San Bernard River Watershed Data Report

April 2018

Table of Contents

The preparation of this report was prepared in cooperation with, and financed through, grants from the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency.

Introduction

Texas Stream Team is a volunteer-based citizen water quality monitoring program. Citizen scientists collect surface water quality data that may be used in the decision-making process to promote and protect a healthy and safe environment for people and aquatic inhabitants. Citizen scientist water quality monitoring occurs at predetermined monitoring sites, at roughly the same time of day each month. Citizen scientist water quality monitoring data provides a valuable resource of information by supplementing professional data collection efforts where resources are limited. The data may be used by professionals to identify water quality trends, target additional data collection needs, identify potential pollution events and sources of pollution, and to test the effectiveness of water quality management measures.

Texas Stream Team citizen scientist data are not used by the state to assess whether water bodies are meeting the designated surface water quality standards. Texas Stream Team citizen scientists use different methods than the professional water quality monitoring community. Texas Stream Team does not utilize those methods due to higher equipment costs, training requirements, and stringent laboratory procedures that are required of the professional community. However, the data collected by Texas Stream Team provides valuable records, often collected in portions of a water body that professionals are not able to monitor frequently or monitor at all. This long-term data set is available and may be considered by the surface water quality professional community to facilitate management and protection of Texas water resources. For additional information about water quality monitoring methods and procedures, including the differences between professional and volunteer monitoring, please refer to the following sources:

- Texas Stream Volunteer Water Quality Monitoring Manual
- Texas Commission on Environmental Quality (TCEQ) Surface Water Quality Monitoring Procedures

The information that Texas Stream Team citizen scientists collect is covered under a TCEQ-approved Quality Assurance Project Plan (QAPP) to ensure that a standard set of methods are used. All data used in watershed data reports are screened by the Texas Stream Team for completeness, precision, and accuracy, in addition to being scrutinized for data quality objectives and with data validation techniques.

The purpose of this report is to provide analysis of data collected by Texas Stream Team citizen scientists. The data presented in this report should be considered in conjunction with other relevant water quality reports in order to provide a holistic view of water quality in this water body. Such sources include, but are not limited to the following potential resources:

- Texas Surface Water Quality Standards
- Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)
- Texas Clean Rivers Program (CRP) partner reports, such as Basin Summary Reports and Highlight Reports
- TCEQ Total Maximum Daily Load (TMDL) reports
- TCEQ and Texas State Soil and Water Conservation Board Nonpoint Source Programs funded reports, including Watershed Protection Plans (WPPs)

Questions regarding this watershed data report should be directed to the Texas Stream Team at (512) 245-1346.

Watershed Location and Physical Description

Location and Climate

The San Bernard River is approximately 120 miles long, originating just south of New Ulm, Texas and ending in the Gulf of Mexico. The San Bernard is classified as brackish water because of freshwater and saltwater mixing at the confluence with the Gulf of Mexico (Friends of the River San Bernard). The river passes through the following counties: Austin, Colorado, Wharton, Fort Bend, and Brazoria (Houston-Galveston Area Council (H-GAC)). The upper portion of the watershed is located on Bay Prairieland and the lower portion of the watershed is located on the Gulf Coast Prairies and Marshes Ecoregion (H-GAC). The major tributaries of the San Bernard are East Bernard, West Bernard, Middle Bernard, Peach, Mound, Coushatta, and Bell creeks, the Little San Bernard River, and McNeal and Redfish bayous (Texas State Historical Association). The terrain is mostly level with elevations ranging from 0" to 400"; it is slow draining and receives between 40" to 54" of average annual rainfall (Native Prairies Association of Texas, H-GAC). Soil types along the river are varied and consist of sand, gravels, sandy clay, silt with local sand, mud, and other fluvial deposits (H-GAC).

Physical Description and Land Use

Due to the flat terrain and soil types, the land surrounding the San Bernard River is well suited for agriculture and cattle grazing (H-GAC). The majority of the land in the watershed is used for agriculture, with some small towns interspersed throughout the region (H-GAC). The river itself is primarily used for boating and fishing (H-GAC). Oil, gas, sulfur, and salt are abundant in this area; as a result, petrochemical industries in the area use barges to transport natural resources in the lower portion of the river (H-GAC).

Wildlife and Wildlife Refuges

The San Bernard Watershed contains three wildlife and habitat areas: the San Bernard National Wildlife Refuge, the Justin Hurst Wildlife Management Area, and the Attwater Prairie Chicken National Wildlife Refuge (H-GAC). The Gulf Coast Prairies and Marshes Ecoregion, where the refuges are located, is one of the most diverse ecosystems and is home to many birds, mammals, reptiles and fish (The Nature Conservancy). The San Bernard National Wildlife Refuge, created in 1968 as a sanctuary and habitat for winter waterfowl and marine species, lies on the coast just south of Sweeny and Brazoria, Texas (H-GAC). The Justin Hurst Wildlife Management area, established between 1985 and 1988, is located in Brazoria, Texas and is found in the southern most region of the San Bernard watershed (H-GAC). The Attwater Prairie Chicken National Wildlife Refuge is near Eagle Lake and was founded in 1983 (H-GAC). Green ash, water hickory, and water oak trees are the predominant species along the San Bernard (H-GAC). The wildlife found in the San Bernard watershed includes: Ring-billed Gulls, Caspian Tern, Willet shorebird, Red-Tailed Hawk, Bald Eagle, Great Blue Heron, Double-crested Cormorant, Snow Goose, Redfish, Speckled trout, White-tailed deer, Feral Hog, Water Moccasin, Oysters, Crabs, and many more (H-GAC).

History

Owing to level ground and slow draining soils, the San Bernard River is prone to flooding, particularly on its eastern edge near Wharton County (Scheibe 2010). Dating back to 1913, the river has experienced major flooding with a record flood in 1998 when 22" of rain fell over the course of two days (Scheibe 2010, Friends of the River San Bernard). In addition to flooding, the San Bernard also experiences a lot of shoreline changes. According to a recent geospatial analysis, the mouth of the San Bernard River has moved west by 2,233 meters from 1974 to 2002 (Chen and Buzan). Several factors are likely to have contributed to this movement including: diversion of the Brazos River for construction of the port of Freeport and dredging of the Gulf Intracoastal Waterway West (GIWW) (H-GAC). The diversion of the Brazos River increased the transportation of sediment to the San Bernard area (H-GAC) while construction of the GIWW reduced the flow of the San Bernard River lower than is necessary to keep the mouth of the river open and flowing (H-GAC). In addition to the Brazos River diversion, there is another river diversion on Wharton county line for the New Gulf Reservoir, which was constructed in 1929 (Texas State Historical Association). Recent droughts, retention ponds, and over vegetation along the banks of the river have also decreased the San Bernard's flow and contributed to changes in its shoreline in the past few decades (H-GAC).

TMDL & Watershed Protection

A TMDL is a water resource management plan that targets pollutants in a stream or body of water. The TMDL Program works to improve water quality in impaired or threatened water bodies in Texas. The program is authorized by and created to fulfill the requirements of Section 303(d) of the federal Clean Water Act. The goal of a TMDL is to restore the full use of a water body that has limited quality in relation to one or more of its uses. The TMDL defines an environmental target and, based on that target, the state and stakeholders develop an implementation plan to mitigate sources of pollution within the watershed and restore full use of the water body.

A WPP is a coordinated framework for implementing prioritized and integrated water quality protection and restoration strategies driven by environmental objectives. Through the WPP process, stakeholders holistically address all of the sources and causes of impairments and threats to both surface and ground water. Developed and implemented through diverse, well integrated partnerships, a WPP assures the long-term health of the watershed with strategies for protecting unimpaired waters and restoring impaired waters. WPPs have a variety of ingredients and can take many forms but they are consistent with guidelines promulgated by the U.S. Environmental Protection Agency (EPA) in 2003.

Due to high fecal bacteria levels, portions of the San Bernard River have been designated unsuitable for recreational activities, such as swimming. In addition, excessive nutrients and low dissolved oxygen levels have also been found which may negatively affect fish and other aquatic life. To protect water quality and reduce fecal bacteria levels in the project area, local stakeholders and H-GAC staff worked together to develop the watershed protection plan. This project was funded by a grant from the Texas Commission for Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (EPA) under the American Recovery and Reinvestment Act (ARRA). H-GAC worked with community stakeholders to develop the plan

Texas Stream Team has become involved in the development and implementation of WPPs and TMDLs. Citizen scientists have become knowledgeable about their local water quality planning efforts. Texas Stream Team citizen scientists' monitoring efforts can supplement professional monitoring plans with identification of pollution hot spots. The data collected by the local citizen scientists are used for tracking water quality changes during implementation of WPPs and TMDLs.

Water Quality Parameters

Water Temperature

Water temperature influences the physiological processes of aquatic organisms and each species has an optimum temperature for survival. High water temperatures increase oxygen demand for aquatic communities and can become stressful for fish and aquatic insects. Water temperature variations are most detrimental when they occur rapidly, leaving the aquatic community no time to adjust. Additionally, the ability of water to hold oxygen in solution (solubility) decreases as temperature increases.

Natural sources of warm water are seasonal, as water temperatures tend to increase during summer and decrease in winter in the Northern Hemisphere. Daily (diurnal) water temperature changes occur during normal heating and cooling patterns. Man-made sources of warm water include power plant effluent after it has been used for cooling or hydroelectric plants that release warmer water. Citizen scientist monitoring may not identify fluctuating patterns due to diurnal changes or events such as power plant releases. While citizen scientist data does not show diurnal temperature fluctuations, it may demonstrate the fluctuations over seasons and years.

Dissolved Oxygen

Oxygen is necessary for the survival of organisms like fish and aquatic insects. The amount of oxygen needed for survival and reproduction of aquatic communities varies according to species composition and adaptations to watershed characteristics like stream gradient, habitat, and available stream flow. The TCEQ Water Quality Standards document lists daily minimum dissolved oxygen (DO) criteria for specific water bodies and presumes criteria according to flow status (perennial, intermittent with perennial pools, and intermittent), aquatic life attributes, and habitat. These criteria are protective of aquatic life and may be used for general comparison purposes.

Table 1: Daily Minimum Dissolved Oxygen Requirements for Aquatic Life

Aquatic Life Sub-category	Daily Minimum Dissolved Oxygen (mg/L)
Exceptional	4.0
High	3.0
Intermediate	3.0
Limited	2.0
Minimal	1.5

The DO concentrations may be influenced by other water quality parameters such as nutrients and temperature. High concentrations of nutrients can lead to excessive surface vegetation growth and algae, which may starve subsurface vegetation of sunlight, and therefore limit the amount of DO in a water body due to reduced photosynthesis. This process, known as eutrophication, is enhanced when the subsurface vegetation and algae die and oxygen is consumed by bacteria during decomposition. Low DO levels may also result from high groundwater inflows due to minimal groundwater aeration, high temperatures that reduce oxygen solubility, or water releases from deeper portions of dams where DO stratification occurs. Supersaturation typically only occurs underneath waterfalls or dams with water flowing over the top.

Specific Conductivity and Total Dissolved Solids

Specific conductivity is a measure of the ability of a body of water to conduct electricity. It is measured in micro Siemens per cubic centimeter ($\mu S/cm^3$). A body of water is more conductive if it has more dissolved solids such as nutrients and salts, which indicates poor water quality if they are overly abundant. High concentrations of nutrients can lower the level of DO, leading to eutrophication. High concentrations of salt can inhibit water absorption and limit root growth for vegetation, leading to an abundance of more drought tolerant plants, and can cause dehydration of fish and amphibians. Sources of total dissolved solids (TDS) can include agricultural runoff, domestic runoff, or discharges from wastewater treatment plants. For this report, specific conductivity values have been converted to TDS using a conversion factor of 0.65 and are reported as mg/L.

pH

The pH scale measures the concentration of hydrogen ions on a range of 0 to 14 and is reported in standard units (su). The pH of water can provide useful information regarding acidity or alkalinity. The range is logarithmic; therefore, every one unit change is representative of a 10-fold increase or decrease in acidity. Acidic sources, indicated by a low pH level, can include acid rain and runoff from acid-laden soils. Acid rain is mostly caused by coal power plants with minimal contributions from the burning of other fossil fuels and other natural processes, such as volcanic emissions. Soil-acidity can be caused by excessive rainfall leaching alkaline materials out of soils, acidic parent material, crop decomposition creating hydrogen ions, or high-yielding fields that have drained the soil of all alkalinity. Sources of high pH (alkaline) include geologic composition, as in the case of limestone increasing alkalinity and the dissolving of carbon dioxide in water. Carbon dioxide is water-soluble and as it dissolves it forms carbonic acid. The most suitable pH range for healthy organisms is between 6.5 and 9.

Salinity

Salinity is the total of all salts dissolved in water, usually expressed in parts per thousand (ppt). Salinity is a term that usually refers to waters receiving marine inflow such as bays and estuaries. In an estuary, the flow of fresh water from streams and rivers mixes with salty ocean water, producing a range of salinity from 0 to 35 ppt. The salt content of water affects the distribution of animal and plant species according to the amount of salinity they can tolerate. Salt pollution can be caused by natural conditions intensified by drought, irrigation return flows, wastewater discharges that may be high in salts, brine waters from oil production activities, or the spreading of road salt during icy conditions. Salt pollution is a problem because it can cause the salt levels of drinking water supplies to rise above recommended levels for human consumption. In some areas, it can cause rivers or streams to become unsuitable for agricultural irrigation or industrial use. Increasing levels might also impair aquatic life in ways that are difficult to determine.

Fresh water and drinking water contain low salt concentrations and usually have a salinity of less than 0.5 ppt, while the salinity of seawater averages about 35 ppt.

E. coli Bacteria

E. coli bacteria originate in the digestive tract of endothermic organisms. The EPA has determined *E. coli* to be the best indicator of the degree of pathogens in a water body, which are far too numerous to be tested for directly, considering the amount of water bodies tested. A pathogen is a biological agent that causes disease. The standard for *E. coli* impairment is based on the geometric mean (geomean) of the *E. coli* measurements taken. A geometric mean is a type of average that incorporates the high variability found in parameters such as *E. coli* which can vary from zero to tens of thousands of CFU/100 mL. The standard for contact recreational use of a water body such as the San Bernard River is 126 CFU/100 mL. A water body is considered impaired if the geometric mean is higher than this standard.

Enterococcus Bacteria

Because it is difficult to directly detect the many different pathogens or parasites that may be present in surface waters, the presence of fecal bacteria has long been used as an indicator of the possible presence of disease-causing organisms. The bacterium used for tidal stream segments is *Enterococcus*. The Environmental Protection Agency (EPA) recommended single sample maximum criterion for Enterococcus bacteria is 104 colony forming units (CFU) per 100 ml. When the counts are above this level, swimming is not recommended.

Orthophosphate

Orthophosphate is the phosphate molecule all by itself. Phosphorus almost always exists in the natural environment as phosphate, which continually cycles through the ecosystem as a nutrient necessary for the growth of most organisms. Testing for orthophosphate detects the amount of phosphate in the water itself, excluding the phosphate bound up in plant and animal tissue. There are other methods to retrieve the phosphate from the material to which it is bound, but they are too complicated and expensive to be conducted by volunteer monitors. Testing for orthophosphate gives us an idea of the degree of phosphate in a water body. It can be used for problem identification, which can be followed up with more detailed professional monitoring, if necessary. Phosphorus inputs into a water body may be caused by the weathering of soils and rocks, discharge from wastewater treatment plants, excessive fertilizer use, failing septic systems, livestock and pet waste, disturbed land areas, drained wetlands, water treatment, and some commercial cleaning products. The effect orthophosphate has on a water body is known as eutrophication and is described above under the "Dissolved Oxygen" section.

Nitrate-Nitrogen

Nitrogen is present in terrestrial or aquatic environments as nitrates, nitrites, and ammonia. Nitrate-nitrogen tests are conducted for maximum data compatibility with the TCEQ and other partners. Just like phosphorus, nitrogen is a nutrient necessary for the growth of most organisms. Nitrogen inputs into a water body may be livestock and pet waste, excessive fertilizer use, failing septic systems, and industrial discharges that contain corrosion inhibitors. The effect nitrogen has on a water body is known as eutrophication and is described above under the "Dissolved Oxygen" section. Nitrates dissolve more readily than phosphates, which tend to be attached to sediment, and therefore can serve as a better indicator of the possibility of sewage or manure pollution during dry weather.

Texas Surface Water Quality Standards

The Texas Surface Water Quality Standards establish explicit goals for the 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 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 (or drinking water). The criteria for evaluating support of those uses include DO, temperature, pH, TDS, toxic substances, and bacteria. The Texas Surface Water Quality Standards also contain narrative criteria (verbal descriptions) that apply to all waters of the state and are used to evaluate support of applicable uses. Narrative criteria include general descriptions, such as the existence of excessive aquatic plant growth, foaming of surface waters, taste- and odor-producing substances, sediment build-up, and toxic materials. Narrative criteria are evaluated by using screening levels, if they are available, as well as other information, including water quality studies, existence of fish kills or contaminant spills, photographic evidence, and local knowledge. Screening levels serve as a reference point to indicate when water quality parameters may be approaching levels of concern.

Data Analysis Methodologies

Data Collection

The field sampling procedures are documented in Texas Stream Team Water Quality Monitoring Manual and its appendices, or the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012). Additionally, all data collection adheres to Texas Stream Team's approved QAPP.

Table 2: Sample Storage, Preservation, and Handling Requirements

Parameter	Matrix	Container	Sample Volume	Preservation	Holding Time
E. coli / Enterococci	Water	Sterile Polystyrene (SPS)	100 mL	Refrigerate at 4ºC*	6 hours
Nitrate/Nitrogen	Water	Plastic Test Tube	10 mL	Refrigerate at 4ºC*	48 hours
Orthophosphate/Phosphorous	Water	Glass Mixing Bottle	25 mL	Refrigerate at 4ºC*	48 hours
Chemical Turbidity	Water	Plastic Turbidity Column	50 mL	Refrigerate at 4ºC*	48 hours

*Preservation performed within 15 minutes of collection.

Processes to Prevent Contamination

Procedures documented in Texas Stream Team Water Quality Monitoring Manual and its appendices, or the TCEQ Surface Water Quality Monitoring Procedures Manual, Volume 1 (August 2012) outline the necessary steps to prevent contamination of samples, including direct collection into sample containers, when possible. Field Quality Control samples are collected to verify that contamination has not occurred.

Documentation of Field Sampling Activities

Field sampling activities are documented on the field data sheet. For all field sampling events the following items are recorded: station ID, location, sampling time, date, and depth, sample collector's name/signature, group identification number, conductivity meter calibration information, and reagent expiration dates are checked and recorded if expired. If reagents or media are expired, it is indicated on the datasheet. Sampling is not encouraged with expired reagents and bacteria media; the corresponding values will be flagged in the database and excluded from data reports. Detailed observational data are recorded, including water appearance, weather, field observations (biological activity and stream uses), algae cover, unusual odors, days since last significant rainfall, and flow severity. Comments related to field measurements, number of participants, total time spent sampling, and total round-trip distance traveled to the sampling site are also recorded for grant and administrative purposes.

Data Entry and Quality Assurance

Data Entry

The citizen scientists collect field data and report the measurement results on Texas Stream Team approved physical or electronic datasheets. The physical data sheet is submitted to the Texas Stream Team and local partner, if applicable. The electronic datasheet is accessible in the online DataViewer and, upon submission and verification, is uploaded directly to the Texas Stream Team Database.

Quality Assurance & Quality Control

All data are reviewed to ensure that they are representative of the samples analyzed and locations where measurements were made, and that the data and associated quality control data conform to specified monitoring procedures and project specifications. The respective field, data management, and Quality Assurance Officer (QAO) data verification responsibilities are listed by task in the Section D1 of the QAPP, available on the Texas Stream Team website.

Data review and verification is performed using a data management checklist and self-assessments, as appropriate to the project task, followed by automated database functions that will validate data as the information is entered into the database. The data are verified and evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Potential errors are identified by examination of documentation and by manual and computer-assisted examination of corollary or unreasonable data. Issues that can be corrected are corrected and documented. If there are errors in the calibration log, expired reagents used to generate the sampling data, or any other deviations from the field or *E. coli* data review checklists, the corresponding data is flagged in the database.

When the QAO receives the physical data sheets, they are validated using the data validation checklist, and then entered into the online database. Any errors are noted in an error log and the errors are flagged in the Texas Stream Team database. When a citizen scientist enters data electronically, the system will automatically flag data outside of the data limits and the citizen scientist will be prompted to correct the mistake or the error will be logged in the database records. The certified QAO will further review any flagged errors before selecting to validate the data. After validation, the data will be formally entered into the database. Once entered, the data can be accessible through the online DataViewer, with the exception of flagged data.

Errors, which may compromise the program's ability to fulfill the completeness criteria prescribed in the QAPP, will be reported to the Texas Stream Team Program Manager. If repeated errors occur, the citizen scientist and/or the group leader will be notified via e-mail or telephone.

Data Analysis Methods

Data are compared to state standards and screening levels, as defined in the Surface Water Quality Monitoring Procedures, to provide readers with a reference point for amounts/levels of parameters that may be of concern. The assessment performed by TCEQ and/or designation of impairment involves more complicated monitoring methods and oversight than used by volunteers and staff in this report. The citizen water quality monitoring data are not used in the assessments mentioned above but are intended to inform stakeholders about general characteristics and assist professionals in identifying areas of potential concern.

Standards & Exceedances

The TCEQ determines a water body to be impaired if more than ten percent of samples, provided by professional monitoring, from the last seven years, exceed the standard for each parameter, except for *E. coli* bacteria. When the observed sample value does not meet the standard, it is referred to as an exceedance. At least ten samples from the last seven years must be collected over at least two years with the same reasonable amount of time between samples for a data set to be considered adequate. The 2014 Texas Surface Water Quality Standards report was used to calculate the exceedances for the San Bernard River Watershed, as seen below in Table 4.

Methods of Analysis

Quality assured data collected from the San Bernard River and its tributaries were exported from the Texas Stream Team database and were then grouped by site.

Once compiled, data was sorted and graphed in Microsoft Excel 2010 using standard methods. Trends over time were analyzed using a linear regression analysis in Minitab v 15. Statistically significant trends were added to Excel to be graphed. The cut off for statistical significance was set to a p-value of ≤ 0.05. A p-value of ≤ 0.05 means that the probability that the observed data matches the actual conditions found in nature is 95%. As the p-value decreases, the confidence that it matches actual conditions in nature increases.

For this report, specific conductivity measurements, gathered by citizen scientists, were converted to TDS using the TCEQ-recommended conversion formula of specific conductivity 0.65. This conversion was made so that volunteer gathered data could be more readily compared to state gathered data. Geomeans were calculated for *E. coli* and *Enterococci* data for trends and for each monitoring site. Due to the variability, the geometric mean is used to summarize bacteria data.

Table 3: TCEQ designated stream segments and standards, as applicable to citizen water quality data in this report (other standards may exist for these water bodies).

			Aquatic Life Use		Recreation Use		General Use			
Segment No.	**Segment Name**	**Description**	**Dissolved Oxygen grab screening level (mg/L)**	**Dissolved Oxygen grab minimum (mg/L)**	**Indicator Bacteria[1] Grab Sample (#/100mL)**	**Indicator Bacteria[1] geometric mean (#/100mL)**	**Water Temp (°C)**	**High pH (SU)**	**Low pH (SU)**	**TDS[2] (mg/L)**
1301	San Bernard River Tidal	From the confluence with the Intracoastal Waterway in Brazoria County to a point 3.2 km (2.0 miles) upstream of SH 35 in Brazoria County	4.0	3.0	130	35	35	9.0	6.5	N/A
1302	San Bernard River	From a point 3.2 km (2.0 miles) upstream of SH 35 in Brazoria County to the county road southeast of New Ulm in Austin County	5.0	3.0	394	126	32	9.0	6.5	500

[2] The indicator bacteria for freshwater is *E. coli* and for saltwater is Enterococci

[2] TCEQ standards are given for total dissolved solids (max 400 mg/L), not conductivity. Because Stream Team monitors measure conductivity rather than total dissolved solids, the standard was converted following the TCEQ's 2010 Guidance for Assessing and Reporting Surface Water Quality in Texas: Conductivity standard = Total Dissolved Solids standard / 0.65.

San Bernard River Watershed Data Analysis

San Bernard River Maps

Numerous maps were prepared to show spatial variation of the parameters. The parameters mapped include DO, pH, TDS, and *Enterococci*. There is also a reference map showing the locations of all active sites. For added reference points in all maps, layers showing monitoring sites, cities, counties, and major highways were included. All shapefiles were downloaded from reliable federal, state, and local agencies.

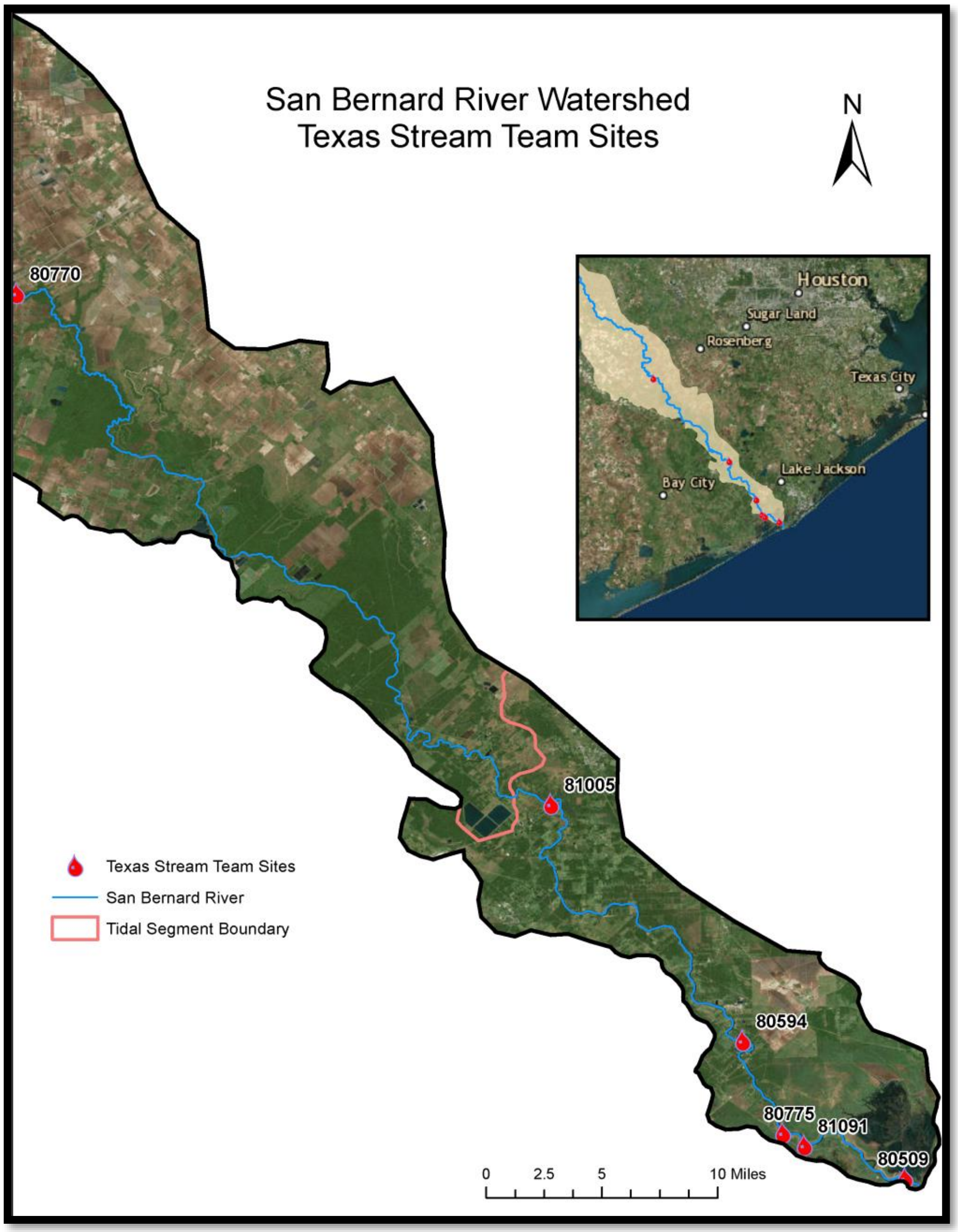

Figure 1: Map of the San Bernard River Watershed with Texas Stream Team Monitor Site ID

San Bernard River Watershed Trends over Time

Sampling Trends over Time

Sampling in the San Bernard River watershed began in November of 2008. A total of 356 monitoring events from 6 sites collected between November 2008 to March 2018 were analyzed.

Table 4: Descriptive parameters for all sites in the San Bernard River Watershed

San Bernard River Watershed November 2008 – March 2018				
Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Water Temperature (°C)	353	22.5 ± 6.6	4.8	33.3
Total Dissolved Solids (mg/L)	147	1674 ± 2860	37.1	12870
Dissolved Oxygen (mg/L)	349	6.1 ± 1.7	2.1	11.2
pH	353	7.3 ± 0.5	6.0	9.5
Salinity	223	11.5 ± 11.6	0.0	41.0
Transparency	298	0.3 ± 0.2	0.0	1.4
Turbidity	37	38 ± 24	10	100
Nitrate-Nitrogen	37	1.2 ± 0.5	1.0	3.0
Orthophosphate	38	0.4 ± 0.2	0.0	1.2
Enterococci (MPN/100 mL)	39	71 ± 1085	10	6257

There were a total of 356 sampling events between 11/10/2008 and 3/17/2018.

Trend Analysis over Time

Air and water temperature

A total of 353 water temperatures and 348 air temperatures were recorded in this watershed. The mean water temperature was 22.5 °C. The minimum water temperature was 4.8 °C and was recorded in December of 2013. The maximum water temperature of 33.3 °C was recorded in July of 2017. The air temperature ranged from a low of -3.5 °C in January of 2017 to a high of 35.6 °C in July of 2015.

