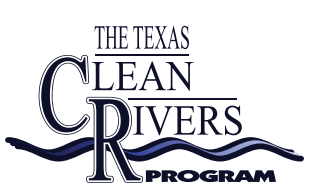
Redspotted sunfish (*Lepomis miniatus*)

2021 Clean Rivers Program San Antonio River Basin Highlight Report



In the creation of this report, all good faith effort was taken to meet accessibility standards as prescribed by the TCEQ. An accessible version of the 2021 Clean Rivers Program San Antonio River Basin Highlight Report is posted on SARA's web site.

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Figure 1: Gray Redhorse (*Moxostoma congestum*) captured and released at Station 14929 Salado Creek at Comanche Park

Acronyms

AgriLife	Texas A&M AgriLife Extension
ALU	Aquatic Life Use
AU	Assessment Unit
BCRAGD	Bandera County River Authority and Groundwater District
BMP	Best Management Plans
BS	Biased Season
CWA	Clean Water Act
CMM	Coordinated Monitoring Meeting
CRP	Clean Rivers Program
CFS	Cubic Feet Per Second
DSHS	Texas Department of State Health Services
EAC	Environmental Advisory Committee
EQIP	Environmental Quality Incentives Program
E. coli	*Escherichia coli*
EPA	U.S. Environmental Protection Agency
FM	Farm to Market
IDNFH	Inks Dam National Fish Hatchery
I-Plan	Implementation Plan
LDC	Load Duration Curve
LID	Low Impact Development
LSAR	Lower San Antonio River
MGD	Million Gallons per Day
MRMS	Mission Reach Mussel Survivability
NLCD	National Land Cover Database
NRCS	U.S. Department of Agriculture's Natural Resources Conservation Service
P-Hab	Physical Habitat
PHIS	Plant and Animal Health Index
RT	Routine Sampling
SARA	San Antonio River Authority
SARIP	San Antonio River Improvements Project
SMARC	San Marcos Aquatic Resource Center
SNARRC	Southwestern Native Aquatic Resource and Recovery Center
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solid
TMDL	Total Maximum Daily Load
TKN	Total Kjeldahl Nitrogen
TSS	Total Suspended Solid
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWS	Texas Wildlife Services
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plans
UAA	Use-Attainability Analyses
USACE	United States Army Corps of Engineers
USAR	Upper San Antonio River
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UV	Ultraviolet
WQMP	Water Quality Management Plans
WWTF	Wastewater Treatment Plant
WPP	Watershed Protection Plan

Introduction

The Clean Rivers Program (CRP) was created by the Texas Legislature in 1991 under the Texas Clean Rivers Act and provides the framework and forum for managing water quality issues through a comprehensive and holistic watershed management approach. The watershed management approach reflects common strategies for data collection and analyses that identify and address regional water quality issues in river basins throughout Texas. The San Antonio River Authority (River Authority) Environmental Sciences Department is responsible for the administration of the CRP to collect and monitor surface water data within the San Antonio River Basin. The CRP together with additional funding provided by the River Authority, the Texas Commission on Environmental Quality (TCEQ) monitoring efforts, and in-kind services provided by the Bandera County River Authority and Ground Water District (BCRAGD) are the primary programs for the collection and assessment of routine water quality data in the San Antonio River Basin in 2020.

2020 Highlights

Covid-19 Pandemic

The COVID-19 pandemic not only challenges monitoring entities throughout the state to maintain their water quality monitoring schedule, but also challenges the resiliency of a generation of environmental stewards and champions. In response to the COVID-19 pandemic, on February 27, 2020 the River Authority's Executive Team released a notice to staff identifying news reports of the coronavirus and its spread across the globe including safety measures to be taken at work and at home to help limit the spread of the virus. From March to April 2020, in keeping with the Governor's Executive Orders for an essential business, the River Authority entered Phase I - Remote Working from Home. This phase included a mandatory 5-day work from home directive, restrictions on all River Authority travel, and video conferencing and conference calls to conduct business. As an essential business, several River Authority departments continued to work, but strict safety measures were enforced. In May, the River Authority entered Phase II of the Return Safe-Work Smart Plan, which remained in effect through the writing of this report. This phase includes maintaining various voluntary/mandatory in office/field work schedules, masks, social distancing, sanitation, limited in-person meetings, and vehicle occupancy restrictions.

During Phase I there were 80 CRP water quality routine, bacterial and biological monitoring events not collected. During the first two weeks of Phase II, May 2020, the River Authority's field crew doubled up on scheduled and missed sampling events and were able to make up 31 CRP routine and biological sampling events not collected in March and April 2020; 49 bacterial samples could not be collected. The 49 bacteria, flow, and field samples represent seven collection events at seven monitoring stations. These stations are collected 52 times a year (every week) and could not be rescheduled. During this time, masks and social distancing requirements dictated that two separate monitoring teams use multiple vehicles when traveling to biological sampling sites.

Figure 2: Spotted Gar (*Lepisosteus oculatus*), captured and released at Station 16731 San Antonio River upstream of the Medina River Confluence.

Mission Reach Intensive Fish Survey

Two important biological events occurred in the 2019-2020 TCEQ fiscal year, including the March 2020 Mission Reach Intensive Fish Study (Intensive Fish Study) and the June 2020 fish kill event. The area for both events centered around assessment Unit 1911_08 of the Upper San Antonio River Watershed. This assessment unit is identified in the TCEQ 2020 Integrated Report as having impairments for fish and benthic macroinvertebrate communities and extends from just upstream of the confluence with Sixmile Creek to just upstream of the confluence with San Pedro Creek. The Intensive Fish Study is a multiyear study with the goals of documenting fish abundance, examining fish species-habitat-instream cover relationships, and determining benthic macroinvertebrate community health, diversity, and density throughout the Mission Reach. Among the highlights of the first-year 2019 Intensive Fish Study was the wide distribution of multiple ages of Guadalupe Bass (Guadalupe Bass Restocking Effort, SARA 2012/2013) and the first ever captured and released Texas Logperch in the Upper San Antonio River Mission Reach area in 1911_08. Both the Guadalupe Bass and the Logperch have a narrow range of habitat preferences, are pollution intolerant fish species, and their presence are indicators of good water quality.

Figure 3: Texas logperch (*Percina carbonaria*), Mission Reach Intensive Fish Study

Ammonia Spill and Fish Kill

On Tuesday, June 30, 2020 late afternoon, River Authority staff was made aware of a fish kill and a strong ammonia odor coming from Apache and San Pedro Creek. The River Authority's Environmental Investigations team conducted an onsite investigation and confirmed the ammonia odor and fish kill on the morning of Wednesday, July 1, 2020. A refrigerant line break at one of local businesses was identified as the source of the ammonia. River Authority staff continued to monitor the area, collect water quality samples, and removed dead fish through July 2nd. The area of concern included Apache Creek, San Pedro Creek, and the San Pedro Creek confluence with Upper San Antonio River in the Mission Reach area. The TCEQ, Texas Parks and Wildlife Department (TPWD), the River Authority's Environmental Sciences and Watershed and Park Operations teams, and the San Antonio Fire Department HazMat Team were involved with the ammonia spill and subsequent fish kill event. In total, 20 species of fish were affected, and 5,500 native and non-native dead fish were collected. Although TPWD fish restitution fines were assessed, there were several highlights associated with the event. The entity responsible for the spill acknowledged their role and proactively requested to be part of the solution. Fines

assessed will be used to mitigate the environmental damage or used for other efforts and projects aimed at enhancing the water quality in the impacted section of the San Antonio River and its tributaries. As prescribed by TPWD protocols, dead fish were collected, measured, and species identified. During the collection, one single Gray Redhorse was identified amongst the dead fish. The Gray Redhorse is a fish species that has a narrow range of habitat preferences, spawning requirements and are intolerant of high turbidity, siltation, and pollution. Tragic as the fish kill event was, this is the first ever documented case of the Gray Redhorse presence in the Mission Reach. The wide distribution of multiple ages of Guadalupe Bass together with the identification of the Texas logperch and Gray Redhorse serve to document water quality improvements associated with the **San Antonio River Improvements Project**[1] in 1911_08 of Upper San Antonio River Mission Reach area. To continue to document water quality improvement, the River Authority's field team will maintain routine water quality and biological collections at three stations in assessment unit 1911_08 of the Upper San Antonio River.

Impairments in the San Antonio River Basin

The **TCEQ 2020 Integrated Report**[2] (2020 Integrated Report) is the most currently approved Integrated Report and will serve as the foundation for impairments and concerns discussions in this report. The TCEQ adopted the 2020 Integrated Report on March 25, 2020, and the United States Environmental Protection Agency (EPA) approved it on May 12, 2020. In the 2020 Integrated Report, there were 13 classified and 23 unclassified stream segments (tributaries) assessed in the San Antonio River Basin. A total of 16 impairments were identified in the classified stream segments and a total of 18 impairments were identified in the unclassified stream segments of the San Antonio River Basin. Elevated levels of *E. coli* remain the primary water quality issue and major cause of impairments in the basin. Of the 36 waterbodies assessed in the San Antonio River Basin, 58% are considered impaired based on *E. coli* concentrations above the primary contract recreation standards allowed under the **Texas Surface Water Quality Standards**[3] (TSWQS). Depressed dissolved oxygen (DO), fish and benthic macroinvertebrate communities, and fish consumption restrictions in the Lower Leon Creek were also identified.

Five new impairments were added to the 2020 303(d) List of Impaired Waterbodies, including two bacteria impairments, one on Ecleto Creek (1901F) and one in the Upper Medina River (1905). Portions of Salado Creek and the Upper San Antonio River are identified as having an impaired benthic macroinvertebrate community; Salado Creek has also been identified as having a fish community impairment. There were three waterbodies removed from the 2020 Integrated Report. Lower Cibolo Creek (1902) and the Upper Medina River are no longer considered to have an impaired fish community and the Lower Leon Creek (1906) is no longer impaired for elevated levels of *E. coli*.

Figure 4: Station 12908 San Antonio River at Woodlawn Avenue, Upper San Antonio River Watershed

Water Quality Monitoring Programs

Overview of 2020 Monitoring

Due to the high expense associated with collecting water quality data and the importance of remaining adaptable to environmental changes, each year the River Authority conducts a coordinated monitoring meeting (CMM) with the TCEQ and other basin monitoring partners. In preparation for the TCEQ 2020 monitoring year, the River Authority conducted a spatial assessment of water quality data collected throughout the San Antonio River Basin. The purpose of the assessment was to look at assessment units with multiple monitoring stations in proximity of each other and determine if the stations possessed statistically similar or different water quality. After the analysis, it was determined that eight stations possessed similar water quality to either the upstream or downstream monitoring station(s), and to prevent duplication of effort, these stations were dropped from the FY2020 monitoring schedule. Most stations dropped were stations related to completed projects and were in visual proximity of each other. In addition, to

determine if metals were present in surface water, the River Authority added the metals in water parameter to 18 existing water quality monitoring stations throughout the basin.

Developing a comprehensive coordinated monitoring schedule (CMS) that supports the various basin and statewide objectives requires intensive planning and coordination. To coordinate the efforts and resources of many diverse organizations while ensuring the San Antonio River Basin monitoring programs remain effective and viable, the CMS undergoes annual review to evaluate new cooperative efforts and any emerging priorities. As the data collected is in support of the TCEQ's Integrated Reports and TSWQS, annual routine monitoring decisions are directed towards:

- Completing data sets where limited information indicates a water quality standard is not supported;
- Waters with known water quality impairments or concerns, or waterbodies where a concern for near nonattainment exists;
- Waters that have no known water quality problems or are without current water quality data.

