. The is also an improving trend for TKN with concentrations of this nutrient decreasing since 2005. A concern for chlorophyll *a* is also present for the main segment. Chlorophyll *a* levels have remained stable over time but concentrations remain consistently higher than the screening criteria.

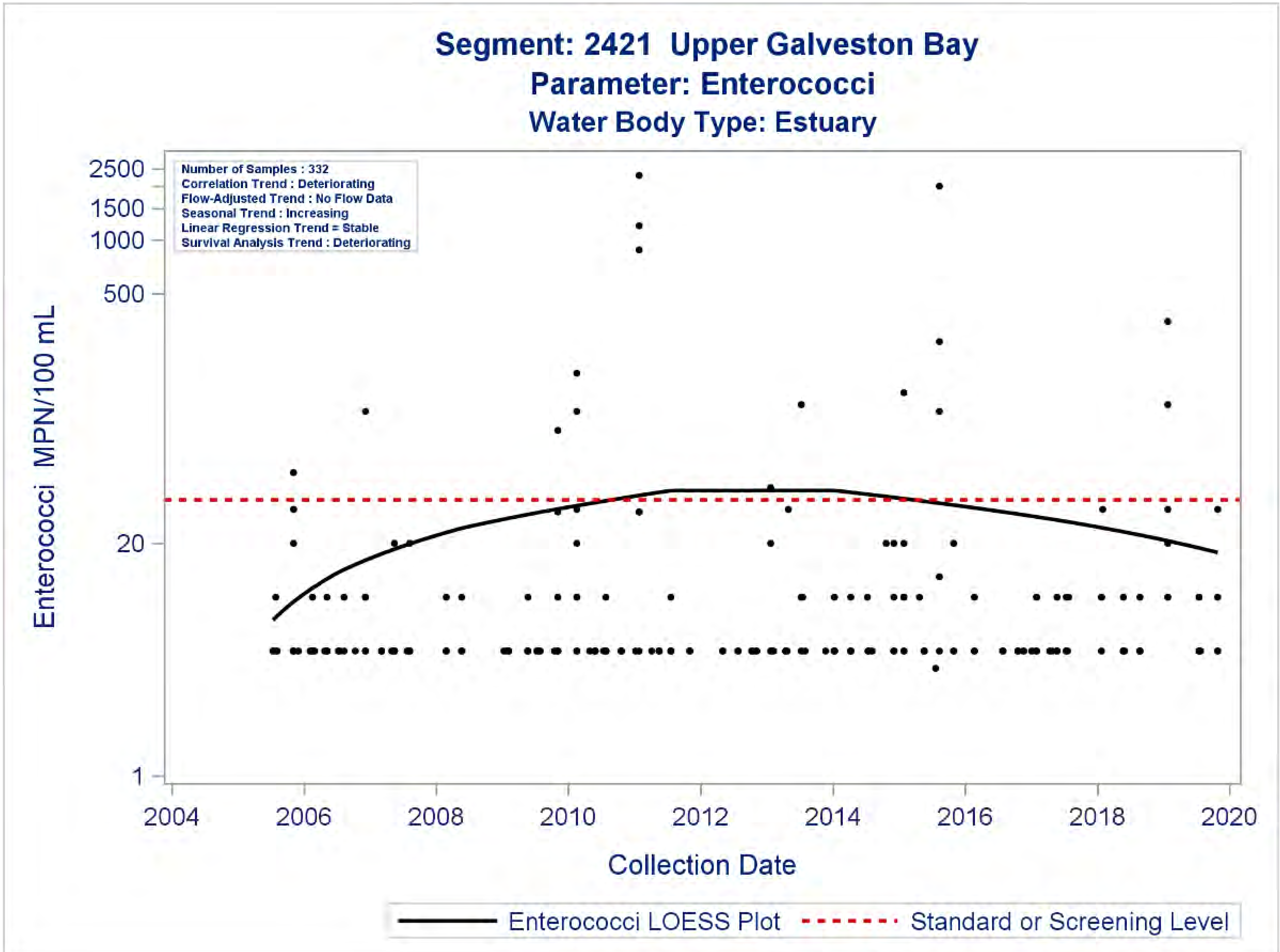
The 2020 IR lists Upper Galveston Bay and two of its tributaries as supporting contact recreation while AU 2421B (Little Cedar Bayou) is not supporting contact recreation due to high bacteria concentrations. The oyster waters of Upper Galveston Bay (2421OW_02 – eastern portion of the bay) however, fully support shellfish harvesting but 2421OW_01 (the western portion of Upper Galveston Bay) is not supporting shellfish harvesting due to bacteria concentrations being too high for oyster consumption. Linear regression analysis detected an improving trend in enterococci levels over time while the LOESS correlation was stable in Pine Gully (AU 2421C).

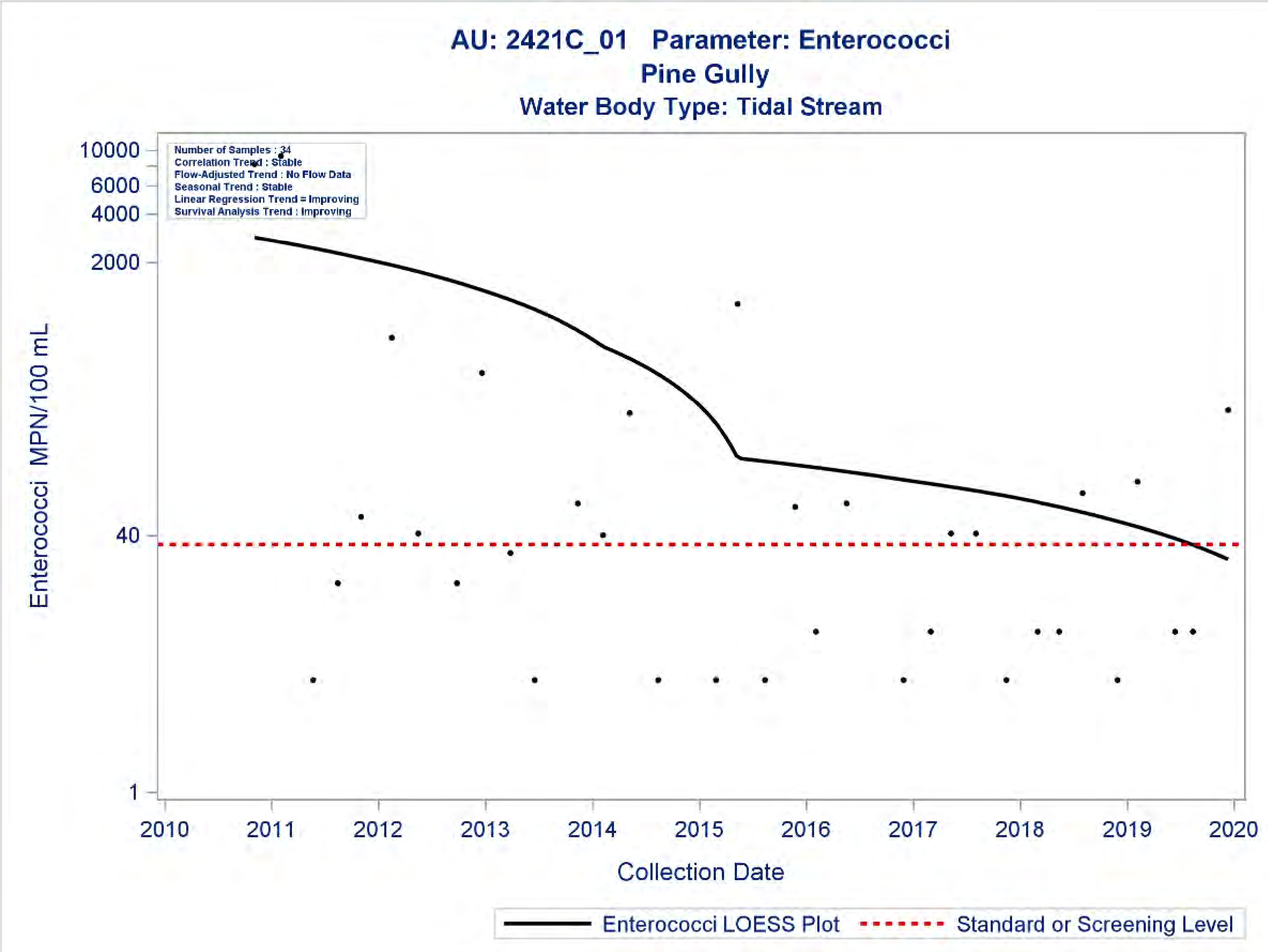
Increasing trends in chloride and specific conductance were observed in Pine Gully.



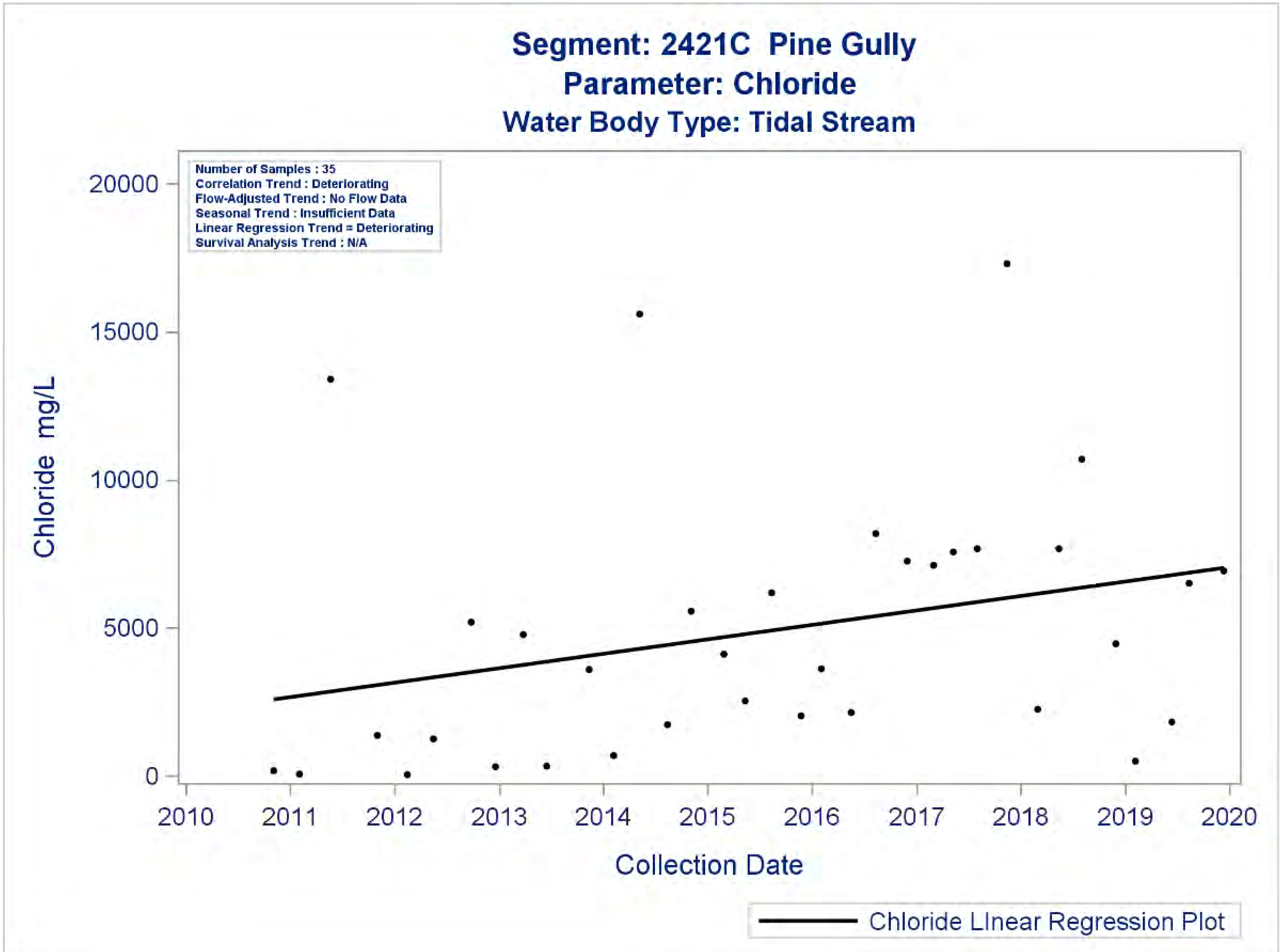
Segment: 2421 Upper Galveston Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 342
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.0
0.2
0.4
0.6
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus Linear Regression Plot
Standard or Screening Level

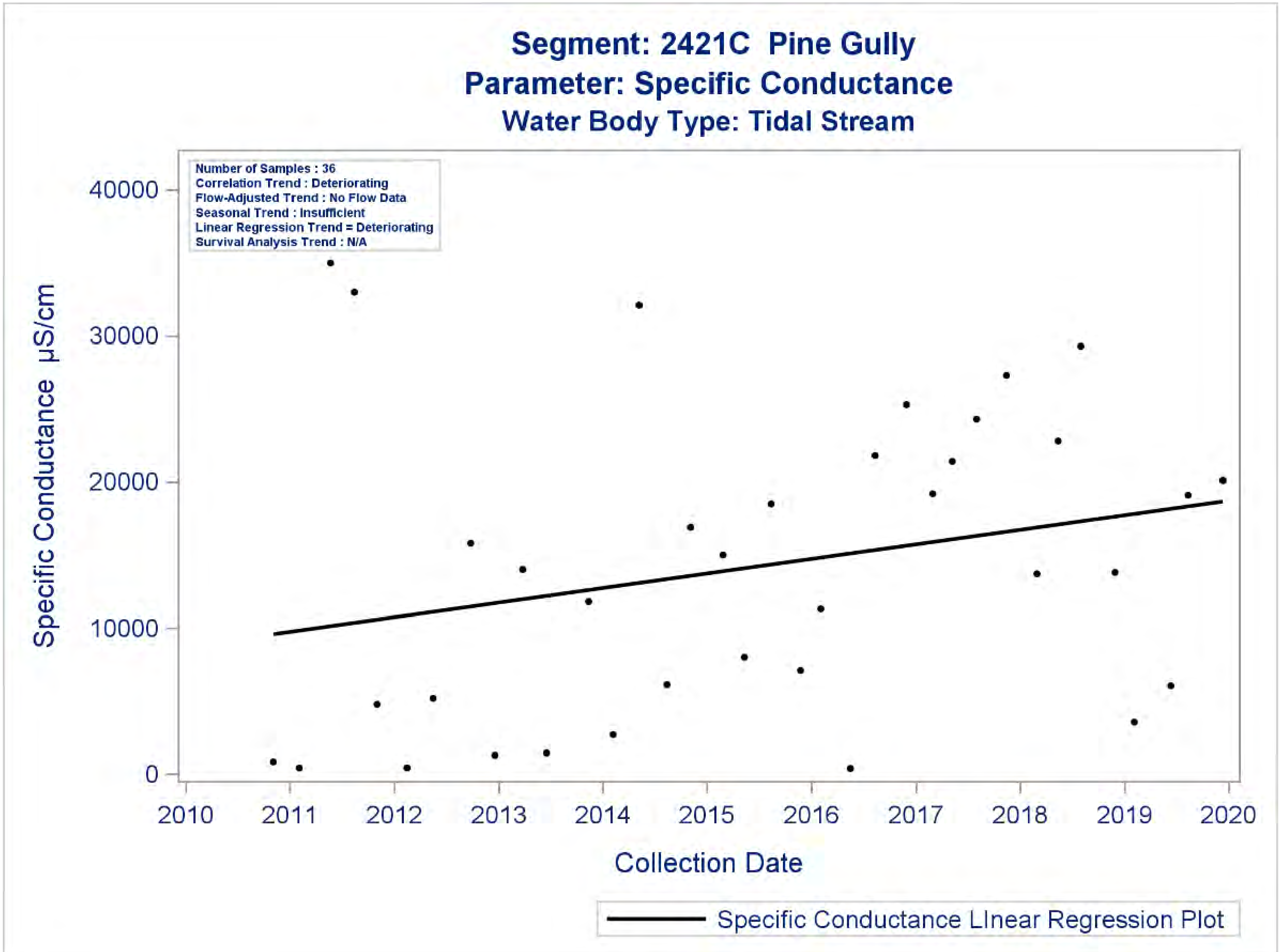

Segment: 2421 Upper Galveston Bay
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 323
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
6
4
3
2
1
0.3
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Kjeldahl Nitrogen LOESS Plot


Segment: 2421 Upper Galveston Bay
Parameter: Enterococci
Water Body Type: Estuary
Number of Samples : 332
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : Deteriorating
Enterococci MPN/100 mL
2500
1500
1000
500
20
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Enterococci LOESS Plot
Standard or Screening Level



AU: 2421C_01 Parameter: Enterococci
Pine Gully
Water Body Type: Tidal Stream
Number of Samples : 34
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : Improving
Enterococci MPN/100 mL
10000
6000
4000
2000
40
1
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Collection Date
Enterococci LOESS Plot
Standard or Screening Level


Segment: 2421C Pine Gully
Parameter: Chloride
Water Body Type: Tidal Stream
Number of Samples : 35
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Chloride mg/L
20000
15000
10000
5000
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Collection Date
Chloride LInear Regression Plot


Segment: 2421C Pine Gully
Parameter: Specific Conductance
Water Body Type: Tidal Stream
Number of Samples : 36
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Specific Conductance µS/cm
40000
30000
20000
10000
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Collection Date
Specific Conductance LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria **Bacteria in Oyster Waters**	2421OW_01 I 2421B_01 I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Improper disposal of waste from boats • Bird rookeries on islands throughout the bay and along the shoreline • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • Create and implement Water Quality Management Plans for individual agricultural properties • More public education on proper boat waste disposal • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs
Elevated Nutrient Concentrations	***Ammonia*** 2421A C ***Nitrate*** 2421_01 C 2421_02 C 2421B C ***Phosphorus*** 2421_01 C 2421_02 C 2421A C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Monitor phosphorus levels at WWTFs to determine if controls are needed. • Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties

	2421B C			• Install and/or maintain riparian buffer areas between agricultural fields and waterways
Elevated Chlorophyll-*a* Concentrations	2421 (Entire Segment) C 2421B C 2421C C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	2421 (Entire Segment) I 2421A I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

- This segment was included in the Houston Ship Channel and Upper Galveston Bay TMDL for PCBs in Fish Tissue.
- This segment was included in the Houston Ship Channel TMDL for Dioxin.
- This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.
- This segment was included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to work with the BIG to implement the I-Plan recommendations for bacteria reduction.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments

- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

BASIN 24 (Lower Portion)

Lower Bays and Estuaries

2433 – Bastrop Bay/Oyster Lake

2432 – Chocolate Bay

2434 – Christmas Bay

2435 – Drum Bay

2423 – East Galveston Bay

2439 – Lower Galveston Bay

2431 – Moses Lake

2437 – Texas City Ship Channel

2424 – West Galveston Bay

Segment Number:	2433	Name:	Bastrop Bay / Oyster Lake		
Area:	5 square miles	**Miles of Shoreline:**	18 miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	0	**Texas Stream Team Monitoring Stations:**	1	**Permitted WWTF Outfalls:**	0

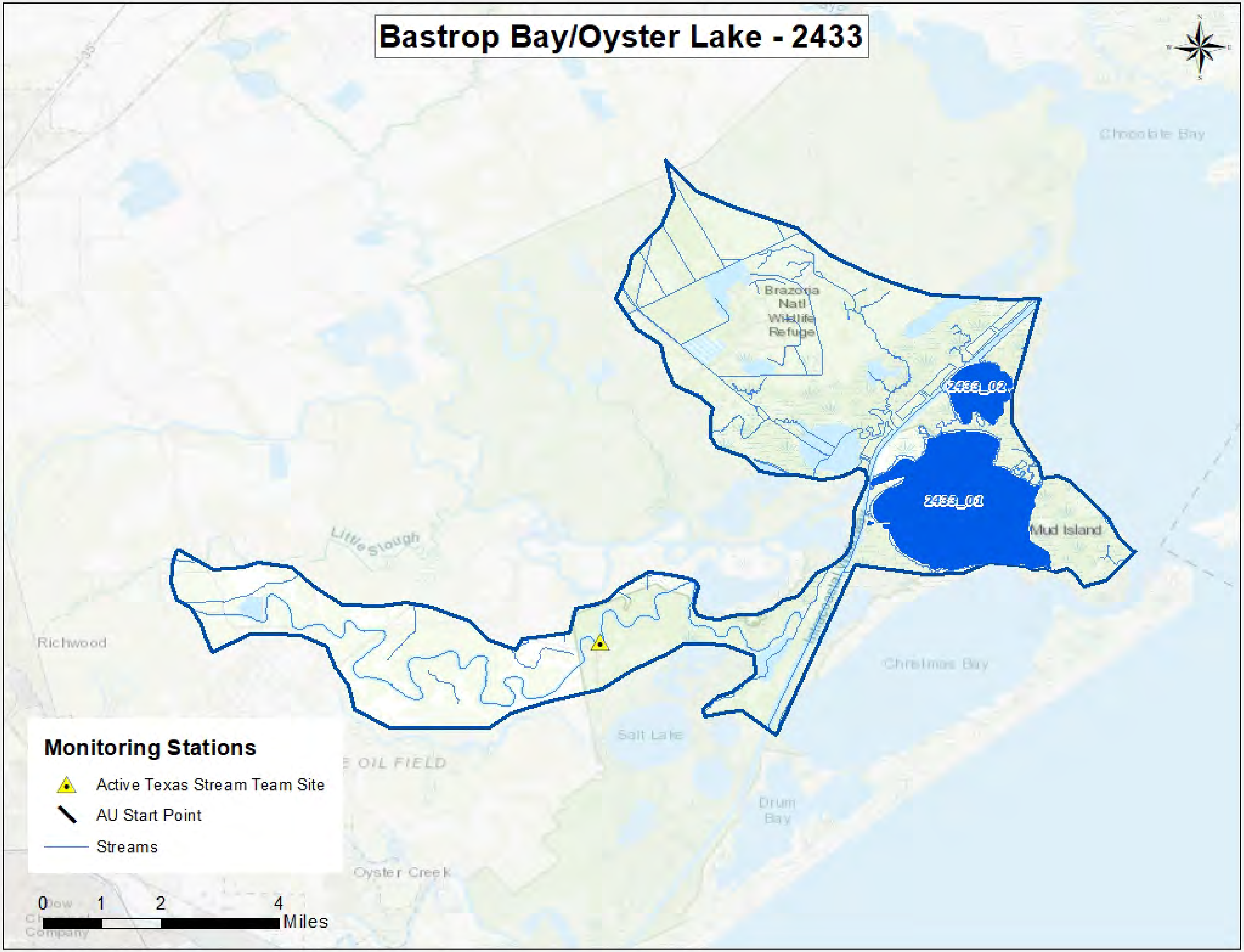
DESCRIPTION

- Segment 2433: **Bastrop Bay / Oyster Lake** (classified water body) – Located immediately west and north of Mud Island at the western end of West Galveston Bay, Bastrop Bay is connected to Oyster Lake via the Gulf Intracoastal Waterway or directly to West Galveston Bay via a cut on the north end of Mud Island in Brazoria County.

- Assessment Unit 2433OW_01: Bastrop Bay (Oyster Waters)

- Assessment Unit 2433OW_02: Oyster Lake (Oyster Waters)

There are no active monitoring stations in Segment 2433.



Bastrop Bay/Oyster Lake - 2433
Chocolate Bay
Brazoria Natl Wildlife Refuge
2433_02
2433_01
Mud Island
Little Slough
Richwood
Christmas Bay
Salt Lake
Drum Bay
Oyster Creek
Monitoring Stations
Active Texas Stream Team Site
AU Start Point
Streams
0 1 2 4
Miles

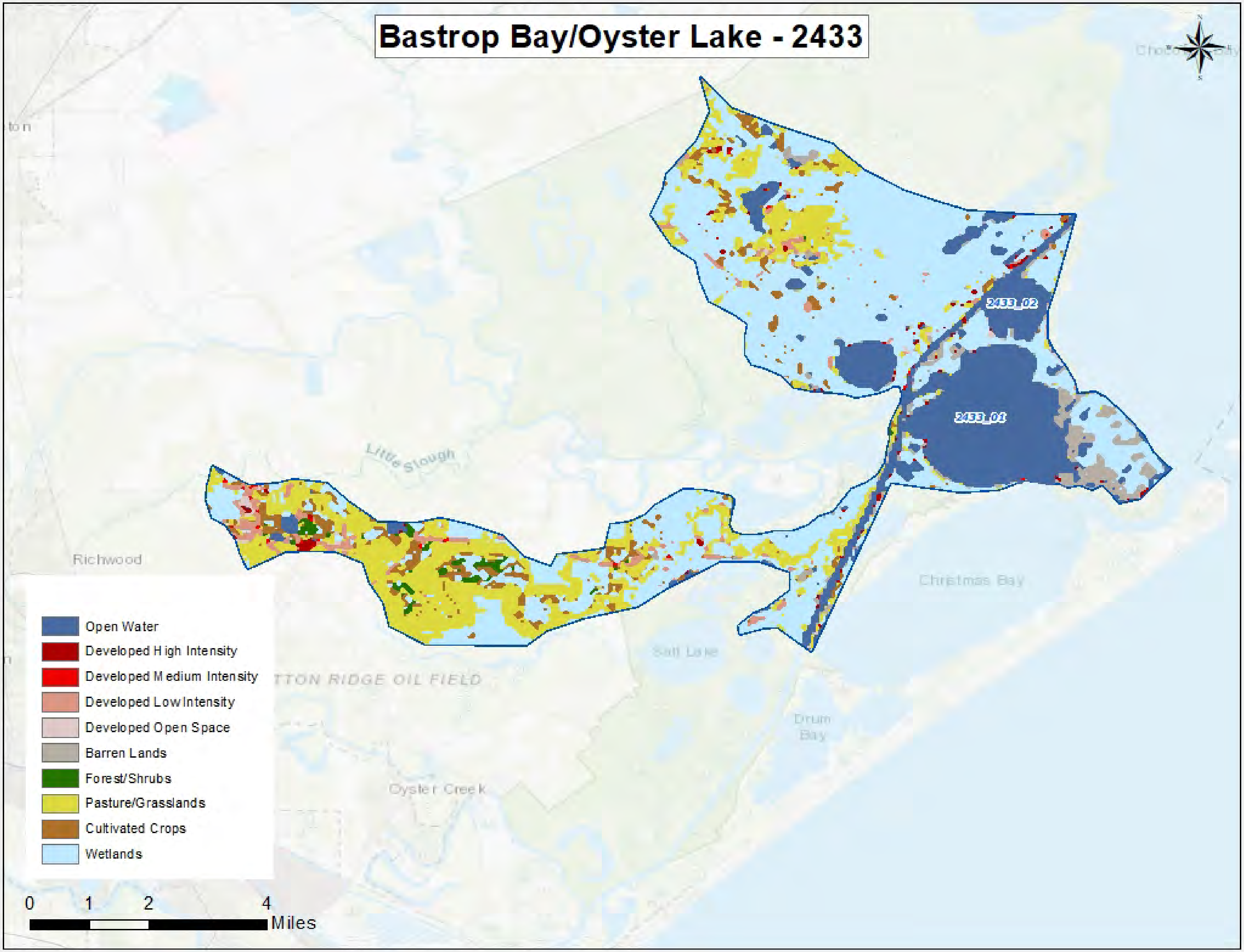
Segment 2433 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43		

Segment Discussion

Watershed Characteristics and Land Cover: Bastrop Bay/Oyster Lake is the receiving water for Bastrop Bayou and connects to Christmas Bay and the Gulf Intracoastal Waterway. Bastrop Bay and Oyster Lake are surrounded by wetlands, coastal grasslands, and the Brazoria National Wildlife Refuge. There are also islands of forested lands and cultivated areas surrounding the bay. The area is home to many species of birds, fish, crustaceans, mollusks, and seagrass.

In this watershed, the predominant land cover classes are Wetlands (49.20 percent), Agriculture (23.32 percent), and Open Water (19.04 percent). Between 2008 and 2018, Agriculture use increased from 703.66 acres to 5,853.23 acres, which attributes to an increase of 731.83 percent. Only 3.93 percent of the watershed is developed. However, Developed land cover has increased 380.93 percent between 2008 and 2018, from 205.27 acres to 987.21 acres.

Segment 2433 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	703.66	2.80	5,853.23	23.32	731.83
Barren Lands	342.04	1.36	940.51	3.75	174.97
Developed	205.27	0.82	987.21	3.93	380.93
Forest/Shrubs	31.80	0.13	191.04	0.76	500.70
Open Water	5,376.19	21.42	4,779.72	19.04	-11.09
Wetlands	18,441.26	73.47	12,349.84	49.20	-33.03
TOTAL	**25,100.22**	**100.00**	**25,101.56**	**100.00**	


Bastrop Bay/Oyster Lake - 2433
2433_02
2433_01
Little Slough
Richwood
Christmas Bay
Salt Lake
Drum Bay
Oyster Creek
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1
2
4
Miles

Water Quality Issues:

Bacteria Impairments and Concerns
Assessment units 2433OW_01 and 2433OW_02 are listed in the 2020 Integrated Report as impaired for oyster waters due to elevated levels of fecal coliform bacteria. These assessment units are closed by the Seafood Safety Division of the Texas Department of State Health Services for the harvesting of oysters and other shellfish for direct marketing.

This segment fully supports its contact recreation use.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

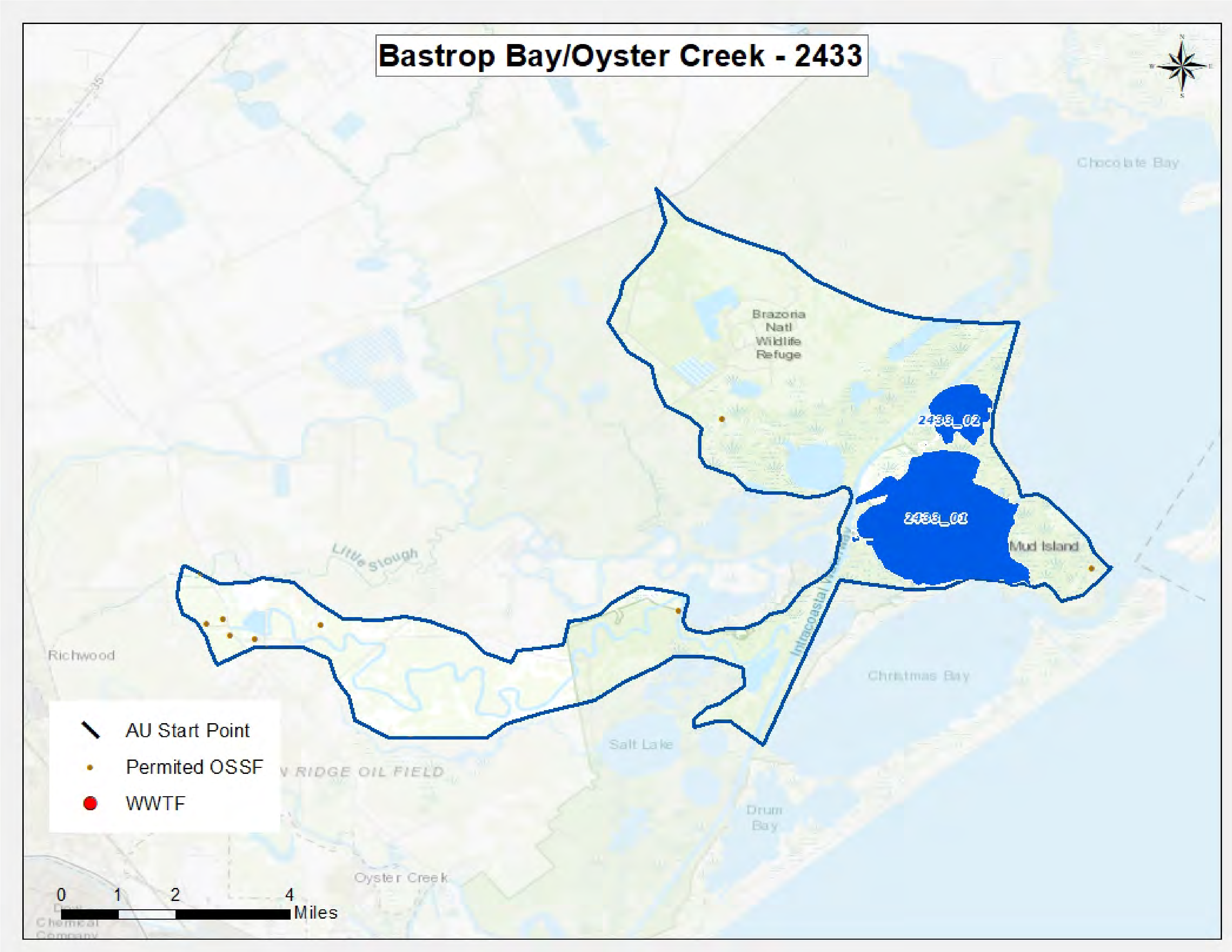
PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Bastrop Bay/Oyster Lake watershed include agricultural runoff and animal/wildlife waste.

There are no permitted wastewater outfalls and 8 permitted on-site sewage facilities in the Bastrop Bay/Oyster Lake watershed. The wastewater treatment facilities and on-site sewage facilities in the Bastrop Bay/Oyster Lake watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Bastrop Bay/Oyster Lake watershed.



Bastrop Bay/Oyster Creek - 2433
Chocolate Bay
Brazoria
Natl
Wildlife
Refuge
2433_02
2433_01
Mud Island
Little Slough
Intracoastal Waterway
Richwood
Christmas Bay
Salt Lake
RIDGE OIL FIELD
Drum
Bay
Oyster Creek
AU Start Point
Permited OSSF
WWTF
0
1
2
4
Miles

Trend Analysis:

Water quality trends for the Bastrop Bay/Oyster Lake (segment 2433) watershed were not evaluated due to insufficient data. No routine water quality data was collected from these water bodies during the period of record for this report.

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria in Oyster Waters	2433OW I	• Animal waste from agricultural production, ranchettes and hobby farms • Urbanization and increased impervious cover • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Add water quality features to stormwater systems • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations

Special Studies:

Bastrop Bay was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was also included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number:	2432	Name:	Chocolate Bay

Area:	7.4 square miles	Miles of Shoreline:	25 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	9	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	21

DESCRIPTION

- Segment 2432: **Chocolate Bay** (classified water body) – Adjoining the northwest side of West Galveston Bay at the Gulf Intracoastal Waterway and extending upstream to confluence with Chocolate Bayou approximately ¾ mile downstream of FM 2004 in southeast Brazoria County

- Segment 2432A (Perennial Stream w/ intermediate ALU): **Mustang Bayou** (unclassified water body) – From the New Bayou confluence upstream to an unnamed tributary 0.3 km (0.19 mi) upstream of State Hwy 35 to an unnamed tributary downstream of Cartwright Road

- Segment 2432B (Perennial Stream w/ high ALU): **Willow Bayou** (unclassified water body) – From the Halls Bayou confluence to a point 9.7 km (6 mi) upstream

- Segment 2432C (Tidal Stream w/ high ALU): **Halls Bayou Tidal** (unclassified water body) — From the Chocolate Bay confluence upstream to a point 31.5 km (19.6 mi) upstream

- Segment 2432D (Perennial Stream w/ high ALU): **Persimmon Bayou** (unclassified water body)—From the New Bayou confluence upstream to the Mustang Bayou confluence

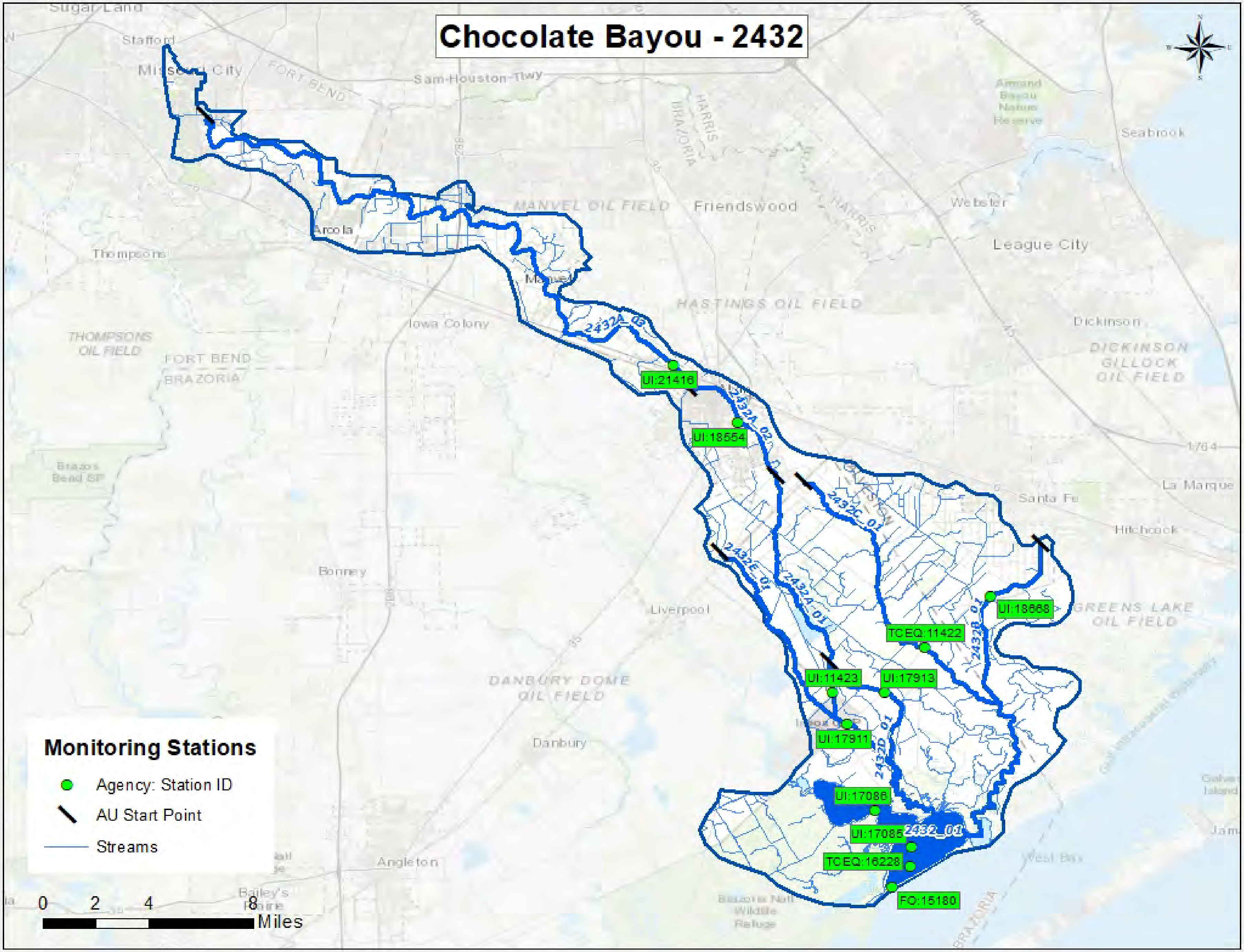
- Segment 2432E (Perennial Stream w/ high ALU): **New Bayou** (unclassified water body)—From the Chocolate Bay confluence upstream 25.4 km (15.8 mi) to an unnamed tributary

- Segment 2432OW (Oyster Waters)

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
17085	2432	CHOCOLATE BAY 1.2 KM EAST OF WHARTON BAYOU AND 8.1 KM DOWNSTREAM OF FM 2004	UI	Quarterly	Field
17086	2432	CHOCOLATE BAY 200 M NORTHWEST OF HORSE GROVE POINT AND 5.1 KM DOWNSTREAM OF FM 2004	UI	Quarterly	Field, Conventional, Bacteria
11423	2432A	MUSTANG BAYOU AT FM 2917 SOUTH OF ALVIN	UI	Quarterly	Field, Conventional, Bacteria, Flow
18554	2432A	MUSTANG BAYOU IMMEDIATELY UPSTREAM OF EAST SOUTH STREET 85 METERS WEST OF SOUTHBOUND SH 35 IN ALVIN USGS ID 8077890	UI	Quarterly	Field, Conventional, Bacteria, Flow
21416	2432A	MUSTANG BAYOU AT THE HEIGHTS-MANVEL ROAD /CARDINAL DRIVE BRIDGE NEAR ALVIN	UI	Quarterly	Field, Conventional, Bacteria, Flow
18668	2432B	WILLOW BAYOU AT BAKER ST 404 M UPSTREAM OF FM 2004 SOUTH OF SANTA FE IN GALVESTON COUNTY	UI	Quarterly	Field, Conventional, Bacteria, Flow
11422	2432C	HALLS BAYOU AT FM 2004 SW OF ALTO LOMA	FO	Quarterly	Field, Conventional, Bacteria
17913	2432D	PERSIMMON BAYOU AT FM 2004 S/SW OF HITCHCOCK	UI	Quarterly	Field, Conventional, Bacteria
17911	2432E	NEW BAYOU AT FM 2004 S/SW OF HITCHCOCK	UI	Quarterly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.



Chocolate Bayou - 2432
Monitoring Stations
Agency: Station ID
AU Start Point
Streams
0 2 4 8
Miles
UI:21416
UI:18554
UI:18668
TCEQ:11422
UI:11423
UI:17913
UI:17911
UI:17086
UI:17085
TCEQ:16228
FO:15180
2432A_03
2432A_02
2432C_01
2432E_01
2432A_01
2432B_01
2432D_01
2432_01

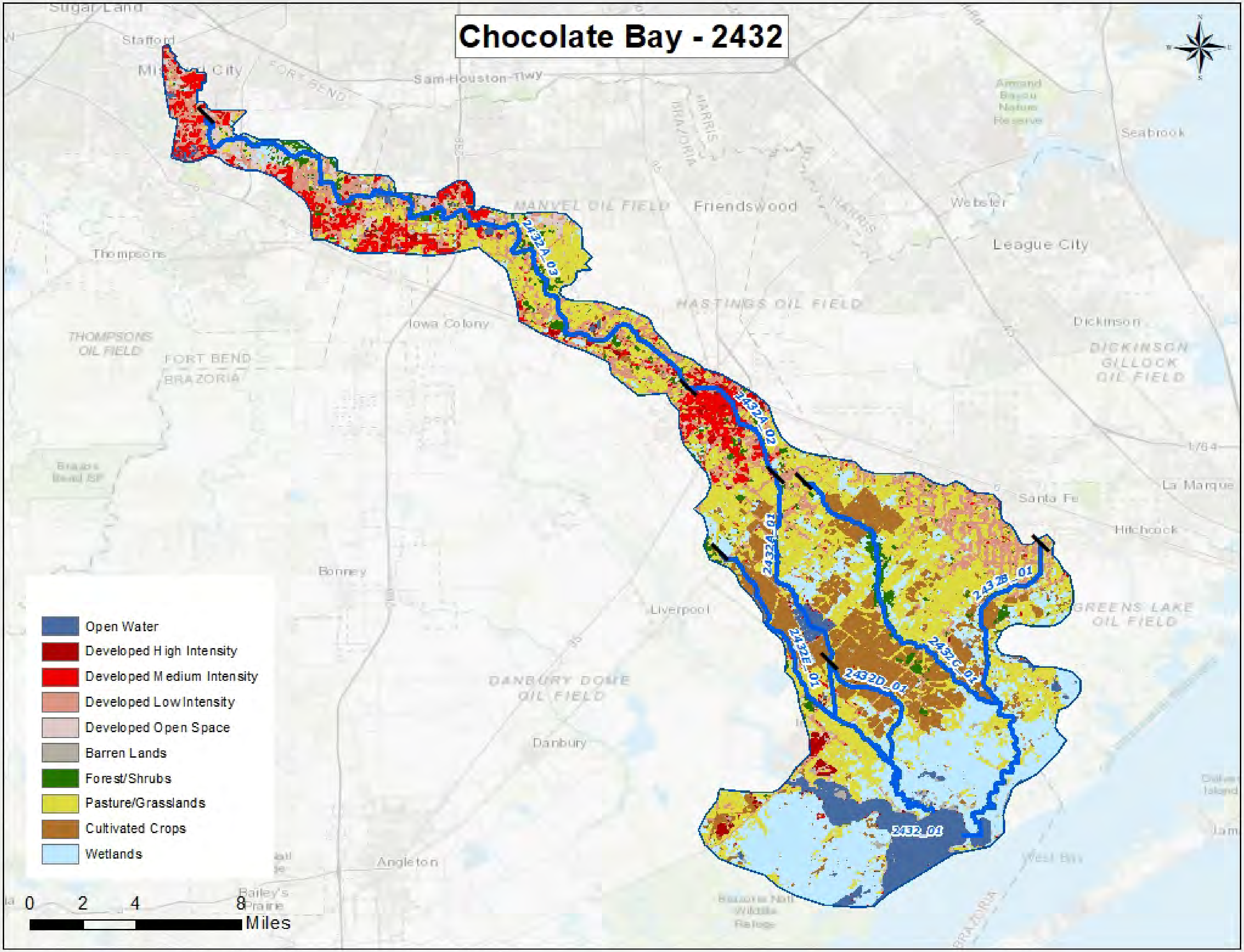
Segment 2432 Water Quality Standards and Screening Levels							
Standards	**Bays & Estuaries**	**Tidal Stream**	**Perennial Stream**	**Screening Levels**	**Bays & Estuaries**	**Tidal Stream**	**Perennial Stream**
Temperature (°C/°F):	35 / 95	35 / 95	35 / 95	Ammonia-N (mg/L):	0.10	0.46	0.33
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	4.0	5.0 / 4.0	Nitrate-N (mg/L):	0.17	1.10	1.95
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	3.0 / 3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46	0.37
pH (standard units):	6.5-9.0	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66	0.69
Enterococci (MPN/100mL) (grab):	104	104	104	Chlorophyll *a* (µg/L):	11.6	21	14.1
Enterococci (MPN/100mL) (geometric mean):	35	35	35				
E. coli (MPN/100mL) (geometric mean)	n/a	n/a	126				
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43	n/a	n/a				

Segment Discussion

Watershed Characteristics and Land Cover:

Chocolate Bay, including major tributaries Mustang Bayou and Halls Bayou, begins its journey in Fort Bend County, the headwaters of Mustang Bayou. Chocolate Bay also receives water from Chocolate Bayou and terminates in West Galveston Bay. The Chocolate Bay watershed is on the northwest side of West Galveston Bay at the Gulf Intercoastal Waterway and extends upstream to the confluence with Chocolate Bayou in Brazoria County. Wetlands and grasslands surround this segment which supports barge traffic servicing the petrochemical industries located upstream. Agriculture, including ranching, is the primary land use throughout the watershed. There are two urban areas in the watershed including the City of Alvin, which is centrally located, and Missouri City, which is located to the north. Agriculture is the predominant land cover class at 45.91 percent, followed by Wetlands (23.29 percent) and Developed lands (20.98 percent).

Segment 2432 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	58,796.48	46.70	57,804.59	45.91	-1.69
Barren Lands	1,942.40	1.54	1,454.69	1.16	-25.11
Developed	25,212.75	20.03	26,413.47	20.98	4.76
Forest/Shrubs	1,172.69	0.93	3,688.65	2.93	214.55
Open Water	6,701.44	5.32	7,218.07	5.73	7.71
Wetlands	32,076.32	25.48	29,323.29	23.29	-8.58
TOTAL	**125,902.09**	**100.00**	**125,902.76**	**100.00**	



Chocolate Bay - 2432
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 2 4 8
Miles
2432A_03
2432A_02
2432A_01
2432B_01
2432C_01
2432D_01
2432E_01
2432_01
Stafford
Sam Houston Tlwy
Manvel Oil Field
Friendswood
Webster
League City
Seabrook
Thompsons
Thompsons Oil Field
Fort Bend
Brazoria
Iowa Colony
Hastings Oil Field
Dickinson
Dickinson Gillock Oil Field
Santa Fe
La Marque
Hitchcock
Bonney
Liverpool
Greens Lake Oil Field
Danbury Dome Oil Field
Danbury
Angleton
Bailey's Prairie
West Bay

Water Quality Issues:

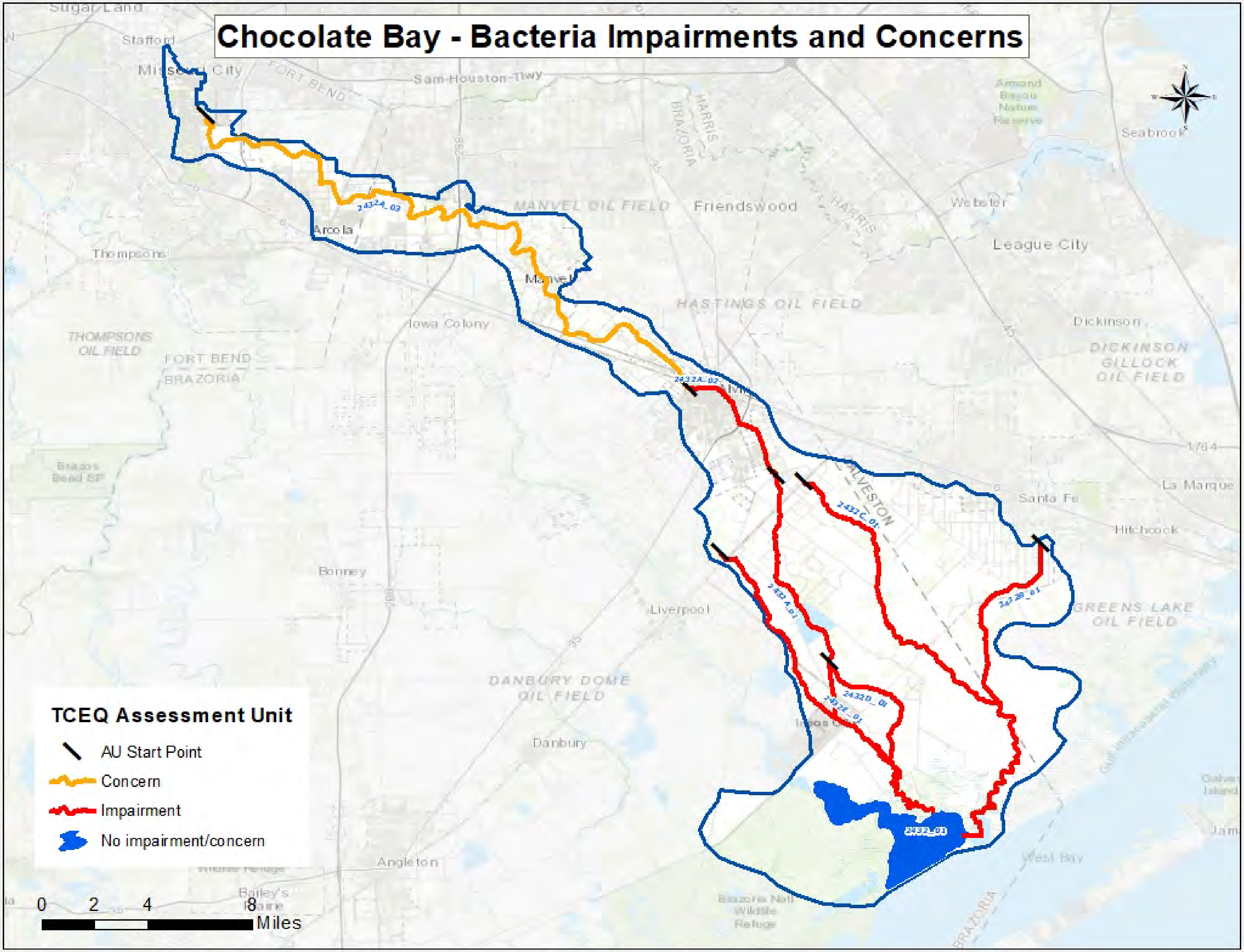
Bacteria Impairments and Concerns
The 2020 Integrated Report lists AUs 2432A_01 and 2432A_02 of Mustang Bayou as being impaired for contact recreation due to elevated *E. coli* bacteria. A concern is indicated in 2432A_03. Contact recreation impairments are also present for Willow Bayou (2432B), Halls Bayou Tidal (2432C), Persimmon Bayou (2432D), and New Bayou (2432E).

The 2020 Integrated Report lists AU 2432OW_01 as impaired for oyster waters. This assessment unit is restricted by the Seafood Safety Division of the Texas Department of State Health Services for the harvesting of oysters and other shellfish for direct marketing.

Dissolved Oxygen Concerns
Chocolate Bay has a concern for depressed dissolved oxygen in Chocolate Bay (AU 2432A_01), Willow Bayou (AU 2432B_01), and Halls Bayou Tidal (AU 2432C_01.

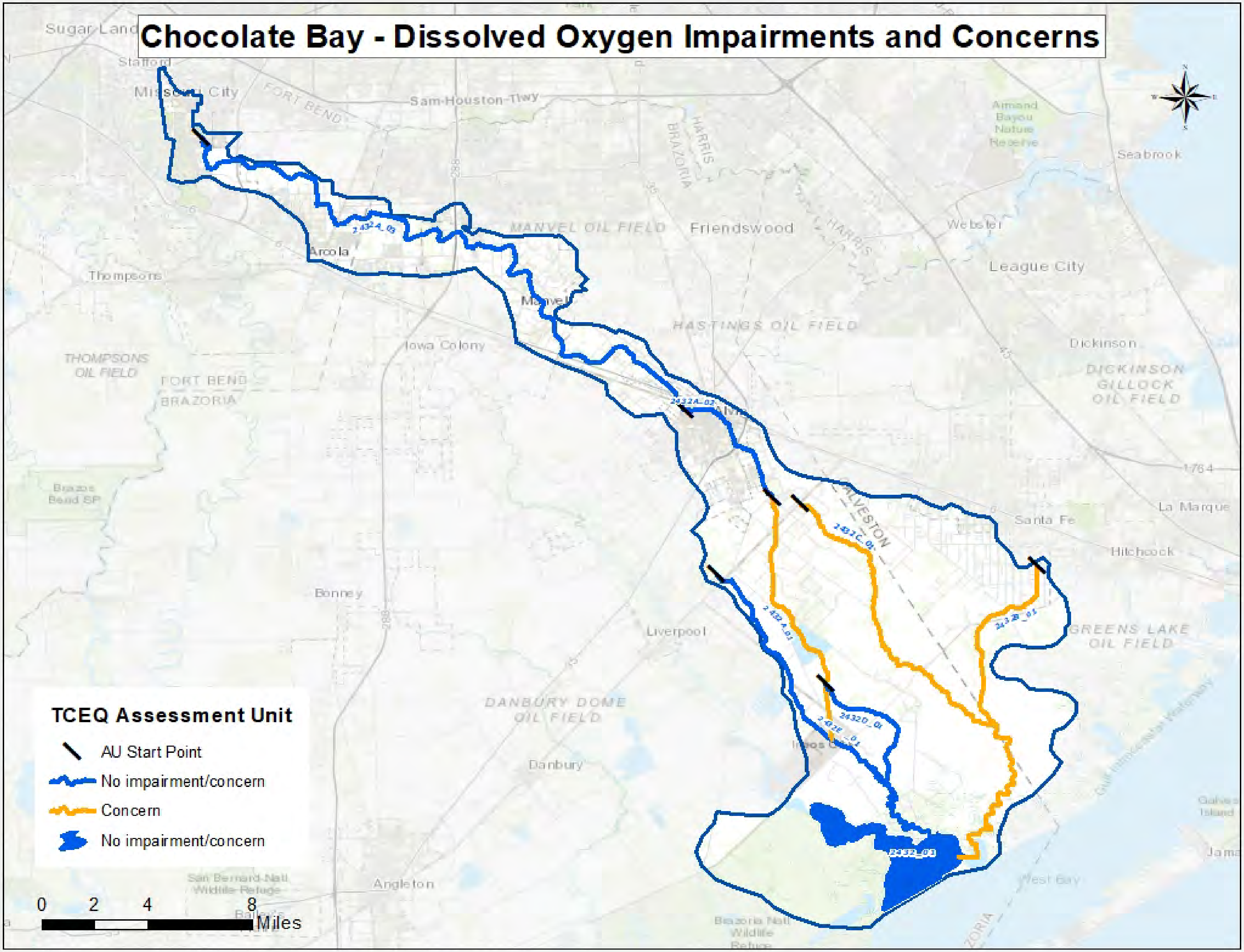
Nutrient Concerns
A concern for ammonia-nitrogen nutrient screening levels is present in Chocolate Bay, with 34.0 percent of samples collected between 12/1/11 – 11/30/18 exceeding the nutrient screening criteria.

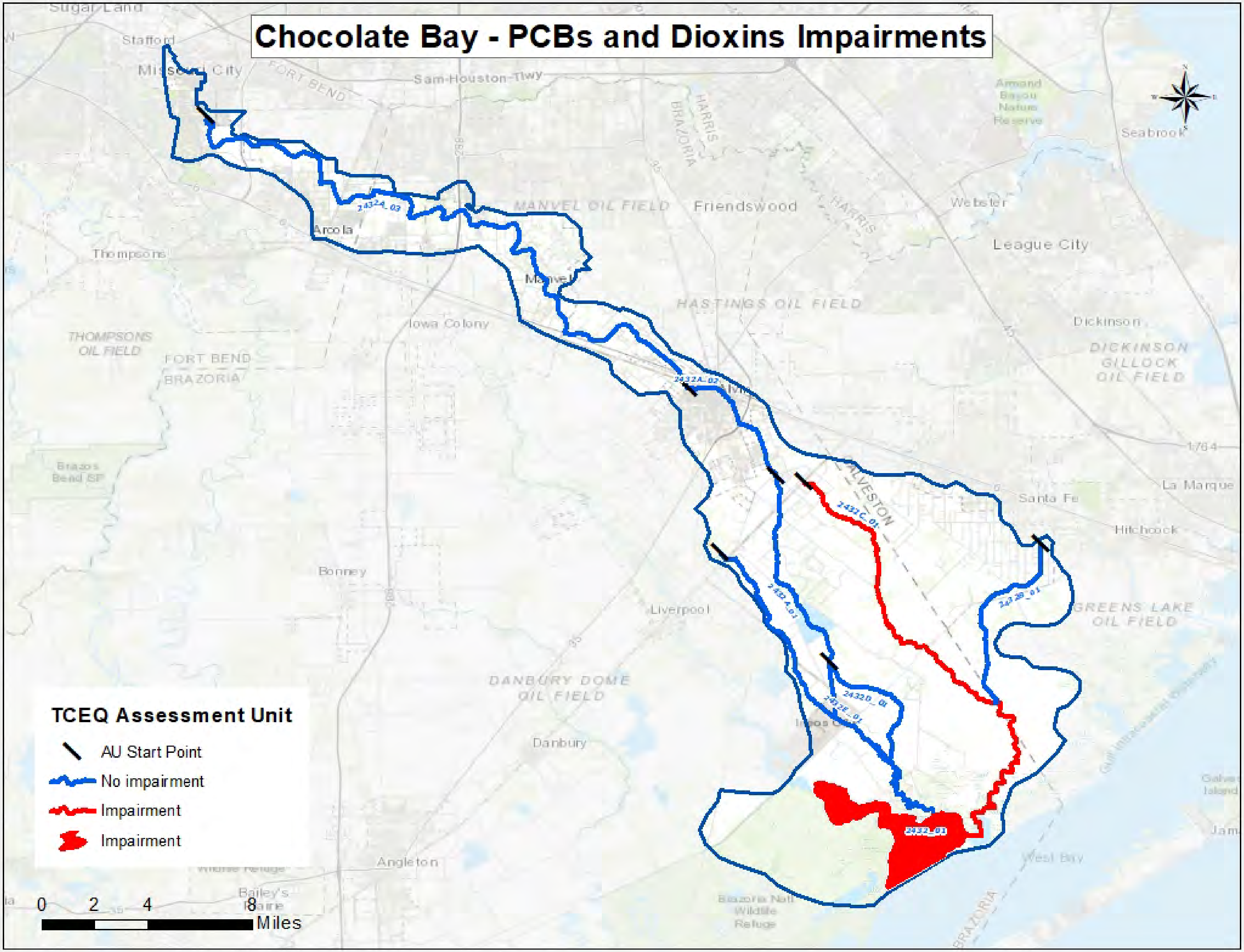
PCBs and Dioxin Impairments
Chocolate Bay (2432) and Halls Bayou (2432C) are listed as impaired for PCBs and Dioxins in species of catfish. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.



Chocolate Bay - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
Concern
Impairment
No impairment/concern
0 2 4 8
Miles

Chocolate Bay - Dissolved Oxygen Impairments and Concerns




Chocolate Bay - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
Impairment
0
2
4
8
Miles
2432A_03
2432A_02
2432C_01
2432A_01
2432B_01
2432D_01
2432E_01
2432_01
Sugar Land
Stafford
Missouri City
Sam Houston Tlwy
FORT BEND
MANVEL OIL FIELD
Friendswood
HARRIS
BRAZORIA
Arcola
Thompsons
Manvel
HASTINGS OIL FIELD
Iowa Colony
THOMPSONS OIL FIELD
FORT BEND
BRAZORIA
Brazos Bend SP
Bonney
Liverpool
DANBURY DOME OIL FIELD
Danbury
Angleton
Bailey's Prairie
Brazoria Natl Wildlife Refuge
Armand Bayou Nature Reserve
Seabrook
Webster
League City
Dickinson
DICKINSON GILLOCK OIL FIELD
La Marque
Santa Fe
Hitchcock
GALVESTON
GREENS LAKE OIL FIELD
West Bay
BRAZORIA

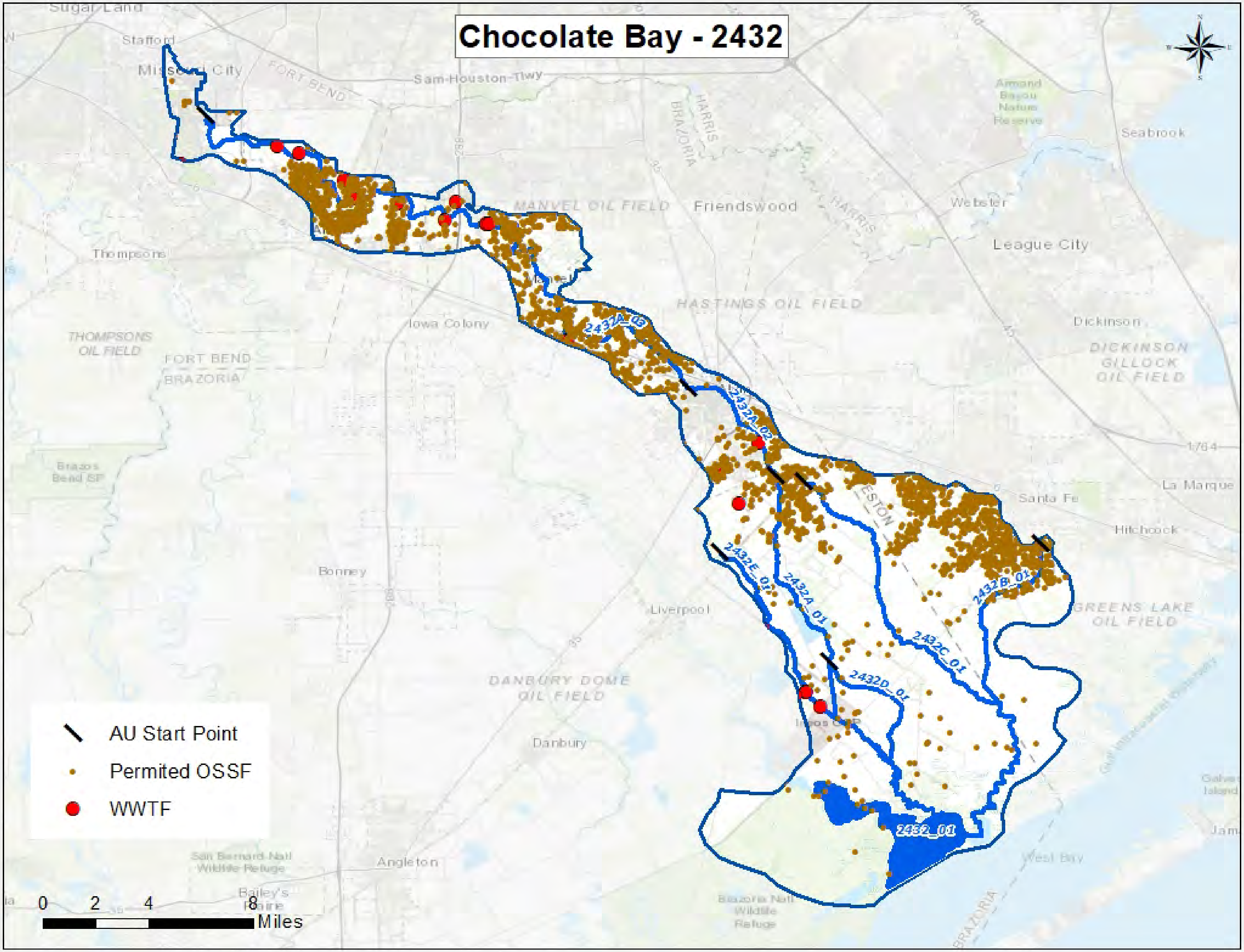
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Chocolate Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, feral hogs, and animal waste.