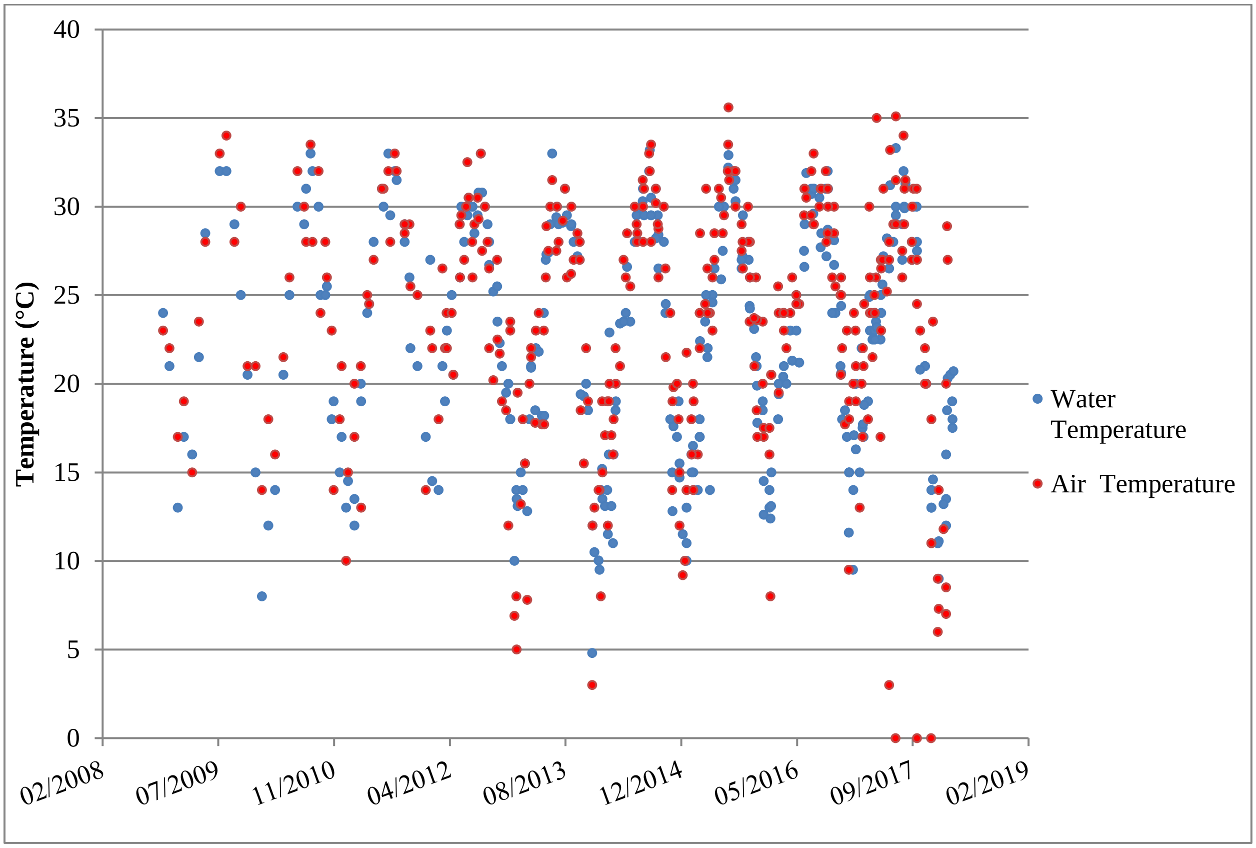

Figure 2: Air and water temperature over time at all sites within the San Bernard River watershed

Total Dissolved Solids

Citizen scientists took 147 TDS measurements in the watershed. The mean TDS concentration in the watershed was 147 mg/L and it ranged from a low of 37 mg/L in September of 2014 to a high of 12,870 mg/L in October of 2015. There was no significant change observed in TDS concentrations over time in the watershed.

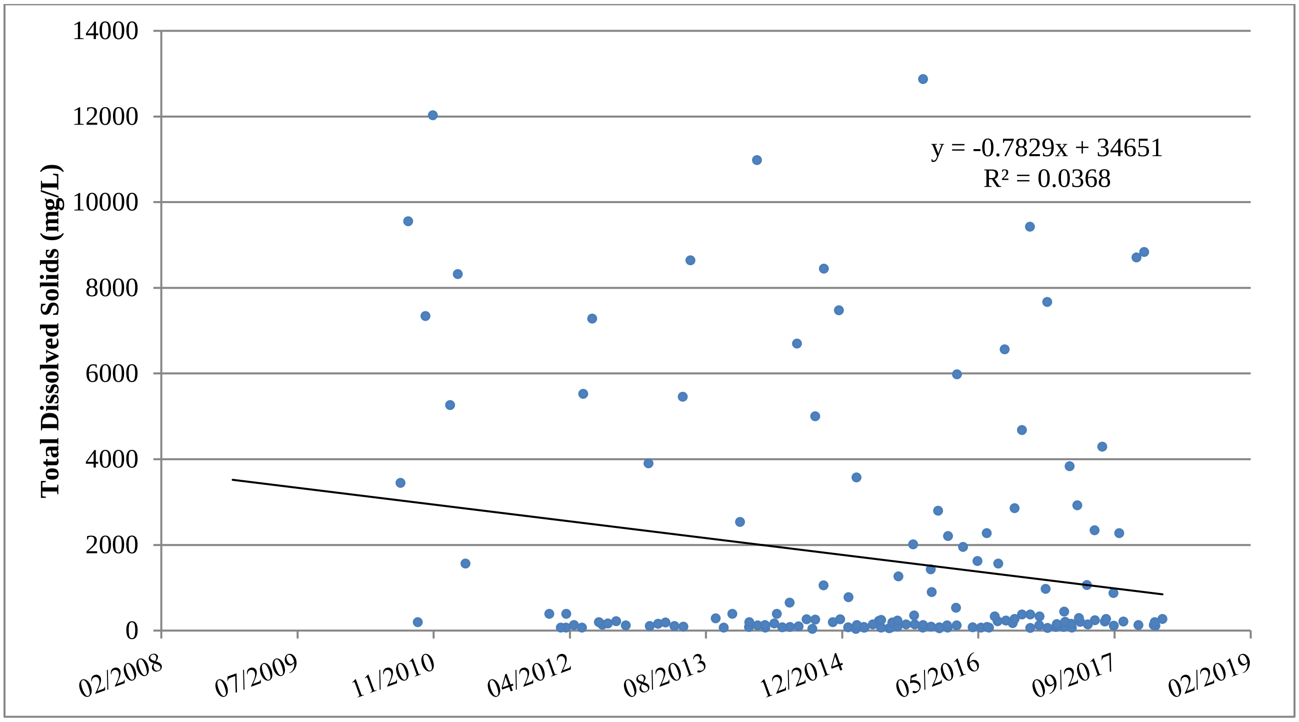

Figure 3: Total dissolved solids over time at all sites within the San Bernard River watershed

Dissolved Oxygen

Citizen scientists took 349 DO samples in the watershed. The mean DO concentration was 6.1 mg/L and it ranged from a low of 2.1 mg/L in August of 2016 to a high of 11.2 mg/L in May of 2014. There was no significant change observed in DO concentrations over time in the watershed.

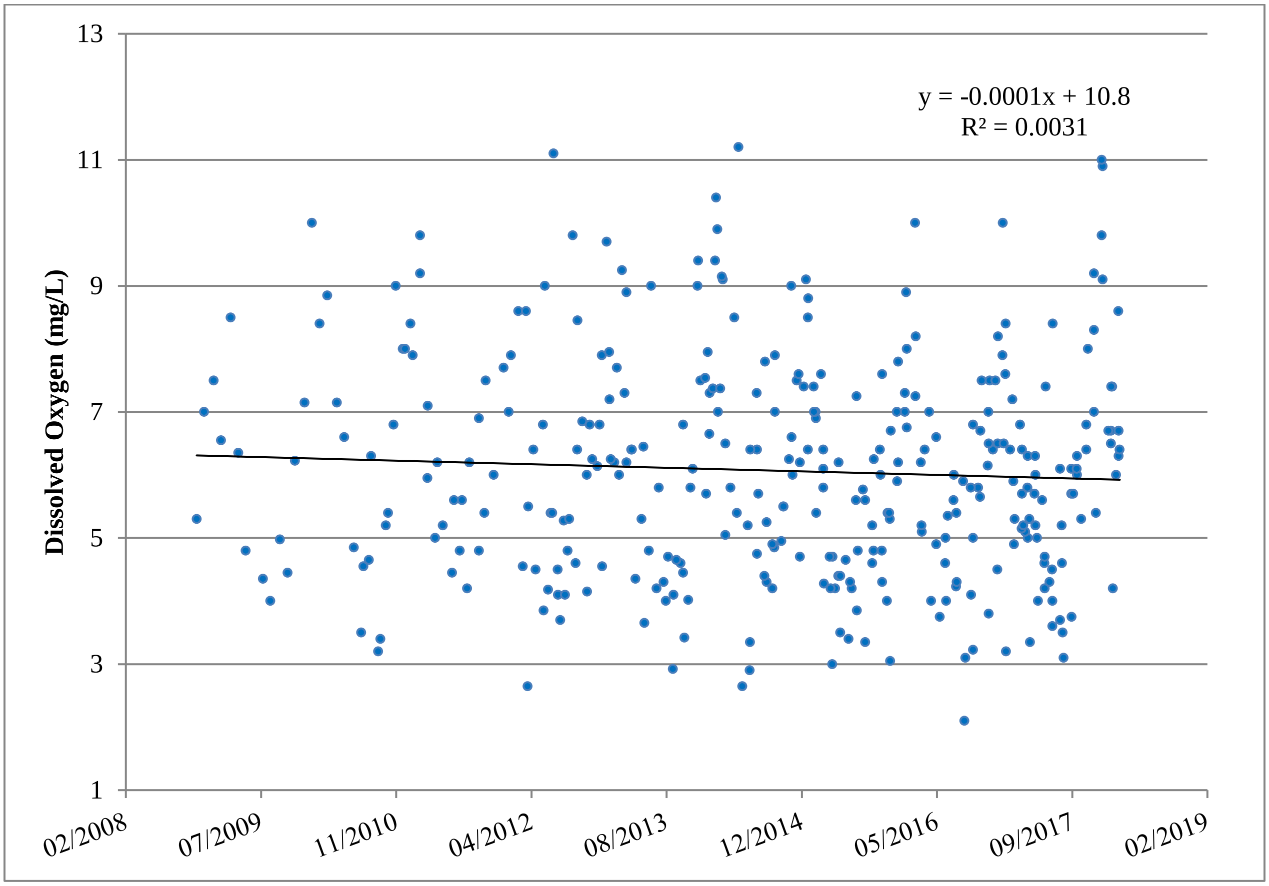

Figure 4: Dissolved oxygen over time at all sites within the San Bernard River watershed

pH

Citizen scientists took 353 pH measurements in the watershed. The mean pH was 7.4 and it ranged from a low of 6.0 which occurred several times to a high of 9.5 in May of 2014. There was no significant change observed in pH over time observed in the watershed.

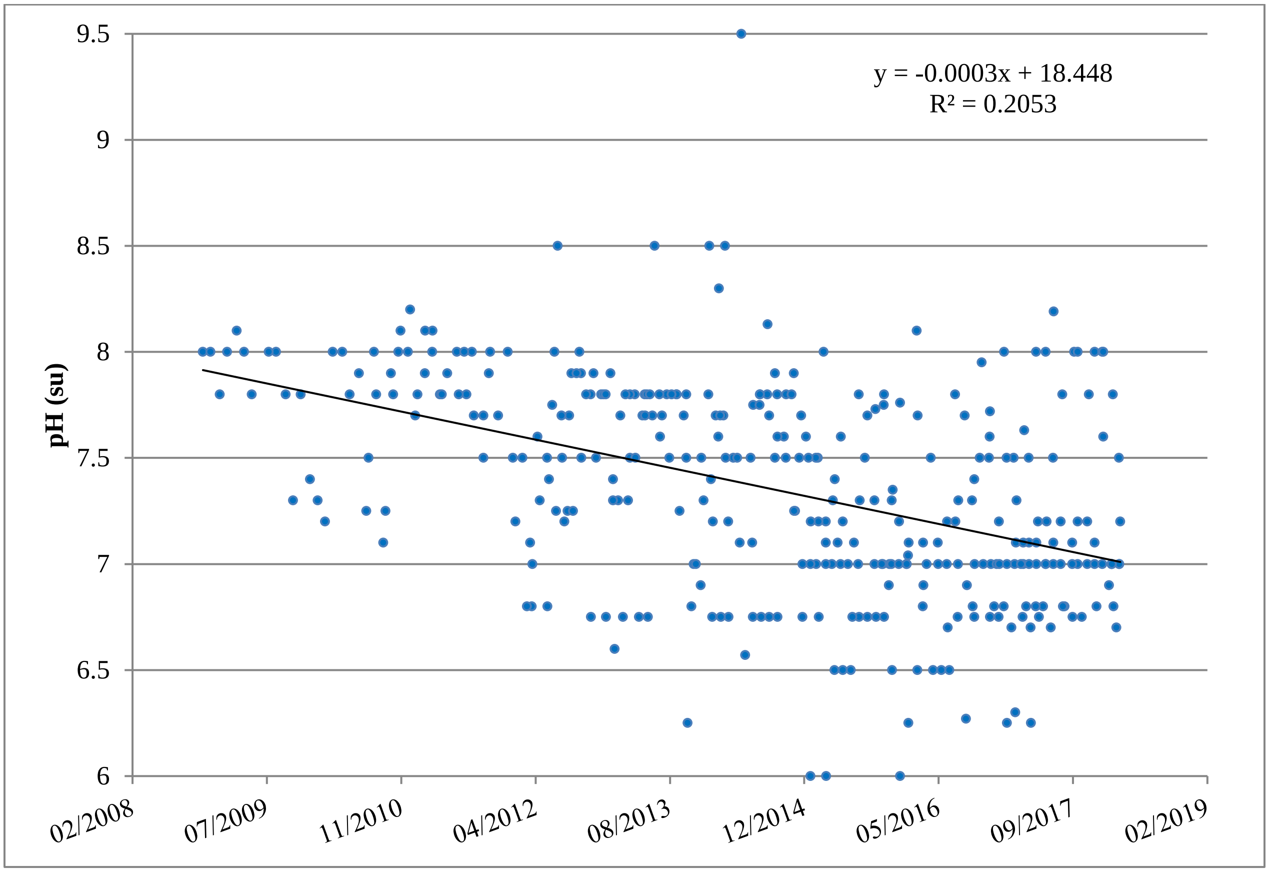

Figure 5: Measured pH over time within the San Bernard River watershed

Salinity

Citizen scientists took 223 salinity measurements in the watershed. The average salinity in the watershed was 11.5 ppt and it ranged from a low of 0.0 ppt which occurred several times to a high of 41.0 ppt in August of 2009. There was no significant change observed in salinity levels over time in the watershed.

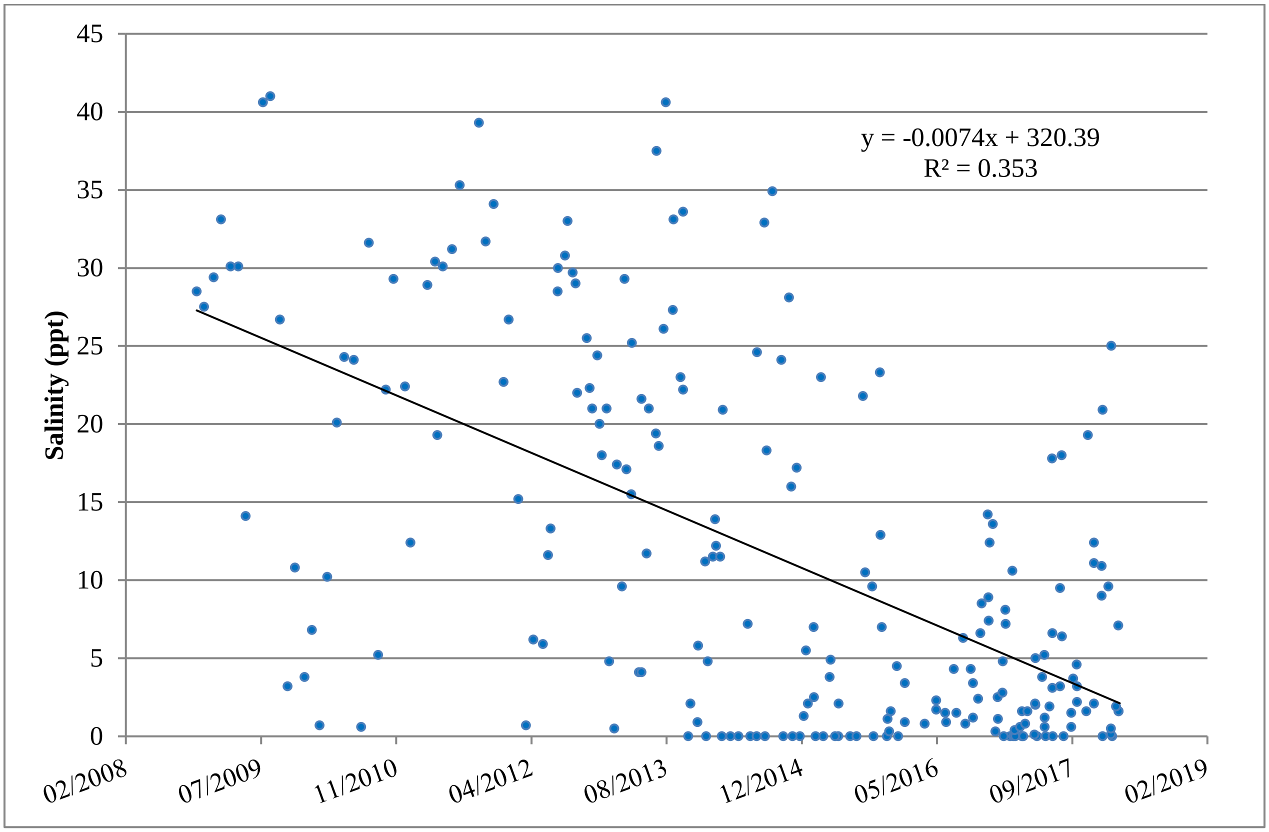

Figure 6: Salinity over time at all sites within the San Bernard River watershed

Transparency

Citizen scientists took 298 transparency measurements in the watershed. The average transparency in the watershed was 0.3 meters and it ranged from a low of 0.0 meters which occurred several times to a high of 1.4 meters in December of 2017. There was no significant change observed in transparency over time in the watershed.

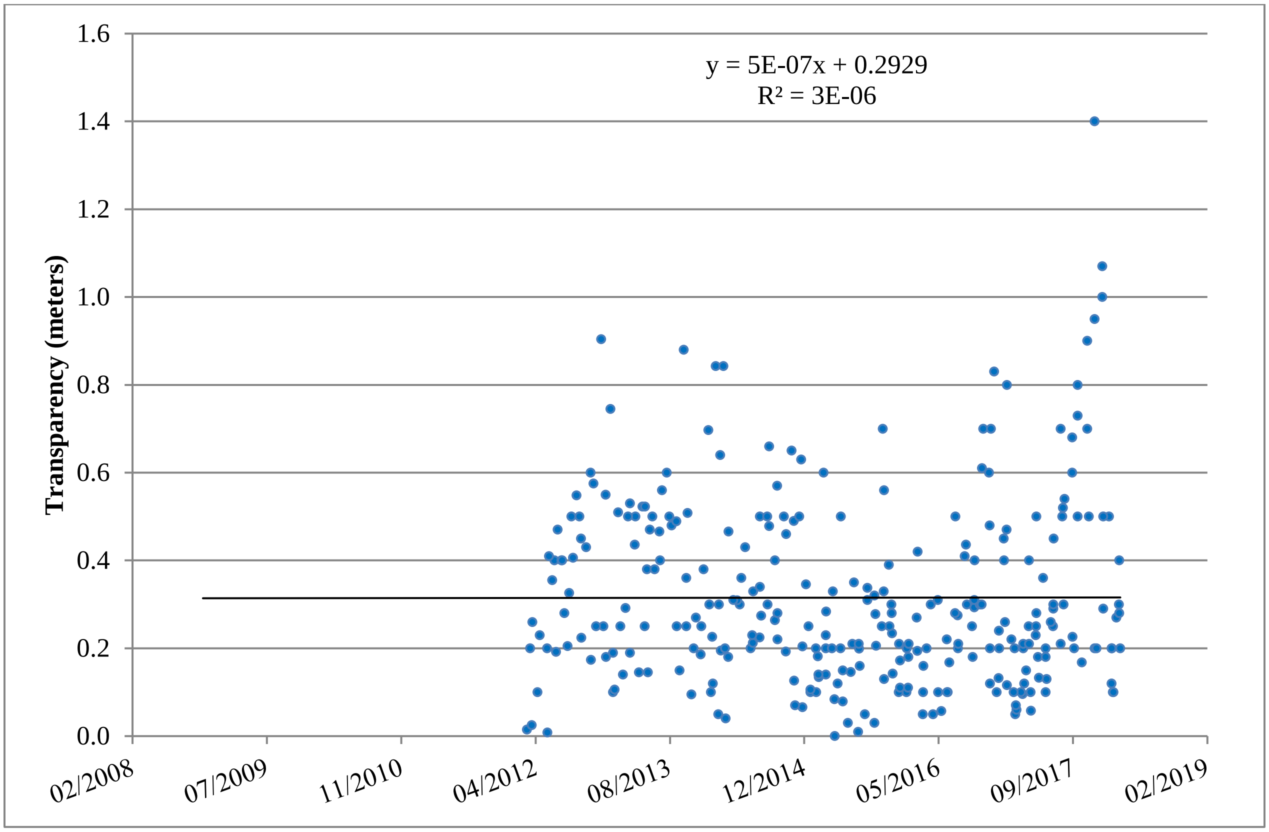

Figure 7: Transparency over time at all sites within the San Bernard River watershed

Turbidity

Citizen scientists took 37 turbidity measurements in the watershed. The average turbidity in the watershed was 38 JTU and it ranged from a low of 10.0 JTU which occurred in February of 2014 and October of 2015 to a high of 100 JTU in July and December of 2015. There was no significant change observed in turbidity over time in the watershed.

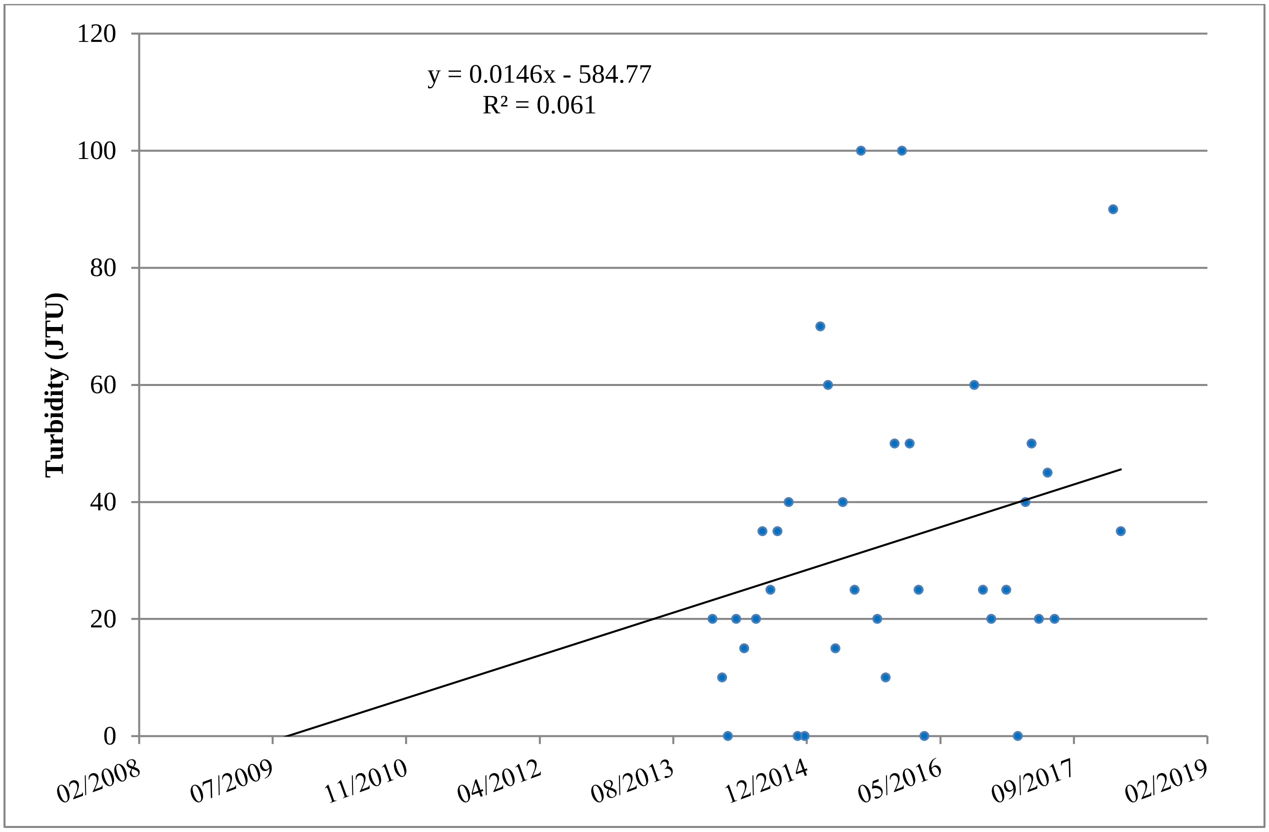

Figure 8: Turbidity over time at all sites within the San Bernard River watershed

Nitrate-Nitrogen

Citizen scientists took 37 nitrate-nitrogen measurements in the watershed. The average nitrate-nitrogen concentration in the watershed was 1.2 mg/L and it ranged from a low of <1.0 mg/L which occurred several times to a high of 3.0 mg/L in March of 2014. There was no significant change observed in nitrate-nitrogen concentrations over time in the watershed.

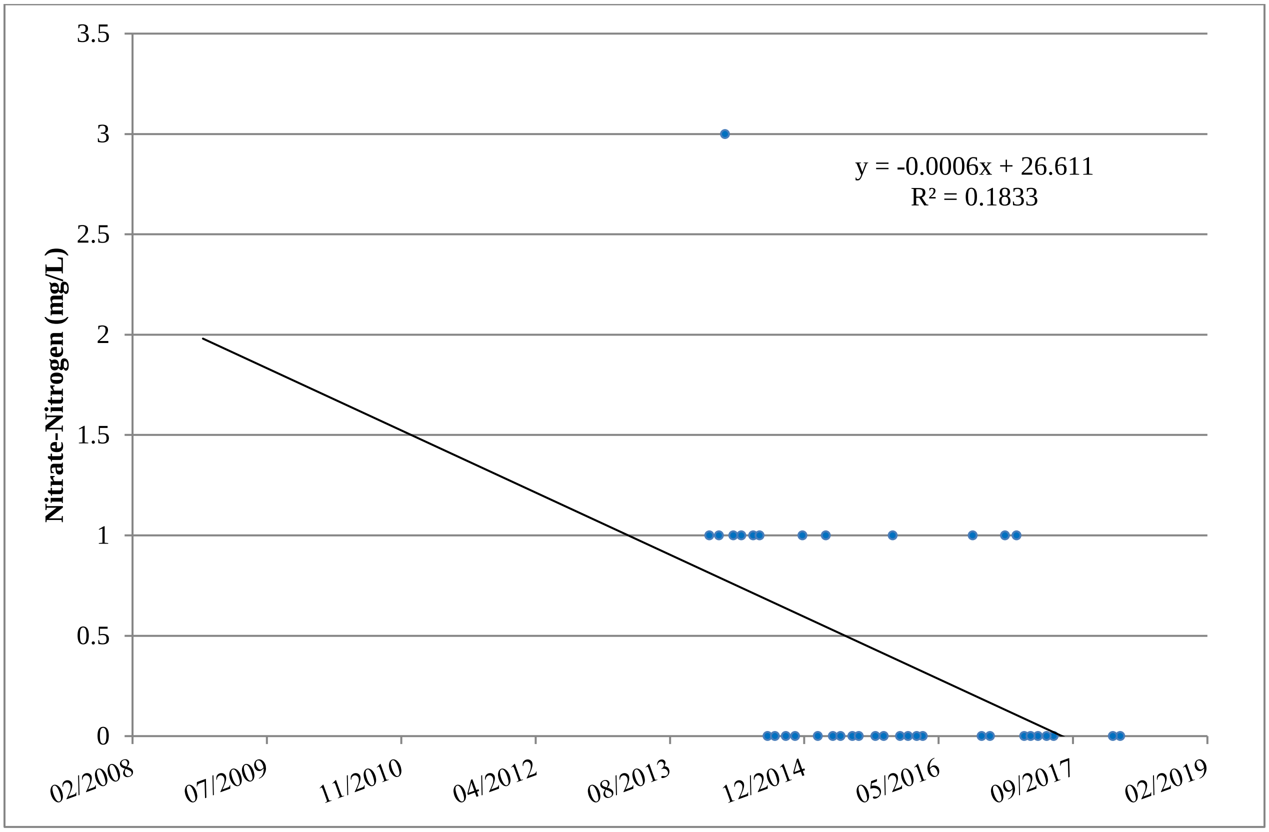

Figure 9: Nitrate-Nitrogen over time at all sites within the San Bernard River watershed

Orthophosphate

Citizen scientists took 38 orthophosphate measurements in the watershed. The average orthophosphate concentration in the watershed was 0.4 mg/L and it ranged from a low of 0.0 mg/L which occurred in July of 2014 to a high of 1.2 mg/L in September of 2014. There was no significant change observed in orthophosphate concentrations over time in the watershed.

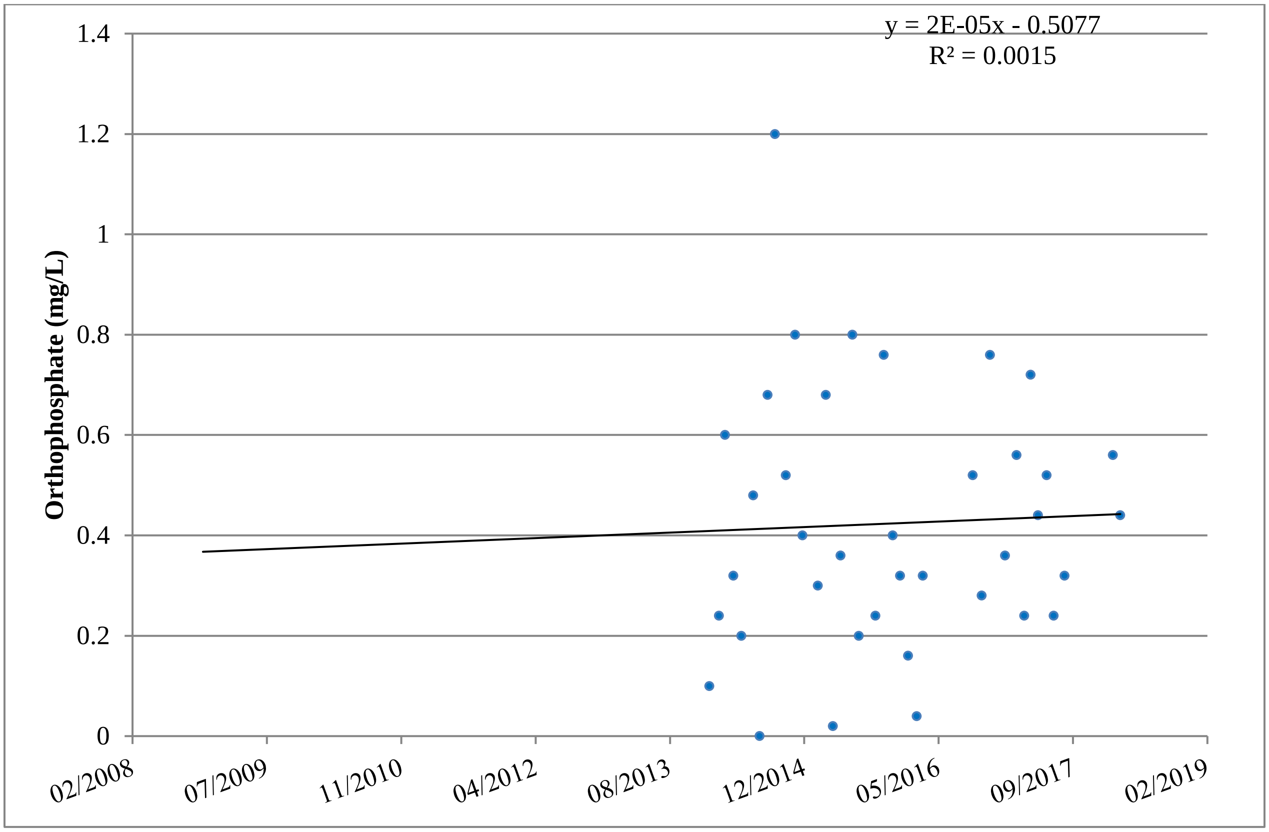

Figure 10: Orthophosphate over time at all sites within the San Bernard River watershed

Enterococci

Citizen scientists took 39 *Enterococci* measurements in the watershed. The *Enterococci* geomean in the watershed was 71 CFU/100 mL and it ranged from a low of 10.0 CFU/100 mL which occurred several times to a high of 6,257 CFU/100 mL in December of 2014. There was no significant change observed in *Enterococci* levels over time in the watershed.