Prior to finalizing the CMS, the River Authority conducts the CMM, normally held in mid-spring. During this meeting, partnering agencies discuss monitoring needs for the San Antonio River Basin for the upcoming year. The River Authority would like to thank the agencies listed below for their help over the years. Their efforts to maximize regional monitoring sampling programs while minimizing duplicative efforts is greatly appreciated.

- The River Authority's CRP Environmental Advisory Stakeholder Committee
- TCEQ Austin and San Antonio Offices
- The Bandera County River Authority and Groundwater District (BCRAGD)
- United States Geological Survey (USGS)
- Guadalupe-Blanco River Authority (GBRA)
- Texas State Soil and Water Conservation Board (TSSWCB)
- The City of Boerne
- Texas Parks and Wildlife Department (TPWD)

During the CMM, information from the CRP Environmental Advisory Stakeholder Committee and the most current Integrated Report are used to select stations and parameters for the 2020 CMS. Chosen stations continue to enhance the overall water quality monitoring coverage while addressing basin priorities. Table 1 gives a big picture view of the FY20 CMS, including number of stations, parameters and water monitoring partners in the San Antonio River Basin for the period of September 2019 through August 2020. Details of past and current CMS can be viewed at the TCEQ **Coordinated Monitoring Schedule website**[4].

Table 1: TCEQ FY2020 Segments, number of monitoring stations, parameters, and partners in the San Antonio River Basin

Segment	Watershed	CE	Stations	24 Hour DO	AqHab	Benthic	Nekton	Metal Water	Metal Sediment	Conventional Chemistry	Chlorophyll Pheophytin	Bacteria	Flow	Field
1901	Lower San Antonio River	SARA	12	6	4	0	4	12	0	72	54	167	151	77
		GBRA	1	0	0	0	0	0	0	12	0	12	12	12
1902	Lower Cibolo Creek	SARA	14	9	4	0	4	12	0	66	36	112	116	70
		TCEQ	1	0	0	0	0	0	0	4	0	4	4	4
1903	Lower Medina River	SARA	6	2	2	0	2	9	0	36	30	36	36	36
1904	Medina Lake	BCRAGD	5	0	0	0	0	0	0	20	8	20	0	20
1905	Upper Medina River	BCRAGD	8	2	2	0	2	4	0	32	8	32	32	32
1906	Lower Leon Creek	SARA	3	2	2	0	2	0	0	18	6	18	18	18
		TCEQ	2	0	0	0	0	4	4	8	0	8	8	8
1907	Upper Leon Creek	SARA	3	0	0	0	0	0	0	6	6	6	18	18
1908	Upper Cibolo Creek	SARA	2	2	2	0	2	6	0	12	0	12	12	12
		TCEQ	1	0	0	0	0	0	0	4	0	4	4	4
1909	Medina Diversion Lake	BCRAGD	1	0	0	0	0	0	0	4	0	4	4	4
1910	Upper Cibolo Creek	SARA	7	8	4	2	4	3	0	42	36	42	42	42
1911	Upper San Antonio River	SARA	21	9	6	2	6	21	0	120	84	310	298	126
1912	Medio Creek	SARA	2	2	2	0	2	3	0	12	12	12	12	12
1913	Mid Cibolo Creek	SARA	3	0	0	0	0	3	0	18	18	18	18	18
TOTAL			92	42	28	4	28	77	4	486	298	817	785	513

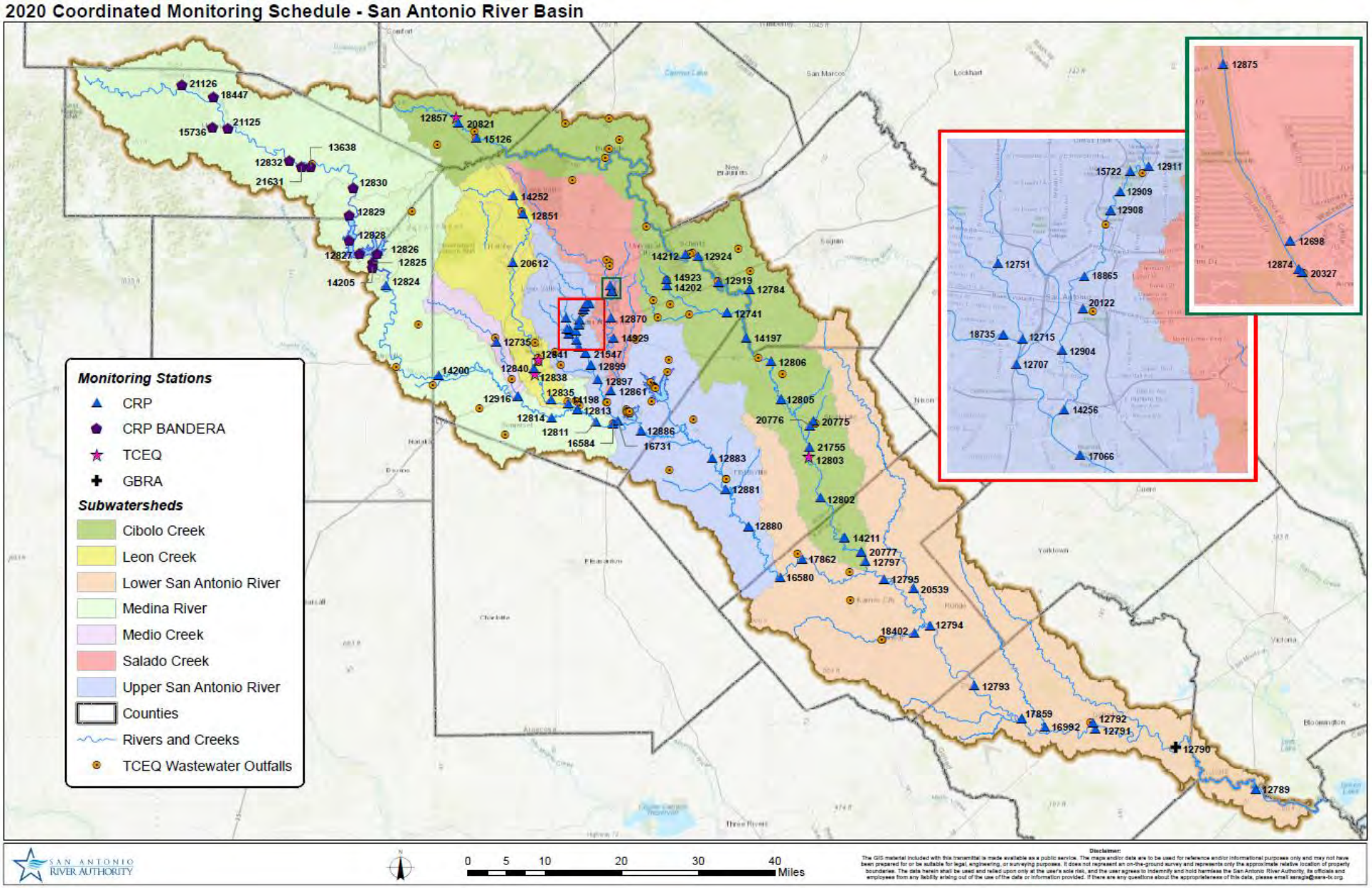

Figure 5: San Antonio River Basin 2020 Clean Rivers Program Monitoring Map

Water Quality Terminology

The water quality conditions of the San Antonio River Watershed discussed in this report describe water quality based on chemical and biological data collected by the River Authority, BCRAGD, GBRA, USGS, City of Boerne, TCEQ and their contractors. The information represents a snapshot of the levels of bacteria, nutrients, aquatic life use, and other water quality parameters throughout six watersheds in the San Antonio River Basin. Prior to discussing the water quality conditions for each watershed, an understanding of water quality parameters, TSWQS, TCEQ 2020 Integrated Report, and TCEQ assessment methodology and processes are needed to understand the complex issues involved in monitoring and assessing water quality data.

Surface Water Quality Parameters

As the data from the CRP is used in support of TCEQ Integrated Reports, TSWQS and stream water compliance decisions, the program operates under a River Authority TCEQ-approved **CRP Quality Assurance Project Plan**[5] (QAPP). The QAPP documents quality assurance and quality control requirements for sample collection, laboratory analyses, and data management. Adherence to the QAPP ensures the water quality data generated is of known and documented quality.

As identified in the QAPP, water quality monitoring collects physicochemical, biological, and hydrological information from waterbodies throughout the San Antonio River Basin. Smaller unclassified waterbodies are also monitored to evaluate and define water quality and to respond to perceived risk for pollution. Water quality parameters collected under CRP are identified below.

Field Parameters are measured at the sampling station and consist of water temperature, pH, DO, specific conductance, and flow. Water temperature, pH, DO, specific conductance measurements are collected using multiprobe instruments. Stream flow information is obtained from USGS gage stations or is collected instantaneously using acoustic doppler or handheld flow meters.

- Water **temperature** affects the oxygen content of the water and is a major factor in biological activity and growth of aquatic organisms. Temperature fluctuations too far above or below an organism's tolerance levels may kill or make them susceptible to disease and parasites. Some chemical compounds are also more toxic to aquatic life at higher temperatures.
- Water **pH** affects the solubility of compounds and the availability of these compounds to aquatic organisms. Example, as pH decreases the toxicity of ammonia increases. Elevated levels of ammonia adversely affect the growth and survival of freshwater organisms.
- **Dissolved oxygen (DO)** in surface water is used by all forms of aquatic life and is used to assess the health of lakes, rivers and creeks.
- **Specific Conductance,** also referred to as conductivity, is a measurement of the ability of water to pass an electrical current. Conductivity is affected by the presence of inorganic dissolved solids such as chloride, sulfate and sodium. Conductivity is also affected by temperature; the warmer the water, the higher the conductivity.
- **Stream Flow** is an important parameter affecting water quality, habitat and aquatic communities. Flow is also a critical component for interpreting historical data and assessing compliance with the TSWQS. Stream flow is affected by weather, increasing during rainstorms and

decreasing during dry periods. Flow also decreases during hot, dry summer months when evaporation rates are high and shoreline vegetation is actively growing.

Figure 6: Mayfly larvae or nymph, order Ephemeroptera; collected as part of CRP biological monitoring efforts.

Additional Surface Water Quality Parameters

24-Hour DO measures the DO concentrations over a 24-hour period at regular intervals (e.g., every 15 minutes) and is usually conducted frequently with biological and habitat assessments. Waterbodies support of the aquatic life use designation is based on the assessment of 24-hour average and minimum criterion as stated in the TSWQS. Grab field DO measurements are also compared to the average DO criterion value and a concern is identified when this screening level is exceeded. Of the three main sources of oxygen introduction into the aquatic environment (direct diffusion from the atmosphere, wind and wave action and photosynthesis) photosynthesis by aquatic plants and phytoplankton is the most important. DO concentrations will typically be highest in the mid- to late-afternoon when photosynthesis rates are greatest and will reach the lowest concentrations just before the sun rises the next morning. This fluctuation pattern is referred to as the "diurnal oxygen cycle". Oxygen is depleted by both natural functions and pollution. Factors affecting DO include water temperature, photosynthesis and respiration by aquatic plants and animals, breakdown of organic matter, flow, and daily and seasonal cycles. Potential causes of DO impairments include excessive nutrients and chemicals, elevated temperatures, and the removal of vegetation.

Nutrients are an important indicator of surface water quality because nitrogen and phosphorus control the growth of aquatic plants. Excessive growth of aquatic plants can cause DO concentrations to decrease during the night to levels that may not sustain aquatic communities. Seasonal variations in concentrations of nutrients are influenced by land use and by natural and human factors that cause variations in stream flow. Parameters include **total phosphorus, ammonia, nitrate, nitrite, and TKN.** Although not considered a nutrient itself, **chlorophyll-*a*** is also analyzed in conjunction with nutrients to help understand the physical characteristics of waterbodies.