There are 21 permitted wastewater outfalls in the Chocolate Bay watershed. In most areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 3,718 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Chocolate Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 45 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Chocolate Bay watershed.



Chocolate Bay - 2432
AU Start Point
Permited OSSF
WWTF
0
2
4
8
Miles
2432A_03
2432A_02
2432A_01
2432B_01
2432C_01
2432D_01
2432E_01
2432_01
Sugar Land
Stafford
Missouri City
Sam Houston Tlwy
Manvel Oil Field
Friendswood
Webster
League City
Seabrook
Thompsons
Iowa Colony
Hastings Oil Field
Dickinson
Dickinson Gillock Oil Field
Thompsons Oil Field
Fort Bend
Brazoria
Santa Fe
La Marque
Hitchcock
Bonney
Liverpool
Greens Lake Oil Field
Danbury Dome Oil Field
Danbury
Angleton
West Bay

Trend Analysis:

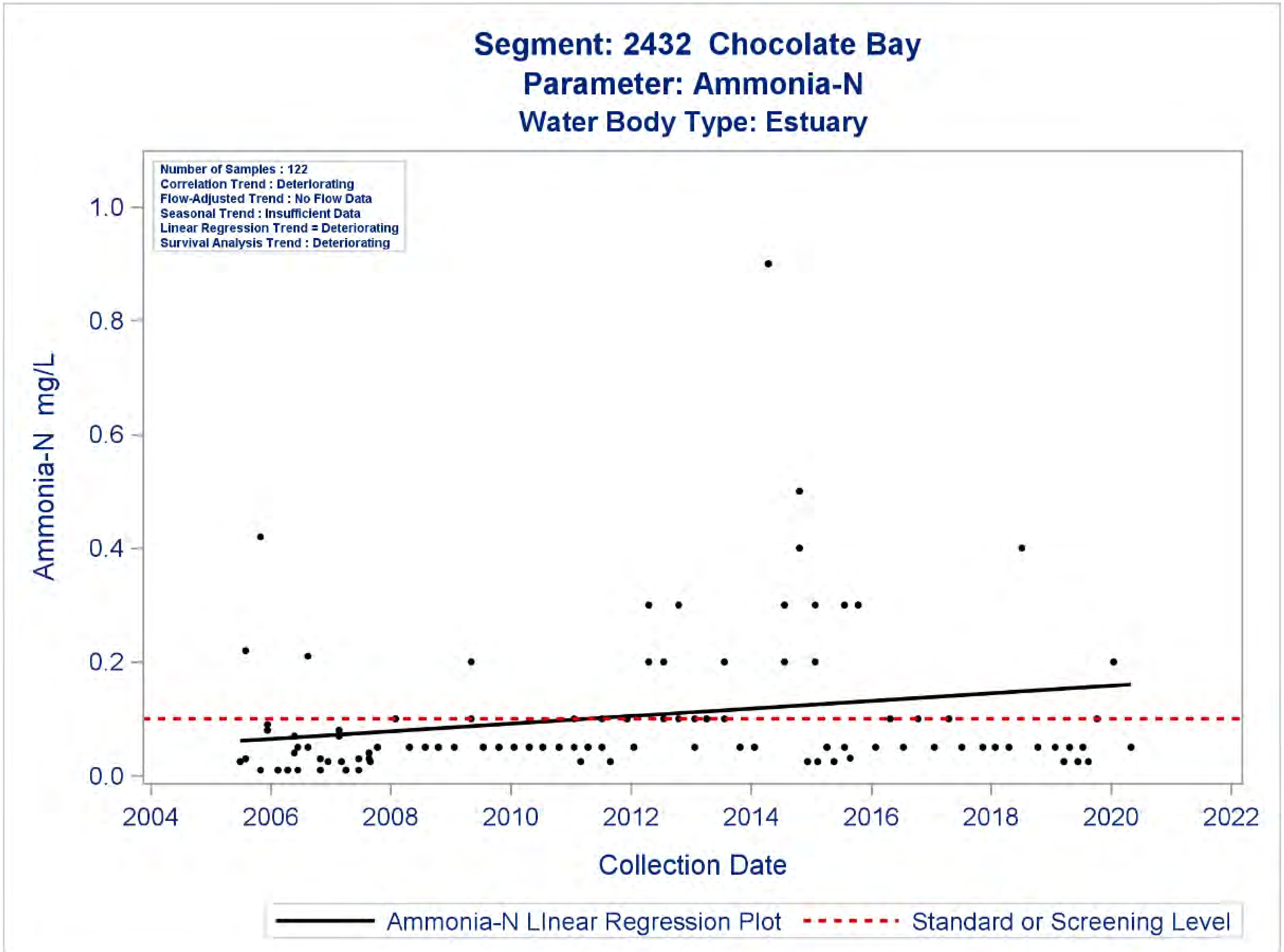
Analysis of water quality data from the Chocolate Bay (segment 2432) watershed revealed 18 parameter trends for all classified and unclassified segments located in the watershed. The main Chocolate Bay segment (2432) had only one trend - increasing ammonia concentrations. Three quarters of the sample results exceeding the screening criteria occurred since 2012.

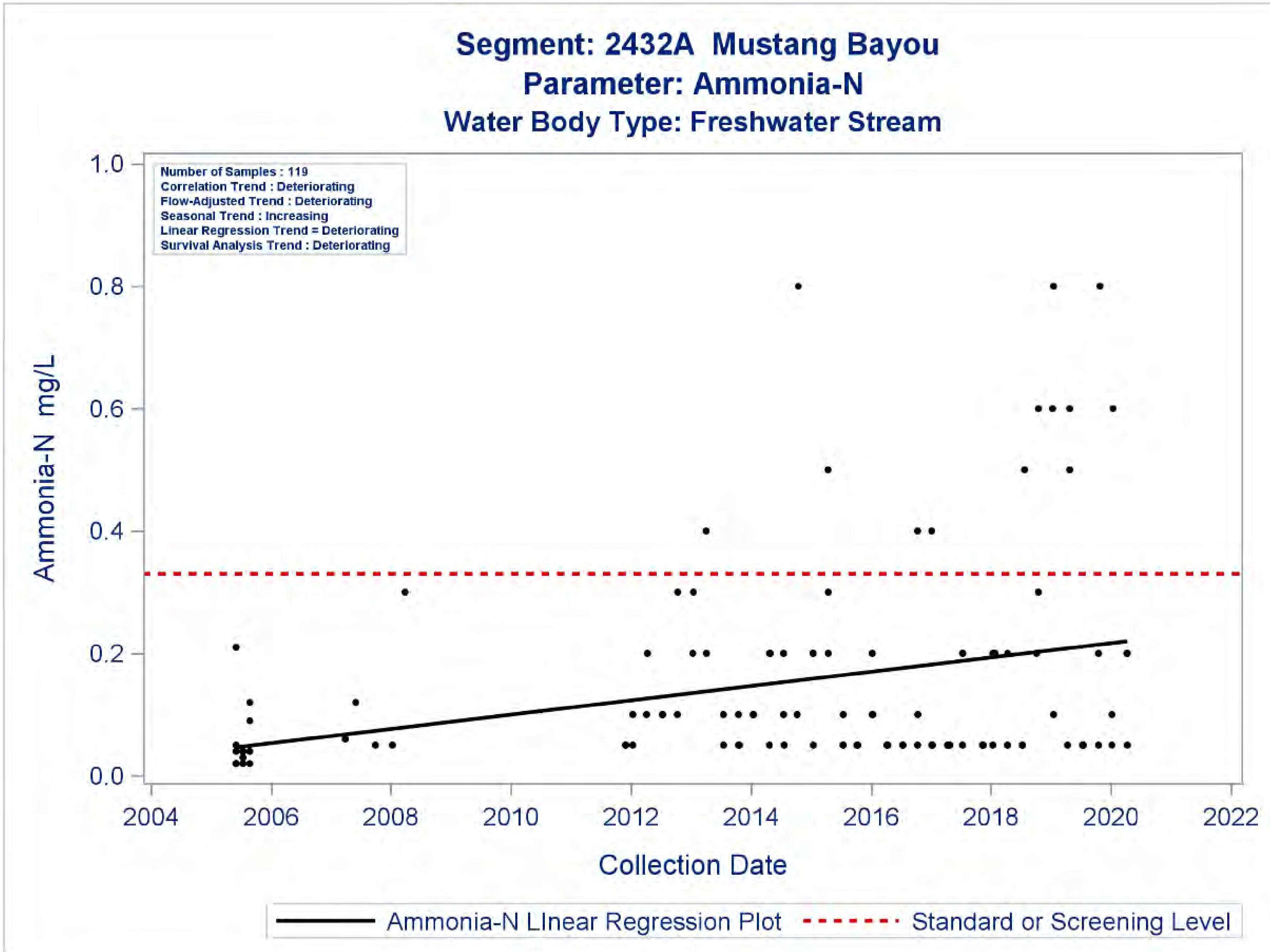
Mustang Bayou (2432A) is the longest unclassified tributary with the largest sub-watershed and is divided into three AUs. Analysis of its data revealed five parameter trends in the unclassified segment as a whole with increasing concentrations of ammonia, total phosphorus, chloride, and specific conductance while water temperature is decreasing over time. For ammonia and total phosphorus, all the exceedences of the screening criteria occurred in 2012 or 2013 and later. In AU2432A_02, there is also a deteriorating trend for nitrates where concentrations are increasing but have not exceeded the screening criteria yet. Simultaneously, AU 2432A_03 also revealed improving or increasing DO but this trend is suspected due to a data gap. Between 2005 and 2020, there is no DO data for the years of 2009 to 2013.

Data for unclassified segment 2432B (Willow Bayou) revealed deteriorating trends for both DO and total phosphorus. It should be noted that a deteriorating DO trend has DO decreasing over time with more frequent violations of the minimum standard and lower DO concentrations in recent years. A deteriorating trend for total phosphorus on the other hand indicates concentrations are increasing and concentrations began to exceed the screening criteria in 2012. Three improving trends were detected for unclassified segment 2432C (Halls Bayou Tidal) with pH, specific conductance and sulfate improving. A fourth trend indicates DO is deteriorating with concentrations decreasing over time.

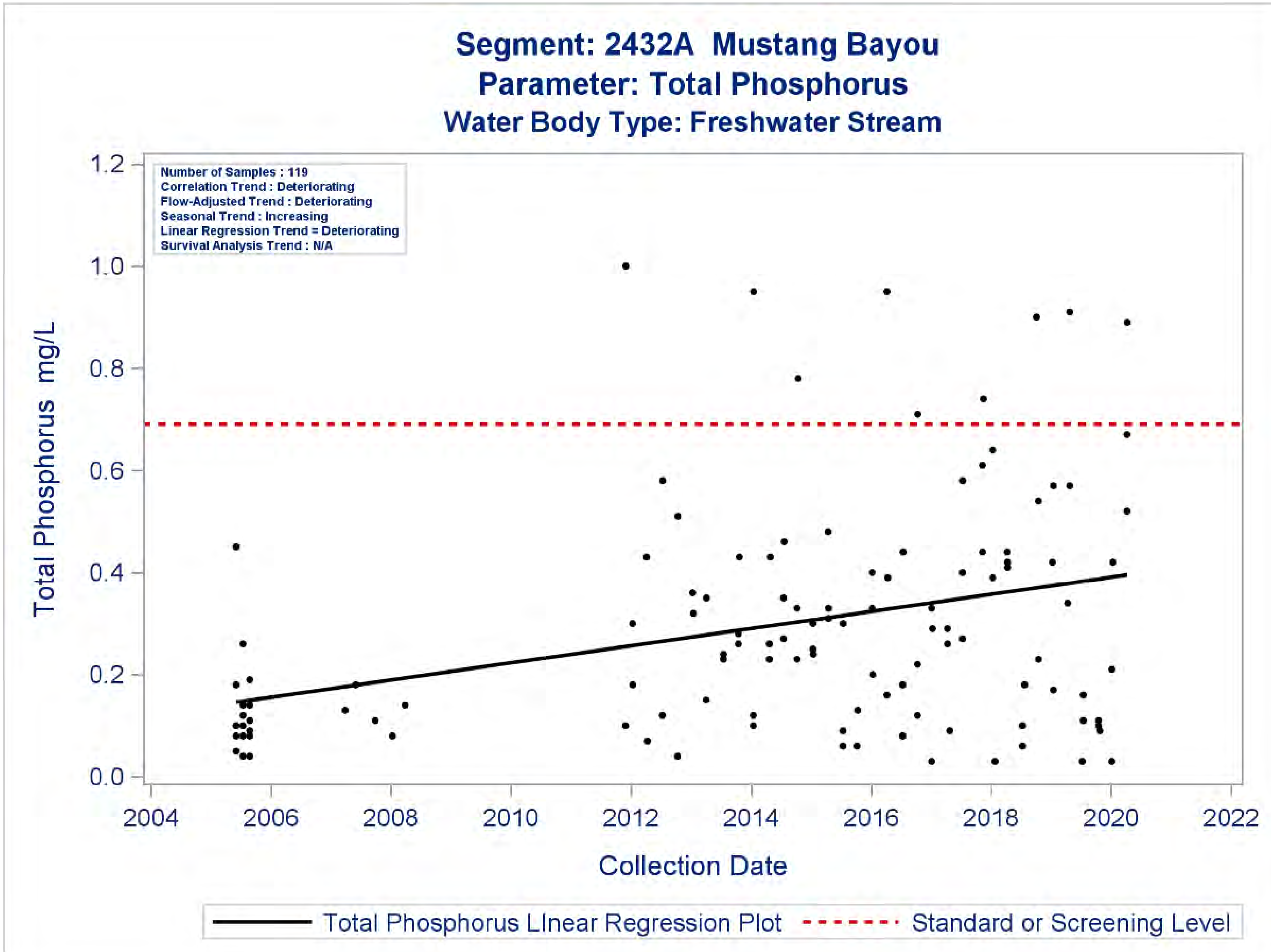
Unclassified tributary segment 2432D (Persimmon Bayou) is a freshwater stream where samples are collected. The only trends are found in Secchi transparency and TSS. When there is a trend with the TSS data, there is usually an inverse relationship to the Secchi transparency data. As sediment loads increase the Secchi transparency depths decrease. Decreasing trends are typically categorized as ‘improving’ trends, as seen in the graph legend, but the water is actually getting more turbid. Finally, unclassified segment 2432E (New Bayou) revealed three parameters trends with improving pH and secchi transparency and deteriorating TSS. Once again, the pH is not a concern due to all samples falling within the acceptable of 6.5 to 9.0 standard units. The trends is due to the highest pH values, which were about 8.5 standard units, being measured at 8.0 standard units or lower since 2012. Once again, the inverse relationship between Secchi transparency and TSS has been revealed. New Bayou is getting more turbid with increased sediment loading and decreasing Secchi depths.

The 2020 Texas Integrated Report lists all unclassified assessment units and Chocolate Bay oyster waters as either impaired or of concern for elevated levels of indicator bacteria. However, there were no trends found in the data. Segments 2432B and 2432C are also listed as having a concern for low dissolved oxygen concentrations in water. As explained in previous paragraphs, both of these unclassified segments have deteriorating trends with lower DO concentrations being measured in more recent years.

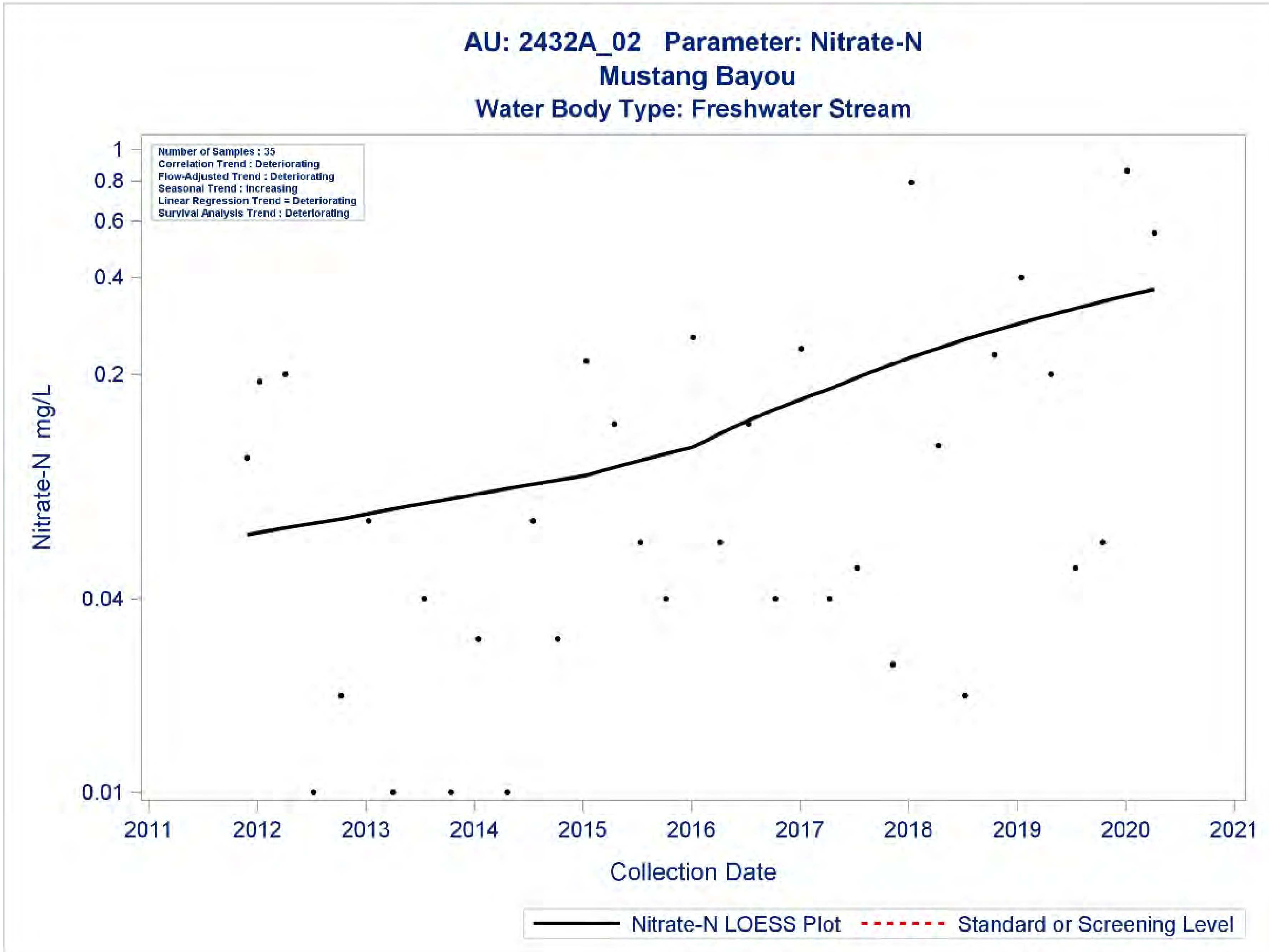

Segment: 2432 Chocolate Bay
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 122
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

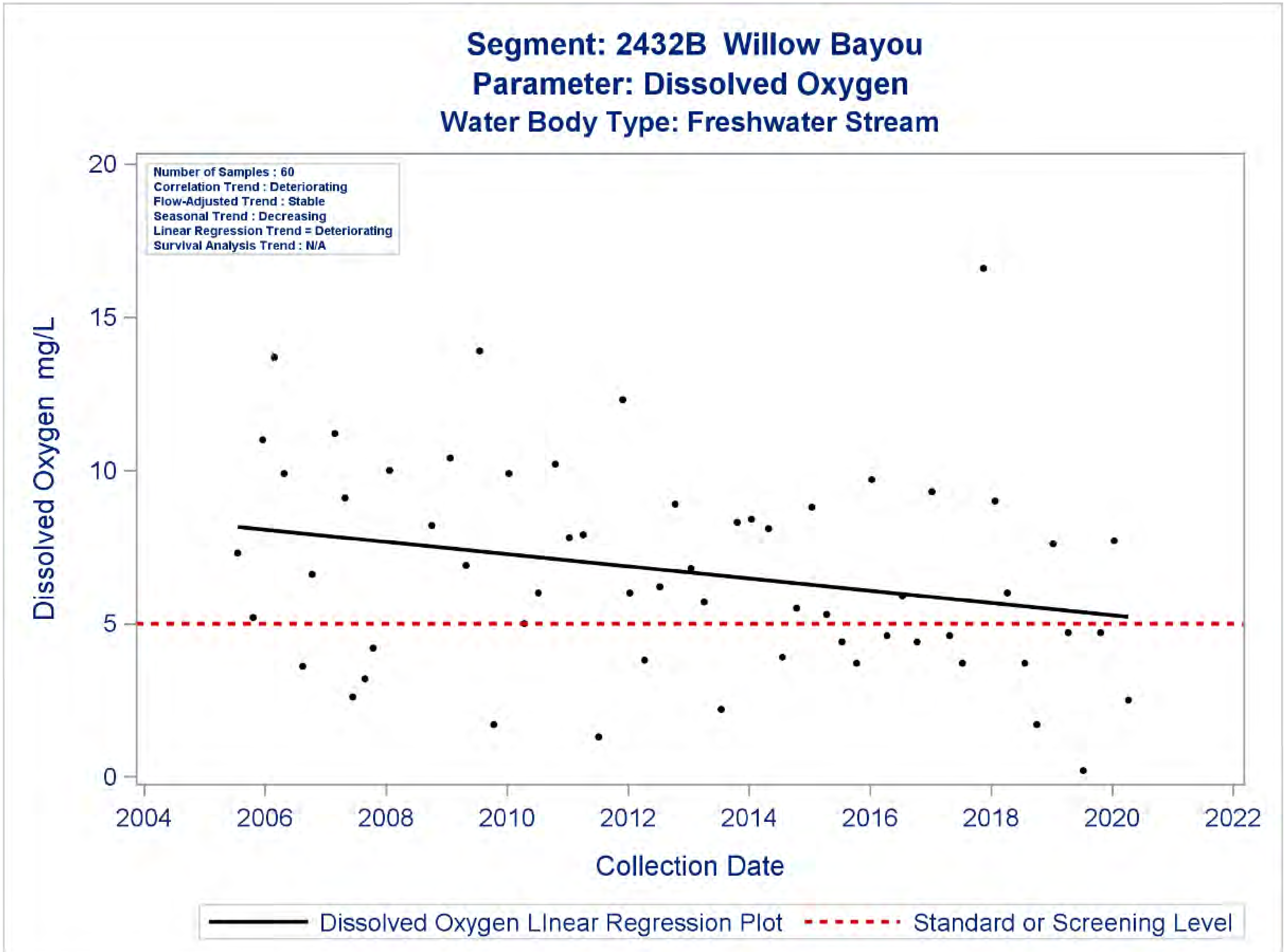


Segment: 2432A Mustang Bayou
Parameter: Ammonia-N
Water Body Type: Freshwater Stream
Number of Samples : 119
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
1.0
0.8
0.6
0.4
0.2
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LInear Regression Plot
Standard or Screening Level

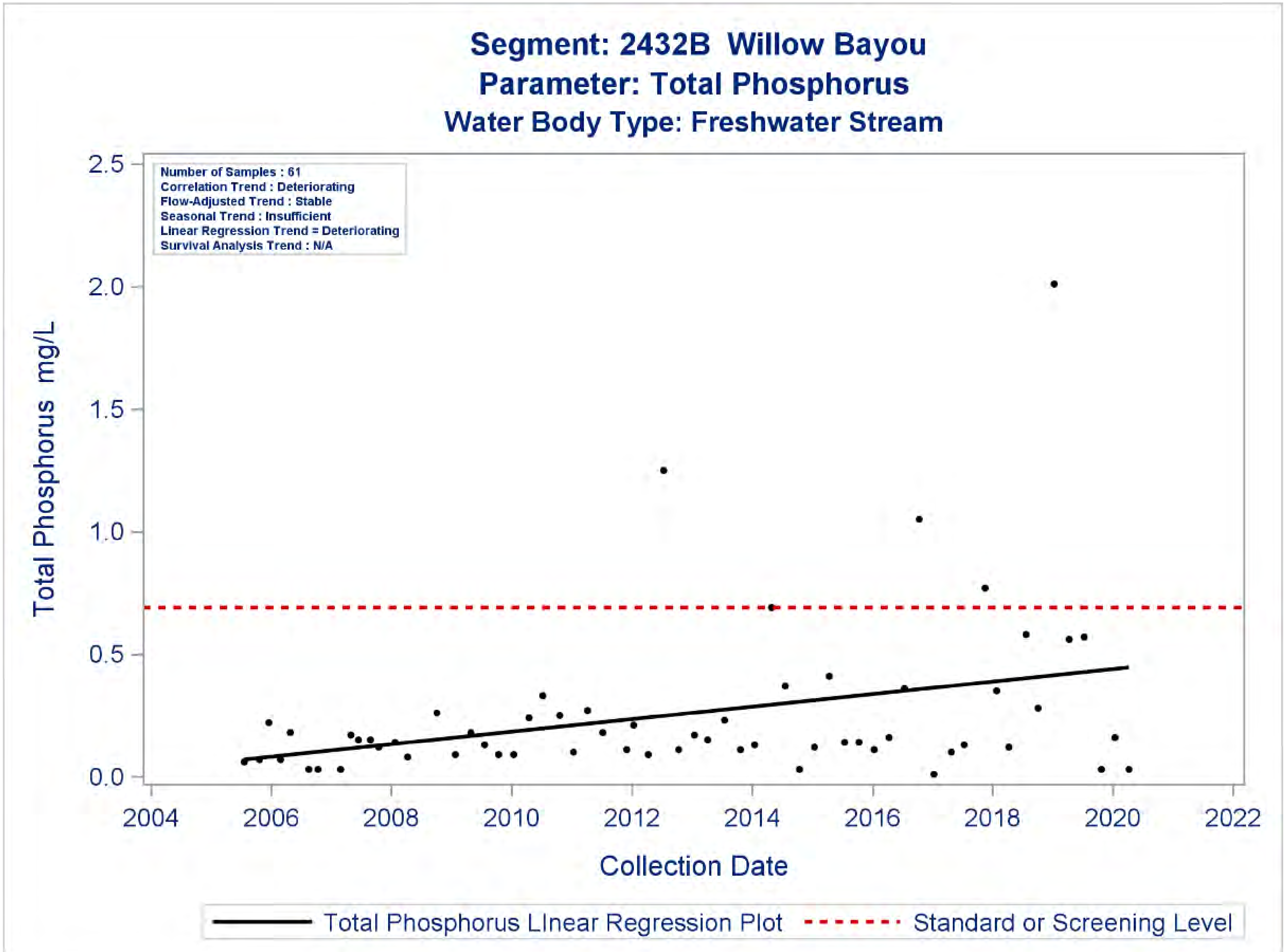


Segment: 2432A Mustang Bayou
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 119
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1.2
1.0
0.8
0.6
0.4
0.2
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level

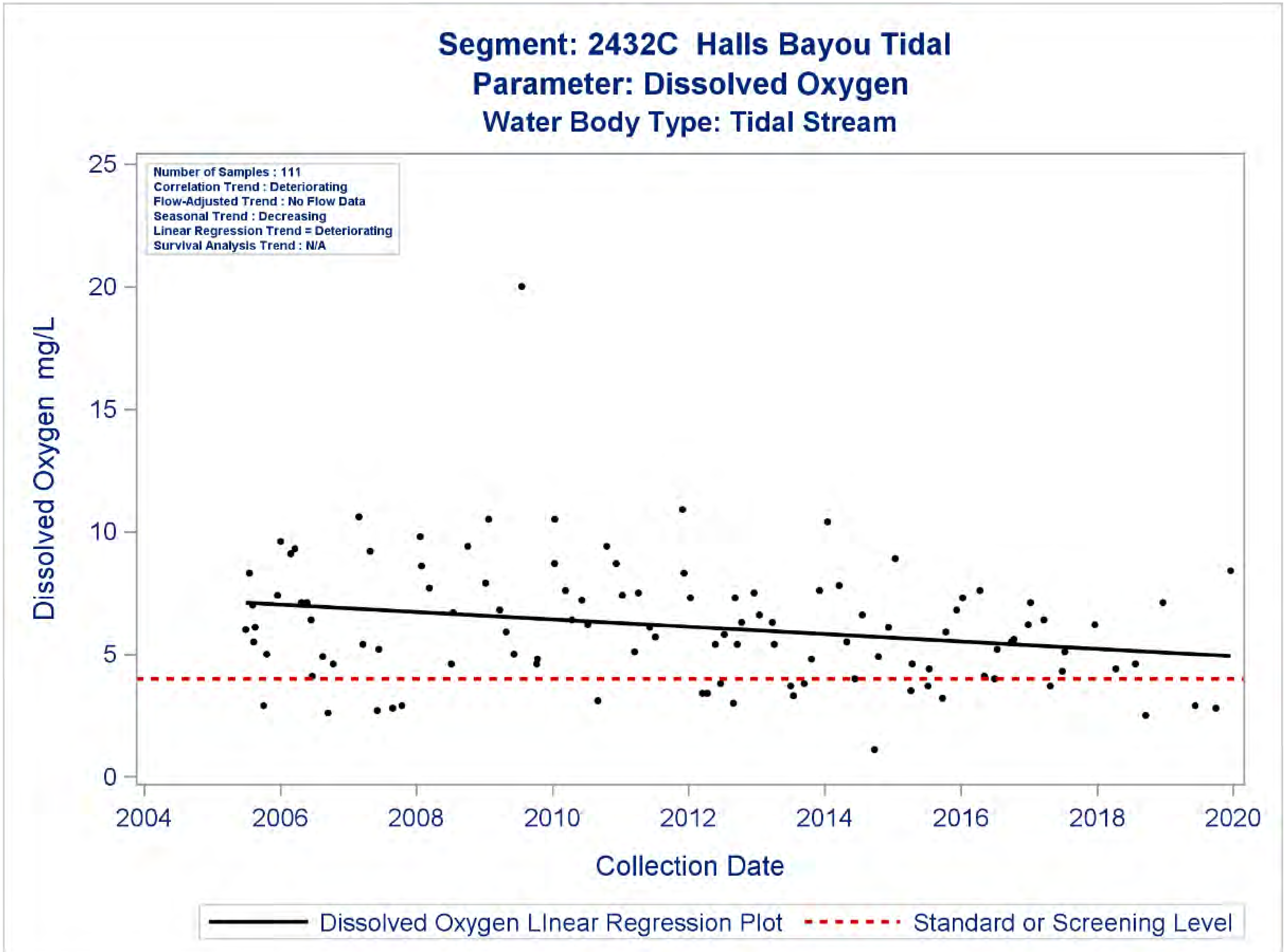

AU: 2432A_02 Parameter: Nitrate-N
Mustang Bayou
Water Body Type: Freshwater Stream
Number of Samples : 35
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
1
0.8
0.6
0.4
0.2
0.04
0.01
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level



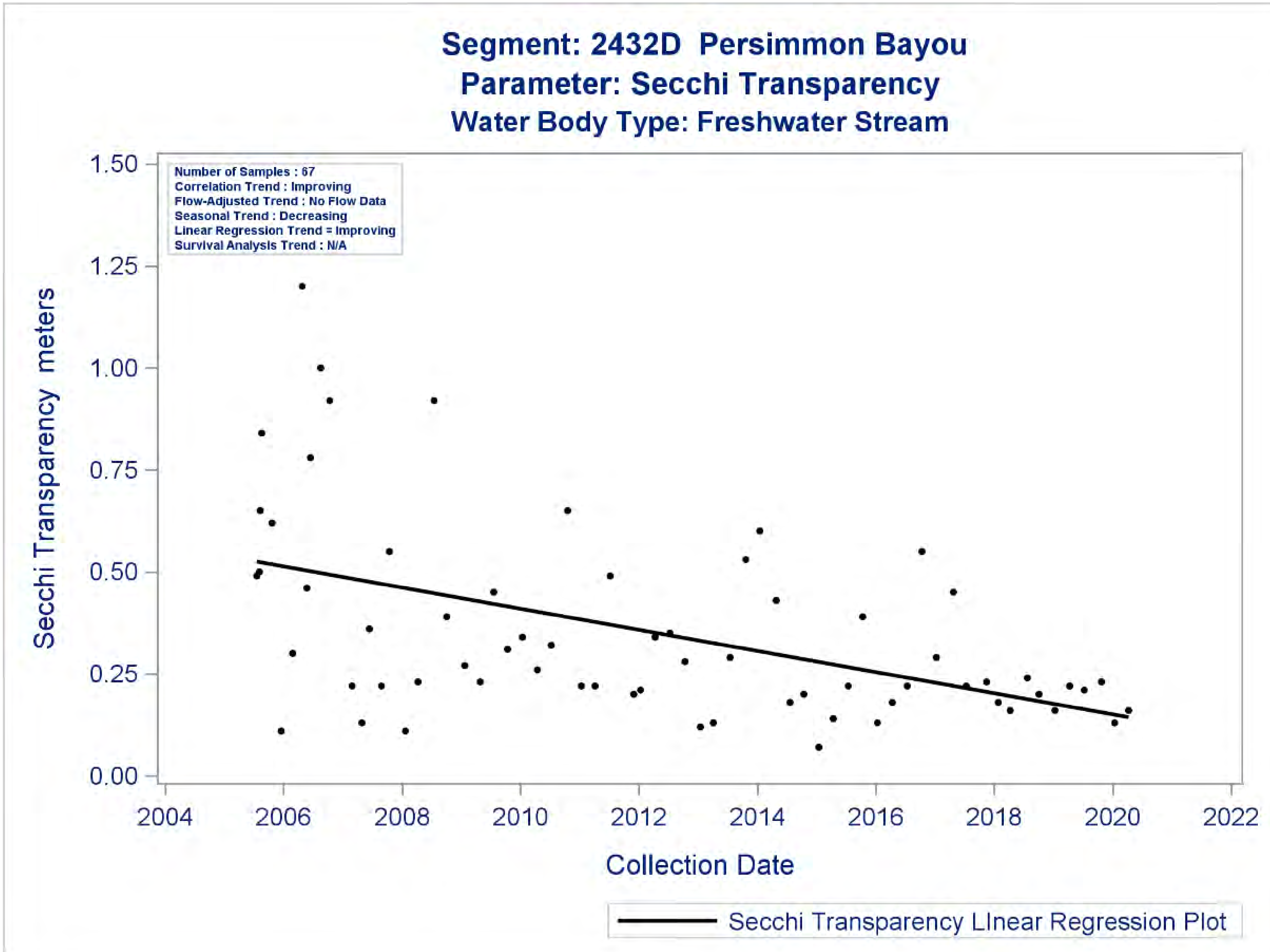
Segment: 2432B Willow Bayou
Parameter: Dissolved Oxygen
Water Body Type: Freshwater Stream
Number of Samples : 60
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
20
15
10
5
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level

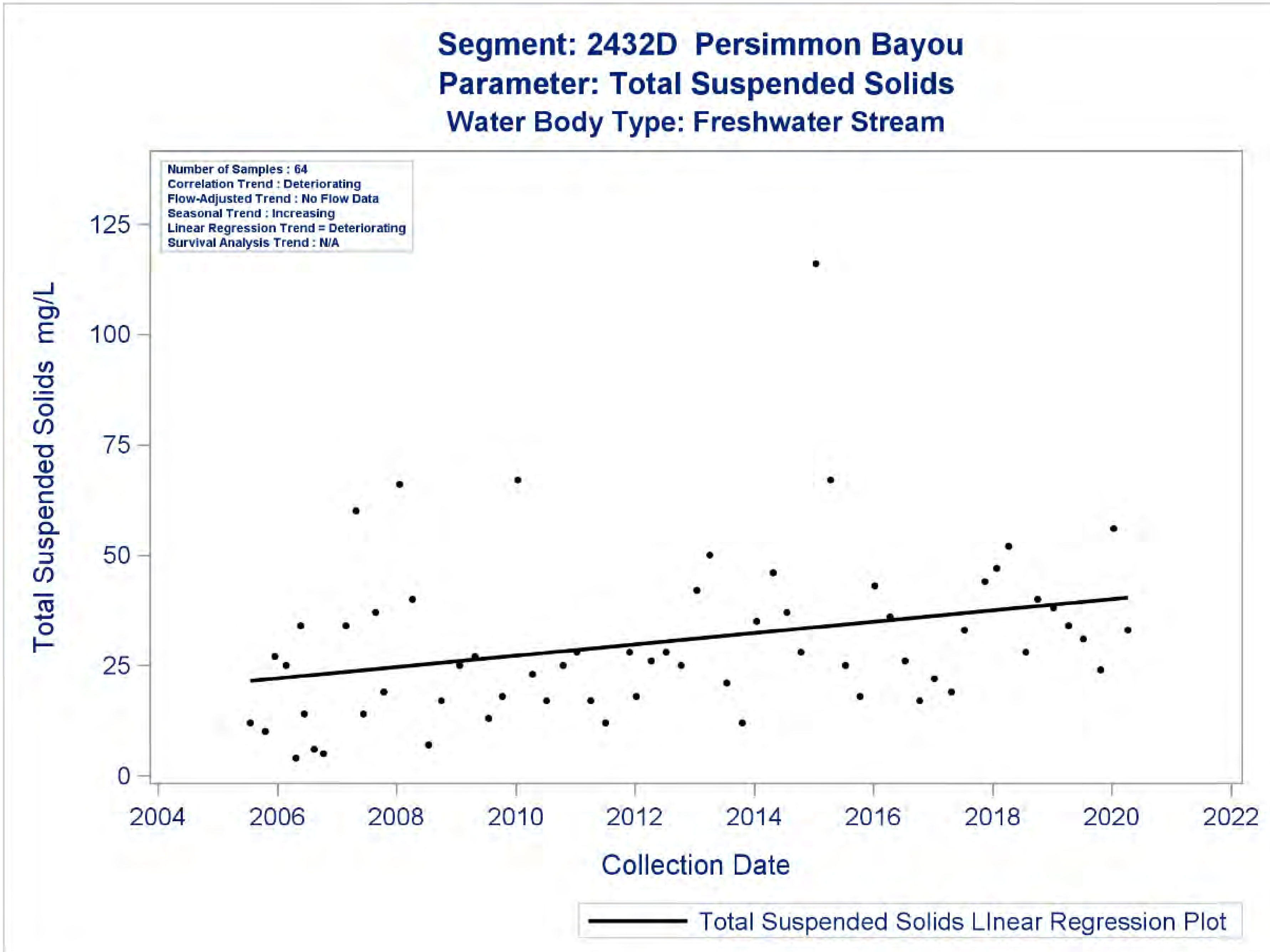


Segment: 2432B Willow Bayou
Parameter: Total Phosphorus
Water Body Type: Freshwater Stream
Number of Samples : 61
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Insufficient
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
2.5
2.0
1.5
1.0
0.5
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



Segment: 2432C Halls Bayou Tidal
Parameter: Dissolved Oxygen
Water Body Type: Tidal Stream
Number of Samples : 111
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
25
20
15
10
5
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Dissolved Oxygen LInear Regression Plot
Standard or Screening Level


Segment: 2432D Persimmon Bayou
Parameter: Secchi Transparency
Water Body Type: Freshwater Stream
Number of Samples : 67
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot


Segment: 2432D Persimmon Bayou
Parameter: Total Suspended Solids
Water Body Type: Freshwater Stream
Number of Samples : 64
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
25
50
75
100
125
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria **Bacteria in Oyster Waters**	2432A_01 I 2432A_02 I 2432A_03 C 2432B_01 I 2432C_01 I 2432D_01 I 2432E_01 I 2432OW I	• Animal waste from agricultural production, hobby farms, and riding stables • Urbanization and increased impervious cover • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	2432A_01 C 2432B_01 C 2432C_01 C	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste)	• Detrimental effect on aquatic biological community	• Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Improve compliance and enforcement of existing stormwater quality permits • More public education regarding OSSF operation and maintenance

		▪ High temperature discharges from industrial WWTFs ▪ Vegetative canopy removed		• Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • More public education regarding disposal of household fats, oils, and grease • Improve operation and maintenance of existing WWTF and collection systems • Regionalize chronically non-compliant WWTFs • Conserve or restore trees and habitat along waterways to maintain/create shade to cool water • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating
Elevated Nutrient Concentrations	***Ammonia*** 2432_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Dioxin/PCBs in Fish Tissue	2432 I 2432C I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

Chocolate Bay Watershed TMDL is under development. TMDL documents have been submitted to TCEQ for Chocolate and Halls Bayous, and the TMDL document for Mustang Bayou will be submitted in 2021. The I-Plan for the Chocolate Bay watershed will cover Chocolate, Halls, and Mustang Bayous. Drafting of this document will begin in summer 2021 and will be submitted in 2023.

Chocolate Bay was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs. This segment was also included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number:	2434	Name:	Christmas Bay

Area:	9.3 square miles	Miles of Shoreline:	26.1 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	1	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	2

DESCRIPTION

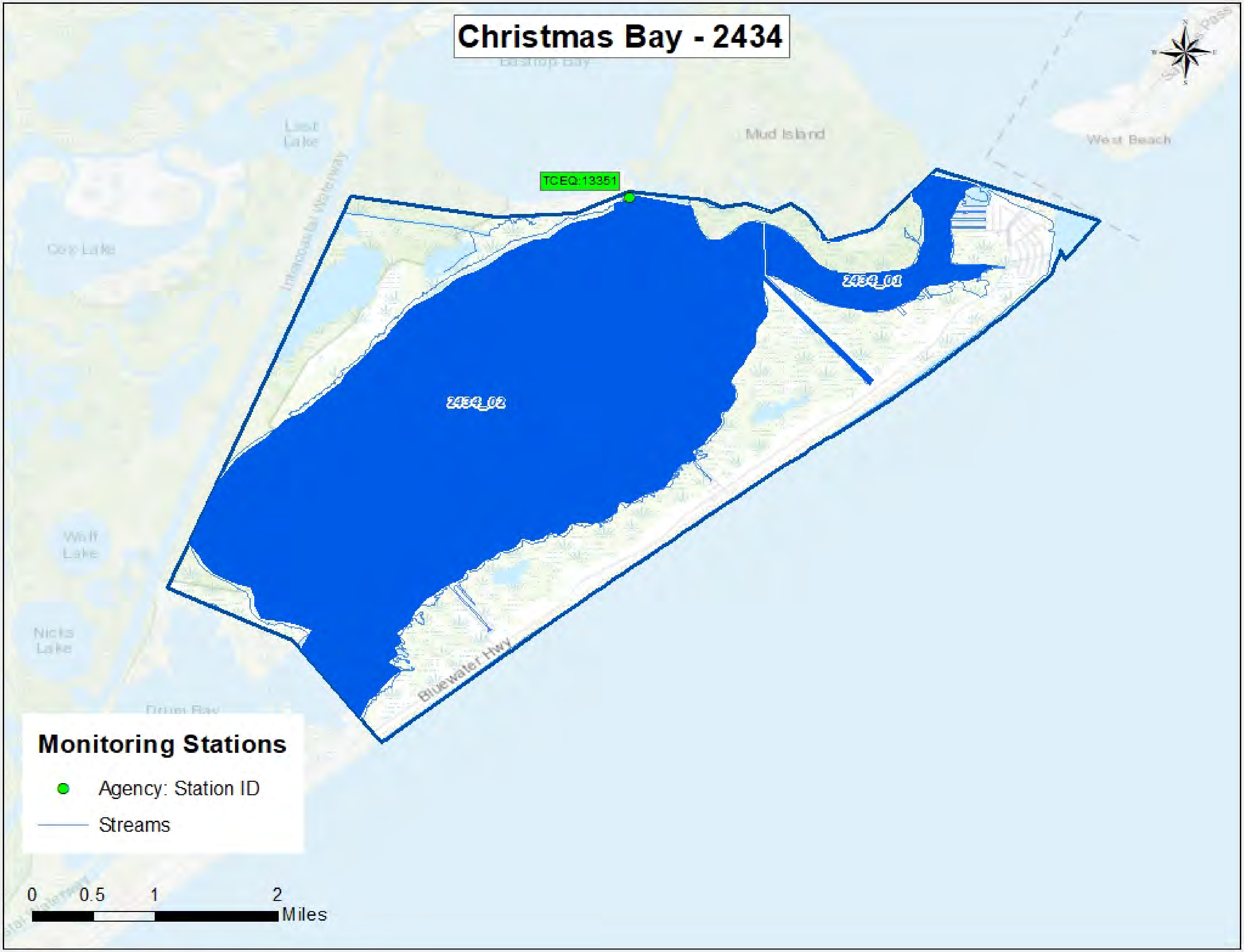
- Segment 2434: **Christmas Bay** (classified water body) – Located on the landward side of Follet's Island in Brazoria County and southwest of Mud Island, it drains into Bastrop Bay to the northeast or directly to West Galveston Bay via a channel on the south side of Mud Island.

- Segment 2434OW (Oyster Waters)

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
13351	2434	CHRISTMAS BAY AT CHRISTMAS POINT	FO	Quarterly	Field, Conventional, Bacteria

FO = TCEQ Regional Office

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.



Christmas Bay - 2434
Bastrop Bay
Last Lake
Mud Island
West Beach
Cox Lake
Intracoastal Waterway
TCEQ:13351
2434_01
2434_02
Wolf Lake
Nicks Lake
Drum Bay
Bluewater Hwy
Monitoring Stations
Agency: Station ID
Streams
0 0.5 1 2
Miles

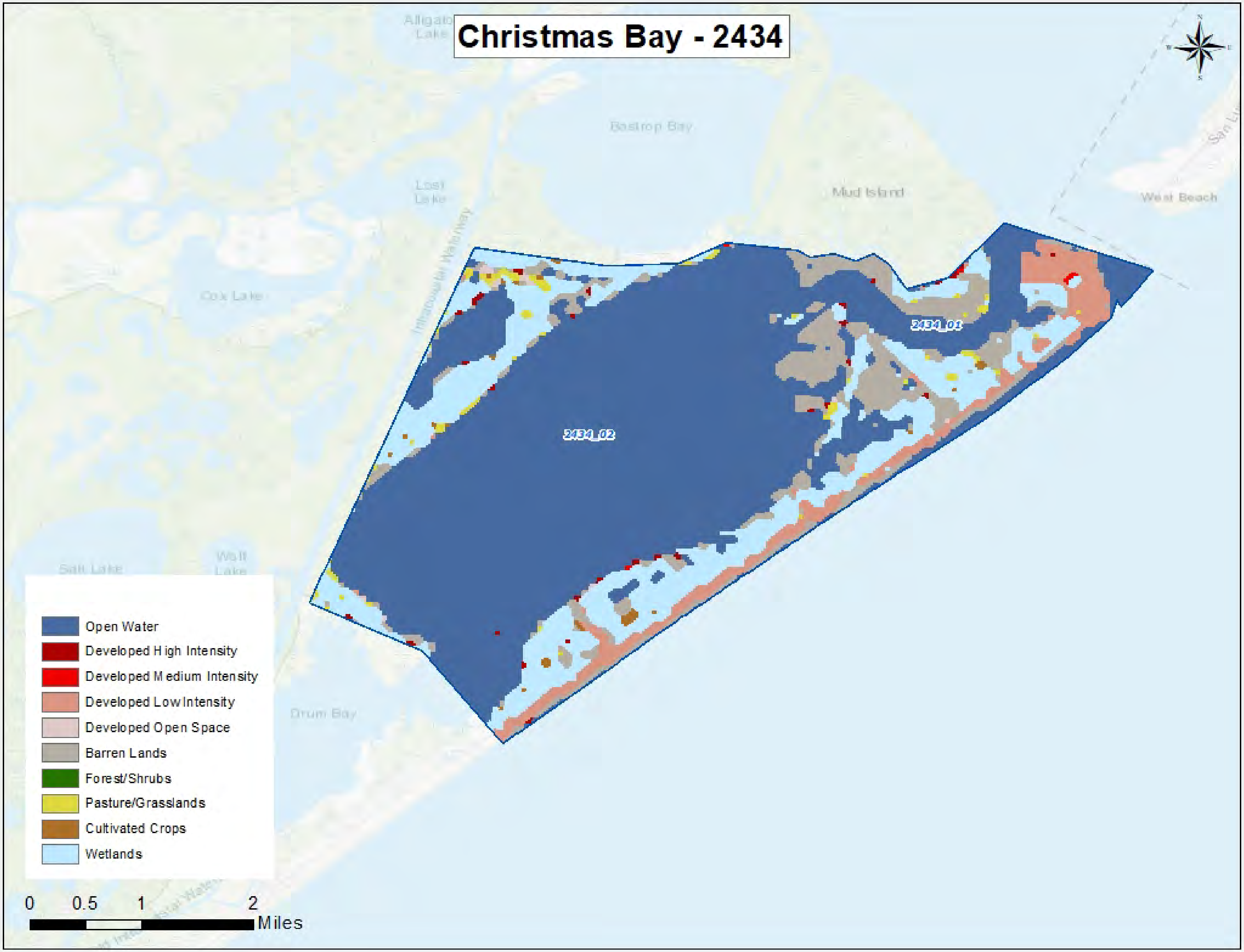
Segment 2434 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43		

Segment Discussion

Watershed Characteristics and Land Cover: Christmas Bay is surrounded by herbaceous wetlands and is bordered by Mud Island to the east and Follets Island, a barrier island, to the south and southeast. To the northwest the Bay is bordered by the Brazoria National Wildlife Refuge. Christmas Bay is isolated from the other surrounding Bays with no direct access to the Intracoastal Waterway. Christmas Bay is a Coastal Preserve and is part of the Texas General Land Office/Texas Parks and Wildlife Department Coastal Preserves Program. The Bay is one of the most pristine areas in the Galveston Bay system and is home to numerous species of birds, fish, crustaceans, mollusks, and several species of seagrass. While isolated from most development, there are two canal communities on Follets Island which drain directly to the bay. These communities exclusively use OSSFs.

Open Water is the largest land cover class at 63.70 percent, followed by Wetlands at 18.19 percent and Barren Lands at 10.68 percent.

Segment 2434 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	2.67	0.03	50.26	0.51	1,782.40
Barren Lands	535.53	5.44	1,051.26	10.68	96.30
Developed	92.52	0.94	560.66	5.70	505.99
Forest/Shrubs	0.00	0.00	119.65	1.22	N/A
Open Water	6,664.53	67.73	6,268.22	63.70	-5.94
Wetlands	2,543.98	25.86	1,790.06	18.19	-29.64
TOTAL	**9,839.22**	**100.00**	**9,840.11**	**100.00**	



Christmas Bay - 2434
Bastrop Bay
Mud Island
West Beach
Lost Lake
Cox Lake
Salt Lake
Wolf Lake
Drum Bay
2434_01
2434_02
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.5 1 2
Miles

Water Quality Issues:

Bacteria Impairments and Concerns
Assessment unit 2434OW_01 is listed in the 2020 Integrated Report as impaired for oyster waters due to elevated levels of fecal coliform bacteria. This assessment unit is closed by the Seafood Safety Division of the Texas Department of State Health Services for the harvesting of oysters and other shellfish for direct marketing.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

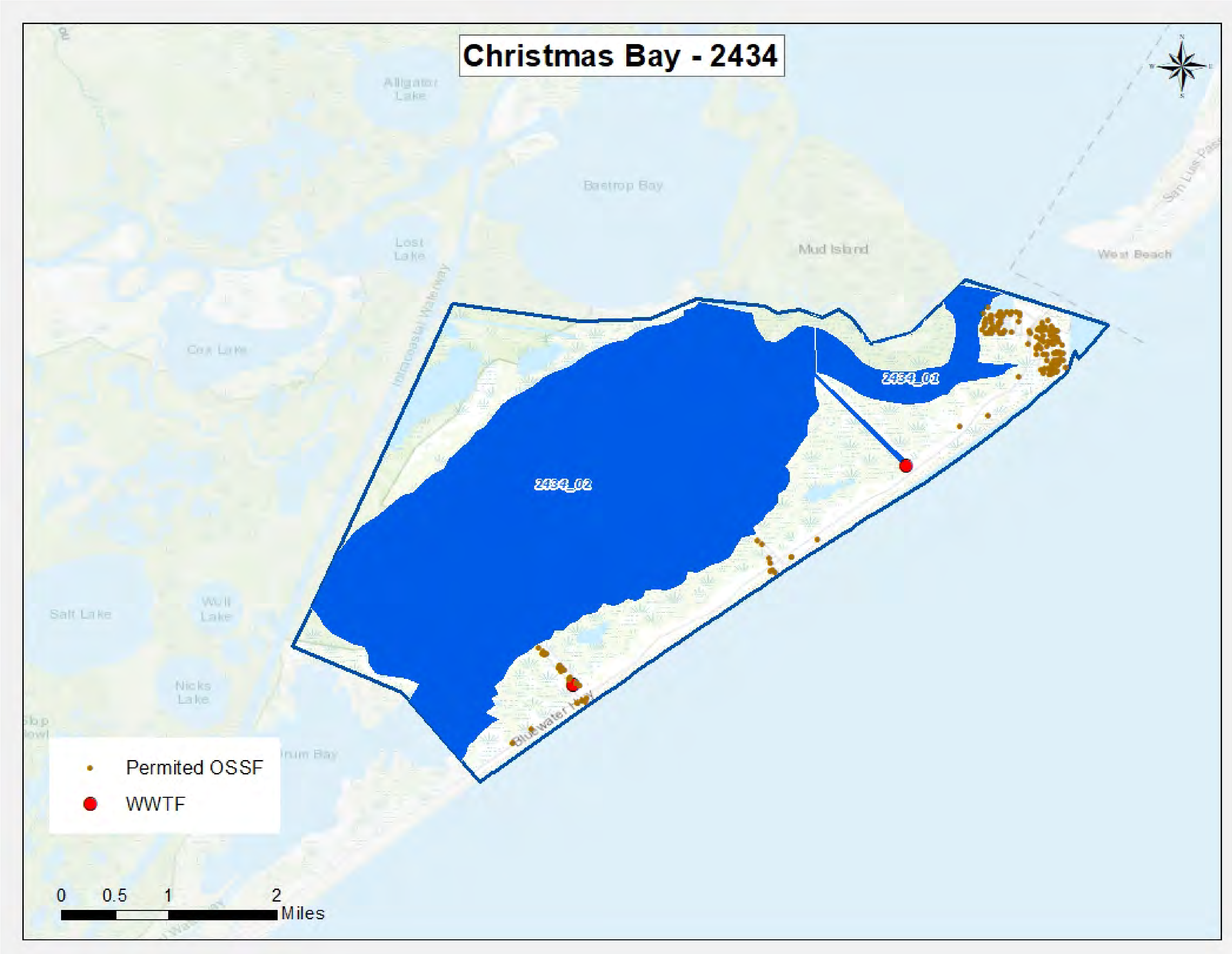
PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Christmas Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are two permitted wastewater outfalls in the Christmas Bay watershed. On-site sewage facilities are the primary source of wastewater disposal. There are 170 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Christmas Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Christmas Bay watershed.



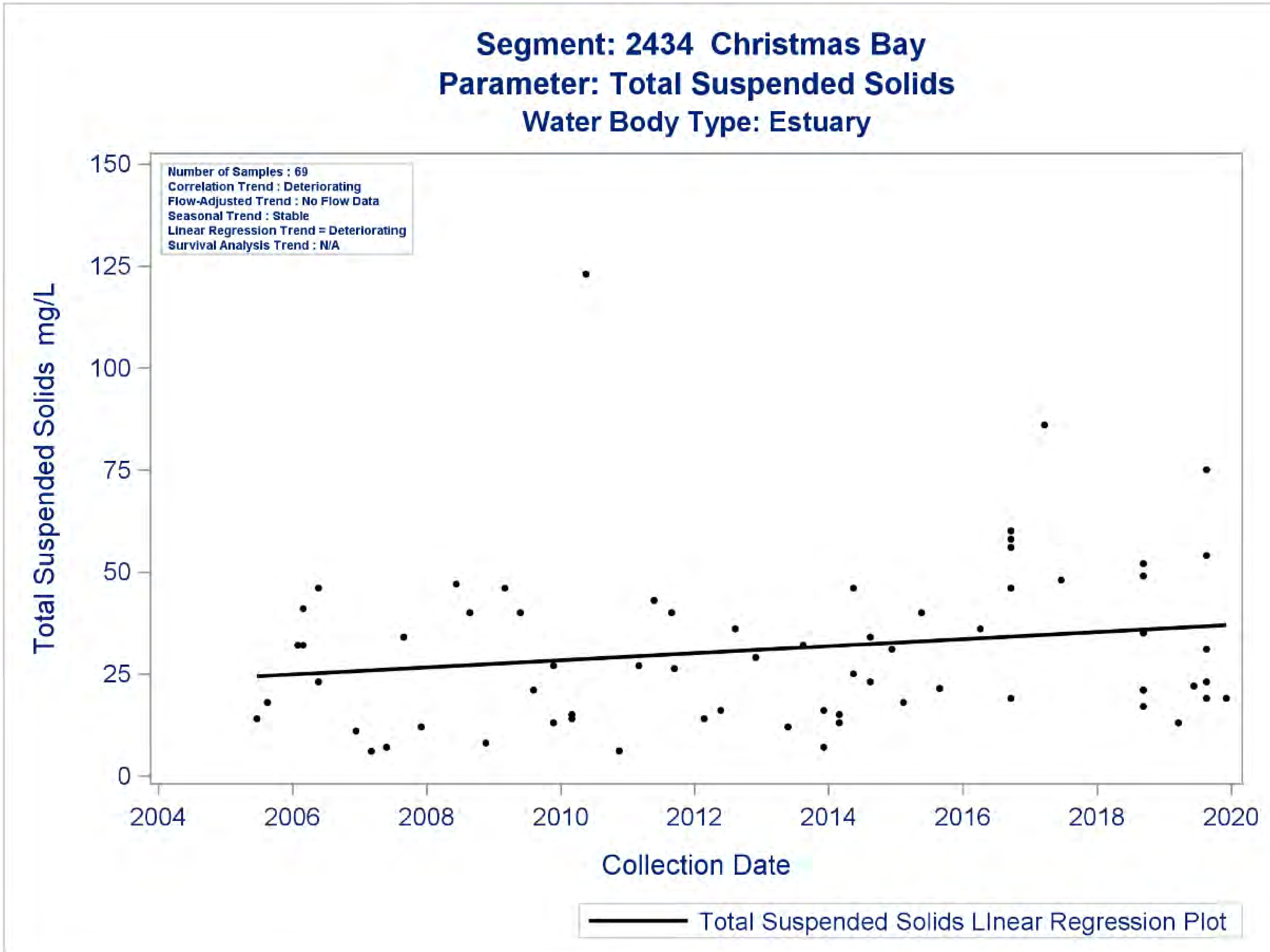
Christmas Bay - 2434
Alligator Lake
Bastrop Bay
Lost Lake
Mud Island
West Beach
San Luis Pass
Intracoastal Waterway
Cox Lake
2434_01
2434_02
Salt Lake
Wolf Lake
Nicks Lake
Bluewater Hwy
Permited OSSF
WWTF
0 0.5 1 2
Miles

Trend Analysis:

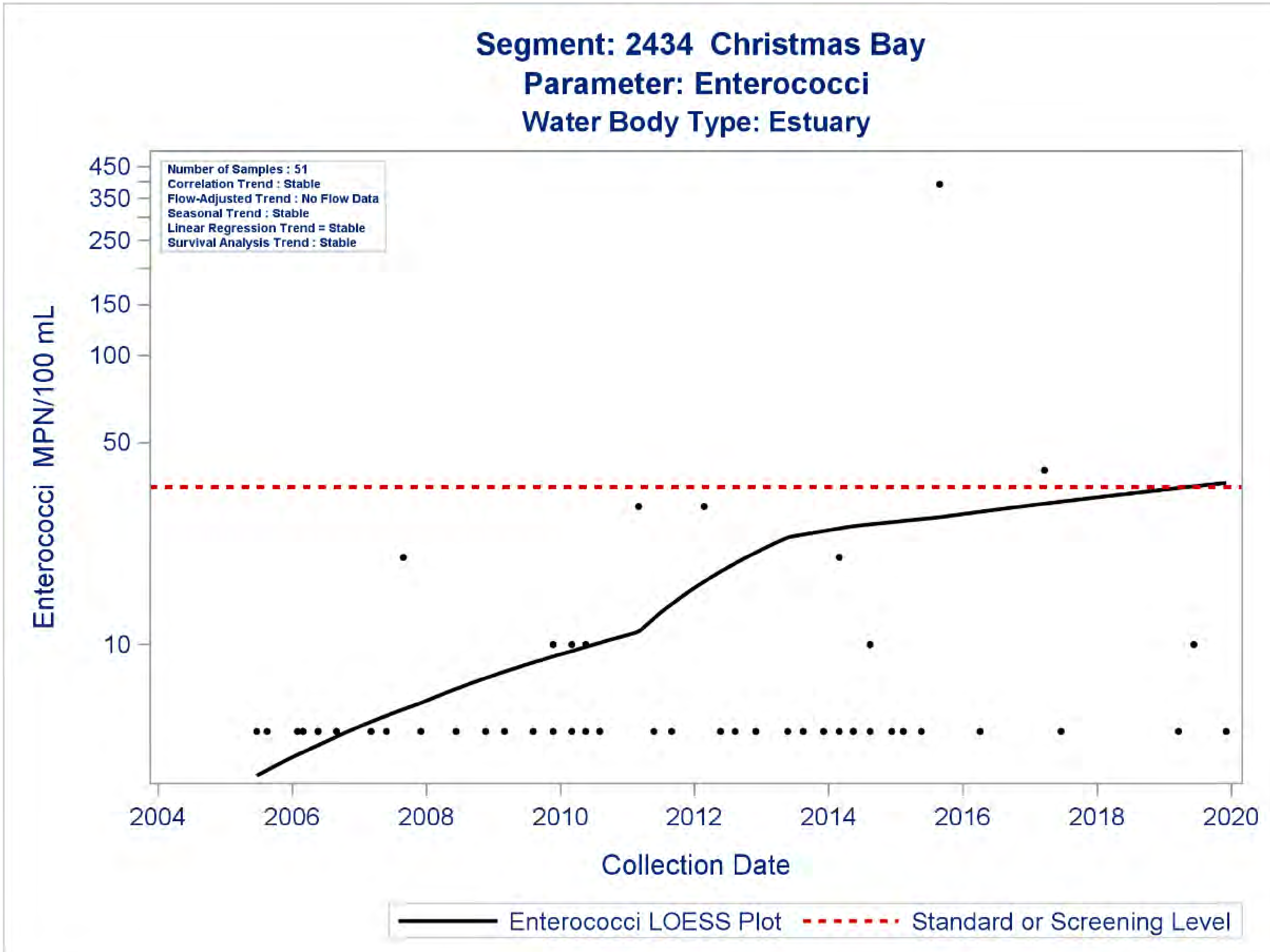
Water quality data for Christmas Bay (segment 2424) identified one parameter trend – TSS is deteriorating. While not a concern yet, if the increasing TSS concentrations trend continues, that does not bode well for sea grasses which rely on clear water. More turbid water could be a detriment to the beds of seagrasses found in the bay.