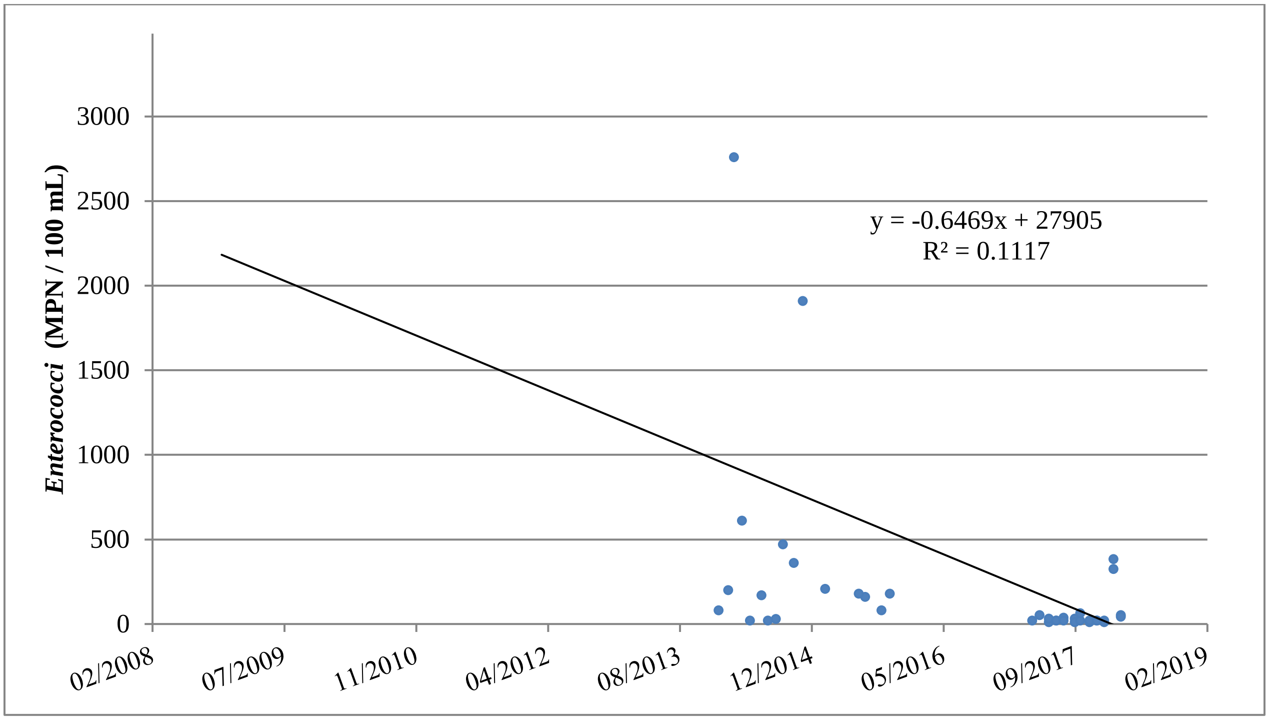

Figure 11: *Enterococci* over time at all sites within the San Bernard River watershed

San Bernard River Watershed Site by Site Analysis

The following sections will provide a brief summarization of analysis, by site. The average minimum and maximum values are reported in order to provide a quick overview of the watershed. The TDS, DO, and pH values are presented as an average, plus or minus the standard deviation from the average. Please see Table 6 on page 32, for a quick overview of the average results.

As previously mentioned in the 'Water Quality Parameters' section, TDS is an important indicator of turbidity and specific conductivity. The higher the TDS measurement, the more conductive the water is. A high TDS result can indicate increased nutrients present in the water. Site 80594 had the highest overall average for TDS, with a result of 3722 ± 3477 mg/L. Site 80770 had the lowest average TDS, with a result of 132 ± 72 mg/L.

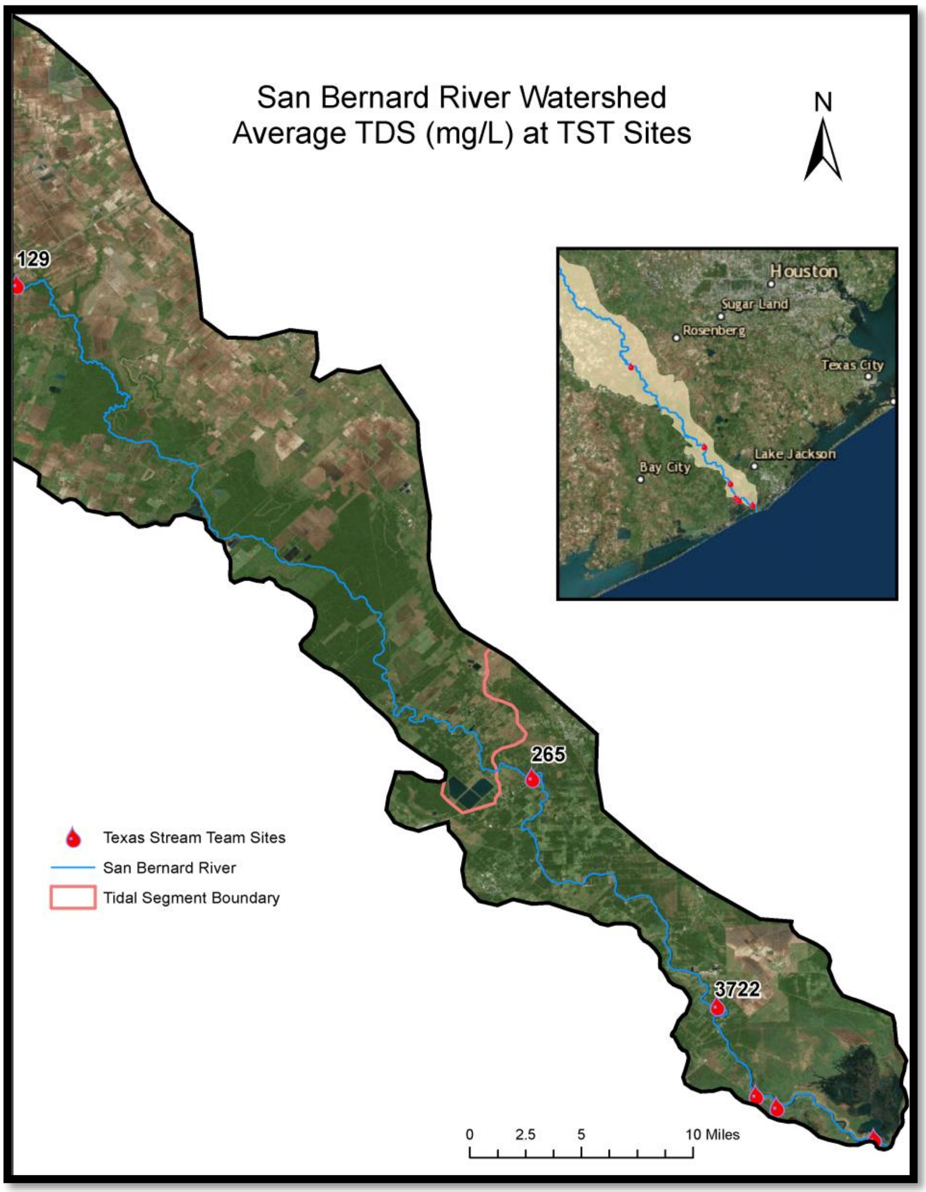

Figure 12: Map of the average total dissolved solids for sites in the San Bernard River watershed

The DO measurement can help to understand the overall health of the aquatic community. If there is a large influx of nutrients into the water body then there will be an increase in surface vegetation growth, which can reduce photosynthesis in the subsurface, thus decreasing the level of DO. Low DO can be dangerous for aquatic inhabitants which rely upon the DO to breathe. The DO levels can also be impacted by temperature; high temperature can limit the amount of oxygen solubility, which can also lead to a low DO measurement. Site 80770 had the lowest average DO reading with a result of 4.8 ± 1.4 mg/L. Site 80775 had the highest average DO reading with a result of 7.1 ± 6.2 mg/L.

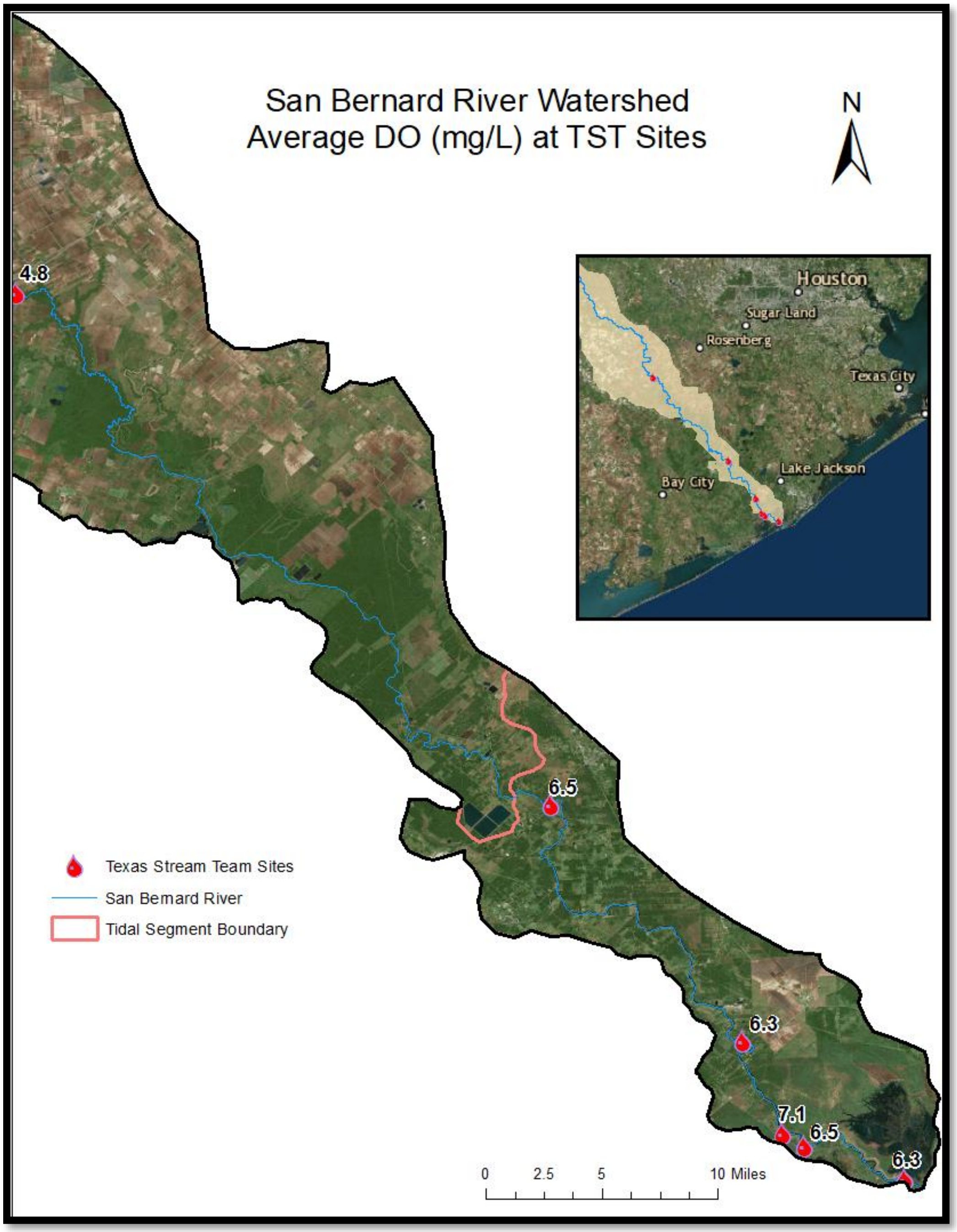

Figure 13: Map of the average dissolved oxygen for sites in the San Bernard River watershed

The pH levels are an important indicator for the overall health of the watershed as well. Aquatic inhabitants typically require a pH range between 6.5 and 9 for the most optimum environment. Anything below 6.5 or above 9 can negatively impact reproduction or can result in fish kills. There were no sampling events analyzed with pH levels reported outside of this widely accepted range. Site 80770 had the highest average pH level, with a result of 6.7 ± 0.3. Site 80509 had the highest average pH level, with a result of 7.6 ± 0.3.

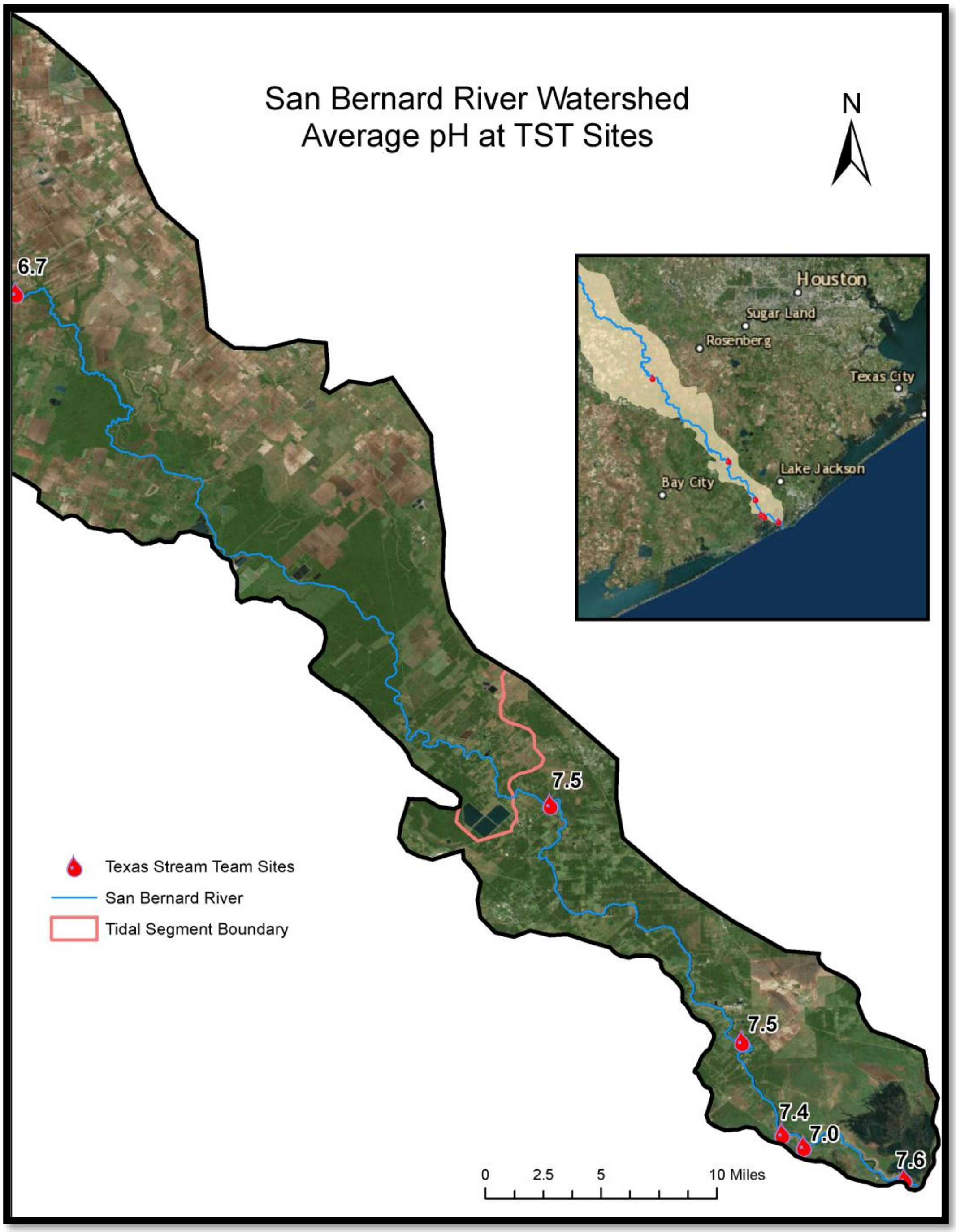

Figure 14: Map of the average pH for sites in the San Bernard River watershed

Salinity can be used to determine the dissolved salt content in a water body. Salinity is usually expressed in parts per thousand. Salinity gradients in estuaries must be maintained to support attainable estuarine dependent aquatic life uses. Numerical salinity criteria for Texas estuaries have not been established because of the high natural variability of salinity in estuarine systems, and because long-term studies by state agencies to assess estuarine salinities are still ongoing. Site 81005 had the highest average salinity level, with a result of 1.1 ± 2.8 ppt. Site 80509 had the highest average salinity level, with a result of 17.5 ± 12.2 ppt.

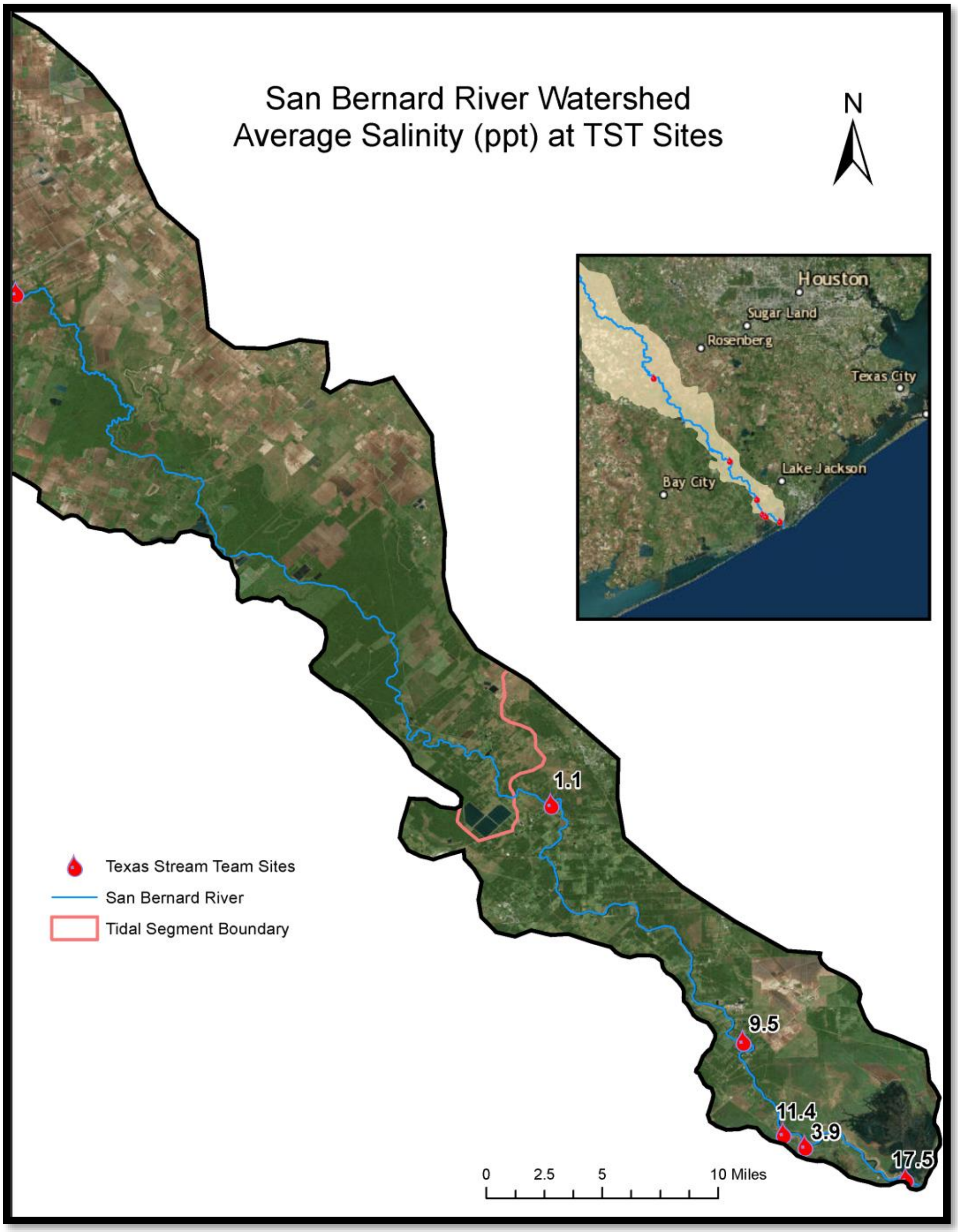

Figure 15: Map of the average salinity for sites in the San Bernard River watershed

Water transparency depends on the amount of particles in the water. When the water is murky or cloudy and contains a lot of particles, the light cannot penetrate as deeply into the water column. Sunlight provides the energy for photosynthesis and determines the depth at which algae and other plants can grow, defining the ecological make-up of a water body. TST citizen scientists use Secchi disks and transparency tubes to measure transparency depth in meters. Site 80770 had the lowest average transparency depth, with a result of 0.19 ± 0.12 meters. Site 80775 had the highest average transparency depth, with a result of 0.48 ± 0.21 meters.

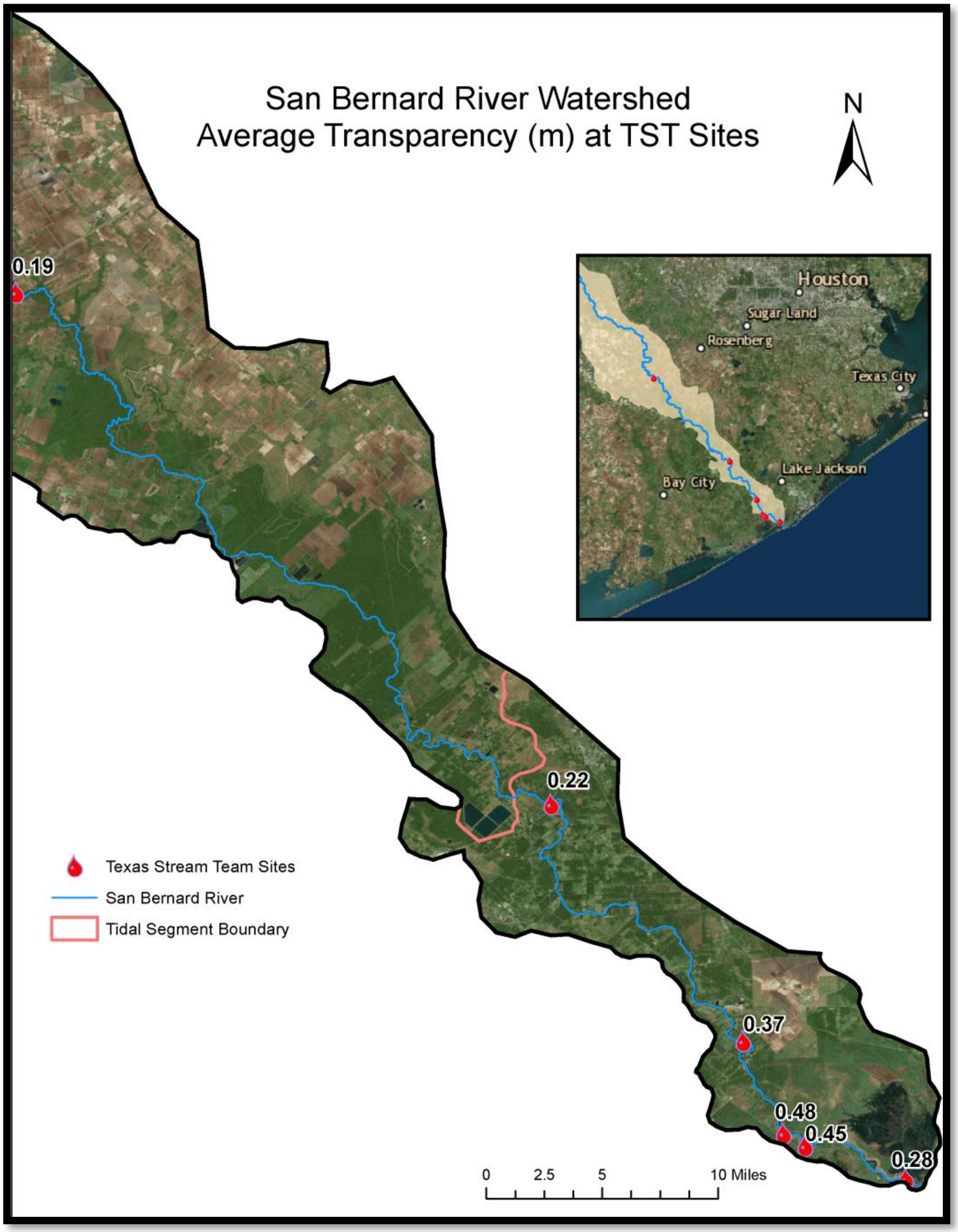

Figure 16: Map of the Transparency depth for sites in the San Bernard River watershed

Turbidity can be useful as an indicator of the effects of runoff from construction, agricultural practices, discharges, and other sources. Turbidity often increases sharply during rainfall, especially in developed watersheds, which typically have relatively high proportions of impervious surfaces. The flow of stormwater runoff from impervious surfaces rapidly increases stream velocity, which increases the erosion rates of streambanks and channels. Regular monitoring of turbidity can help detect trends that might indicate increasing erosion in developing watersheds. However, turbidity is closely related to stream flow and velocity and should be correlated with these factors. There were a few sampling events, at Site 81005, with turbidity measurements reported above 100 JTU. Site 81005 was the only Texas Stream Team site measured for chemical turbidity within the San Bernard River watershed, with an average turbidity measurement of 60 ± 60 JTU.

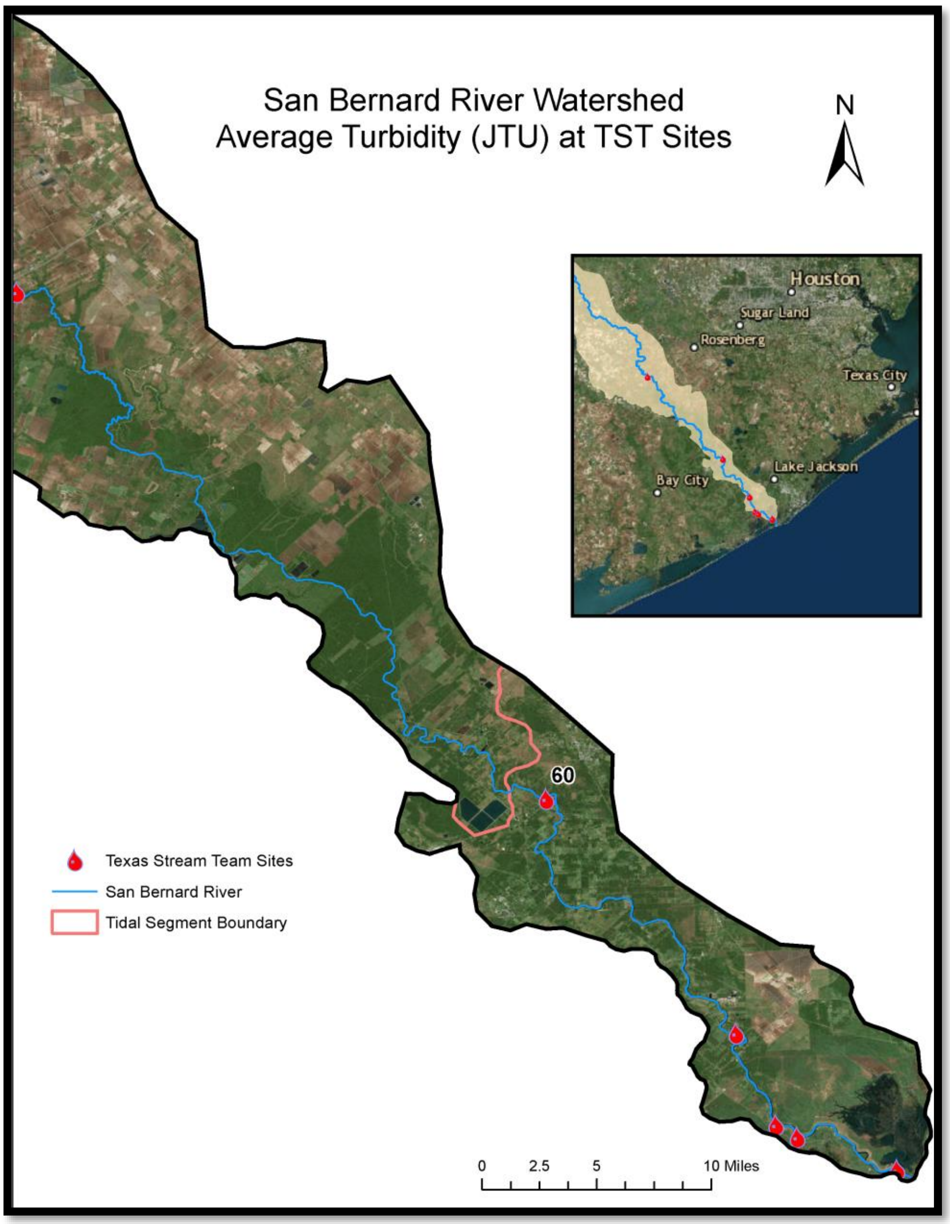

Figure 17: Map of Turbidity levels for sites in the San Bernard River watershed

Nitrates are essential plant nutrients, but in excess amount they can cause significant water quality problems. Excess nitrates can cause hypoxia (low DO) and can become toxic to warm-blooded animals at higher concentrations (10 mg/L or higher) under certain conditions. The natural level of ammonia or nitrate in surface water is typically low (less than 1 mg/L); in the effluent of wastewater treatment plants, it can range up to 30 mg/L. Sources of nitrates include wastewater treatment plants, runoff from fertilized lawns and cropland, failing on-site septic systems, runoff from animal manure storage areas, and industrial discharges that contain corrosion inhibitors. There was one sampling event, at Site 81005, with nitrate-nitrogen concentrations reported above 1 mg/L. Site 81005 had an average nitrate-nitrogen concentration of 1.05 ± 0.32 mg/L.