- **Phosphorus**, under natural conditions, is the limiting nutrient for plant growth in most freshwater streams and rivers. However, when introduced even in modest quantities can result in excessive plant growth, algal blooms, low DO, and death or stress of aquatic organisms.
- **Nitrogen** in surface water is composed of **organic nitrogen** and inorganic forms of nitrogen such as **ammonia, nitrate, and nitrite**. Decomposition of aquatic life and effluent release from wastewater treatment plants can result in high organic nitrogen levels, while **inorganic nitrogen** levels are enhanced by agricultural and residential runoff (fertilizers). Although all these forms of nitrogen are present in surface water, the unionized form of ammonia (NH_3) is the most toxic to aquatic life. Elevated levels of nitrogen can result in excessive plant growth, algal blooms, low DO, and stress or death of aquatic organisms. Elevated nitrite concentrations can produce “brown blood disease” which, in fish, limits the bloods ability to transport oxygen.
- **Total Kjeldahl Nitrogen** (TKN) provides information for both the organic and the inorganic forms of nitrogen. By subtracting the inorganic concentrations obtained from other methods, the concentration of organic nitrogen can be determined. The decay of excessive levels of organic matter can affect aquatic life by lowering the available oxygen in the water and increasing water turbidity which reduces the light available to photosynthetic organisms. Organic wastes also settle out on the bottom of the stream, altering the characteristics of the substratum.
- **Chlorophyll-*a*** is a green pigment found in plants and algae. Chlorophyll-*a* measurements are used to estimate phytoplankton biomass. Levels of chlorophyll-*a* in surface waters naturally fluctuate over time. Consistently high levels are indicators of poor water quality and may be a result of excess nutrient loading.

To assess monitoring data for Integrated Reports, the TCEQ utilizes numeric screening levels for total phosphorus, nitrate nitrogen, ammonia nitrogen and chlorophyll-*a*. On June 30, 2010, the TCEQ adopted numerical nutrient criteria for 75 reservoirs in the 2010 TSWQS. On August 20,

2014, the TCEQ sent a revised and expanded version of the **Nutrient Criteria Development Work Plan**[6] for the State of Texas, to the EPA for review.

Chloride and Sulfate are inorganic anions present in surface and wastewater. Their concentrations can vary from watershed to watershed. As a result, specific numeric standards for chloride and sulfate have been set for each classified stream segment in the basin. Under natural conditions, chloride concentrations are relatively low; sulfates generally occur in higher concentrations. Elevated levels of chloride and sulfate affect the ionic composition of water which in turn can increase the toxicity of other compounds. Both inorganic ions can impact the designated uses and can come from natural and manmade sources, such as natural mineral content of parent substrate, wastewater discharges, agricultural runoff, and oil field activities.

Total Suspended Solids (TSS) refers to the amount of solid material suspended in surface water. It differs from turbidity in that it provides the actual weight of suspended matter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage. High concentrations of suspended solids can cause water quality issues for stream health and aquatic life, including higher concentrations of bacteria, nutrients, pesticides, and metals in waterbodies. These contaminants may bind to particles on land and be washed into waterbodies during storm events.

E. coli bacteria are typically not harmful to humans, but their presence is an indicator of recent fecal matter contamination which may contain pathogens dangerous to humans. Poorly maintained or ineffective septic systems, overflow of domestic sewage, nonpoint sources, wildlife, pet waste, and runoff from animal feedlots can elevate bacteria levels. According to the TCEQ 2020 Integrated Report, 58% of all waterbodies assessed in the San Antonio River Basin are considered impaired based on bacteria concentrations above the primary contract recreation geometric-mean criterion of 126 colony forming units per 100mL (cfu/100mL) as allowed under the TSWQS.

Texas Surface Water Quality Standards

In the TSWQS, the TCEQ assigns designated uses for all classified segments and defines five categories of use: aquatic life, recreation, fish consumption, public water supply, and general use. Each waterbody in the San Antonio River Basin is evaluated against its designated aquatic life use, the contact recreation standard, and general use. See Table 2 for Site-Specific Uses and Criteria for Classified Segments in the San Antonio River Basin. Fish Consumption Use and Public Water Supply Use are assigned and assessed to specific segments within the San Antonio River Basin. The designated uses as identified in the TSWQS are:

Aquatic Life Use: Aquatic Life Use is determined by DO criteria, toxic substances in water, ambient water toxicity and sediment toxicity test results. Numerous habitat, benthic macroinvertebrate and fish communities' measurements are also assessed, provided that the minimum number of samples are available. Each criterion is evaluated independently, and an impairment is identified when any one of the criteria is not attained. Segments are designated in one of five categories for aquatic life use based upon the results being evaluated: exceptional, high, intermediate, limited, or minimal.

Recreation Use: Recreation Use categories and criteria are assigned to all waterbodies. Two organisms are routinely analyzed in water samples collected to determine support of the recreation use: *E. coli* in freshwater and Enterococci in tidal waterbodies and certain inland waterbodies.

General Use: Water quality criteria for several constituents are established in the TSWQS to safeguard general water quality rather than one specific use. Parameters such as water temperature, pH, chloride, sulfate, and total dissolved solids are the parameters protecting aquatic life, recreation, public water supply and other beneficial uses.

Fish Consumption Use: Fish Consumption Use is assessed by review of the **Texas Department of State Health Service**[7] (TDSHS) published fish tissue data, human risk assessment information, consumption advisories and aquatic life closures. The TSWQS requires that surface waters shall not be toxic to humans from consumption of aquatic organisms. The TDSHS website contains information regarding fish consumption advisories and aquatic life closures. Fish consumption use is supported in waterbodies where the TDSHS has collected tissue data and a subsequent risk assessment indicates that no significant risk due to consumption of pollutants over a person's lifetime exists.

Public Water Supply Use: Public Water Supply use is evaluated for surface waterbodies that are designated in the TSWQS for public water supply use. Human health criteria from the TSWQS are used to determine whether the segment is supporting Public Water Supply Use. The human health criteria are based, in part, on the primary maximum contaminant levels adopted in the Texas Administrative Code (30 TAC §290).

Figure 7: Largemouth bass (*Micropterus salmoides*); captured and released during a biological collection event in the Upper San Antonio River.

Table 2: Site-Specific Uses and Criteria for Classified Segments as identified in Appendix A in the 2018 TSWQS

Segment	Segment Description	Uses			Criteria										Nutrient Screening Levels			
		Recreation[8]	Aquatic Life	Domestic Water Supply	Chloride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)	Dissolved Oxygen Grab Screening Average (mg/L)	Dissolved Oxygen Grab Minimum(mg/L)	24 Hour Dissolved Oxygen Average (mg/L)	24 Hour Dissolved Oxygen Minimum (mg/L)	pH Range (SU)	Temperature[6] (^{o}C)	*E. coli* geomean[1] (CFU/100ml)	Ammonia Nitrogen (mg/L)	Nitrate Nitrogen (mg/L)	Total Phosphorus (mg/L)	Chlorophyll-*a* (µg/L)
1901	Lower San Antonio River	PCR1	High		180	140	750	5.0	3.0	5.0	3.0	6.5-9.0	32.2	126	0.33	1.95	0.69	14.1
1902	Lower Cibolo Creek	PCR1	High		170	275	900	5.0	3.0	5.0	3.0	6.5-9.0	32.2	126	0.33	1.95	0.69	14.1
1903	Medina River Below Medina Diversion Lake	PCR1	High	PS[2]/AP[3]	120	120	700	5.0	3.0	5.0	3.0	6.5-9.0	32.2	126	0.33	1.95	0.69	14.1
1904	Medina Lake	PCR1	High	PS/AP[3]	80	75	350	5.0	3.0	5.0	3.0	6.5-9.0	31.1	126	0.11	0.37	5.00	26.7
1905	Medina River Above Medina Lake[4]	PCR1	Excellent	PS	50	150	400	6.0	4.0	6.0	4.0	6.5-9.0	31.1	126	0.33	1.95	0.69	14.1
1906 [5]	Lower Leon Creek	PCR1	High	PS[5]	120	120	700	5.0	3.0	5.0	3.0	6.5-9.0	35	126	0.33	1.95	0.69	14.1
1907	Upper Leon Creek	PCR1	High	PS/AP[3]	55	240	550	5.0	3.0	5.0	3.0	6.5-9.0	35	126	0.33	1.95	0.69	14.1
1908	Upper Cibolo Creek	PCR1	High	PS/AP[3]	50	100	600	5.0	3.0	5.0	3.0	6.5-9.0	32.2	126	0.33	1.95	0.69	14.1
1909	Medina Diversion Lake	PCR1	High	PS/AP[3]	50	75	400	5.0	3.0	5.0	3.0	6.5-9.0	32.2	126	0.11	0.37	0.20	26.7
1910	Salado Creek	PCR1	High	PS/AP[3]	140	200	600	5.0	3.0	5.0	3.0	6.5-9.0	32.2	126	0.33	1.95	0.69	14.1
1911	Upper San Antonio River	PCR1	High		150	150	750	5.0	3.0	5.0	3.0	6.5-9.0	32.2	126	0.33	1.95	0.69	14.1
1912	Medio Creek	PCR1	Intermediate		150	150	750	4.0	3.0	4.0	3.0	6.5-9.0	35	126	0.33	1.95	0.69	14.1
1913	Mid Cibolo Creek[7]	PCR1	Low		150	150	750	3.0	2.0	3.0	2.0	6.5-9.0	32.2	126	0.33	1.95	0.69	14.1

[1] The indicator bacteria for freshwater is *E. coli*

[2] For Segment 1903, the public supply designation does not apply from the confluence of the San Antonio River in Bexar County upstream to a point 2.5 Kilometers (1.5 miles) upstream of the confluence of Leon Creek.

[3] The aquifer protection use applies to areas in the contributing, recharge and transition zones of the Edward Aquifer.

[4] The critical low-flow for Segment 1905 is calculated according to §307.8(a)(2)(B) of the TSWQS

[5] For Segment 1906, the public supply designation does not apply from the confluence of the Medina River in Bexar County upstream to a point 4.8 Kilometers (3 miles) upstream.

[6] Temperature was converted from ^{o}F to ^{o}C, the criteria for temperature are listed as maximum values at any site within the segment.

[7] Mid Cibolo Creek is an intermittent stream with perennial pools

[8] Primary Contact Recreation 1geometric mean criterion for *E.coli* is 126 per 100 mL with a single grab criterion for E.coli of 399 per 100 mL.

Figure 8: American green tree frog (*Hyla cinerea*), Salado Creek Watershed

Guidance for Assessing and Reporting Surface Water Quality in Texas

In the development of TCEQ Integrated Reports, specific assessment methods are utilized as described in the **2020 Guidance for Assessing and Reporting Surface Water Quality in Texas**[8] (Guidance). The Guidance is developed by TCEQ staff with input through an advisory stakeholder process. Individuals representing diverse organizations and interests are invited to participate in the revision of current guidance and to develop, review, and comment on new draft guidance every few years. The advisory group includes, but is not limited to, state agencies, environmental consultants, river authorities, environmental groups, industry, agricultural interests, and municipalities.