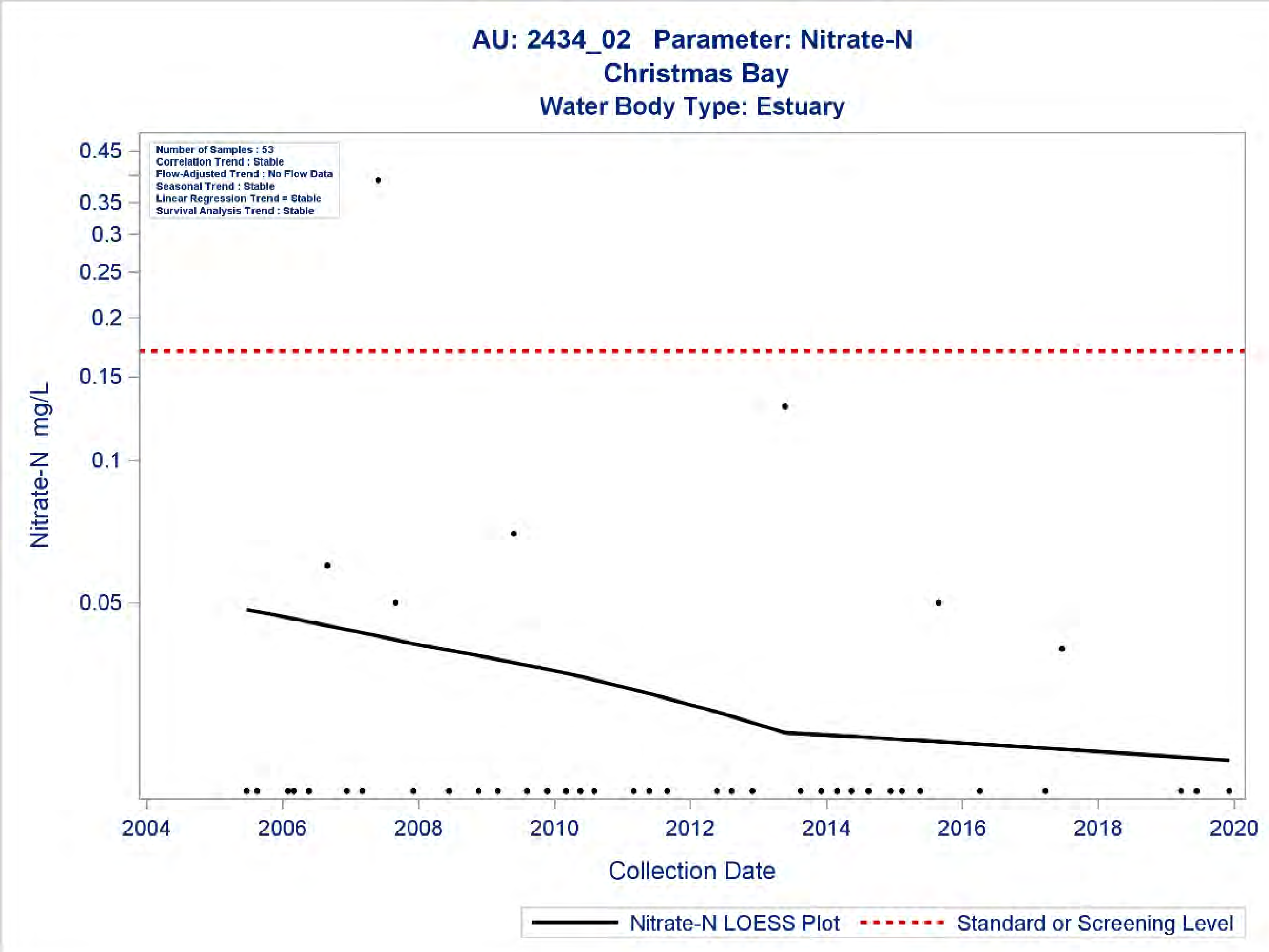
During the LOESS correlation analysis three parameter trends were seen but those same parameters did not have linear regression trends. Those correlation trends were for sulfate, chloride and specific conductance which are not of a concern at this time. In the linear regression analysis, one improving trend for DO was seen but there was no LOESS correlation trend for the same parameter. The DO concentrations in Christmas Bay were all confirmed to be greater than the minimum water quality standard of 4.0 mg/L.

The only impairment listed in the 2020 Texas Integrated Report for this segment is for elevated levels of bacteria in oyster waters. Fecal coliform bacteria is the indicator used to assess oyster waters. The Clean Rivers Program does not collect fecal coliform data, but analysis of enterococci bacteria data shows bacteria results that remain consistently below the 35 MPN/100 mL water quality standard during the period of record which supports this segment's primary contact recreation and high aquatic life use designations. Ammonia, nitrate, and total phosphorus have stable trends with all three parameters having results well below the screening criteria. Nitrate is the only parameter with one result exceeding the screening criteria in the entire period of record.



Segment: 2434 Christmas Bay
Parameter: Total Suspended Solids
Water Body Type: Estuary
Number of Samples : 69
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
150
125
100
75
50
25
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Suspended Solids LInear Regression Plot


Segment: 2434 Christmas Bay
Parameter: Enterococci
Water Body Type: Estuary
Number of Samples : 51
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Enterococci MPN/100 mL
450
350
250
150
100
50
10
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Enterococci LOESS Plot
Standard or Screening Level



AU: 2434_02 Parameter: Nitrate-N
Christmas Bay
Water Body Type: Estuary
Number of Samples : 53
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Stable
Survival Analysis Trend : Stable
Nitrate-N mg/L
0.45
0.35
0.3
0.25
0.2
0.15
0.1
0.05
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Nitrate-N LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria in Oyster Waters	2434OW_01 I	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Add water quality features to stormwater systems • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations

Special Studies:

Christmas Bay was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was also included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number:	2435	Name:	Drum Bay		
Area:	2 square miles	Miles of Shoreline:	12.2 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	0	Texas Stream Team Monitoring Stations:	1	Permitted WWTF Outfalls:	1

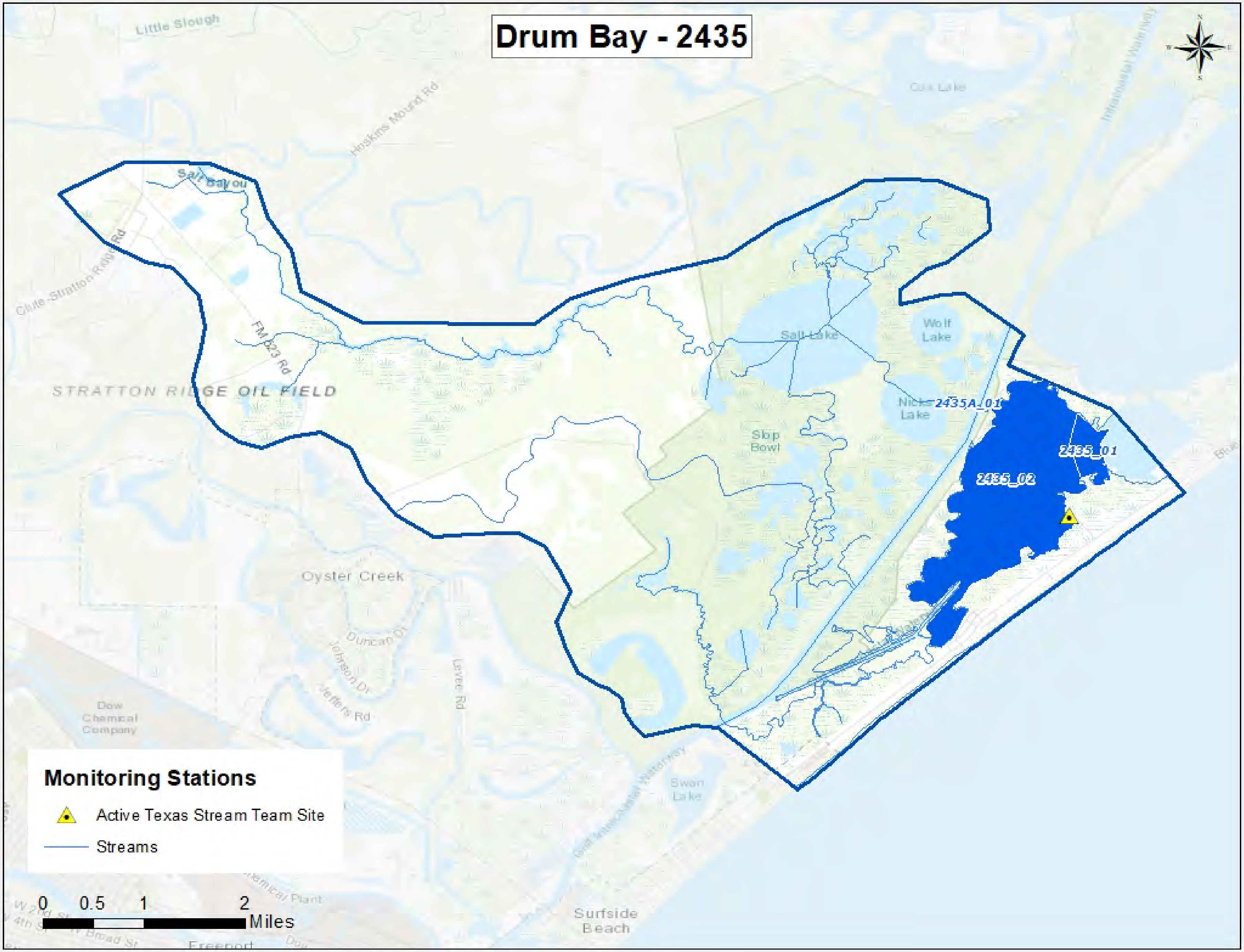
DESCRIPTION

- Segment 2435: **Drum Bay** (classified water body) - Located on the landward side of Follet's Island in Brazoria County extending southwest from the confluence with Christmas Bay, it is connected to the Gulf Intracoastal Waterway via a cut on the far western end and via a cut from the north called Nick's Cut.

- Segment 2435A: **Nicks Cut** (unclassified water body) – Cut from Nicks Lake to Gulf Intracoastal Waterway to Drum Bay in Brazoria County.

- Segment 2435OW (Oyster Waters)

There are no active monitoring stations in Segment 2435.


Drum Bay - 2435
Monitoring Stations
Active Texas Stream Team Site
Streams
0
0.5
1
2
Miles
Little Slough
Hoskins Mound Rd
Salt Bayou
Clute-Stratton Ridge Rd
FM 523 Rd
STRATTON RIDGE OIL FIELD
Salt Lake
Wolf Lake
Nicks Lake
Slop Bowl
2435A_01
2435_01
2435_02
Oyster Creek
Duncan Dr
Johnson Dr
Jeffers Rd
Levee Rd
Dow Chemical Company
Swan Lake
Gulf Intracoastal Waterway
Surfside Beach
Freeport
Intracoastal Waterway

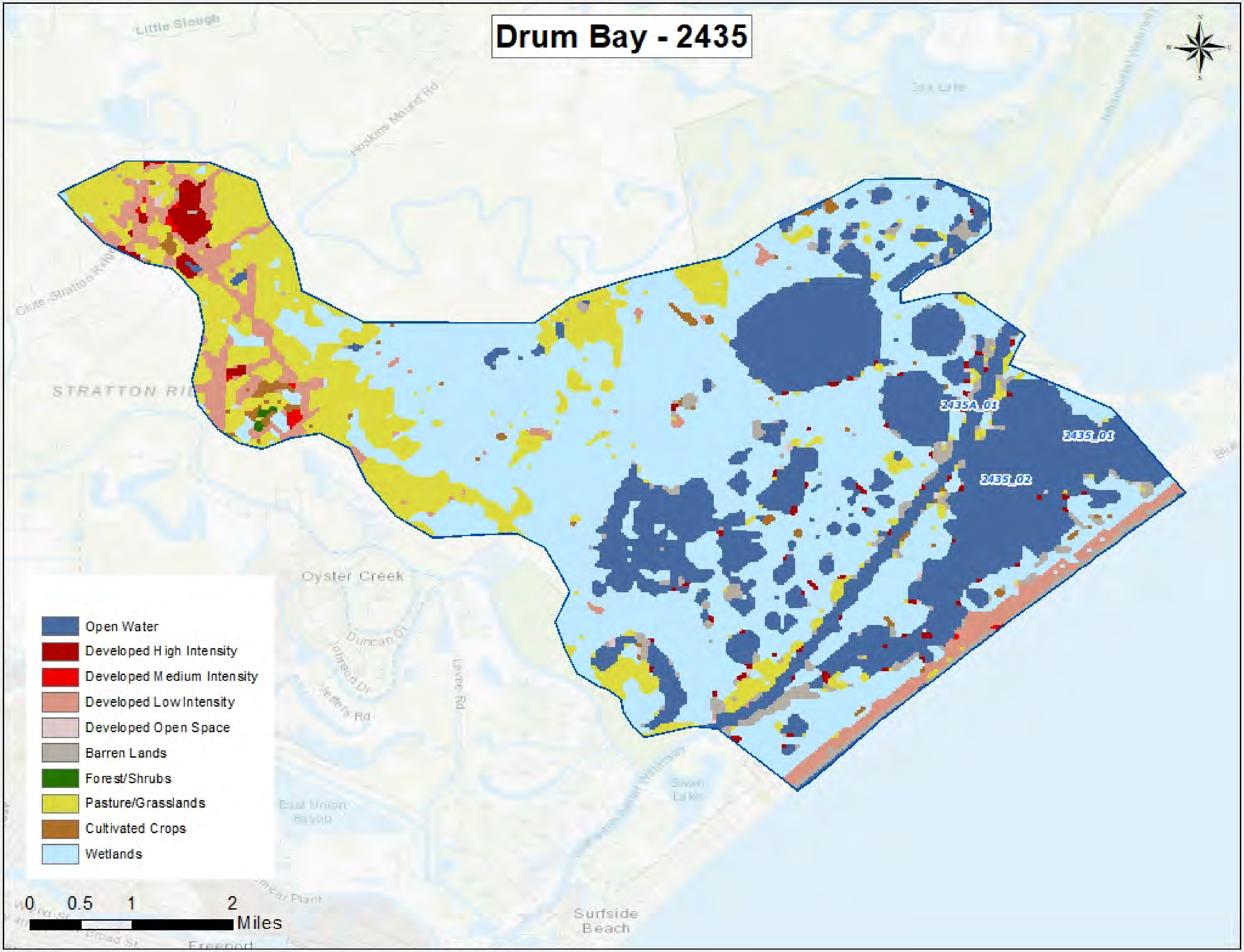
Segment 2435 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43		

Segment Discussion

Watershed Characteristics and Land Cover: Drum Bay is located on the landward side of Follet's Island in Brazoria County and extends southwest from its confluence with Christmas Bay. It is connected to the Gulf Intracoastal Waterway via a cut on the far western end and on the north shore via two shallow washovers.

The area is surrounded by herbaceous wetlands and by the Brazoria National Wildlife Refuge. Wetlands are the predominant land cover class, at 48.15 percent, followed by Open Water (25.58 percent) and Agriculture (15.82 percent).

Segment 2435 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	857.56	4.89	2,772.83	15.82	223.34
Barren Lands	496.39	2.83	609.36	3.48	22.76
Developed	239.30	1.37	1,210.72	6.91	405.95
Forest/Shrubs	16.01	0.09	10.01	0.06	-37.50
Open Water	4,511.96	25.75	4,481.71	25.58	-0.67
Wetlands	11,400.88	65.07	8,437.68	48.15	-25.99
TOTAL	**17,522.10**	**100.00**	**17,522.32**	**100.00**	



Drum Bay - 2435
2435A_01
2435_01
2435_02
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.5 1 2
Miles
Little Slough
Hoskins Mound Rd
STRATTON RI
Oyster Creek
Surfside Beach
Freeport

Water Quality Issues:

Bacteria Impairments and Concerns
Assessment units 2435OW_01 and 2435OW_02 are listed in the 2020 Integrated Report as impaired for oyster waters due to elevated levels of fecal coliform bacteria. These assessment units are closed by the Seafood Safety Division of the Texas Department of State Health Services for the harvesting of oysters and other shellfish for direct marketing.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

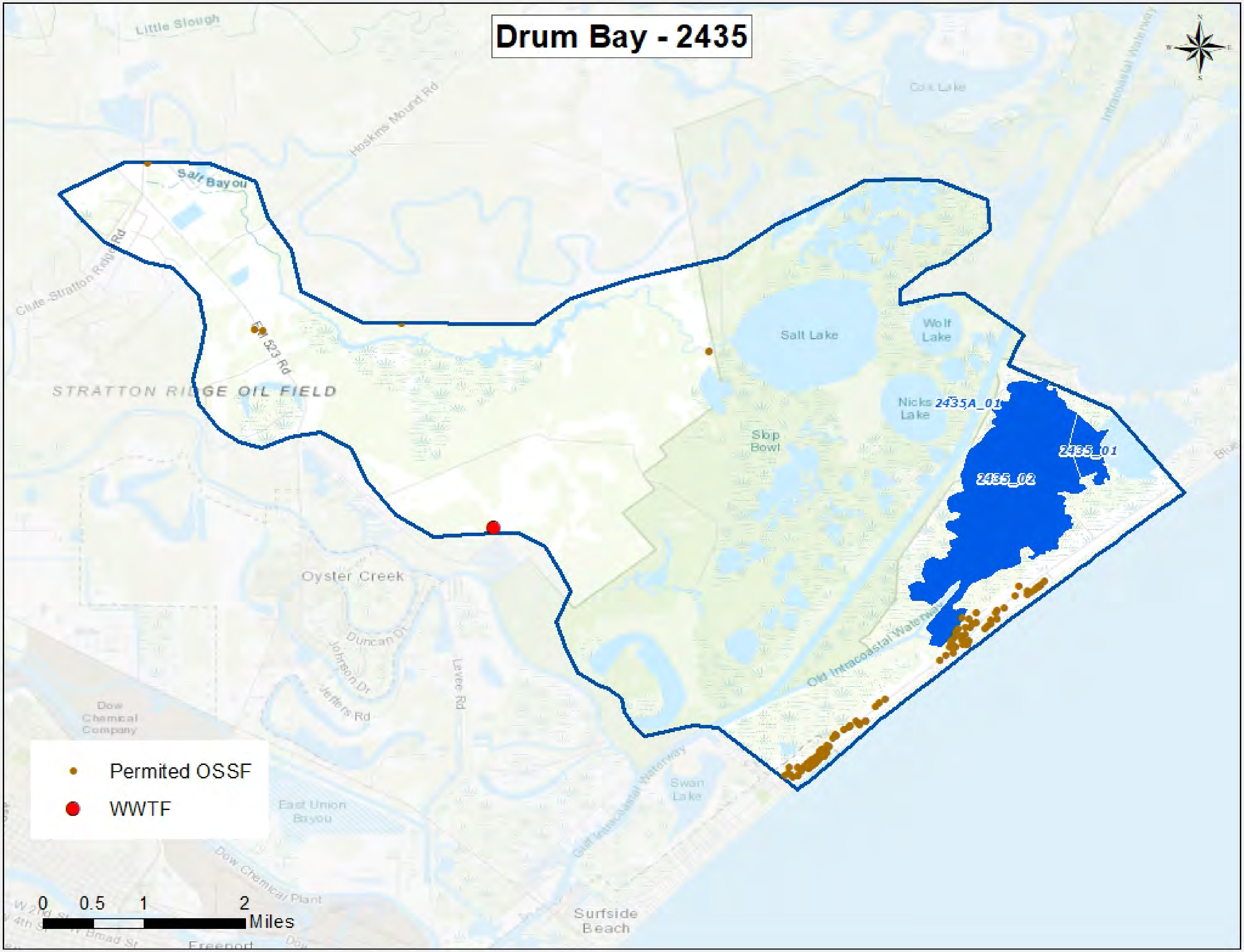
PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Drum Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, failing on-site sewage facilities, stormwater runoff, and animal waste.

There is 1 permitted wastewater outfall in the Drum Bay watershed. On-site sewage facilities are the primary source of wastewater disposal, with 124 permitted on-site sewage facilities located within the watershed. These systems are primarily located along the coast. The wastewater treatment facilities and on-site sewage facilities in the Drum Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Drum Bay watershed.



Drum Bay - 2435
Permited OSSF
WWTF
2435A_01
2435_01
2435_02
Salt Lake
Wolf Lake
Nicks Lake
Slop Bowl
Salt Bayou
Little Slough
Hoskins Mound Rd
Clute-Stratton Ridge Rd
FM 523 Rd
STRATTON RIDGE OIL FIELD
Oyster Creek
Duncan Dr
Johnson Dr
Jeffers Rd
Levee Rd
Dow Chemical Company
East Union Bayou
Dow Chemical Plant
Old Intracoastal Waterway
Gulf Intracoastal Waterway
Intracoastal Waterway
Swan Lake
Cox Lake
Surfside Beach
Freeport
0 0.5 1 2
Miles

Trend Analysis:

Water quality trends for the watersheds Drum Bay (segment 2433) and Nicks Cut (segment 2435A) were not evaluated due to insufficient data. No routine water quality data was collected from these water bodies during the period of record for this report.

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria in Oyster Waters	2435OW I	• Animal waste from cattle grazing • Developments with malfunctioning OSSFs • Year-round and migratory bird populations • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs

Special Studies:

This segment was included in the Houston Ship Channel TMDL for Dioxin. This segment was also included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number: 2423	Name: East Galveston Bay

Area:	57 square miles	Miles of Shoreline:	51 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	5	Texas Stream Team Monitoring Stations:	2	Permitted WWTF Outfalls:	3

DESCRIPTION

- Segment 2423: **East Galveston Bay** (classified water body) – A 134.9 square kilometer (52.1 square mile) portion of Galveston Bay located on the landward side of Bolivar Peninsula extending westward from the Galveston County line east of High Island to an imaginary north-south line extending from Smith Point southeast to approximately ½ mile east of Pepper Grove Cove on Elm Grove Point and east of Bluewater Subdivision on Bolivar Peninsula

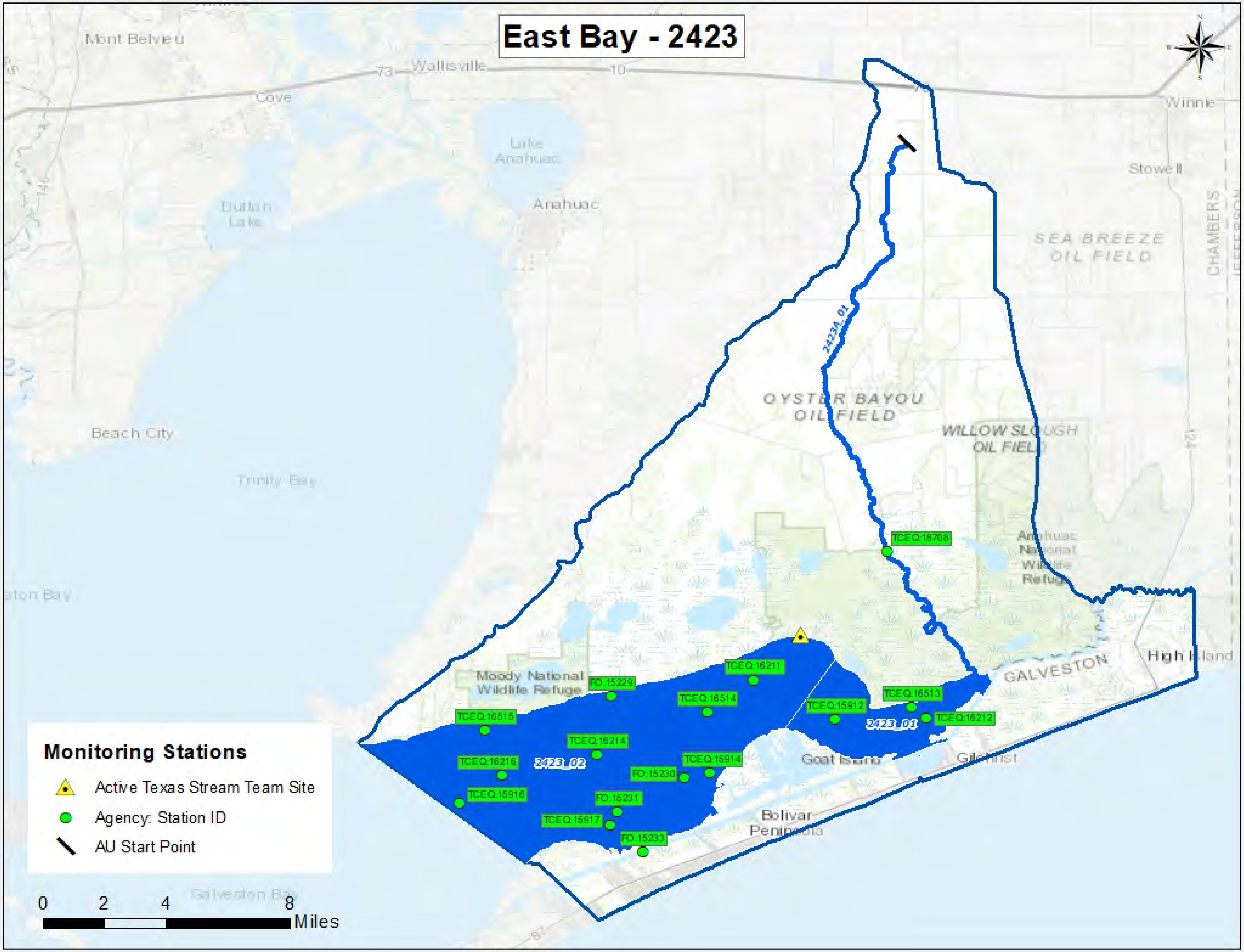
- Segment 2423A (Tidal Stream w/ high ALU): **Oyster Bayou** (unclassified water body) — From the East Bay confluence to a point 2.2 km (1.4 mi) upstream from SH 65 in Chambers County

- Segment 2423OW (Oyster Waters)

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
15229	2423	EAST BAY AT 95GB013	FO	QUARTERLY	Field, Conventional, Bacteria
15230	2423	EAST BAY AT 95GB017 1 MI WNW OF BIG PASTURE BAYOU	FO	QUARTERLY	Field, Conventional, Bacteria
15912	2423	EAST BAY AT 96GB016 1 MI WEST OF FROZEN POINT	FO	QUARTERLY	Field, Conventional, Bacteria
16214	2423	EAST BAY AT 97GB020 3.09 MI NORTH AND 0.36 MI WEST OF STINGAREE CUT	FO	ONE/YEAR QUARTERLY	Metals in Sediment, Organics in Sediment Field, Conventional, Bacteria
18708	2423A	OYSTER BAYOU MID CHANNEL AT ANAHUAC NATIONAL WILDLIFE REFUGE BOAT CANAL CONFLUENCE	FO	QUARTERLY	Field, Conventional, Bacteria

FO = TCEQ Regional Office

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.


East Bay - 2423
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
0 2 4 8
Miles
2423_01
2423_02
2423A_01
TCEQ:18708
TCEQ:16211
FO:15229
TCEQ:16514
TCEQ:16515
TCEQ:16513
TCEQ:15912
TCEQ:16212
TCEQ:16214
TCEQ:16216
TCEQ:15914
FO:15230
TCEQ:15916
FO:15231
TCEQ:15917
FO:15233
Mont Belvieu
Wallisville
Cove
Lake Anahuac
Anahuac
Beach City
Trinity Bay
Winnie
Stowell
SEA BREEZE OIL FIELD
OYSTER BAYOU OIL FIELD
WILLOW SLOUGH OIL FIELD
Moody National Wildlife Refuge
GALVESTON
High Island
Bolivar Peninsula
Galveston Bay
CHAMBERS

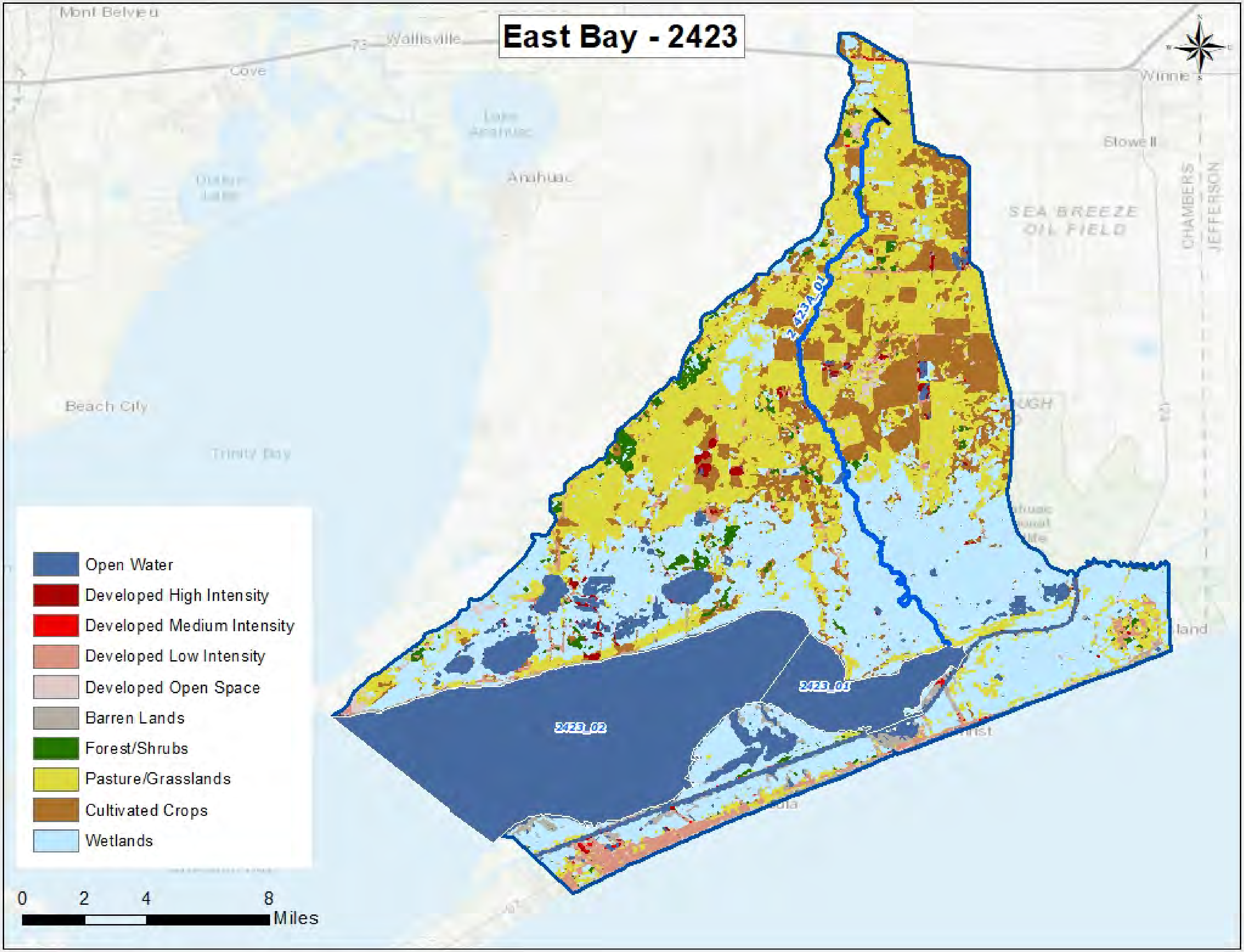
Segment 2423 Water Quality Standards and Screening Levels					
Standards	**Bays & Estuaries**	**Tidal Stream**	**Screening Levels**	**Bays & Estuaries**	**Tidal Stream**
Temperature (°C/°F):	35	35 / 95	Ammonia-N (mg/L):	0.10	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	4.0	Nitrate-N (mg/L):	0.17	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66
Enterococci (MPN/100mL) (grab):	130	130	Chlorophyll *a* (µg/L):	11.6	21
Enterococci (MPN/100mL) (geometric mean):	35	35			
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43				

Segment Discussion

Watershed Characteristics and Land Cover: The East Galveston Bay (2423) watershed is primarily undeveloped and includes East Bay, the Upper Bolivar Peninsula, and part of Chambers County. Salt marshes, coastal prairies, and wetlands make up the majority of undeveloped land surrounding the shoreline of East Bay. On the peninsula, development is mostly limited to single family homes, most of which are vacation homes, and small commercial operations. There are several industrial areas on Bolivar Peninsula, including oil and gas production, commercial shrimping, and oyster harvesting. There are a few small unincorporated communities, such as Gilcrest, Crystal Beach, and High Island, located along the peninsula. Homes and businesses in the watershed are exclusively using on-site sewage facilities. Chambers County, which drains to East Bay, maintains ranching as the primary activity in the area. There are also two wildlife refuges, a wildlife management area, and a bird sanctuary located in the watershed.

The largest land cover categories in the watershed are Agriculture (34.70 percent), Wetlands (32.73 percent), and Open Water (25.33 percent). Only 3.85 percent of the watershed is classified as Developed.

Segment 2423 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	54,075.47	30.97	60,573.86	34.70	12.02
Barren Lands	1,122.21	0.64	3,141.11	1.80	179.90
Developed	4,754.82	2.72	6,716.34	3.85	41.25
Forest/Shrubs	124.32	0.07	2,789.28	1.60	2,143.65
Open Water	46,404.60	26.58	44,215.78	25.33	-4.72
Wetlands	68,109.95	39.01	57,142.30	32.73	-16.10
TOTAL	**174,591.4**	**100**	**174,578.7**	**100**	


East Bay - 2423
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
2
4
8
Miles
2423A_01
2423_01
2423_02
Mont Belvieu
Wallisville
Cove
Anahuac
Beach City
Trinity Bay
Winnie
Stowell
SEA BREEZE OIL FIELD
CHAMBERS
JEFFERSON

Water Quality Issues:

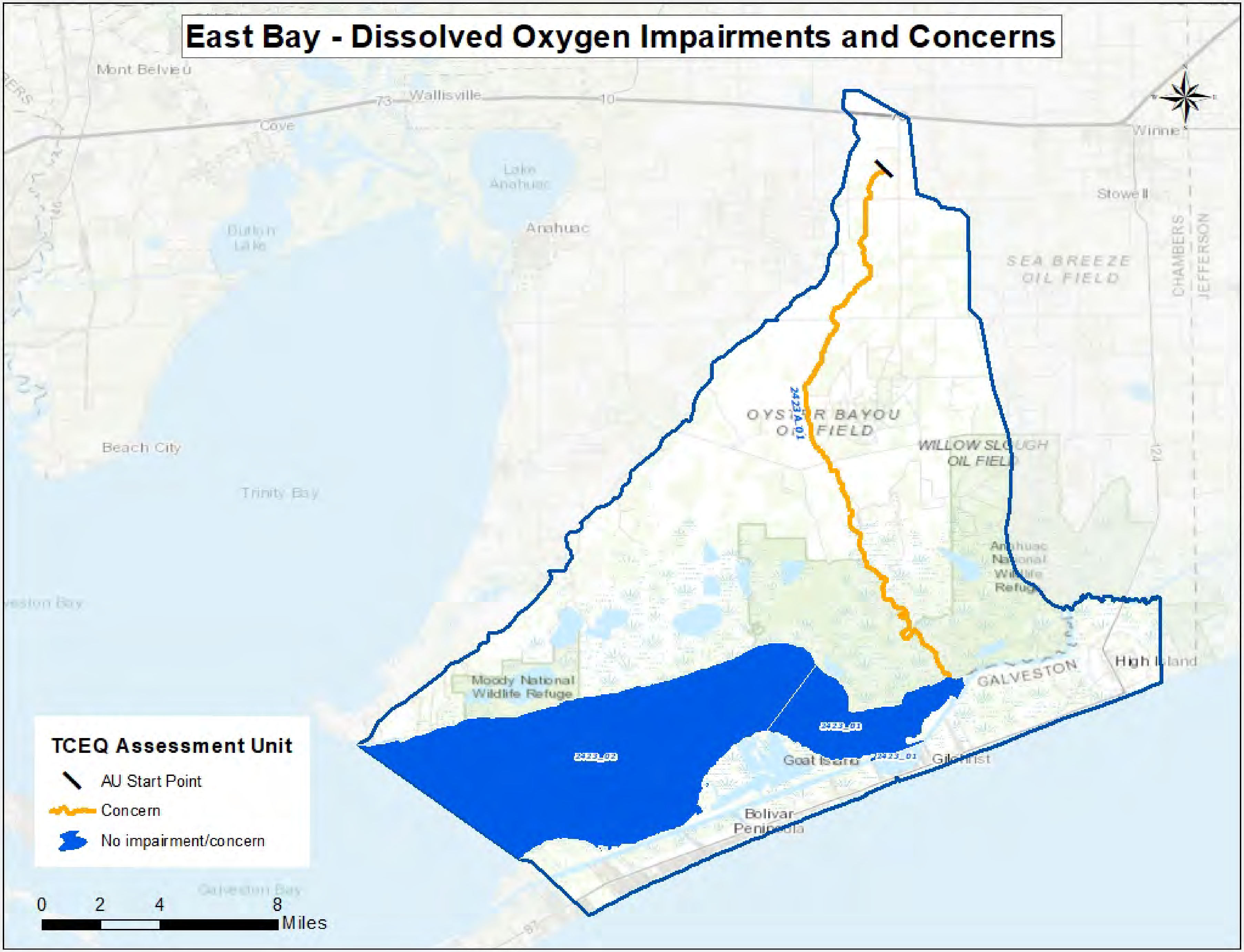
Bacteria Impairments and Concerns
The 2020 Integrated Report lists AU 2423OW_01 as impaired for oyster waters due to elevated levels of enterococci bacteria. This assessment unit, which is the east end area of the bay adjacent to the Intracoastal Water Way and the East Bay Bayou, is restricted by the Seafood Safety Division of the Texas Department of State Health Services for the harvesting of oysters and other shellfish for direct marketing.

Dissolved Oxygen Impairments and Concerns
A concern based on dissolved oxygen grab screening levels was identified in AU 2432A_01.

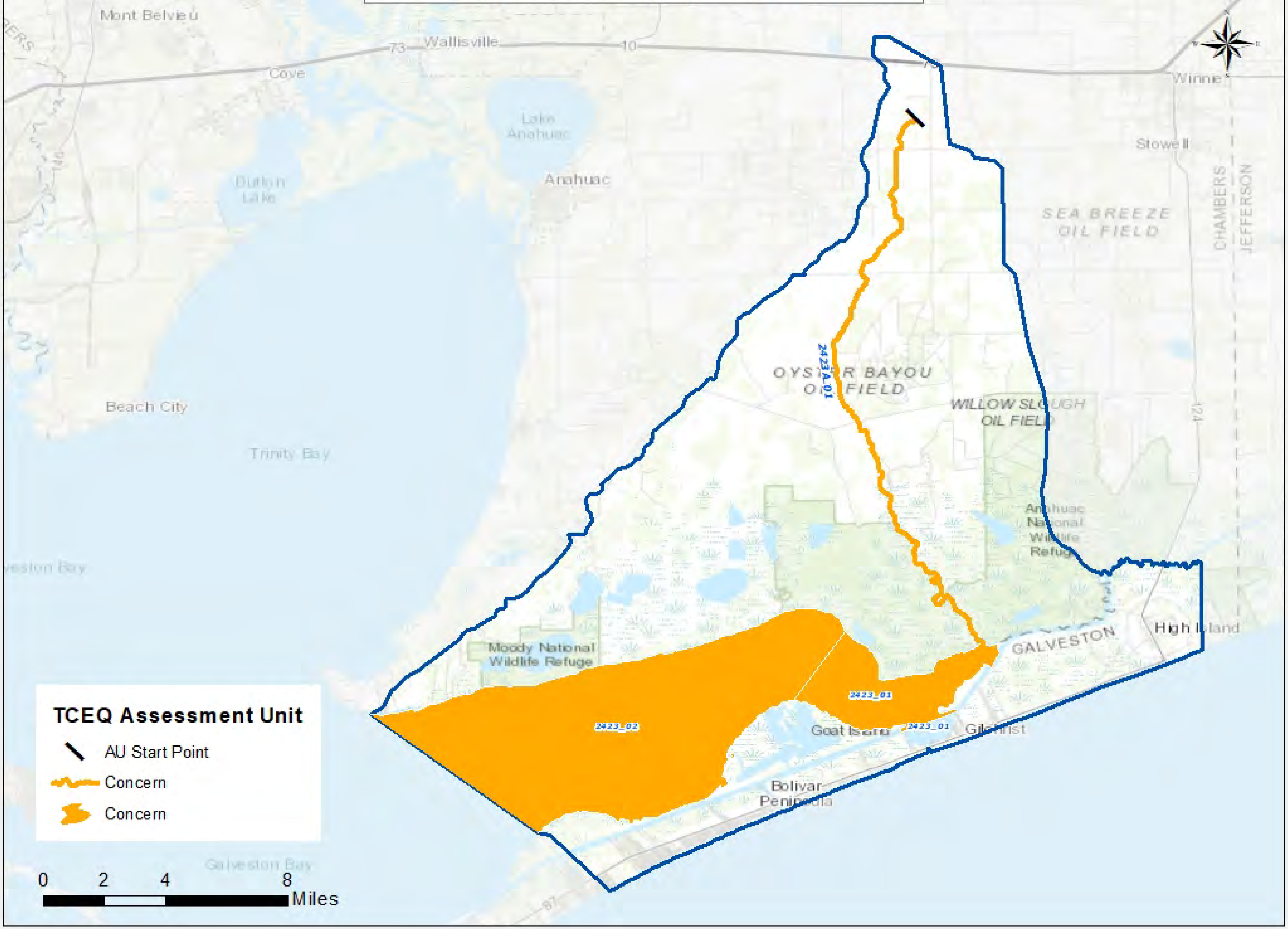
Nutrient Concerns
There are no nutrient concerns in this segment.

Chlorophyll-a Concerns
East Bay (2423_01 and 2423_02) and Oyster Bayou (2423A_01) also have chlorophyll-*a* concerns based upon water quality screening criteria levels.

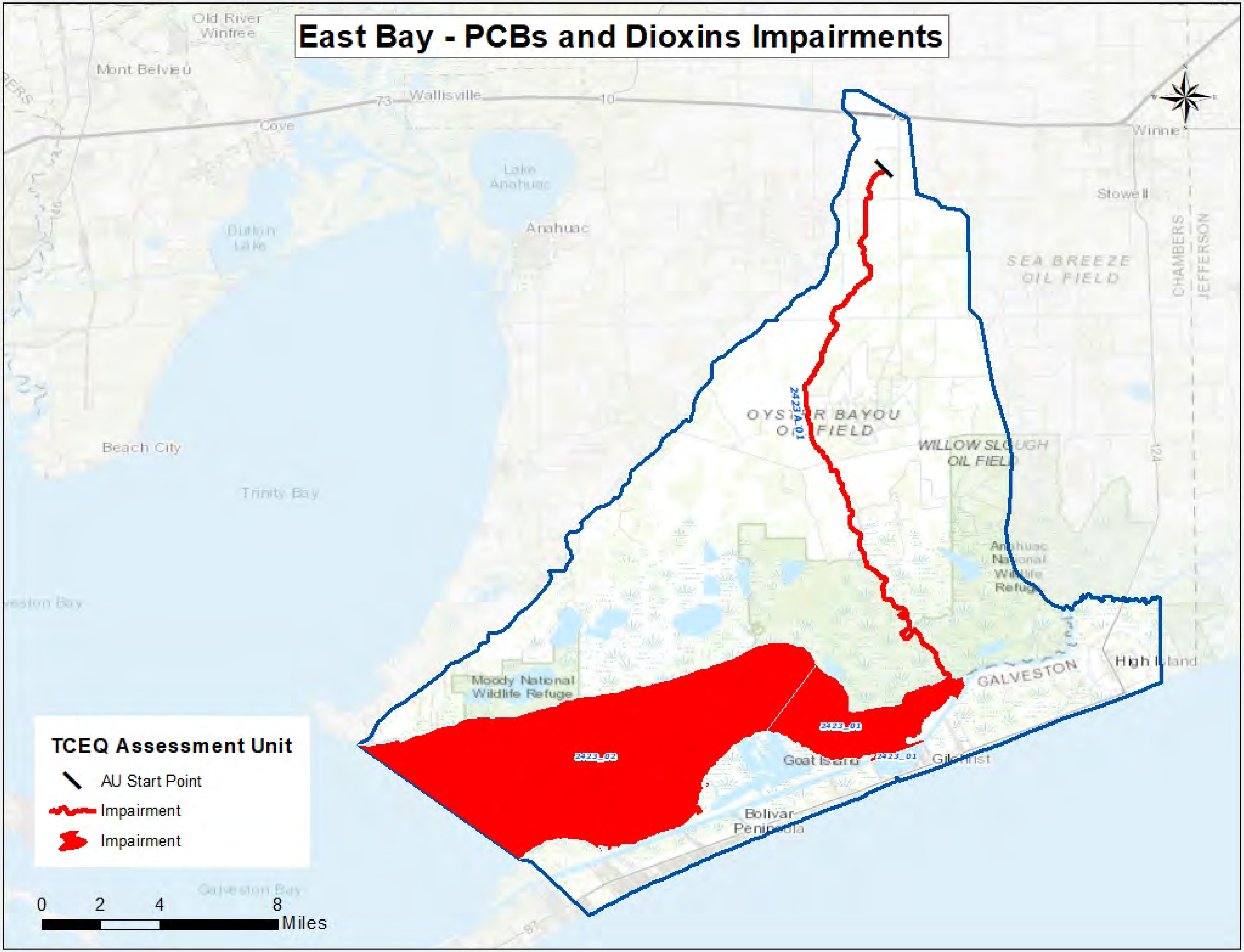
PCBs and Dioxin Impairments
East Galveston Bay and Oyster Bayou are listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory has been issued by the Texas Department of State Health Services.


East Bay - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
Concern
No impairment/concern
0
2
4
8
Miles
Mont Belvieu
Wallisville
Cove
Lake Anahuac
Anahuac
Winnie
Stowell
SEA BREEZE OIL FIELD
CHAMBERS
JEFFERSON
Beach City
Trinity Bay
Moody National Wildlife Refuge
GALVESTON
High Island
Goat Island
Gilchrist
Bolivar Peninsula
Galveston Bay
2423A_01
2422_02
2423_01

East Bay - Chlorophyll-a Concerns



East Bay - PCBs and Dioxins Impairments



Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the East Galveston Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, and animal waste.

There are 3 permitted wastewater outfalls in the East Galveston Bay watershed. In this watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 1,517 permitted on-site sewage facilities within the watershed, with most of them located on the Bolivar Peninsula. The wastewater treatment facilities and on-site sewage facilities in the East Galveston Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the East Galveston Bay watershed.

East Bay - 2423
AU Start Point
Permited OSSF
WWTF
0
2
4
8
Miles
Mont Belvieu
Wallisville
Cove
Lake Anahuac
Anahuac
Dutton Lake
Beach City
Trinity Bay
Galveston Bay
Winnie
Stowell
SEA BREEZE OIL FIELD
CHAMBERS
JEFFERSON
OYSTER BAYOU OIL FIELD
WILLOW SLOUGH OIL FIELD
2423A_01
Anahuac National Wildlife Refuge
Moody National Wildlife Refuge
GALVESTON
2423_01
2423_02
Goat Island
Bolivar Peninsula

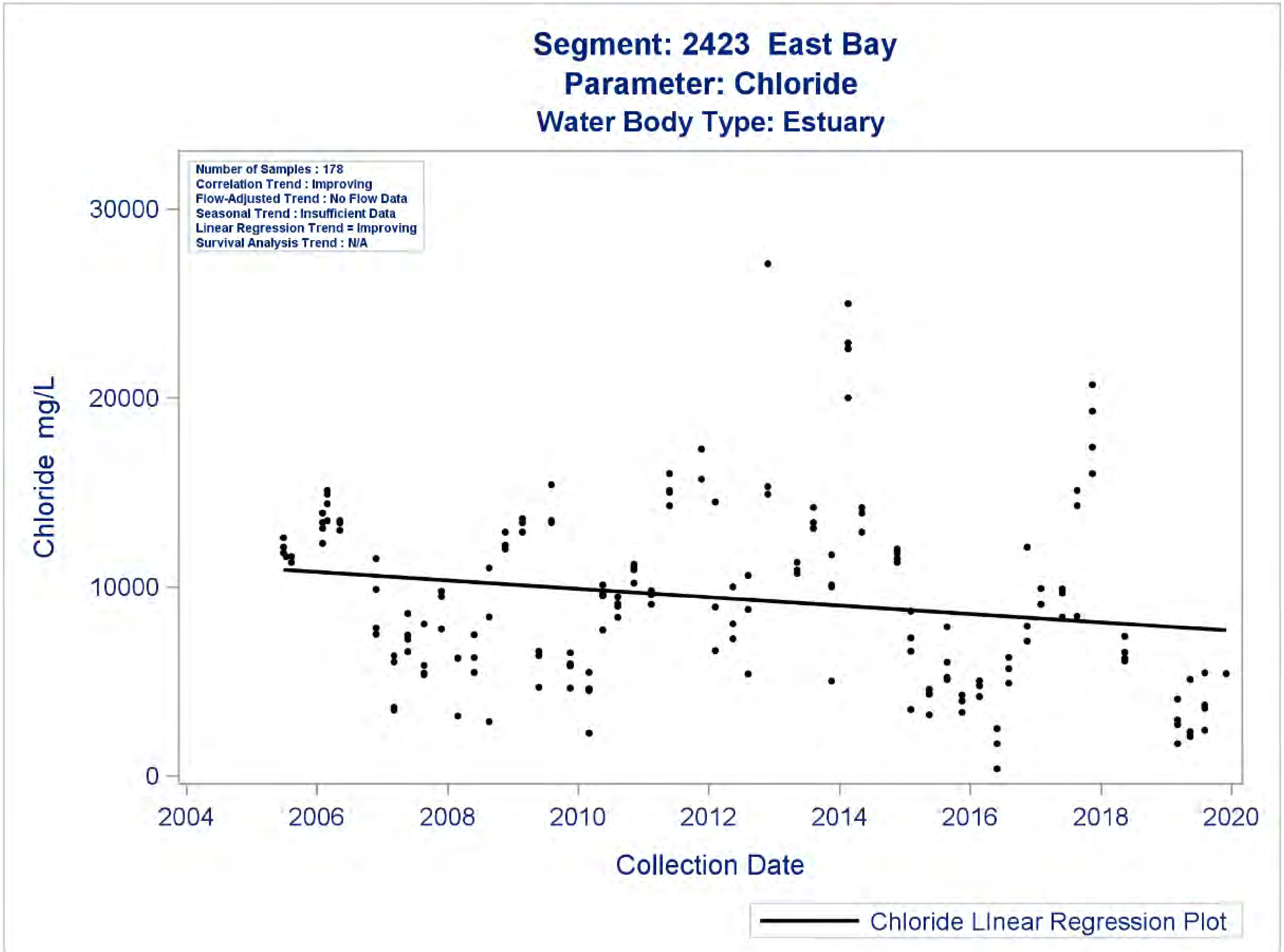
Trend Analysis:

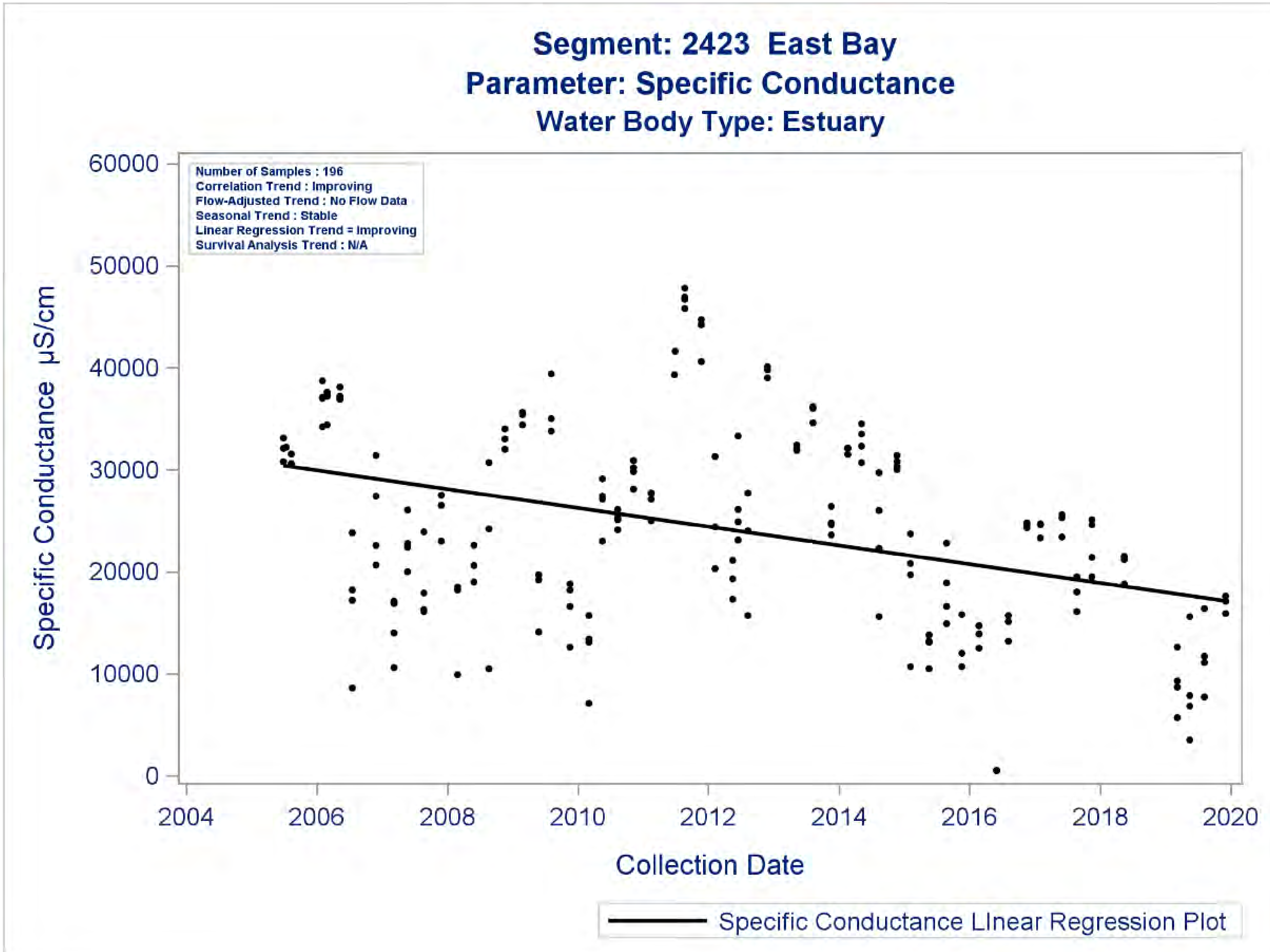
Analysis of water quality data for East Galveston Bay (segment 2423) identified five parameter trends which included decreasing chloride, specific conductance, total phosphorus, and sulfate concentrations while pH was found to be increasing. The pH trend is not problematic at this time because all measurements were found to be in the acceptable range of 6.5 to 9.0 standard units. However, in late 2019 there was one value measured at 9.0 which may or may not point to future excursions of the acceptable pH range.

Rollover Pass, a man-made cut through the Bolivar Peninsula in Galveston County in 1955, was intended to improve fishing conditions and promote fish passage from the Gulf of Mexico to inshore water of East Bay. However, studies have demonstrated the pass can bring too much salt water into the bays and nearby estuaries, which in turn hurts oysteries and other fish habitats. In 2011, the Texas Legislature authorized the closure of Rollover Pass and in September of 2019, the Texas General Land Office officially closed the pass. The effects of this closure have not been fully documented with only 12 samples collected since its closure to East Bay. Theoretically, the closure may have a dramatic effect on many water quality parameters in the future, not just chloride, specific conductance, sulfate, and pH.

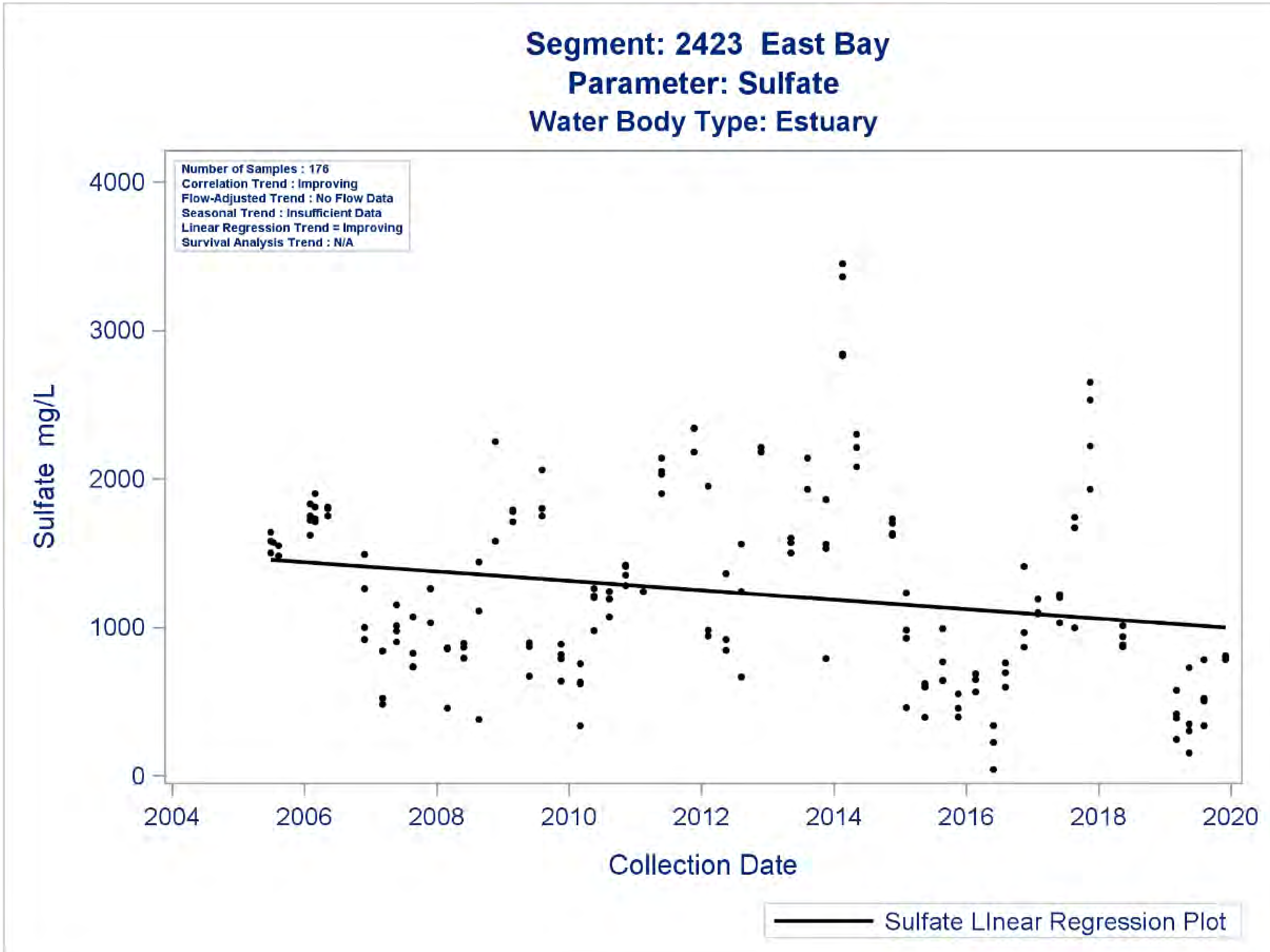
The 2020 Texas Integrated Report also lists the East Bay (2423) watershed as having a concern for chlorophyll *a* concentrations. Analysis of chlorophyll *a* data for East Bay (2423) and Oyster Bayou (2423A) indicated there was insufficient data to determine if there was a trend. There is no concern for other nutrients in either East Bay or Oyster Bayou. Total phosphorus concentrations support this ‘no concern’ by revealing a downward or improving trend with concentrations being measured less than the screening level since around 2011.

The East Bay watershed is currently impaired for elevated levels of indicator bacteria in oyster waters and for PCB and dioxin in edible fish tissue. Analysis of enterococci data for the main East Bay segment detected relatively stable conditions over time. Refer to the Water Quality Issues discussion above for more information about oyster water bacteria impairments.