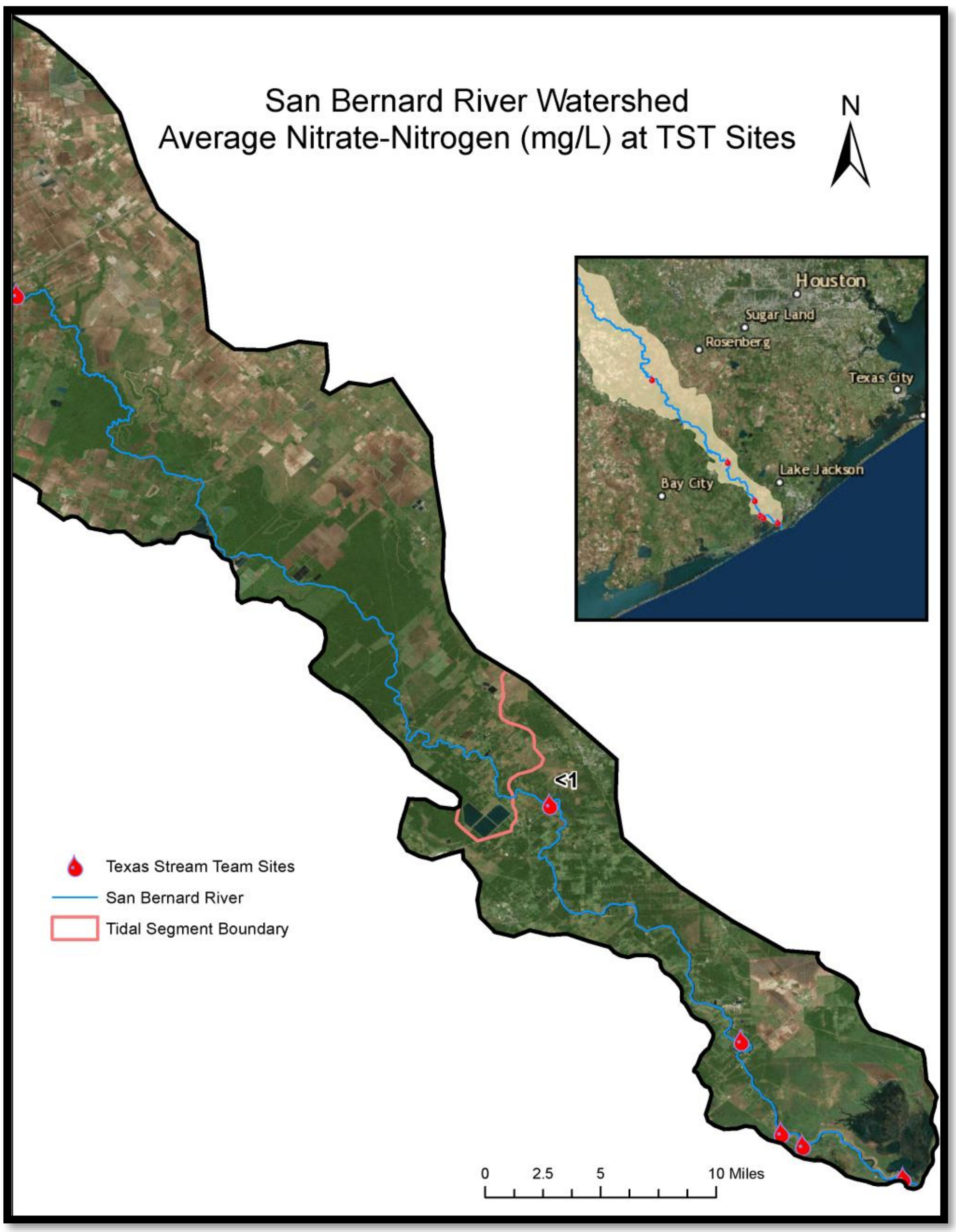

Figure 18: Map of the Nitrate-Nitrogen concentrations for sites in the San Bernard River watershed

Dense algal blooms or rapid plant growth can occur in waters rich in phosphorus, a limiting nutrient for eutrophication since it is typically in shortest supply. Sources are human and animal wastes and fertilizers. The EPA water quality criteria state that phosphates should not exceed 0.10 mg/L in streams or flowing waters not discharging into lakes or reservoirs to control algal growth. There were several sampling events, at Sites 81005, with orthophosphate concentrations reported above 0.10 mg/L. Site 81005 had an average orthophosphate concentration of 0.42 ± 0.25 mg/L.

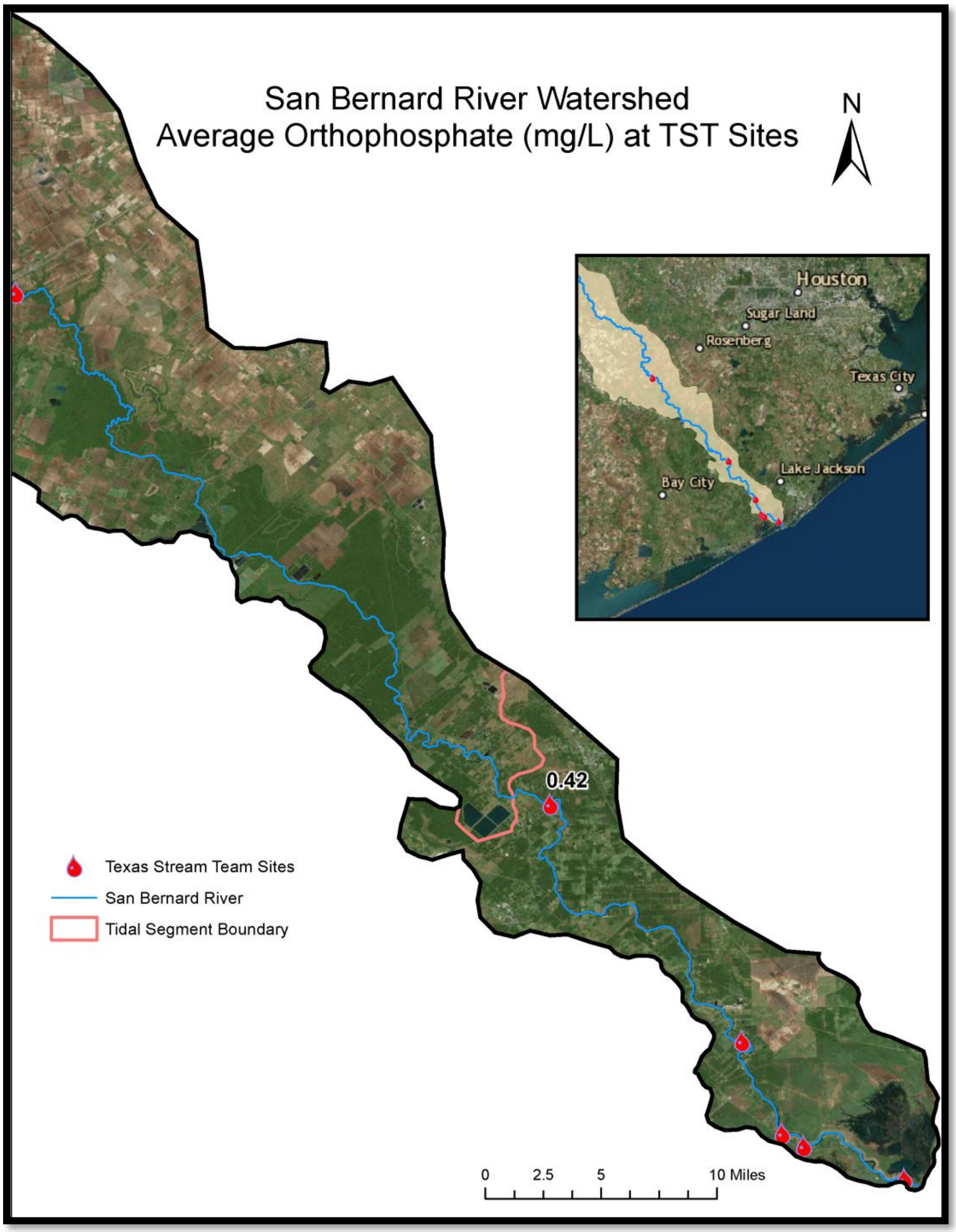

Figure 19: Map of the Orthophosphate concentrations for sites in the San Bernard River watershed

Enterococci are a group of indicator bacteria that indicates the presence or absence of fecal matter in the water and the potentially harmful microorganisms associated with fecal waste. Its presence above the TCEQ surface water quality standard for a single sample (89 MPN/100 mL) or geometric mean (35 MPN/100 mL) indicates a possible human health risk for primary contact recreation. There were a few sampling events at Site 81005 with elevated *IEnterococci* levels reported above the standard for a single sample and the geometric mean at Site 81005 was above 35 MPN/100 mL. Site 81005 had an *Enterococci* geomean of 225 ± 1540 MPN/100 mL.

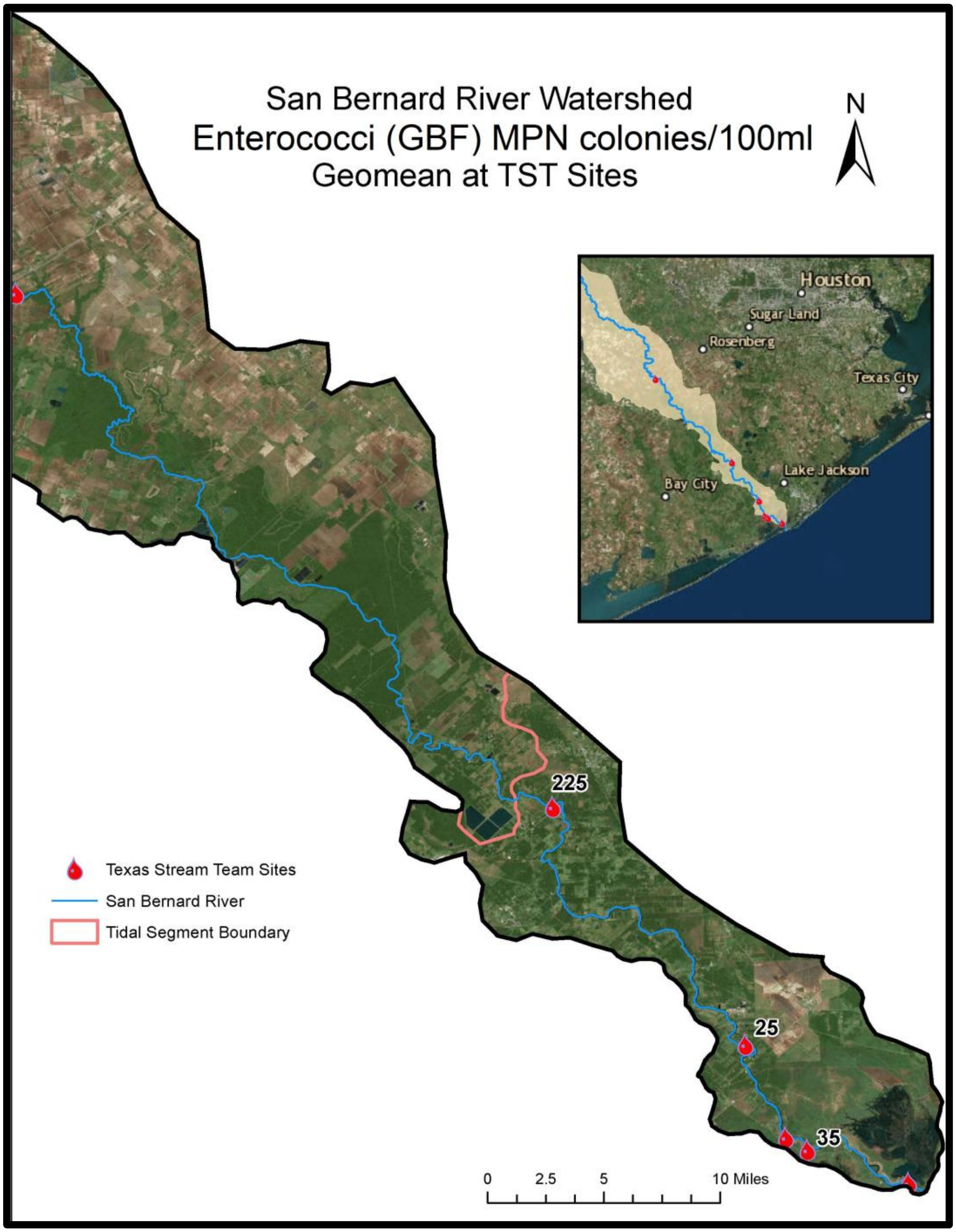

Figure 20: Map of the *Enterococci* levels for sites in the San Bernard River watershed

See Table 5 for a summary of average results at all sites. Additionally, it is important to note that there was variation in the number of times each site was tested, the time of day at which each site was tested, and the time of month the sampling occurred. Another aspect to consider is that citizen scientists are asked to conduct water quality testing within a two-hour timeframe each month. While this is a quick overview of the results, it is important to note the natural diurnal and seasonal variation in these water quality parameters. Texas Stream Team citizen scientist data is not used by the state to assess whether water bodies are meeting the designated surface water quality standards.

Table 5: Average Values for all sites

Site	TDS (mg/L)	DO (mg/L)	pH	Salinity (ppt)	Transparency (m)	Turbidity (JTU)	Nitrate-Nitrogen (mg/L)	Orthophosphate (mg/L)	*Enterococci* (MPN/ 100 mL)
80770	132 ± 72	4.8 ± 1.4	6.7 ± 0.3	N/A	0.19 ± 0.12	N/A	N/A	N/A	N/A
81005	272 ± 265	6.5 ± 1.8	7.6 ± 0.6	1 ± 3	0.22 ± 0.11	60 ± 60	1 ± 0	0.42 ± 0.25	225 ± 1540
80594	3722 ± 3477	6.3 ± 1.7	7.5 ± 0.4	10 ± 9	0.37 ± 0.20	N/A	N/A	N/A	25 ± 84
80775	N/A	6.0 ± 1..7	7.4 ± 0.5	12.5 ± 9.9	0.48 ± 0.21	N/A	N/A	N/A	N/A
81091	N/A	6.5 ± 1.5	7.0 ± 0.0	3.9 ± 4.2	0.45 ± 0.31	N/A	N/A	N/A	35 ± 107
80509	N/A	6.3 ± 1.7	7.6 ± 0.3	17.5 ± 12.2	0.29 ± 0.17	N/A	N/A	N/A	N/A

Site 80770 – San Bernard River at Bates M. Allen Park

Site Description

This site is located at a Fort Bend County Park downstream from US 59. Bates M. Allen Park includes wetlands, walking trails, fishing piers, lake, and canoe ramps. The site is monitored just downstream from SWQM Station 17420 which is immediately downstream of US 59 in the freshwater Segment 1302.

Sampling Information

This site was sampled 59 times from February 2012 to February 2018.

Table 6: Descriptive parameters for Site 80770

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	56	132 ± 72	52	377
Water Temperature (°C)	59	22.7 ± 5.8	11.6	32.9
Dissolved Oxygen (mg/L)	59	4.8 ± 1.4	2.1	8.5
pH (su)	59	6.7 ± 0.3	6.0	7.5
Transparency (m)	59	0.19 ± 0.12	0.01	0.51

Site 80770 was sampled 59 times between 2/29/2012 and 2/20/2018.

Air and water temperature

There were 59 air and 59 water temperature measurements taken at this site. The mean water temperature was 22.7 °C. The minimum water temperature was 11.6 °C and was recorded in December of 2016. The maximum water temperature was 32.9 °C and was recorded in July of 2015. The air temperature ranged from a low of 9.5 °C recorded in December of 2016 to a high of 35.6 °C recorded in July of 2015.

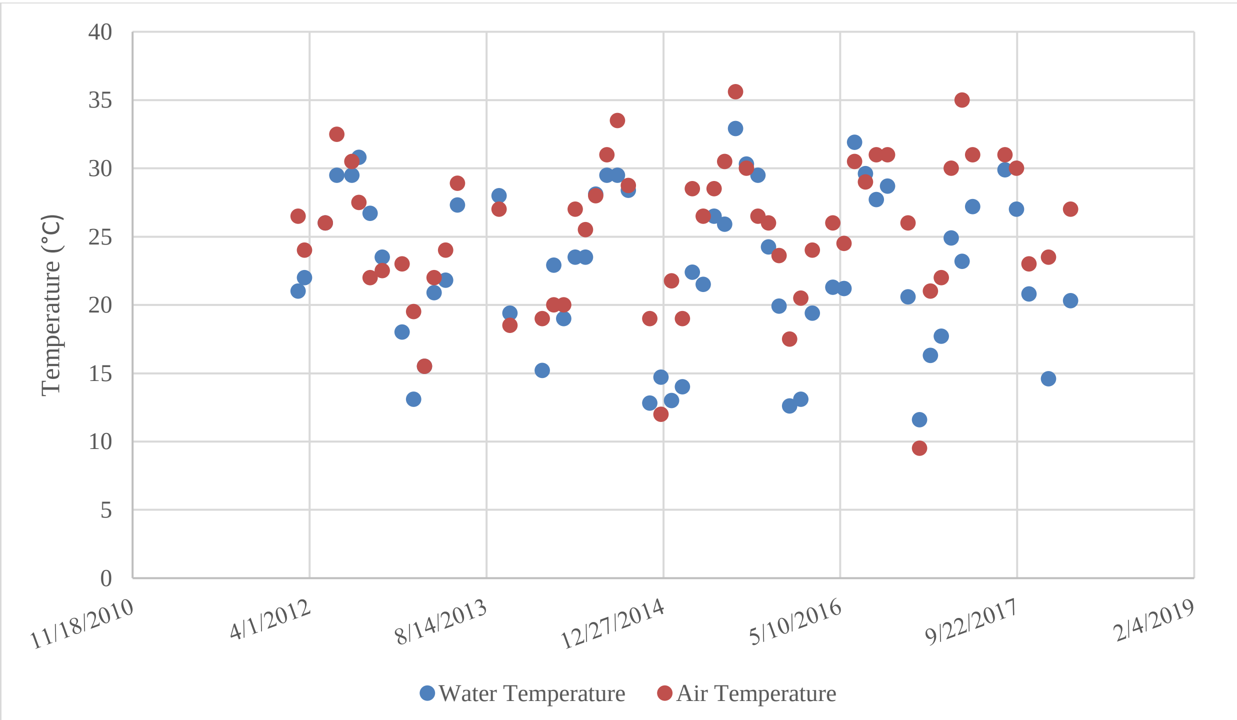

Figure 21: Air and water temperature at site 80770

Total Dissolved Solids

Citizen scientists collected 56 TDS measurements at this site. The mean TDS concentration was 132 mg/L. The minimum TDS measurement was recorded in June and December of 2015 and was 52 mg/L. The maximum TDS measurement was 377 mg/L and was recorded in November of 2016. There was no relationship between TDS concentrations and time observed at this site.

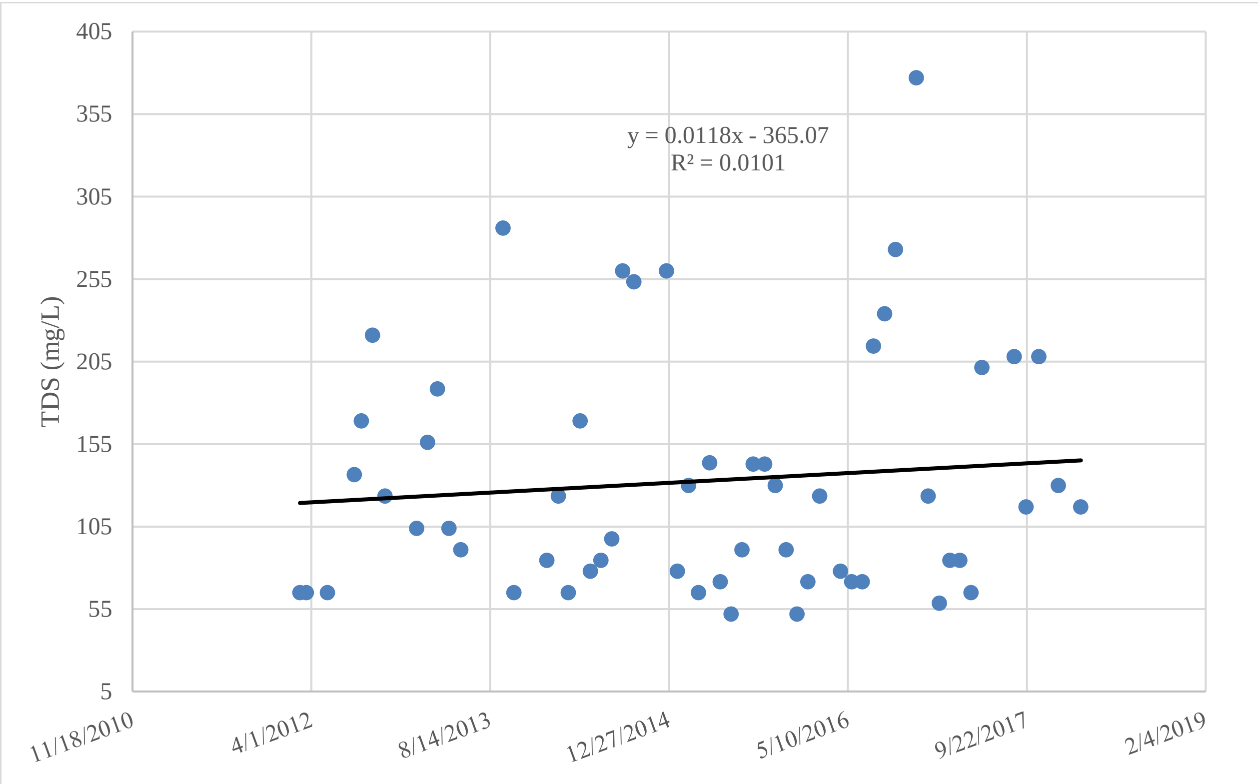

Figure 22: Total Dissolved Solids at site 80770

Dissolved Oxygen

Citizen scientists collected 59 DO samples at this site. The mean DO concentration was 4.8 mg/L and it ranged from a low of 2.1 mg/L in August 2016 to a high of 8.5 mg/L in April 2014. There was no relationship between DO concentrations and time observed at this site.

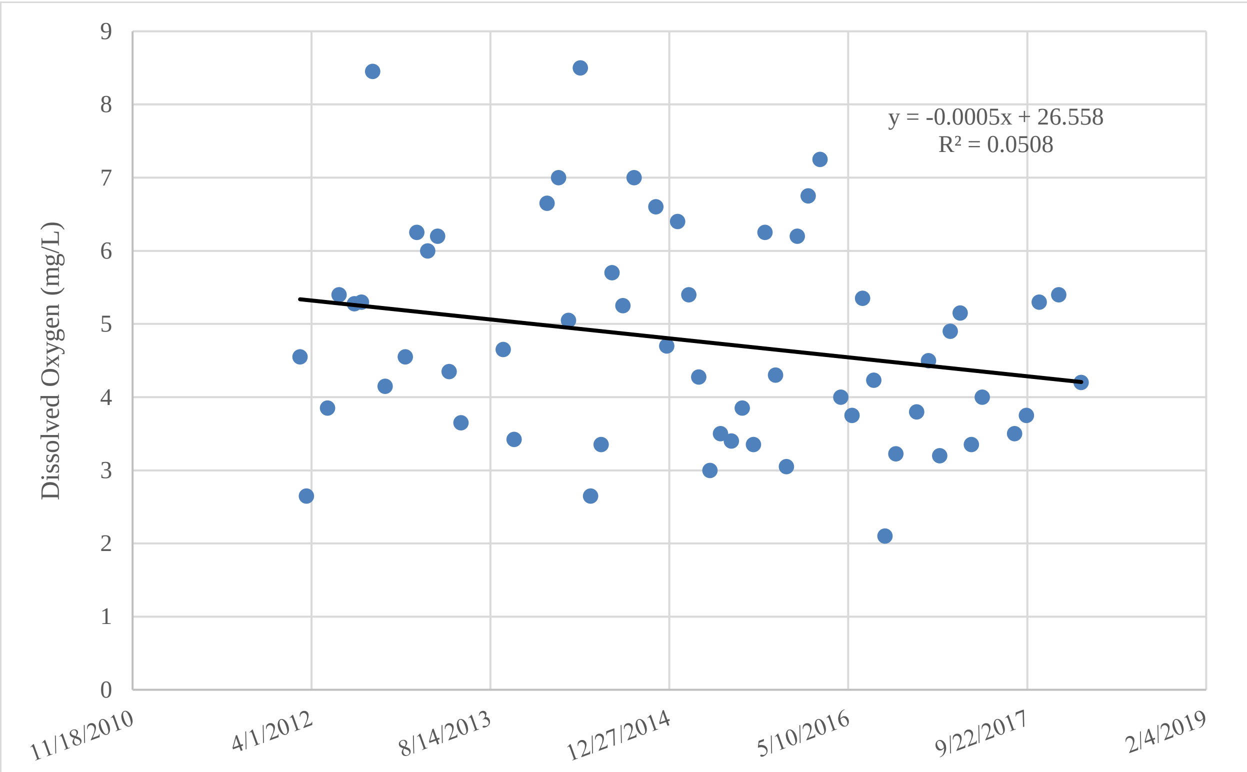

Figure 23: Dissolved Oxygen at site 80770

pH

There were 59 pH samples taken at this site. The mean pH was 6.7 and it ranged from a low of 6.0 which occurred in January, March, and December of 2015 to a high of 7.5 which occurred several times at this site. There was no significant relationship between pH and time observed at this site.

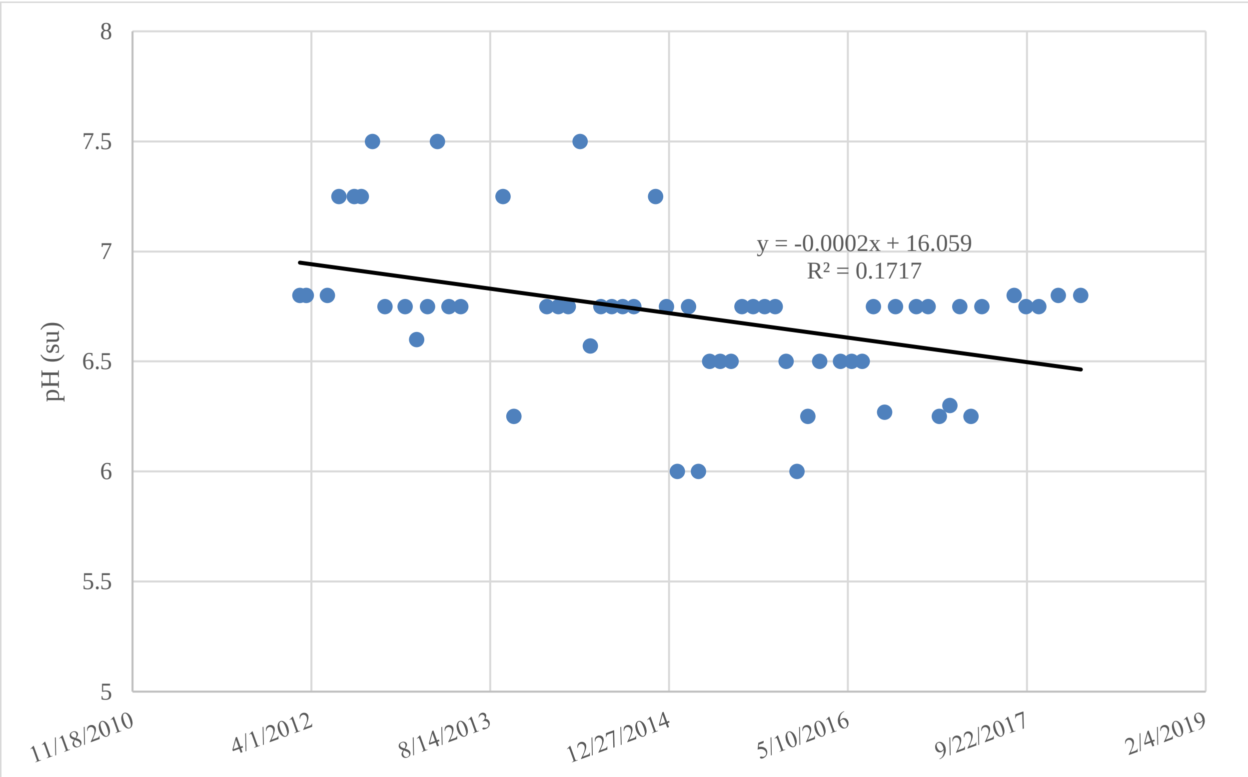

Figure 24: pH at site 80770

Transparency

Citizen scientists collected a total of 59 transparency measurements at this site. The mean was 0.19 m with the minimum of 0.01 m which in May of 2012 and the maximum of 0.51 m which occurred in October of 2013. There was no significant relationship between pH and time observed at this site.

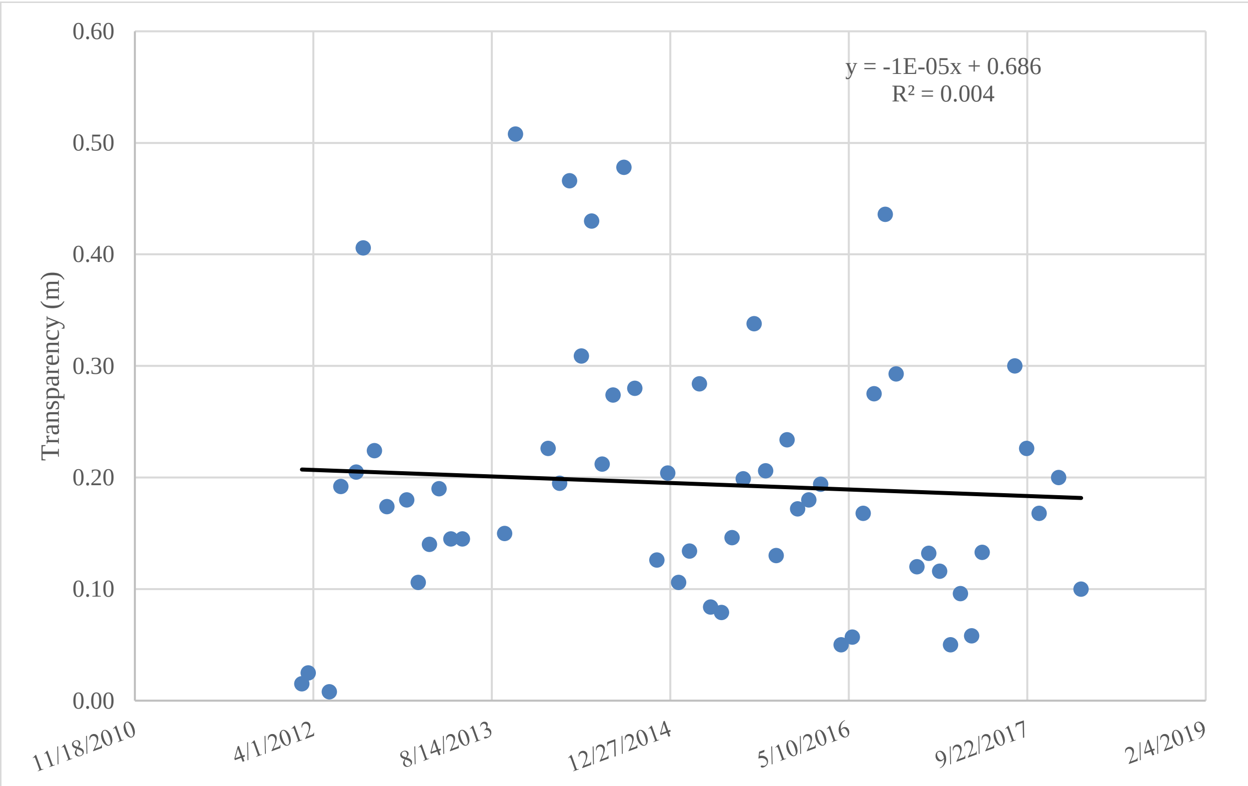

Figure 25: Transparency at site 80770

Site 81005 – San Bernard River at Hanson Riverside County Park

Site Description

This site is located at a Brazoria County park downstream from SH 35. Hanson Riverside County Park is a 75-acre wooded day-use park along the San Bernard River near West Columbia and Sweeny. The site is monitored just downstream from SWQM Station 20460 at SH 35 in the tidal Segment 1301.

Sampling Information

This site was sampled 41 times from January 2014 to March 2018.

Table 7: Descriptive parameters for Site 81005

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	29	272 ± 265	37	1053
Water Temperature (°C)	41	22.6 ± 6.6	9.5	3.33
Dissolved Oxygen (mg/L)	40	6.5 ± 1.8	3.1	11.2
pH (su)	40	7.6 ± 0.6	6.7	9.5
Salinity (ppm)	30	1.1 ± 3	0	12.2
Transparency (m)	41	0.22 ± 0.11	0.05	0.54
Turbidity (JTU)	37	60 ± 60	10	200
Nitrate-Nitrogen (mg/L)	37	1 ± 0	1	3
Orthophosphate (mg/L)	38	0.42 ± 0.25	0.00	1.20
Enterococci (CFU/100 mL)	17	225 ± 1540	20	6257

Site 81005 was sampled 41 times between 1/8/2014 and 3/17/2018.

Air and water temperature

There were 40 air and 41 water temperature measurements taken at this site. The mean water temperature was 22.6 °C. The minimum water temperature was 9.5 °C and was recorded in January of 2014. The maximum water temperature was 33.3 °C and was recorded in July of 2017. The air temperature ranged from a low of 7.3 °C recorded in January of 2018 to a high of 35.1 °C recorded in July of 2017.