Classified Segments

In order to manage the vast extent of surface waters in Texas, and the ecological diversity of the state, the major rivers, lakes, and estuaries have been subdivided and assigned tracking numbers called classified segments. A classified segment is a waterbody or portion of a waterbody that is individually defined in the TSWQS. A segment is intended to have relatively homogeneous chemical, physical, and hydrological characteristics. A segment provides the basic unit for assigning site-specific standards and for applying water quality management programs of the TCEQ. Classified segments may include streams, rivers, bays, estuaries, wetlands, lakes, or reservoirs. Classified segments are protected by site-specific criteria as stated in the TSWQS. The classified segments are assigned four-digit numbers. The first two digits correspond to the major basin in which they are located. The last two digits distinguish individual segments within the basin. For example, Segment 1901 is in basin 19 (San Antonio River Basin) and 01 represents the Lower San Antonio River from the confluence with the Guadalupe River in Refugio/Victoria County to a point 600 meters downstream of FM 791 at Mays crossing near Falls City in Karnes County.

Unclassified Waterbodies (Tributaries)

Due to the great extent of waters in the state, not all bodies of water are classified in the TSWQS. For example, when managing a classified segment of the Lower San Antonio River, it may be necessary to examine water quality in the tributaries that flow into that segment. Some of these tributaries may not be part of the classified segment system. When that happens, for management purposes, the tributary is assigned a unique tracking number that is referred to as an unclassified waterbody. This unclassified tributary will be designated with the number of the classified segment in the watershed it is located, along with a letter. Example 1901A Escondido Creek and 1901B Cabeza Creek are tributaries of the Lower San Antonio River (1901). Unclassified waterbodies are small and often intermittent, typically not assigned specific water quality standards. Unclassified waterbodies are generally assessed on the flow and the criteria for the classified segment into which they flow, but in some cases may be assigned specific water quality standards. Site-specific ALU and associated DO criteria have been assigned to some unclassified water bodies through receiving water assessments. For other unclassified water bodies, the ALU and associated DO criteria are presumed based on the flow-type or other information developed by the TCEQ water programs.

Assessment Units

Each segment and waterbody are further broken down into sub-areas called assessment units (AU). For the purpose of TCEQ assessments, each watershed's impairments and/or concerns for designated use support are reported at the AU sub-area levels, which is defined as the smallest geographic area of use support reported in the Integrated Report. Each AU within a segment is assigned a number such as 1901_01. A segment may

consist of more than one AU, 1901_01, 1901_02, 1901_03 and so on. Support of criteria and uses are examined for each AU. To address water quality regulatory activity such as permitting, standards development, and remediation, use support information applies to the AU level.

2020 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d)

The TCEQ, in keeping with its mission to protect the state's natural resources, regularly monitors the condition of the state's surface waters and assesses water quality. The Integrated Report for Clean Water Act, Sections 305(b) and 303(d) is a statewide report on the status of state surface waters and is prepared and submitted to the U.S. Environmental Protection Agency (EPA) every two years. The TCEQ adopted the 2020 Integrated Report on March 25, 2020, and the United States Environmental Protection Agency (EPA) approved it on May 12, 2020.

To provide information on water quality status to the public, EPA, and other TCEQ programs, the Integrated Report assigns each assessed waterbody to one of five categories. The five-part categorization of waters (Table 3) is an important tool for water quality management throughout the State. Within this framework, higher category numbers correspond to the increased levels of effort required to manage water quality. Waterbodies in Category 1 are meeting all their designated uses and simply require routine monitoring and preventive action. Waterbodies identified in Category 5, also known as the 303(d) List of Impaired Water, represent situations where water quality criteria are not attained, and water quality management actions are needed to address the issue. For segments in Category 5a, the TCEQ must develop a scientific allocation called a total maximum daily load (TMDL) and an implementation plan to implement the findings in the TMDL. Alternatively, 5b could also represent situations where water quality standards revisions may be needed in a specific area to better reflect ambient water quality conditions. A **Summary of the 2020 Texas Integrated Report**[9] impairments can be viewed at the TCEQ's website.

Table 3: Categories included in the 2020 Integrated Report

Category	Definition
1	All designated uses are supported, no use is threatened.
2	Available data and/or information indicate that some, but not all of the designated uses are supported.
3	Insufficient or no data and information to determine if standard is attained
4	Standard is not attained or nonattainment is predicted in the near future due to one or more parameters, but no TMDLs are required
	a) All TMDLs have been completed and approved by EPA.
	b) Other pollution control requirements are reasonably expected to result in the attainment of the water qualit y standard in the near future.
	c) Nonattainment of the standard for one or more parameters is shown to be caused by pollution, n ot by pollutants and that the water quality conditions cannot be changed by the allocation and control of pollutants through the TMDL process.
5	Standard is not attained or nonattainment is predicted in the near future for one or more parameters.
	a) TMDLs are underway, scheduled, or may be scheduled for one or more parameters.
	b) A review of the standards for one or more parameters will be conducted before a management strategy is selected, including a possible revision to the water quality standards.
	c) Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

Total Maximum Daily Loads, Implementation Plans and Watershed Protection Plans

Total Maximum Daily Loads (TMDLs) and their implementation plans are developed to address segments listed in Category 5a. The TCEQ is required to establish a TMDL for each impairment in each segment in Category 5a. The TCEQ then develops an implementation plan to achieve the loading allocations defined in the TMDL in cooperation with other governing agencies. TMDLs are subject to EPA approval; implementation plans are not.

In order to restore water quality, it is first necessary to be reasonably certain of the sources and causes of pollution. One way to accomplish this is to develop a scientific allocation called a **TMDL.** The goals of a TMDL are to determine the maximum amount of a pollutant that a waterbody can receive and still both attain and maintain its water quality standards; and to allocate this allowable amount (load) to point and nonpoint sources in the watershed. TMDLs must be submitted to the EPA for review and approval. A TMDL is normally prepared for each pollutant in each impaired segment. This may mean that more than one TMDL can be developed for any one waterbody. After a TMDL is completed, a **TMDL Implementation Plan (I-Plan)** is developed that describes the regulatory and voluntary activities necessary to achieve the pollutant reductions identified in the TMDL. Management activities incorporate both non-regulatory and regulatory mechanisms, such as permit effluent limits and recommendations, nonpoint source pollution management practices, proposed revisions to stream standards, special projects, pollution prevention, public education, and watershed-specific rule recommendations. The best strategies for each individual watershed are developed in cooperation with regional and local stakeholders. The I-Plan describes these various activities, the schedule for implementing them, and the legal authority for the regulatory measures. It also provides reasonable assurance that the voluntary practices will be undertaken. For instance, the plan may identify grant funds that have been secured to implement voluntary actions. The plan also includes the measurable results that will be achieved through the plan, along with a follow-up monitoring plan to determine its success. The ultimate goal is always the attainment of the water quality standard, but additional, interim results may be evaluated to assess progress toward that goal.

The TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB) support the development and implementation of **Watershed Protection Plans (WPPs)** that prevent or manage nonpoint source pollution. WPPs are developed through local stakeholder groups, usually with funding and technical assistance from the TCEQ and/or the TSSWCB, along with the U.S. Environmental Protection Agency. WPPs are similar to I-Plans in that both define actions needed to reduce pollution and restore water quality, are developed in cooperation with regional and local stakeholders and are based on the best available scientific methods and tools. WPPs differ from I-Plans in that I-Plans are remedial actions for impaired waters; WPPs may be either remedial or preventive. Also, I-Plans are based on TMDLs; WPPs use other environmental measures to meet goals for water quality.

Figure 9: 2020 Michael Gonzales Memorial Intern, Sarah Mock, Spotted Gar (*Lepisosteus oculatus*), Salado Creek Watershed

Water Quality of the San Antonio River Watershed

This report utilizes the 2020 Integrated Report to describe the water quality conditions of the San Antonio River Watershed and represents a periodic snapshot of conditions over a seven to ten-year period. The 2020 Integrated Report assessment period of record for the last seven years is December 1, 2011 through November 30, 2018. Samples from these seven years are evaluated when available, and if necessary, the most recent samples collected in the preceding three years (December 1, 2008 through November 30, 2011) may also be included to meet the requirements for minimum sample number. The watershed summaries in this section are intended to develop a greater understanding of water quality conditions and will provide an overview of activities and water quality issues that occurred within the basin during the TCEQ 2020 fiscal year, including information for each segment, maps, sub-watershed descriptions, monitoring stations, concerns and impairments, including any projects or efforts to address water quality issues. Details of the impairments and concerns for each watershed, as identified in the 2020 Integrated Report, are also included in map and table formats at the end of each watershed summary. An impairment and concern map will not be included if no impairments or concerns were identified in the 2020 Integrated Report.

The Impairment and Concern map and table at the end of each watershed summary identifies impairments and concerns for each assessment unit assessed in the 2020 Integrated Report. If an assessment unit is not meeting the assigned designated use, that designated use will be identified as *Impaired* in a red box. If the assessment unit is close to violating the water quality standard or screening level, the assessment unit will be identified as a *Concern* in a yellow box. The table of impairments and concerns provides additional details on assessment units that were not assessed (NA) in the 2020 Integrated Report as a result of limited data (LD), inadequate data (ID) or data that is temporally not representative (TR) of conditions in the assessment area.

Figure 10: Kayaking in the Mission Reach, Padre Park in the Upper San Antonio River Watershed

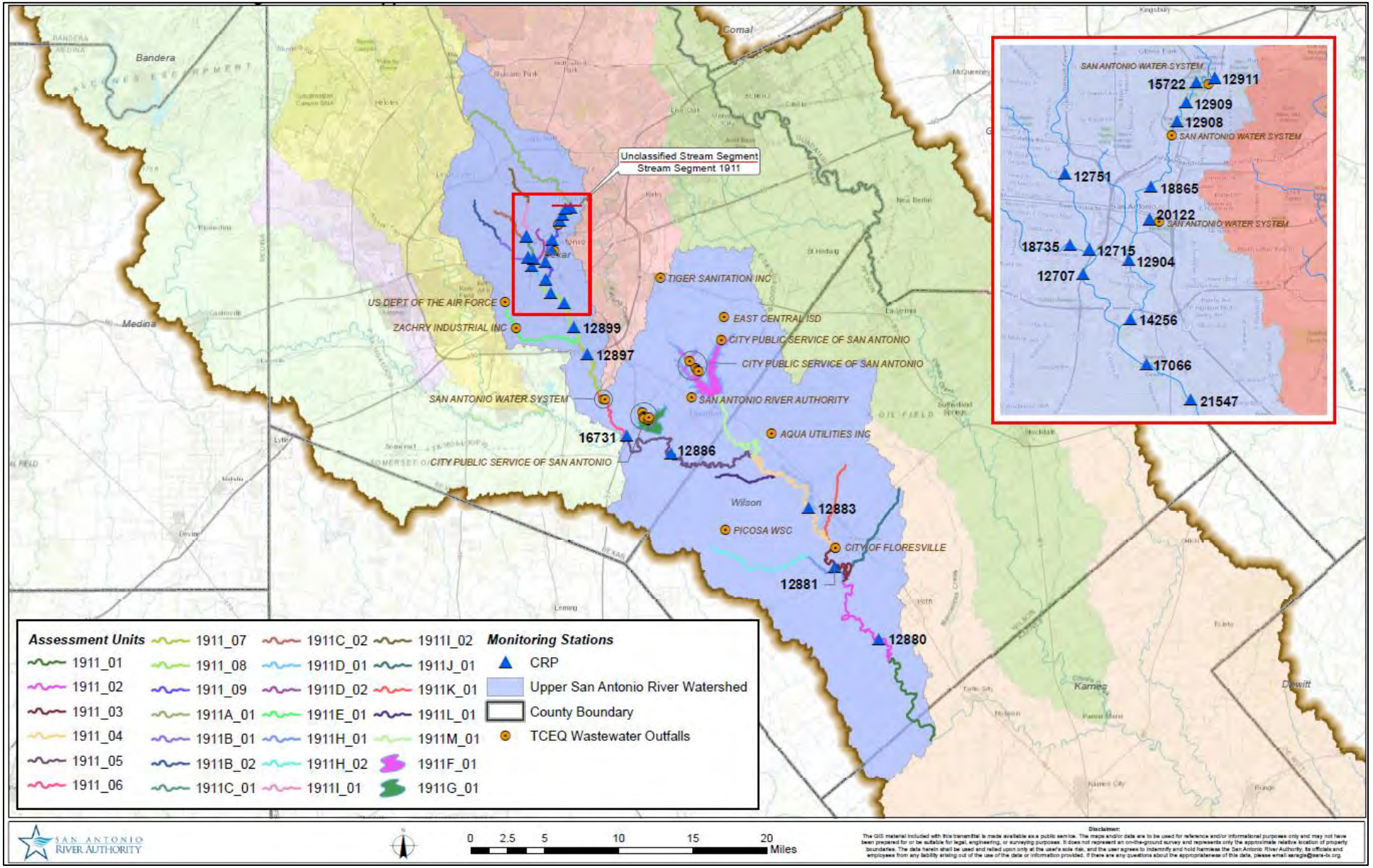

Figure 11: 2020 Monitoring Map for the Upper San Antonio River Watershed

Drainage Area: 544 square miles

Aquifers: Trinity, Edwards, Carrizo

River Segments: 1911, 1911A, 1911B, 1911C, 1911D, 1911E, 1911F, 1911G, 1911H, 1911I, 1911J, 1911K, 1911L, 1911M