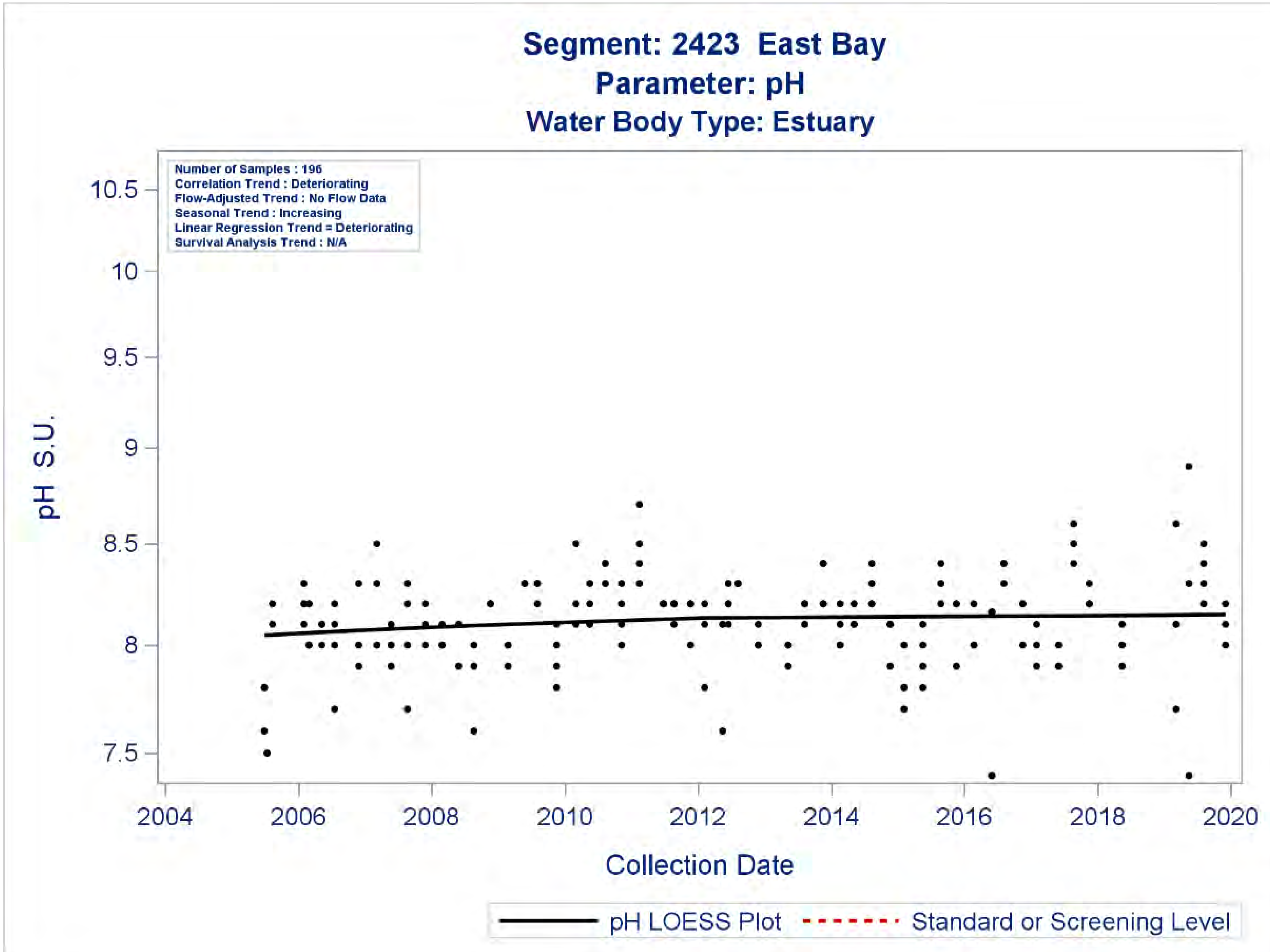

Segment: 2423 East Bay
Parameter: Chloride
Water Body Type: Estuary
Number of Samples : 178
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Chloride mg/L
30000
20000
10000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Chloride Linear Regression Plot



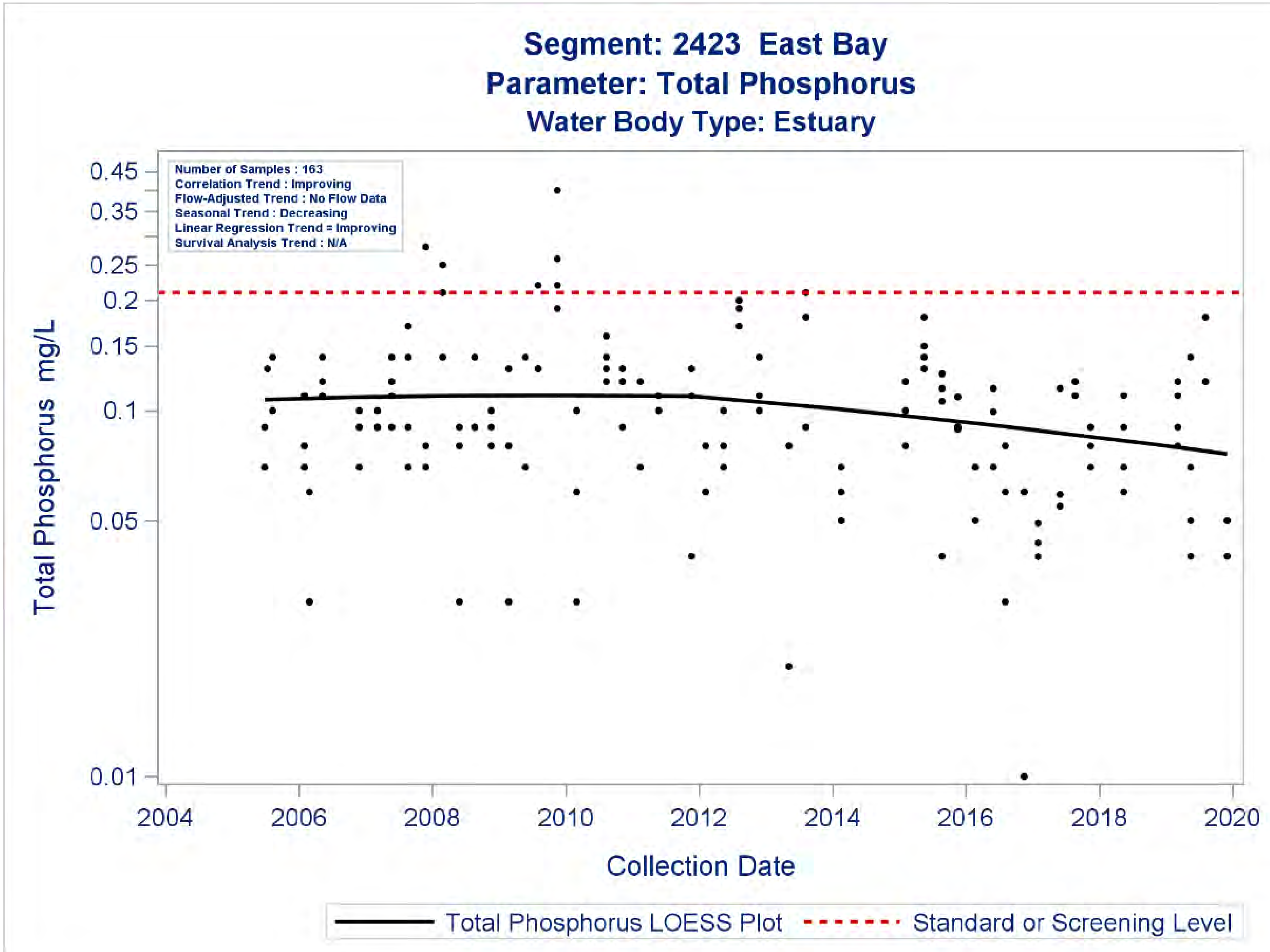
Segment: 2423 East Bay
Parameter: Specific Conductance
Water Body Type: Estuary
Number of Samples : 196
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Specific Conductance µS/cm
60000
50000
40000
30000
20000
10000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Specific Conductance LInear Regression Plot



Segment: 2423 East Bay
Parameter: Sulfate
Water Body Type: Estuary
Number of Samples : 176
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Sulfate mg/L
4000
3000
2000
1000
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Sulfate LInear Regression Plot



Segment: 2423 East Bay
Parameter: pH
Water Body Type: Estuary
Number of Samples : 196
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
pH S.U.
10.5
10
9.5
9
8.5
8
7.5
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
pH LOESS Plot
Standard or Screening Level


Segment: 2423 East Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 163
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.45
0.35
0.25
0.2
0.15
0.1
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria **Bacteria in Oyster Waters**	2432A I 2423OW I	• Animal waste from agricultural production, ranches, hobby farms, and riding stables • Bird rookeries on islands throughout the bay and along the shoreline • Improper disposal of waste from boats • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education on proper boat waste disposal • More public education regarding OSSF operations and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	***DO Grab Screening*** 2432A C	▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, agricultural production, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Excessive nutrients and organic matter from agricultural production, and related activities	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • More public education on pet waste; household fats, oils, and grease disposal; and OSSF maintenance • Improve compliance and enforcement of existing stormwater quality permits • Expand the use of LID and green infrastructure practices

			▪ Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields ▪ Vegetative canopy removed		• Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Work with drainage districts and agencies to change practices of clear-cutting and channelizing waterways to protect from solar heating • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Conserve or plant canopy trees and habitat along waterways to maintain/create shade to cool water.
Elevated Chlorophyll -*a* Concentrations	2423 2423A	C C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	2423 2423A	I I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

This segment was included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number:	2439		Name:	Lower Galveston Bay	
Area:	362 square miles	**Miles of Shoreline:**	70 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	14	**Texas Stream Team Monitoring Stations:**	7	**Permitted WWTF Outfalls:**	13

DESCRIPTION

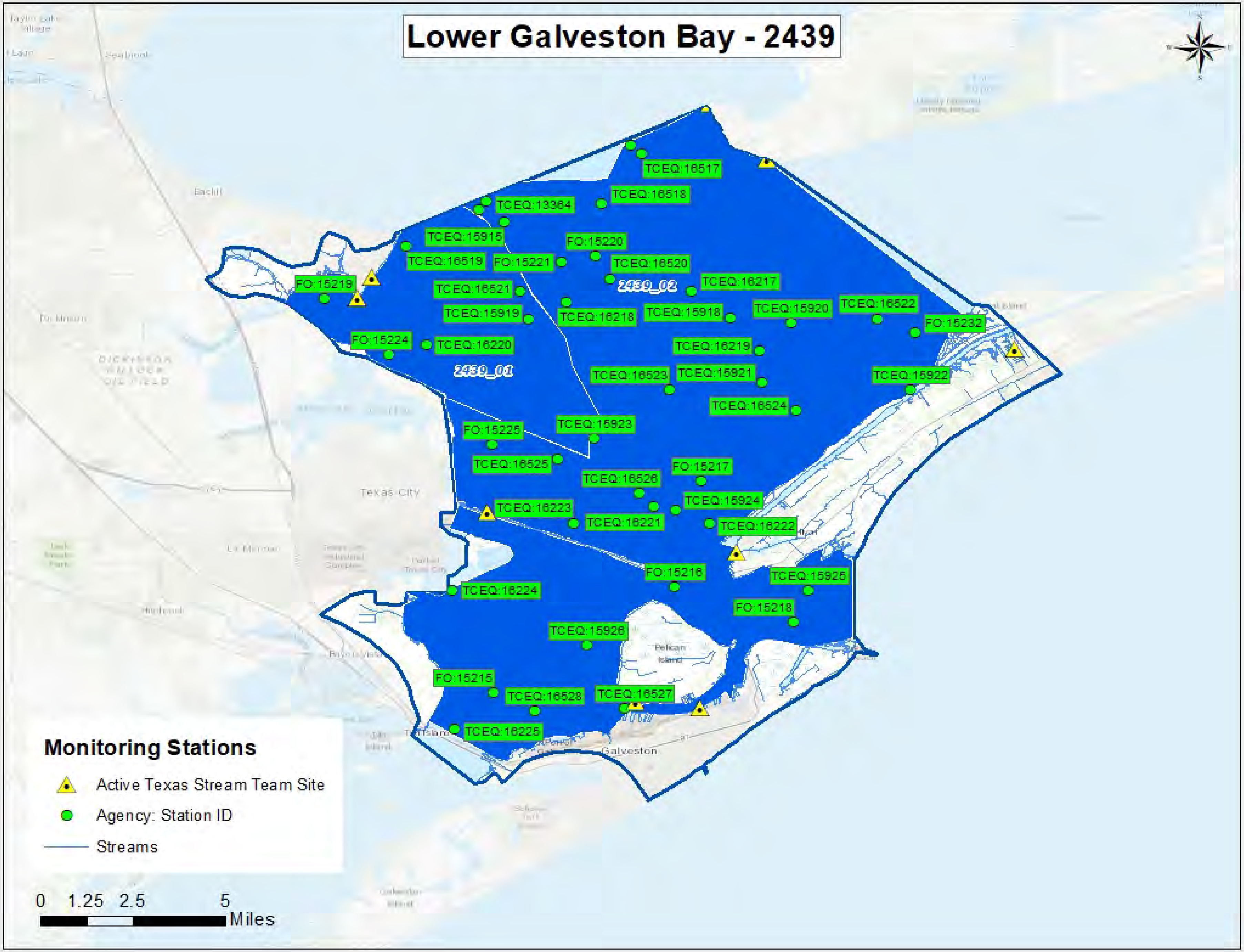
- Segment 2439: **Lower Galveston Bay** – A 361.6 square kilometer (139.2 square mile) portion of Galveston Bay located entirely within Galveston County extending eastward from the Galveston Causeway (IH-45) past Bolivar Roads (the pass between Galveston Island and Bolivar Peninsula) to an imaginary north-south line from Smith Point to approximately ½ mile east of Pepper Grove Cove on Elm Grove Point and east of Bluewater Subdivision on Bolivar Peninsula. And south of the imaginary line between Eagle Pt and Redfish Reef near the community of San Leon in Galveston County and Smith Point in Chambers County.

- Segment 2439OW (Oyster Waters)

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
13364	2439	BAYPORT CHANNEL MID CHANNEL SOUTH OF S SHADY LN AT PINE TRL IMMEDIATELY EAST OF TURNING BASIN	FO	Quarterly One/Year	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment
15215	2439	LOWER GALVESTON BAY AT 95GB030 0.4 MI NORTH OF ICWW MARKER 18	FO	Quarterly	Field, Conventional, Bacteria
15216	2439	LOWER GALVESTON BAY AT 95GB028 0.4 MI EAST OF THE INTERSECTION OF THE TCSC AND THE ICWW	FO	Quarterly	Field, Conventional, Bacteria
15218	2439	LOWER GALVESTON BAY AT 95GB029 IN BOLIVAR ROADS 0.85 MI EAST OF CM 16	FO	Quarterly	Field, Conventional, Bacteria
15219	2439	LOWER GALVESTON BAY AT 95GB023 IN MIDDLE OF DICKINSON BAY	FO	Quarterly	Field, Conventional, Bacteria
15220	2439	LOWER GALVESTON BAY AT 95GB020 1.5 MI ENE OF HSC 52	FO	Quarterly	Field, Conventional, Bacteria
15221	2439	LOWER GALVESTON BAY AT 95GB021 0.85 MI ENE OF HSC 52	FO	Quarterly	Field, Conventional, Bacteria
15222	2439	LOWER GALVESTON BAY AT 95GB018 AT SE CORNER OF REDFISH REEF	FO	Quarterly	Field, Conventional, Bacteria
15223	2439	LOWER GALVESTON BAY AT 95GB015 2 MI WSW OF SMITH POINT	FO	Quarterly	Field, Conventional, Bacteria
15224	2439	LOWER GALVESTON BAY AT 95GB025 NEAR MOSES LAKE TIDE GATE	FO	Quarterly	Field, Conventional, Bacteria
15225	2439	LOWER GALVESTON BAY AT 95GB026 1.8 MI SE OF DOLLAR POINT	FO	Quarterly	Field, Conventional, Bacteria
15232	2439	LOWER GALVESTON BAY AT 95GB024 1.5 MI NORTH OF SIEVERS CUT 0.75 MI WEST OF PEPPER GROVE POINT	FO	Quarterly	Field, Conventional, Bacteria
15925	2439	LOWER GALVESTON BAY AT 96GB030 IN BOLIVAR ROADS 0.7 MI SE OF FORT TRAVIS	FO	Quarterly One/Year	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment
16523	2439	LOWER GALVESTON BAY 5.75MI WEST OF SIEVERS COVE 5MI NORTH OF END OF TEXAS CITY DIKE/98GB030	FO	Quarterly One/Year	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment

FO = TCEQ Regional Office

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.


Lower Galveston Bay - 2439
TCEQ:16517
TCEQ:16518
TCEQ:13364
TCEQ:15915
FO:15220
TCEQ:16519
FO:15221
TCEQ:16520
FO:15219
2439_02
TCEQ:16217
TCEQ:16521
TCEQ:15919
TCEQ:16218
TCEQ:15918
TCEQ:15920
TCEQ:16522
FO:15232
FO:15224
TCEQ:16220
TCEQ:16219
2439_01
TCEQ:16523
TCEQ:15921
TCEQ:15922
TCEQ:16524
FO:15225
TCEQ:15923
TCEQ:16525
FO:15217
TCEQ:16526
Texas City
TCEQ:16223
TCEQ:15924
TCEQ:16221
TCEQ:16222
FO:15216
TCEQ:15925
TCEQ:16224
FO:15218
TCEQ:15926
Pelican Island
FO:15215
TCEQ:16528
TCEQ:16527
TCEQ:16225
Galveston
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
Streams
0 1.25 2.5 5
Miles

Segment 2439 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43		

Segment Discussion

Watershed Characteristics and Land Cover: This segment primarily receives flow from other bodies of water such as Upper Galveston Bay, East Bay, West Bay and the Gulf of Mexico. The land portion of the watershed includes parts of the cities of Galveston and Texas City, and the unincorporated communities of San Leon and Port Bolivar. The eastern end of Galveston Island is heavily urbanized with commercial shipping operations located along both the north and south shores of the Galveston Ship Channel. A large portion of Pelican Island, located to the north of the channel, is used for dredge disposal and contains a great deal of wetland habitat. Likewise, the east end of the Galveston Island on the bay side of the seawall is a dredge disposal area.

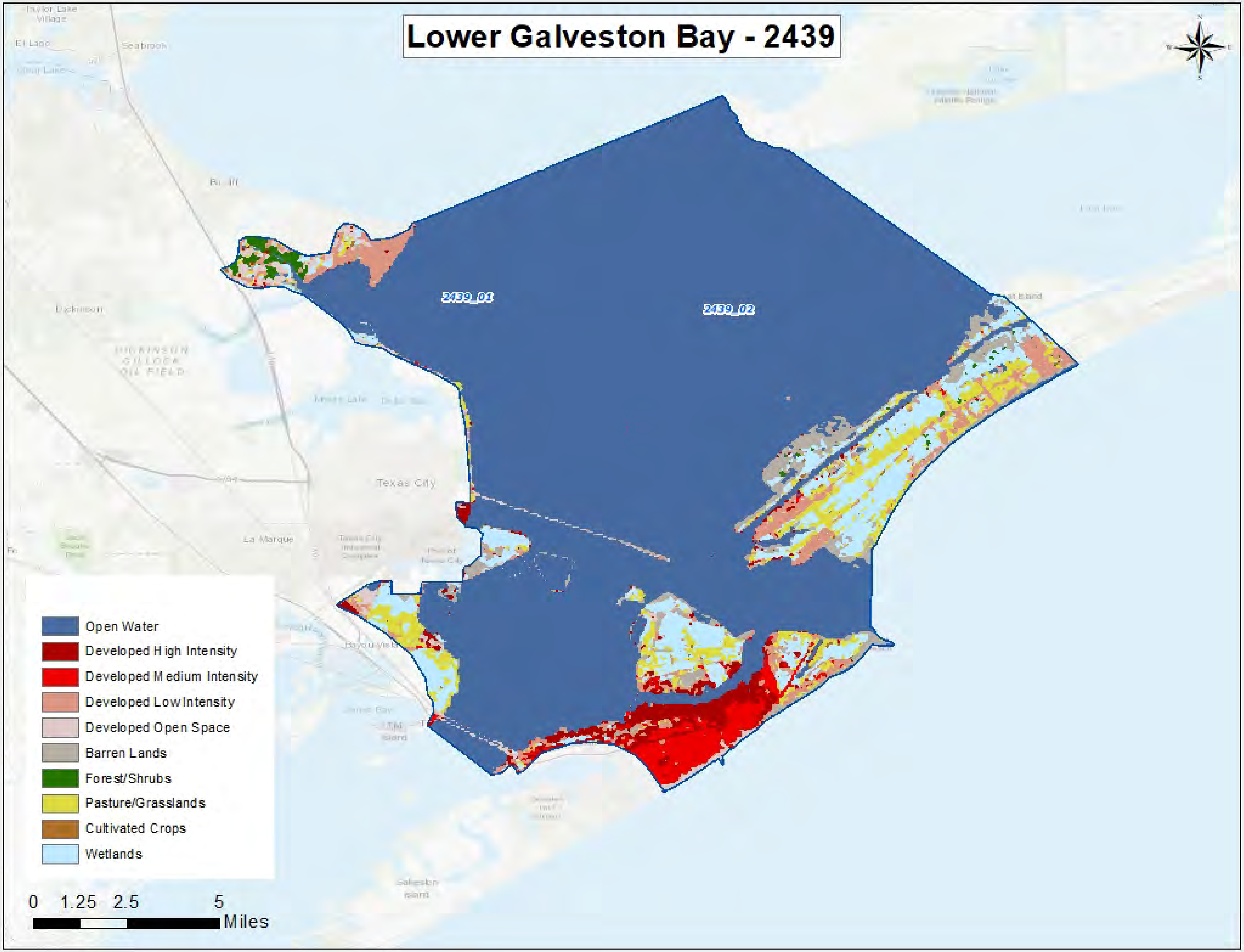
While Texas City is heavily industrialized with a high concentration of refineries and related petrochemical installations, only a relatively small area drains directly to Lower Galveston Bay. Most of Texas City drains through Moses Lake via pumping stations located on the city lagoons. In addition to the wetlands and grasslands, this area also includes several other industrial operations such as landfills, offsite disposal areas, and a superfund site. The other Texas City land area draining to the Bay is the Texas City Dike and all the bay shoreline along the seawall levee north of the dike. A few shrimp boats dock along the dike but there are no permanently located businesses on the dike. This area supports public recreation such as swimming, wade fishing and wind surfing.

North of Texas City is the unincorporated community of San Leon. It is moderately developed with a mix of residential and commercial land uses. Though smaller in size, the community of Pt. Bolivar on Bolivar Peninsula is also a year-round community of mixed residential and commercial uses. Farther east along the peninsula are large tracts of undeveloped land supporting wetland, marsh and grassland habitats intersected with small residential developments and a few canal communities. Many of these houses are vacation homes without year-round occupants.

Lower Galveston Bay is a crossroads of many waterways. It supports high volumes of ocean-going ships and barge traffic, particularly along the ship channels and the Intracoastal Waterway. Extensive commercial oyster beds are located across the upper portion of Lower Galveston Bay while the entire bay is used extensively for recreational activities such as boating, fishing and birding.

Open Water is the largest land cover class, making up 76.76 percent of the watershed.

Segment 2439 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	2,141.67	1.76	4,962.76	4.07	131.72
Barren Lands	2,313.36	1.90	3,794.96	3.11	64.05
Developed	7,869.91	6.46	10,556.22	8.66	34.13
Forest/Shrubs	38.47	0.03	555.10	0.46	1,342.94
Open Water	95,468.60	78.36	93,521.08	76.76	-2.03
Wetlands	13,998.91	11.49	8,440.80	6.93	-39.70
TOTAL	**121,830.92**	**100.00**	**121,830.92**	**100.00**	



Lower Galveston Bay - 2439
2439_01
2439_02
Texas City
La Marque
Dickinson
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1.25 2.5 5
Miles

Water Quality Issues:

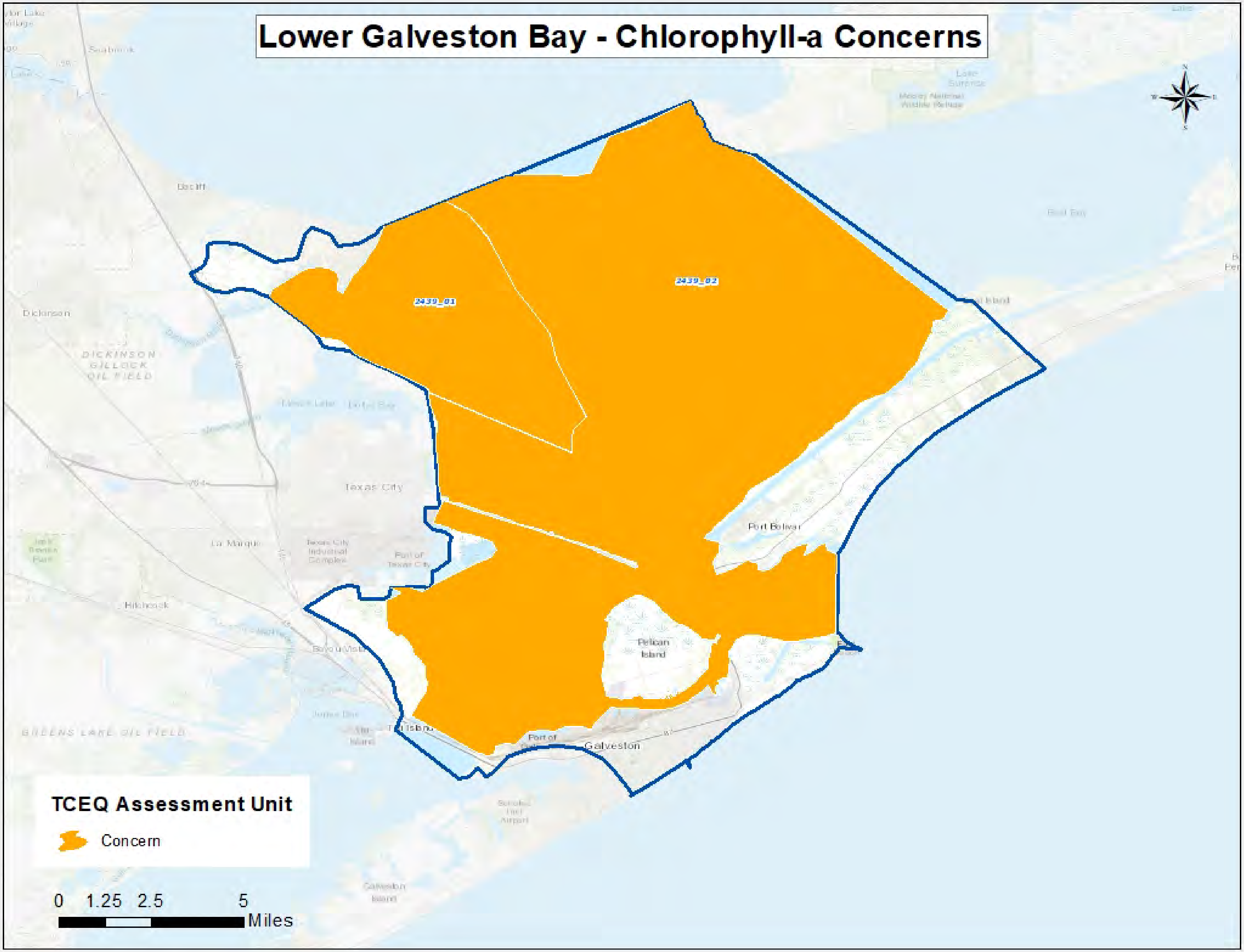
Bacteria Impairments and Concerns
Assessment unit 2439OW_01, which is the area of Lower Galveston Bay located near the Texas City Ship Channel and Moses Lake, is listed in the 2020 Integrated Report as impaired for oyster waters due to elevated levels of fecal coliform bacteria. This assessment unit is closed by the Seafood Safety Division of the Texas Department of State Health Services for the harvesting of oysters and other shellfish for direct marketing.

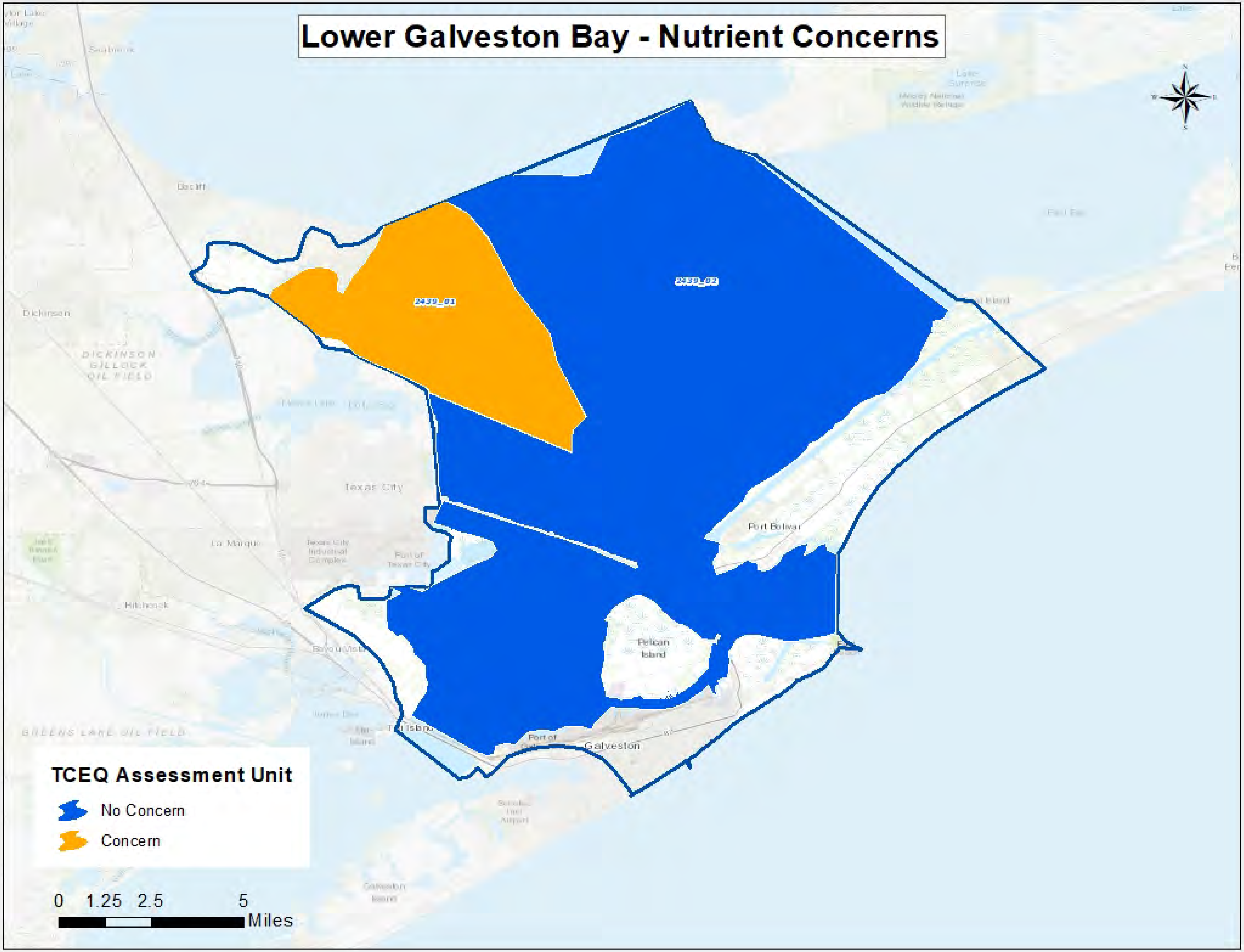
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
A nutrient concern for nitrate-nitrogen was identified for Lower Galveston Bay. In the 2020 assessment, which covers the period of 12/1/11 – 11/30/18, 31.7 percent of nitrate-nitrogen samples and 36.8 percent of chlorophyll-*a* sample exceeded the nutrient screening levels.

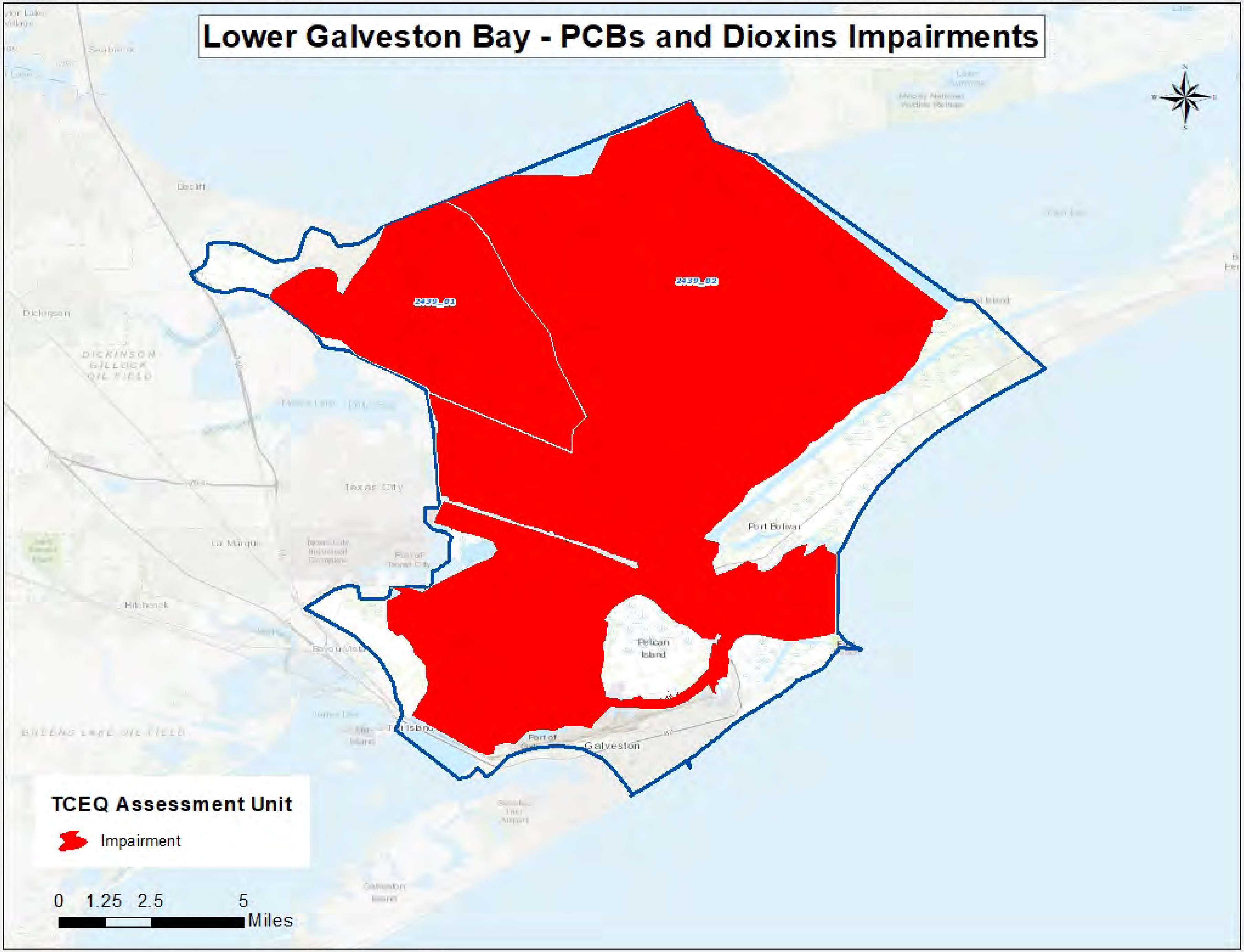
Chlorophyll-a Concerns
Lower Galveston Bay has concerns for chlorophyll-a in both 2439_01 and 2439_02.

PCBs and Dioxin Impairments
Lower Galveston Bay is listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from this segment indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.


Lower Galveston Bay - Chlorophyll-a Concerns
2439_01
2439_02
Texas City
La Marque
Dickinson
DICKINSON GILLOCK OIL FIELD
Hitchcock
Port Bolivar
Pelican Island
Galveston
GREENS LAKE OIL FIELD
TCEQ Assessment Unit
Concern
0 1.25 2.5 5
Miles



Lower Galveston Bay - Nutrient Concerns
2439_01
2439_02
Dickinson
Texas City
La Marque
Hitchcock
Port Bolivar
Pelican Island
Galveston
TCEQ Assessment Unit
No Concern
Concern
0 1.25 2.5 5
Miles


Lower Galveston Bay - PCBs and Dioxins Impairments
2439_01
2439_02
Bacliff
Dickinson
DICKINSON GILLOCK OIL FIELD
Texas City
La Marque
Port of Texas City
Hitchcock
Bayou Vista
Port Bolivar
Pelican Island
Galveston
TCEQ Assessment Unit
Impairment
0 1.25 2.5 5
Miles

Potential Sources of Water Quality Issues:

Potential sources of fecal indicator bacteria and nutrients in the Lower Galveston Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

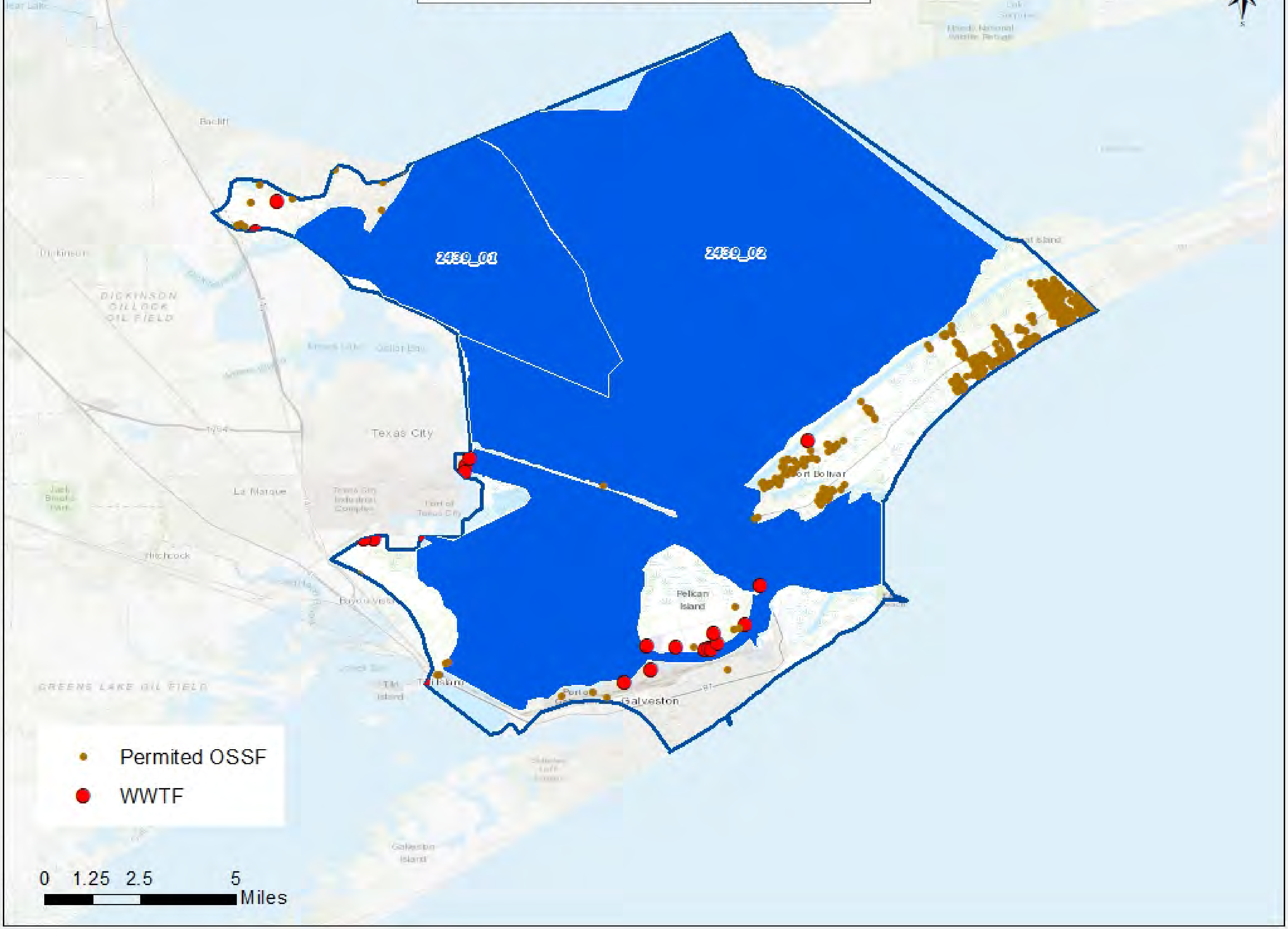
There are 13 permitted wastewater outfalls in the Lower Galveston Bay watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 654 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the Lower Galveston Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 2 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Lower Galveston Bay watershed.

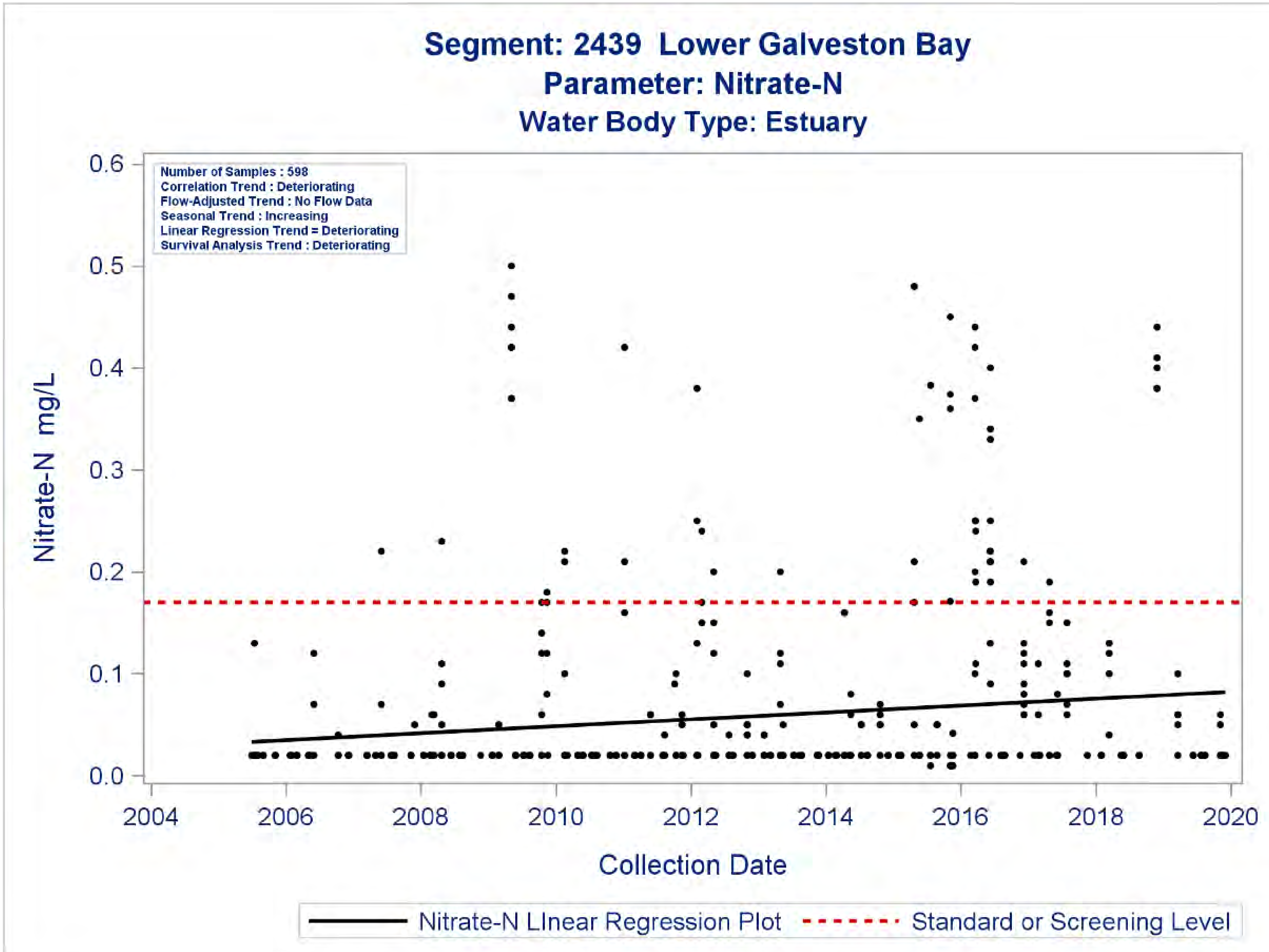
Lower Galveston Bay - 2439



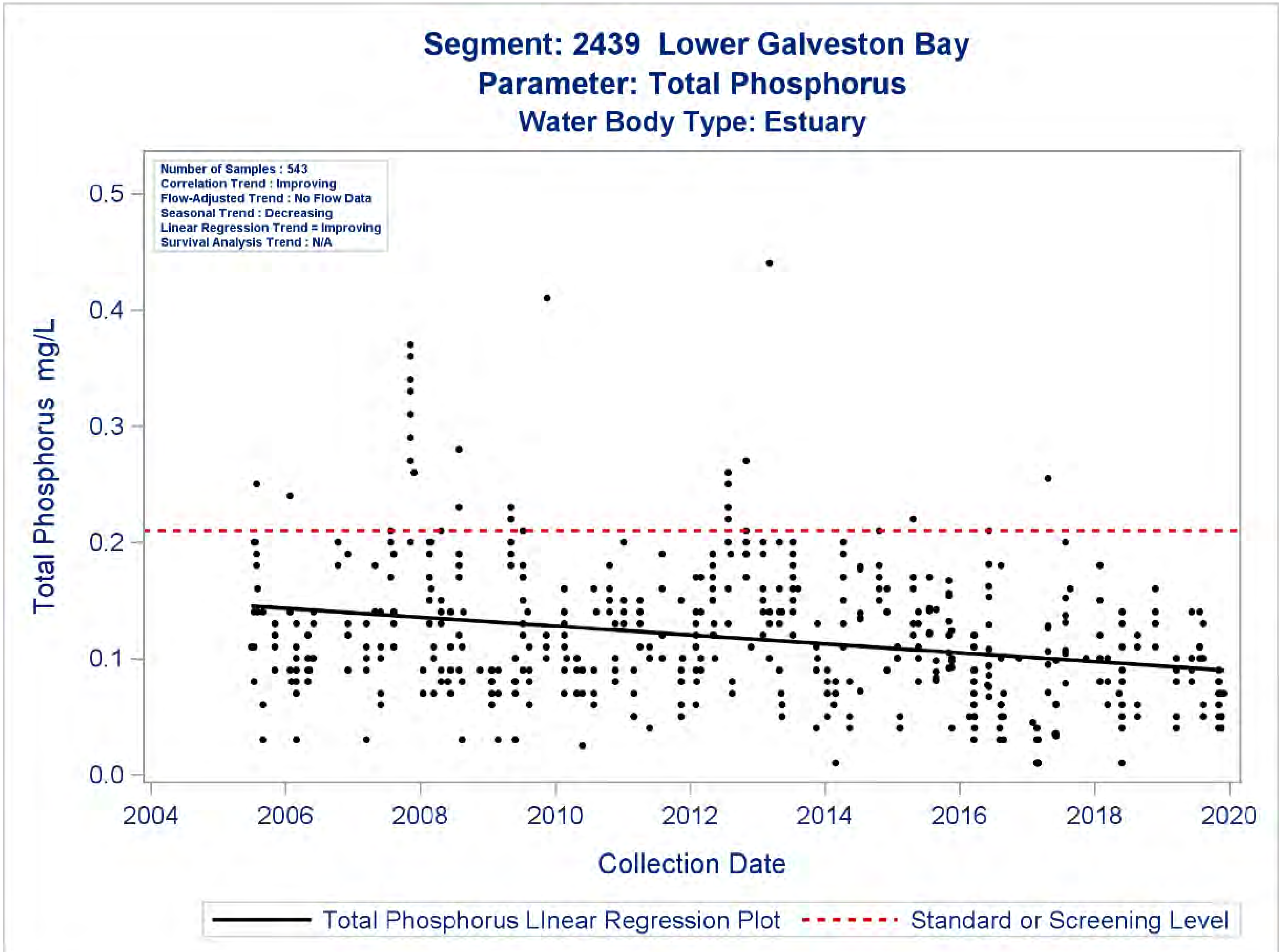
Trend Analysis:

Analysis of water quality data for Lower Galveston Bay (segment 2439) revealed seven parameter trends including deteriorating trends of increasing nitrate and enterococci bacteria concentrations, and Secchi transparency depth measurements. Less than 10% of the nitrate samples exceed the screening criteria but results below the screening criteria are creeping up. The improving trends showed decreasing concentrations of chloride, specific conductance, sulfate, and total phosphorus. Since 2014, only two sample results have exceeded the screening criteria for total phosphorus and those below the criteria appear to be decreasing.

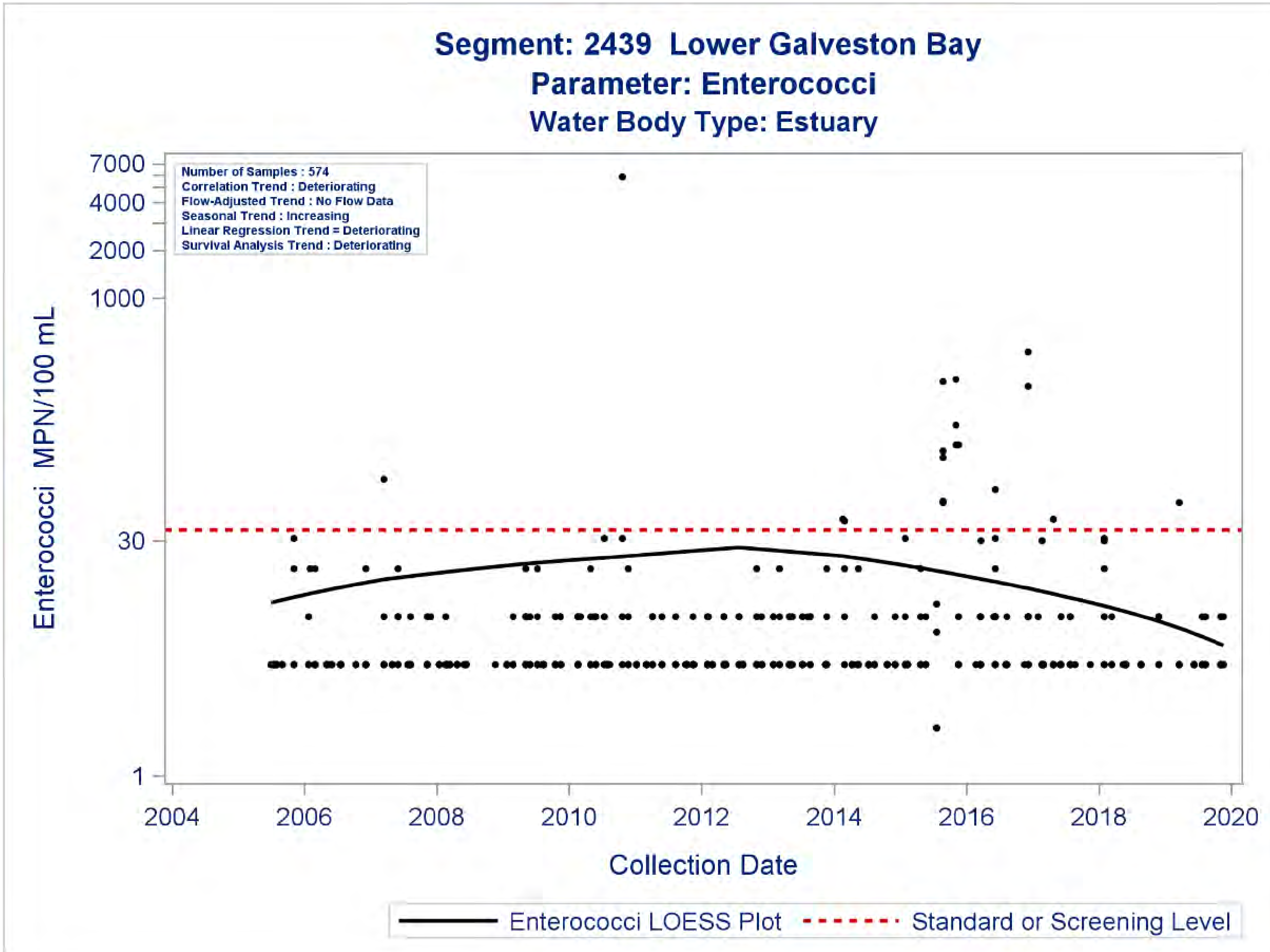
The 2020 Texas Integrated Report lists this segment as impaired for indicator bacteria in oyster waters. Since the Clean Rivers Program does not collect fecal coliform samples, the concentrations of enterococci bacteria were examined. There is a deteriorating trend where increasing enterococci bacteria is exceeding the standard for contact recreation.



Segment: 2439 Lower Galveston Bay
Parameter: Nitrate-N
Water Body Type: Estuary
Number of Samples : 598
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0.0
0.1
0.2
0.3
0.4
0.5
0.6
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level



Segment: 2439 Lower Galveston Bay
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 543
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Phosphorus mg/L
0.5
0.4
0.3
0.2
0.1
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LInear Regression Plot
Standard or Screening Level



Segment: 2439 Lower Galveston Bay
Parameter: Enterococci
Water Body Type: Estuary
Number of Samples : 574
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
7000
4000
2000
1000
30
1
Enterococci MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Enterococci LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria in Oyster Waters	2439OW_01 I	• Urbanization and increased impervious cover • Animal waste from agricultural production and hobby farms • Constructed stormwater controls failing • Improper disposal of waste from boats • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Improve compliance and enforcement of existing stormwater quality permits • Enhance use of LID and green infrastructure practices within the segment • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • More public education on proper boat waste disposal • More public education regarding OSSF operation and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Regionalize chronically non-compliant WWTFs • Encourage all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Elevated Nutrient Concentrations	***Nitrate*** 2439_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits

		• Agricultural runoff from row crops, fallow fields pastures, and animal operations		• Reduce or manage fertilizer runoff from residential and agricultural areas • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Elevated Chlorophyll -*a* Concentrations	2439_01 C 2439_02 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from residential and agricultural areas
Dioxin/PCBs in Fish Tissue	2439 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

Lower Galveston Bay was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs. This segment was also included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 2431	Name: Moses Lake

Area:	4 square miles	Miles of Shoreline:	10.7 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life

Number of Active Monitoring Stations:	4	Texas Stream Team Monitoring Stations:	1	Permitted WWTF Outfalls:	6

DESCRIPTION

- Segment 2431: **Moses Lake** (classified water body) – An 8.5 square kilometer (3.3 square mile) water body on the western shore of Lower Galveston Bay entirely enclosed by the Texas City levee system immediately north of the urbanized portion of the City of Texas City, south of and adjacent to Dickinson Bay in Galveston County

- Segment 2431A (Tidal Stream w/ high ALU): **Moses Bayou** (unclassified water body) — From Moses Lake confluence to 2.2 km (1.4 mi) upstream of SH 3 in Galveston County

- Segment 2431B (Estuary w/ high ALU): **Seawall Lagoon** (unclassified water body) – Located approximately 1.9 km (1.2 mi) south of Dollar Point adjacent to Bay Street N in Galveston County

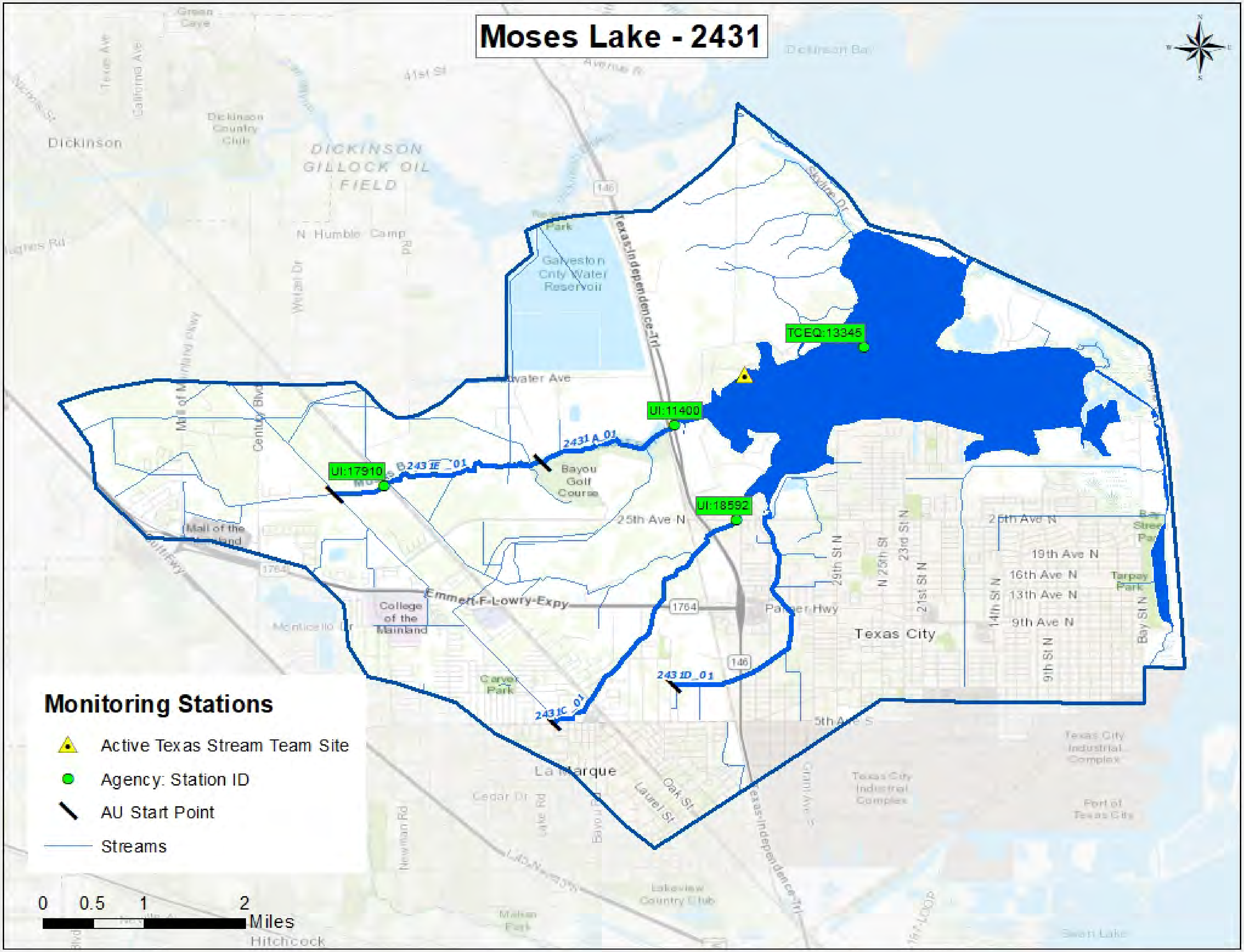
- Segment 2431C (Tidal Stream w/ high ALU): **Unnamed Tributary to the Southern Arm (west) of Moses Lake** (unclassified water body) – From the confluence with the southern arm (west) of Moses Lake to a point 0.45 mi upstream of State Highway 3 near La Marque

- Segment 2431D (Tidal Stream w/ high ALU): **Unnamed Tributary to the Southern Arm (east) of Moses Lake** (unclassified water body) – From the confluence with the southern arm (east) of Moses Lake to a point 0.6 mi upstream of State Highway 146 in Texas City

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
13345	2431	MOSES LAKE CM 9	FO	Quarterly One/Year	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment
11400	2431A	MOSES BAYOU AT NORTHBOUND SH 146 BRIDGE AT MID-BRIDGE NORTH OF LA MARQUE	UI	Quarterly	Field, Conventional, Bacteria
17910	2431A	MOSES BAYOU AT SH 3 IN TEXAS CITY	UI	Quarterly	Field, Conventional, Bacteria, Flow
18592	2431C	UNNAMED TRIBUTARY OF MOSES LAKE AT STATE LOOP 197/25TH AVE NORTH 432 M EAST OF NORTHBOUND SH 146 IN TEXAS CITY	UI	Quarterly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston

Moses Lake - 2431



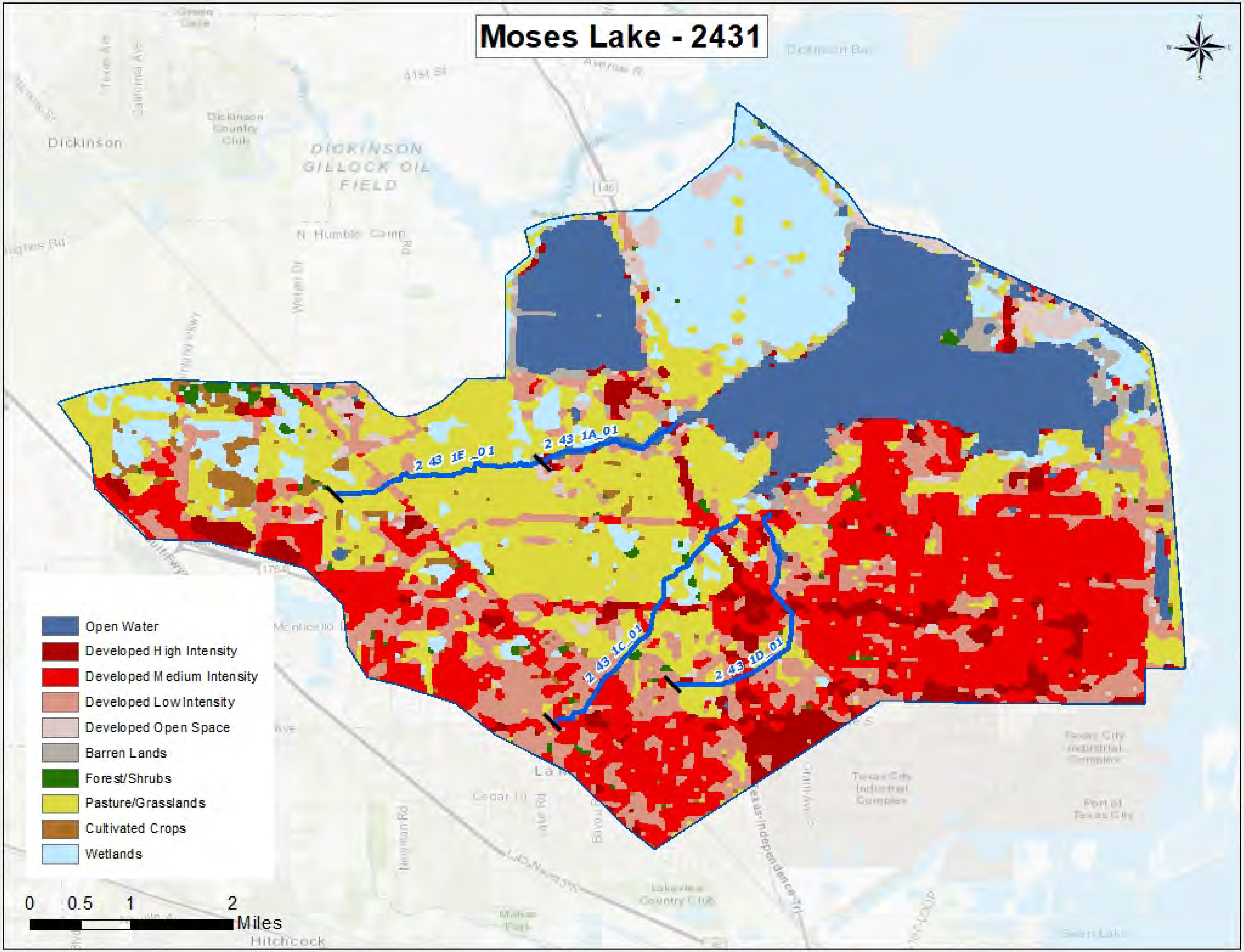
Segment 2431 Water Quality Standards and Screening Levels					
Standards	**Bays & Estuaries**	**Tidal Stream**	**Screening Levels**	**Bays & Estuaries**	**Tidal Stream**
Temperature (°C/°F):	35 / 95	35 / 95	Ammonia-N (mg/L):	0.10	0.46
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	4.0	Nitrate-N (mg/L):	0.17	1.10
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66
Enterococci (MPN/100mL) (grab):	130	130	Chlorophyll *a* (µg/L):	11.6	21
Enterococci (MPN/100mL) (geometric mean):	35	35			

Segment Discussion

Watershed Characteristics and Land Cover: Moses Lake, including its major tributary Moses Bayou, lies north of the cities of La Marque and Texas City and traverses eastward to Lower Galveston Bay. The northeastern and northwestern portions of the Moses Lake watershed consist mostly of grasslands and forested lands. Ranchettes are the common semi-rural development in this area. Large tracts of undisturbed wetlands and marsh habitats surround Moses Lake and Dollar Bay, an adjacent lagoon. In contrast, the southern section of the watershed is highly urbanized and includes a part of the Texas City petrochemical complex. Development is also concentrated along the major thoroughfares that run through the watershed. Only the urbanized areas of Texas City and La Marque are serviced by municipal wastewater collection and treatment systems. The remaining developments rely on on-site wastewater treatment systems.