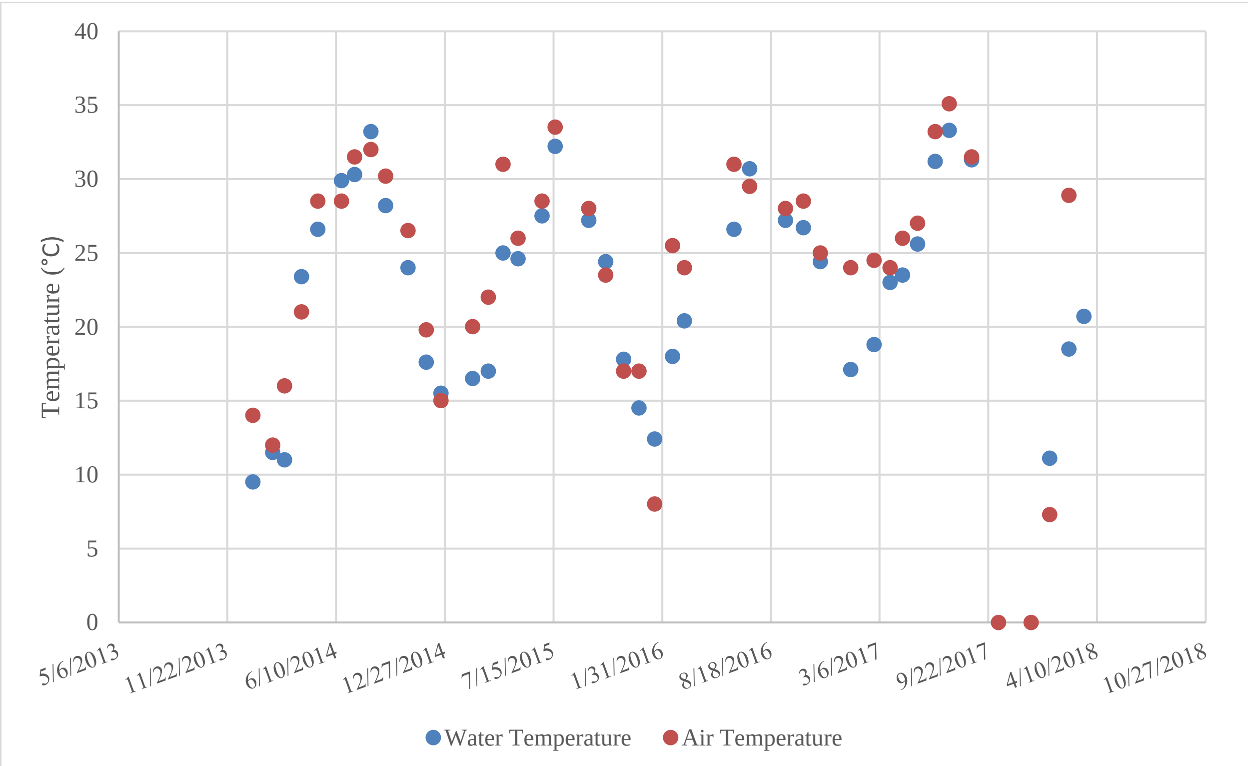

Figure 26: Air and water temperature at site 81005

Total Dissolved Solids

Citizen scientists collected 29 TDS measurements at this site. The mean TDS concentration was 272 mg/L. The minimum TDS measurement was recorded in September of 2014 and was 37 mg/L. The maximum TDS measurement was 1053 mg/L and was recorded in October of 2014. There was no relationship between TDS concentrations and time observed at this site.

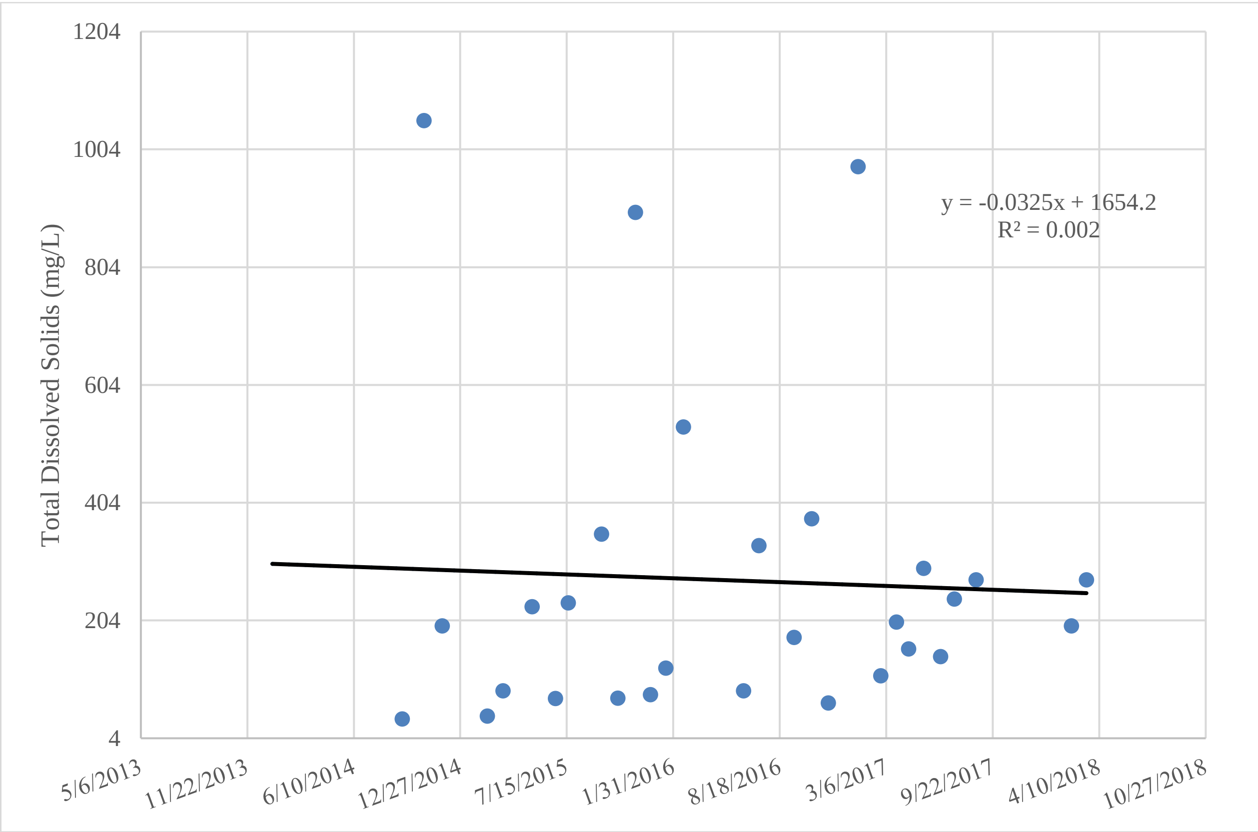

Figure 27: Total dissolved solids at site 81005

Dissolved Oxygen

Citizen scientists collected 40 DO samples at this site. The mean DO concentration was 6.5 mg/L and it ranged from a low of 3.1 mg/L in August of 2017 to a high of 11.2 mg/L in May of 2014. There was no relationship between DO concentrations and time observed at this site.

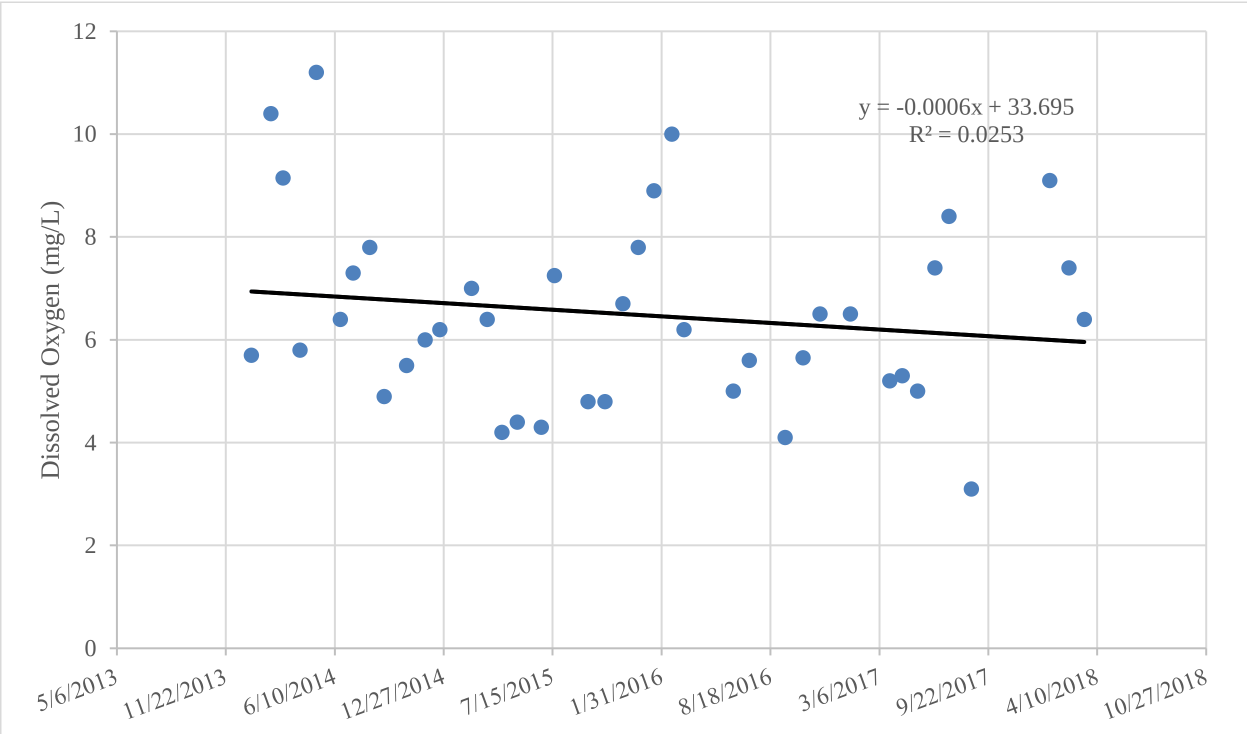

Figure 28: Dissolved oxygen at site 81005

pH

There were 41 pH samples taken at this site. The mean pH was 7.5 and it ranged from a low of 4.45 in January of 2017 to a high of 9.5 in May of 2014. There was no significant relationship between pH and time observed at this site.

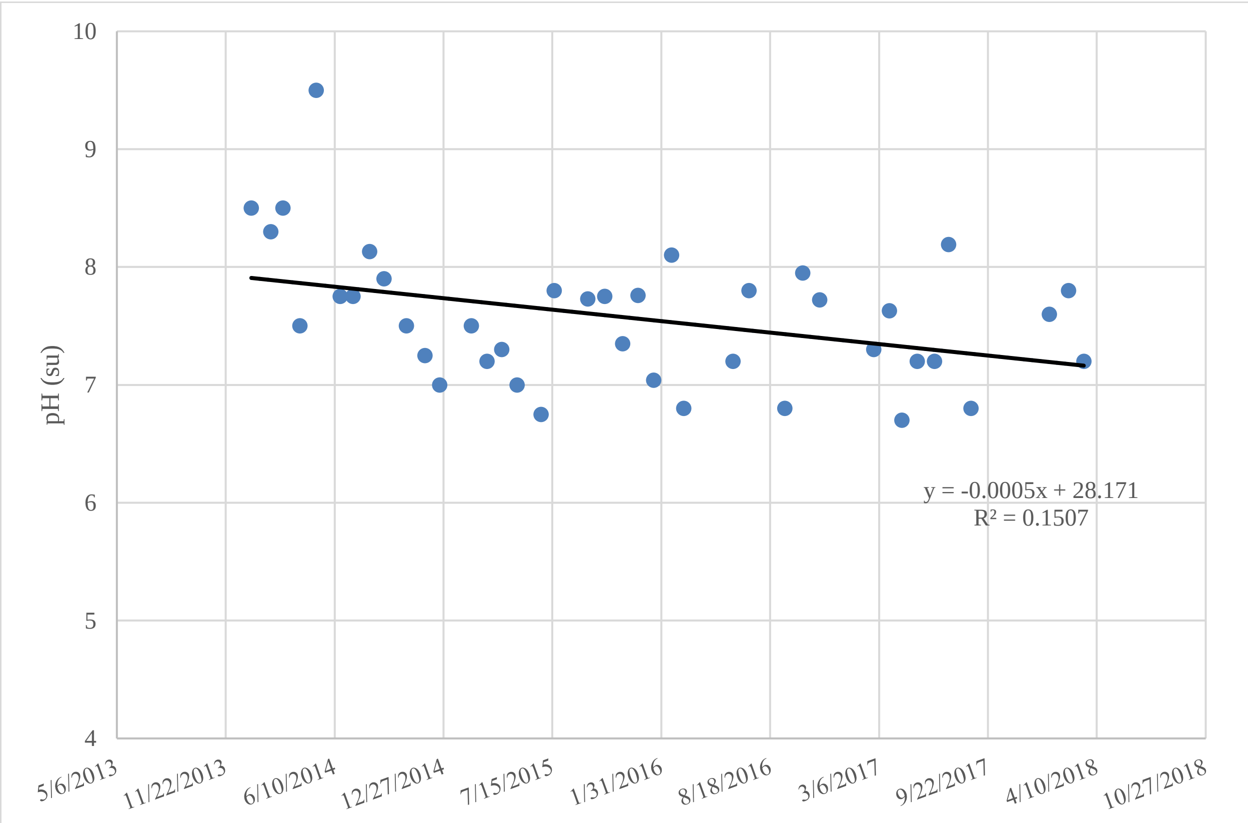

Figure 29: pH at site 81005

Salinity

Citizen scientists collected 30 salinity concentrations at this site. The mean salinity was 1 ppt. The minimum salinity measurement was 0.0 ppt and it was recorded several times during sampling events. The maximum salinity measurement was 12.2 ppt and was recorded in February of 2014. There was no relationship between salinity concentrations and time observed at this site.

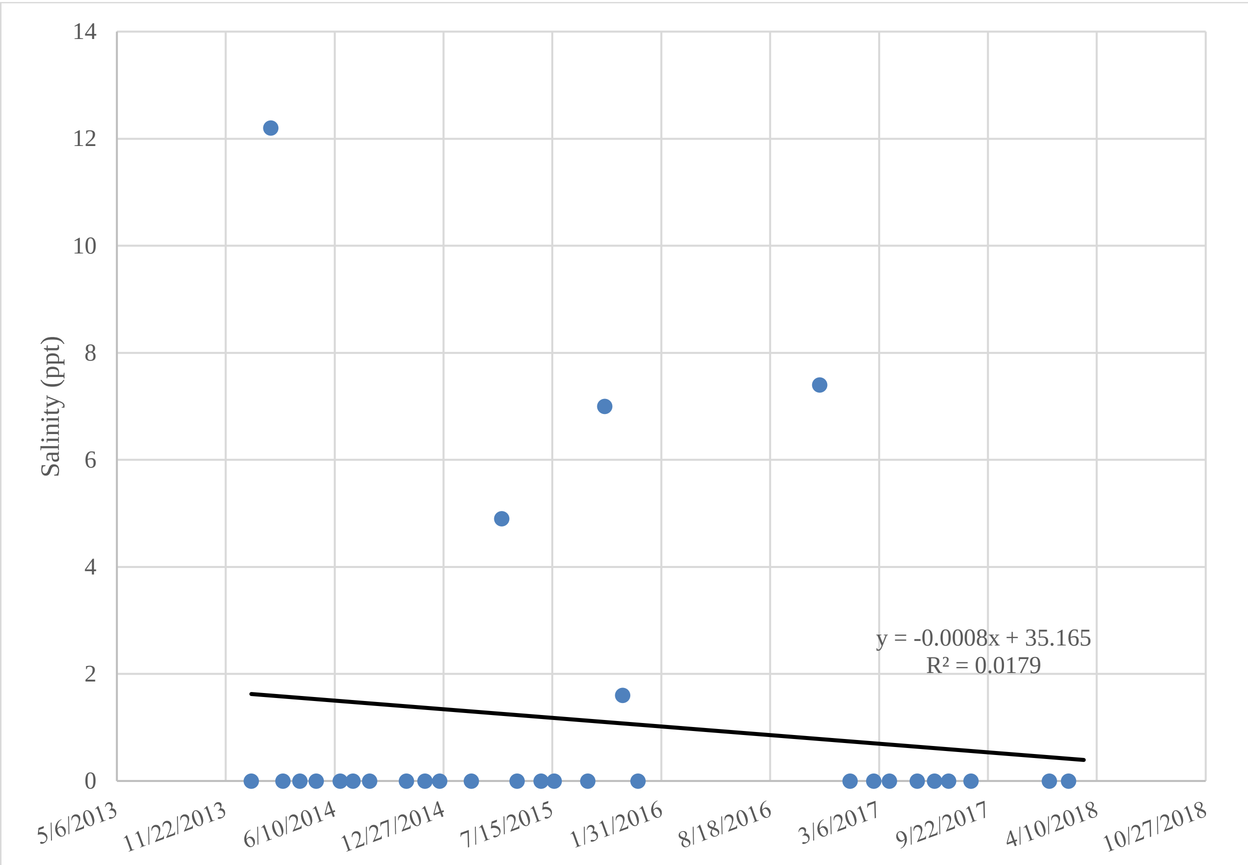

Figure 30: Salinity at site 81005

Transparency

There were 41 transparency measurements taken at this site. The mean transparency was 0.22 m. The minimum transparency measurement was recorded in March of 2016 and was 0.05 m. The maximum transparency measurement was 0.54 m and was recorded in August of 2017. There was no relationship between transparency and time observed at this site.

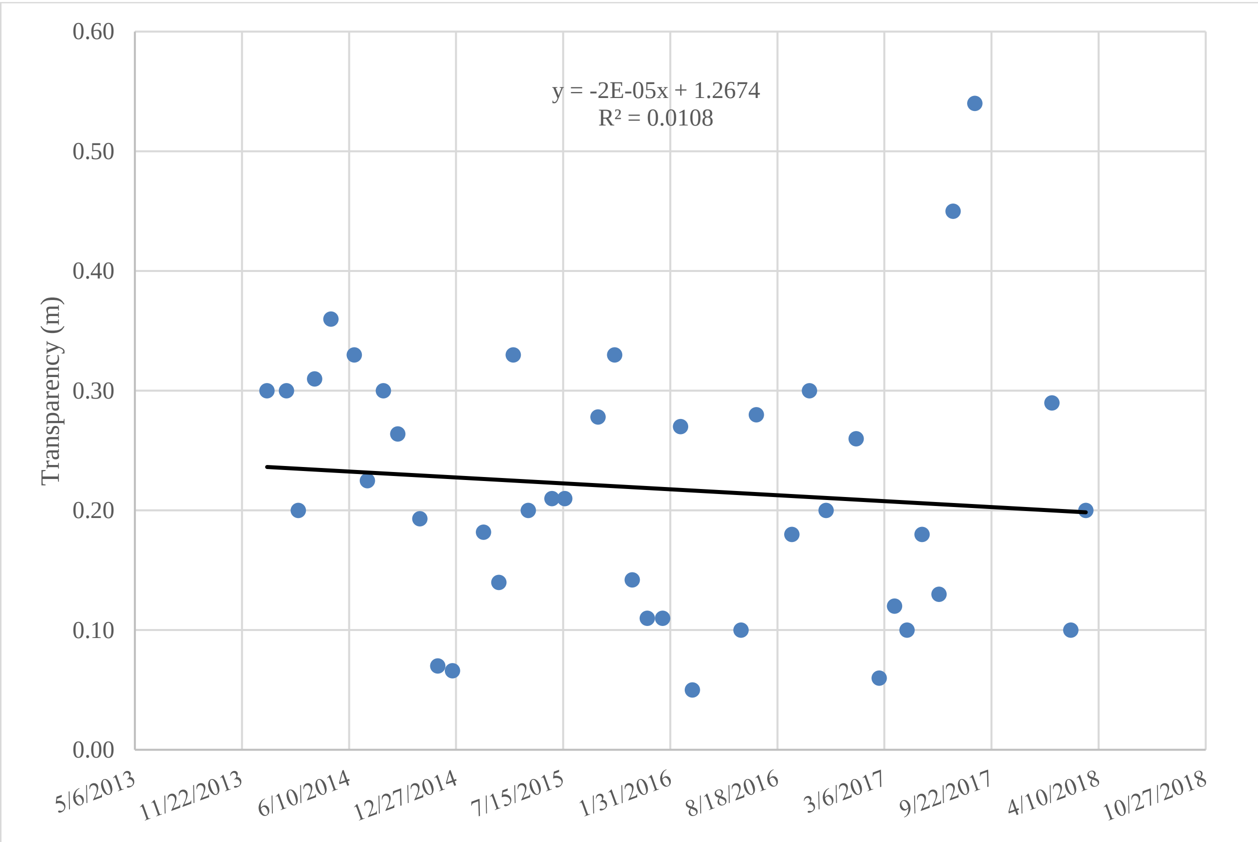

Figure 31: Transparency at site 81005

Turbidity

There were 37 turbidity samples taken at this site. The mean turbidity was 60 NTU. The minimum turbidity measurement was recorded in February of 2014 and October of 2015 and was 10 NTU. The maximum turbidity measurement was 200 NTU and was recorded several times. There was no relationship between turbidity and time observed at this site.

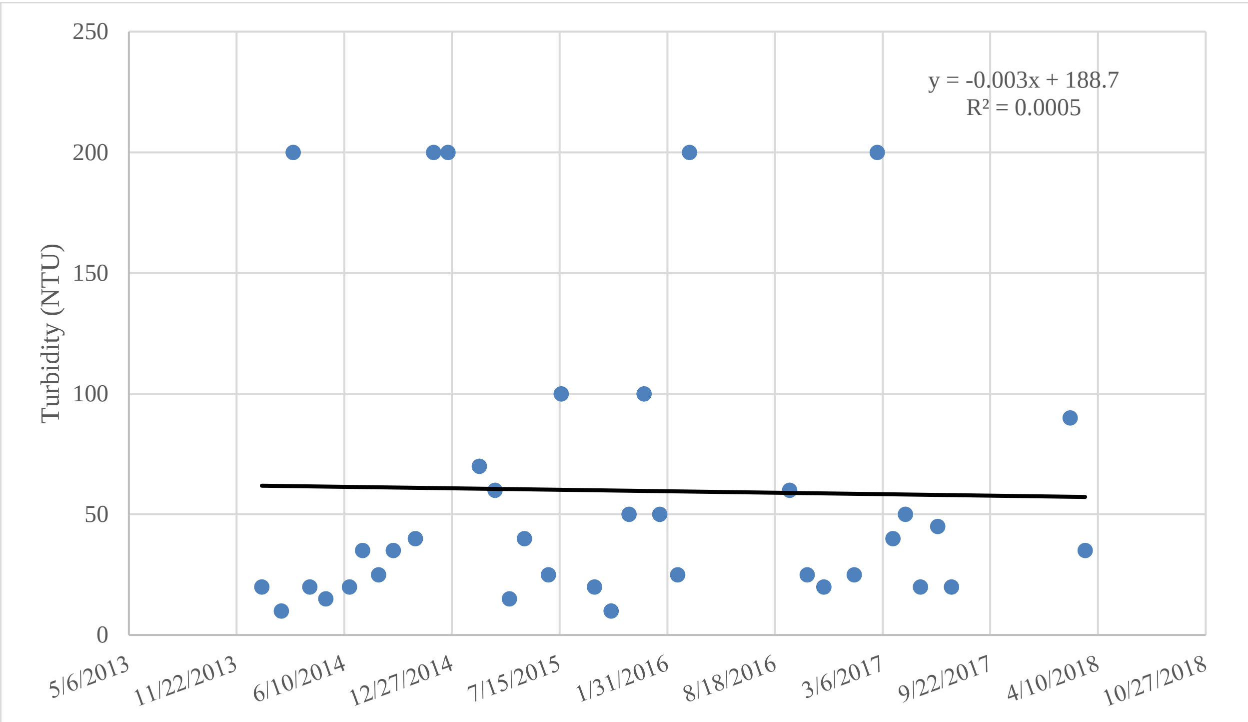

Figure 32: Turbidity at site 81005

Nitrate-Nitrogen

There were 37 nitrate-nitrogen samples collected at this site. The mean nitrate-nitrogen concentration was 1 mg/L. The minimum TDS measurement was recorded several times and was 1 mg/L. The maximum TDS measurement was 3 mg/L and was recorded in March of 2014. There was no relationship between nitrate-nitrogen concentrations and time observed at this site.

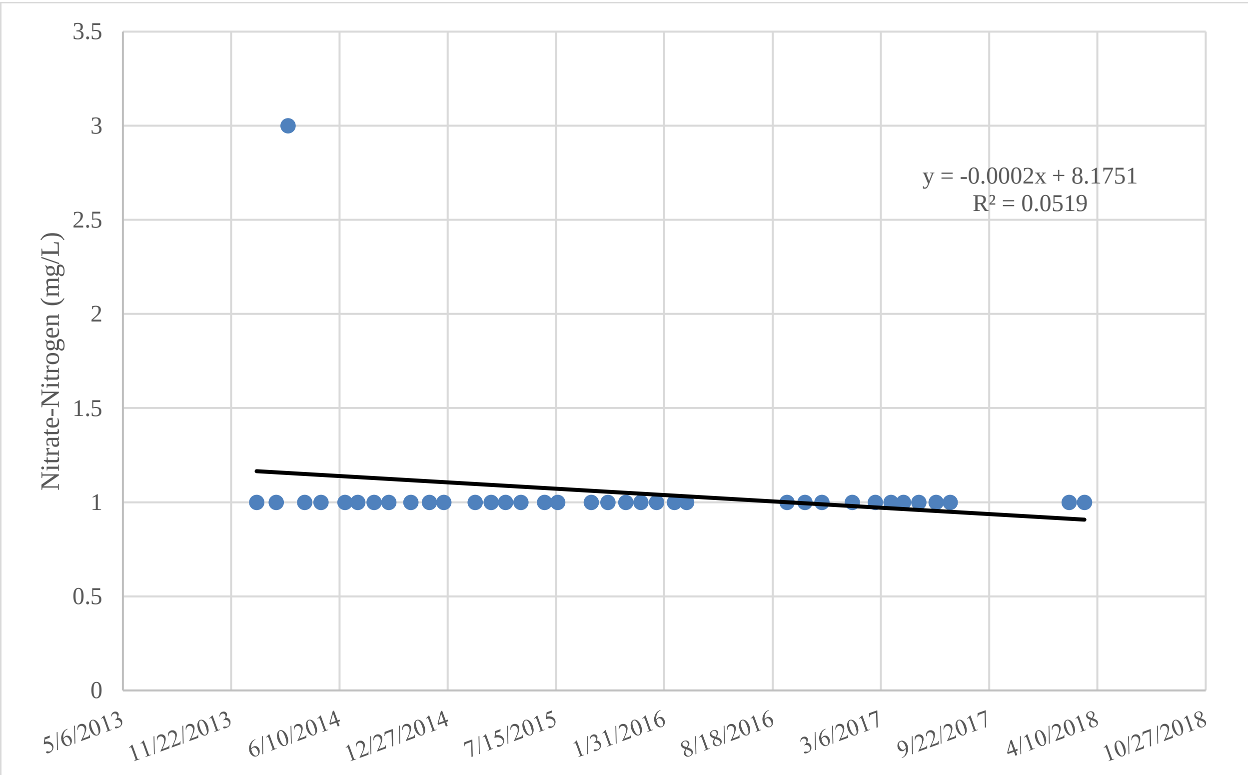

Figure 33: Nitrate-Nitrogen at site 81005

Orthophosphate

Citizen scientists collected 38 orthophosphate concentrations at this site. The mean orthophosphate concentration was 0.42 mg/L. The minimum orthophosphate measurement was recorded in April of 2015 and was 0.02 mg/L. The maximum orthophosphate measurement was 1.2 mg/L and was recorded in September of 2014. There was no relationship between orthophosphate concentrations and time observed at this site.

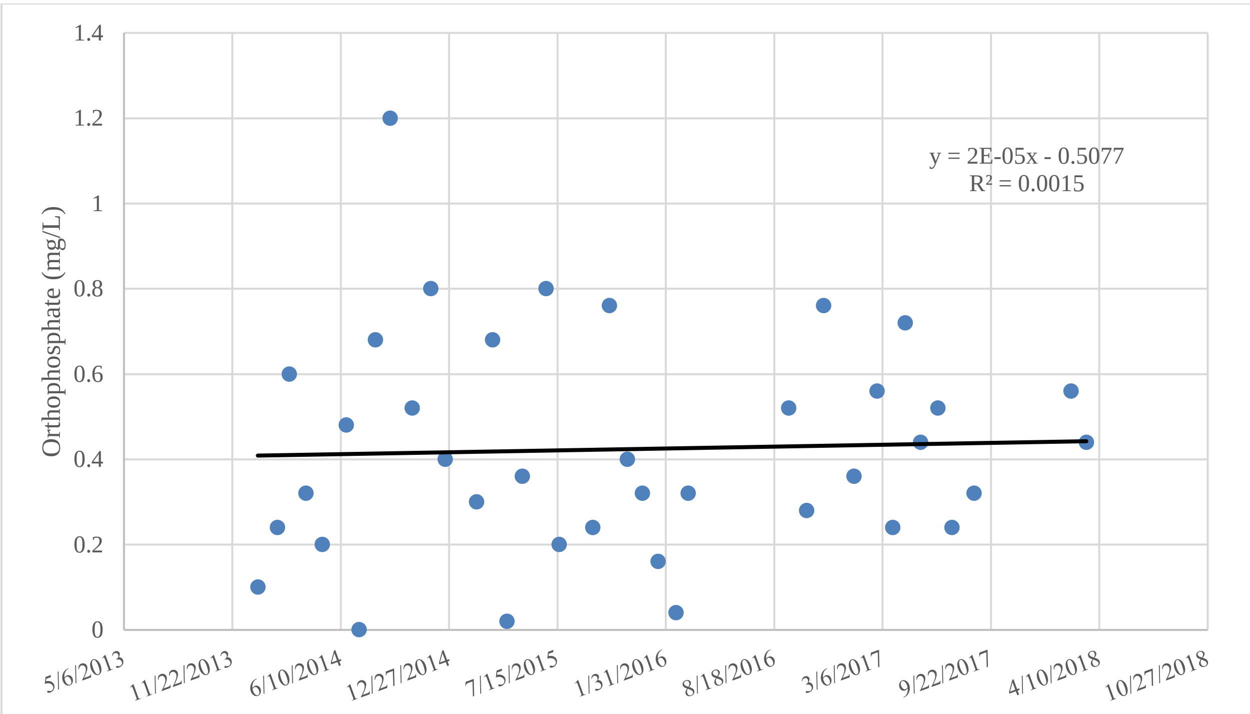

Figure 34: Orthophosphate at site 81005

Enterococci

Citizen scientists collected a total of 17 *Enterococci* measurements at this site. The geomean was 225 CFU/100 mL. The minimum was 20 CFU/100 mL which occurred in May and July of 2014 and the maximum was 6257 CFU/100 mL which occurred in December of 2014. There was no significant increase or decrease in *Enterococci* over time observed at this site.