Cities: San Antonio, Floresville

Counties: Bexar, Karnes, Wilson

Ecoregion: East Central Texas Plains, Texas Blackland Prairies, Edwards Plateau

Vegetation Cover: 5.85% Deciduous Forest, 0.29% Evergreen Forest, 0.46% Herbaceous, 3.28% Mixed Forest, 31.7% Shrub/Scrub

Land Uses: 0.18% Barren Land, 4.26% Cultivated Crops, 0.1% Developed, High Intensity, 1.4% Developed, Low Intensity, 0.46% Developed, Medium Intensity, 2.32% Developed, Open Space, 0.35% Emergent Herbaceous Wetlands, 45.89% Hay/Pasture, 0.51% Open Water, 2.95% Woody Wetlands

Figure 12: Water Quality Monitoring Station 12899 Upper San Antonio River at Padre Road

Upper San Antonio River - Segment 1911

The San Antonio River essentially begins under another name – Olmos Creek, which has its headwaters just north of Loop 1604. Just south of Olmos Dam, the San Antonio Springs discharges at rates between 0 and 100 cubic feet per second (cfs), depending upon the level of the Edwards Aquifer (SAR WPP, December 2006). The riparian habitat between Olmos Dam and Brackenridge Park is dense and includes a variety of trees and plants such as live oak, hackberry, cedar elm, pecan, Texas oak, Texas persimmon, lantana, and cutgrass. Just upstream of Brackenridge Park on the grounds of Incarnate Word University, the creek becomes known as the San Antonio River, which then flows through the heavily urbanized downtown district of San Antonio. As the San Antonio River flows past South Loop 410 into its rural reach, it becomes wider and deeper and takes on the natural characteristics of South Texas streams influenced by the geology of East Central Texas Plains. The watershed has an average yearly rainfall of 26 to 34 inches. Base flow of the Upper San Antonio River is artificially maintained with well water discharges from the San Antonio Zoo and reuse water from the San Antonio Water Systems Recycling Centers.

Major classified tributaries to the Upper San Antonio River include the Medina River and Salado Creek. Unclassified waterbodies of the Upper San Antonio River assessed in the 2020 Integrated Report include Apache Creek, Alazan Creek, San Pedro Creek, Sixmile Creek, Picosa Creek, Martinez Creek, Pajarito Creek, Seguin Branch, and Unnamed Tributary of the Upper San Antonio River. As a result of insufficient data, Olmos Creek (1911A), Calaveras Reservoir (1911F), Braunig Reservoir (1911G), and Calaveras Creek (1911M) were not assessed in the 2020 Integrated Report. Details of the impairments and concerns for the Upper San Antonio River Watershed can be seen in Figure 16 and Table 4.

Segment 1911 – Upper San Antonio River: The Upper San Antonio River is a classified stream segment and extends from a point 600 meters (660 yards) downstream of FM 791 at Mays Crossing near Falls City in Karnes County to a point 100 meters (110 yards) upstream of Hildebrand Avenue at San Antonio in Bexar County. According to the 2020 Integrated Report, the Upper San Antonio River is identified as impaired for not supporting the primary contact recreation use. Elevated levels of *E. coli* bacteria have been identified in several AU's throughout the Upper San Antonio River Watershed. Fish and benthic macroinvertebrate communities' impairments have also been documented. Habitat, nitrate, total phosphorus, and chlorophyll-*a* have been listed as concerns.

Segment 1911B – Apache Creek: Extends from the confluence with San Pedro Creek upstream to the headwaters at SH 421 (Bandera Road) in San Antonio. Apache Creek has a concern for water quality based on nitrate nutrient screening levels. An impairment for elevated levels of *E. coli* bacteria has also been identified.

Segment 1911C – Alazan Creek: Extends from the confluence with Apache Creek up to 0.4 km (0.25 mi) upstream of St. Cloud in San Antonio, Bexar County, Texas. An impairment for elevated levels of *E. coli* bacteria has been identified.

Segment 1911D – San Pedro Creek: Extends from the confluence with Segment 1911 to the upper end of the waterbody. San Pedro Creek has a concern for water quality based on nitrate nutrient screening levels. An impairment for elevated levels of *E. coli* bacteria has also been identified.

Segment 1911E – Sixmile Creek: Extends from the confluence with 1911 to the upper end of the waterbody. Sixmile Creek has been identified as impaired for elevated levels of *E. coli* bacteria.

Segment 1911H – Picosa Creek: Extends from the confluence with Segment 1911 to the upper end of the waterbody. Picosa Creek is in Wilson County and has been identified as impaired for not supporting the limited aquatic life use designation. The impairment is based on 24-hour DO minimum and average concentrations below the limited aquatic life criterion.

Segment 1911I – Martinez Creek: Extends from the confluence of Alazan Creek in central San Antonio upstream to the terminus at Vance Jackson Road in north San Antonio. An impairment for elevated levels of *E. coli* bacteria has been identified.

Segment 1911J – Pajarito Creek: Extends from the confluence with the Upper San Antonio River upstream to the headwaters at Wilson CR 403 northwest of Floresville. Pajarito Creek has concerns for elevated levels of *E. coli* bacteria.

Segment 1911K – Seguin Branch: Extends from the confluence with the Upper San Antonio River upstream to the headwaters approximately 2.2 km upstream of Wilson CR 331 north of Floresville. Seguin Branch has concerns for elevated levels of *E. coli* bacteria.

Segment 1911L – Unnamed Tributary of the Upper San Antonio River: Extends from the confluence with the Upper San Antonio River upstream to the confluence with an unnamed tributary 200 m upstream of FM 1303 in Wilson County. This segment has been identified as having a concern for DO concentrations below the limited aquatic life criterion.

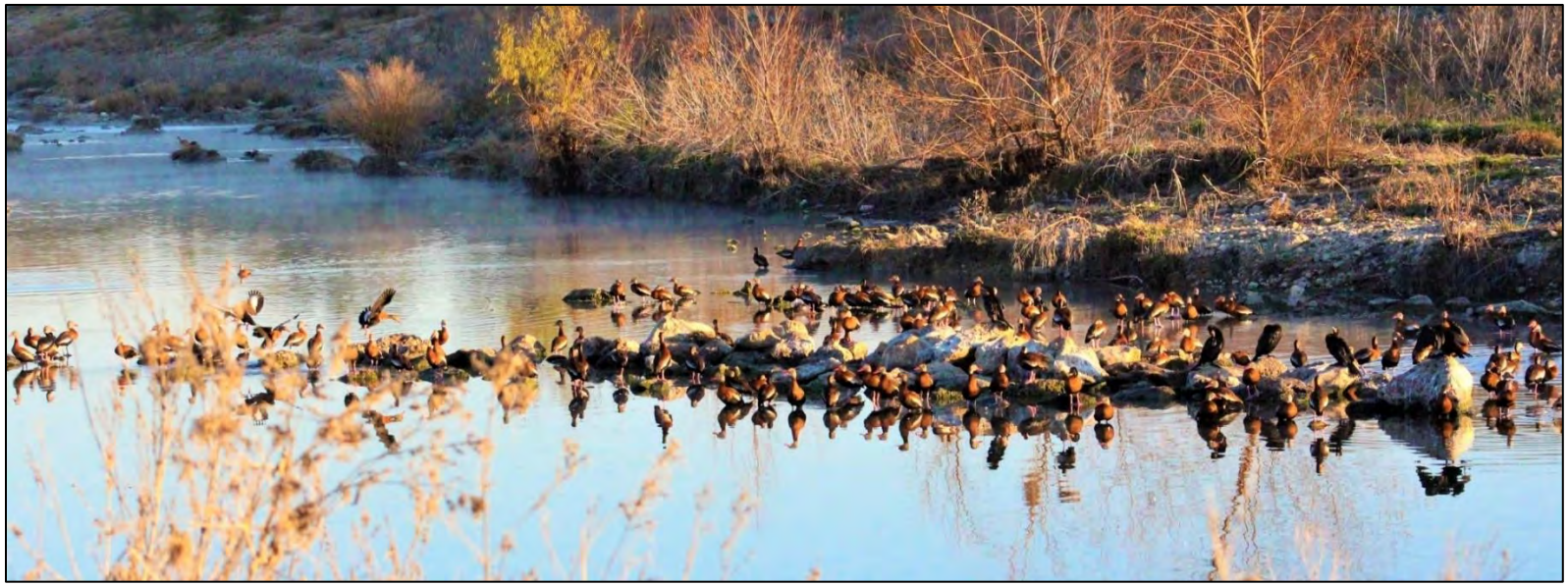

Figure 13: Black-bellied Whistling Ducks and Cormorants in the Upper San Antonio River Watershed

Activities in the Watershed

Upper San Antonio River Watershed Protection Plan and the Implementation Plan for Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watershed: In response to the Three Total Maximum Daily Loads for Bacteria in the San Antonio area, the River Authority, TCEQ, and Texas A&M AgriLife worked with communities, interest groups, and local organizations to involve stakeholders with the **development of the SARA Original Upper San Antonio River Watershed Protection Plan[10]** (WPP) and the **SARA Update Upper San Antonio River Watershed Protection Plan[11]** (I-Plan). The WPP and I-Plan contain management measures designed to guide activities that will improve water quality, identify and describe Best Management Practices (BMP) that will be implemented and tracked to reduce bacteria in the watershed, and establish a timeline for implementation. Follow-up tracking and monitoring plans are also included to determine the effectiveness of the BMPs. The ultimate goal of the I-Plan is to meet primary contact recreation uses in the identified segments by reducing concentrations of *E. coli* bacteria to levels established in the TMDLs. Some of the management measures in the USAR I-Plan include:

- Advancement of Low Impact Development.
- Wastewater collection and transmission system operation and maintenance programs to reduce sanitary sewer overflows.
- San Antonio Zoo UV treatment system implementation.
- Avian management for the riverwalk and other riparian areas.
- Increase awareness and enforcement of pet control ordinances and expansion of pooper scooper program.

Stakeholders meet periodically to track implementation progress and evaluate management measures that may or may not be working and make changes as necessary.