The most predominant land cover category is Developed lands at 44.30 percent, followed by Agriculture (24.27 percent), Open Water (15.04 percent), and Wetlands (13.38 percent).

Segment 2431 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	5,937.74	25.29	5,696.44	24.27	-4.06
Barren Lands	551.32	2.35	507.51	2.16	-7.95
Developed	9,986.67	42.54	10,399.88	44.30	4.14
Forest/Shrubs	69.16	0.29	199.71	0.85	188.75
Open Water	3,655.51	15.57	3,530.75	15.04	-3.41
Wetlands	3,274.77	13.95	3,140.00	13.38	-4.12
TOTAL	**23,475.18**	**100.00**	**23,474.29**	**100.00**	


Moses Lake - 2431
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
0.5
1
2
Miles
2431E_01
2431A_01
2431C_01
2431D_01
Dickinson
DICKINSON GILLOCK OIL FIELD
Hitchcock

Water Quality Issues:

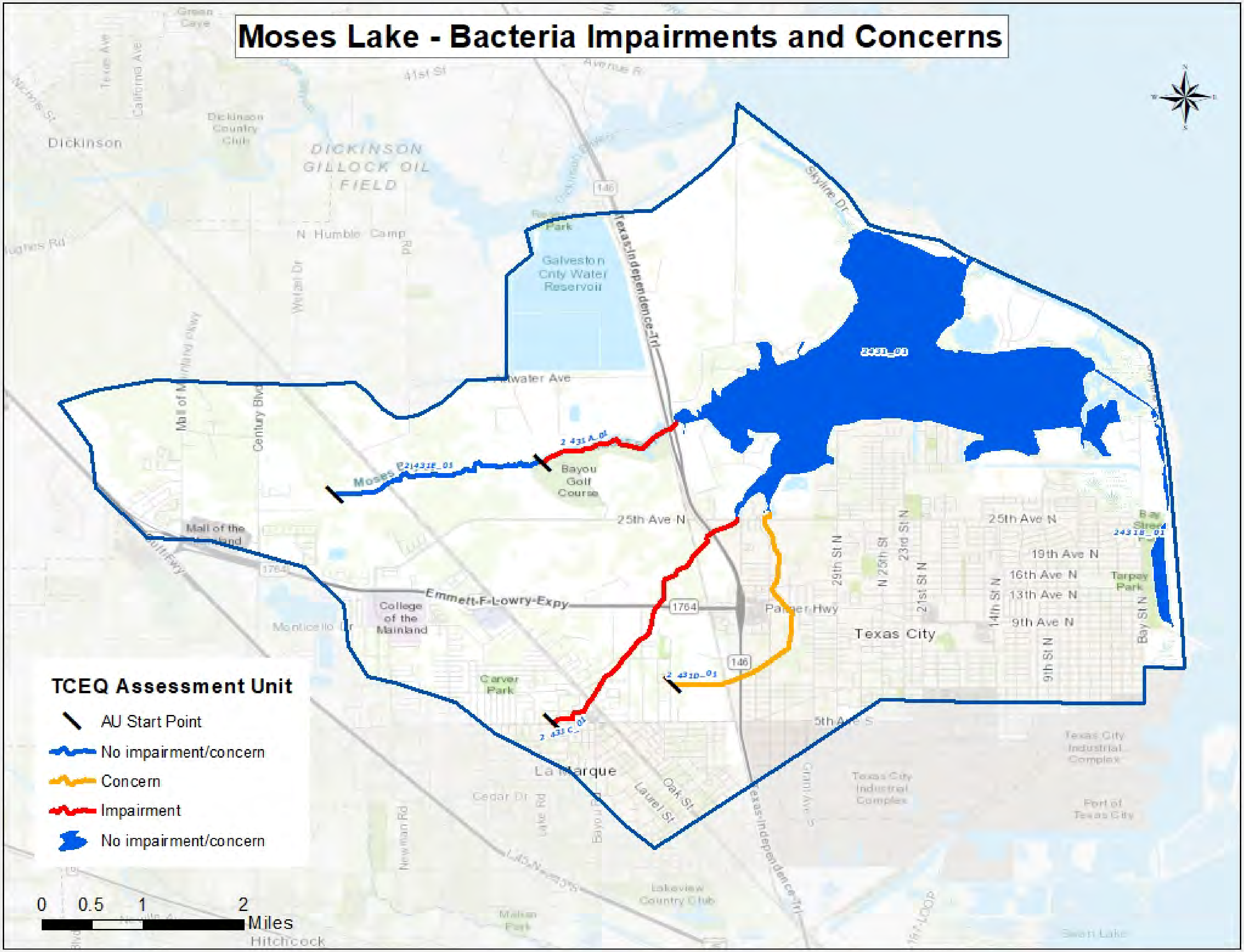
Bacteria Impairments and Concerns
An impairment for contact recreation use is listed in the 2020 Integrated Report for Moses Bayou (2431A) and the Unnamed Tributary of Moses Lake West (2431C). There is a concern for bacteria in the Unnamed Tributary of Moses Lake East (2431D). These impairments are based upon elevated levels of enterococci bacteria.

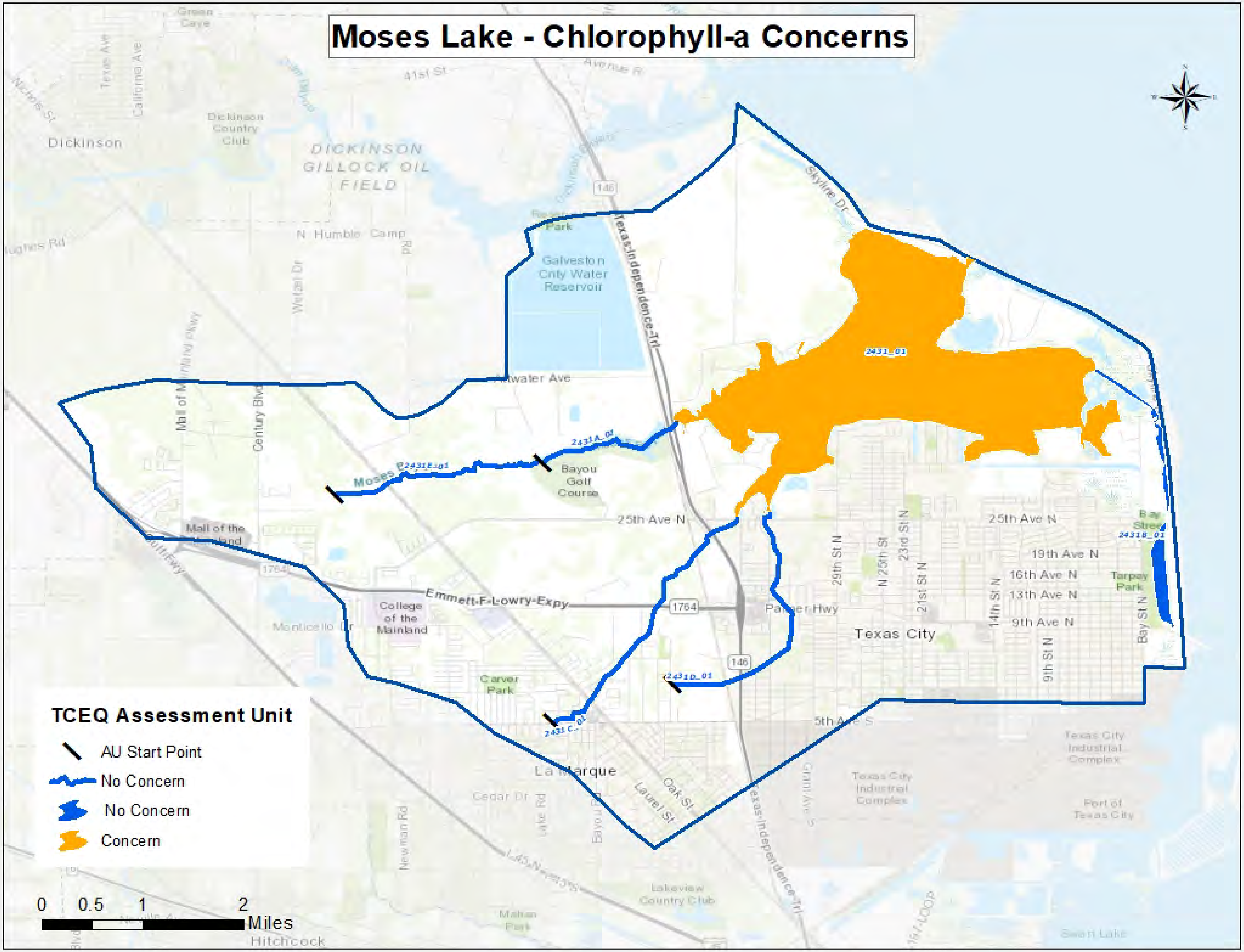
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

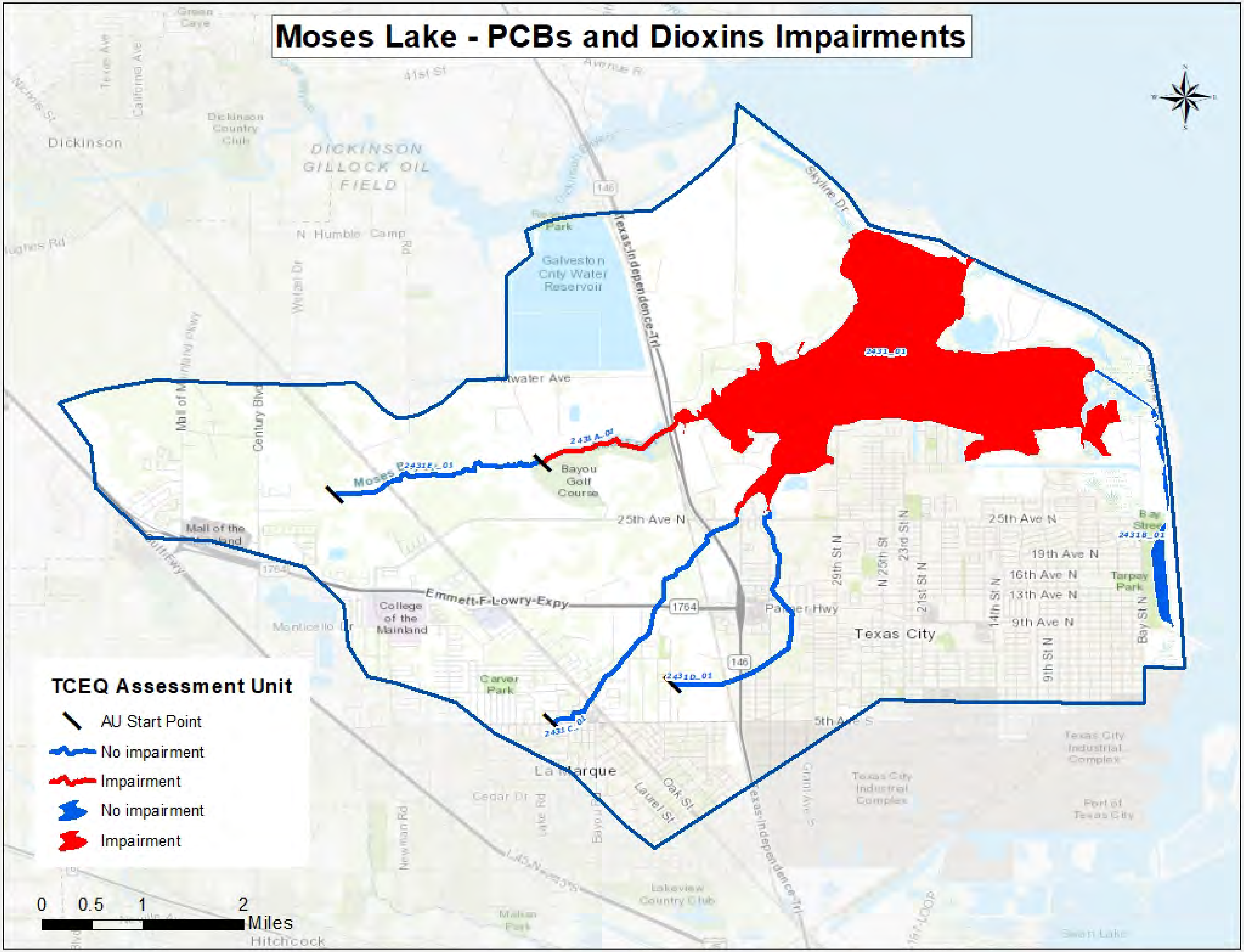
Nutrient Concerns
There are no nutrient concerns in this segment.

Chlorophyll-a Concerns
Moses Lake (2431) has a concern for chlorophyll-*a* due to samples exceeding nutrient screening levels.

PCBs and Dioxin Impairments
Moses Lake and Moses Bayou are listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.


Moses Lake - Bacteria Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
No impairment/concern
0 0.5 1 2 Miles
2431_01
2431A_01
2431B_01
2431C_01
2431D_01
2431E_01
Dickinson
Texas City
La Marque
Hitchcock
Galveston Cnty Water Reservoir
Bayou Golf Course
College of the Mainland
Carver Park
Tarpey Park
Mall of the Mainland
Dickinson Country Club
DICKINSON GILLOCK OIL FIELD
Texas City Industrial Complex
Port of Texas City
Lakeview Country Club
Emmett-F-Lowry-Expy
Texas-Independence-Trl
25th Ave N
Palmer Hwy


Moses Lake - Chlorophyll-a Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
No Concern
Concern
0
0.5
1
2
Miles
2431_01
2431A_01
2431B_01
2431C_01
2431D_01
2431E_01
Moses
Dickinson
DICKINSON
GILLOCK OIL
FIELD
Dickinson
Country
Club
Galveston
Cnty Water
Reservoir
Bayou
Golf
Course
Mall of the Mainland
College
of the
Mainland
Carver
Park
La Marque
Texas City
Tarpey
Park
Texas City
Industrial
Complex
Port of
Texas City
Lakeview
Country Club
Hitchcock
25th Ave N
19th Ave N
16th Ave N
13th Ave N
9th Ave N
5th Ave S
Emmett-F-Lowry-Expy
Texas-Independence-Trl
Skyline Dr
Century Blvd
Mall of Mainland Pkwy
Monticello Dr
N Humble Camp Rd
41st St
Atwater Ave
Palmer Hwy
Bay St N
Oak St
Laurel St
Cedar Dr
Newman Rd
Lake Rd
146
1764


Moses Lake - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
No impairment
Impairment
0 0.5 1 2
Miles
2431_01
2431A_01
2431B_01
2431C_01
2431D_01
2431E_01
Dickinson
DICKINSON GILLOCK OIL FIELD
Galveston Cnty Water Reservoir
Bayou Golf Course
College of the Mainland
Carver Park
Texas City
La Marque
Hitchcock
Texas City Industrial Complex
Port of Texas City
Lakeview Country Club
Tarpey Park
Mall of the Mainland
Emmett-F-Lowry-Expy
Texas-Independence-Trl
25th Ave N
Atwater Ave
Palmer Hwy
19th Ave N
16th Ave N
13th Ave N
9th Ave N
5th Ave S
N Humble Camp Rd
Skyline Dr
Dickinson Country Club
Monticello Dr
Century Blvd
Mall of Mainland Pkwy

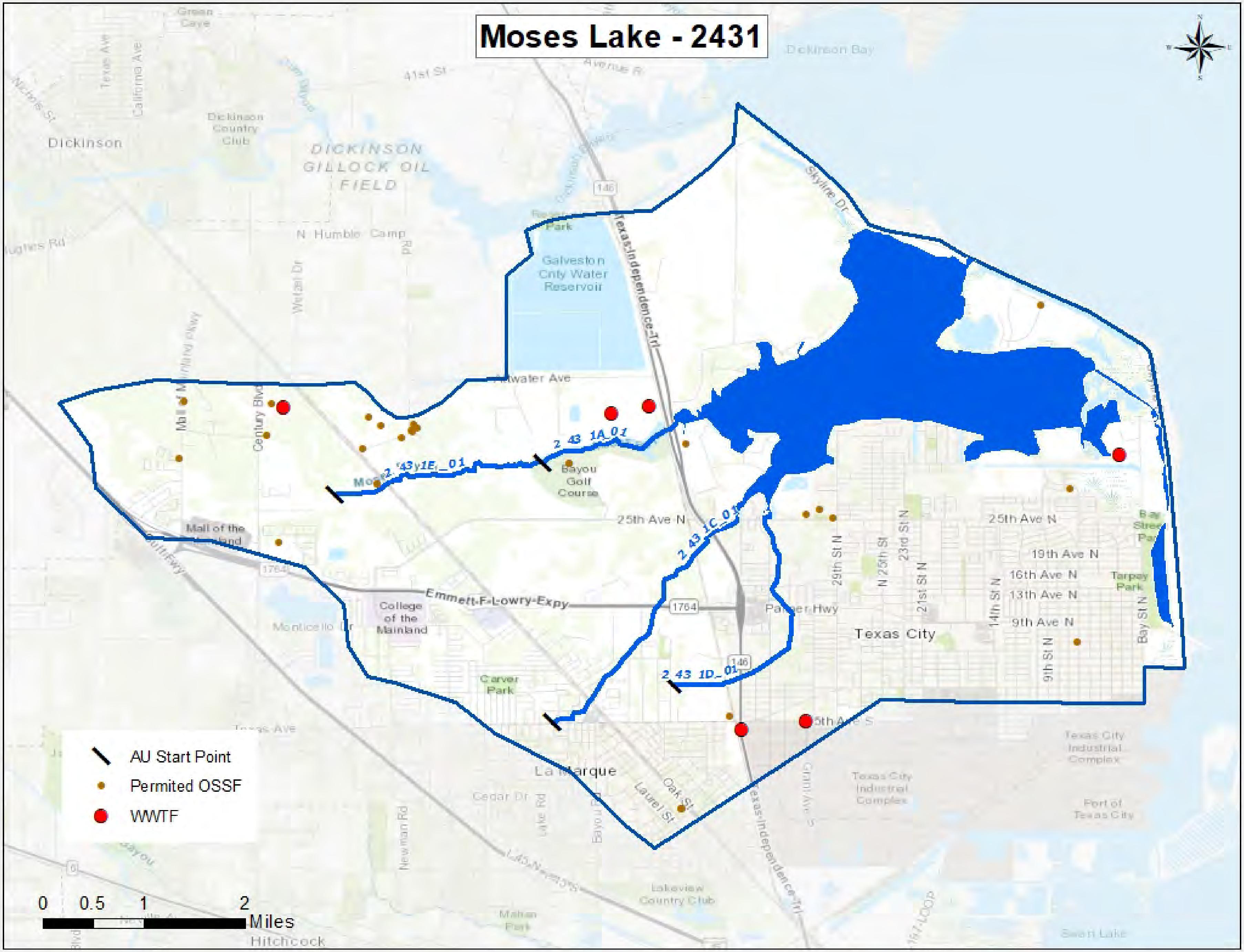
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Moses Lake watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 6 permitted wastewater outfalls and 28 permitted on-site sewage facilities in the Moses Lake watershed. The wastewater treatment facilities and on-site sewage facilities in the Burnett Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 28 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Moses Lake watershed.



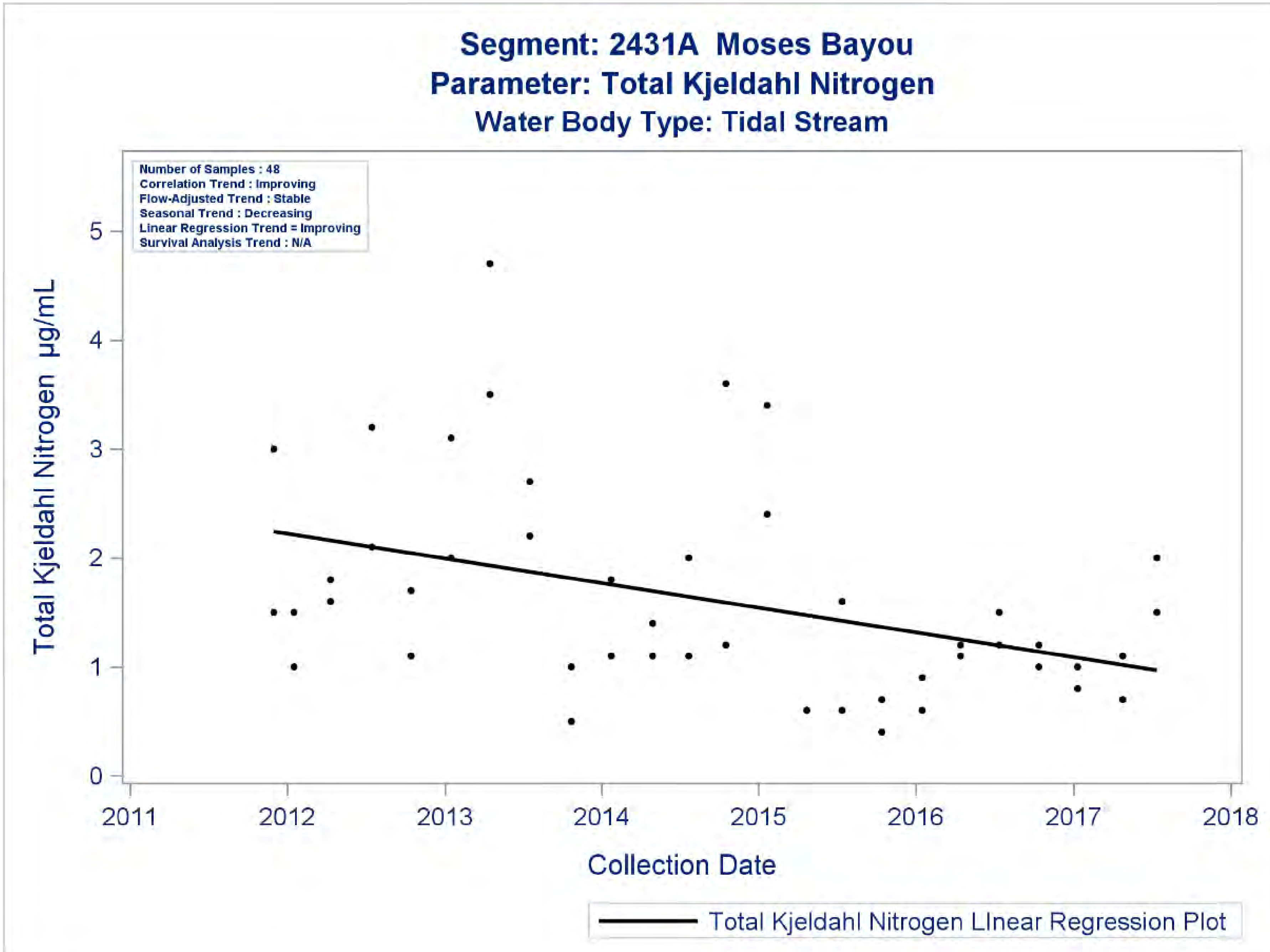
Moses Lake - 2431
Dickinson Bay
Dickinson
Dickinson Country Club
DICKINSON GILLOCK OIL FIELD
N Humble Camp Rd
Galveston Cnty Water Reservoir
Atwater Ave
Texas-Independence-Trl
Skyline Dr
Bayou Golf Course
25th Ave N
Mall of the Mainland
Emmett-F-Lowry-Expy
College of the Mainland
Monticello Dr
Carver Park
Palmer Hwy
Texas City
19th Ave N
16th Ave N
13th Ave N
9th Ave N
29th St N
N 25th St
23rd St N
21st St N
14th St N
9th St N
Bay St N
Tarpey Park
La Marque
Cedar Dr
Laurel St
Oak St
Texas City Industrial Complex
Port of Texas City
Lakeview Country Club
Hitchcock
Swan Lake
2_43_1A_01
2_43_1C_01
2_43_1D_01
AU Start Point
Permited OSSF
WWTF
0 0.5 1 2
Miles

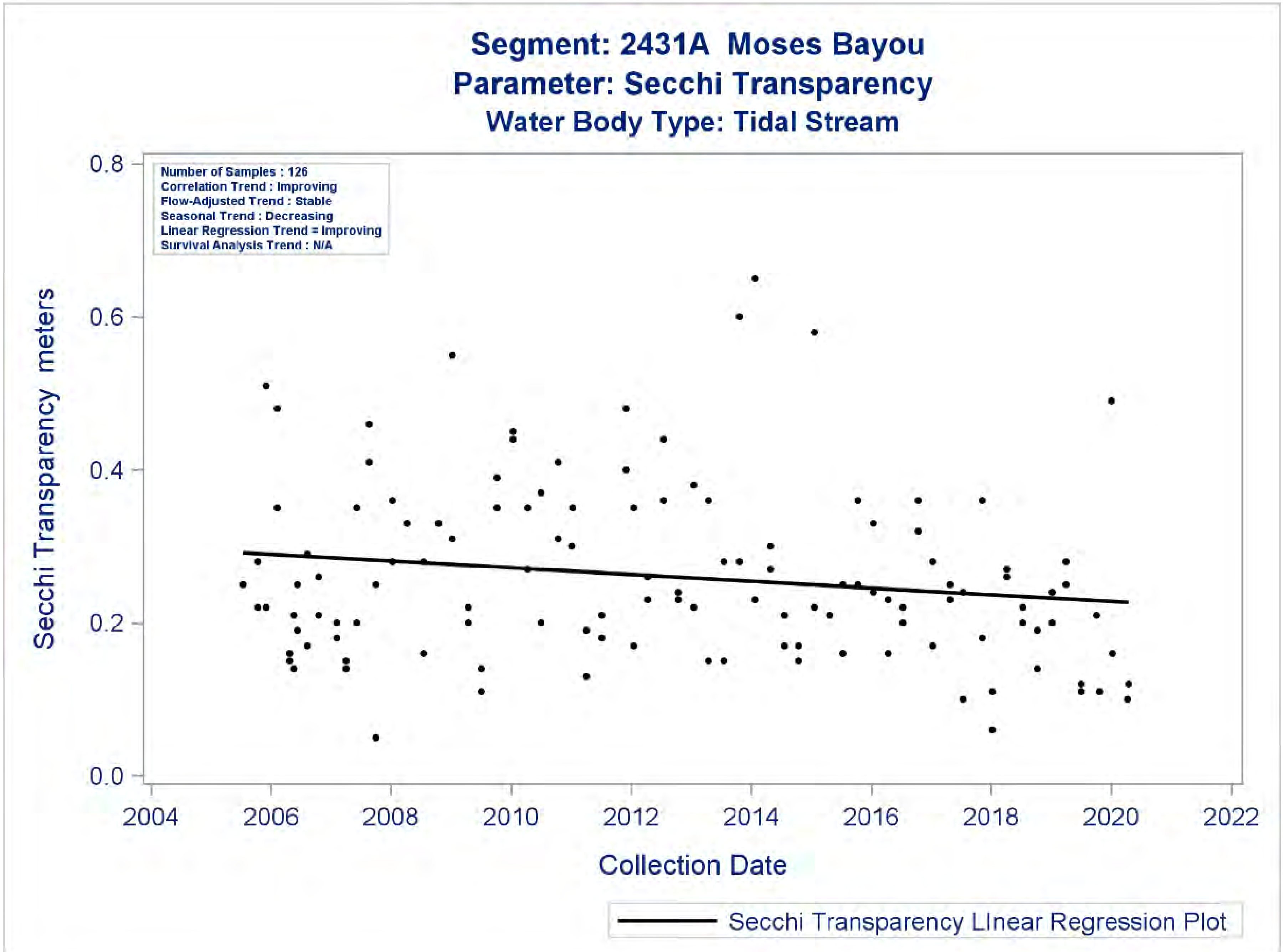
Trend Analysis:

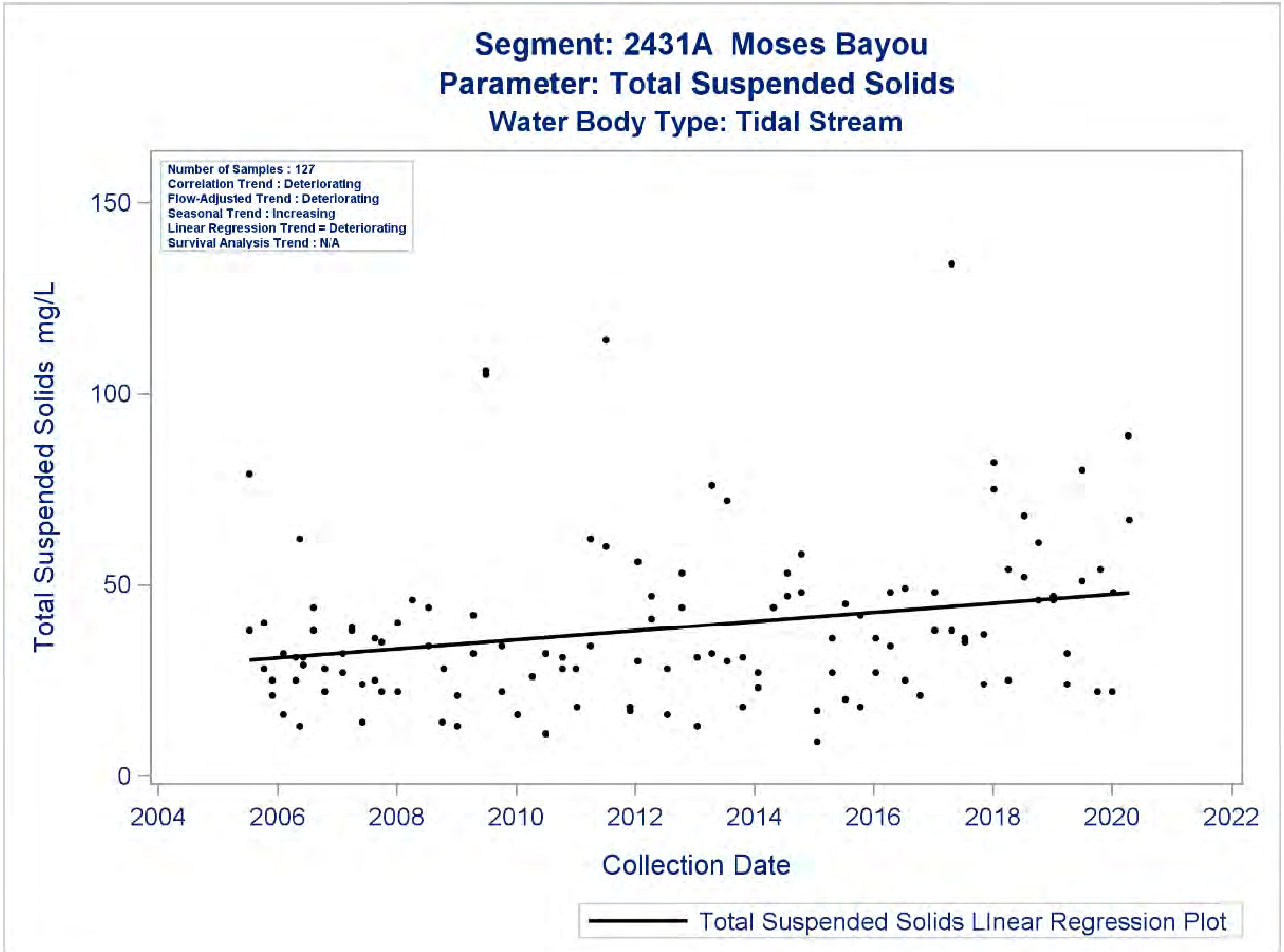
Analysis of water quality data for the Moses Lake watershed (segment 2431) revealed nine parameter trends for three out of the five segments evaluated in the Moses Lake watershed. The main Moses Lake segment revealed three parameter trends including decreasing concentrations of chloride, specific conductance, and sulfate.

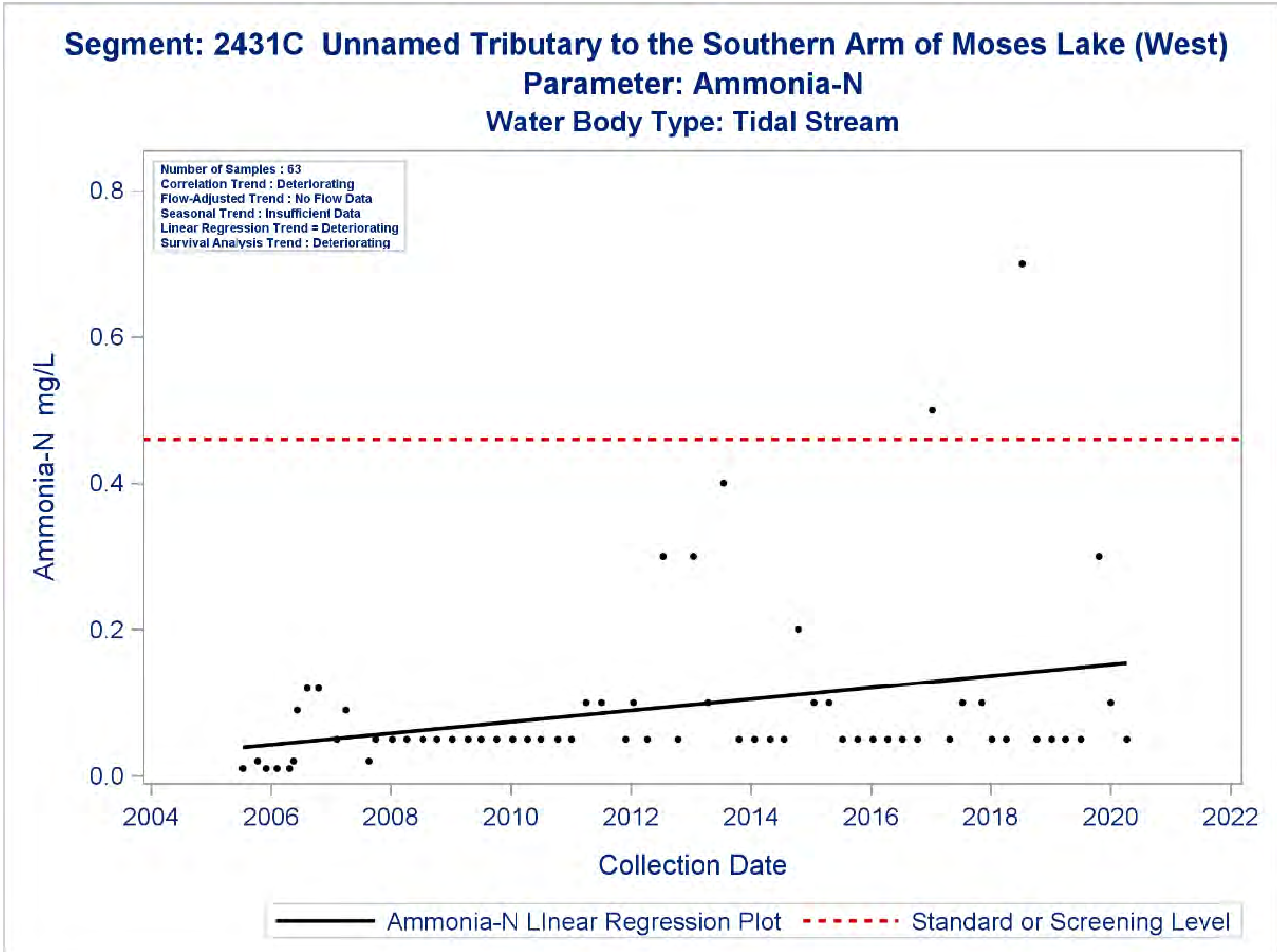
Unclassified segment 2431A (Moses Bayou) had five parameter trends including improving trends for TKN concentrations and Secchi transparency which means more turbid water and decreasing depths. Simultaneously, increasing concentrations of enterococci bacteria and TSS indicate deteriorating trends. When there is a trend with the TSS data, there is an inverse relationship to the Secchi transparency data. Where sediment loads are increasing the Secchi transparency depth is decreasing. Decreasing trends are typically categorized as 'improving' trends, as seen in the graph legend, but the water is actually getting more turbid. Lastly, the unclassified segment 2431C (Unnamed Tributary to the Southern Arm (west) of Moses Lake) had one deteriorating parameter trend with increasing ammonia concentrations.

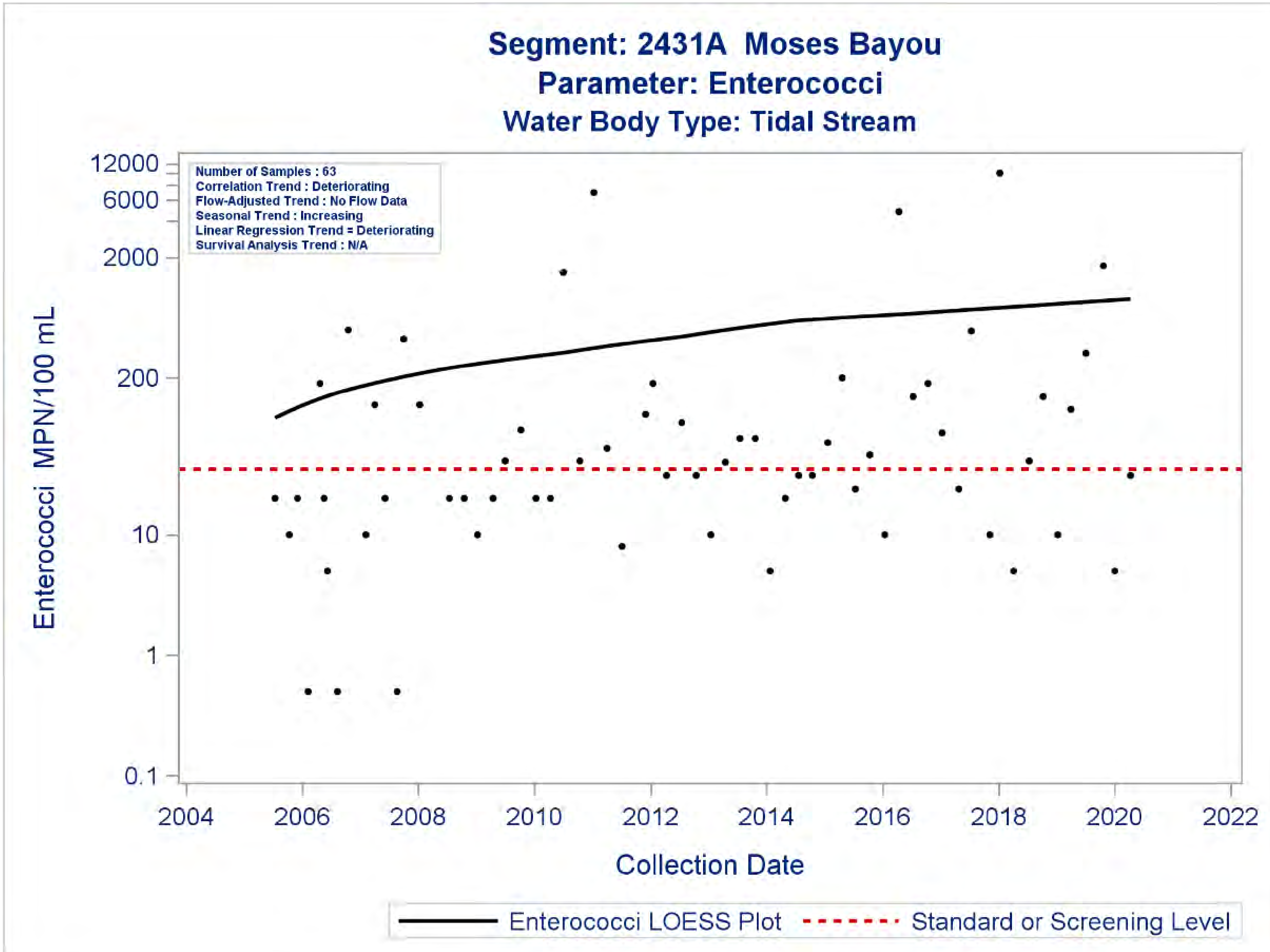
The 2020 Texas Integrated report lists Moses Bayou (2431A) and the Unnamed Tributary to the Southern Arm of Moses Lake (west) (2431C) as being impaired for bacteria (recreation use). Analysis of enterococci bacteria data revealed a deteriorating trend in Moses Bayou but a relatively stable trend over time for the unnamed tributary. However, nearly half of all bacteria samples collected in those two segments during the period of record exceed the 35 MPN/100 mL geometric mean standard for enterococci. A concern for chlorophyll *a* concentrations also exists for the main Moses Lake segment. Analysis of chlorophyll *a* data revealed no trend over time, but concentrations greater than the 11.6 µg/L screening criteria were measured almost 20% of the time.

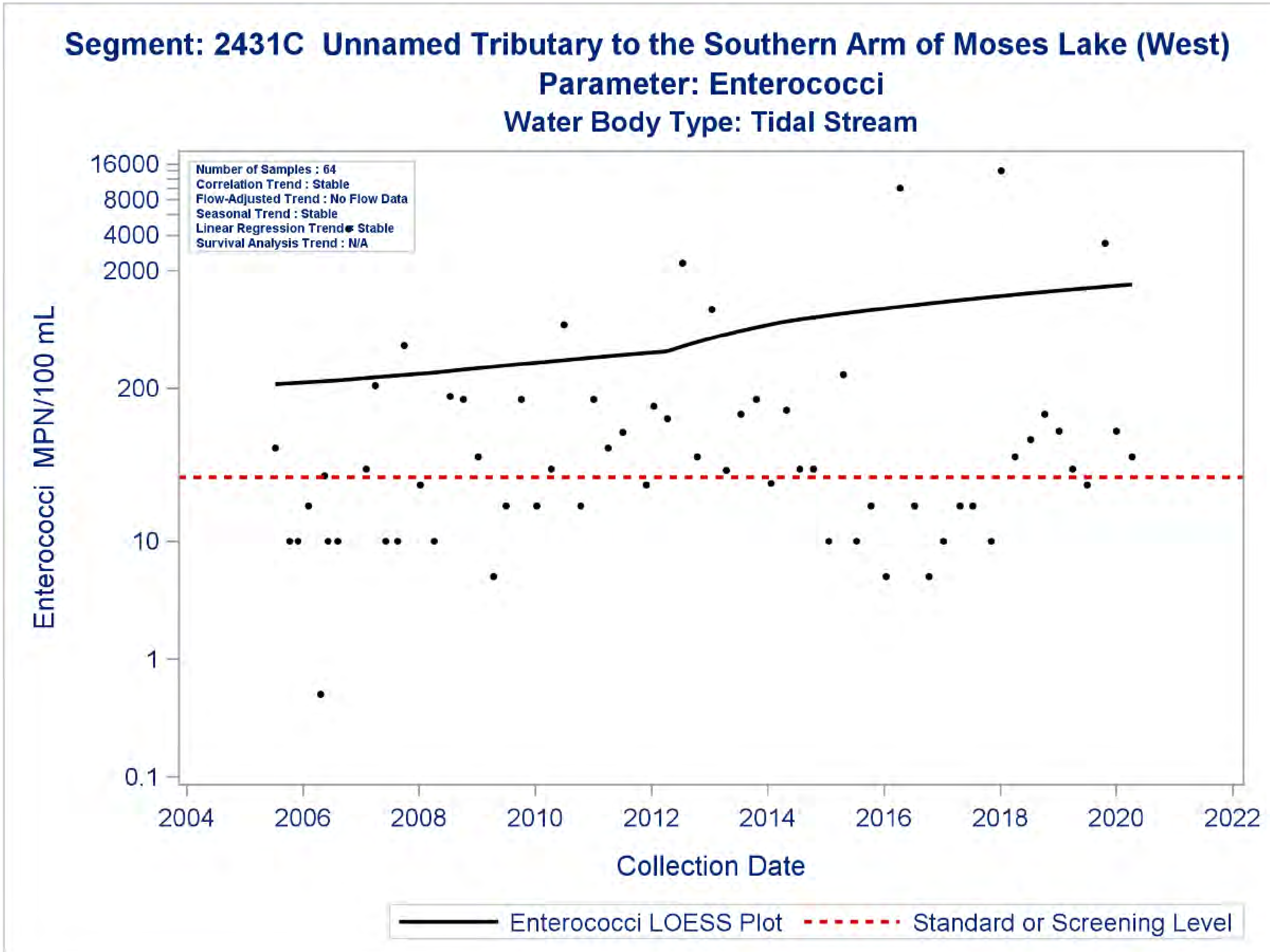

Segment: 2431A Moses Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Tidal Stream
Number of Samples : 48
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2011
2012
2013
2014
2015
2016
2017
2018
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot


Segment: 2431A Moses Bayou
Parameter: Secchi Transparency
Water Body Type: Tidal Stream
Number of Samples : 126
Correlation Trend : Improving
Flow-Adjusted Trend : Stable
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
0.8
0.6
0.4
0.2
0.0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot


Segment: 2431A Moses Bayou
Parameter: Total Suspended Solids
Water Body Type: Tidal Stream
Number of Samples : 127
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Deteriorating
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
150
100
50
0
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids Linear Regression Plot


Segment: 2431C Unnamed Tributary to the Southern Arm of Moses Lake (West)
Parameter: Ammonia-N
Water Body Type: Tidal Stream
Number of Samples : 63
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient Data
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
0.0
0.2
0.4
0.6
0.8
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N Linear Regression Plot
Standard or Screening Level


Segment: 2431A Moses Bayou
Parameter: Enterococci
Water Body Type: Tidal Stream
Number of Samples : 63
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Enterococci MPN/100 mL
12000
6000
2000
200
10
1
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Enterococci LOESS Plot
Standard or Screening Level


Segment: 2431C Unnamed Tributary to the Southern Arm of Moses Lake (West)
Parameter: Enterococci
Water Body Type: Tidal Stream
Number of Samples : 64
Correlation Trend : Stable
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Stable
Linear Regression Trend : Stable
Survival Analysis Trend : N/A
16000
8000
4000
2000
200
10
1
0.1
Enterococci MPN/100 mL
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Enterococci LOESS Plot
Standard or Screening Level

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	2431A I 2431C I 2431D C	• Urbanization and increased impervious cover • Constructed stormwater controls failing • Animal waste from agricultural production, hobby farms, and riding stables • Improper or no pet waste disposal • Developments with malfunctioning OSSFs • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs • WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Encourage Water Quality Management Plans or similar projects for agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • More public education on pet waste disposal • More public education regarding OSSF operations and maintenance • Ensure proper citing of new or replacement OSSFs • Regionalize chronically non-compliant WWTFs • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Elevated Chlorophyll -*a* Concentrations	2431 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas

Dioxin/PCBs in Fish Tissue	2431 2431A	I I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

The Moses Lake watershed is included in the Highland Bayou WPP. The WPP is under development with the latest draft being completed in February 2021. For more information, please visit the following URL: https://agrilife.org/highlandbayou/. TX AgriLife is also working in Galveston and Brazoria counties to assist implementation of watershed-based plans.

Moses Lake was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices

- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

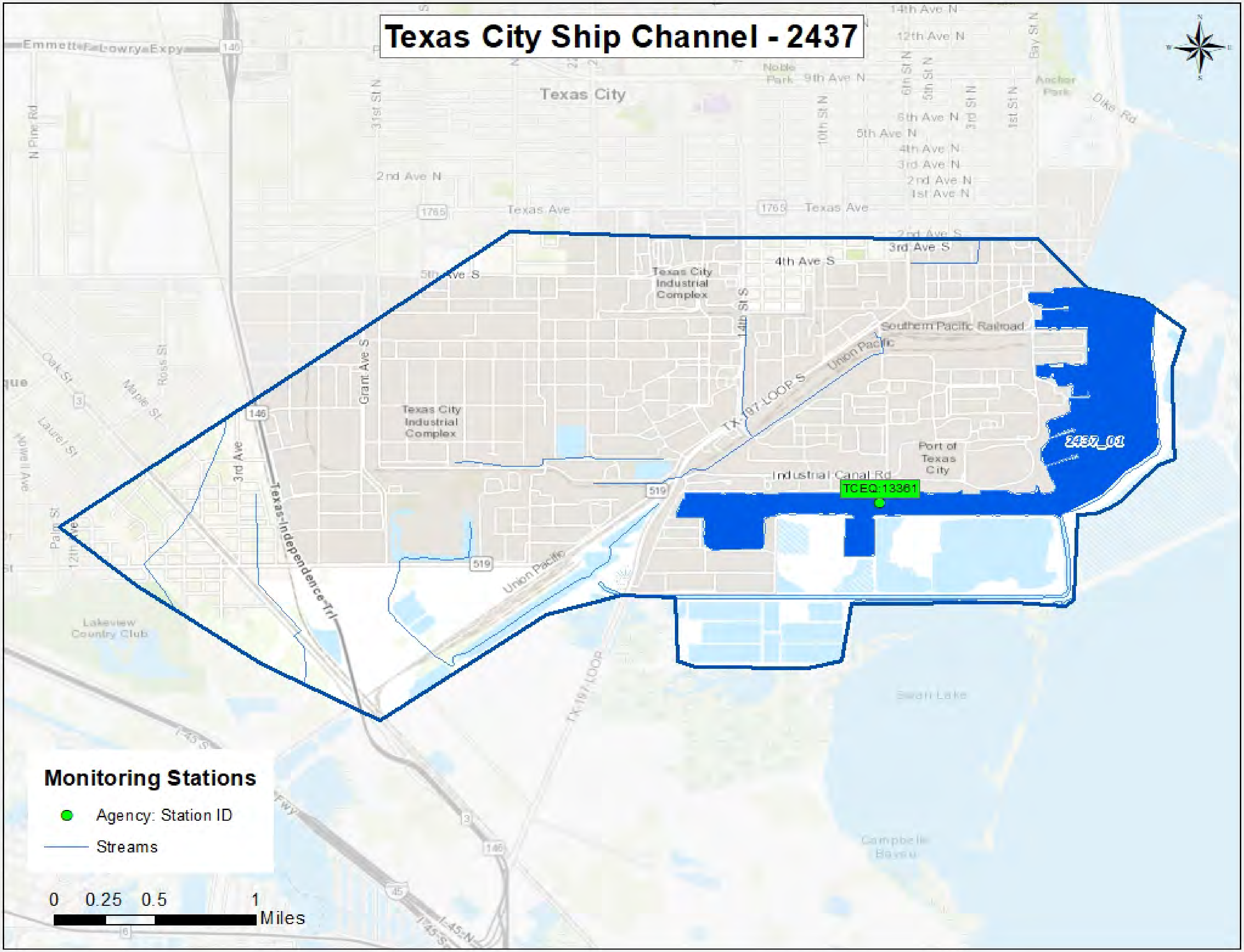
Segment Number:	2437	Name:	Texas City Ship Channel
Area: 0.7 square miles	**Miles of Shoreline:** 9 miles	**Designated Uses:**	Noncontact Recreation; High Aquatic Life
Number of Active Monitoring Stations: 1	**Texas Stream Team Monitoring Stations:** 0	**Permitted WWTF Outfalls:**	34

DESCRIPTION

- Segment 2437: **Texas City Ship Channel** (classified water body) – A 1.6 square kilometer (0.6 square mile) navigation channel immediately south of the Texas City Dike on the western shore of Lower Galveston Bay in Galveston

FY 2021 Active Routine Monitoring Stations					
Station ID	**Segment ID**	**Site Description**	**Monitoring Entity**	**Frequency**	**Parameter Groups**
13361	2437	TEXAS CITY SHIP CHANNEL TEXAS CITY CANAL MIDWAY BETWEEN MOUTH AND TERMINUS	FO	Quarterly Two/Year One/Year	Field, Conventional, Bacteria Metals in Water Metals in Sediment, Organics in Sediment

FO = TCEQ Regional Office



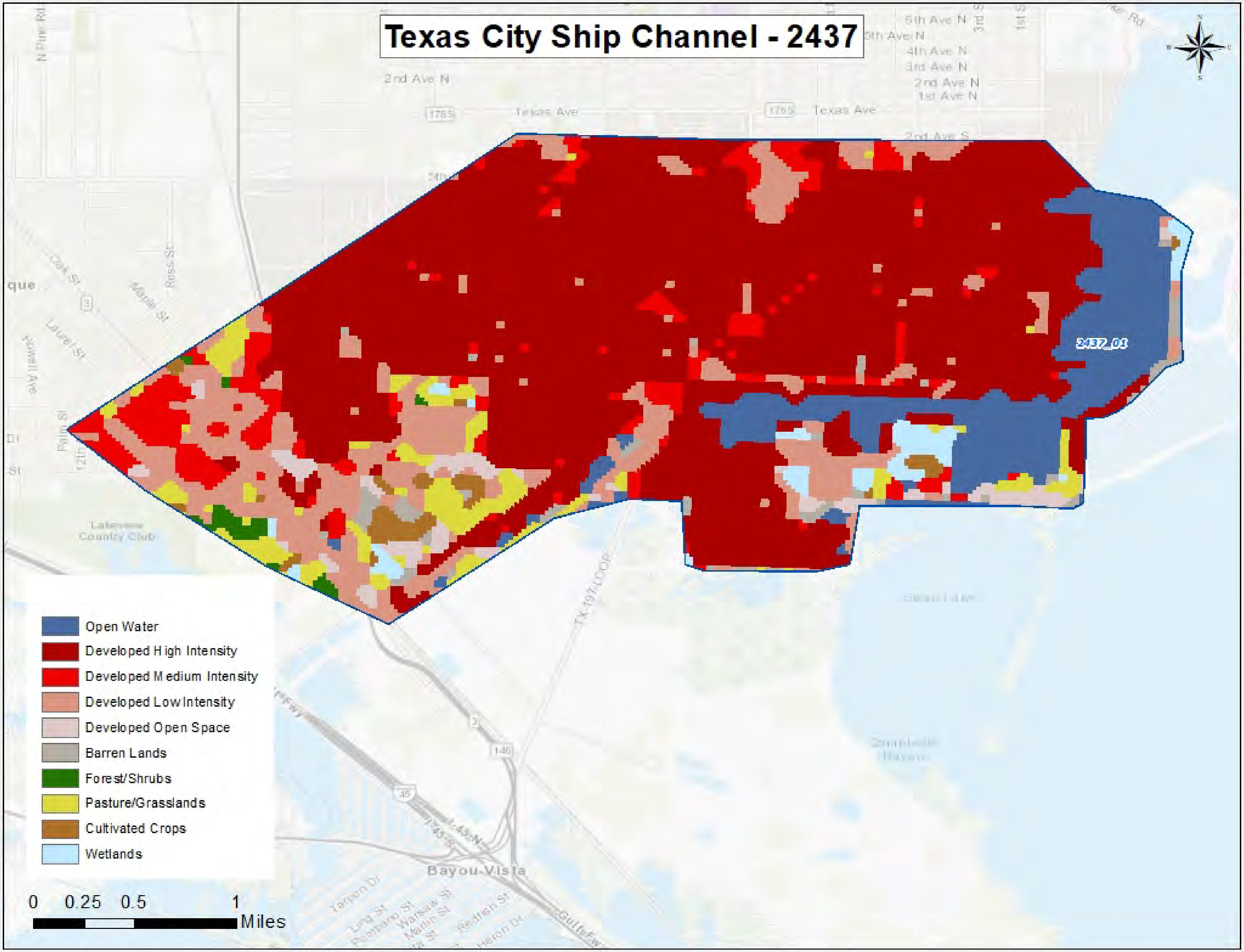
Texas City Ship Channel - 2437
Texas City
Texas City Industrial Complex
Texas City Industrial Complex
Port of Texas City
Southern Pacific Railroad
Union Pacific
Industrial Canal Rd
TCEQ:13361
2437_01
Texas Ave
2nd Ave N
4th Ave S
5th Ave S
Lakeview Country Club
Swan Lake
Campbells Bayou
Monitoring Stations
Agency: Station ID
Streams
0 0.25 0.5 1
Miles

Segment 2437 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics and Land Cover: The Texas City petrochemical complex makes up the majority this watershed. Developed land cover is 79.93 percent of the watershed. Texas City Ship Channel supports heavy barge and ship traffic on a regular basis with docks used to load and unload raw materials and finished products occupying the entire north shoreline and area around the turning basin. An off-plant disposal area (OPDA) is situated on the south shore leaving only portions of Shoal Point/Snake Island, a dredge spoil disposal area, undeveloped. A small residential and commercial area of the City of La Marque located in the western portion of the watershed drains storm water into the channel via the Industrial Canal. The ship channel receives storm water and wastewater discharges from the industrial complex.

Segment 2437 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	228.40	4.69	295.12	6.05	29.21
Barren Lands	71.83	1.47	86.07	1.77	19.82
Developed	3,582.35	73.51	3,896.37	79.93	8.77
Forest/Shrubs	0.67	0.01	27.13	0.56	3,949.25
Open Water	557.32	11.44	472.59	9.70	-15.03
Wetlands	432.78	8.88	97.19	1.99	-77.54
TOTAL	**4,873.35**	**100.00**	**4,874.46**	**100.00**	



Texas City Ship Channel - 2437
2437_01
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 0.25 0.5 1
Miles

Water Quality Issues:

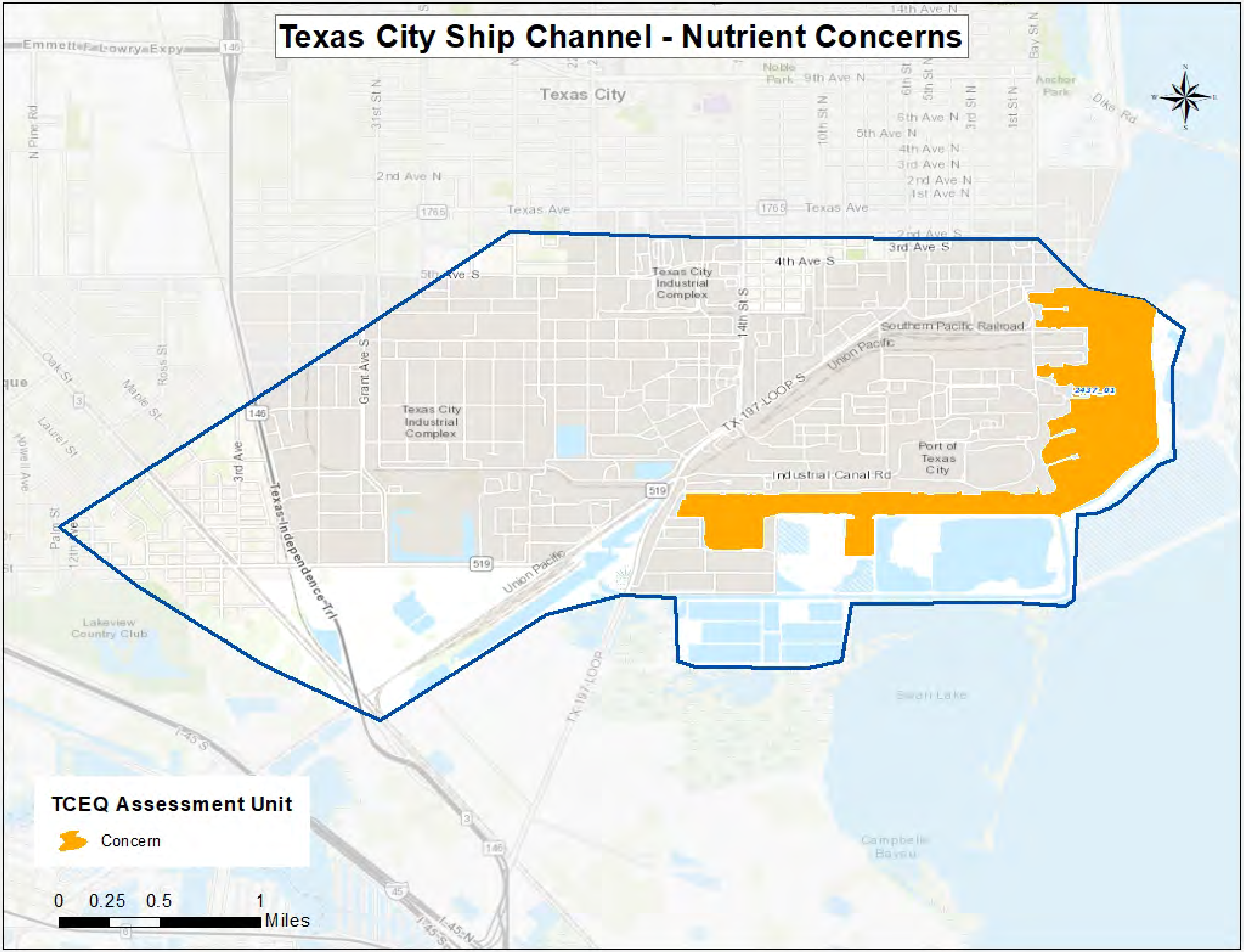
Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

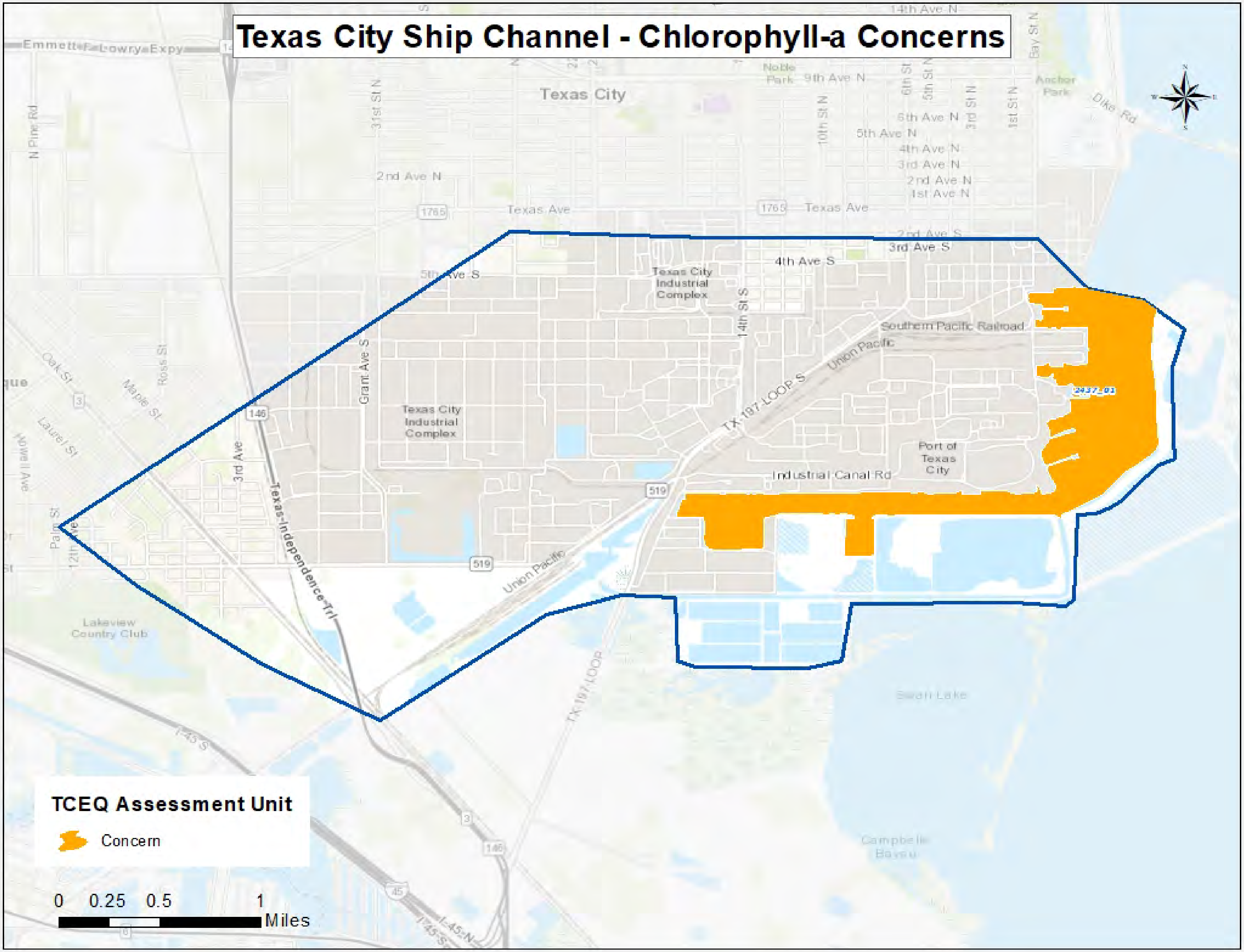
Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
The Texas City Ship Channel (2437) is listed in the 2020 Integrated Report with a concern for nutrient screening levels for nitrate-nitrogen. For samples collected between 12/1/11 – 11/30/18, 48.0 percent of samples exceeded the screening level.