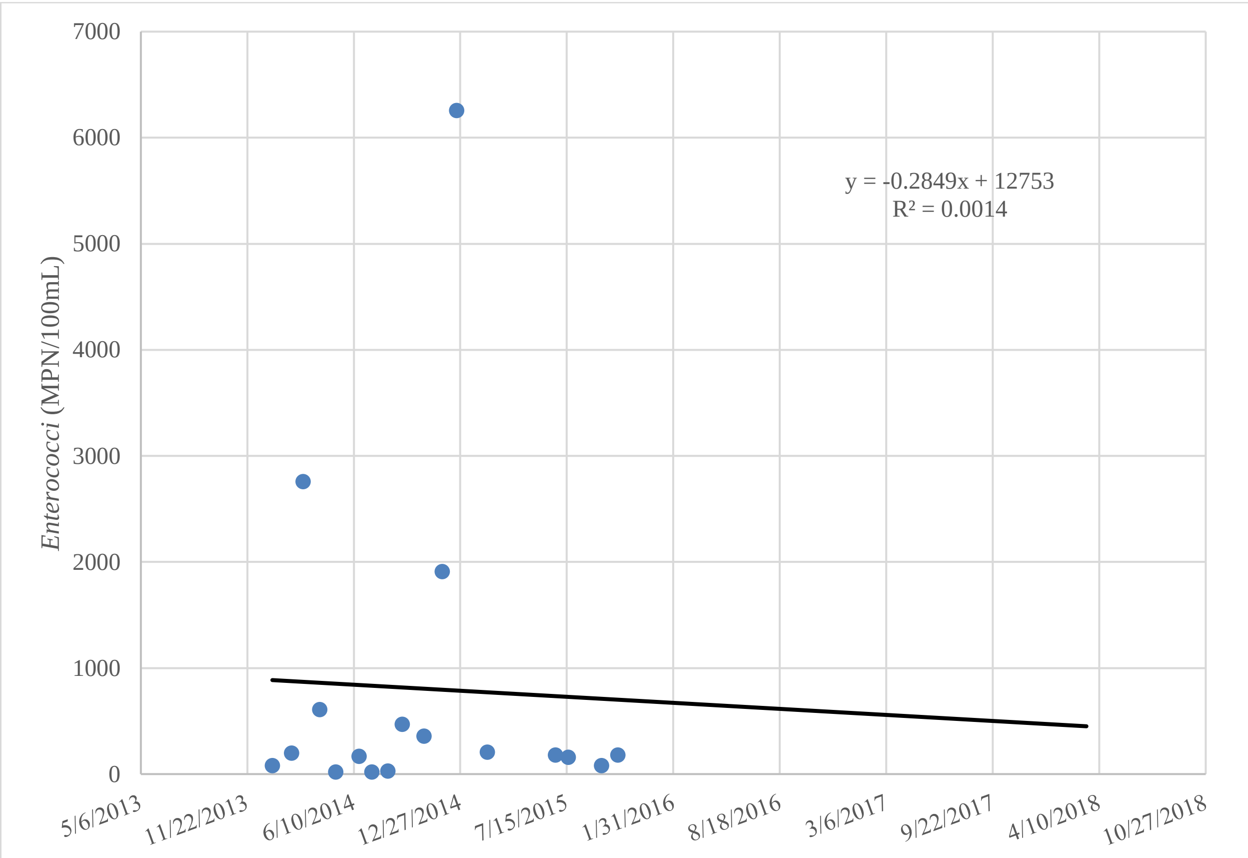

Figure 35: *Enterococci* at site 81005

Site 80594 – San Bernard River at 2649 County Road 496

Site Description

This site is located south of the town of Brazoria. The site is located on a monitor's dock along a residential area on the San Bernard River. This site is surrounded by open farm land and suburban areas with a slight riparian zone observed.

Sampling Information

This site was sampled 84 times from July 2010 to March 2018.

Table 8: Descriptive parameters for Site 80594

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Total Dissolved Solids (mg/L)	62	3722 ± 3477	65	12870
Water Temperature (°C)	84	23.1 ± 6.3	10.5	33.0
Dissolved Oxygen (mg/L)	84	6.3 ± 1.7	2.9	11.1
pH (su)	83	7.5 ± 0.4	6.9	8.5
Salinity (ppt)	34	10 ± 9	0.12	32
Transparency (m)	66	0.37 ± 0.20	0.07	1.07
E. coli (CFU/100 mL)	12	24.89 ± 84.26	10	324

Site 80594 was sampled 83 times between 9/7/2018 and 1/16/2018.

Air and water temperature

There were 83 air and 84 water temperature measurements taken at this site. The mean water temperature was 23.1 °C. The minimum water temperature was 10.5 °C and was recorded in December of 2013. The maximum water temperature was 33.0 °C and was recorded in June of 2013. The air temperature ranged from a low of 5.0 °C recorded in January of 2013 to a high of 32.0 °C recorded in August of 2015.

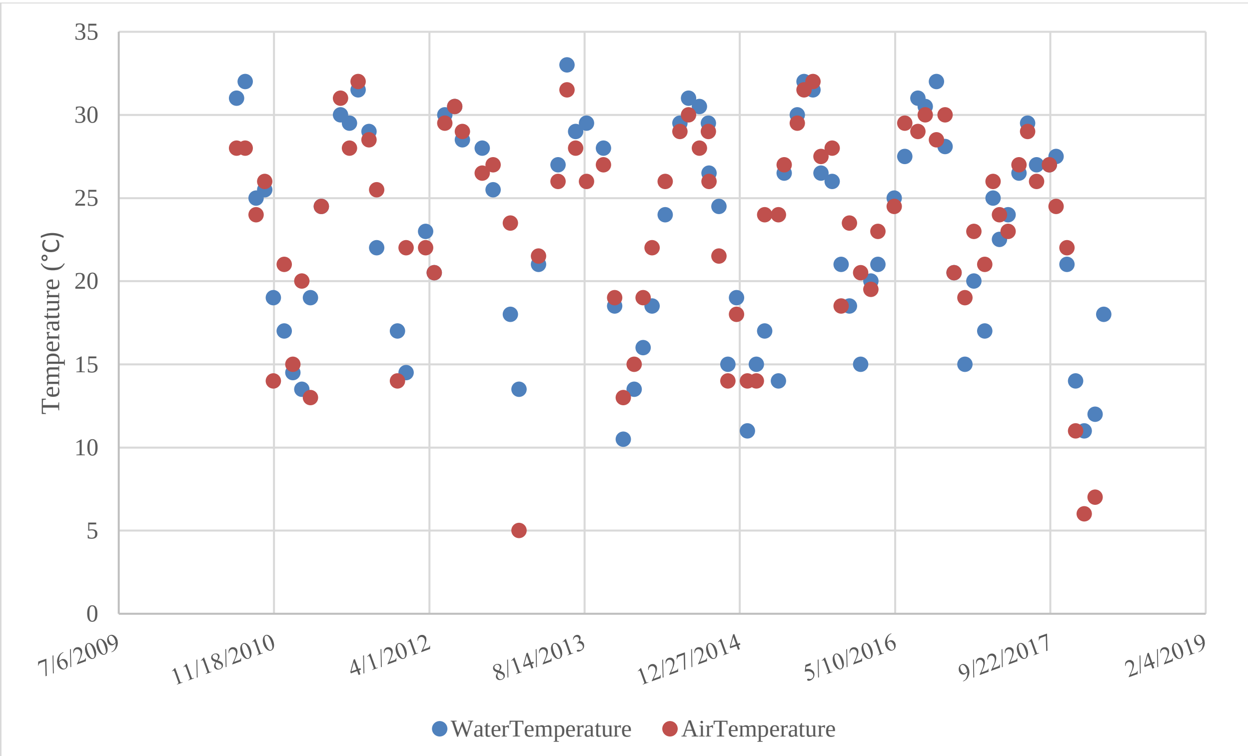

Figure 36: Air and water temperature at site 80594

Total Dissolved Solids

Citizen scientists collected 62 TDS measurements at this site. The mean TDS concentration was 3722 mg/L. The minimum TDS measurement was recorded in March of 2015 and was 65 mg/L. The maximum TDS measurement was 12,870 mg/L and was recorded in October of 2015. There is no significant relationship between TDS concentrations and time observed at this site.

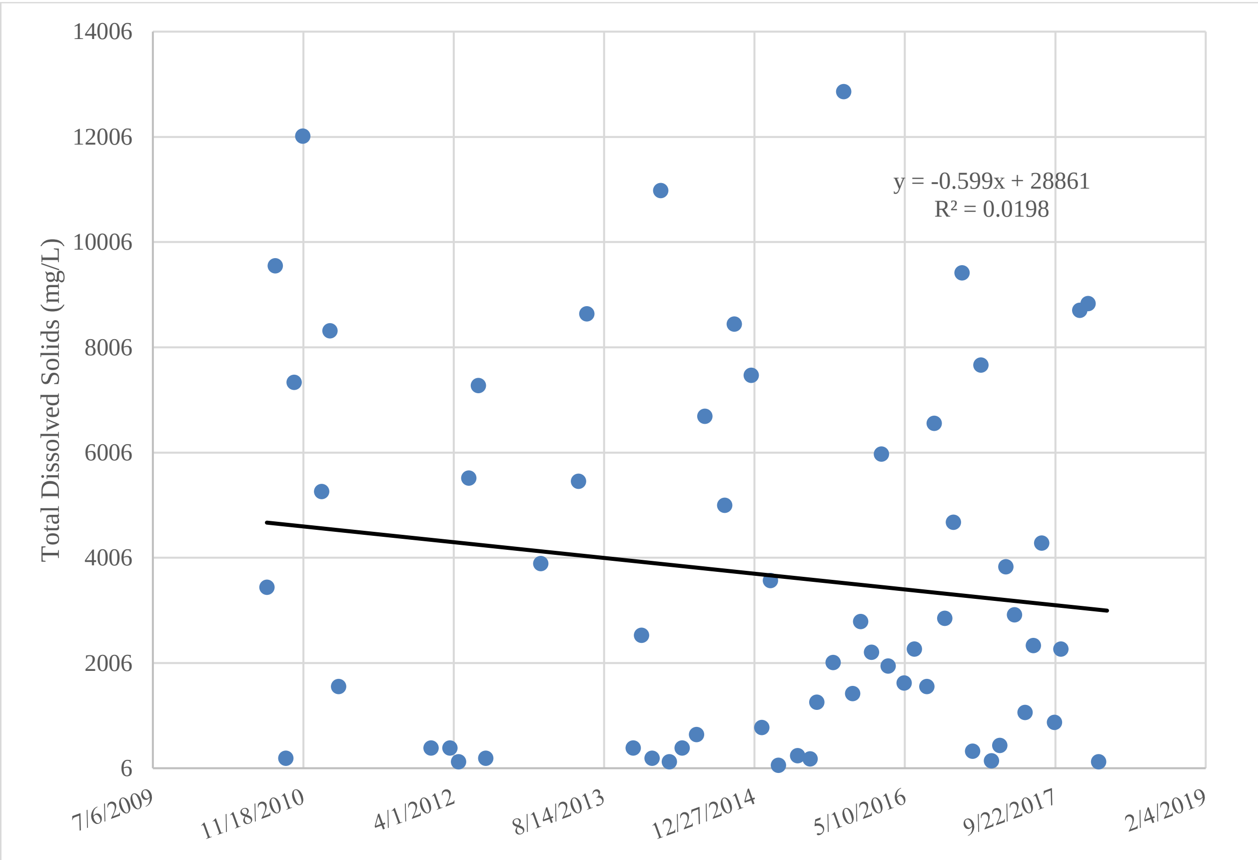

Figure 37: Total Dissolved Solids at site 80594

Dissolved Oxygen

Citizen scientists collected 84 DO samples at this site. The mean DO concentration was 6.3 mg/L and it ranged from a low of 2.9 mg/L in June of 2014 to a high of 11.1 mg/L in June of 2012. There is no significant relationship between DO concentrations and time observed at this site.

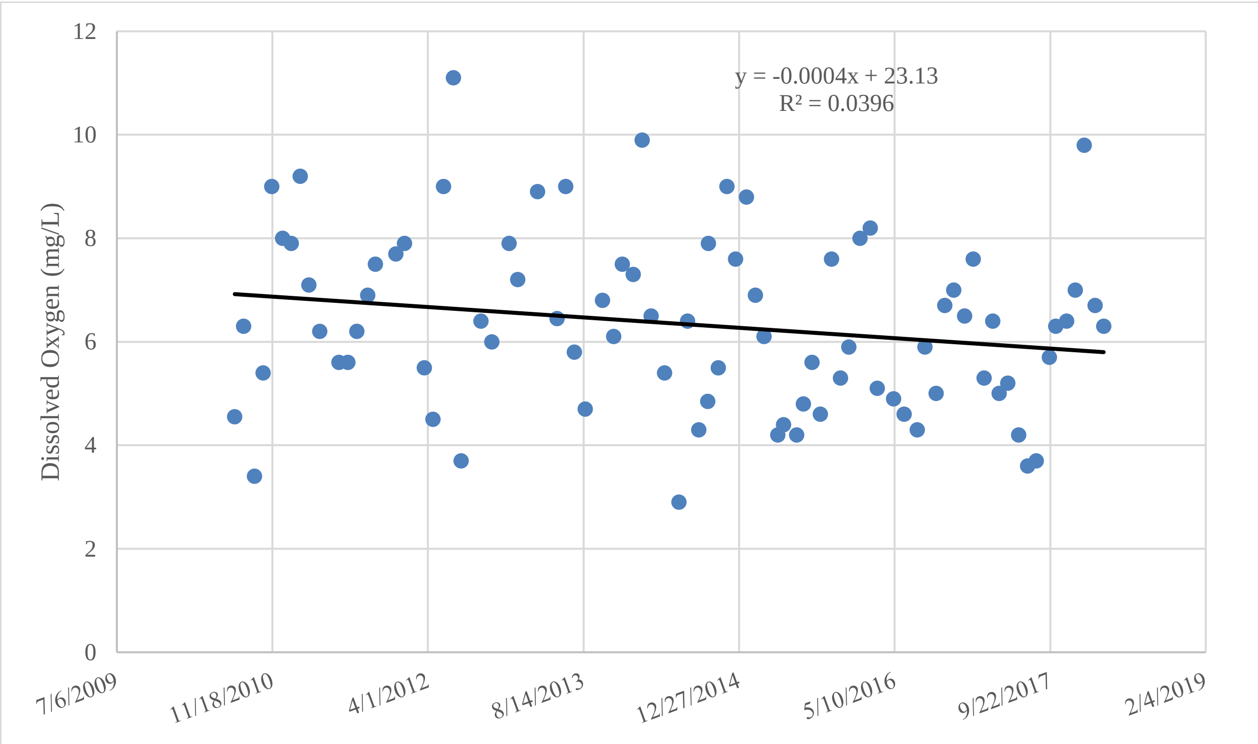

Figure 38: Dissolved oxygen at site 80594

pH

There were 83 pH samples taken at this site. The mean pH was 7.5 and it ranged from a low of 6.9 in March of 2016 to a high of 8.5 in June of 2012 and June of 2013. There was no significant relationship between pH and time observed at this site.

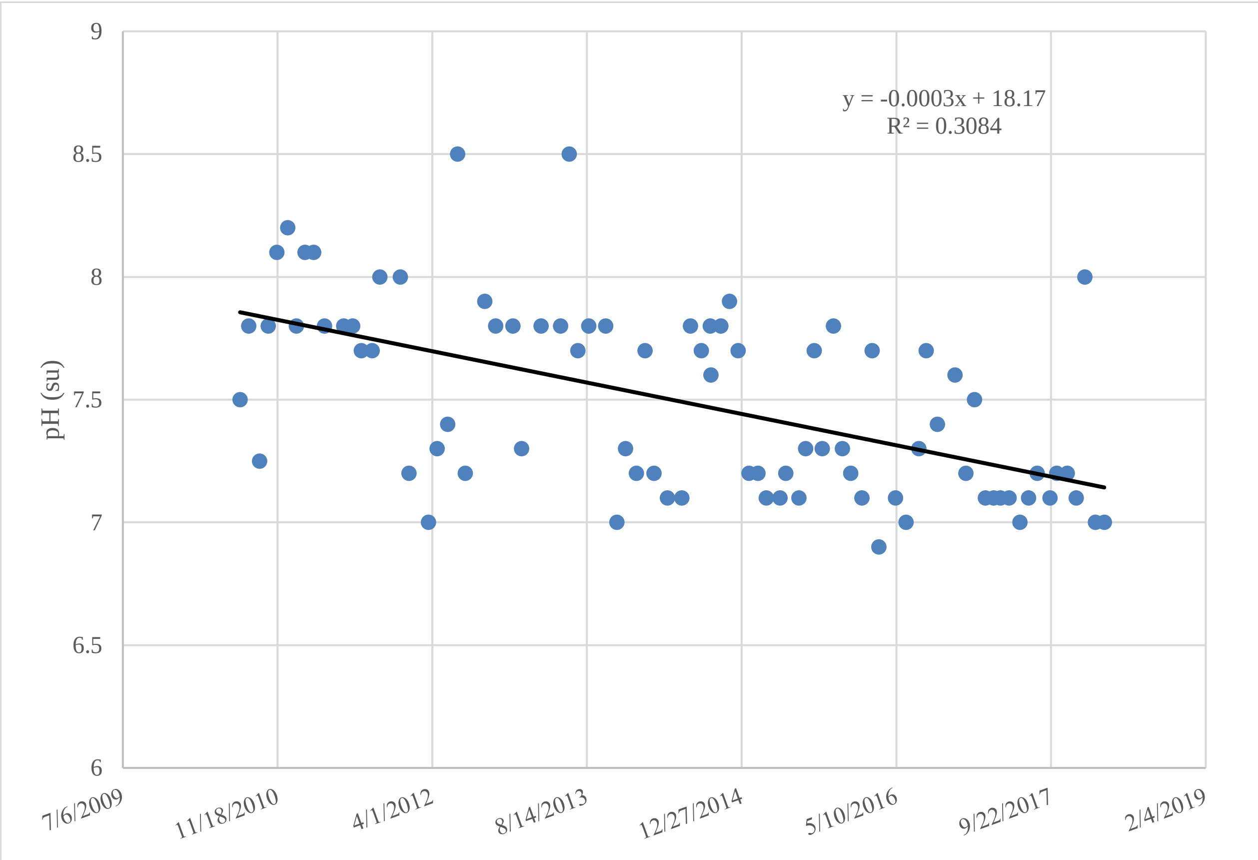

Figure 39: pH at site 80594

Salinity

There were 34 salinity samples taken at this site. The mean salinity was 10 ppm and it ranged from a low of 0.12 ppt in February of 2018 to a high of 31.7 ppt in October of 2011. There was a downward trend relationship between salinity and time observed at this site.

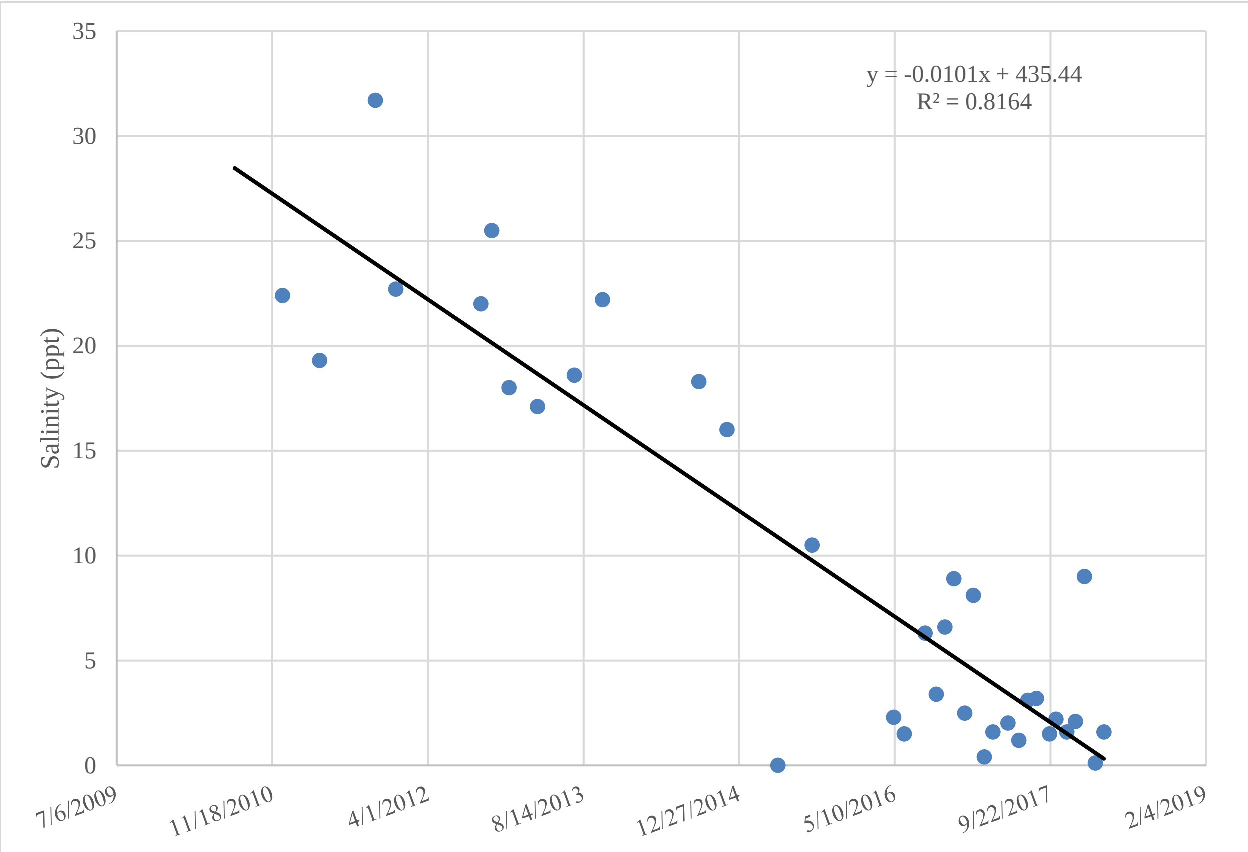

Figure 40: Salinity at site 80594

Transparency

There were 66 transparency samples taken at this site. The mean transparency was 0.37 m and it ranged from a low of 0.7 in February of 2017 to a high of 1.07 m in January of 2018. There was no significant relationship between transparency and time observed at this site.

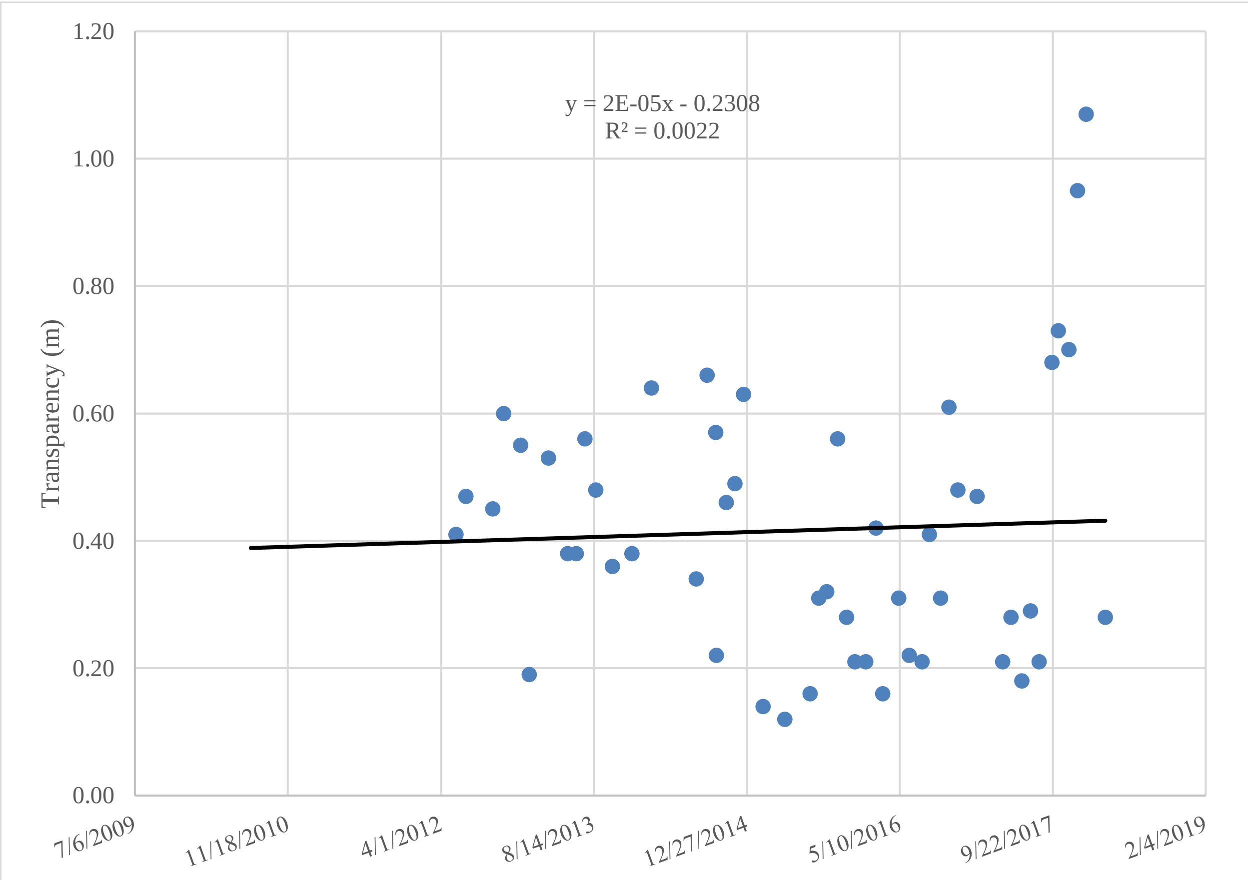

Figure 41: Transparency at site 80594

E. coli

Citizen scientists collected a total of 12 *E. coli* measurements at this site. The geomean was 24.89 CFU/100 mL. The minimum was 10 CFU/100 mL which occurred in June of 2017 and the maximum was 324 CFU/100 mL which occurred in February 2018. There was no significant increase or decrease in *E. coli* over time observed at this site.

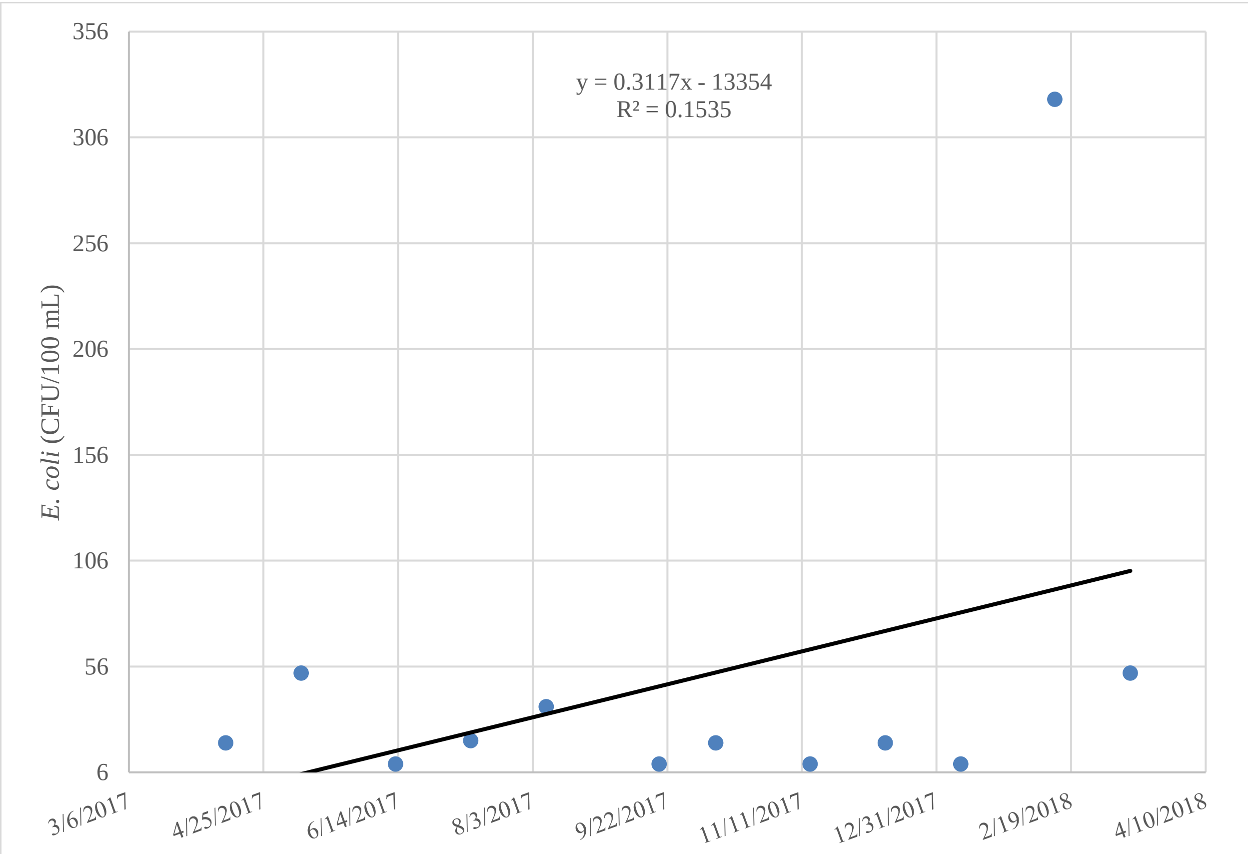

Figure 42: *E. coli* at site 80594

Site 80775 – San Bernard River at Cox's Reef

Site Description

This site is located north of San Bernard National Wildlife Refuge. The site is located on a monitor's dock along a residential area on the San Bernard River. It is surrounded by open farm land and suburban areas with a treed riparian zone observed.

Sampling Information

This site was sampled 35 times between June 2012 and March 2018.

Table 9: Descriptive parameters for Site 80775

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Water Temperature (°C)	35	20.5 ± 7.3	4.8	30.8
Dissolved Oxygen (mg/L)	31	6.0 ± 1.7	2.9	9.7
pH (su)	35	7.4 ± 0.5	6.7	7.9
Salinity (ppm)	31	12.5 ± 9.9	0.1	30.8
Transparency (m)	35	0.48 ± 0.21	0.10	0.90

Site 80775 was sampled 35 times between 8/4/2012 and 3/3/2018.

Air and water temperature

There were 34 air and 35 water temperature measurements taken from this site. The mean water temperature was 20.7 °C. The water temperature ranged from a low of 10 °C in January of 2013 to a high of 30.8 °C in August of 2012. The air temperature ranged from a low of 6.9 °C in January of 2013 to a high of 30.0 °C in September of 2012.