The River Road Eco-Restoration Project: The United States Army Corps of Engineers (USACE) and the River Authority have partnered to conduct an aquatic ecosystem restoration feasibility study on the last unchannelized reach of the Upper San Antonio River in Brackenridge Park, stretching from Mulberry Street to Highway 281. According to the TCEQ Integrated Report, this portion of the river has been identified as having a fish community impairment. Erosion, invasive flora and fauna, degrading river stability, and the decline of natural riparian buffer have also been identified in this section of the river. Solutions being evaluated include the addition and modification of natural channel structures, bank stabilization, invasive species removal and their replacement with native vegetation, the removal of artificial structures hindering natural stream and fish movement, and the increase and restoration of the riparian zone. These potential solutions could improve river health through the reduction of silt, erosion, and bacteria, while improving water quality and aquatic communities.

Mission Reach Intensive Fish Study: In March 2019, River Authority staff initiated the multiyear Mission Reach Intensive Fish Study. The study's objectives are to establish fish abundance, examine fish species-habitat-instream cover relationships, and determine benthic macroinvertebrate community health, diversity, and density throughout the Mission Reach. The Mission Reach was divided into five individual sampling reaches based on what are believed to be significant barriers to fish passage. Each reach was sampled using a combination of electrofishing and seining as deemed appropriate for each type of habitat encountered. At each habitat, captured fish were identified, counted, measured, and released. A variety of detailed

habitat observations and measurements were also recorded for each habitat. In 2019 a single benthic macroinvertebrate sample was collected for each sampling reach by compositing samples from each of five randomly selected riffles. Benthic macroinvertebrates collected contained individuals representing 41 unique taxa in 30 families. Staff sampled 76 individual habitats and collected 878 individual fish representing 21 species. Among the highlights of the effort were the wide distribution of multiple age groups of Guadalupe Bass and the first ever documented Texas Logperch. The Guadalupe Bass and the Texas Logperch are very pollution intolerant fish species and their presence in the Mission Reach is an indicator of good water and habitat quality.

Figure 14: San Pedro Creek Culture Park, Rain from the Heavens water feature, Upper San Antonio River Watershed

Mission Reach Mussel Survivability Study: Freshwater mussels are filter-feeding, sedentary organisms that provide a tremendous amount of ecosystem services. The 2014 River Authority Holistic Freshwater Mussel Project provided scientists with evidence that native freshwater mussels once existed far into the headwaters of the San Antonio River long before anthropogenic alteration drove them out. The Mission Reach Restoration, an ecosystem restoration of an eight mile stretch of river just downstream of downtown San Antonio, was completed in 2013 and has provided a tremendous lift in ecosystem functionality and resiliency. This restoration has allowed River Authority biologists to determine how effective a large-scale urban river restoration can be by looking at an assortment of biological responses. The Mission Reach Mussel Survivability Study (MRMS) has three groups of adult mussels held at two sites within the newly restored reach and one control site in the Lower San Antonio River which is known to sustain a healthy mussel population. Biologists are comparing survival and growth of these two study populations to determine if water and sediment quality would allow mussels to survive and thrive. Mussels at one of the Mission Reach sites have better survival and higher growth than those at the control site after two years in the study. There are quite a few unanswered questions to explore; however, it is a promising step forward towards a mussel reintroduction into this restored reach. Scientists are addressing these questions to ensure that all concerns for a reintroduction of this scale have been addressed in a holistic manner.

Freshwater Mussel Propagation Project: Early indications of the MRMS study suggest that both water and sediment quality are sufficient to sustain the four species assessed. As the MRMS study progresses, biologists will be able to make more definitive conclusions on overall health and viability of the mussels and determine if reintroduction of mussels into the Mission Reach is practical. In order to prepare for this potential re-introduction, it is critical to develop propagation methodology for all four species included in the MRMS study, and subsequently use reared individuals to assess instream juvenile survivability. Juvenile survivability is an important factor in determining if mussel reintroduction is possible.

Freshwater mussels begin life as parasitic larvae known as glochidia. When these larval mussels are expelled by the female, they must find a suitable host fish to develop. They attach themselves to the fish's gills or other soft tissue and after several weeks, the larvae transform into juvenile mussels. They then fall off the host fish and settle on the bottom of the creek. If they settle on suitable habitat, their journey to adulthood begins. In order to accomplish these objectives, River Authority staff have partnered with three United States Fish and Wildlife Service (USFWS) facilities; 1) the San Marcos Aquatic Resource Center (SMARC) in San Marcos, TX, 2) the Inks Dam National Fish Hatchery (IDNFH) in Burnet, TX, and 3) the Southwestern Native Aquatic Resource and Recovery Center (SNARRC) in Dexter, New Mexico. SMARC will be focusing on propagation methodology and conducting applied research on physiological limitations, SNARRC will conduct genetic sequencing on mussels found in the San Antonio River Basin to establish genetic diversity and structure and IDNFH will serve as the production facility should River Authority staff decide to move forward with a full scale re-introduction. Additional information on the Mission Reach Mussel Survivability Study and the Freshwater Mussel Propagation Project can be found in the Environmental Projects, Studies and Efforts section of this report.

Figure 15: Preparation for genetic testing for the Freshwater Mussel Project in the Lower San Antonio River Watershed

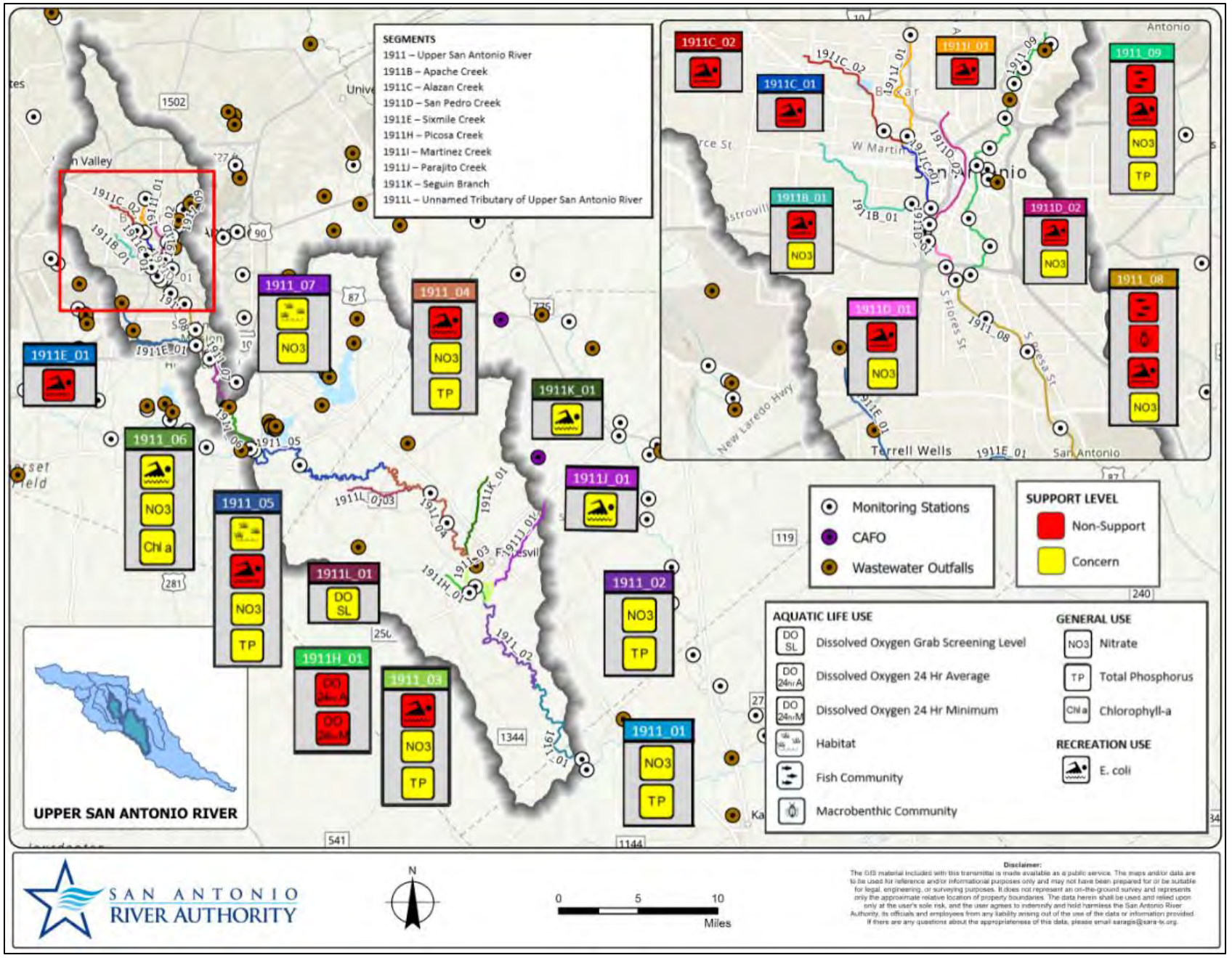

Figure 16: 2020 TCEQ Integrated Report; Impairments and Concerns in the Upper San Antonio River

Table 4: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1911 Upper San Antonio River and Tributaries										
Seg_AU	**Designated Use**	**Method**	**Parameter Description**	**Criteria**	**# of Samples Assessed**	**# of Samples Exceeding Criteria**	**Mean of Samples Exceeding Criteria or Bacteria Geomean**	**Data Set Qualifier**	**Integrated Level of Support**	**Impairment Category**
1911 Upper San Antonio River										
1911_01	General Use	Nutrient Screening Level	Nitrate	1.95	54	53	10.74	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	54	48	1.35	AD	CS	
1911_02	General Use	Nutrient Screening Level	Nitrate	1.95	--	--	--	ID	CS*	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	--	--	--	ID	CS*	
1911_03	Recreation Use	Bacteria Geomean	*E. coli*	126	326	1	140.20	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	46	46	12.30	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	46	44	1.45	AD	CS	
1911_04	Recreation Use	Bacteria Geomean	*E. coli*	126	26	1	212.67	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	26	25	11.27	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	26	24	1.58	AD	CS	
1911_05	Aquatic Life Use	Habitat	Habitat	20	3	--	17	TR	CS	
	Recreation Use	Bacteria Geomean	*E. coli*	126	94	1	167.09	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	94	91	12.77	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	94	85	1.61	AD	CS	
1911_06	Recreation Use	Bacteria Geomean	*E. coli*	126	97	1	138.01	AD	CN	
	General Use	Nutrient Screening Level	Chlorophyll-*a*	14.10	85	22	29.18	AD	CS	
	General Use	Nutrient Screening Level	Nitrate	1.95	96	24	2.84	AD	CS	
1911_07	Aquatic Life Use	Habitat	Habitat	20	4	--	19	AD	CS	
	General Use	Nutrient Screening Level	Nitrate	1.95	31	12	3.97	AD	CS	
1911_08	Aquatic Life Use	Fish Community	Fish Community	41	7	--	38	AD	**NS**	5c
	Aquatic Life Use	Macrobenthic Community	Macrobenthic Community	29	7	--	27	AD	**NS**	5c
	Recreation Use	Bacteria Geomean	*E. coli*	126	429	1	251.86	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	87	68	4.45	AD	CS	
1911_09	Aquatic Life Use	Fish Community	Fish Community	41	7	--	38	AD	**NS**	5c
	Recreation Use	Bacteria Geomean	*E. coli*	126	864	1	560.57	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	381	353	9.09	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	384	242	1.48	AD	CS	

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

LD - Limited Data (less than 9, greater than 3)

ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

***** Indicates the Integrated Level of Support was carried forward from a previous assessment due to inadequate data .

Table 4: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1911 Upper San Antonio River and Tributaries										
Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1911B Apache Creek										
1911B_01	Recreation Use	Bacteria Geomean	*E. coli*	126	40	1	508.05	AD	NS	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	42	24	3.28	AD	CS	
1911C Alazan Creek										
1911C_01	Recreation Use	Bacteria Geomean	*E. coli*	126	42	1	467.95	AD	NS	4a
1911C_02	Recreation Use	Bacteria Geomean	*E. coli*	126	14	1	280.21	LD	NS*	4a
1911D San Pedro Creek										
1911D_01	Recreation Use	Bacteria Geomean	*E. coli*	126	203	1	326.21	AD	NS	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	55	23	2.52	AD	CS	
1911D_02	Recreation Use	Bacteria Geomean	*E. coli*	126	12	1	516.74	LD	NS*	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	12	9	2.24	AD	CS	
1911E Sixmile Creek										
1911E_01	Recreation Use	Bacteria Geomean	*E. coli*	126	12	1	494.47	LD	NS*	4a
1911H Picosa Creek										
1911H_01	Aquatic Life	Dissolved Oxygen 24hr Average	Dissolved Oxygen 24hr Avg	3	10	9	0.52	AD	NS	5c
	Aquatic Life	Dissolved Oxygen 24hr Minimum	Dissolved Oxygen 24hr Min	2	10	9	0.29	AD	NS	5c
1911I Martinez Creek										
1911I_01	Recreation Use	Bacteria Geomean	*E. coli*	126	39	1	296.64	AD	NS	5a
1911J Pajarito Creek										
1911J_01	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	
1911K Martinez Creek										
1911K_01	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	
1911L Unnamed tributary of Upper San Antonio River										
1911L_01	Aquatic Life	Dissolved Oxygen screening Level	Dissolved Oxygen Grab	2	--	--	--	ID	CS*	

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

LD - Limited Data (less than 9, greater than 3)

ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

***** Indicates the Integrated Level of Support was carried forward from a previous assessment due to inadequate data .

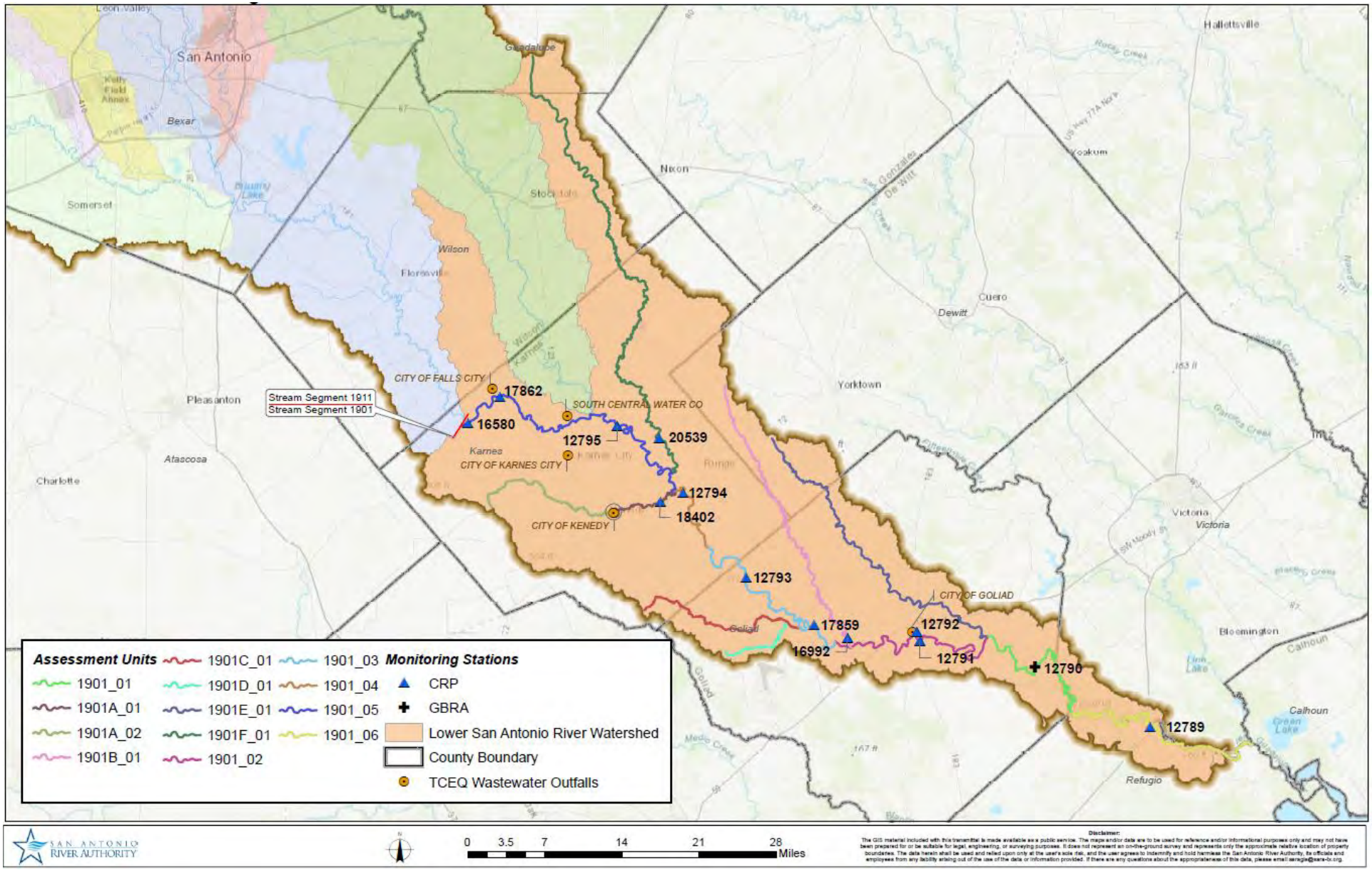

Figure 17: 2020 Monitoring Map for the Lower San Antonio River Watershed

Drainage Area: 1192 square miles

Aquifers: Gulf Coast, Carrizo

River Segments: 1901, 1901A, 1901B, 1901C, 1901D, 1901E, 1901F

Cities: Falls City, Goliad, Karnes City, Kenedy, Poth, Runge

Counties: Guadalupe, Wilson, Karnes, De Witt, Goliad, Victoria, Refugio

EcoRegion: East Central Texas Plains, Western Gulf Coastal Plain, Texas Blackland Prairies

Vegetation Cover: 5.85% Deciduous Forest, 0.29% Evergreen Forest
0.46% Herbaceous, 3.28% Mixed Forest, 31.70% Shrub/Scrub

Land Uses: 0.18% Barren Land, 4.26% Cultivated Crops, 0.10% Developed, High Intensity, 1.40% Developed, Low Intensity, 0.46% Developed, Medium Intensity,
2.32% Developed, Open Space,
0.35% Emergent Herbaceous Wetlands, 45.89% Hay/Pasture
0.51% Open Water, 2.95% Woody Wetlands

Figure 18: Just upstream of Station 16580 Lower San Antonio River at Conquista Crossing

Lower San Antonio River – Segment 1901

The Lower San Antonio River (LSAR) is 153 miles long and has a watershed of approximately 1192 square miles. The LSAR flows through Karnes and Goliad counties and forms the boundary between Refugio and Victoria counties before reaching its confluence with the Guadalupe River near San Antonio Bay. A very small edge of this watershed east of the Cibolo and San Antonio River confluence is in the Blackland Prairie ecoregion. The majority of the watershed is in the East Central Texas Plains. This ecoregion is also known as the South Texas Brush Country. This region has shallow clay and sandy loam soils, which are gently sloping to level. The predominant land use is grazing and crop production. Originally, this area was a post oak savanna; however, mesquite, acacia and prickly pear cactus are now more common. At the southern end of the watershed is the Western Gulf Coastal Plains. The watershed has an average yearly rainfall of 28 to 40 inches. The soils in this ecoregion are nearly level sands and sandy loams. Plants in this ecoregion include mesquite, acacia, cordgrass marshes, tallgrass and mid-grass prairies. Although there are population centers, land uses are predominantly agricultural and ranching. Major tributaries to the LSAR include the Upper San Antonio River and Cibolo Creek.

Unclassified tributaries of the LSAR assessed in the 2020 Integrated Report include Escondido Creek, Cabeza Creek, Manahuilla Creek, and Ecleto Creek. As a result of insufficient data, Hord Creek (1901C) and Lost Creek (1901D) were not assessed in the 2020 Integrated Report. Details of the impairments and concerns for the Lower San Antonio River Watershed can be seen in Figure 22 and Table 5.

Segment 1901 – Lower San Antonio River: The Lower San Antonio River is a classified stream segment and starts from the confluence with the Guadalupe River in Refugio/Victoria County to a point 600 meters (660 yards) downstream of FM 791 at Mays crossing near Falls City in Karnes County. According to the 2020 Integrated Report, the Lower San Antonio River is identified as impaired for not supporting the primary contact recreation use. Elevated levels of *E. coli* bacteria have been identified in several reaches throughout the Lower San Antonio River Watershed. A fish community impairment has also been documented in the lower portion of the segment. *E. coli*, fish community, habitat, nitrate, total phosphorus, and chlorophyll-*a* have been listed as concerns.

Segment 1901A – Escondido Creek: Extends from the confluence the with Lower San Antonio River upstream to the headwaters near Karnes CR 210 and FM 99. Escondido Creek has concerns for water quality based on nitrate and total phosphorus nutrient screening levels; an impairment for elevated levels of *E. coli* bacteria has also been identified.

Segment 1901B – Cabeza Creek: Extends from the confluence with the Lower San Antonio River, west of Goliad, Goliad County, up to the upper end of the waterbody. Cabeza Creek has been identified as impaired for elevated levels of *E. coli* bacteria.

Segment 1901E – Manahuilla Creek: Extends from the confluence with the Lower San Antonio River upstream to the headwaters southeast of Nordheim in DeWitt County. Manahuilla Creek has concerns for elevated levels of *E. coli*.

Segment 1901F – Ecleto Creek: Extends from the confluence with the Lower San Antonio River upstream to the headwaters adjacent to SH 123 south of Seguin in Guadalupe County. Ecleto Creek has been identified as impaired for not supporting the limited aquatic life use designation. The

impairment is based on DO concentrations below the limited aquatic life criterion; an *E. coli* impairment has also been identified. Concerns for chlorophyll-*a* and DO grab screening levels have also been documented.

Figure 19: Biological Monitoring Station 12792 Lower San Antonio River at the Southern Pacific Railroad Bridge in Goliad

Activities in the Watershed

In April 2006, the TCEQ initiated the **One Total Maximum Daily Load for Bacteria in the Lower San Antonio River**[12]**.** In response to the TMDL, the Texas State Soil and Water Conservation Board (TSSWCB), District 3, and local landowners expressed interest in addressing the bacteria impairment in the LSAR. The TMDL identified grazing livestock as one of the potential sources of bacteria. In partnership with Karnes and Wilson Counties and funding provided by the Texas State Soil and Water Conservation Board (TSSWCB), U.S. Environmental Protection Agency (EPA), and with Environmental Quality Incentives Program (EQIP) funding provided by the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS), voluntary conservation plans and water quality management plans (WQMPs) were developed and implemented in ranches in the watershed. An EPA **Nonpoint Source Success Story, Implementing Practices Through Cooperative Conservation Improves Water Quality in the Lower San Antonio River**[13] identifies the long-term *E. coli* geometric means were meeting the state water quality standard for primary contact recreation in several assessment units of the Lower San Antonio River as a result of conservation practices, best management practices, and management plans. The applicable water quality standard requires that the geometric mean of *E. coli* not exceed 126 colony-forming units per 100 milliliters (cfu/100 mL). As a result of these efforts, LSAR assessment units 1901_01 and 1901_05 were removed from the 2014 TCEQs 303(d) List of Impaired Waterbodies. With a geometric mean of 126.58 cfu/100mL, the 2020 Integrated Report, identifies assessment unit 1901_01 as having a concern for near nonattainment of state water quality standard for primary contact recreation. Assessment unit 1901_05 continues to support the primary contact recreation use designation.