Chlorophyll-a Concerns
This segment is also listed with a concern for nutrient screening levels for chlorophyll-*a.* For samples assessed for the 2020 Integrated Report, 45.8 percent of the samples exceeded the nutrient screening level.

PCBs and Dioxin Impairments
The Texas City Ship Channel is listed as impaired for PCBs and Dioxins in species of catfish. Fish samples collected from this segment indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory issued by the Texas Department of State Health Services (TDSHS) is in effect.


Texas City Ship Channel - Nutrient Concerns
Texas City
Texas City Industrial Complex
Texas City Industrial Complex
Port of Texas City
Southern Pacific Railroad
Union Pacific
Industrial Canal Rd
TX-197-LOOP S
Texas-Independence-Trl
Lakeview Country Club
Swan Lake
Campbell Bayou
2437_01
TCEQ Assessment Unit
Concern
0 0.25 0.5 1
Miles



Texas City Ship Channel - Chlorophyll-a Concerns
TCEQ Assessment Unit
Concern
0 0.25 0.5 1
Miles
2437_01
Texas City
Texas City Industrial Complex
Port of Texas City
Southern Pacific Railroad
Industrial Canal Rd
Lakeview Country Club
Swan Lake
Campbell Bayou

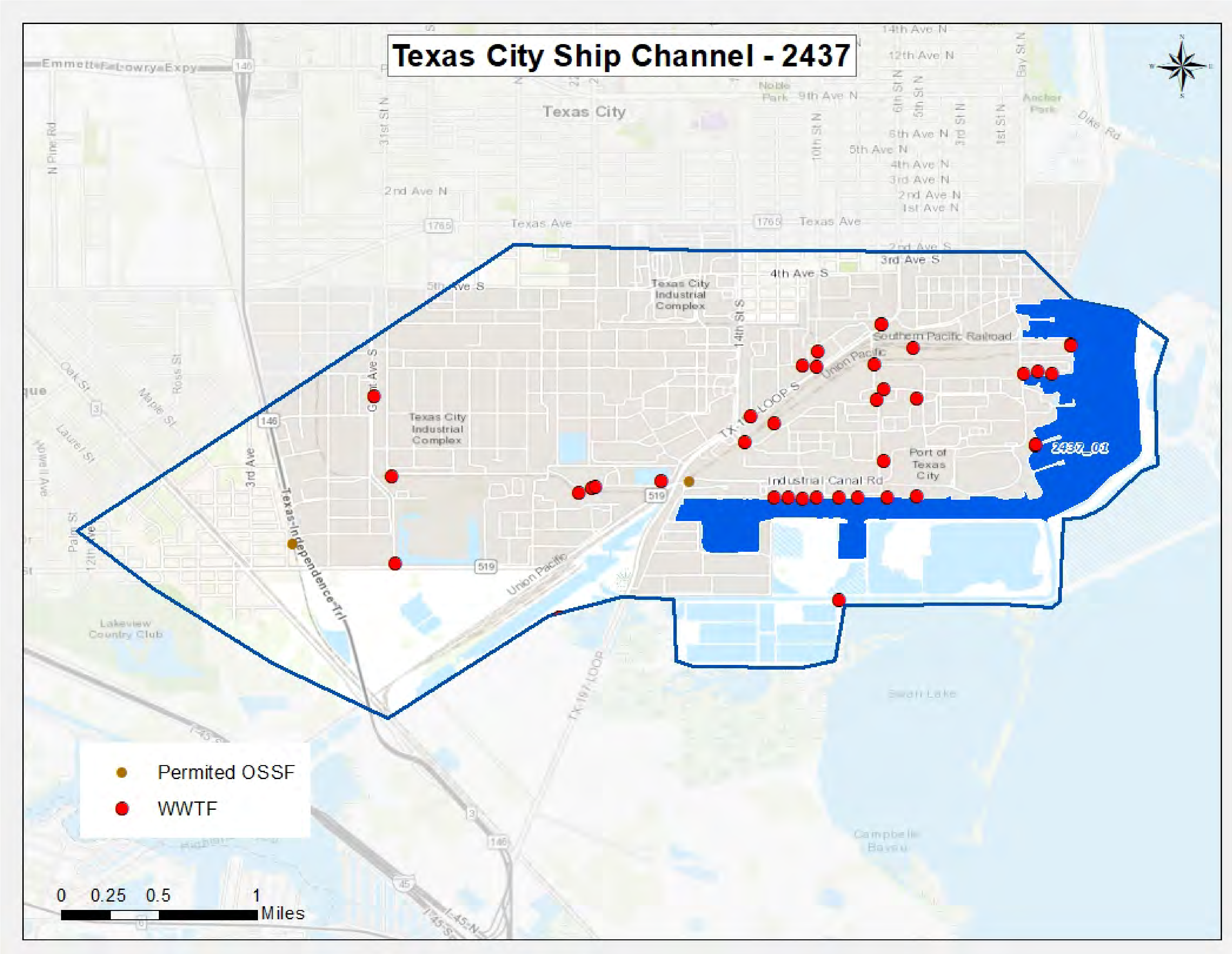
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Texas City Ship Channel watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, stormwater runoff, and animal waste.

There are 34 permitted wastewater outfalls and 2 permitted on-site sewage facilities in the Texas City Ship Channel watershed. The wastewater treatment facilities and on-site sewage facilities in the Texas City Ship Channel watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Texas City Ship Channel watershed.

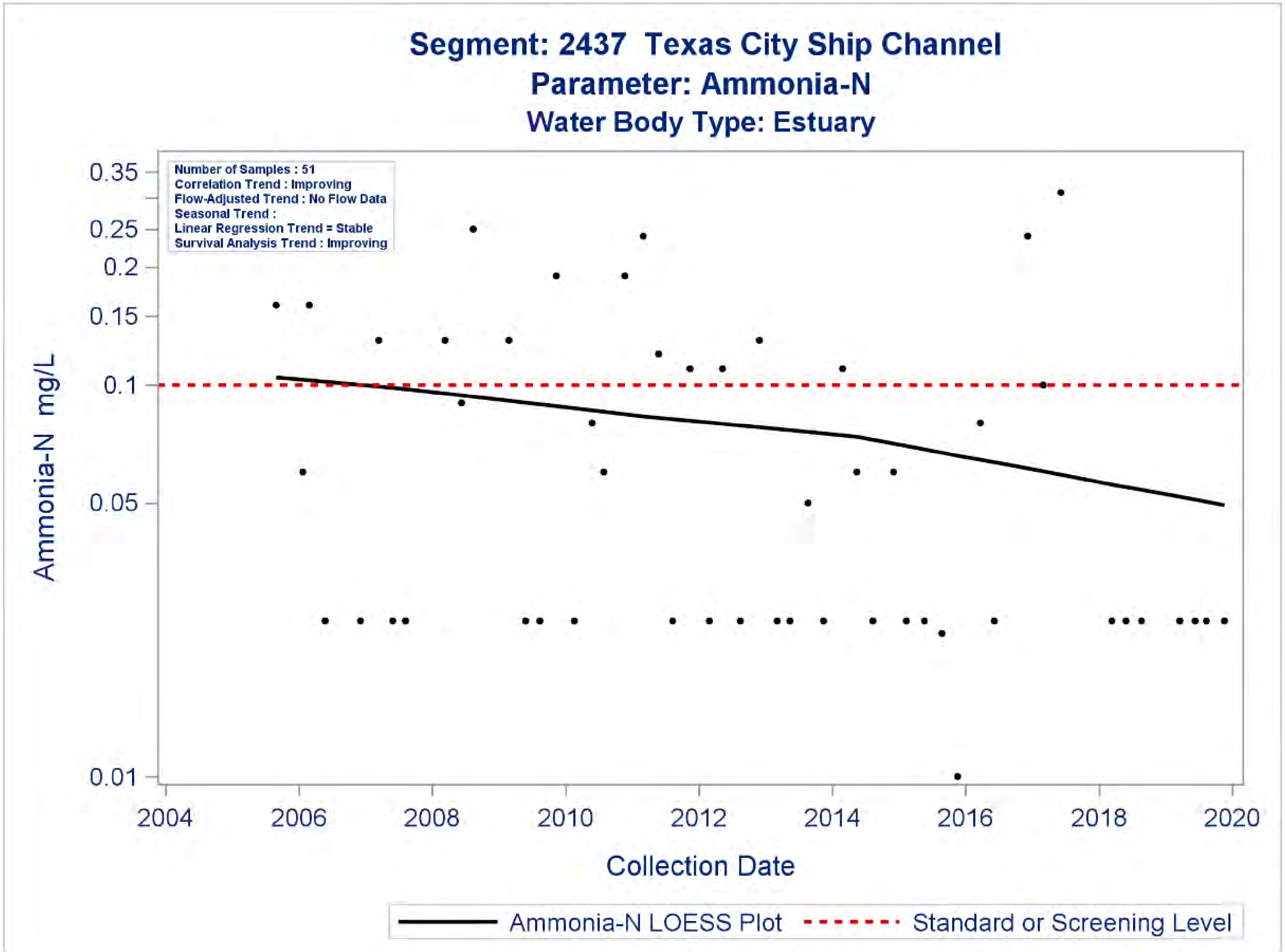


Texas City Ship Channel - 2437
Permited OSSF
WWTF
2437_01
Texas City
Texas City Industrial Complex
Port of Texas City
Industrial Canal Rd
Southern Pacific Railroad
Union Pacific
Texas Ave
4th Ave S
3rd Ave S
5th Ave S
14th St S
Texas-Independence-Trl
Lakeview Country Club
Swan Lake
Campbells Bayou
Emmett F Lowry Expy
0 0.25 0.5 1
Miles

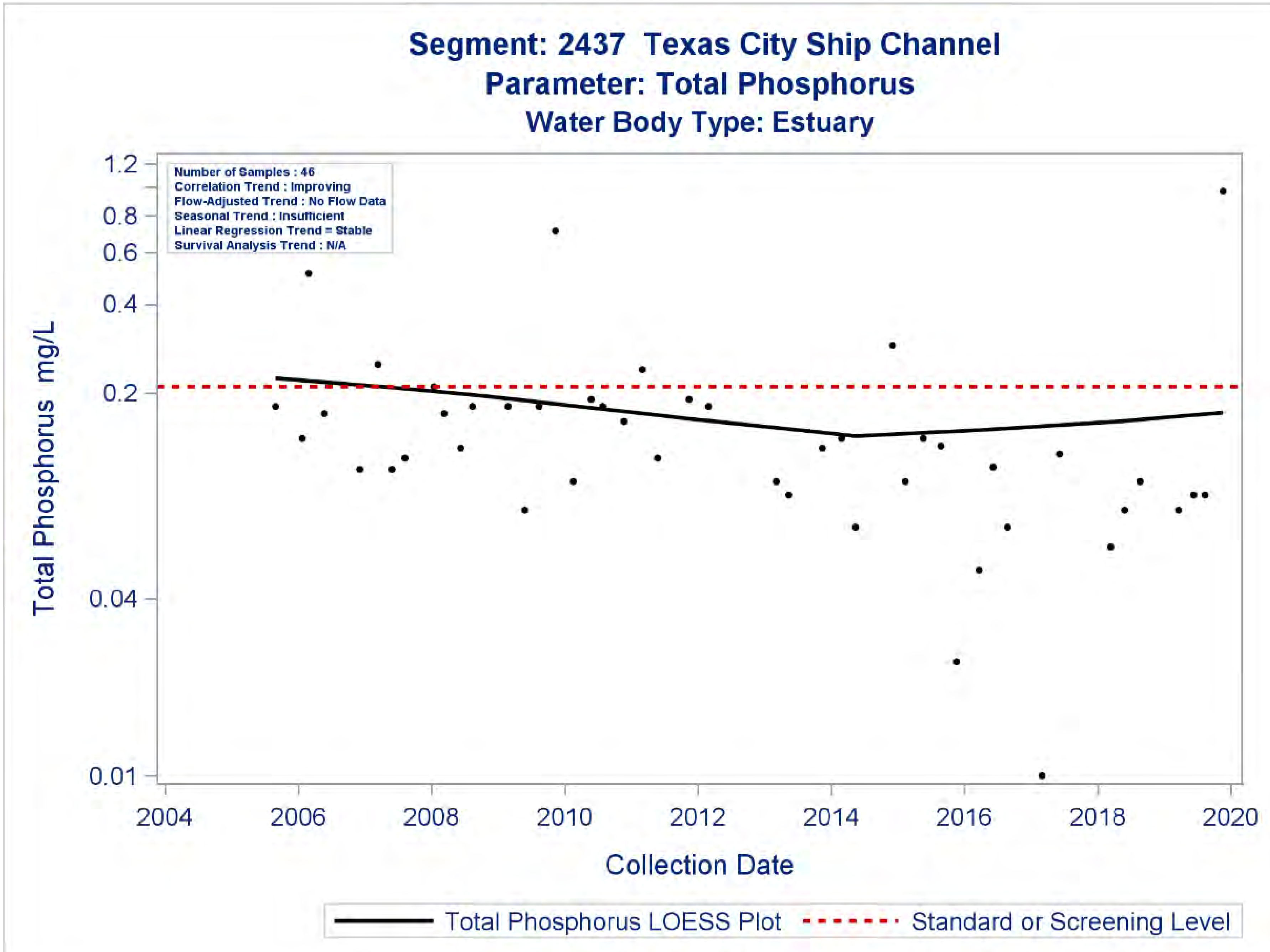
Trend Analysis:

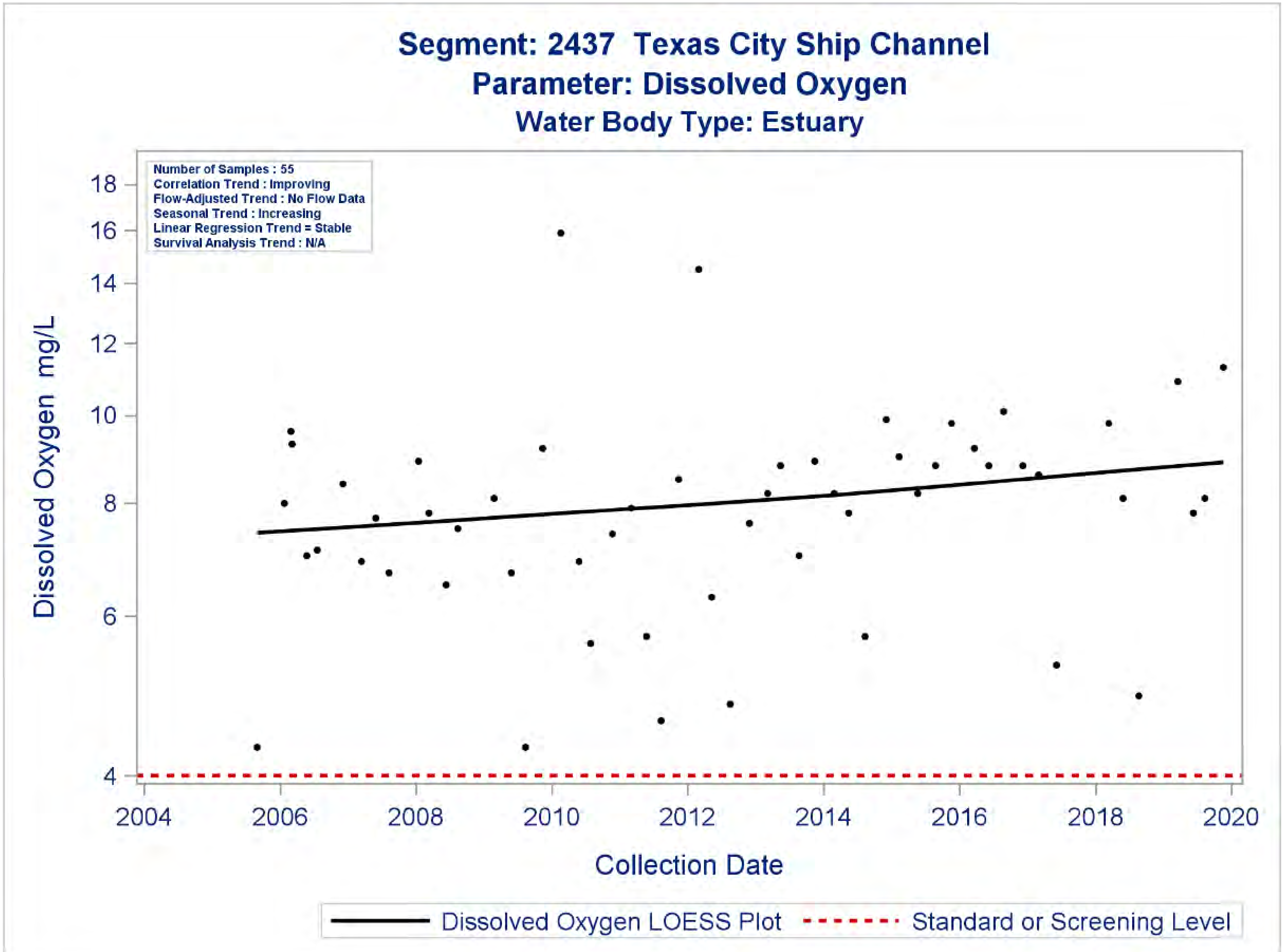
Analysis of Texas City Ship Channel (segment 2437) data revealed no parameters that had both a trend in the LOESS correlation analysis and the linear regression analysis. Rather, there were five parameter trends from the LOESS correlation analysis including improving ammonia, total phosphorus, DO, and specific conductance. Concentrations of ammonia which exceed the screening criteria are becoming more infrequent. Total phosphorus concentrations are seldom greater than the screening criteria and results since 2016 are being measured well below the criteria. Improving DO means the concentrations are increasing over time. There were no values measured below the screening criteria during the period of record. The median DO level is beginning to increase with fewer samples being measured between 5.0 and 7.5 mg/L. The correlation analysis also shows pH is deteriorating which means the standard units are increasing. There is no concern at this time since all measurements are still within the acceptable range of 6.5 to 9.0 standard units.

The 2020 Texas Integrated Report lists this segment as having a concern for elevated nutrient levels. Concentrations of total phosphorus seem to be improving while nitrate levels have remained relatively stable with nearly 50% of the samples collected found to exceed the screening criteria.

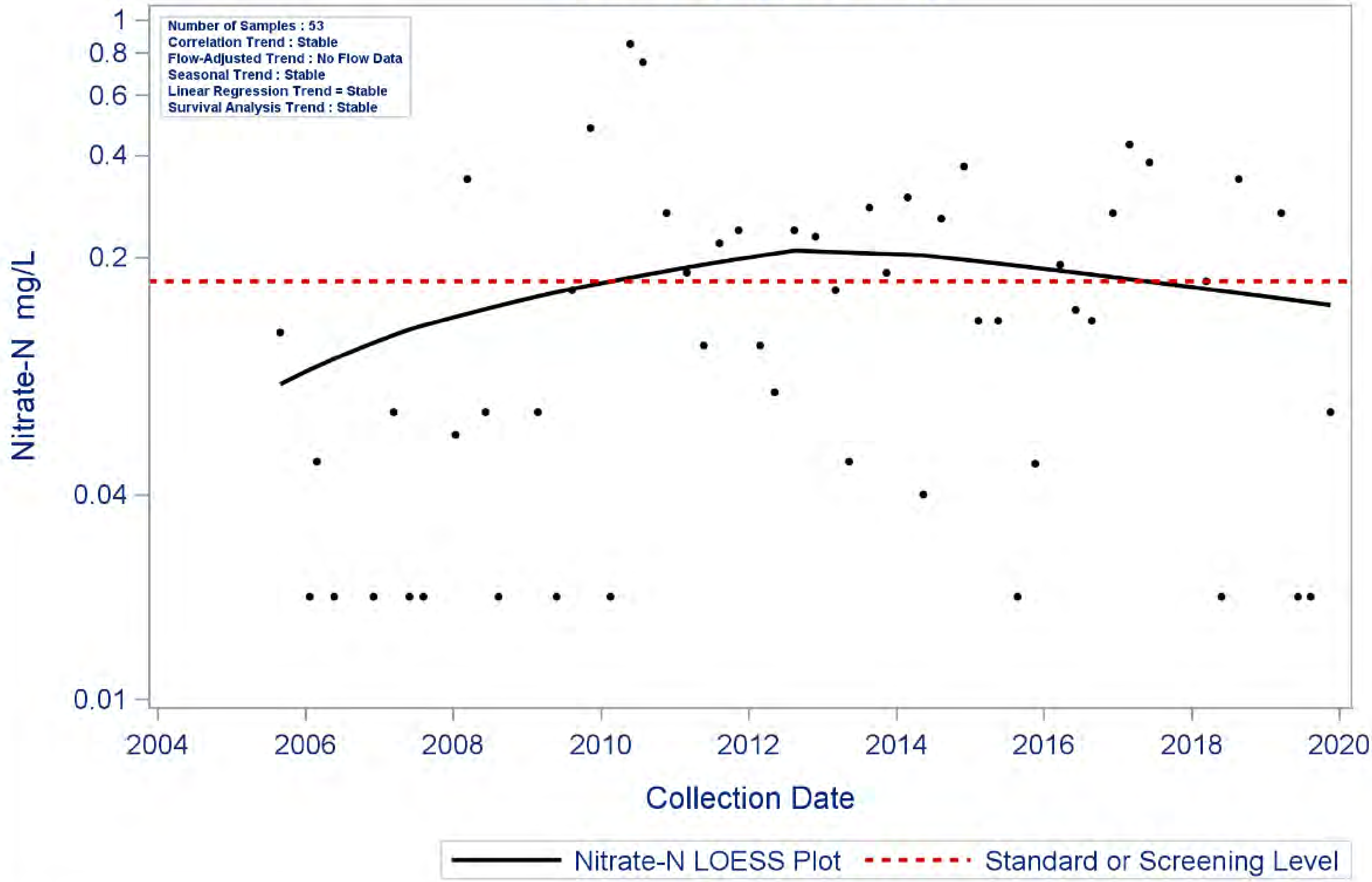


Segment: 2437 Texas City Ship Channel
Parameter: Ammonia-N
Water Body Type: Estuary
Number of Samples : 51
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend :
Linear Regression Trend = Stable
Survival Analysis Trend : Improving
Ammonia-N mg/L
0.35
0.25
0.2
0.15
0.1
0.05
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level


Segment: 2437 Texas City Ship Channel
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 46
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Insufficient
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Total Phosphorus mg/L
1.2
0.8
0.6
0.4
0.2
0.04
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level


Segment: 2437 Texas City Ship Channel
Parameter: Dissolved Oxygen
Water Body Type: Estuary
Number of Samples : 55
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
Dissolved Oxygen mg/L
18
16
14
12
10
8
6
4
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Dissolved Oxygen LOESS Plot
Standard or Screening Level

Segment: 2437 Texas City Ship Channel
Parameter: Nitrate-N
Water Body Type: Estuary



Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Nitrite-Nitrogen Concentrations	2437 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permits • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways
Elevated Chlorophyll -*a* Concentrations	2437 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	2437 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA • Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health (https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Continue monitoring and assessment of fish tissue to determine status of impairment • Encourage EPA and responsible parties to work together to remediate Superfund site • Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

The Texas City Ship Channel was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

Segment Number:	2424	Name:	West Galveston Bay

Area:	74 square miles	Miles of Shoreline:	172 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters
Number of Active Monitoring Stations:	18	Texas Stream Team Monitoring Stations:	13	Permitted WWTF Outfalls:	6

DESCRIPTION

- Segment 2424: **West Galveston Bay** (classified water body) – A 179.5 square kilometer (69.3 square mile) portion of the Galveston Bay system located on the landward side of Galveston Island, extending from the Galveston Causeway (IH-45) in Galveston County to the western side of San Luis Pass and the eastern shore of Mud Island in Brazoria County

- Segment 2424A (Tidal Stream w/ high ALU): **Highland Bayou** (unclassified water body) — From Jones Bay confluence to Avenue Q 0.8 km (0.5 mi) north of SH 6 between Arcadia and Alta Loma in Galveston County

- Segment 2424B (Estuary w/ high ALU): **Lake Madeline** (unclassified water body) – Located between Jones Street, Stewart Street, and Pine Street, north of the seawall on Galveston Island

- Segment 2424C (Tidal Stream w/ high ALU): **Marchand Bayou** (unclassified water body) — From Highland Bayou confluence to 0.72 km (0.45 mi) north of IH 45 in Galveston County

- Segment 2424D (Estuary w/ high ALU): **Offatts Bayou** (unclassified water body) — Located on the east end of Galveston Island, running parallel with the southern terminus of IH 45, and joins West Bay near Teichman Point

- Segment 2424E (Estuary w/ high ALU): **English Bayou** (unclassified water body) – Between IH 45, Bayou Shore Drive, South Shore Rear and SH 342 on Galveston Island

- Segment 2424F (Estuary w/ high ALU): **Crash Basin** (unclassified water body) – Located off West Bay near the outlet of Offatts Bayou and adjacent to Teichman Point in Galveston County

- Segment 2424G (Tidal Stream w/ high ALU): **Highland Bayou Diversion Canal** (unclassified water body) – From the confluence with an unnamed tributary adjacent to Jones Bayou upstream to the Highland Bayou confluence

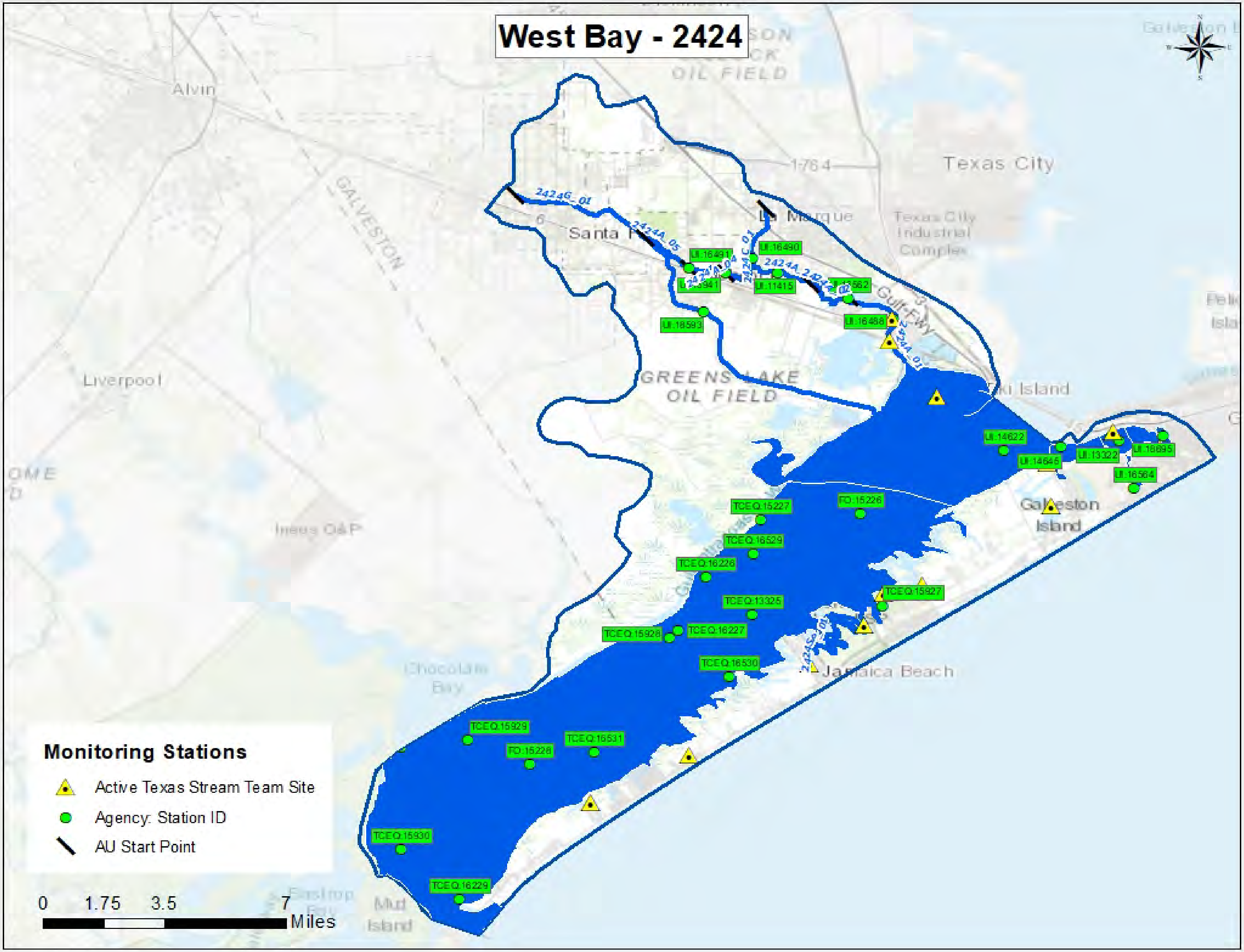
- Segment 2424OW (Oyster Waters)

- Segment 2424SP: **Galveston Island State Park** (Recreational beaches)

FY 2021 Active Routine Monitoring Stations					
Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
11421	2424	MCGINNES BARGE CANAL 0.4 MILES UPSTREAM FROM INTRACOASTAL WATERWAY	FO	Two/Year	Field, Conventional, Bacteria, Metals in Water, Metals in Sediment, Organics in Sediment
13325	2424	WEST BAY NEAR CARANCAHUA REEF 2.7 KM SE IF CARABCAHUA OINT ABD 2.5 KM NORTHWEST OF CARANCAHUA COVE	FO	Quarterly One/Year	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment
14622	2424	WEST BAY AT RANGE MARKER D BETWEEN SOUTH DEER ISLAND AND TEICHMAN POINT	UI	Quarterly	Field, Conventional, Bacteria
15226	2424	WEST BAY AT 95GB031 2.1 MI SOUTH OF ICWW MARKER 59	FO	Quarterly	Field, Conventional, Bacteria
15227	2424	WEST BAY AT 95GB032 NEAR THE NORTH SHORELINE HALFWAY BETWEEN GREENS CUT AND CARANCAHUA CUT	FO	Quarterly	Field, Conventional, Bacteria
15228	2424	WEST BAY AT 95GB034 HALFWAY BETWEEN BAY HARBOR AND ALLIGATOR POINT	FO	Quarterly	Field, Conventional, Bacteria
16565	2424	ICWW 200FT EAST OF MCGINNES PITS OUTFALL ON ICWW APPROX .64 MI SOUTH AND .68 MI WEST OF CARANCAHUA BAYOU CONFLUENCE	FO	Two/Year	Field, Conventional, Bacteria, Metals in Sediment, Organics in Sediment
11415	2424A	HIGHLAND BAYOU AT FAIRWOOD ROAD IN LA MARQUE IN GALVESTON COUNTY	UI	Quarterly	Field, Conventional, Bacteria
15941	2424A	HIGHLAND BAYOU AT FM 519	UI	Quarterly	Field, Conventional, Bacteria
16488	2424A	HIGHLAND BAYOU 80 M NORTHEAST OF SH 6 BRIDGE CENTERPOINT IN BAYOU VISTA WEST OF IH 45 IN GALVESTON COUNTY	UI	Quarterly	Field, Conventional, Bacteria
16491	2424A	HIGHLAND BAYOU AT FM 2004 IN HITCHCOCK IN GALVESTON COUNTY	UI	Quarterly	Field, Conventional, Bacteria
16562	2424A	HIGHLAND BAYOU AT END OF BAYOU LANE FREDDIESVILLE	UI	Quarterly	Field, Conventional, Bacteria
16564	2424B	LAKE MADELINE AT CORNER OF BELUCHE DRIVE AND DOMINIQUE DRIVE IN GALVESTON	UI	Quarterly	Field, Conventional, Bacteria
16490	2424C	MARCHAND BAYOU TIDAL AT FM519 IN HITCHCOCK	UI	Quarterly	Field, Conventional, Bacteria
13322	2424D	WEST BAY OFFAT BAYOU MID BAYOU OPPOSITE LAKE MADELINE CANAL	UI	Quarterly	Field, Conventional, Bacteria
14645	2424D	OFFATTS BAYOU OFF CM 18	UI	Quarterly	Field, Conventional, Bacteria
18695	2424E	ENGLISH BAYOU MID BAYOU 250 M EAST AND 83 M SOUTH OF 61ST ST BRIDGE CENTERPOINT IN GALVESTON	UI	Quarterly	Field, Conventional, Bacteria
18593	2424G	HIGHLAND BAYOU DIVERSION CANAL MID CHANNEL AT SECOND STREET BRIDGE 467 M UPSTREAM OF PRICE ROAD WWTP RELEASE IN HITCHCOCK	UI	Quarterly	Field, Conventional, Bacteria

FO = TCEQ Regional Office
UI = University of Houston Clear Lake – Environmental Institute of Houston

Map may reflect active and historical stations that are monitored on a rotating basis and included in data trends.


West Bay - 2424
Monitoring Stations
Active Texas Stream Team Site
Agency: Station ID
AU Start Point
0
1.75
3.5
7
Miles
Alvin
Texas City
Santa Fe
La Marque
Texas City Industrial Complex
Liverpool
GREENS LAKE OIL FIELD
Tiki Island
Galveston Island
Jamaica Beach
Chocolate Bay
Mud Island
2424G_01
2424A_05
2424A_02
UI:16491
UI:16490
UI:11415
UI:18593
UI:16488
UI:14622
UI:14645
UI:13322
UI:18695
UI:16564
TCEQ:15227
FO:15226
TCEQ:16529
TCEQ:16228
TCEQ:15927
TCEQ:13325
TCEQ:15928
TCEQ:16227
TCEQ:16530
TCEQ:15929
FO:15228
TCEQ:16531
TCEQ:15930
TCEQ:16229

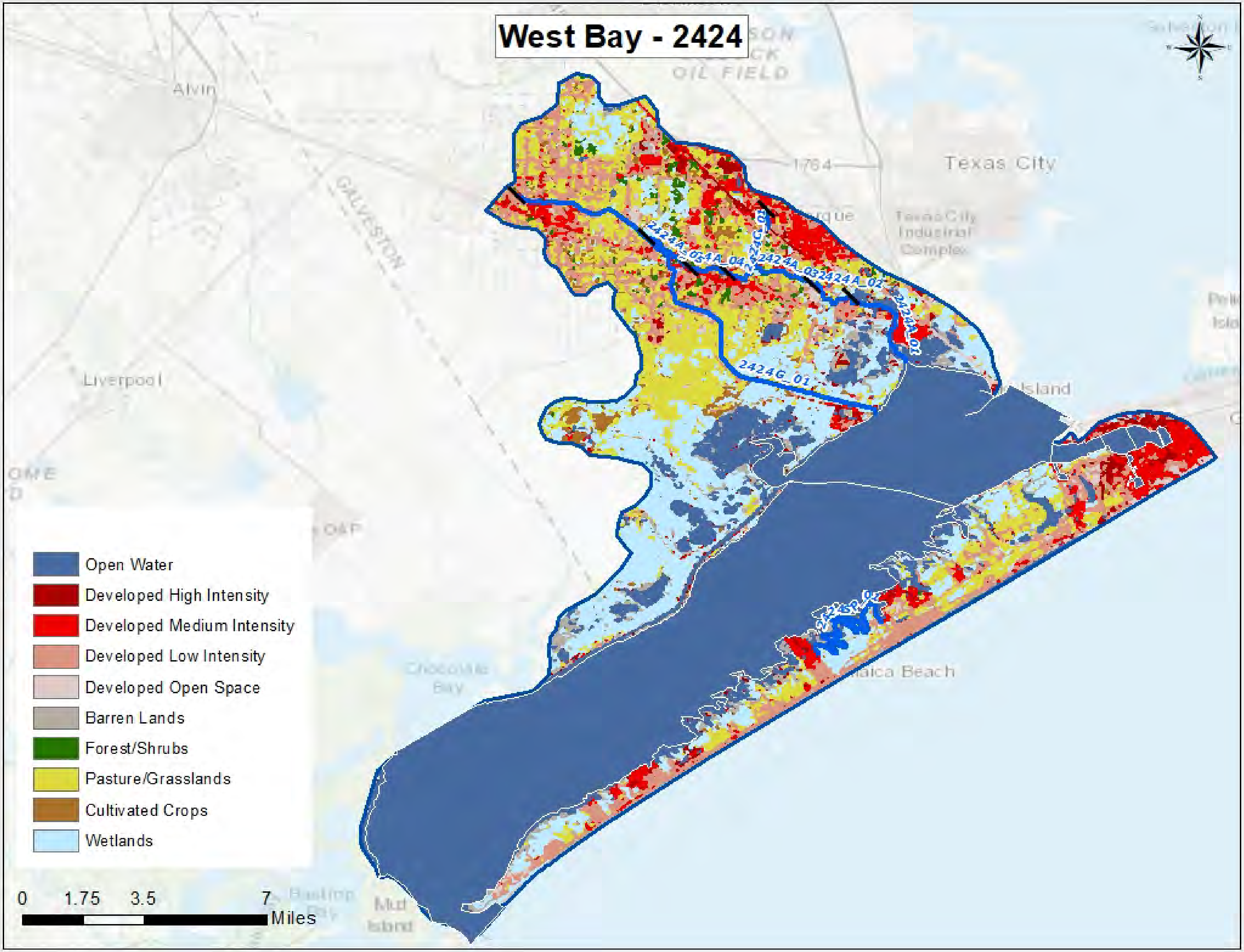
Segment 2424 Water Quality Standards and Screening Levels					
Standards	**Bays & Estuaries**	**Tidal Stream**	**Screening Levels**	**Bays & Estuaries**	**Tidal Stream**
Temperature (°C/°F):	35	35 / 95	Ammonia-N (mg/L):	0.10	0.46
Dissolved Oxygen (24-Hr Average) (mg/L):	4.0	4.0	Nitrate-N (mg/L):	0.17	1.10
Dissolved Oxygen (Absolute Minima) (mg/L):	3.0	3.0	Orthophosphate Phosphorus (mg/L):	0.19	0.46
pH (standard units):	6.5-9.0	6.5-9.0	Total Phosphorus-P (mg/L):	0.21	0.66
Enterococci (MPN/100mL) (grab):	130	130	Chlorophyll a (µg/L):	11.6	21
Enterococci (MPN/100mL) (geometric mean):	35	35			
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43				

Segment Discussion

Watershed Characteristics and Land Cover: The West Galveston Bay (2424) watershed encompasses the bay side of Galveston Island and many coastal wetlands on the landward side of the bay. There are several classified and unclassified bays and tributaries that drain into the bay system. The bay side of Galveston Island includes sporadically placed low intensity developments, grasslands with coastal scrub and wetlands. On the mainland, the communities of Hitchcock, La Marque, Bayou Vista, and Tiki Island are located west of IH-45 and are drained by Highland and Marchand Bayous to Jones Bay, a sub bay to West Galveston Bay.

Open Water is the largest land cover class for this watershed, at 44.29 percent of the area. Agriculture makes up 15.20 percent of the watershed. Grazing lands and domestic animal facilities are common in the southwestern and northwestern portions of the watershed. Between 2008 and 2018, Agriculture land cover increased from 10,675 acres to 18,988 acres, an increase of 77.87 percent. Most of the Developed land cover in this watershed is low intensity, mixed residential and commercial development. Overall, developed lands cover 19.42 percent of the watershed.

Segment 2424 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	10,675.43	8.55	18,988.13	15.20	77.87
Barren Lands	4,035.59	3.23	5,043.04	4.04	24.96
Developed	24,131.02	19.32	24,254.67	19.42	0.51
Forest/Shrubs	887.36	0.71	1,121.10	0.90	26.34
Open Water	57,168.99	45.76	55,328.88	44.29	-3.22
Wetlands	28,020.50	22.43	20,184.61	16.16	-27.96
TOTAL	**124,918.88**	**100.00**	**124,920.44**	**100.00**	


West Bay - 2424
Alvin
Texas City
Liverpool
GALVESTON
OIL FIELD
Texas City Industrial Complex
1764
2424A_05
2424A_04
2424A_03
2424A_02
2424A_01
2424C_01
2424G_01
Island
Chocolate Bay
Mud Island
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1.75
3.5
7
Miles

Water Quality Issues:

Bacteria Impairments and Concerns
In the 2020 Integrated Report, four of five assessment units in Highland Bayou (2424A_02, 2424A_03, 2424A_04, and 2424A_05) do not support contact recreation due to elevate levels of enterococci. An impairment is also present in Marchand Bayou (2424C_01) and Highland Bayou Diversion Canal (2424G_01).

There is a shellfish harvesting restriction on a portion of West Galveston Bay (2424OW_02), which is the area of the bay adjacent to Lower Galveston Bay and Galveston Island.

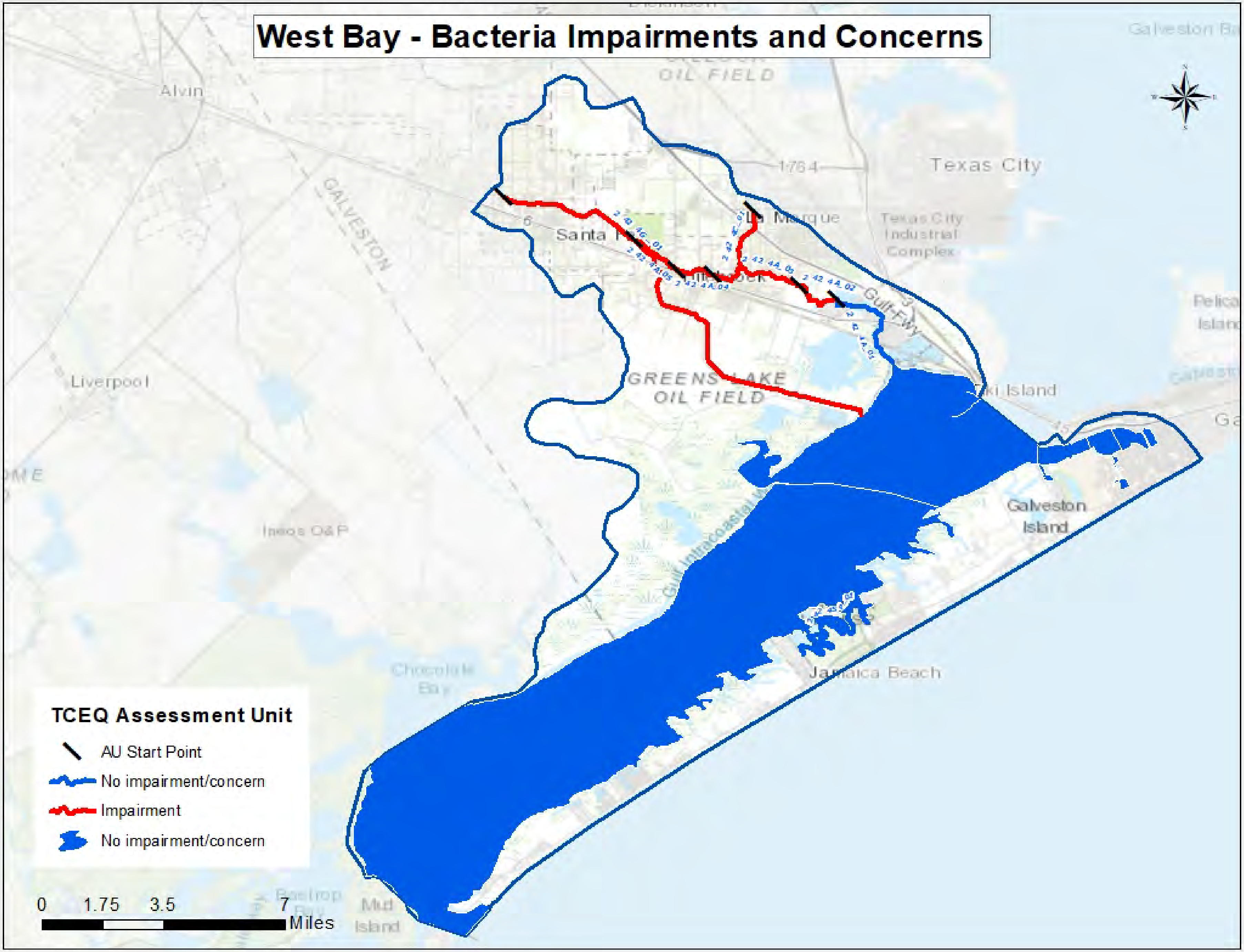
Dissolved Oxygen Impairments and Concerns
There are numerous dissolved oxygen impairments and concerns in Highland Bayou (2424A) The assessment units 2424A_05 (Highland Bayou) is impaired for both 24-hour average and 24-hour minimum dissolved oxygen measurements that are below the water quality standard. There are dissolved oxygen screening level concerns in assessment units 2424A_03 and 2424A_04, with an impairment for dissolved oxygen grab minimum in 2424A_04. There is also a concern for dissolved oxygen 24-hour minimum in 2424A_02.

Marchand Bayou (2424C_01) has an impairment for 24-hour dissolved oxygen minimum and a concern for 24-hour dissolved oxygen average. There is also a concern for dissolved oxygen grab screening levels in Lake Madeline (2424B).

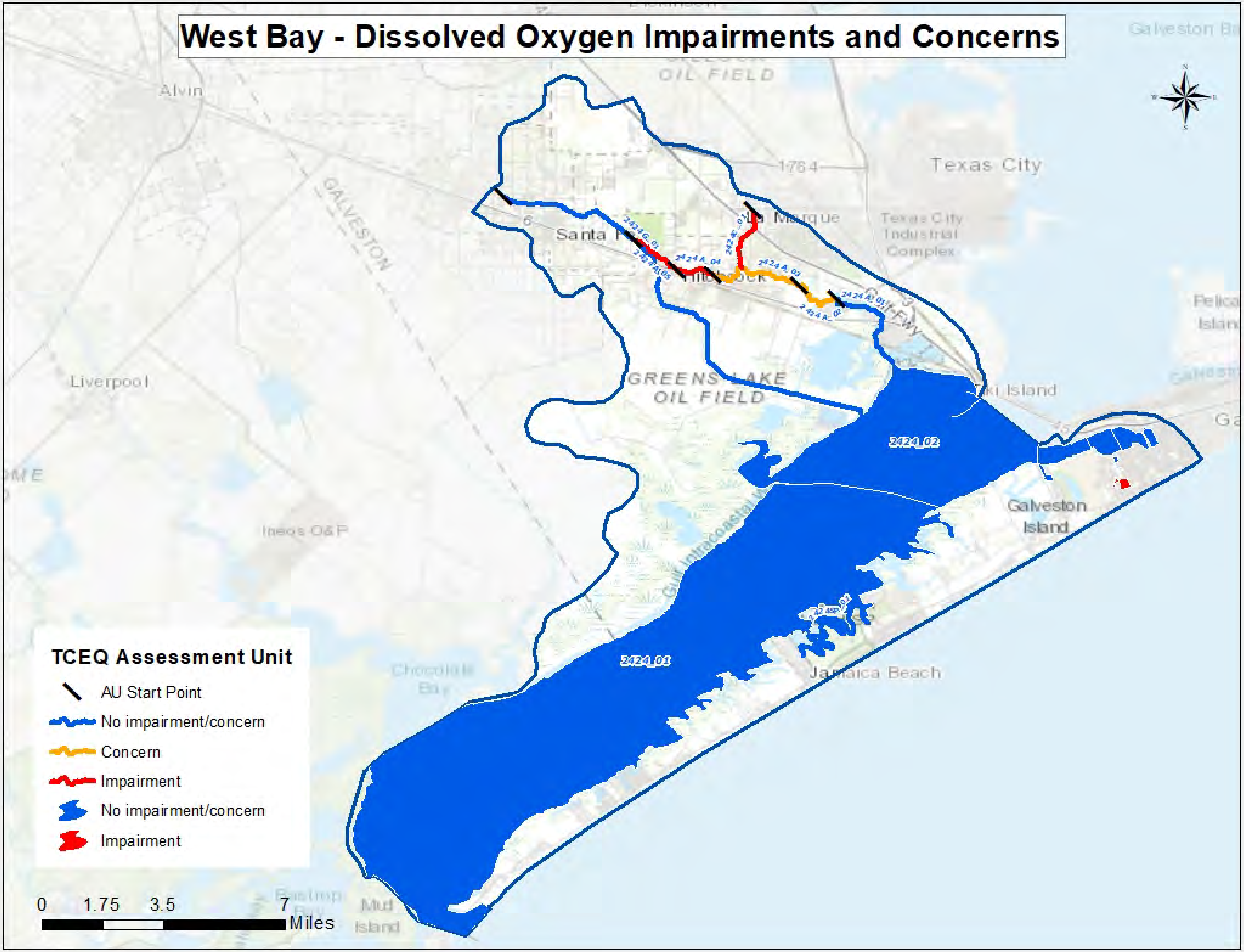
Nutrient Concerns
Nutrient screening level concerns are found in several assessment units in this watershed. Ammonia-nitrogen is of concern in Lake Madeline (2424B_01) and Offatts Bayou (2424D_02). Total Phosphorus is of concern in Lake Madeline (2424B_01), Offatts Bayou (2424D_02), and English Bayou (2424E_01).

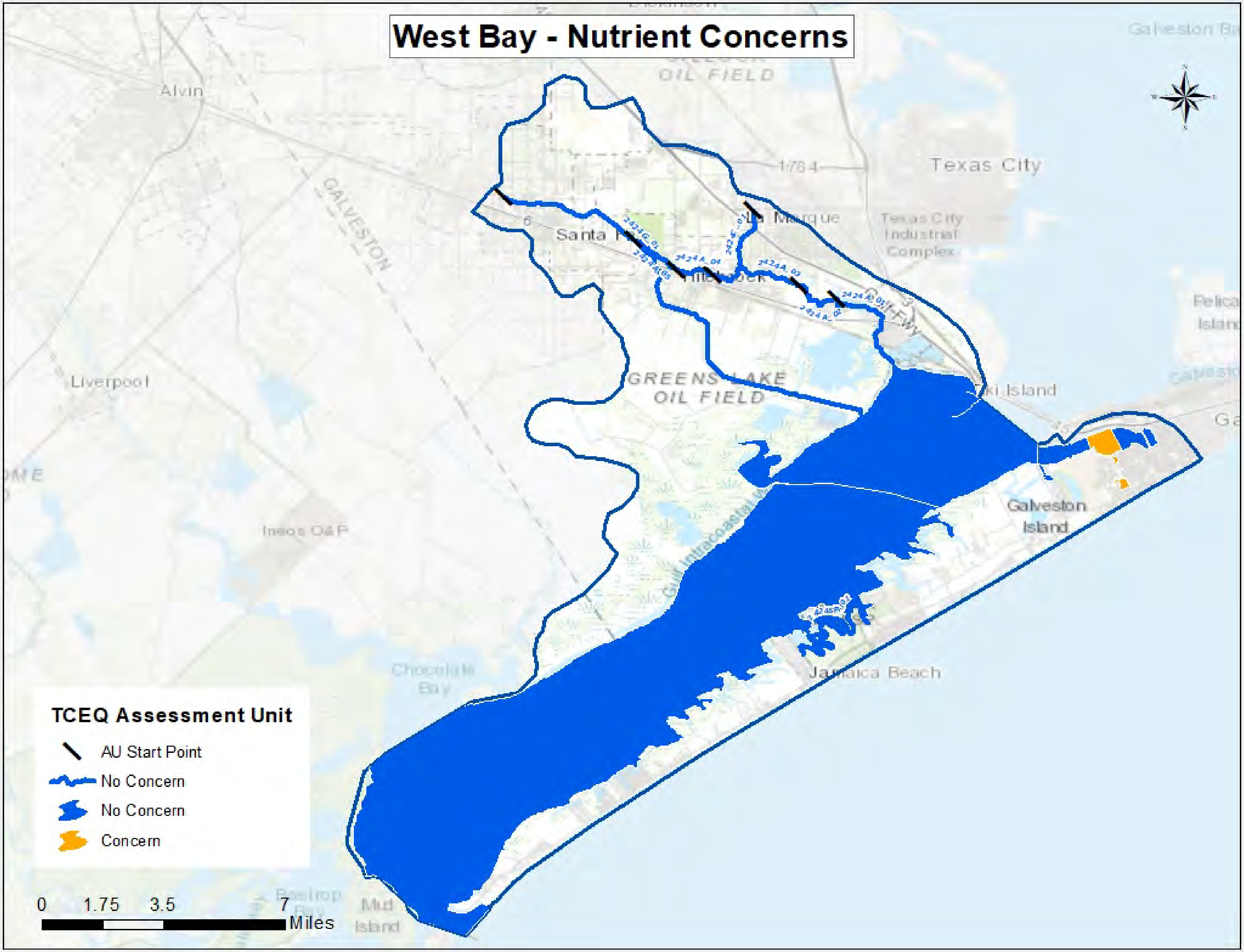
Chlorophyll-a Concerns
Three assessment units in Highland Bayou (AUs 2424A_02, 2424A_03, and 2424A_05) have concerns based upon chlorophyll-*a* screening levels. Concerns are also present in Lake Madeline (2424B_01) and one assessment unit of Offatts Bayou (2424D_02).

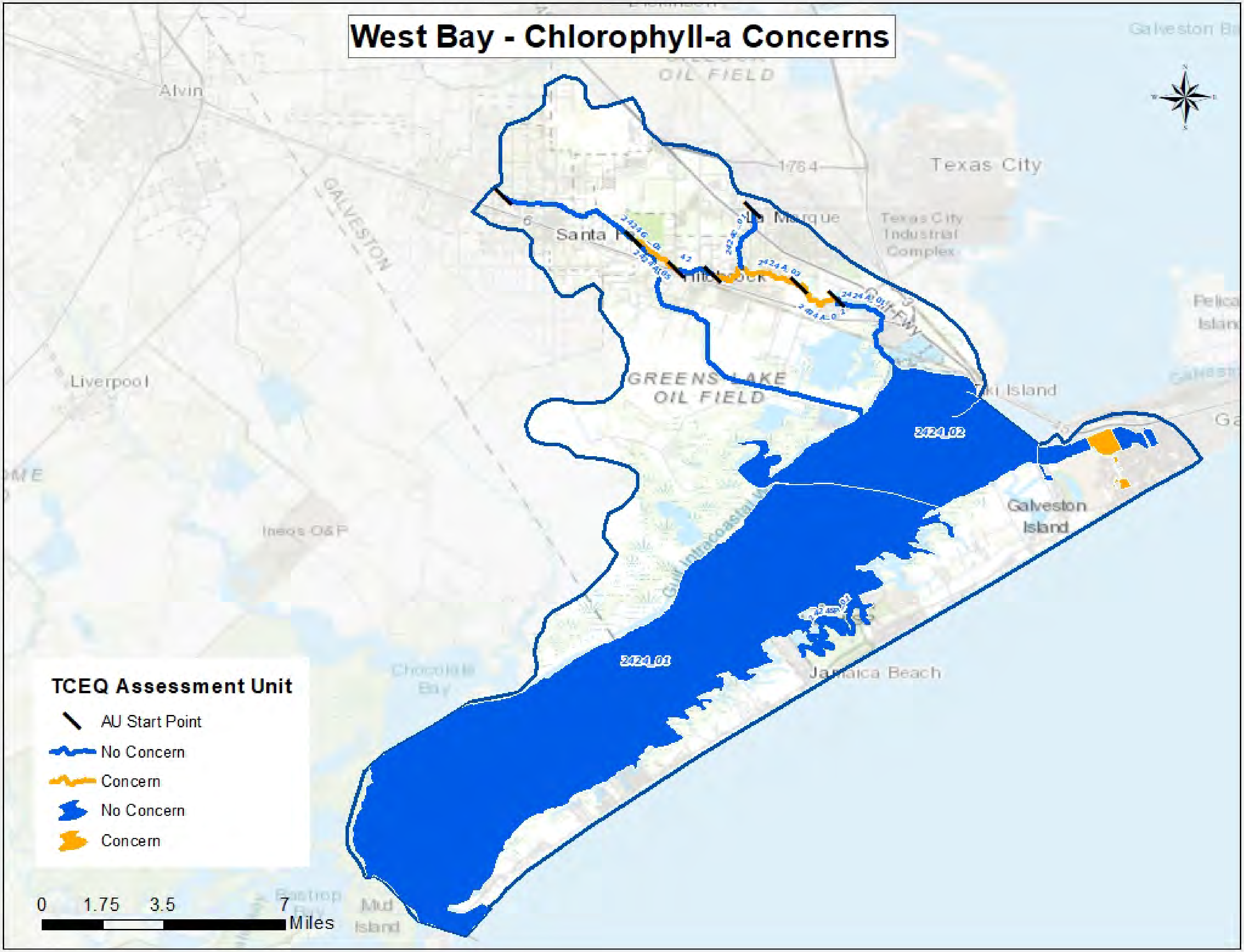
PCBs and Dioxin Impairments
West Galveston Bay (2424), Highlands Bayou (2424A), and Offatts Bayou (2424D) are listed as impaired for PCBs and Dioxins in all species of catfish. Fish samples collected from these segments indicate the presence of PCBs at a concentration exceeding health assessment guidelines. A fish consumption advisory has been issued by the Texas Department of State Health Services.