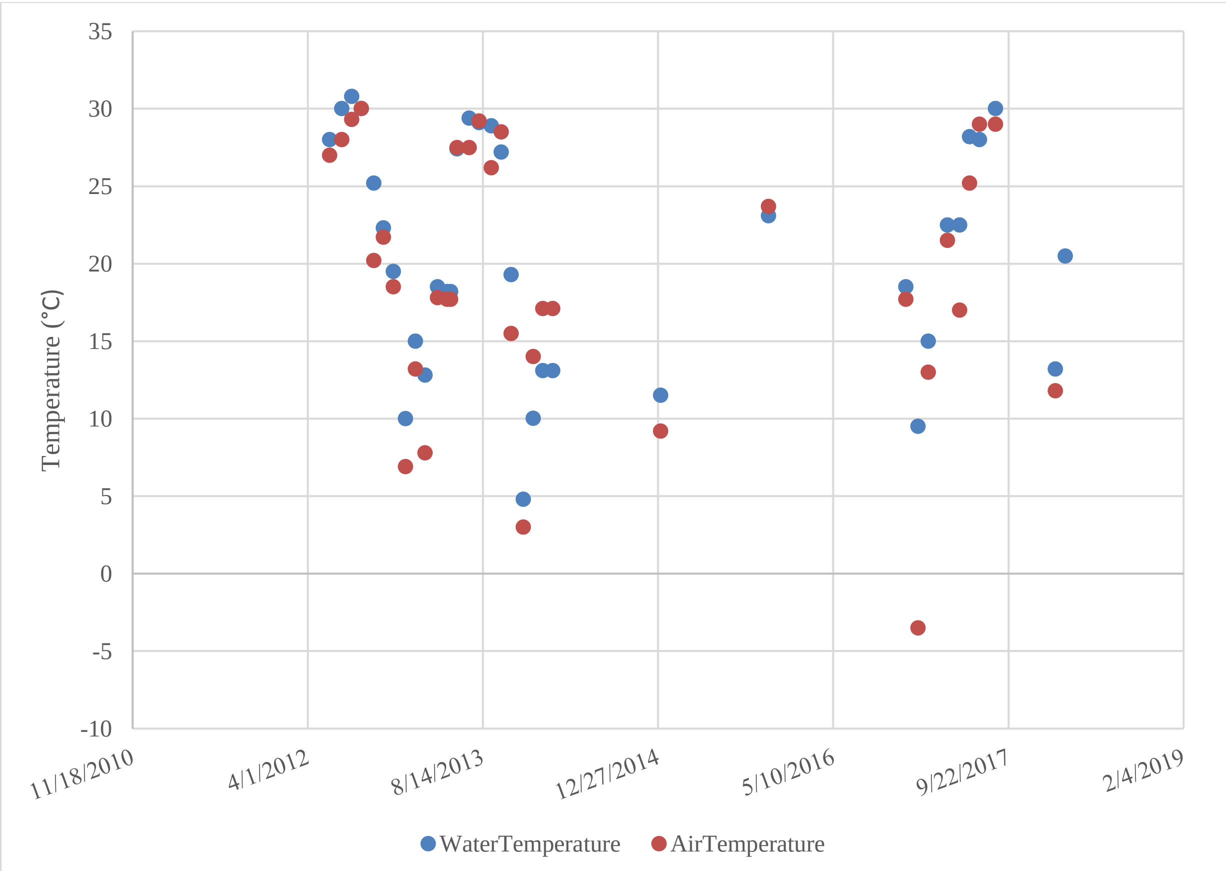

Figure 43: Air and water temperature at site 80775

Dissolved Oxygen

Citizen scientists collected 31 DO samples at this site. The mean DO concentration was 6.0 mg/L and it ranged from a low of 2.9 mg/L in September of 2013 to a high of 9.7 mg/L in January of 2013. There was no relationship between DO concentrations and time observed at this site.

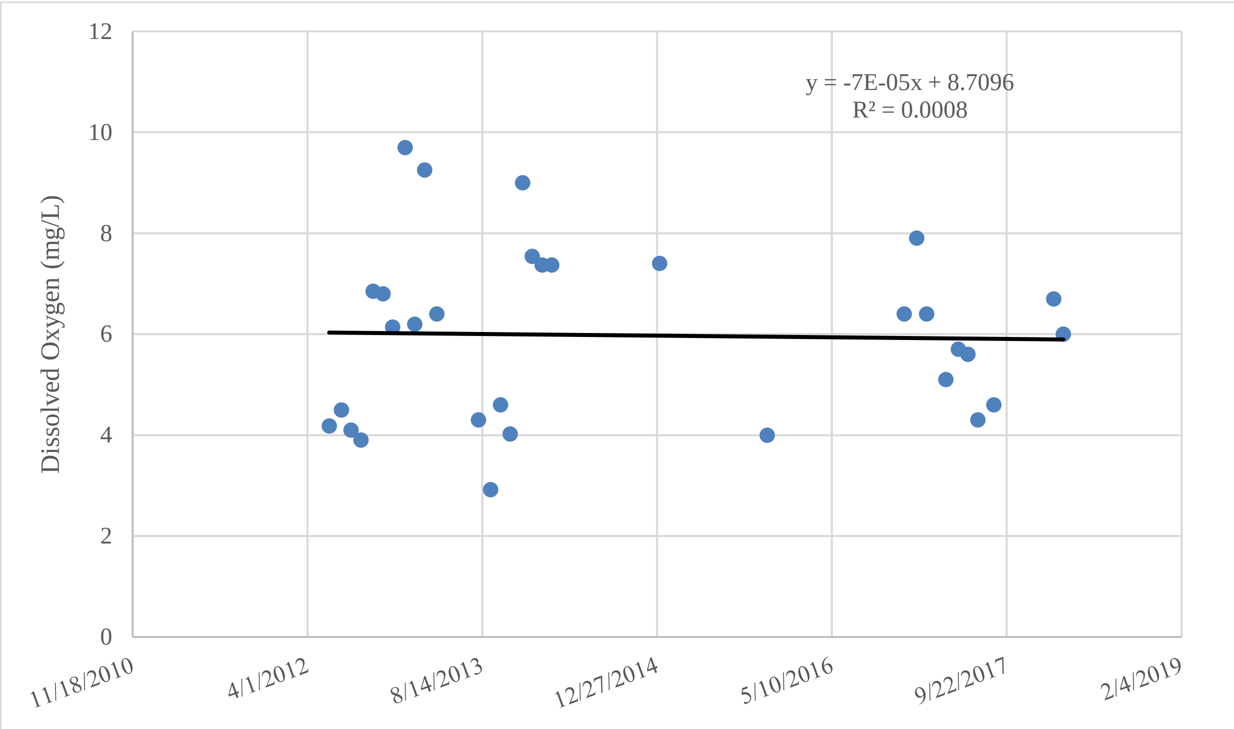

Figure 44: Dissolved Oxygen at site 80775

pH

Citizen scientists recorded 35 pH measurements at this site. The mean pH was 7.4 and it ranged from a low of 6.7 in February and July of 2017 and March of 2018 to a high of 7.9 in September and November of 2012 and January of 2013. There was a downward trend relationship between pH and time observed at this site.

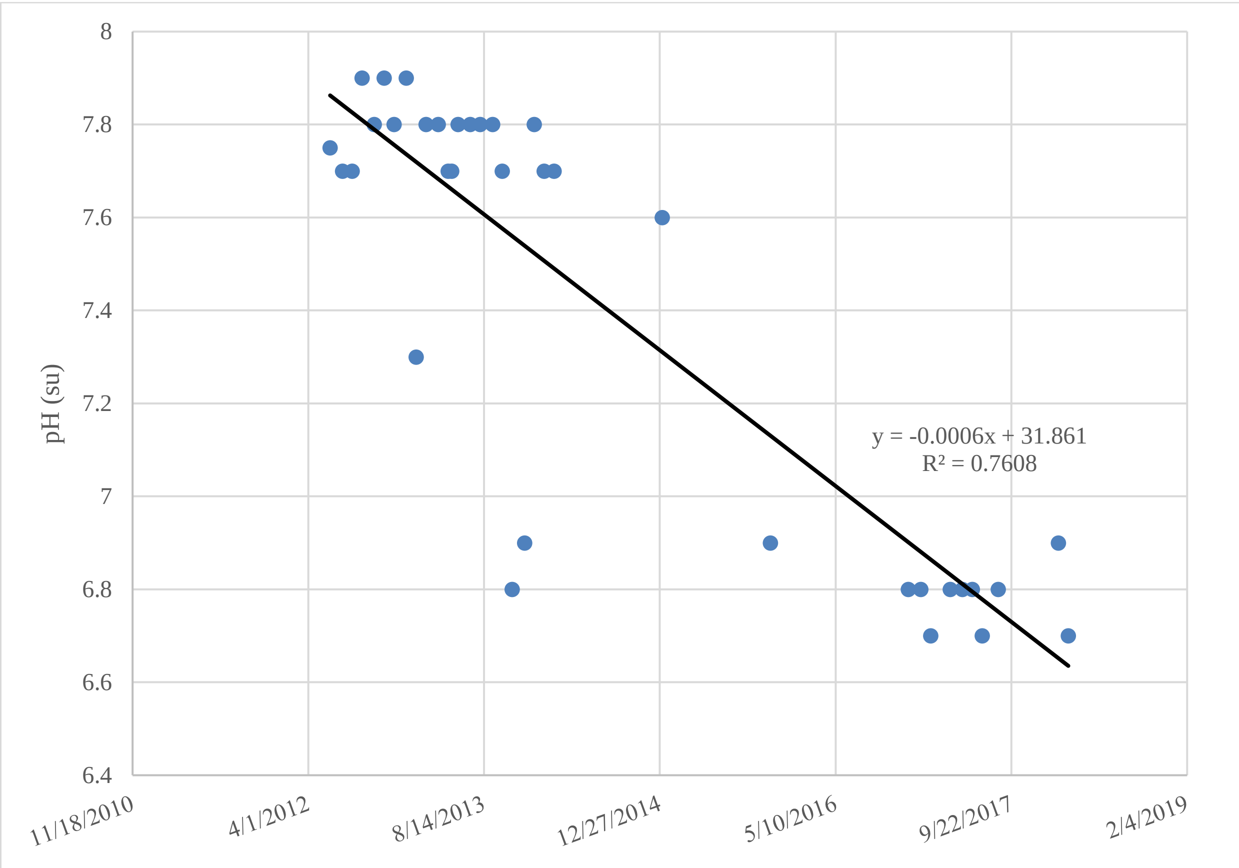

Figure 45: pH at site 80775

Salinity

Citizen scientists recorded 31 salinity measurements at this site. The mean salinity was 12.5 ppm and it ranged from a low of 0.1 ppm in May 2017 to a high of 30.8 ppm in August of 2012. There was no relationship between salinity and time observed at this site.

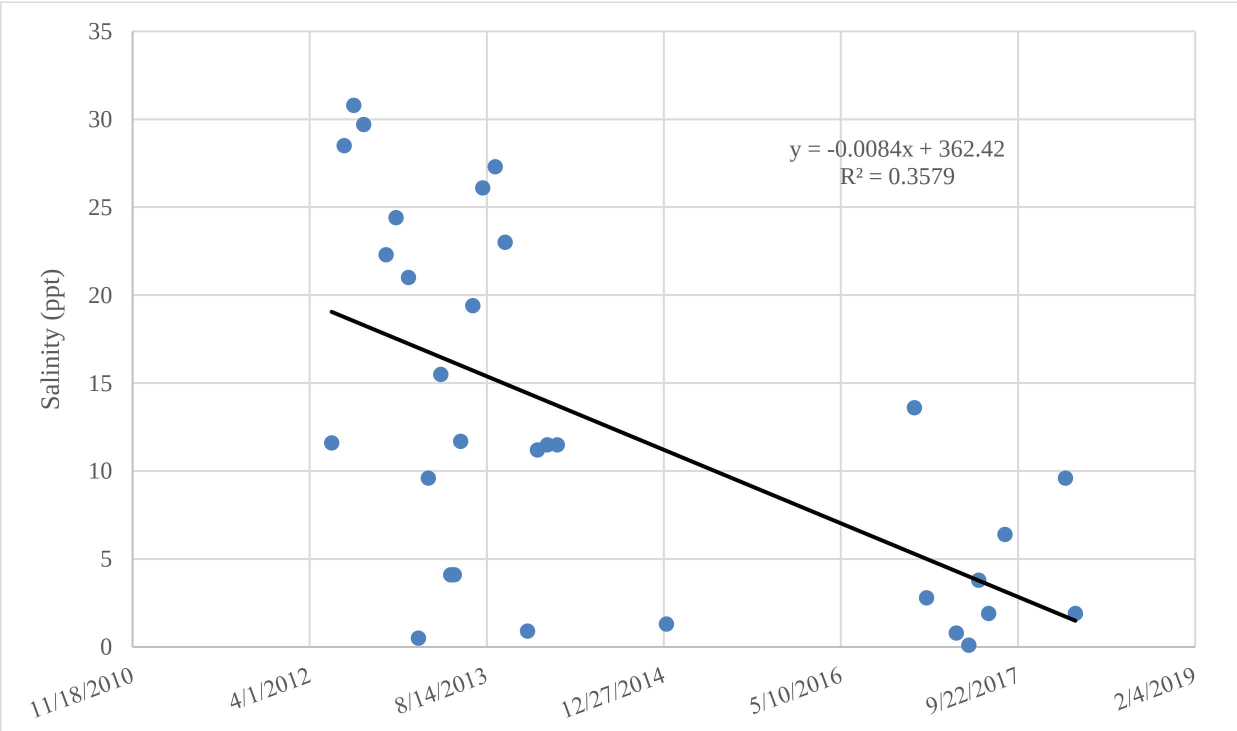

Figure 46: Total dissolved solids at site 80775

Transparency

Citizen scientists collected a total of 35 transparency measurements at this site. The mean was 11.4 m. The minimum was 0.1 m which occurred in November of 2013 and the maximum was 0.90 m which occurred in December of 2012. There was no significant relationship between transparency and time observed at this site.

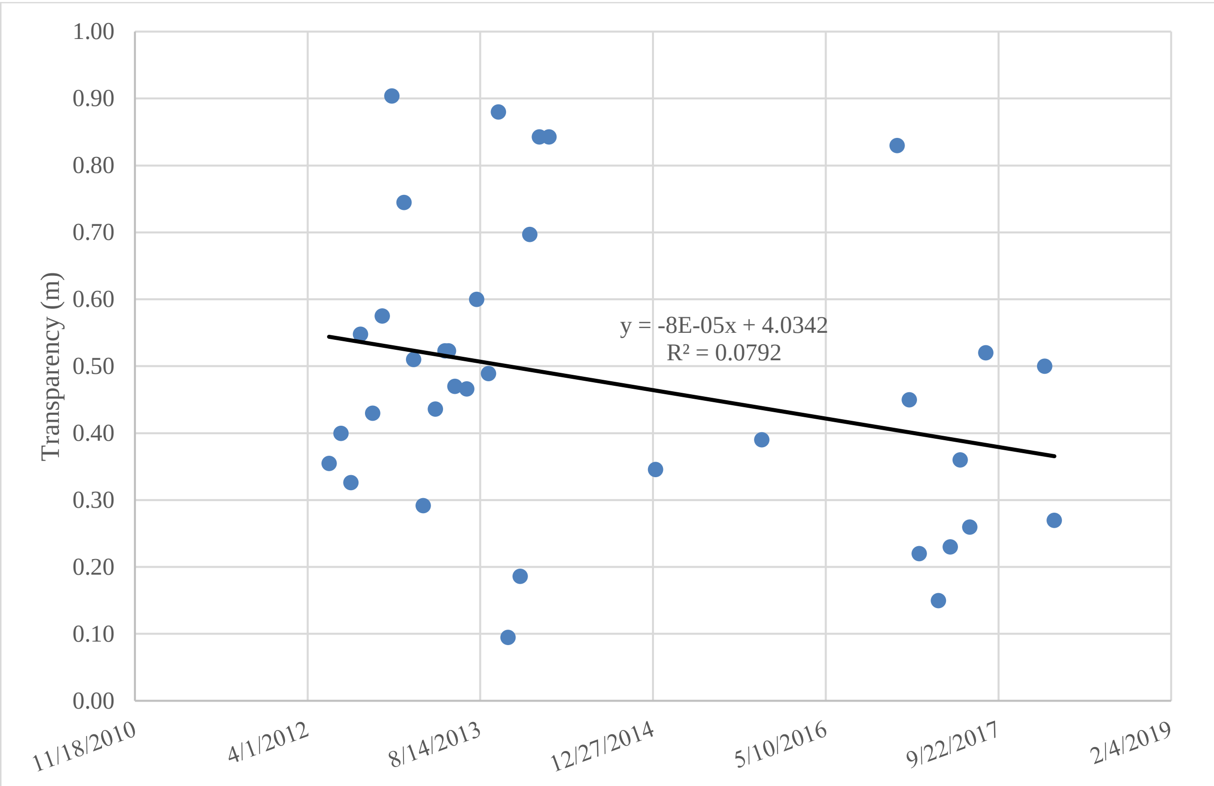

Figure 47: Transparency at site 80775

Site 81091 – San Bernard River Tidal at Rio Vista Dock

Site Description
This site is located 4.5 miles downstream from the Churchill Bridge. The water samples are collected off of a private dock at Rio Vista.

Sampling Information
This site was sampled 29 times between January 2015 and March 2018.

Table 10: Descriptive parameters for Site 81091

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Water Temperature (°C)	29	21.5 ± 6.2	10.0	31.0
Dissolved Oxygen (mg/L)	29	6.5 ± 1.5	3.1	11.0
pH (su)	29	7.0 ± 0.0	6.9	7.0
Salinity (ppt)	23	4.6 ± 4.2	0.3	12.9
Transparency (m)	29	0.45 ± 0.31	0.10	1.40
E. coli (CFU/100 mL)	10	35 ± 107	20	384

Site 81091 was sampled 29 times between 1/19/2015 and 3/13/2018.

Air and water temperature

There were 28 air and 29 water temperature samples recorded at this site. The mean water temperature was 21.5 °C and ranged from a low of 10.0 °C in January of 2015 to a high of 31 °C in July and September of 2016. The air temperature ranged from a low of 8.5 °C in February of 2018 to a high of 33.0 °C in July of 2016.

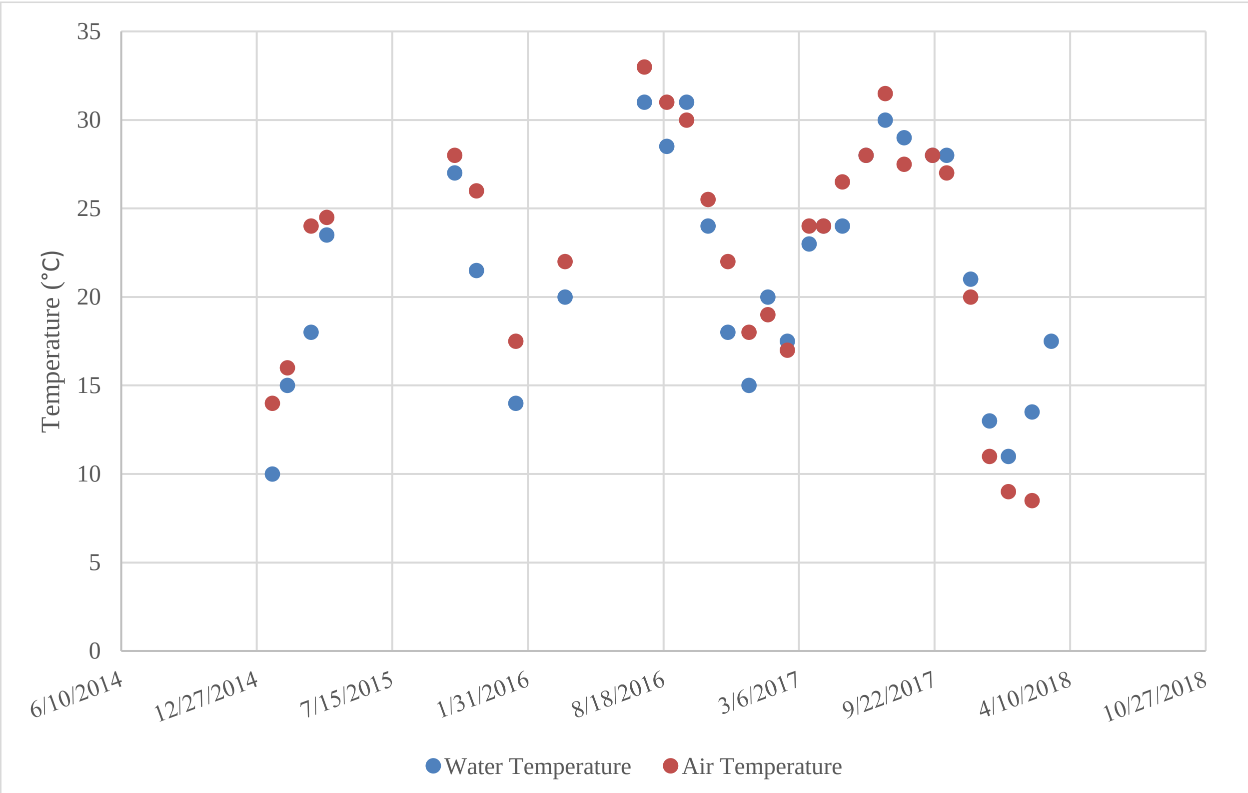

Figure 48: Air and water temperature at site 81091

Dissolved Oxygen

Citizen scientists took 29 DO samples at this site. The mean DO concentration was 6.5 mg/L and it ranged from a low of 3.1 mg/L in August of 2016 to a high of 11.0 mg/L in January of 2018. There was no significant change in DO concentrations over time observed at this site.

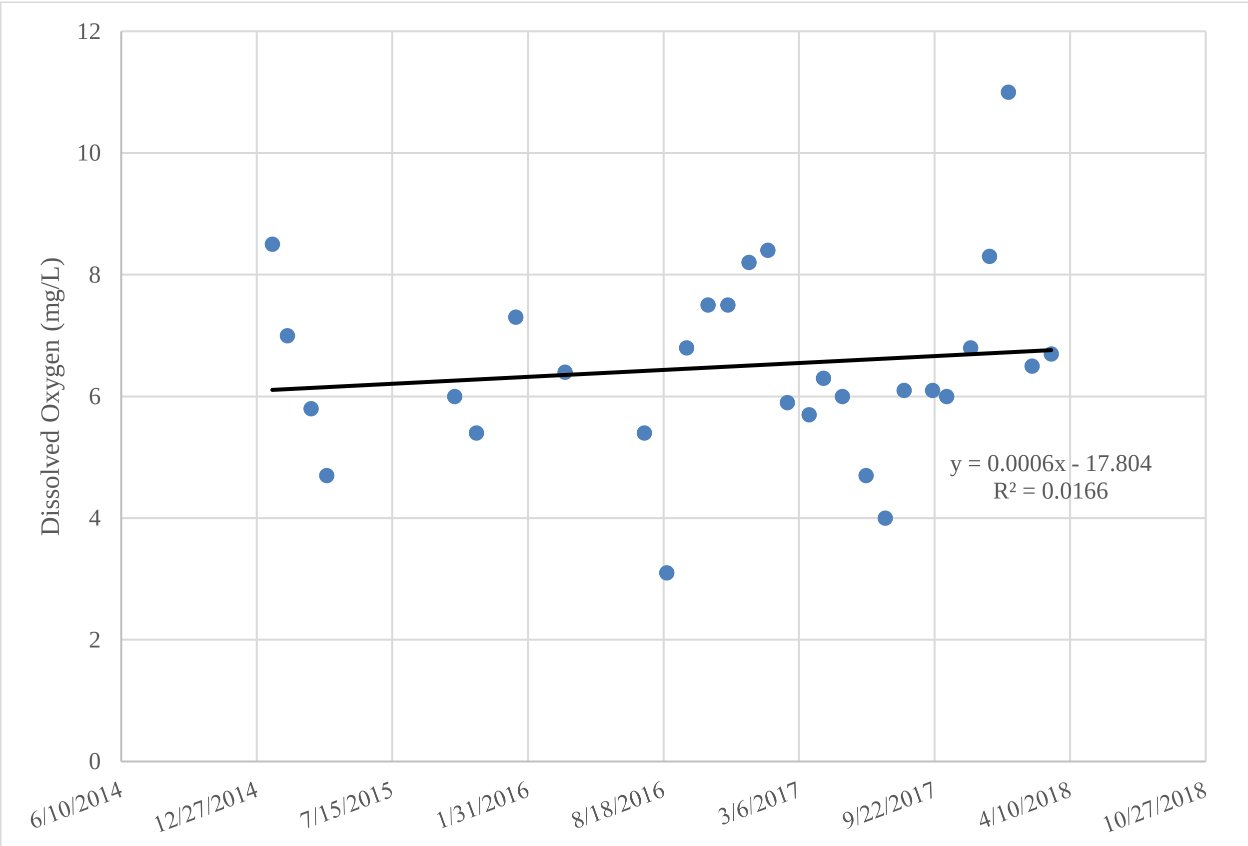

Figure 49: Dissolved oxygen at site 81091

pH

Citizen scientists took 29 pH measurements at this site. The mean pH was 7.0 and it ranged from a low of 6.9 in August of 2016 to a high of 7.0 which occurred several times. There was no significant change in pH level over time observed at this site.

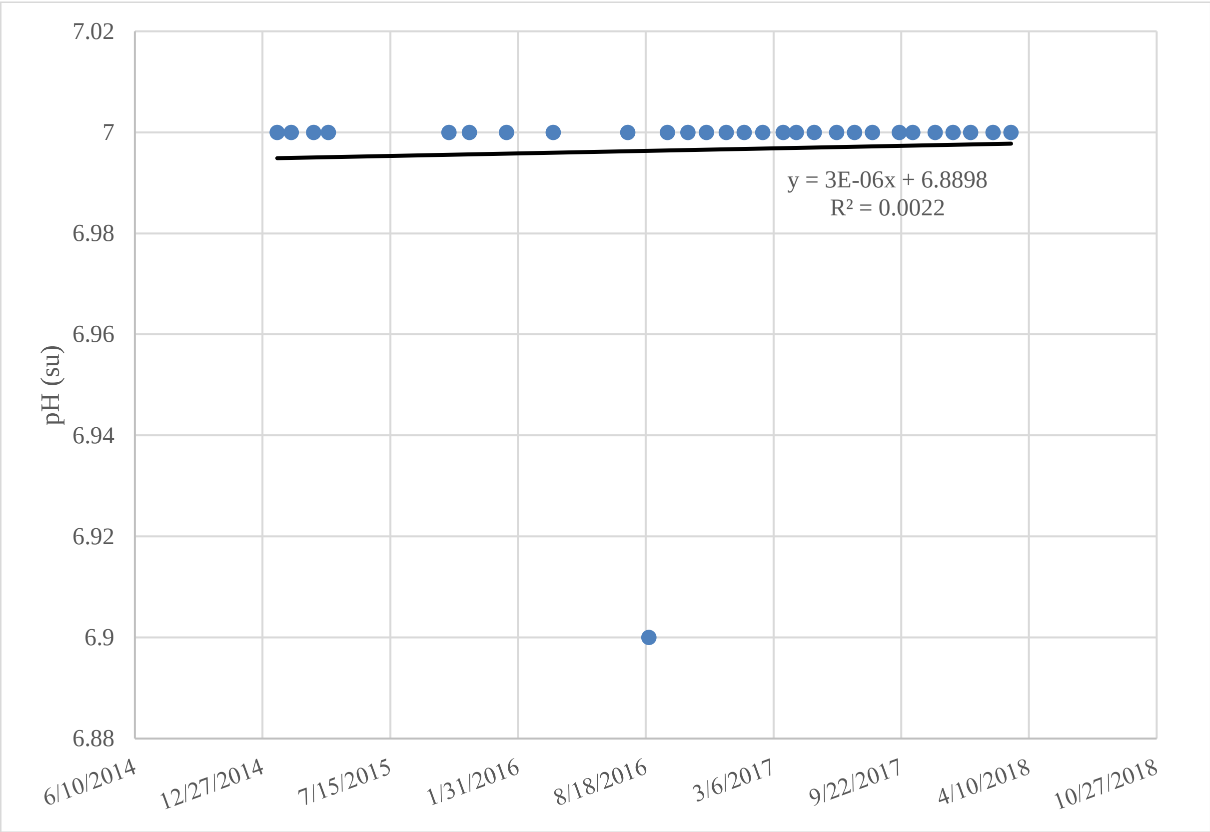

Figure 50: pH at site 81091

Salinity

Citizen scientists collected 23 salinity measurements at this site. The mean salinity was 4.6 ppt and it ranged from a low of 0.3 ppt in November of 2015 to a high of 12.9 ppm in October of 2015. There was no significant change in salinity measurements over time observed at this site.

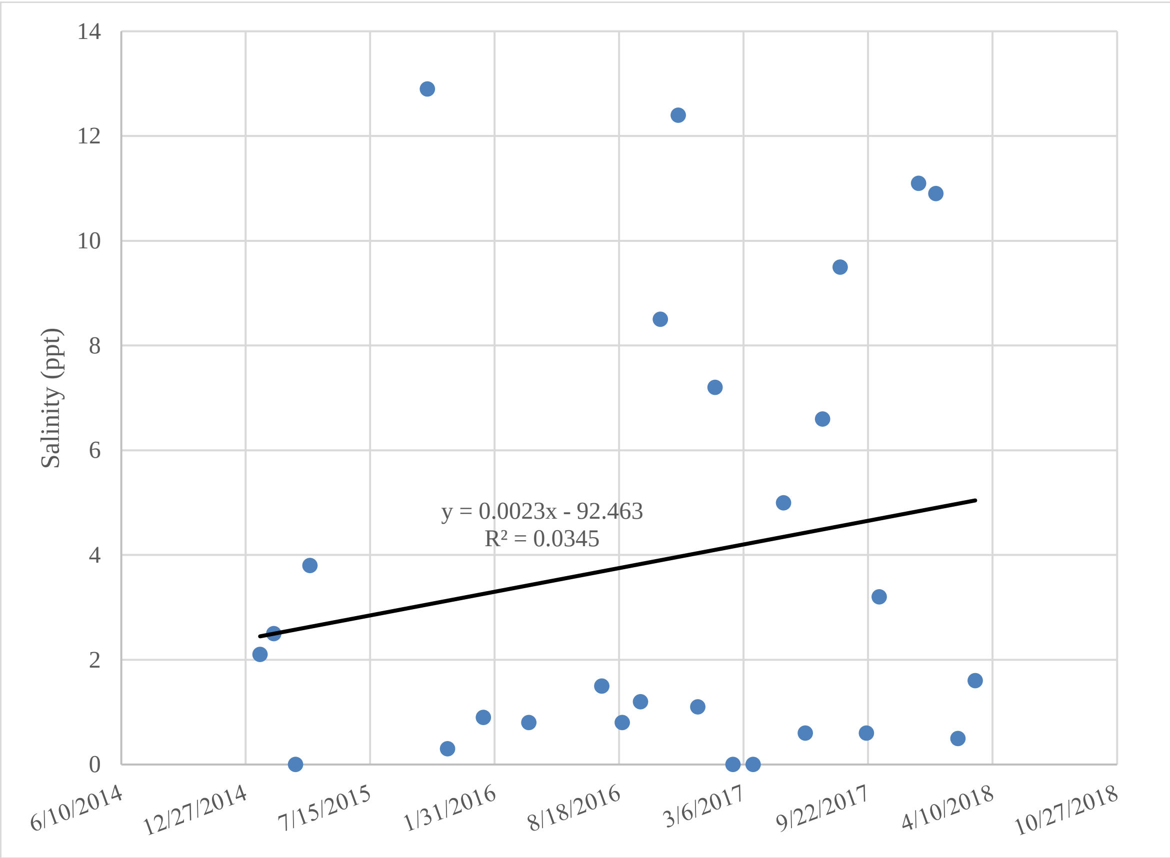

Figure 51: Salinity at site 81091

Transparency

Citizen scientists collected a total of 29 transparency measurements at this site. The mean was 0.45 m. The minimum was 0.10 m which occurred in January and February of 2013 and the maximum was 1.40 m which occurred in December of 2017. There was no significant relationship between transparency and time observed at this site.

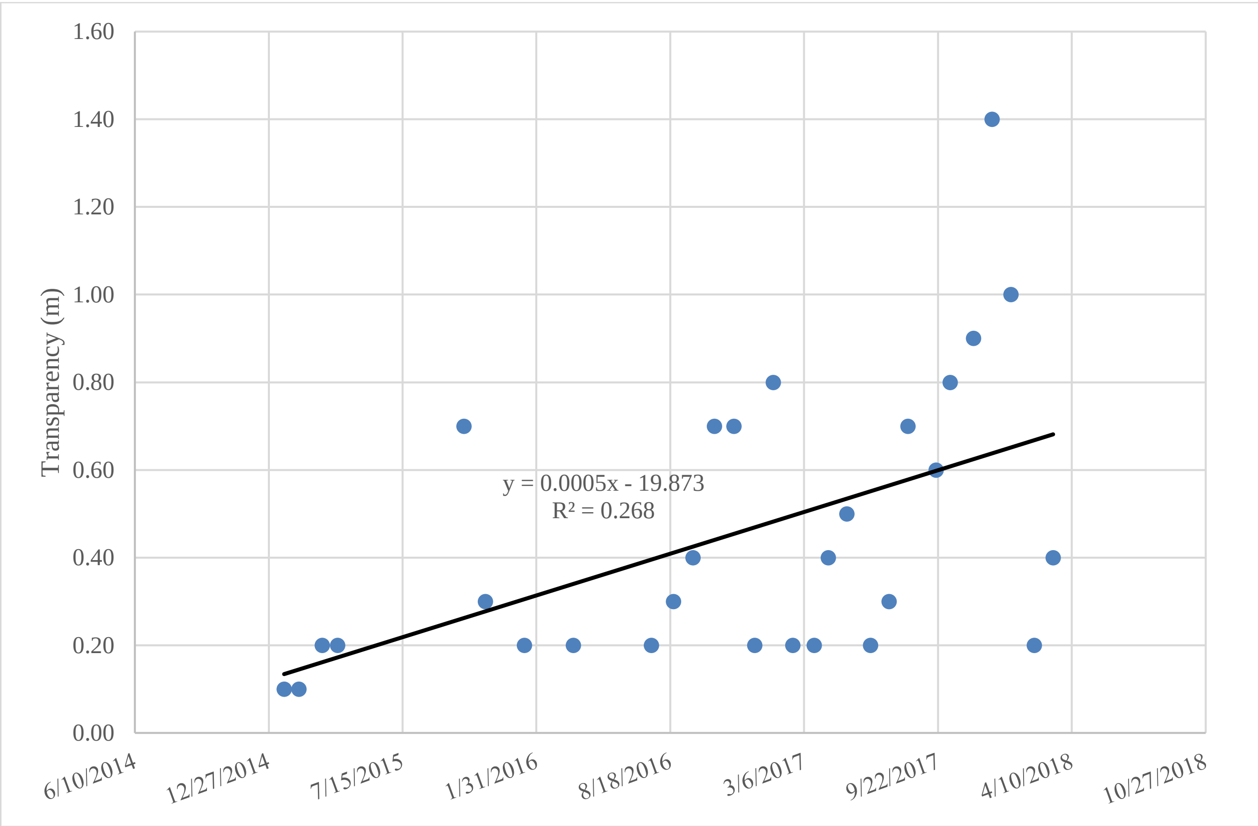

Figure 52: Transparency at site 81091

E. coli

Citizen scientists collected a total of 10 *E. coli* measurements at this site. The geomean was 35 CFU/100 mL. The minimum was 20 CFU/100 mL which occurred several times and the maximum was 384 CFU/100 mL which occurred in February of 2018. There was no significant increase or decrease in *E. coli* over time observed at this site.

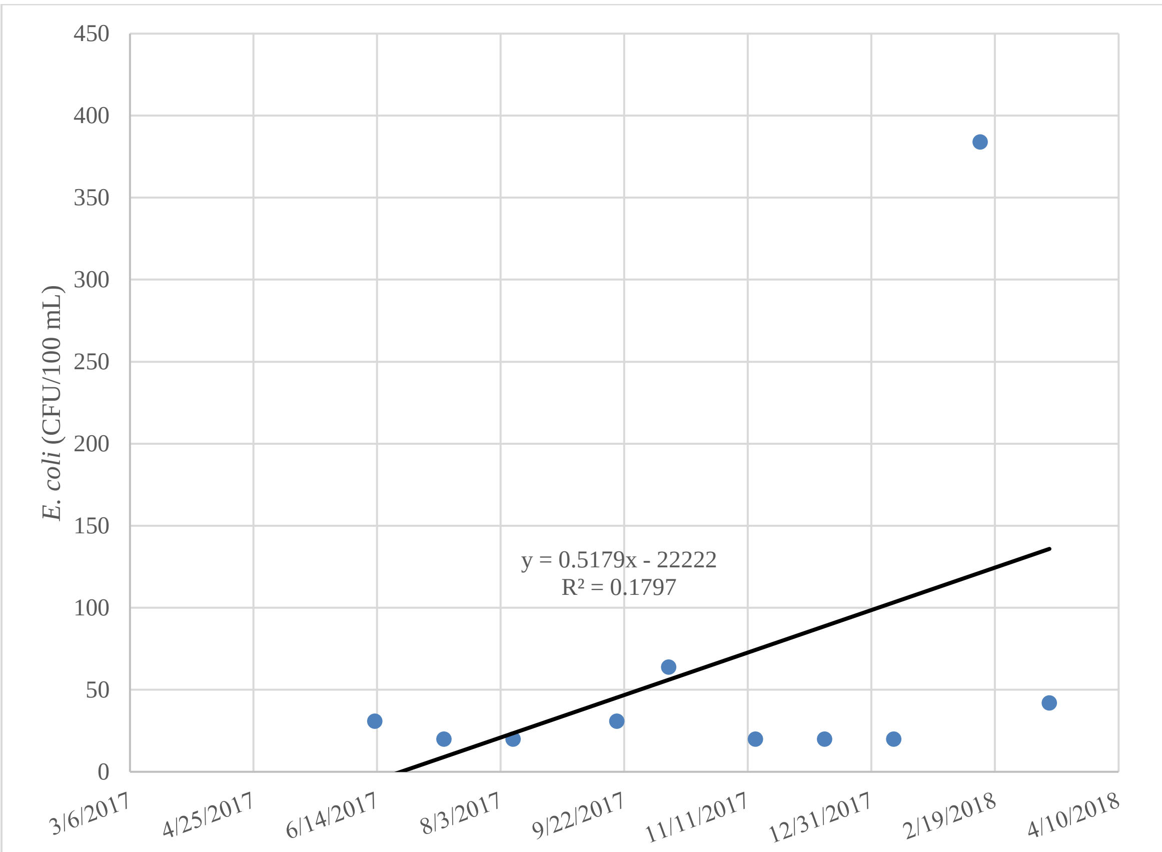

Figure 53: *E. coli* at site 81091

Site 80509 – San Bernard River at Fisherman's Isle

Site Description
Fisherman's Isle is next to River's End Volunteer Fire Department Station 1 and is located in Brazoria County, Texas, United States. Fisherman's Isle has a length of 0.22 kilometers. The San Bernard River flows on both sides of Fisherman's Isle Village of River's End.

Sampling Information
This site was sampled 106 times between November 2008 and March 2018.

Table 11: Descriptive parameters for Site 80509

Parameter	Number of Samples	Mean ± Standard Deviation	Min	Max
Water Temperature (°C)	105	22.7 ± 7.0	3.0	33.0
Dissolved Oxygen (mg/L)	106	6.3 ± 1.7	3.2	10.9
pH (su)	106	7.6 ± 0.3	6.7	8.1
Salinity (ppt)	97	17.5 ± 12.2	0.3	41.0
Transparency (m)	67	0.29 ± 0.17	0.01	0.65

Site 80509 was sampled 106 times between 11/10/2008 and 3/12/2018.

Air and water temperature

There were 104 air and 105 water temperature samples collected at this site. The mean water temperature was 22.7 °C and it ranged from a low of 3.0 °C in June of 2017 to a high of 33.0 in July of 2011, August of 2012, and July of 2017. The air temperature ranged from a low of 3.0 °C in June of 2017 to a high of 34.0 °C in August of 2017.

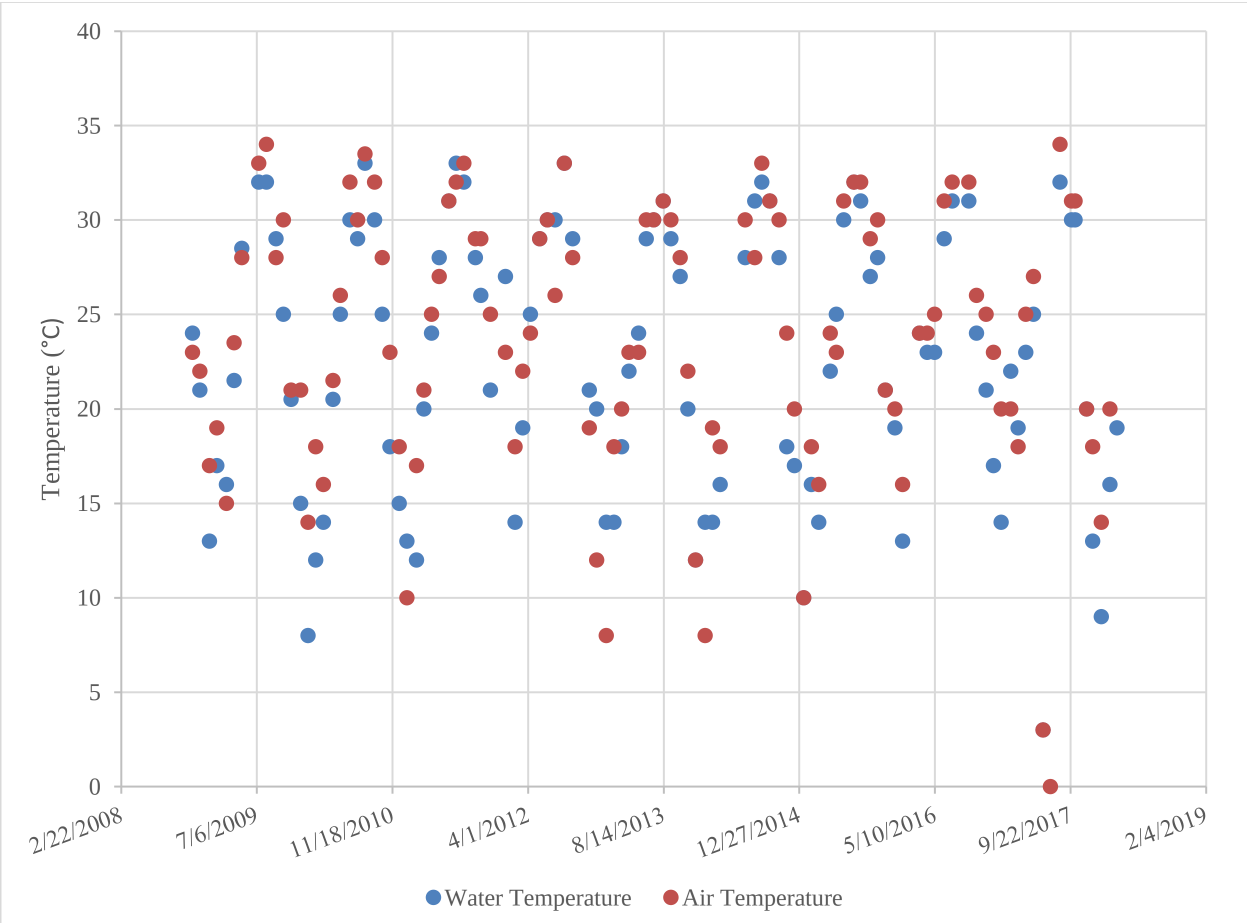

Figure 54: Air and water temperature at site 80509

Dissolved Oxygen

Citizen scientists collected 106 DO samples at this site. The mean DO concentration was 6.3 mg/L and it ranged from a low of 3.2 mg/L in September of 2010 to a high of 10.9 mg/L in January of 2018. There was no significant change in DO concentrations over time observed at this site.

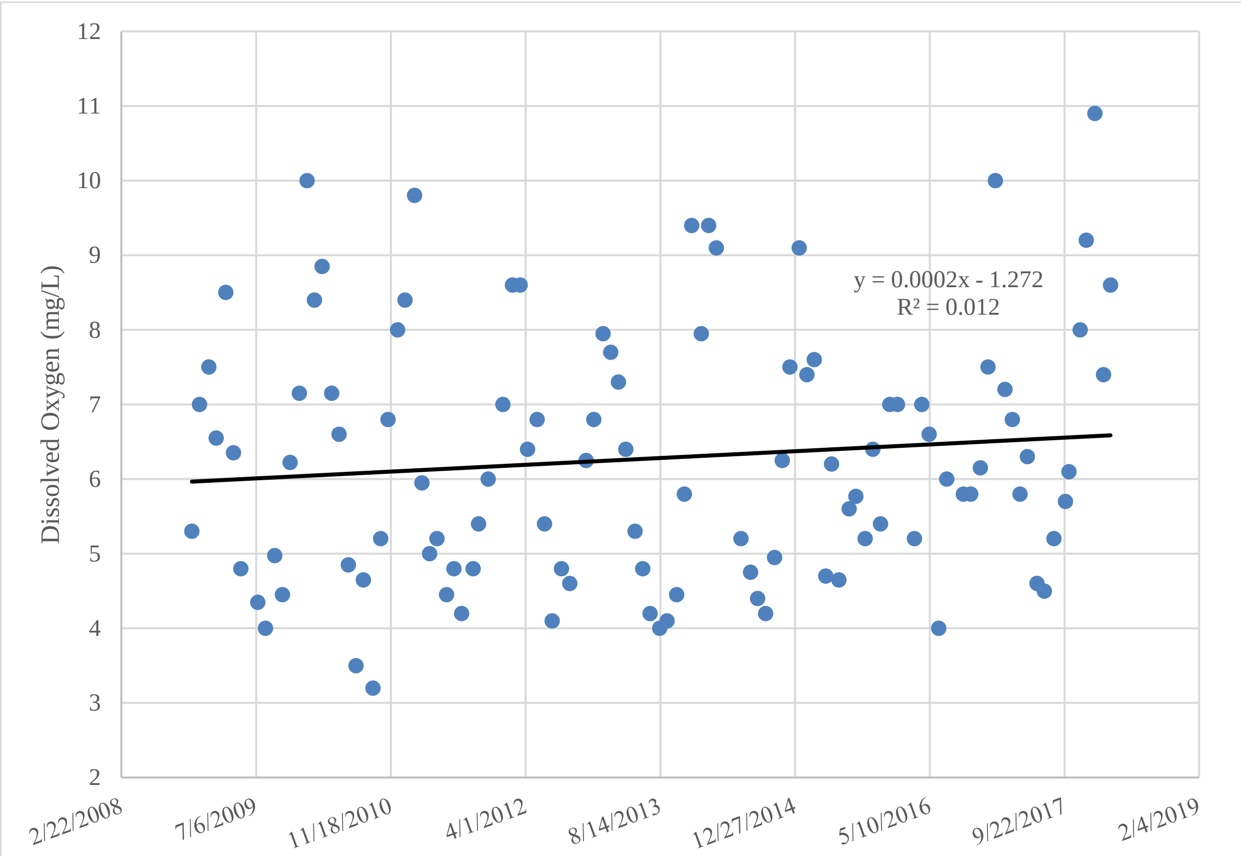

Figure 55: Dissolved oxygen at site 80509

pH

Citizen scientists collected 106 pH measurements at this site. The mean pH was 7.6, it ranged from a low of 6.7 in June of 2016 to a high of 8.0 which occurred several times. There was no significant change in pH over time observed at this site.

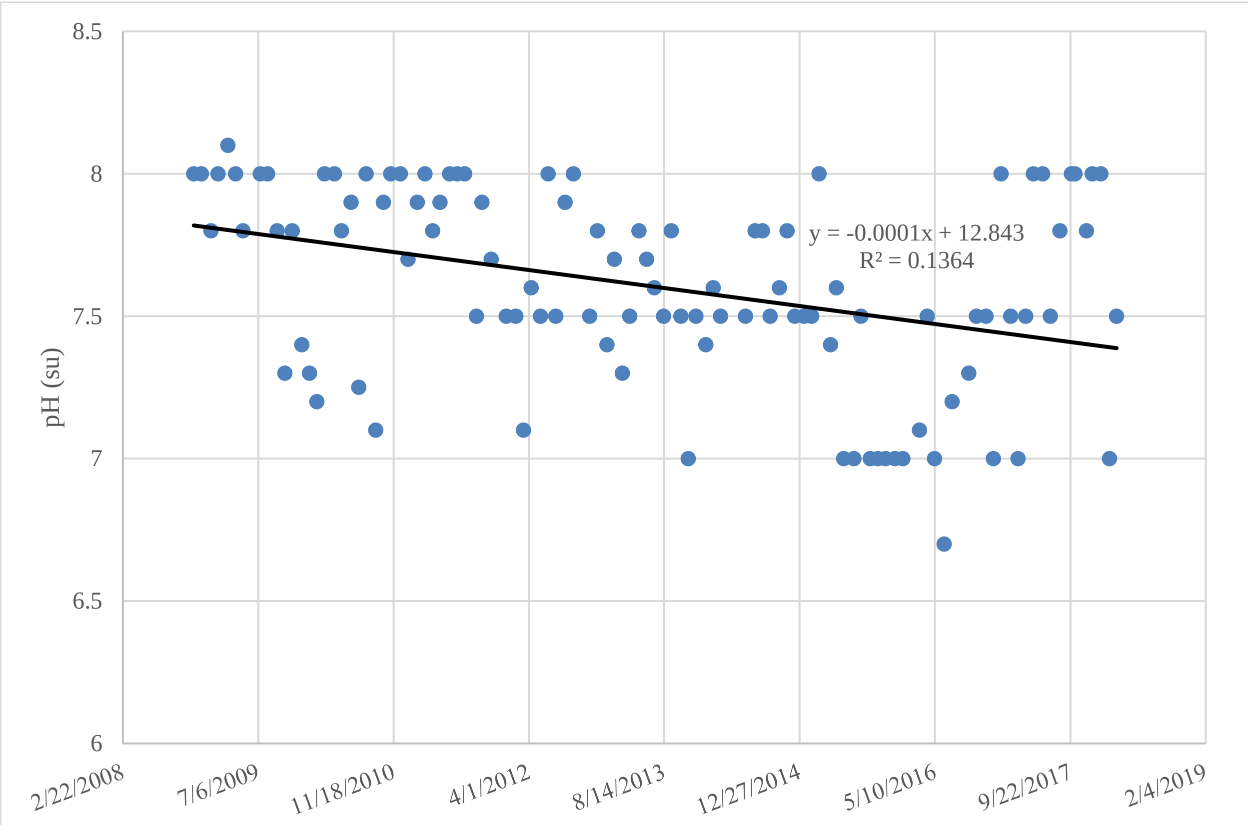

Figure 56: pH at site 80509

Salinity

Citizen scientists collected a total of 97 salinity measurements at this site. The mean was 17.5 ppt. The minimum was 0.3 ppt which occurred in December of 2016 and the maximum was 41 ppt which occurred in August of 2009. There was no significant increase or decrease in salinity over the time observed at this site.

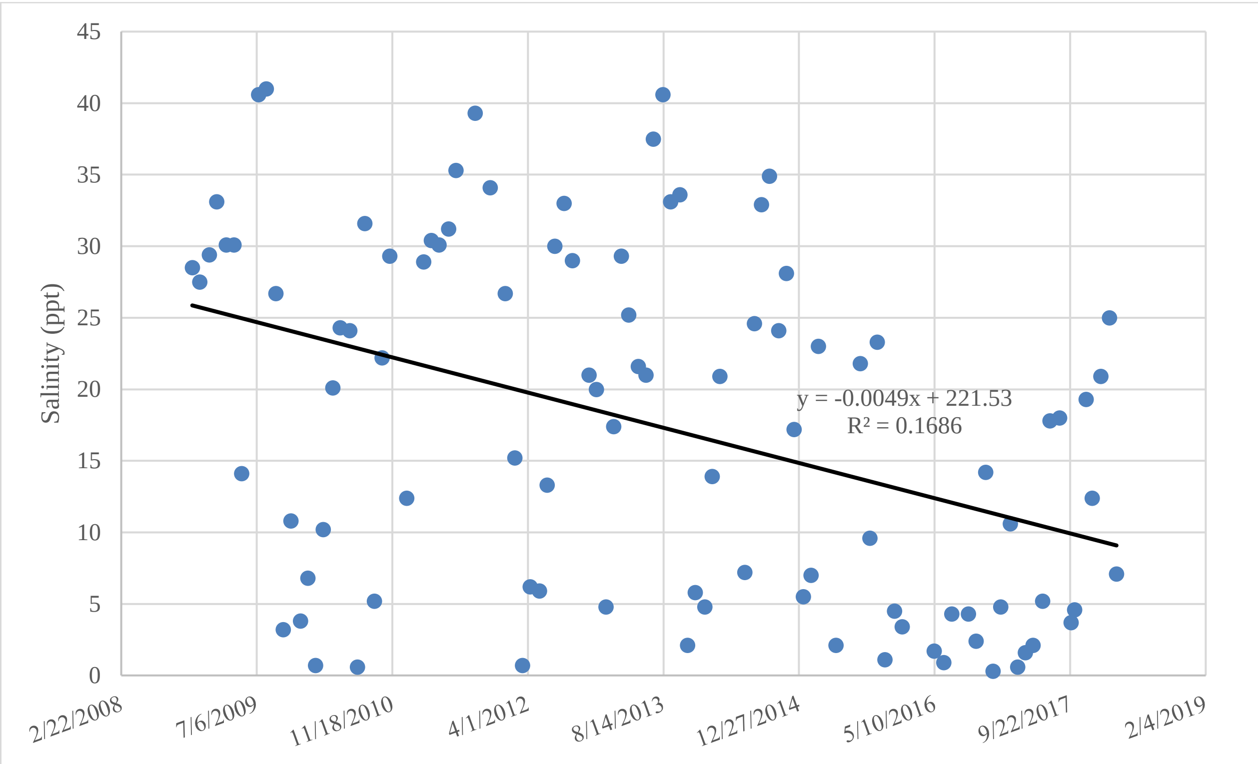

Figure 57: Salinity at site 80509

Transparency

There was 67 sample of transparency measurements collected at this site. The mean was 0.29 m. The minimum was 0.01 m which occurred in July of 2015 and the maximum was 0.65 m which occurred in November of 2014. There was no significant increase or decrease in transparency measurements over the time observed at this site.

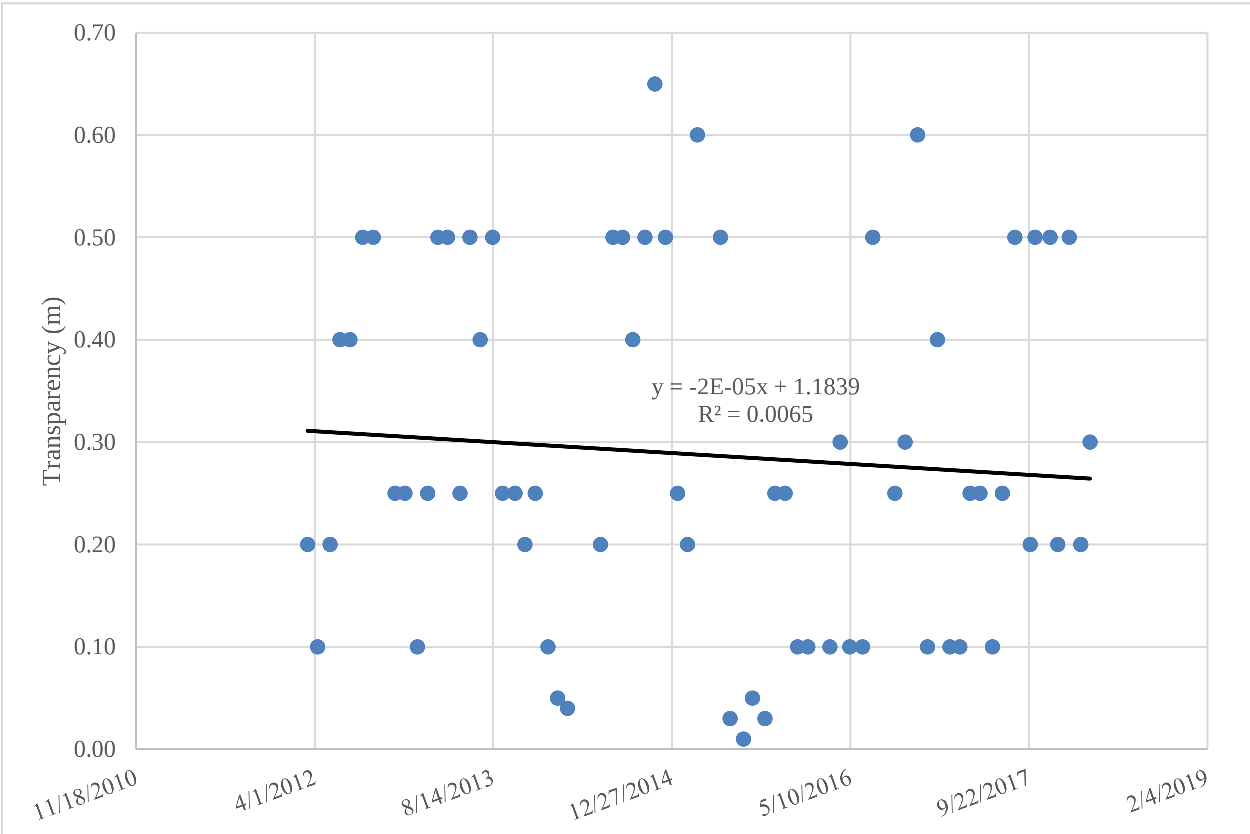

Figure 58: Transparency at site 80509

Friends of the River San Bernard

Friends of the River (FOR) San Bernard is a non-profit [I.R.S. 501(c)3] organization set up by citizens who live on or around the river. The main goal of the FOR San Bernard is to keep the river clean and its mouth open. Their mission is to restore, protect, promote and ensure a clean, healthy, flowing San Bernard River for the sanity and enjoyment of present and future generations.

The FOR San Bernard hosts a variety of events; i.e. a yearly river clean up, Adopt-a-Highway trash pick-ups, monthly breakfasts on the river, two boat parades and a men vs women fishing tournament. In 2010, the FOR San Bernard enacted their first conservation easement on the San Bernard watershed. Also, the FOR San Bernard conducts classroom presentations for fifth grade students at local schools through its FOR San Bernard Ranger program. The FOR San Bernard also offers a scholarship program for graduating high school seniors living in the San Bernard watershed.

H-GAC Texas Stream Team citizen scientists measure the physical and chemical parameters of San Bernard River at two locations. Tests are done on the same day at the same time each month. The test reports the pH level, salinity, temperature, DO and turbidity of the water. On March 2017, *E. coli* test was added, conducted through a partnership with Galveston Bay Foundation.

San Bernard River Mouth

A San Bernard River Mouth News Brief, Feb 2014

"After being closed since December 2012, the possibility of reopening the mouth of the San Bernard to the Gulf looked dismal. Friends of the River San Bernard attended the first meeting of the Gulf Coast Ecosystem Restoration Council in Galveston in June of last year. It was there, FOTRSB learned about the BP Deepwater Horizon oil spill funds that hopefully will be coming to the Texas Gulf Coast.

FOTRSB thanks the Brazoria County Commissioners for their efforts in supporting reopening the mouth of the San Bernard by unanimously voting to enter into negotiations with Dannenbaum Engineering for the RESTORE Act funded project of dredging open the mouth and building protective jetties."

January 26, 2018 - State Representative Bonnen, Commissioner Payne, Commissioner Linder, and project leaders from GLO, TPWD, USFWS, and USACE take investigative boat trip to the mouth.

"One of Brazoria County's top priorities is reopening the mouth of the San Bernard River. I have worked with many dedicated citizens and local elected officials towards this endeavor over the years, with our most significant victory being the state and federal approval of RESTORE funding (Deepwater Horizon oil spill funds) to make this project a reality. Hurricane Harvey's destruction has since changed the scope of the reopening project. Today I joined Commissioner Payne, Commissioner Linder, and project leaders from the GLO, TPWD, USFWS, and USACE to review the revisions of this undertaking so we can continue moving forward."   - STATE REPRESENTATIVE DENNIS BONNEN Facebook 1-26-18

Timeline of Reopening the Mouth Events and Photos of the Mouth Intracoastal Waterway:

http://www.sanbernardriver.com/mouth.php

San Bernard River Watershed Summary

Texas Stream Team citizen scientists monitored several water quality parameters from 6 different sites from 2008 to 2018, including TDS, DO, pH levels, salinity, transparency, turbidity, nitrate-nitrogen, orthophosphate, and *Enterococci*. Data from the 6 monitoring sites was analyzed to find trends over the monitoring periods. During the time observed, there was no significant increase or decrease in TDS concentration within the watershed as a whole. At times, sites 81005, 81091, and 80594 had elevated levels of *Enterococci* bacteria higher than TCEQ contact recreation standards for a single threshold value of 130 cfu / 100 mL. Besides seasonal variations, there have been no statistically significant relationships between a decrease in DO levels and time at individual sites. The FOR San Bernard and the H-GAC citizen scientist monitoring group will continue to monitor the water quality of the San Bernard River watershed. Future work will consist of nutrient monitoring at sites where there are concerns. H-GAC will continue to support existing Texas Stream Team citizen scientists with supplies for local citizen scientists to collect and test samples for water quality. Additionally, the H-GAC will continue to create new Texas Stream Team monitoring sites and activate existing sites.

Get Involved with Texas Stream Team!

Once trained, citizen scientists can directly participate in monitoring by communicating their data to various stakeholders. Some options include: participating in the CRP Steering Committee Process, providing information during "public comment" periods, attending city council and advisory panel meetings, developing relations with local TCEQ and river authority water specialists, and, if necessary, filing complaints with environmental agencies, contacting elected representatives and media, or starting organized local efforts to address areas of concern.

The Texas Clean Rivers Act established a way for the citizens of Texas to participate in building the foundation for effective statewide watershed planning activities. Each CRP partner agency has established a steering committee to set priorities within its basin. These committees bring together the diverse stakeholder interests in each basin and watershed. Steering committee participants include representatives from the public, government, industry, business, agriculture, and environmental groups. The steering committee is designed to allow local concerns to be addressed and regional solutions to be formulated. For more information about participating in these steering committee meetings, please contact the appropriate CRP partner agency for your river basin at:
http://www.tceq.state.tx.us/compliance/monitoring/crp/partners.html.

Currently, Texas Stream Team is working with various public and private organizations to facilitate data and information sharing. One component of this process includes interacting with watershed stakeholders at CRP steering committee meetings. A major function of these meetings is to discuss water quality issues and to obtain input from the public. While participation in this process may not bring about instantaneous results, it is a great place to begin making institutional connections and to learn how to become involved in the assessment and protection system that Texas agencies use to keep water resources healthy and sustainable.

Sources

Houston-Galveston Area Council (H-GAC). San Bernard River Watershed Protection Plan. https://www.h-http://www.h-gac.com/community/water/watershed_protection/san-bernard-river.aspx

Scheibe 2010. Friends of the River San Bernard River Facts. http://www.sanbernardriver.com/river_facts.php

Texas State Historical Association. San Bernard River. https://tshaonline.org/handbook/online/articles/rns07

Native Prairies Association of Texas. Gulf Praries and Marshes. http://texasprairie.org/index.php/npat_prairies/region_info/gulf_prairies_and_marshes/

Chen and Buzan. Restoration of the Mouth of the San Bernard River to the Gulg of Mexico, Brazoria County, Texas. http://www.sanbernardtx.com/attachments/File/Links/San_Bernard_FINAL_EA_12-10-08.pdf

Appendix A- List of Tables and Figures

Tables

Figures

Appendix B- List of Acronyms

CFU – Colony-forming unit

CRP – Clean Rivers Program

DO – Dissolved Oxygen

EPA – Environmental Protection Agency

FOR San Bernard – Friends of the River San Bernard

H-GAC – Houston Galveston Area Council

NPAT **-** Native Prairies Association of Texas

QAO **-** Quality Assurance Officer

QAPP **-** Quality Assurance Project Plan

TCEQ – Texas Commission on Environmental Quality

TDS – Total Dissolved Solids

TMDL – Total Maximum Daily Load

TPWD – Texas Parks & Wildlife Department

TWDB – Texas Water Development Board

USACE – United States Army Corps of Engineers

USDA – United States Department of Agriculture

WPP – Watershed Protection Plan