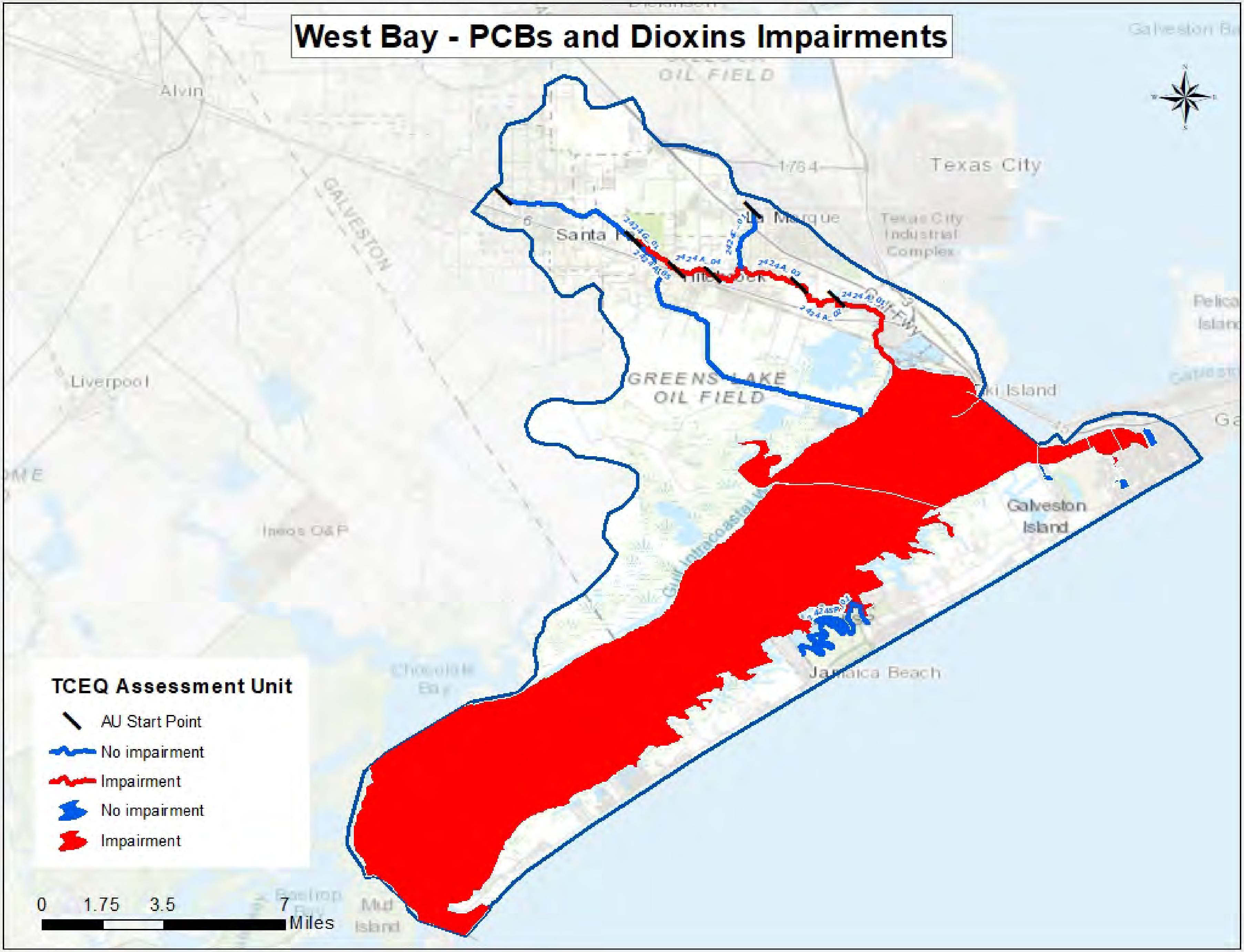


West Bay - Bacteria Impairments and Concerns
OIL FIELD
Alvin
Texas City
1764
Texas City
Industrial
Complex
GALVESTON
Liverpool
GREENS LAKE
OIL FIELD
Galveston
Island
Ineos O&P
Chocolate
Bay
Jamaica Beach
Mud
Island
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Impairment
No impairment/concern
0
1.75
3.5
7
Miles


West Bay - Dissolved Oxygen Impairments and Concerns
TCEQ Assessment Unit
AU Start Point
No impairment/concern
Concern
Impairment
No impairment/concern
Impairment
0
1.75
3.5
7
Miles
Alvin
Texas City
Santa Fe
La Marque
Hitchcock
Texas City Industrial Complex
Liverpool
GREENS LAKE OIL FIELD
Tiki Island
Galveston Island
Jamaica Beach
Chocolate Bay
Mud Island
Ineos O&P
2424_02
2424_01
GALVESTON


West Bay - Nutrient Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
No Concern
Concern
0 1.75 3.5 7
Miles
Alvin
Texas City
Texas City Industrial Complex
Santa Fe
La Marque
Hitchcock
Liverpool
Ineos O&P
GREENS LAKE OIL FIELD
Galveston Island
Jamaica Beach
Chocolate Bay
Mud Island
Tiki Island
Gulf Intracoastal Wy
GALVESTON


West Bay - Chlorophyll-a Concerns
TCEQ Assessment Unit
AU Start Point
No Concern
Concern
No Concern
Concern
0
1.75
3.5
7
Miles
2424_01
2424_02
Alvin
Texas City
Texas City Industrial Complex
La Marque
Santa Fe
Hitchcock
Liverpool
GREENS LAKE OIL FIELD
OIL FIELD
GALVESTON
Galveston Island
Jamaica Beach
Tiki Island
Chocolate Bay
Mud Island
Bastrop Bay
Ineos O&P
Gulf Intracoastal Wy


West Bay - PCBs and Dioxins Impairments
TCEQ Assessment Unit
AU Start Point
No impairment
Impairment
No impairment
Impairment
0 1.75 3.5 7
Miles
Texas City
Santa Fe
La Marque
Hitchcock
Texas City Industrial Complex
Tiki Island
Galveston Island
Jamaica Beach
Liverpool
Alvin
GALVESTON
GREENS LAKE OIL FIELD
Chocolate Bay
Mud Island
Gulf Intracoastal Waterway

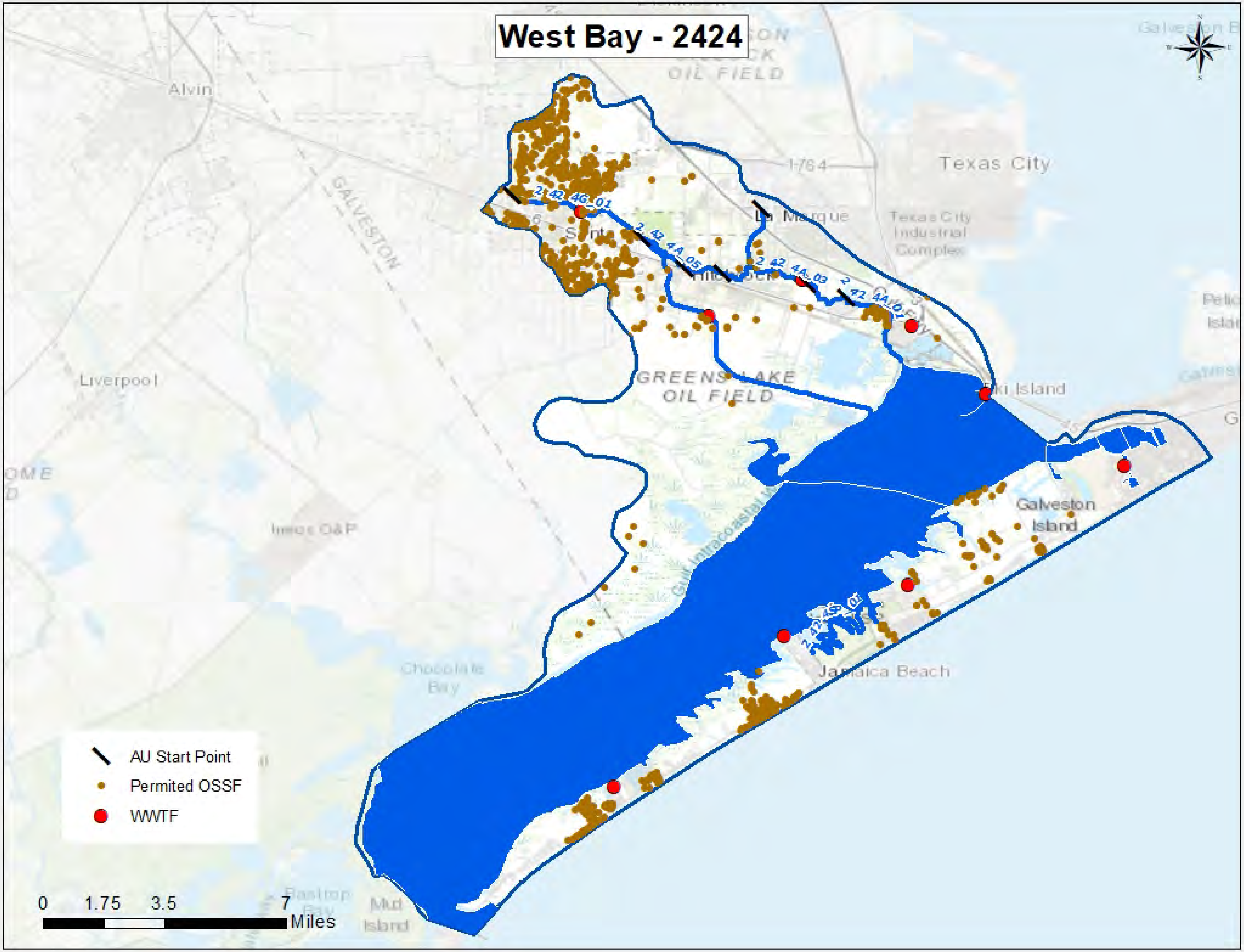
Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the West Galveston Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 6 permitted wastewater outfalls in the West Galveston Bay watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 1,031 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the West Galveston Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 33 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

Polychlorinated Biphenyls (PCBs) and Dioxins are persistent pollutants in the environment and have been found in this watershed. PCBs are manmade chemicals that were once used widely in electrical equipment, hydraulic fluids, lubricants, and plasticizers. Dioxins are a trace byproduct of many industrial and chemical process such as bleaching, organic chemical manufacturing, and low temperature combustion. These compounds can enter the environment through spills, leaks, and improper disposal and storage. These chemicals can be transported long distances and bind to soil and sediment. These compounds enter the aquatic food chain by benthic organisms feeding on the sediments. As larger aquatic species feed on the smaller species, the concentration of the compounds in tissues increases to the point which make certain species a danger for human consumption. Waste pits located adjacent to the San Jacinto River immediately upstream of I-10 are the most likely source.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the West Galveston Bay watershed.



West Bay - 2424
AU Start Point
Permited OSSF
WWTF
0
1.75
3.5
7
Miles
Texas City
Alvin
Liverpool
Galveston Island
Jamaica Beach
GREENS LAKE OIL FIELD

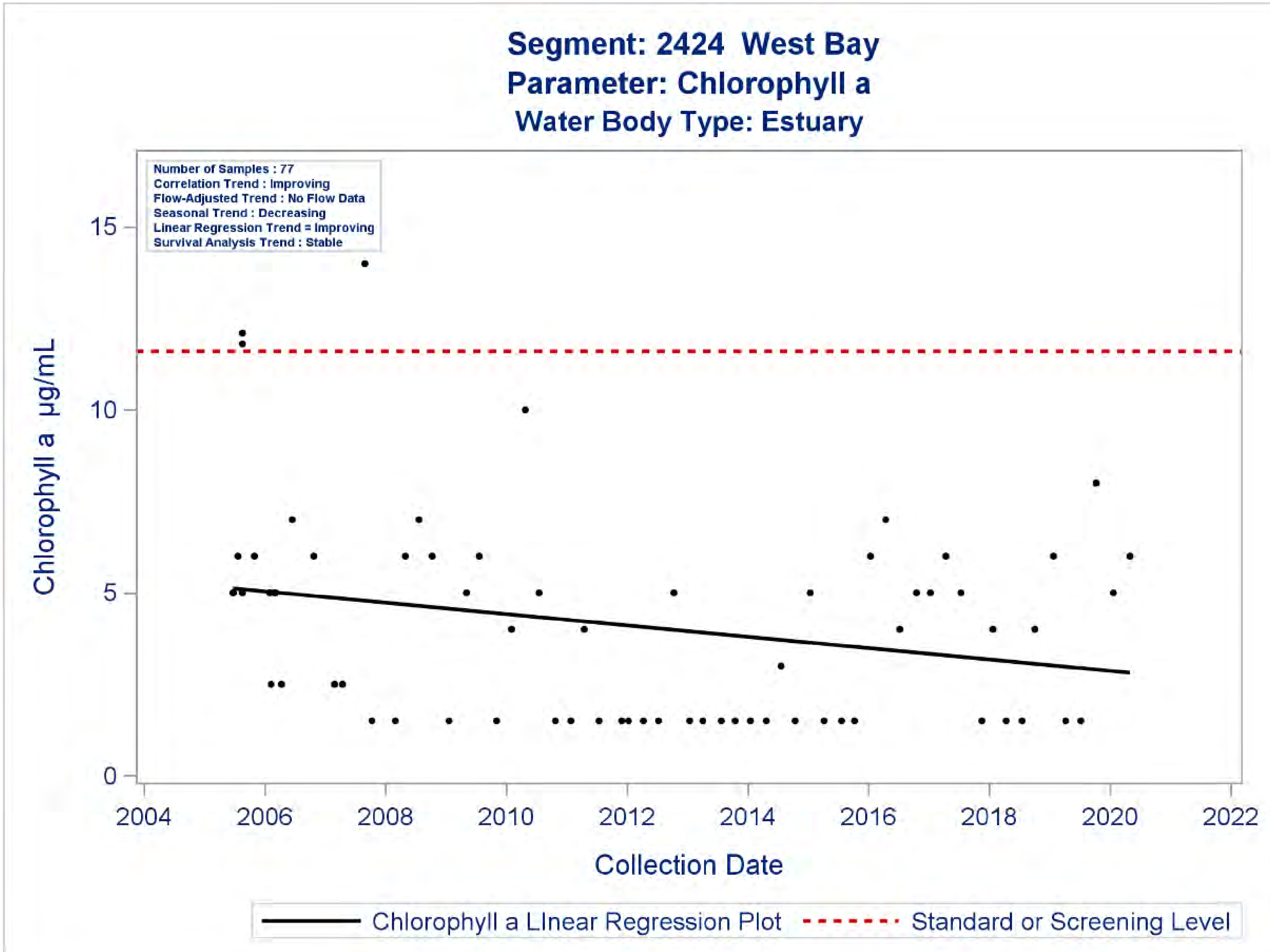
Trend Analysis:

Classified segment 2424 (West Galveston Bay) is comprised of many unclassified segments. The unclassified segments which were evaluated for trends included Highland Bayou (2424A), Lake Madeline (2424B), Marchand Bayou (2424C), Offatts Bayou (2424D), English Bayou (2424E), Crash Basin (2424F), and Highland Bayou Diversion Canal (2424G). Analysis of water quality data identified a total of 12 parameter trends with seven found in the classified segment (2424) and a combination of ten parameters trends found in the unclassified segments of the West Galveston Bay watershed. Trends were found in all evaluated water bodies except the Crash Basin (2424F).

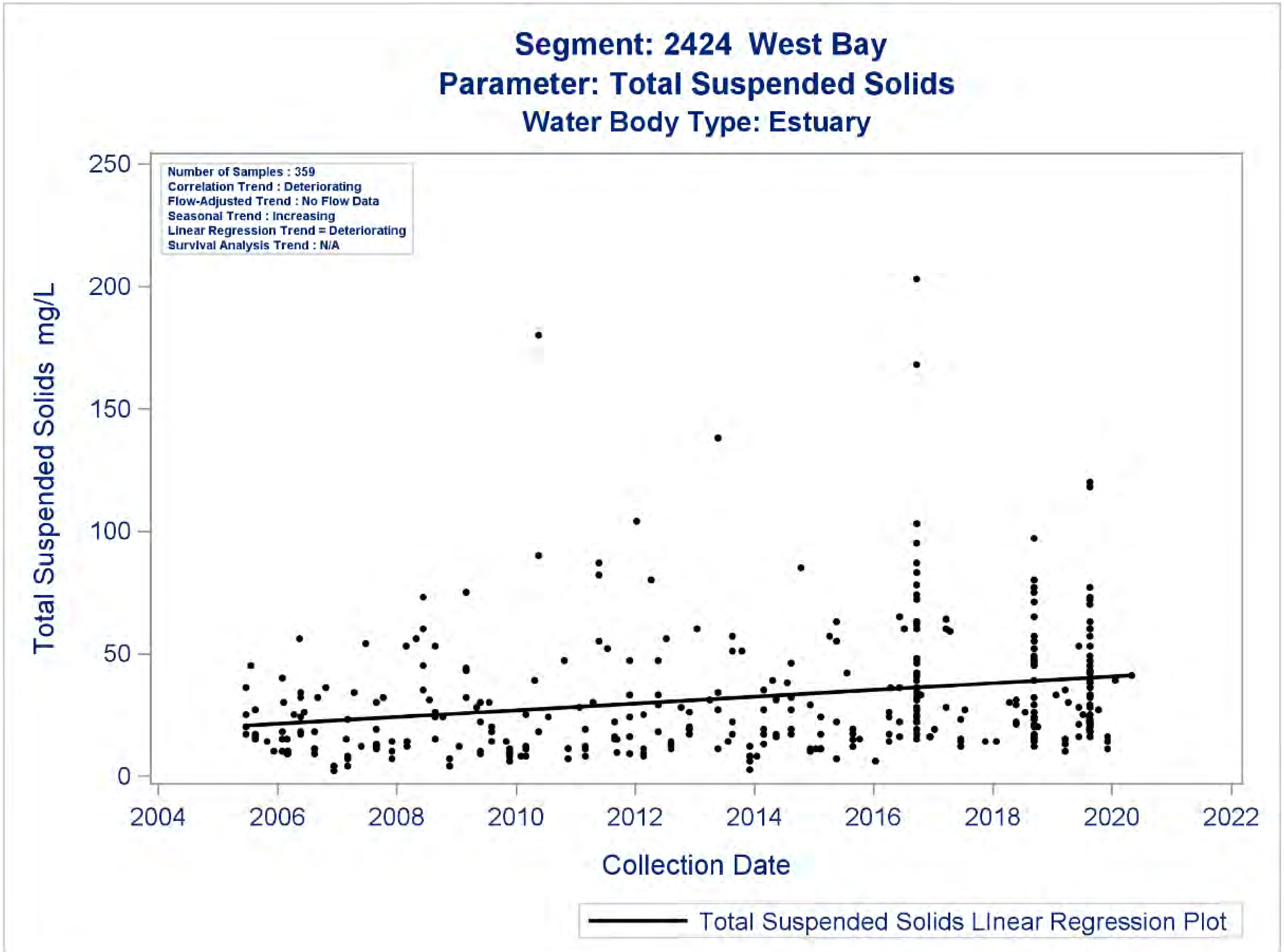
The seven trends identified in the main body of West Bay (2424) included decreasing concentrations of chloride, chlorophyll *a*, specific conductance, Secchi transparency, and TKN, while temperature and TSS were deteriorating with concentrations increasing over the period of record. The chlorophyll *a* trend revealed measurements were all below the screening criteria after 2008. When there is a trend with the TSS data, there is an inverse relationship to the Secchi transparency data. As sediment loads are increasing the Secchi transparency depth is generally decreasing. Decreasing trends are typically categorized as 'improving' trends, as seen in the graph legend, but the water is actually getting more turbid.

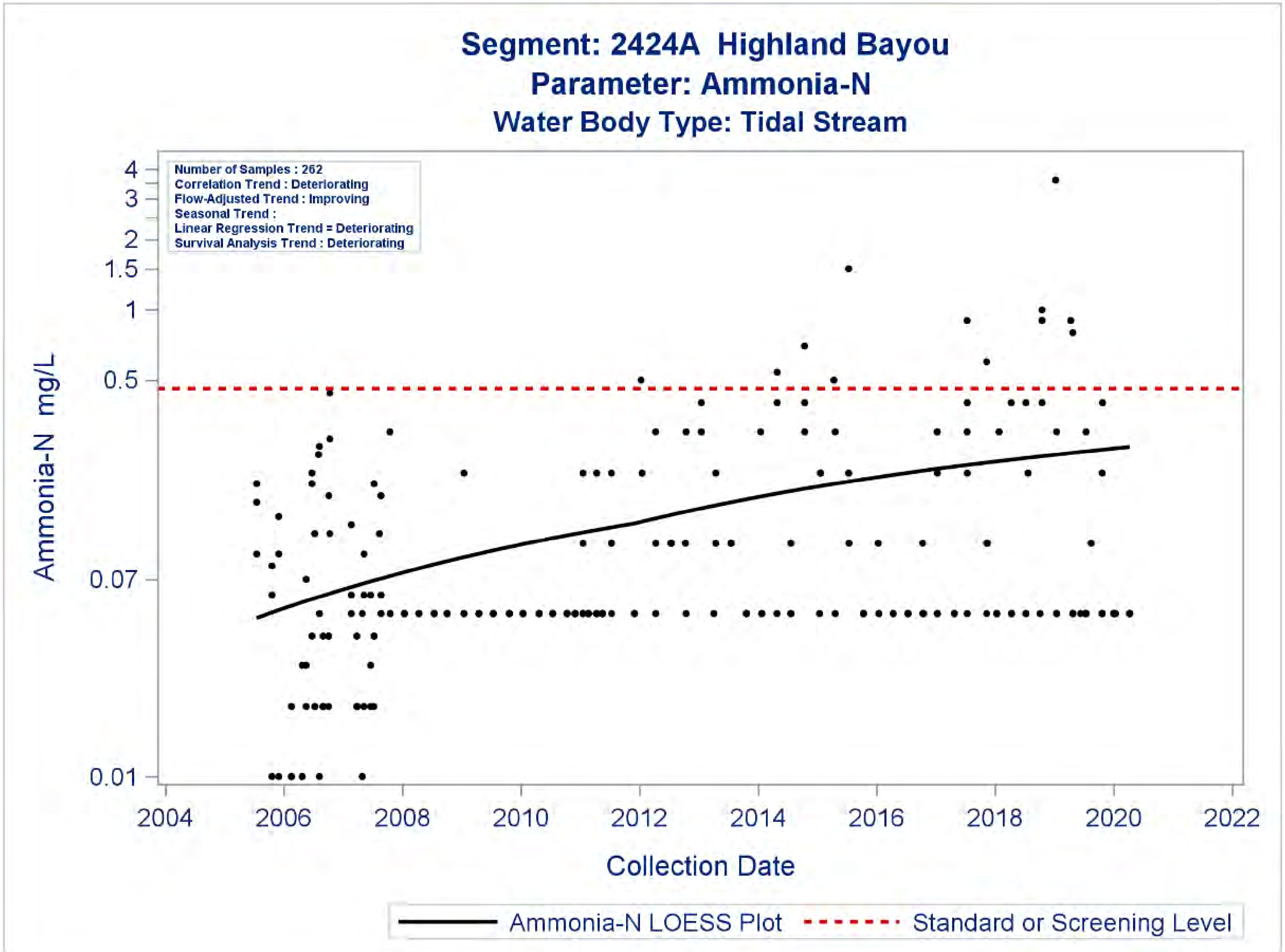
Highland Bayou (2424A) had a total of six parameter trends – increasing ammonia and nitrate, and increasing Secchi transparency depths, temperature, pH, and DO were detected. Lake Madeline (2424B) had only two improving trends for TKN and specific conductance. and Marchand Bayou (2424C) had five parameter trends including increasing concentrations of ammonia, nitrate, and total phosphorus but improving or decreasing Secchi transparency depths and temperature. Unclassified segment 2424D (Offatts Bayou) showed four parameter trends – increasing concentrations of enterococci bacteria and total phosphorus and decreasing concentrations of TKN and specific conductance. Three parameter trends were detected in the English Bayou (2424E) dataset including increasing enterococci bacteria concentrations and decreasing TKN and specific conductance. Finally, improving trends or decreasing concentrations in TKN and specific conductance were detected for the Highland Bayou Diversion Canal (2424G).

Analysis of enterococci data for Offatts Bayou (2424D) and English Bayou (2424E) revealed increasing bacteria concentrations over time, however, examination of the graphs show extreme spikes occur on an infrequent basis with concentrations reaching higher than 20,000 MPN/100 mL during the period of record. Spikes at this magnitude are likely related to illicit discharges or sanitary sewer overflows (SSOs) that introduce large volumes of untreated sewage into waterways. Refer to the Water Quality Issues discussion above for more information about oyster water bacteria and PCB/dioxin impairments.

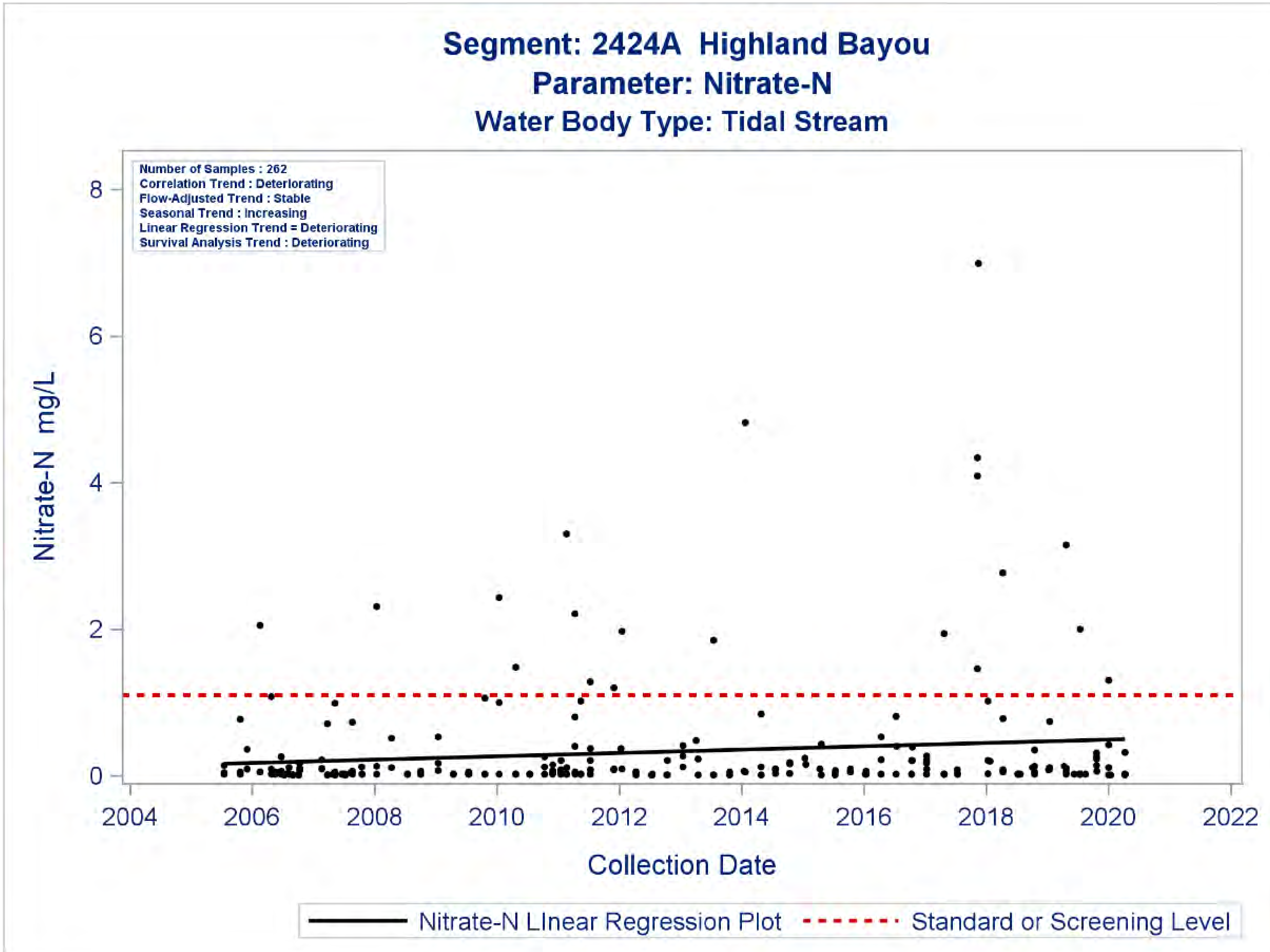


Segment: 2424 West Bay
Parameter: Chlorophyll a
Water Body Type: Estuary
Number of Samples : 77
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : Stable
Chlorophyll a µg/mL
0
5
10
15
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Chlorophyll a LInear Regression Plot
Standard or Screening Level

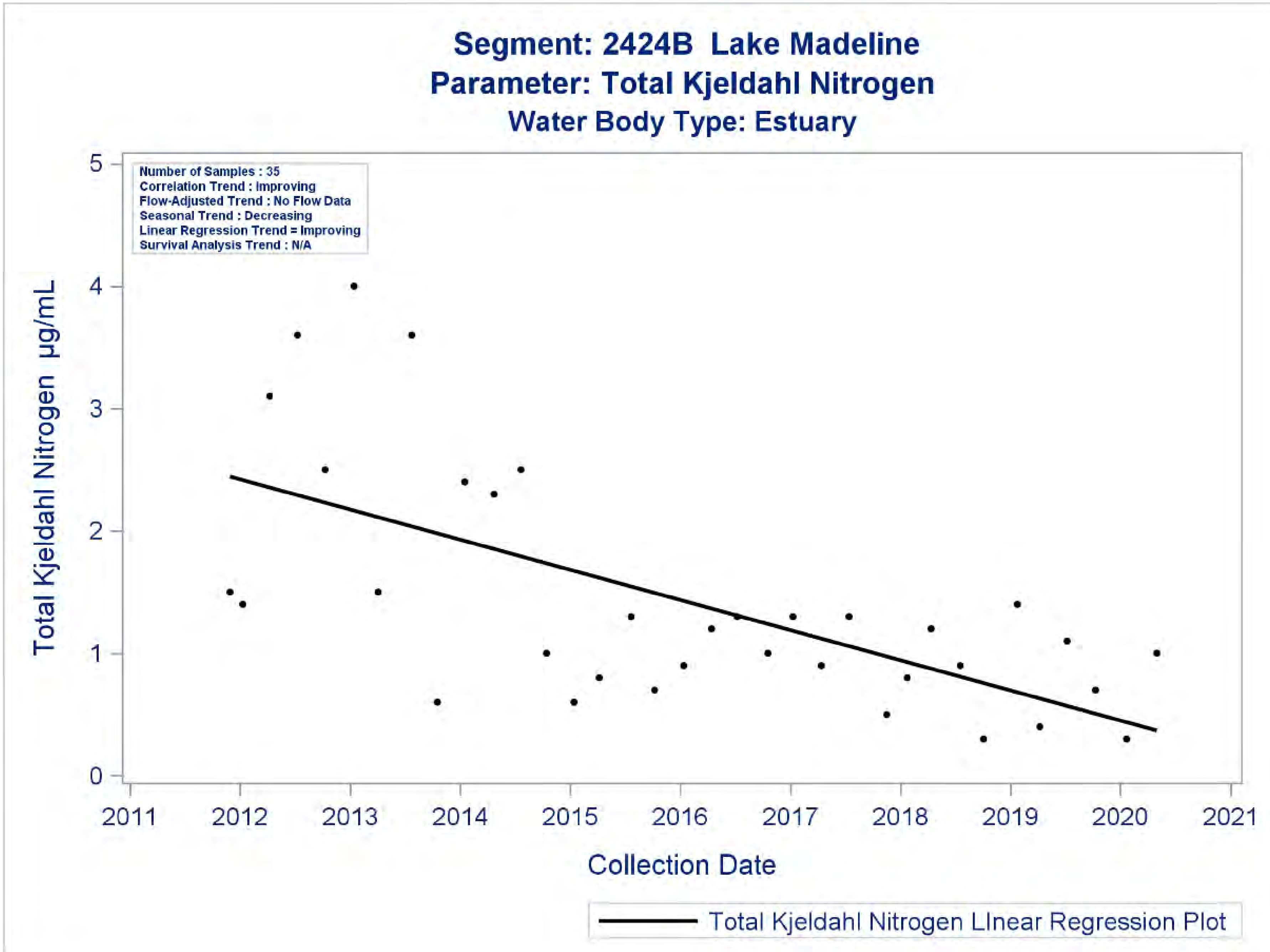

Segment: 2424 West Bay
Parameter: Total Suspended Solids
Water Body Type: Estuary
Number of Samples : 359
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
0
50
100
150
200
250
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids Linear Regression Plot



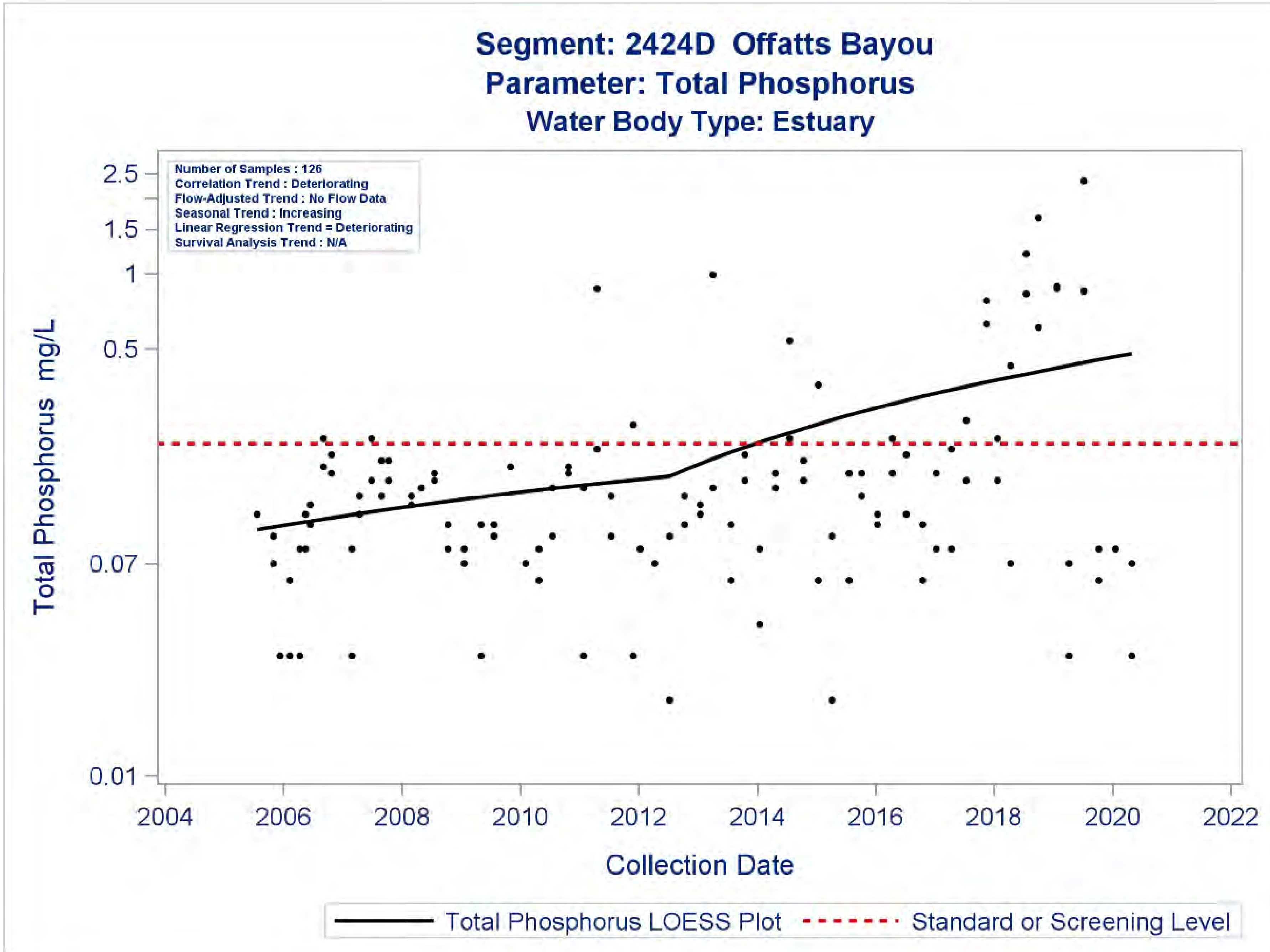
Segment: 2424A Highland Bayou
Parameter: Ammonia-N
Water Body Type: Tidal Stream
Number of Samples : 262
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Improving
Seasonal Trend :
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Ammonia-N mg/L
4
3
2
1.5
1
0.5
0.07
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Ammonia-N LOESS Plot
Standard or Screening Level



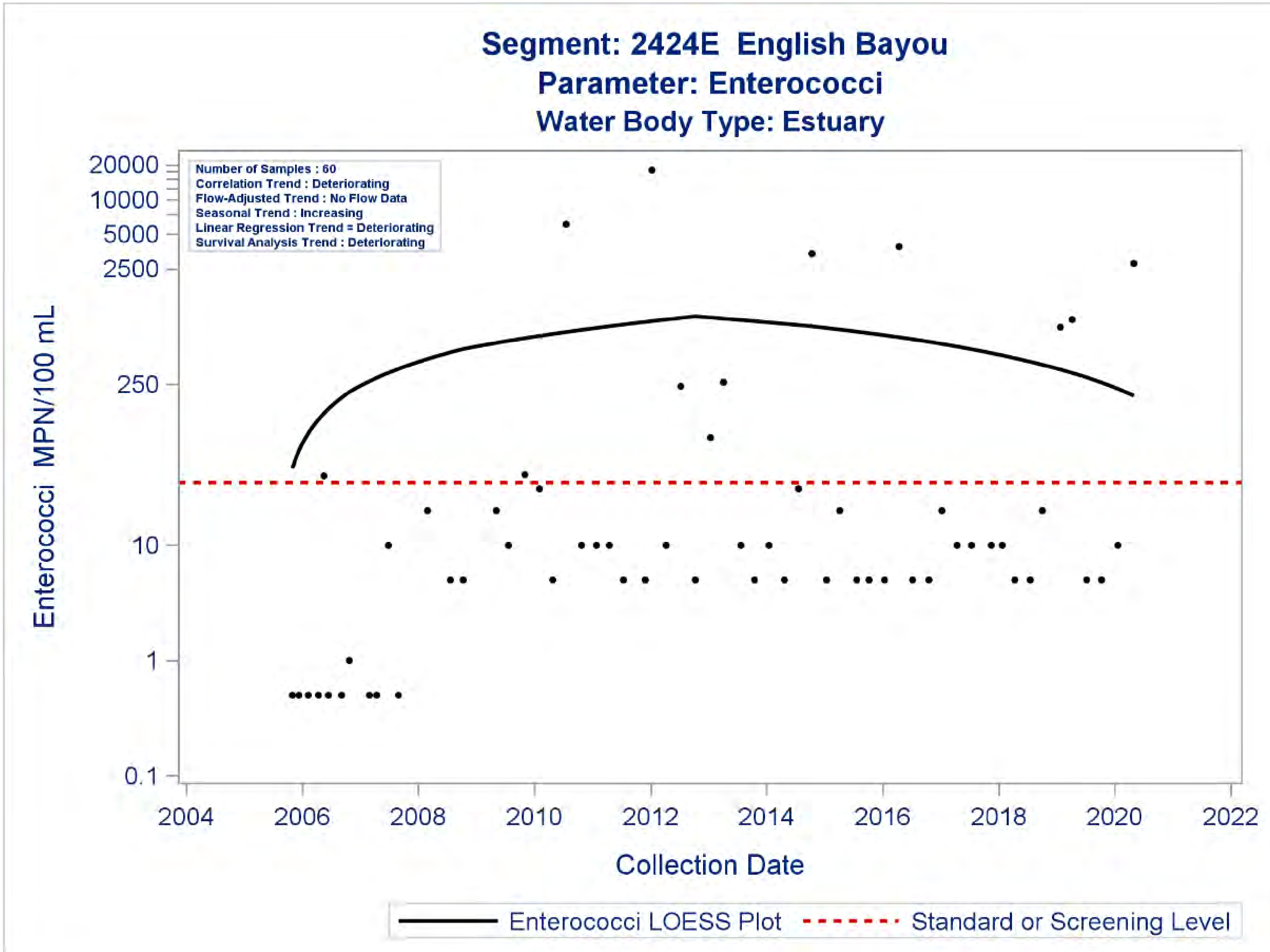
Segment: 2424A Highland Bayou
Parameter: Nitrate-N
Water Body Type: Tidal Stream
Number of Samples : 262
Correlation Trend : Deteriorating
Flow-Adjusted Trend : Stable
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Nitrate-N mg/L
0
2
4
6
8
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Nitrate-N LInear Regression Plot
Standard or Screening Level



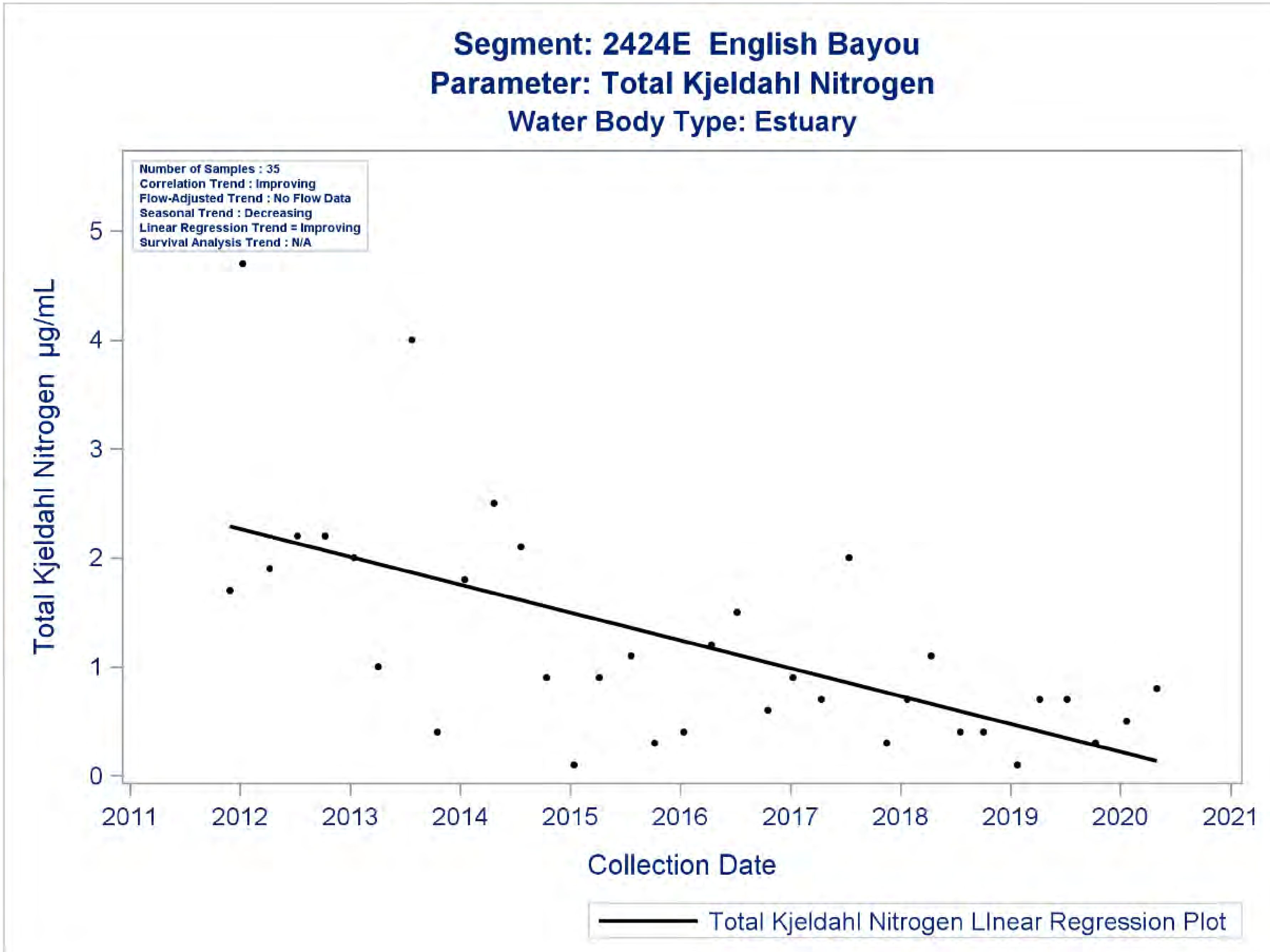
Segment: 2424B Lake Madeline
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 35
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot



Segment: 2424D Offatts Bayou
Parameter: Total Phosphorus
Water Body Type: Estuary
Number of Samples : 126
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Phosphorus mg/L
2.5
1.5
1
0.5
0.07
0.01
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Phosphorus LOESS Plot
Standard or Screening Level



Segment: 2424E English Bayou
Parameter: Enterococci
Water Body Type: Estuary
Number of Samples : 60
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : Deteriorating
Enterococci MPN/100 mL
20000
10000
5000
2500
250
10
1
0.1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Enterococci LOESS Plot
Standard or Screening Level



Segment: 2424E English Bayou
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Estuary
Number of Samples : 35
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
0
1
2
3
4
5
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Collection Date
Total Kjeldahl Nitrogen LInear Regression Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria **Bacteria in Oyster Waters**	2424A_02 I 2424A_03 I 2424A_04 I 2424A_05 I 2424C_01 I 2424G_01 I 2424OW_02 I	• Animal waste from agricultural production, ranches, hobby farms, and riding stables • Urbanization and increased impervious cover • Constructed stormwater controls failing • Bird rookeries on islands throughout the bay and along the shoreline • Improper disposal of waste from boats • Developments with malfunctioning OSSFs • Improper or no pet waste disposal • Waste haulers illegal discharges/improper disposal • Direct and dry weather discharges • Poorly operated or undersized WWTFs, WWTF non-compliance, overflows, and collection system by-passes	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Implement stream fencing or alternative water supplies to keep livestock out of or away from waterways • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or conserve vegetative buffer areas along all waterways • Improve compliance and enforcement of existing stormwater quality permits • Improve construction oversight to minimize TSS discharges to waterways • Add water quality features to stormwater systems • More public education on proper boat waste disposal • More public education regarding OSSF operations and maintenance • Ensure proper citing of new or replacement OSSFs • More public education on pet waste disposal • Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations
Low Dissolved Oxygen Concentrations	***24-Hour Avg*** 2424A_05 I 2424C_01 C ***24-Hour Min*** 2424A_02 C 2424A_05 I 2424C_01 I ***DO Grab Min***	▪ Excessive nutrients and organic matter from agricultural production, and related activities ▪ Excessive nutrients and organic matter from WWTF effluent, SSOs, malfunctioning OSSFs, illegal disposal of grease trap waste, and biodegradable solid waste (e.g., grass clippings and pet waste) ▪ Vegetative canopy removed	• Detrimental effect on aquatic biological community	• Create and implement Water Quality Management Plans for individual agricultural properties • Improve compliance and enforcement of existing stormwater quality permits • Install and/or maintain riparian buffer areas between agricultural fields and waterways • More public education regarding OSSF operation and maintenance

	2424A_04 I 2424B_01 I ***<u>DO Grab Screening Level</u>*** 2424A_03 C 2424A_04 C 2424B_01 C			• More public education regarding disposal of household fats, oils, and grease • Improve operation and maintenance of existing WWTF and collection systems • Regionalize chronically non-compliant WWTFs • More public education on pet waste disposal • Work with drainage districts and agencies to change practices of clear cutting and channelizing waterways to protect from solar heating
Elevated Nutrient Concentrations	***<u>Ammonia</u>*** 2423B_01 C 2424D_02 C ***<u>Phosphorus</u>*** 2424B_01 C 2424D_02 C 2424E_01 C	• WWTF effluent, sanitary sewer overflows, and malfunctioning OSSFs • Fertilizer runoff from urbanized properties, such as landscaped areas, residential lawns, and sport fields • Agricultural runoff from row crops, fallow fields pastures, and animal operations	• Detrimental effect on aquatic biological community • Can increase algal production • Algal growth can affect dissolved oxygen concentrations, which can be detrimental to the aquatic biological community	• Improve operation and maintenance of existing WWTF and collection systems • Improve compliance and enforcement of existing stormwater quality permit • Expand use of LID and green infrastructure practices • Create and implement Water Quality Management Plans for individual agricultural properties • Install and/or maintain riparian buffer areas between agricultural fields and waterways • Monitor phosphorus levels at WWTFs to determine if controls are needed.
Elevated Chlorophyll -*a* Concentrations	2424A_02 C 2424A_03 C 2424A_05 C 2424B_01 C 2424D_02 C	• Fertilizer runoff from surrounding watershed promote algal growth in waterways • Nutrient loading from WWTPs effluent, sanitary sewer overflows, and malfunctioning OSSFs promote algal growth	• Decrease in water clarity • Can cause swings in dissolved oxygen due to photosynthesis	• Improve compliance and enforcement of existing storm water quality permits. • Improve storm water controls in new developments • Support/continue/initiate public education regarding nutrients and consequences • Reduce or manage fertilizer runoff from agricultural areas
Dioxin/PCBs in Fish Tissue	2424_01 I 2424_02 I 2424A_01 I 2424A_02 I 2424A_03 I	• Waste pit located along the San Jacinto River immediately upstream of I-10 bridge is now a National Priority List Superfund site managed by EPA	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health	• Continue to monitor and assess to determine impairment status • Encourage EPA and responsible parties to work together to remediate Superfund site

	2424A_04 I 2424A_05 I 2424D_01 I 2424D_02 I 2424D_03 I	• Concentrated deposits outside boundaries of the waste pits • Unknown industrial or urban sources	(https://dshs.texas.gov/seafood/MapsPDF/AdvisoryMaps/GalvestonBay-EstuaryMap-2.pdf)	• Remove or contain contamination from locations already identified • Encourage additional testing to locate all unknown sources/deposits

Special Studies:

A portion of the West Galveston Bay watershed, including Highland Bayou, Marchand Bayou, and Moses Bayou are included in the Highland Bayou WPP. The WPP is under development with the latest draft being completed in February 2021. For more information, please visit the following URL: https://agrilife.org/highlandbayou/. TX AgriLife is also working in Galveston and Brazoria counties to assist implementation of watershed-based plans.

West Galveston Bay was included in the San Jacinto-Brazos Coastal Basin Bacteria Reduction Project. The characterization report for this project was completed in 2017. For more information, please visit the following URL: https://www.h-gac.com/watershed-based-plans/san-jacinto-brazos-coastal-basin-tmdl-and-implementation-plan.

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs. This segment was also included in the Oyster Waters I-Plan for bacteria (approved in 2015).

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand the use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal
- Continue to work with the Galveston Bay Estuary Program regarding dioxin and PCB contamination.

BASIN 25 (Gulf of Mexico)

Gulf of Mexico and Adjacent Waterways

2442 – Cedar Lakes

2441A – Live Oak Bayou

2441 – East Matagorda Bay

2501 – Gulf of Mexico

Segment Number: 2442 Name: Cedar Lakes

Area:	6.7 square miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life; Oyster Waters

Number of Active Monitoring Stations:	0	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	7

DESCRIPTION

- Segment 2442: **Cedar Lakes** is located down the coast from and southwest of the San Bernard River, the Cedar Lakes lie between the Gulf Intercoastal Waterway on the north and a barrier island and the Gulf of Mexico to the southeast.

- Segment 2442OW: Oyster Waters

There are no active monitoring stations in Segment 2442.

Segment 2442 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43		

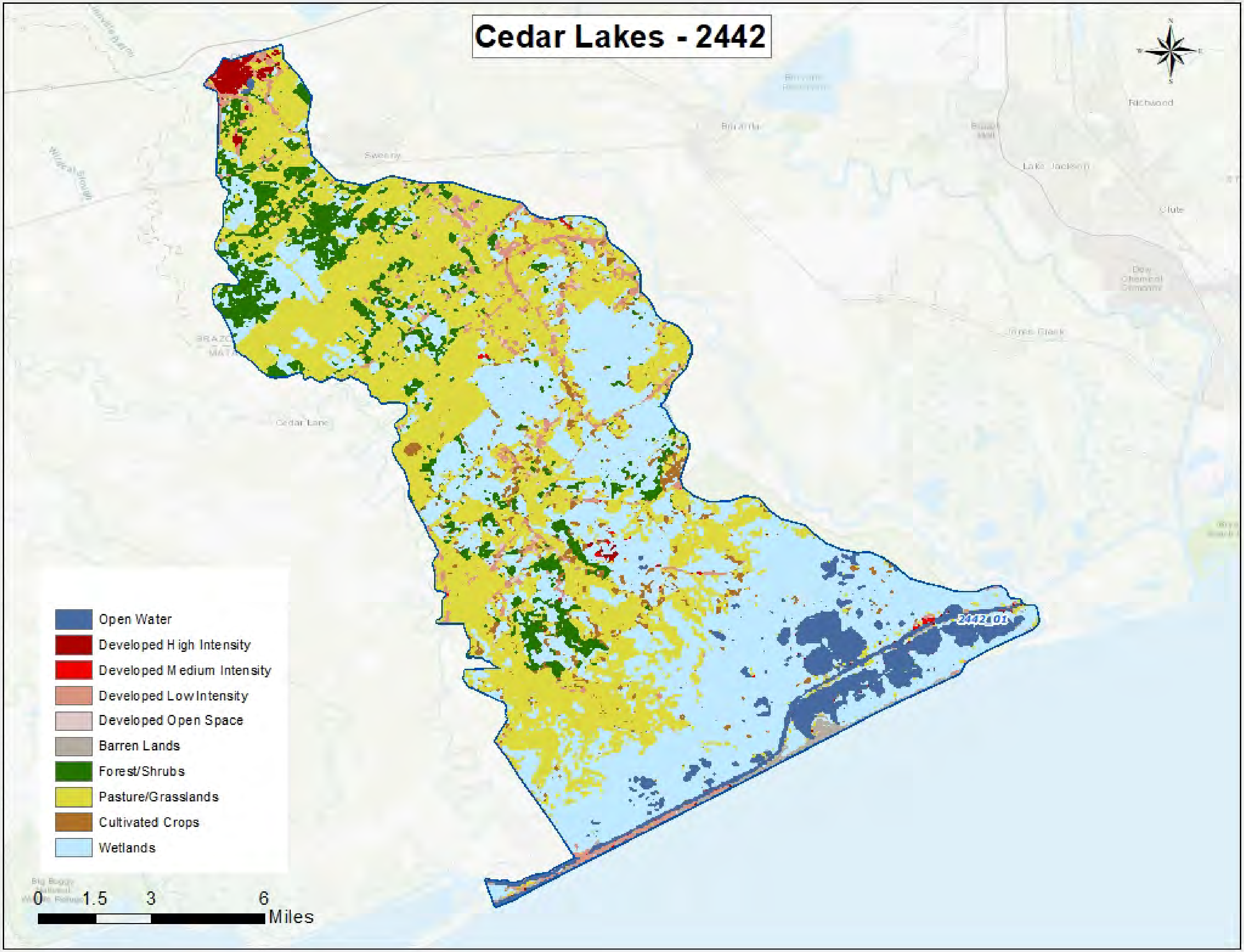
Segment Discussion

Watershed Characteristics and Land Cover: Cedar Lake Creek begins in northwest Brazoria County. It flows southeasterly into Cedar Lakes (Segment 2442) and ultimately to the Gulf of Mexico. The San Bernard Wildlife Refuge is adjacent to the creek.

The primary land cover types in this watershed are Wetlands (42.82 percent) and Agriculture (39.11 percent), consisting of pasture/grassland and cultivated crops. Between 2008 and 2018, Forest/Shrubs land cover has increased by 78.7 percent, from approximately 4,189 acres (4.23 percent) to 7,486 acres (7.55%) percent). Developed land cover has increased 204.6 percent, from 1,513 acres (1.53 percent) to 4,610 acres (4.65 percent). Wetlands have decreased by 29.39 percent, from 60,096 acres (60.64 percent) in 2008 to 42,432 acres (42.82 percent) in 2018.

Segment 2441A Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	25,907.52	26.14	38,755.53	39.11	49.59
Barren Lands	1,158.01	1.17	665.41	0.67	-42.54
Developed	1,513.40	1.53	4,610.04	4.65	204.61
Forest/Shrubs	4,189.26	4.23	7,486.28	7.55	78.70
Open Water	6,231.97	6.29	5,152.46	5.20	-17.32
Wetlands	60,095.93	60.64	42,431.95	42.82	-29.39
TOTAL	**99,096.10**	**100.00**	**99,101.65**	**100.00**	


Cedar Lakes - 2442
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1.5 3 6
Miles
2442_01

Water Quality Issues:

AU 2442OW (Oyster Waters) was not assessed for the 2020 Integrated Report. However, AU 2442OW_01 was cited in the 2020 Texas Integrated Report as being on the Department of State Health Services (DSHS) Shellfish Restrictions map from 12/01/2011 through 11/20/2018.

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

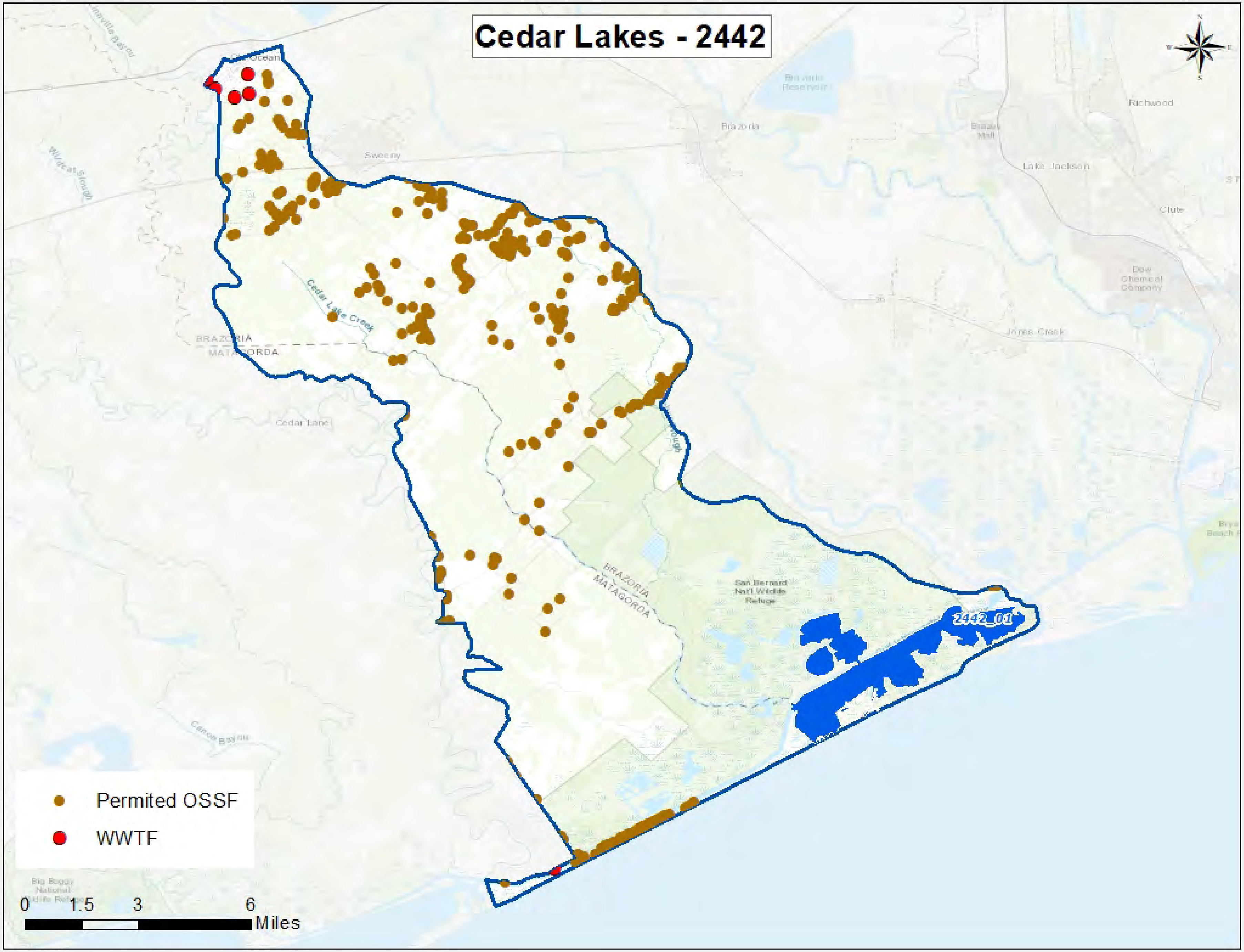
PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Potential Sources of Water Quality Issues: Although there are no bacteria or nutrient concerns in Cedar Lakes, there are potential sources of fecal indicator bacteria and nutrients in the watershed, including both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 5 permitted wastewater outfalls in the Cedar Lakes watershed. In most areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 368 permitted on-site sewage facilities within the watershed. The wastewater treatment facilities and on-site sewage facilities in the Cedar Lakes watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were no sanitary sewer overflows reported in the sewer collection systems.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Cedar Lakes watershed.



Cedar Lakes - 2442
Permited OSSF
WWTF
0 1.5 3 6
Miles
2442_01
Cedar Lake Creek
BRAZORIA
MATAGORDA
San Bernard Nat'l Wildlife Refuge
Brazoria
Sweeny
Richwood
Lake Jackson
Clute
Jones Creek
Cedar Lane
Dow Chemical Company

Trend Analysis:

Water quality trends for the watershed of Cedar Lakes (segment 2442) were not evaluated due to insufficient data. No routine water quality data was collected from these water bodies during the period of record for this report.

Water Quality Issues Summary				
Issue	Affected Area (2020 Assessment) *I = Impairment* *C = Concern*	Possible Causes/Influences / Concerns Voiced by Stakeholders	Possible Effects	Possible Solutions / Actions To Be Taken
This segment was not assessed for the 2020 Integrated Report.				

Special Studies:

There are no ongoing projects in this watershed.

Recommendations:

- Collect and expand water quality monitoring data to assess segment and support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal.

Segment Number: 2441A Name: Live Oak Bayou

Area:	250.6 square miles	**Length:**	36.3 miles	**Designated Uses:**	Primary Contact Recreation 1; High Aquatic Life
Number of Active Monitoring Stations:	0	**Texas Stream Team Monitoring Stations:**	0	**Permitted WWTF Outfalls:**	5

DESCRIPTION

- Segment 2441A: **Live Oak Bayou** (Unclassified water body) flows into the northeast section of the lake and east of Big Boggy National Wildlife Refuge.

There are no active monitoring stations in Segment 2441A.

Segment 2441A Water Quality Standards and Screening Levels

Standards	Tidal Stream	Screening Levels	Tidal Stream
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43		

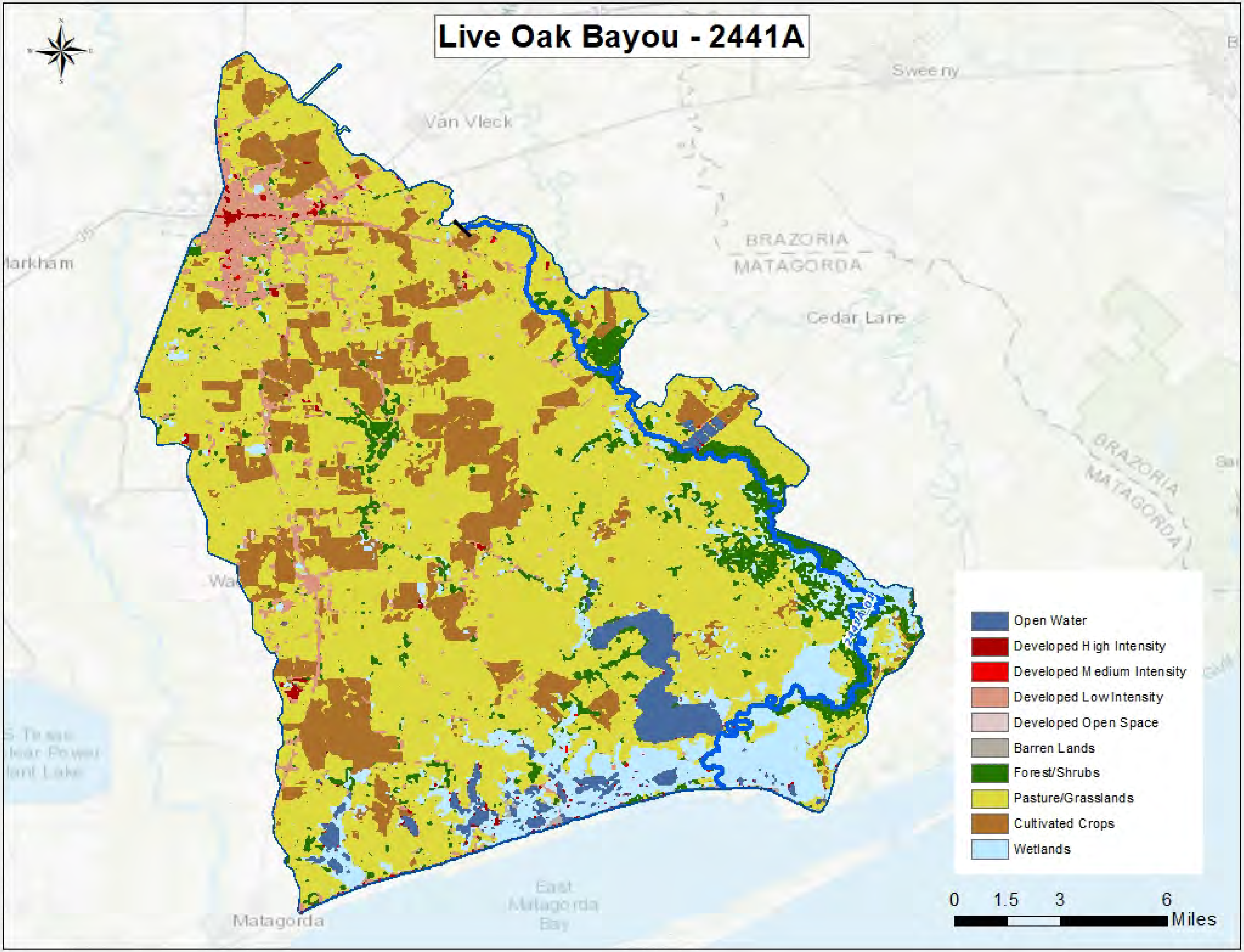
Segment Discussion

Watershed Characteristics and Land Cover: The intermittent headwaters of Live Oak Bayou (Segment 2441A) begin in Bay Prairie east of Bay City in eastern Matagorda County. The bayou flows southeast for nineteen miles, crossing the Gulf Intercoastal Waterway, before emptying into Live Oak Bay, which is part of East Matagorda Bay.

Agriculture, consisting of pasture/grassland and cultivated crops, is the primary land cover type in this watershed (75.16 percent). Between 2008 and 2018, Forest/Shrubs land cover has increased by 756 percent, from approximately 1,175 acres (0.73 percent) to 10,067 acres (6.28 percent). Developed land cover has increased 45.6 percent, from 6,092 acres (3.80 percent) to 8,868 acres (5.53 percent). Wetlands have decreased by 59.94 percent, from 38,667 acres (24.11 percent) in 2008 to 15,645 acres (9.76 percent) in 2018.

Segment 2441A Land Cover

Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	108,549.90	67.69	120,523.46	75.16	11.03
Barren Lands	885.58	0.55	227.07	0.14	-74.36
Developed	6,092.30	3.80	8,868.02	5.53	45.56
Forest/Shrubs	1,175.36	0.73	10,066.73	6.28	756.48
Open Water	4,987.44	3.11	5,029.70	3.14	0.84
Wetlands	38,667.24	24.11	15,645.08	9.76	-59.54
TOTAL	**160,357.83**	**100.00**	**160,360.05**	**100.00**	


Live Oak Bayou - 2441A
Sweeny
Van Vleck
BRAZORIA
MATAGORDA
Cedar Lane
BRAZORIA
MATAGORDA
Matagorda
East
Matagorda
Bay
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0
1.5
3
6
Miles

Water Quality Issues:

This unclassified segment was not assessed for the 2020 Integrated Report.

Bacteria Impairments or Concerns
There are no bacteria impairments in this segment.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

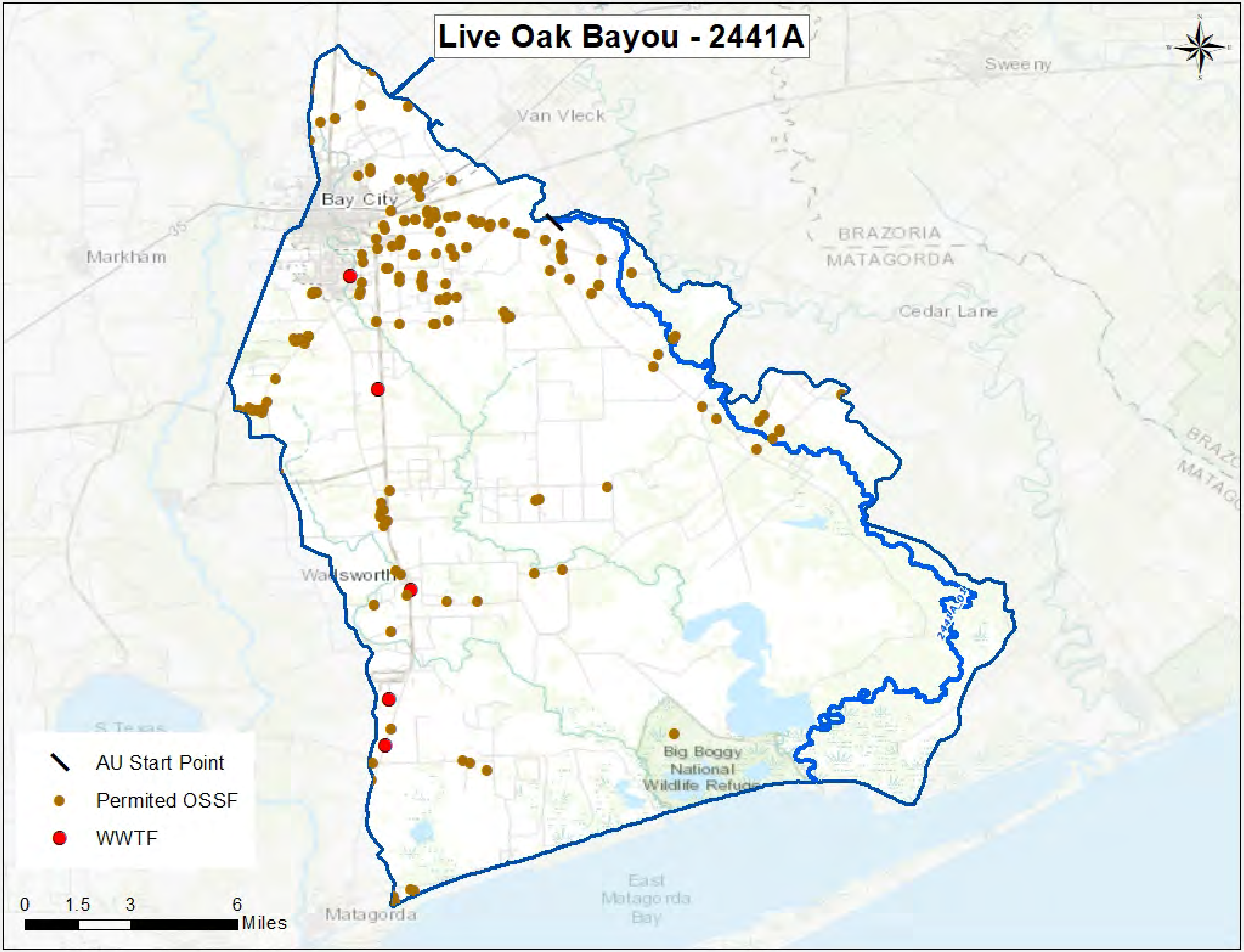
PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Potential Sources of Water Quality Issues: Although there are not impairments or concerns for bacteria or nutrients in Live Oak Bayou, there are potential sources of fecal indicator bacteria and nutrients in the sub-watershed, including both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There are 5 permitted wastewater outfalls in the Live Oak Bayou sub-watershed. In some areas of the sub-watershed, on-site sewage facilities are the primary source of wastewater disposal, with 159 permitted on-site sewage facilities in the area. The wastewater treatment facilities and on-site sewage facilities in the Live Oak Bayou sub-watershed are shown in the accompanying map.

For the period of 2010 – 2019, there were a total of 11 sanitary sewer overflows reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Live Oak Bayou sub-watershed.



Live Oak Bayou - 2441A
Sweeny
Van Vleck
Bay City
Markham
BRAZORIA
MATAGORDA
Cedar Lane
BRAZO
MATAGO
Wadsworth
2441A_01
Big Boggy
National
Wildlife Refuge
East
Matagorda
Bay
Matagorda
S Texas
AU Start Point
Permited OSSF
WWTF
0
1.5
3
6
Miles

Trend Analysis:

Water quality trends for the watershed of Live Oak Bayou (segment 2441A) were not evaluated due to insufficient data. No routine water quality data was collected from these water bodies during the period of record for this report.

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
This segment was not assessed for the 2020 Integrated Report.				

Special Studies:

Live Oak Bayou has been added to the review for the Basin 13 Characterization Report for the Colorado Coastal Basin, though there is limited data available to complete an assessment.

Texas Water Resource Institute will be working with Matagorda County to address agriculture, stormwater and OSSF education. The Texas State Soil and Water Coordination Board hired a resource technician to expand the use of agriculture water quality management plans in Matagorda County. The Tres Palacios WPP was approved in 2018 for a watershed near to this segment, and many of the same stakeholders will be involved with this segment.

Recommendations:

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- Collect and expand water quality monitoring data to assess the segment and support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities

- Expand the use of LID and green infrastructure practices
- 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
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 2441	Name: East Matagorda Bay
Area: 55.7 square miles	**Designated Uses:** Primary Contact Recreation 1; Exceptional Aquatic Life; Oyster Waters

Number of Active Monitoring Stations:	Texas Stream Team Monitoring Stations:	Permitted WWTF Outfalls:
1	0	1

DESCRIPTION

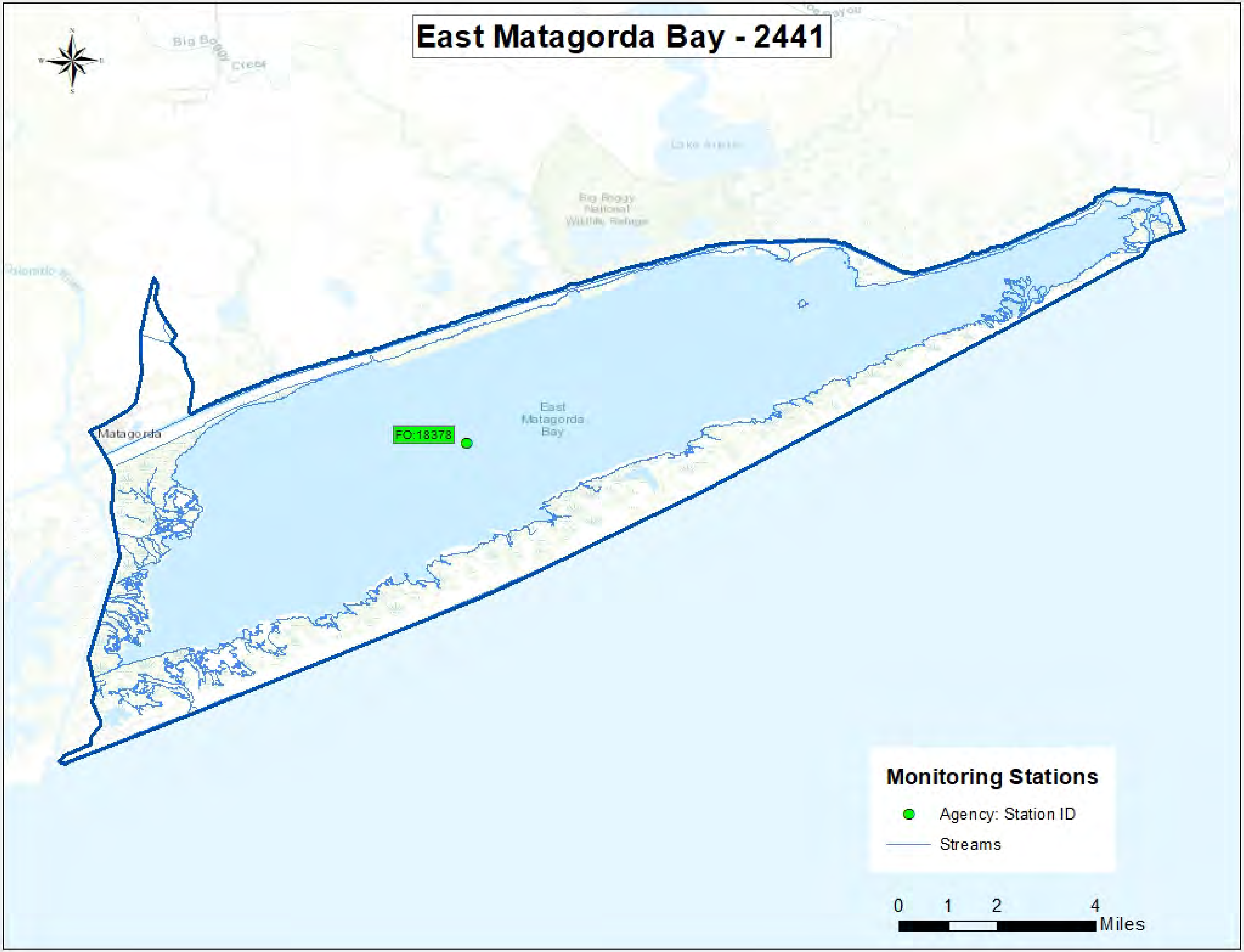
- Segment 2441: **East Matagorda Bay** located in Matagorda County and east of the Colorado River channel which flows to the Gulf of Mexico; it stretches to the east where the bay receives flow from Live Oak Bayou then meets Caney Creek which also flows to the Gulf of Mexico. Bordered by Intercoastal Waterway on the north along with Big Boggy National Wildlife Refuge. A barrier island is located on the Gulf of Mexico side of the bay.

- Segment 2441OW (Oyster Waters)

FY 2021 Active Routine Monitoring Stations

Station ID	Segment ID	Site Description	Monitoring Entity	Frequency	Parameter Groups
18378	2441	EAST MATAGORDA BAY 2.60 KM SOUTH AND 2.75 KM EAST OF OLD GULF CUT AND APPROXIMATELY 5.84 KM SSW OF BOGGY BAYOU CUT	FO	Quarterly One/Year	Field, Conventional, Bacteria Metals in Sediment, Organics in Sediment

FO = TCEQ Regional Office


East Matagorda Bay - 2441
Big Boggy Creek
Lake Austin
Big Boggy National Wildlife Refuge
Matagorda
FO:18378
East Matagorda Bay
Monitoring Stations
Agency: Station ID
Streams
0 1 2 4
Miles

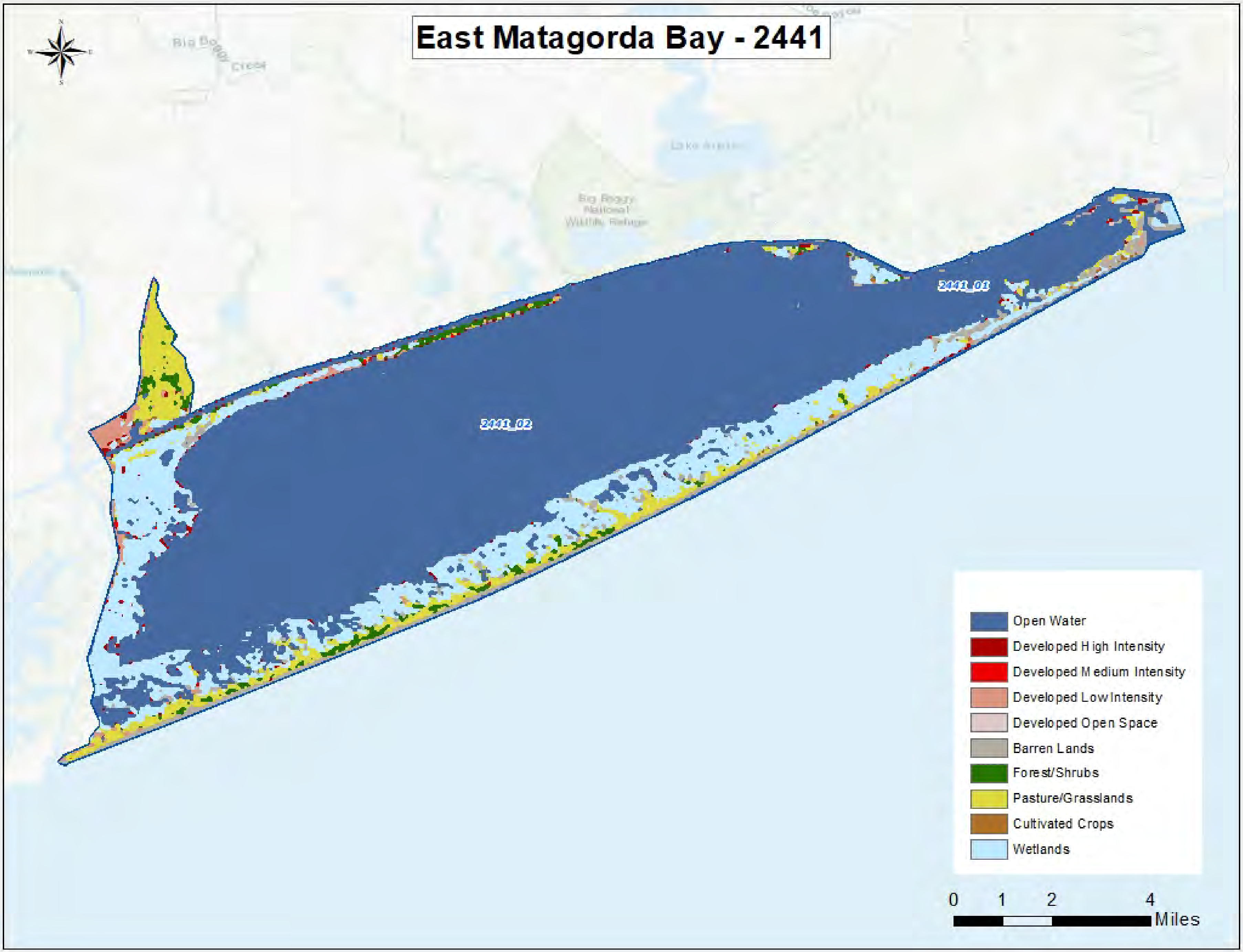
Segment 2441 Water Quality Standards and Screening Levels			
Standards	**Bays & Estuaries**	**Screening Levels**	**Bays & Estuaries**
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	5.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	4.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		
Fecal Coliform in Oyster Waters (CFU/100mL) (median/grab):	14/43		

Segment Discussion

Watershed Characteristics and Land Cover: East Matagorda Bay (Segment 2441) is a minor estuary and coastal marshland located along the coast in Matagorda County. The bay is enclosed by the Matagorda Peninsula and the tidal flats at the mouth of the Colorado River. There are no sources of river inflow into the bay. It receives freshwater inflow from runoff from surrounding coastal watersheds. This watershed is home to numerous species of marine and freshwater fish.

The primary land cover types in this watershed are Open Water (72.24 percent) and Wetlands (15.86 percent). Between 2008 and 2018, Agriculture land cover has increased by 388 percent, from approximately 575 acres (1.05 percent) to 2804 acres (5.11 percent). Developed land cover has increased 256 percent, from 335 acres (0.61 percent) to 1,192 acres (2.17 percent).

Segment 2441 Land Cover					
Land Cover Class Name	Area Acres 2008	Area % 2008	Area Acres 2018	Area % 2018	% Change
Agriculture	574.67	1.05	2,804.41	5.11	388.00
Barren Lands	3,131.77	5.70	1,734.68	3.16	-44.61
Developed	334.93	0.61	1,192.04	2.17	255.91
Forest/Shrubs	0.00	0.00	803.96	1.46	N/A
Open Water	40,633.21	73.97	39,679.14	72.24	-2.35
Wetlands	10,254.21	18.67	8,713.01	15.86	-15.03
TOTAL	**54,928.80**	**100.00**	**54,927.24**	**100.00**	


East Matagorda Bay - 2441
2441_01
2441_02
Open Water
Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Barren Lands
Forest/Shrubs
Pasture/Grasslands
Cultivated Crops
Wetlands
0 1 2 4
Miles

Water Quality Issues:

Bacteria Impairments and Concerns
East Matagorda Bay is fully supporting its designated use of Primary Contact Recreation 1. Of the 24 samples from 12/01/11 – 11/30/18 evaluated for the 2020 Texas Integrated Report (2441_02), only one sample exceeded the single sample criteria of 130 cfu/100 mL for enterococci. The result for this sample was 16,000 cfu/100 mL.

AU 2441OW_01, which includes the Caney Creek arm and the western shoreline area, is listed as non-supporting for its designated Oyster Waters use due to elevated bacteria. AU 2441OW_02, which includes the remainder of the bay, is fully supporting for its designated Oyster Waters use.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no concerns listed for nutrients for this segment in the 2020 Texas Integrated Report. For the period of 12/01/11 – 11/30/18, two values exceeded the nutrient screening level of ammonia, one sample exceeded for chlorophyll-a, and two samples exceeded for total phosphorus at 2441_02.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

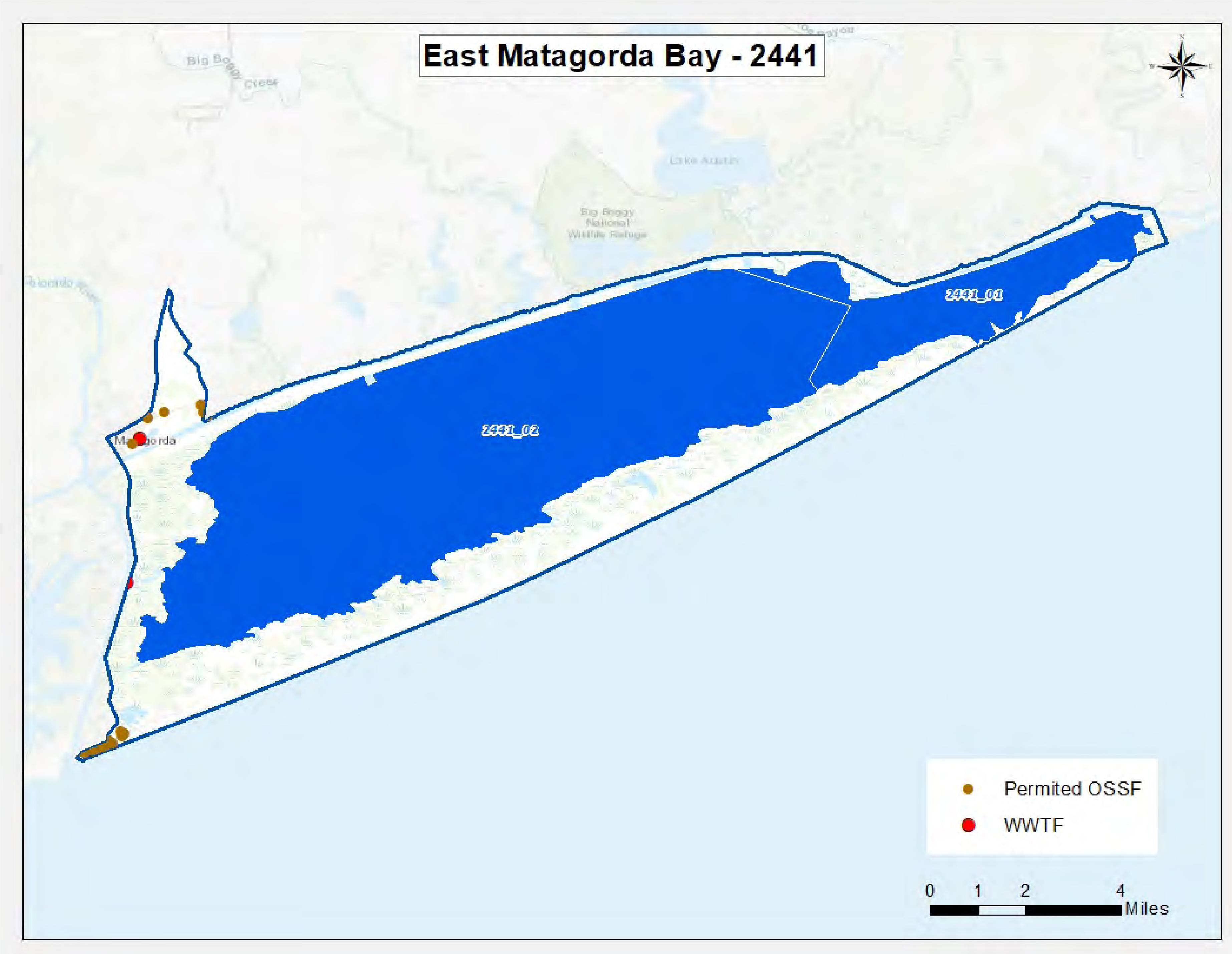
Potential Sources of Water Quality Issues:

Potential sources of fecal indicator bacteria and nutrients in the East Matagorda Bay watershed include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, and animal waste.

There is 1 permitted wastewater outfalls in the East Matagorda Bay watershed. In some areas of the watershed, on-site sewage facilities are the primary source of wastewater disposal. There are 20 permitted on-site sewage facilities in the watershed. The wastewater treatment facilities and on-site sewage facilities in the East Matagorda Bay watershed are shown in the accompanying map.

For the period of 2010 – 2019, there was 1 sanitary sewer overflow reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the East Matagorda Bay watershed.

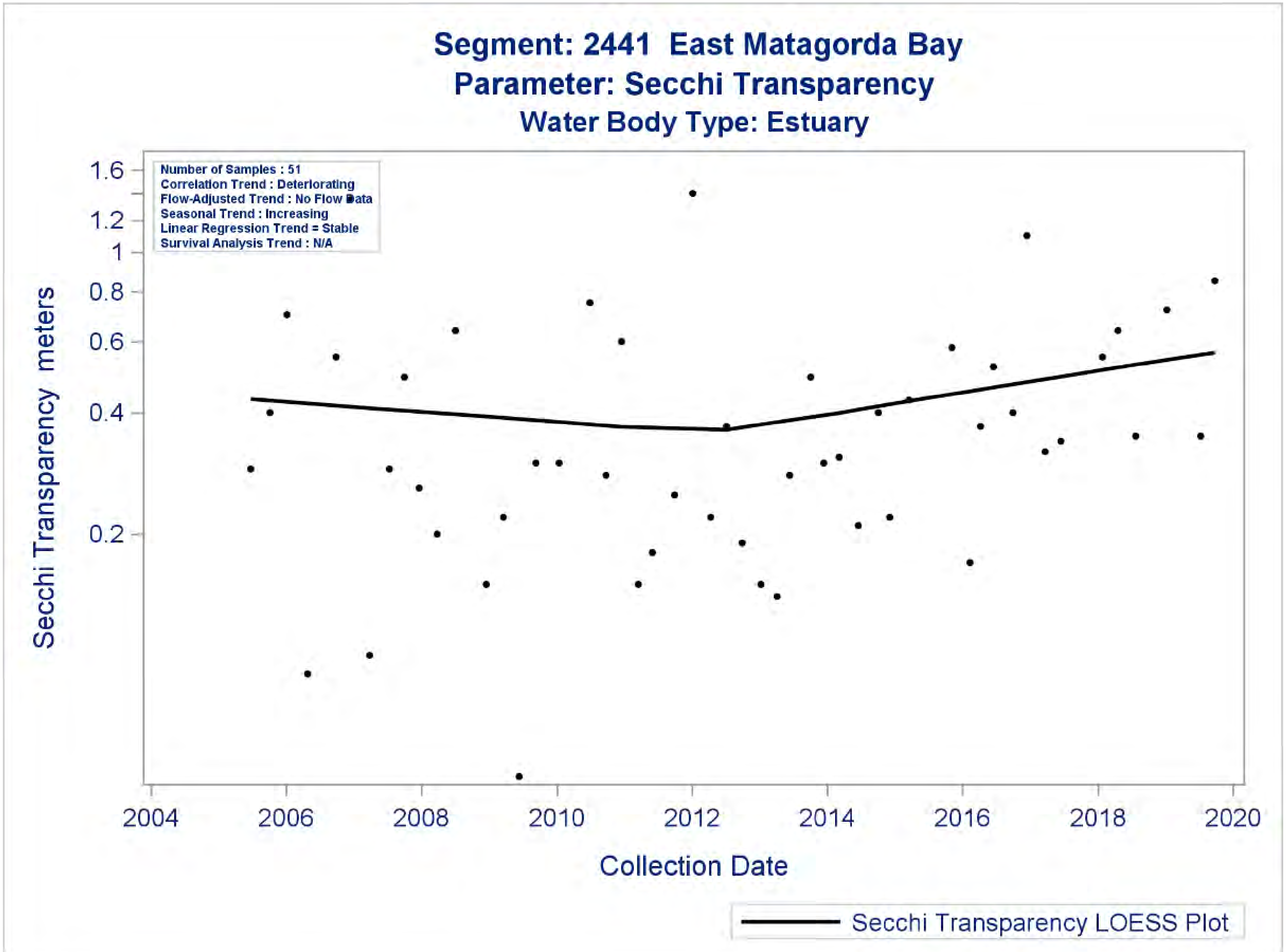


East Matagorda Bay - 2441
Big Boggy Creek
Lake Austin
Big Boggy National Wildlife Refuge
2441_01
2441_02
Matagorda
Permited OSSF
WWTF
0 1 2 4
Miles

Trend Analysis:

There were no parameters analyzed for East Matagorda Bay (segment 2441) that included a trend in both the LOESS correlation analysis and the linear regression analysis. The only parameter to display a LOESS correlation trend was Secchi transparency which was deteriorating (Secchi depths were increasing). Generally, this increasing trend would indicate the water was becoming less turbid but there is no related trend of any kind found in the TSS data.

The 2020 Texas Integrated Report also lists this segment as having a concern for bacteria in oyster waters. Analysis for this segment detected no trend in the enterococci bacteria data. Only one sample exceeded the single sample criteria of 130 MPN/100 mL for enterococci.



Segment: 2441 East Matagorda Bay
Parameter: Secchi Transparency
Water Body Type: Estuary
Number of Samples : 51
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Stable
Survival Analysis Trend : N/A
1.6
1.2
1
0.8
0.6
0.4
0.2
Secchi Transparency meters
2004
2006
2008
2010
2012
2014
2016
2018
2020
Collection Date
Secchi Transparency LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria in Oyster Waters	2441OW_01 I	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Constructed stormwater controls failing • Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Direct and dry weather discharges • Improper or no pet waste disposal • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses • Fecal bacteria and viruses can contaminate shellfish that are used for food consumption	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Improve compliance and enforcement of existing stormwater quality permits • Improve storm water controls in new developments by adding bacteria reduction measures • Improve construction oversight to minimize TSS discharges to waterways • More public education on pet waste disposal • Promote and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing and alternative water supplies to keep livestock out of or away from waterways

Special Studies:

No special studies are currently ongoing in this watershed. The Texas Water Resource Institute will be working with Matagorda County to address agriculture, stormwater and OSSF education. The Texas State Soil and Water Coordination Board hired a resource technician to expand the use of agriculture water quality management plans in Matagorda County. The Tres Palacios WPP was approved in 2018 for a watershed near to this segment, and many of the same stakeholders will be involved with this segment.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, and grease
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

Segment Number: 2501		Name: Gulf of Mexico	
Miles of Beach Front:	145 miles	Designated Uses:	Primary Contact Recreation 1; High Aquatic Life

Number of Active Monitoring Stations:	0	Texas Stream Team Monitoring Stations:	0	Permitted WWTF Outfalls:	0

DESCRIPTION

This report addresses only a portion of the Gulf of Mexico along the upper Texas coast from the Jefferson-Chambers County Line south to the mouth of the San Bernard River below Freeport.

Assessment Unit	Area Description
AU 2501_02	Jefferson-Chambers County line area
AU 2501_03	Bolivar Point to San Luis Pass area
AU 2501_04	Freeport Area

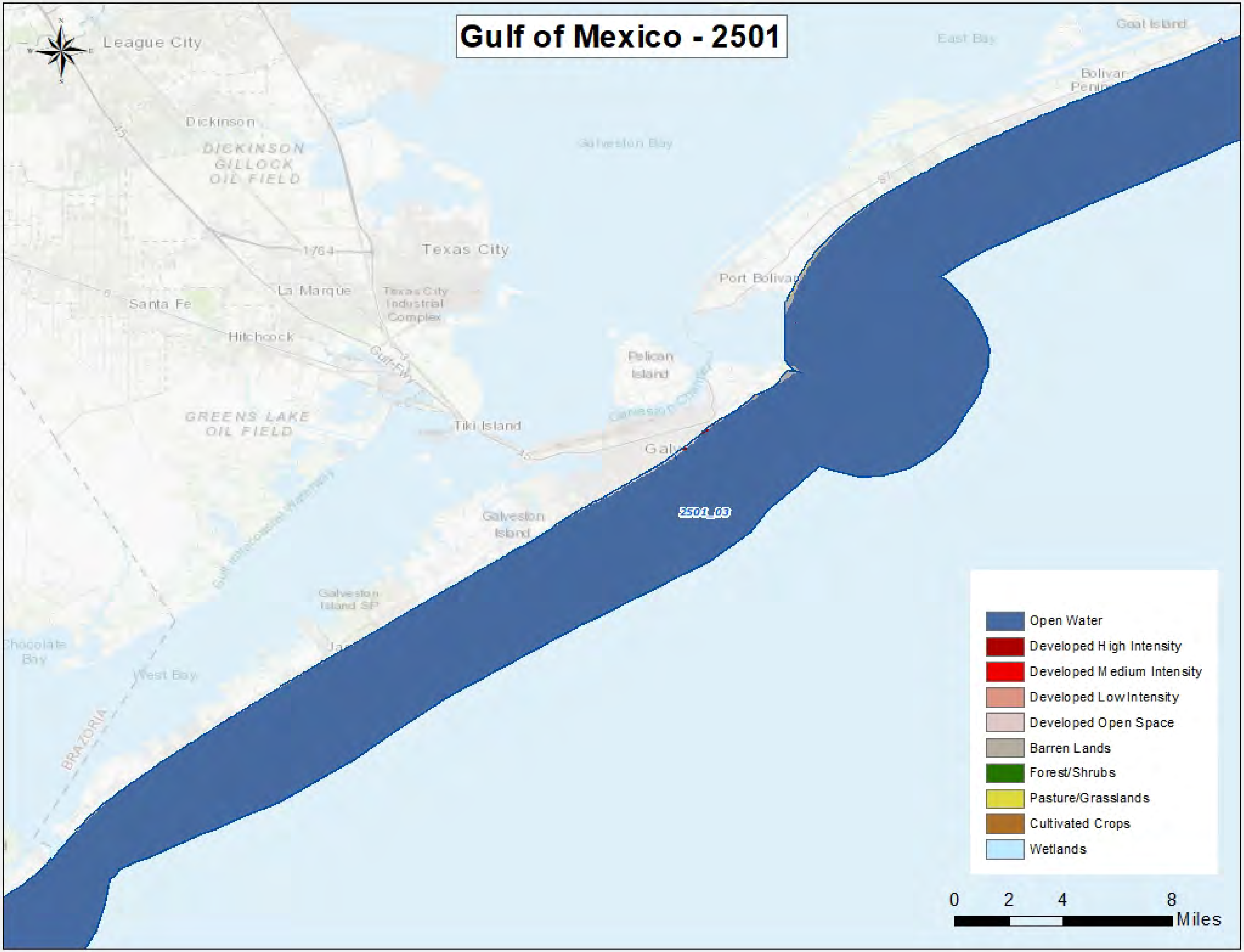
Segment 2501 Water Quality Standards and Screening Levels

Standards	Bays & Estuaries	Screening Levels	Bays & Estuaries
Temperature (°C/°F):	35 / 95	Ammonia-N (mg/L):	0.10
Dissolved Oxygen *(24-Hr Average)* (mg/L):	4.0	Nitrate-N (mg/L):	0.17
Dissolved Oxygen *(Absolute Minima)* (mg/L):	3.0	Orthophosphate Phosphorus (mg/L):	0.19
pH (standard units):	6.5-9.0	Total Phosphorus-P (mg/L):	0.21
Enterococci (MPN/100mL) (grab):	130	Chlorophyll *a* (µg/L):	11.6
Enterococci (MPN/100mL) (geometric mean):	35		

Segment Discussion

Watershed Characteristics: This segment includes the entire coastal area of the Upper Texas Gulf Coast including the counties of Chambers, Galveston, Brazoria and Matagorda. The part of the coast along Matagorda, Brazoria, and Chambers counties are less densely populated with mostly residential uses along the coast. Brazoria County has a few more densely populated areas – Freeport and Lake Jackson – upstream from the waterways that drain into the Gulf of Mexico. Galveston County has the most densely populated areas along the coast in this portion of the watershed. The entrance to the Galveston and Houston ship channels is between Galveston Island and Bolivar Peninsula and this area is used on a consistent basis by heavy boat and barge traffic. There are a number of heavy industrial sites along the Houston Ship Channel including Texas City, Bayport, and Morgan's Point. The entire stretch along the Gulf of Mexico is used for recreation.

Gulf of Mexico - 2501



Water Quality Issues:

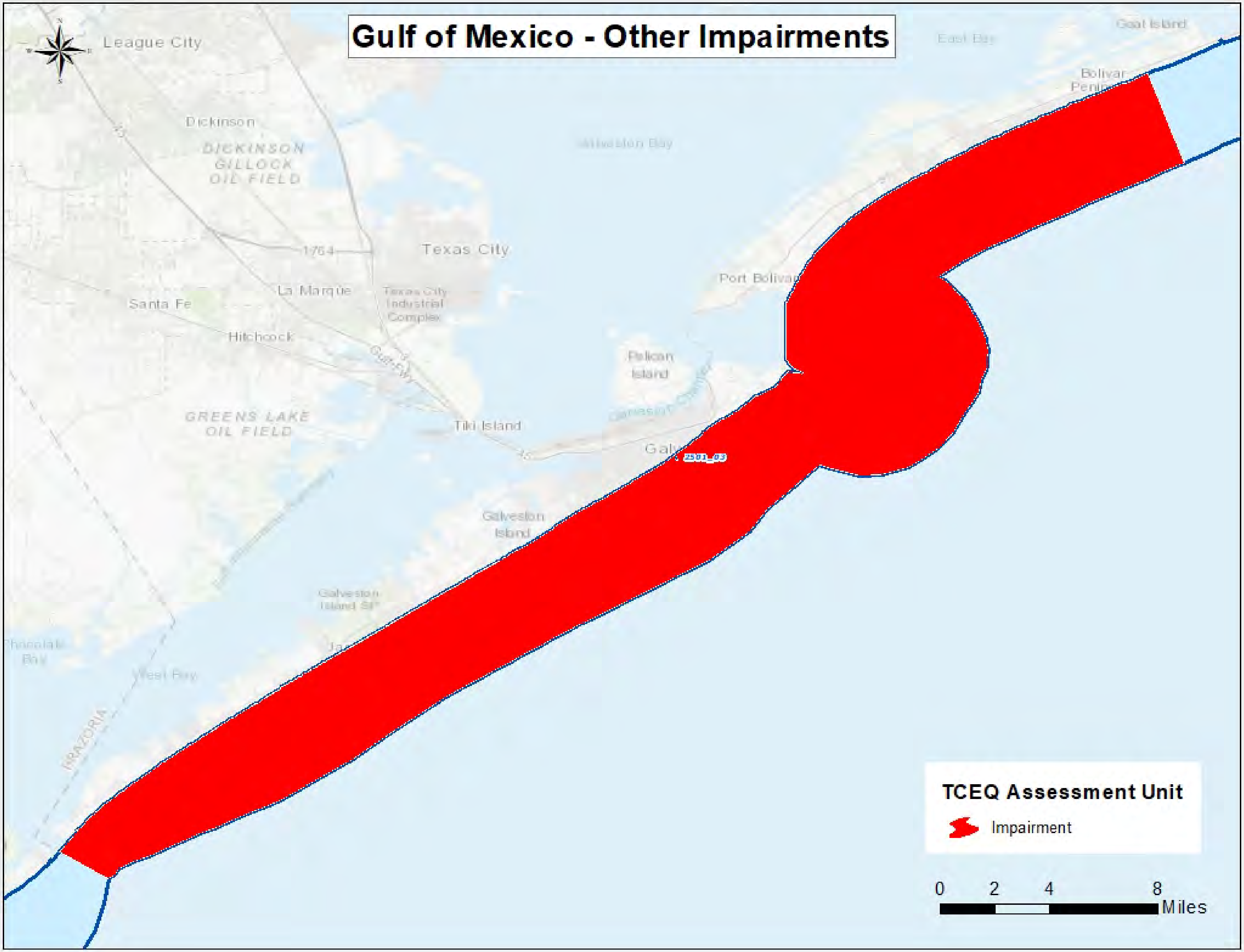
Bacteria Impairments and Concerns
The 2020 Integrated Report lists AU 2501_02 (Jefferson-Chambers County line area) as being impaired for contact recreation due to elevated levels of enterococci bacteria. The bacteria geometric mean was 142.34 MPN/100 mL, which exceeds the water quality standard of 35 MPN/100 mL. For bacteria grab samples, 12 of 27 samples (44.4 percent) exceeded the single grab criteria of 130 MPN/100 mL.

Dissolved Oxygen Impairments or Concerns
There are no dissolved oxygen impairments in this segment.

Nutrient Concerns
There are no nutrient concerns in this segment.

PCBs and Dioxins Impairments
There are no PCBs/Dioxins impairments in this segment.

Mercury in Edible Fish Tissue
All portions of segment 2501 along the upper Texas Gulf Coast, including those within the Houston-Galveston Area Council planning region (AU 2501_02 through AU 2501_04), are not supporting their fish consumption use. These assessment units are once again listed as impaired in the 2020 Integrated Reports for high levels of mercury found consistently in the edible tissue of fish. Due to the elevated level of mercury, the Texas Department of State Health Services issued a Limited Consumption Fish and Shellfish Advisory for this water body.



Gulf of Mexico - Other Impairments
League City
Dickinson
DICKINSON GILLOCK OIL FIELD
Texas City
La Marque
Texas City Industrial Complex
Santa Fe
Hitchcock
GREENS LAKE OIL FIELD
Tiki Island
Pelican Island
Port Bolivar
Bolivar Peninsula
Goat Island
East Bay
Galveston Bay
Galveston Island
Galveston Island SP
West Bay
BRAZORIA
2501_03
TCEQ Assessment Unit
Impairment
0 2 4 8
Miles

Potential Sources of Water Quality Issues: Potential sources of fecal indicator bacteria and nutrients in the Gulf of Mexico include both point source and nonpoint sources. These sources include wastewater treatment facility outfalls, sanitary sewer overflows, failing on-site sewage facilities, stormwater runoff, fertilizers, and animal waste.

There are no permitted wastewater outfalls discharging directly to this segment. However, effluent discharged into other water bodies throughout the region ultimately flow to the Gulf of Mexico. There are no on-site sewage facilities for this segment.

For the period of 2010 – 2019, there was 1 sanitary sewer overflow reported in the sewer collection systems. While this number of sanitary sewer overflows may not necessarily cause chronically high bacteria within this waterway, the number and volume of each discrete event may cause acute conditions that could affect public health. Sources of sanitary sewer overflows include aging wastewater infrastructure, mechanical failure, inflow and infiltration, and improper disposal of fats, oils, and grease.

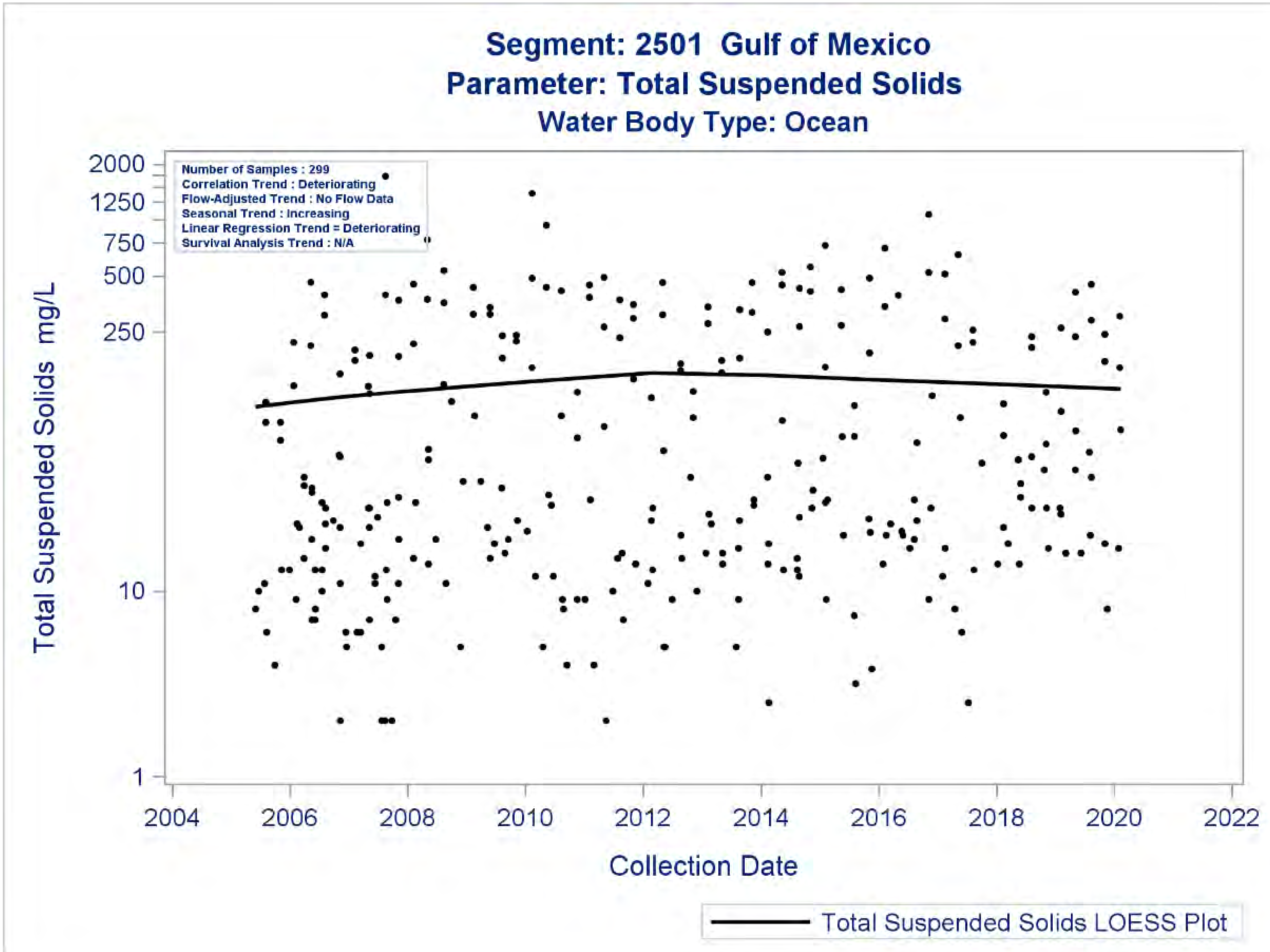
The source of mercury is unknown. Mercury typically enters water bodies through atmospheric deposition or through direct discharge of waste containing mercury. Possible industrial or urban sources include coal-fired power plants, coal and wood-fired industrial boilers, chlorine production, and offshore oil and gas drilling.

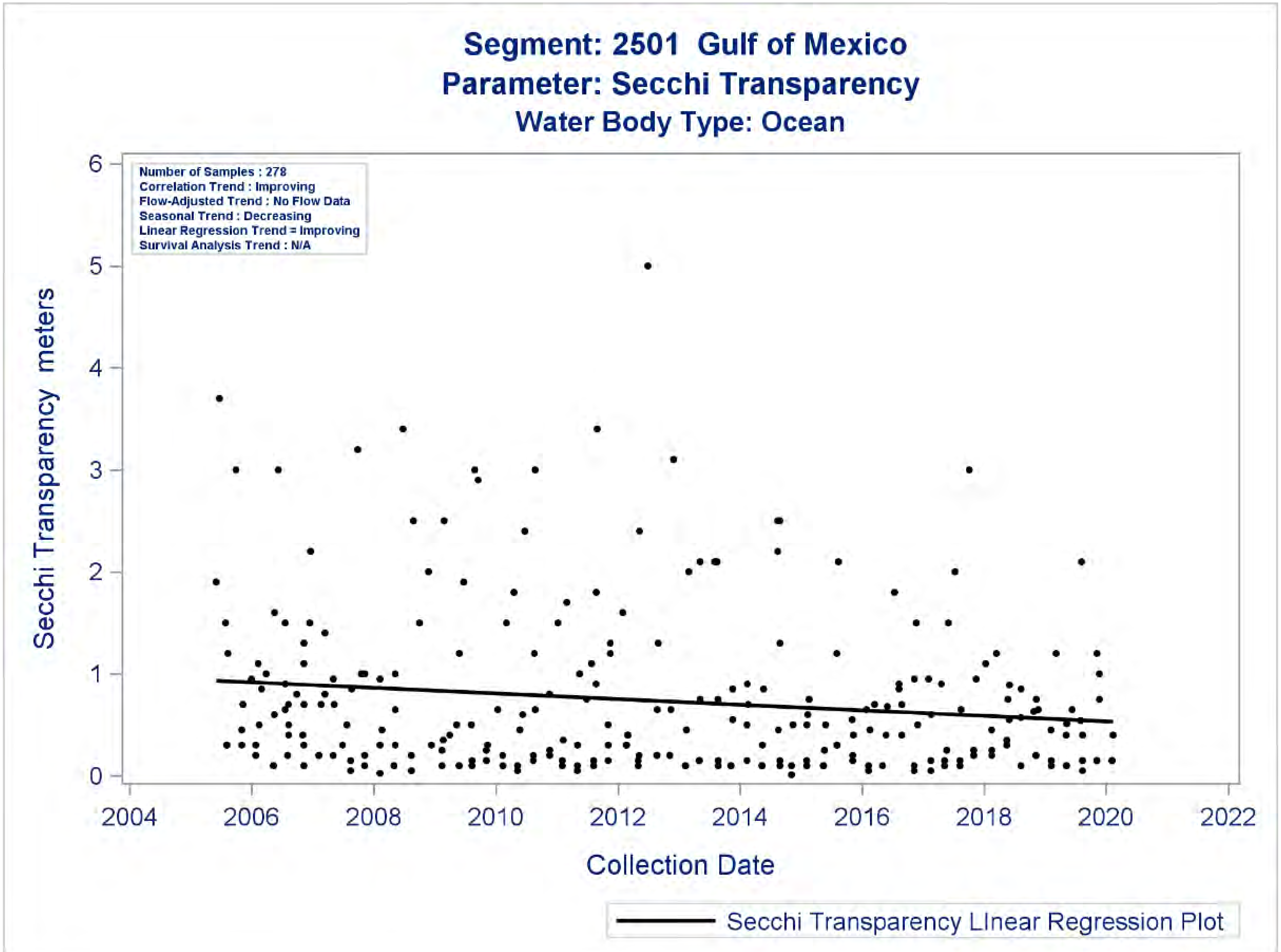
For more information on potential sources of water quality issues, please refer to the Water Quality Issues Summary table for the Gulf of Mexico watershed.

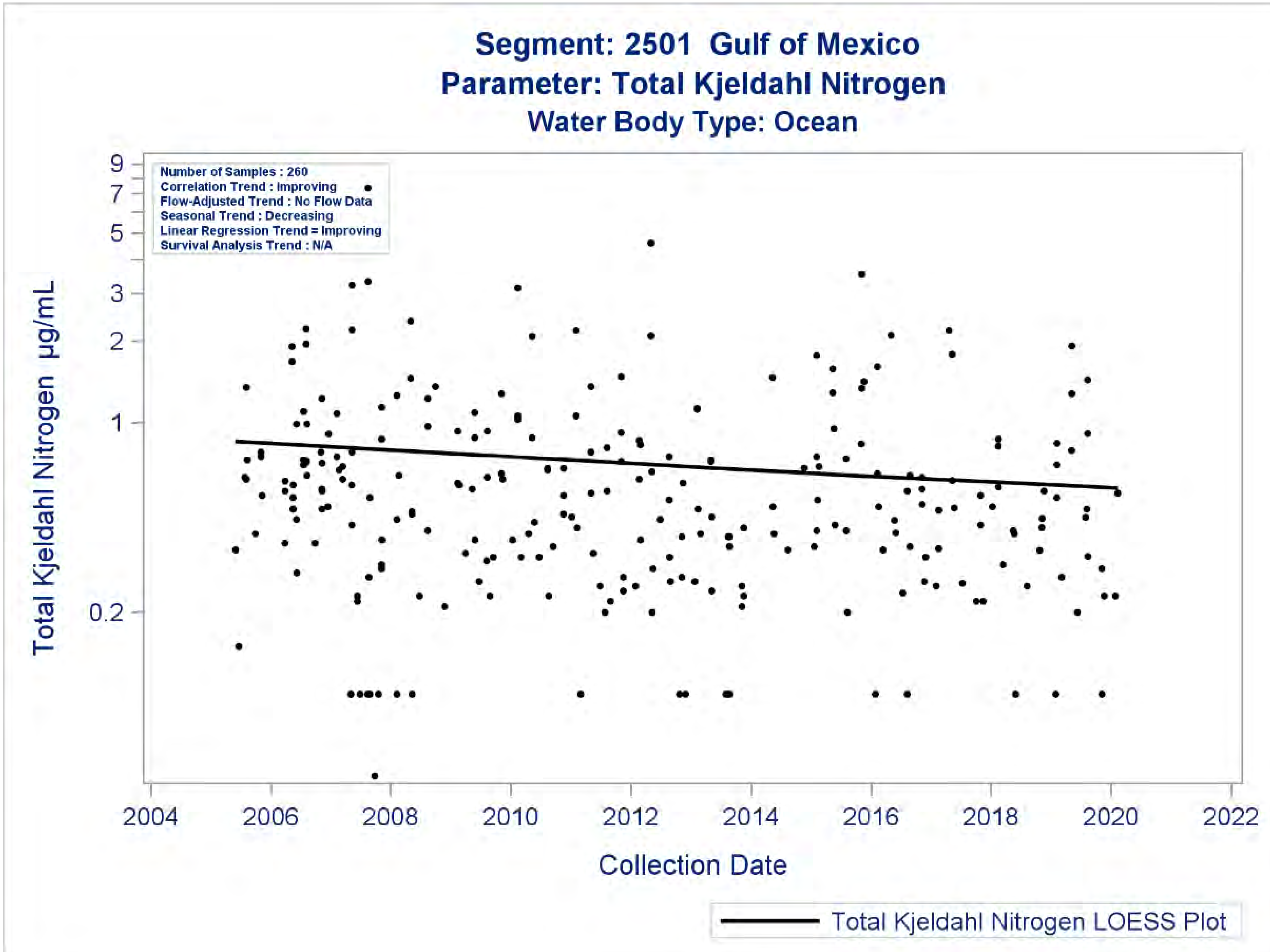
Trend Analysis:

Analysis of water quality data for the Gulf of Mexico identified four parameter trends including an increasing TSS trend and a decreasing trend for Secchi transparency. When there is a trend with the TSS data, there is frequently an inverse relationship to the Secchi transparency data. Where sediment loads are increasing the Secchi transparency depth is decreasing. Decreasing trends are typically categorized as ‘improving’ trends, as seen in the graph legend, but the water is actually getting more turbid. The other two improving trends showed decreasing concentrations of TKN and chloride. However, neither of these parameters were of great concern.

The 2020 Texas Integrated Report lists the Gulf of Mexico as impaired for elevated levels of bacteria. Analysis of enterococci for the one active monitoring station located in this segment detected a stable trend during the period of record. In fact, all samples collected since 2010 have exceeded the 35 MPN/100 mL standard with concentrations reaching levels as high as approximately 5,000 MPN/100 mL on a regular basis.


Segment: 2501 Gulf of Mexico
Parameter: Total Suspended Solids
Water Body Type: Ocean
Number of Samples : 299
Correlation Trend : Deteriorating
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Increasing
Linear Regression Trend = Deteriorating
Survival Analysis Trend : N/A
Total Suspended Solids mg/L
2000
1250
750
500
250
10
1
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Suspended Solids LOESS Plot


Segment: 2501 Gulf of Mexico
Parameter: Secchi Transparency
Water Body Type: Ocean
Number of Samples : 278
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Secchi Transparency meters
0
1
2
3
4
5
6
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Secchi Transparency LInear Regression Plot



Segment: 2501 Gulf of Mexico
Parameter: Total Kjeldahl Nitrogen
Water Body Type: Ocean
Number of Samples : 260
Correlation Trend : Improving
Flow-Adjusted Trend : No Flow Data
Seasonal Trend : Decreasing
Linear Regression Trend = Improving
Survival Analysis Trend : N/A
Total Kjeldahl Nitrogen µg/mL
9
7
5
3
2
1
0.2
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
Collection Date
Total Kjeldahl Nitrogen LOESS Plot

Water Quality Issues Summary				
Issue	**Affected Area (2020 Assessment)** *I = Impairment* *C = Concern*	**Possible Causes/Influences / Concerns Voiced by Stakeholders**	**Possible Effects**	**Possible Solutions / Actions To Be Taken**
Elevated Levels of Bacteria	2501_02 I	• WWTF non-compliance, overflows, and collection system by-passes • Developments with malfunctioning OSSFs • Constructed stormwater controls failing • Urbanization and increased impervious cover • Animal waste from agricultural production and domestic animal facilities • Direct and dry weather discharges • Improper or no pet waste disposal • Animal waste from agricultural production, hobby farms, and riding stables	• Water body does not meet the water quality standard for Primary Contact Recreation • Contact recreation (e.g., swimming) could lead to gastrointestinal illnesses	• Require all systems to develop and implement a utility asset management program and protect against power outages at lift stations • More public education regarding OSSF operation and maintenance • Improve compliance and enforcement of existing stormwater quality permits • Improve storm water controls in new developments by adding bacteria reduction measures • Improve construction oversight to minimize TSS discharges to waterways • More public education on pet waste disposal • Promote and implement Water Quality Management Plans for individual agricultural properties • Implement stream fencing and alternative water supplies to keep livestock out of or away from waterways
Mercury in Edible Fish Tissue	2501_02 I 2501_03 I 2501_04 I	• Legacy pollutant in sediment • Unknown industrial or urban sources, possibly including coal fired power plants, coal and wood-fired industrial boilers, hazardous waste combustion, chlorine production, and offshore oil and gas drilling	• The Texas DSHS has concluded that consuming fish from this water body poses an apparent hazard to public health	• Continue monitoring fish populations and publicizing advisories • Continue to contain, remove, and monitor known contaminated sites • Support efforts aimed at reducing mercury emissions from coal-fired power plants • Support the reduced use of industrial mercury

Special Studies:

This segment was included in the Galveston Bay System Survey of Dioxin and PCBs.

Recommendations:

- Address concerns found in this segment summary through stakeholder participation.
- Continue collecting water quality data to support actions associated with any future watershed protection plan or TMDL development and possible modeling.
- Continue to analyze Discharge Monitoring Report data and present results to TCEQ, wastewater permittees, local governments/utility districts, and stakeholders through updates to the Regional Water Quality Management Plan
- Improve compliance and enforcement of existing stormwater quality permits and improve stormwater controls in new developments
- Support public education programs to inform business and homeowners on appropriate disposal of fats, oil, grease and wipes
- Support programs that oversee the maintenance, repair, and replacement of on-site sewage facilities
- 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
- Expand use of LID and green infrastructure practices
- Create and implement Water Quality Management Plans for individual agricultural properties
- Support public education on pet waste disposal

RECOMMENDATIONS and CONCLUSION

Recommendations and Conclusion

Findings

Bacteria

- Bacteria continues to be the most widespread and pervasive pollutant in the region.
- 44% of stream miles throughout the H-GAC region are impaired by elevated levels of bacteria.
- 7 stream segments show significant improvement in bacteria levels compared to 3 segments showing degradation.

Dissolved Oxygen (DO)

- Depressed DO levels are a concern in over 18% of stream miles in the region.
- 5 stream segments show significant improvement in DO levels compared to 4 segments showing degradation.

Nutrients

- Concerns for nutrients continue to rise.
- 31% of stream miles throughout the basins contain nutrients at levels higher than the screening criteria.
- 18 stream segments show significant improvement compared to 11 stream segments showing rising nutrient levels.

Chlorophyll a

- 17% of stream miles in the region exceed the state recommended chlorophyll *a* screening criteria.
- 2 stream segments show improving chlorophyll *a* concentrations compared to 13 segments showing increasing concentration.

PCBs and Dioxins

- PCBs and Dioxins in fish tissue continue to be of great concern in coastal Bays and Estuaries as well as in other tidal segments.
- PCB and Dioxin levels exceed standards in 53% of tidal waters
- There has been no change in PCB or Dioxin levels in the bays and estuaries or tidal segments in the region.

Recommendations

- Encourage the addition of water quality features (ex. rain gardens, rain barrels) to stormwater systems.
- Promote and encourage Low Impact Development (LID) in growing urbanized areas.
- Encourage Water Quality Management Plans or similar projects for agricultural properties.
- Utilize regional best management practices (BMPs) and on-site sewage system facilities (OSSF) databases to prioritize problem areas.
- Offer educational webinars and workshops that can be accessed remotely in order to reach a larger demographic.
- Work with local agencies to implement management measures recommended in the Bacteria Implementation Group (BIG) I-Plan for Bacteria Reduction.
- Expand the BIG geographic area to increase connectivity of BMPs with neighboring watersheds.
- Continue to support watershed protection planning and implementation of Watershed Protection Plans (WPPs) throughout the region.
- Work with the TCEQ Standards Team on the development of nutrient standards for water bodies.
- Continue to expand routine water quality monitoring by adding new local agencies to the Regional Water Quality Monitoring Network.
- Continue to expand Texas Stream Team monitoring in priority areas.
- Begin working with USGS and EPA to develop guidelines for the monitoring of emerging pollutants.
- Work with local partner and contract labs to lower detection limits for nutrients.

Recommendations to Regulators

The Clean Rivers Program provides the majority of the data used in analyses of the Texas Integrated Report of Surface Water Quality (IR) for the Clean Water Act Sections 305(b) and 3030(d) (IR). It provides the basis for most of the Watershed Protection Plan and Total Maximum Daily Load work throughout the state as well. Clean Rivers Program partners strive to streamline programs, eliminate duplication, and work efficiently. As budgets are tightened, and costs of doing business continue to rise, Clean Rivers Program partners may be forced to reduce the ambient monitoring done in their basins.

H-GAC recommends that limited nonpoint source (NPS) monitoring be funded under CRP. While routine monitoring shows overall trends in water quality, smaller scaled NPS monitoring will allow CRP to better assess the success of NPS controls in individual watersheds that would otherwise go undetected by using routine ambient data. The ability to assist local MS4 permit holders to determine if actions to reduce NPS are working would be a great help.

Priorities

The Clean Rivers Program has always done an exceptional job collecting high quality data. H-GAC and its local partners will continue to collect high quality ambient data to establish water quality trends to better identify problem areas. The greatest challenge is to determine which factors have the greatest impact on water quality variations in our watersheds. H-GAC's Clean Rivers Program efforts, in coordination with other water resource programs, continue to work toward identifying the primary factors impacting regional water quality conditions. H-GAC's Clean Rivers Program will continue to track water quality progress in waterbodies that have completed watershed-based plans to help determine if implementation strategies are having the desired impact. Coupled with the implementation of the low impact development (LID), on-site sewage facility (OSSF), and BMP databases, we will have greater quantifiable information regarding the impact of BMPs in our watersheds. The BMP, LID, and OSSF databases are continuously updated to reflect current projects and facilities. This data is then merged through GIS to provide more meaningful spatial analysis of problem areas.

Elevated levels of bacteria continue to be a priority for the region. H-GAC has been and will continue to work on recommendations from the Bacteria Implementation Group (BIG) that address bacteria problems. Current examples include the targeted bacteria monitoring that began in 2020 by both professional and volunteer monitors. This monitoring is being conducted on waterbodies that have some of the highest bacteria levels in the region. H-GAC and local partner agencies are collecting bacteria data to identify, and hopefully eliminate, bacteria sources. Other bacteria studies beginning in 2021 include the development of Clear Creek and East Fork San Jacinto River Watershed Protection Plans. H-GAC will also continue developing TMDL/I Plans to address bacterial impairments for the San Jacinto-Brazos Coastal and the Brazos-Colorado Coastal Basins.

Conclusion

H-GAC's Clean Rivers Program is the foundation upon which the assessment of the region's water quality is based. It also provides the data for which most water quality initiatives in the region are established and evaluated. The region's population is projected to increase by 3.5 million by 2040. As the region grows, monitoring, protecting, and improving water quality will become even more important than it is today. H-GAC's Clean Rivers Program will continue to provide high quality data to assess water health and provide insight as to what needs to be done to maintain or improve the quality of the region's waterways. The region could face many water quality issues in the future. However, when communities work together to prioritize these issues and put focused effort on solving problems, there has been great success. With sustained effort and increased awareness, the region can work together to protect and improve water quality for years to come.

This report is prepared in cooperation with the Texas Commission on Environmental Quality under the authorization of the Texas Clean Rivers Act.

Houston-Galveston Area Council

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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