Figure 20: Channel Catfish (*Ictalurus punctatus*); biological event at Station 16731 San Antonio River upstream of the Medina River Confluence

In addition to the WQMPs, the TCEQ TMDL Program contracted with Texas A&M AgriLife Research to work with stakeholders to develop the **Implementation Plan for Five Total Maximum Daily Loads for Bacteria in the Lower San Antonio River Watershed Segment 1901 Assessment Units 1901_01, 1901_02, 1901_03, 1901_04, 1901_05**[14]. The Lower San Antonio River Implementation Plan (LSAR I-Plan) describes the steps the watershed stakeholders and the TCEQ would take toward achieving pollutant reductions identified in the original TMDL report and outlines the schedule for implementation activities. The ultimate goal of the LSAR I-Plan is to restore the primary contact recreation uses in Segment 1901 by reducing concentrations of bacteria to levels established in the 2008 LSAR TMDL. The original TMDL document was based on segment units (Segment 1901) but the TCEQ program now uses individual assessment units within segments. Although the LSAR I-Plan focuses on the five impaired TMDL Assessment Units within the segment, some information covers the entire LSAR watershed. On August 8, 2018, the TCEQ approved the LSAR I-Plan.

The LSAR I-Plan contains management measures designed to guide activities that will improve water quality, identifies and describes Best Management Practices (BMP) that will be implemented and tracked to reduce bacteria in the watershed, and establishes a timeline for implementation. Follow-up tracking and monitoring plans are also included to determine the effectiveness of the BMPs. Some of the management measures in the LSAR I-Plan include:

- Develop and implement conservation plans in priority areas of the watershed; educate landowners on appropriate stocking rates and grazing plans. Remove and manage feral hogs.
- Promote the reduction of illicit dumping and proper disposal of wastes; utilize the River Authority's Environmental Investigators.
- Coordinate and expand existing water quality monitoring in the watershed.
- Explore re-designation of the flow type for Cabeza Creek.

Escondido Creek Parkway: Escondido Creek is a tributary of the San Antonio River in Karnes County. Over the last few years, the River Authority and the City of Kenedy have worked together to acquire a 1.25 mile stretch along Escondido Creek within the City limits for the purpose of creating a public park for its citizens. The Parkway serves the community by enhancing recreational opportunities while simultaneously preserving the creek. In 2016, the River Authority held a series of public meetings for the Escondido Creek Parkway Project to establish a vision of what the park could look like. The vision served as a guide to the development of a Master Plan. The linear park connects Kenedy's City Park with the downtown district, allowing park users to directly access recreational areas without crossing US 181. Future residential development to the north will also be able to connect to the Parkway via the historic San Antonio and Aransas Pass railway bed. The Escondido Creek Parkway extends from the Joe Gully City Park to 5th Street, approximately 1.25 miles.

The project was completed in phases. Phase I included the acquisition of property for the parkway. Phase II included planning and design of hike and bike trails, pavilion, playground, and other amenities. Development of a park in downtown Kenedy serves as a trailhead for the Parkway. There are Low Impact Development (LID) features and rainwater harvesting included in the design. Phase III was the construction phase. In 2017, the River Authority established the Escondido Creek Oversight Committee. This committee consists of representatives from the City of Kenedy, the 4B

Corporation, the Chamber of Commerce, the Kenedy School Board, Kenedy Parks and Recreation Board, the San Antonio River Foundation and the River Authority. The purpose of the committee is to be ambassadors offering feedback to ensure the community is represented throughout the Escondido Creek Parkway Project.

Groundbreaking for the Escondido Creek Parkway Project began on December 20, 2018 and the grand opening and ribbon cutting ceremony was conducted on October 16, 2020. The Parkway includes hike and bike trails, playground, splash pad, amphitheater, and skate park. The maintenance of the parkway will be carried out by the River Authority. This is the first linear park in Karnes County. This project will give the community many opportunities to get out and enjoy the creek.

Figure 21: Young Flathead Catfish (*Pylodictis olivaris*); biological monitoring event at 16580 San Antonio River at Conquista Crossing

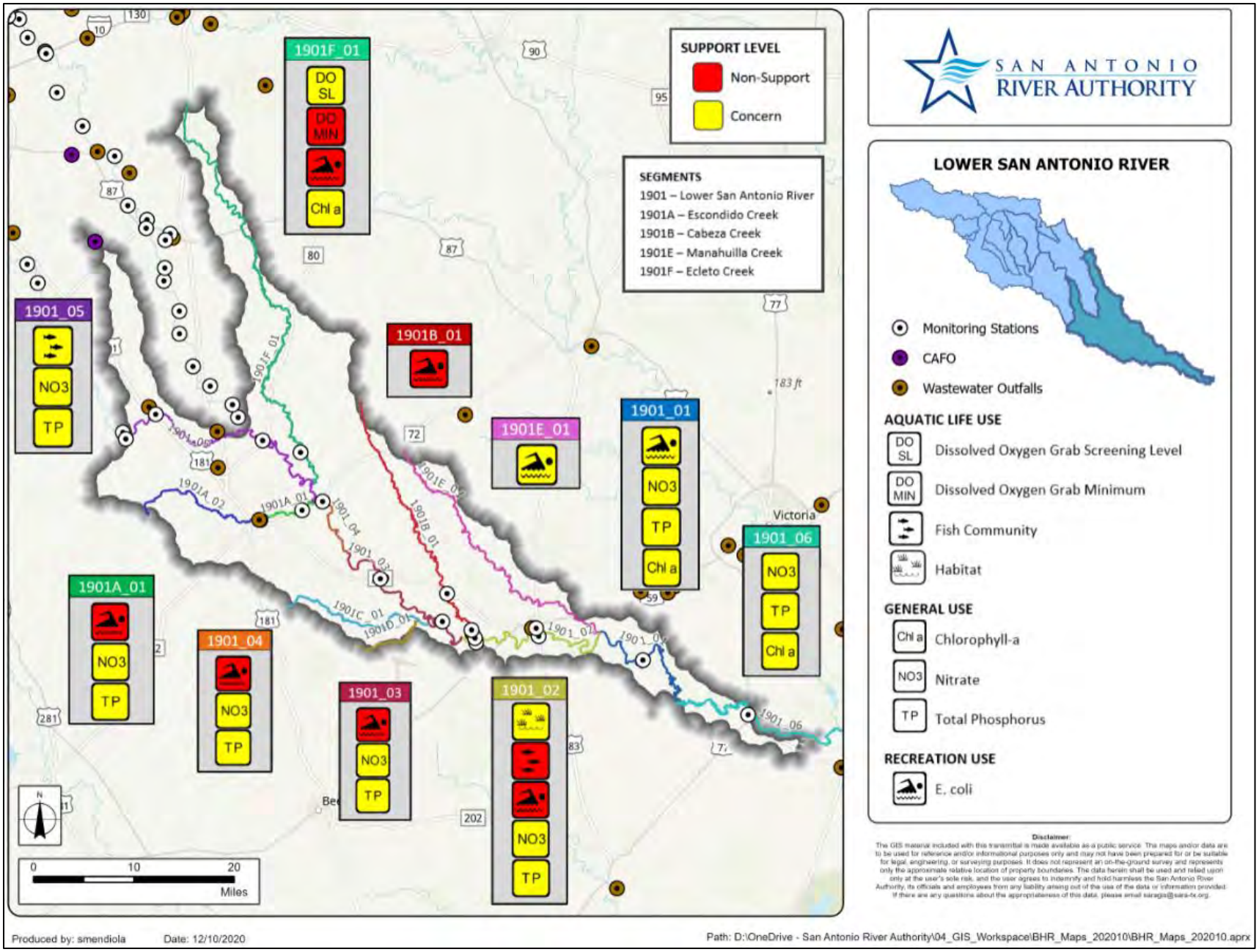

Figure 22: 2020 TCEQ Integrated Report; Impairments and Concerns in the Lower San Antonio River

Table 5: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1901 Lower San Antonio River and Tributaries										
Seg_AU	**Designated Use**	**Method**	**Parameter Description**	**Criteria**	**# of Samples Assessed**	**# of Samples Exceeding Criteria**	**Mean of Samples Exceeding Criteria or Bacteria Geomean**	**Data Set Qualifier**	**Integrated Level of Support**	**Impairment Category**
1901 Lower San Antonio River										
1901_01	Recreation Use	Bacteria Geomean	*E. coli*	126	83	1	126.58	AD	CN	
	General Use	Nutrient Screening Level	Chlorophyll-*a*	14.10	81	20	42.96	AD	CS	
	General Use	Nutrient Screening Level	Nitrate	1.95	83	82	6.97	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	83	57	1.05	AD	CS	
1901_02	Aquatic Life Use	Fish Community	Fish Community	42	7	--	38	TR	**NS***	5c
	Aquatic Life Use	Habitat	Habitat	20	7	--	17	TR	CS	
	Recreation Use	Bacteria Geomean	*E. coli*	126	354	1	183.89	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	53	52	8.39	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	53	38	1.20	AD	CS	
1901_03	Recreation Use	Bacteria Geomean	*E. coli*	126	100	1	149.00	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	100	97	8.63	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	100	79	1.12	AD	CS	
1901_04	Recreation Use	Bacteria Geomean	*E. coli*	126	51	1	188.08	AD	**NS**	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	51	49	9.59	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	51	44	1.18	AD	CS	
1901_05	Aquatic Life Use	Fish Community	Fish Community	42	9	--	38	AD	CN	
	General Use	Nutrient Screening Level	Nitrate	1.95	152	149	10.62	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	152	131	1.27	AD	CS	
1905_06	General Use	Nutrient Screening Level	Chlorophyll-*a*	14.10	--	--	--	ID	CS*	
	General Use	Nutrient Screening Level	Nitrate	1.95	7	7	7.18	LD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	7	7	1.18	LD	CS	

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)
LD - Limited Data (less than 9, greater than 3)
ID - Inadequate Data (less than 4)
TR - Temporally Not Representative
-- Not Applicable or data not provided
***** Indicates the Integrated Level of Support was carried forward from a previous assessment due to inadequate data .

Integrated Level of Support

NS - Nonsupport
CS - Screening Level Concern
CN - Use Concern
NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.
5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.
5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

Table 5: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1901 Lower San Antonio River and Tributaries										
Seg_AU	**Designated Use**	**Method**	**Parameter Description**	**Criteria**	**# of Samples Assessed**	**# of Samples Exceeding Criteria**	**Mean of Samples Exceeding Criteria or Bacteria Geomean**	**Data Set Qualifier**	**Level of Support**	**Impairment Category**
1901A Escondido Creek										
1901A_01	Recreation Use	Bacteria Geomean	*E. coli*	126	51	1	783.96	AD	**NS**	5c
	General Use	Nutrient Screening Level	Nitrate	1.95	51	42	13.59	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	52	50	2.32	AD	CS	
1901B Cabeza Creek										
1901B_01	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	**NS***	5c
1901E Manahuilla Creek										
1901E_01	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	
1901F Ecleto Creek										
1901F_01	Aquatic Life	Dissolved Oxygen Grab Minimum	Dissolved Oxygen Grab	2	36	6	1.12	AD	**NS**	5C
	Aquatic Life	Dissolved Oxygen Grab Screening Level	Dissolved Oxygen Grab	3	36	12	1.84	AD	CS	
	General Use	Nutrient Screening Level	Chlorophyll-*a*	14.10	37	14	34.71	AD	CS	
	Recreation Use	Bacteria Geomean	*E. coli*	126	37	1	163.90	AD	**NS**	5c

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Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

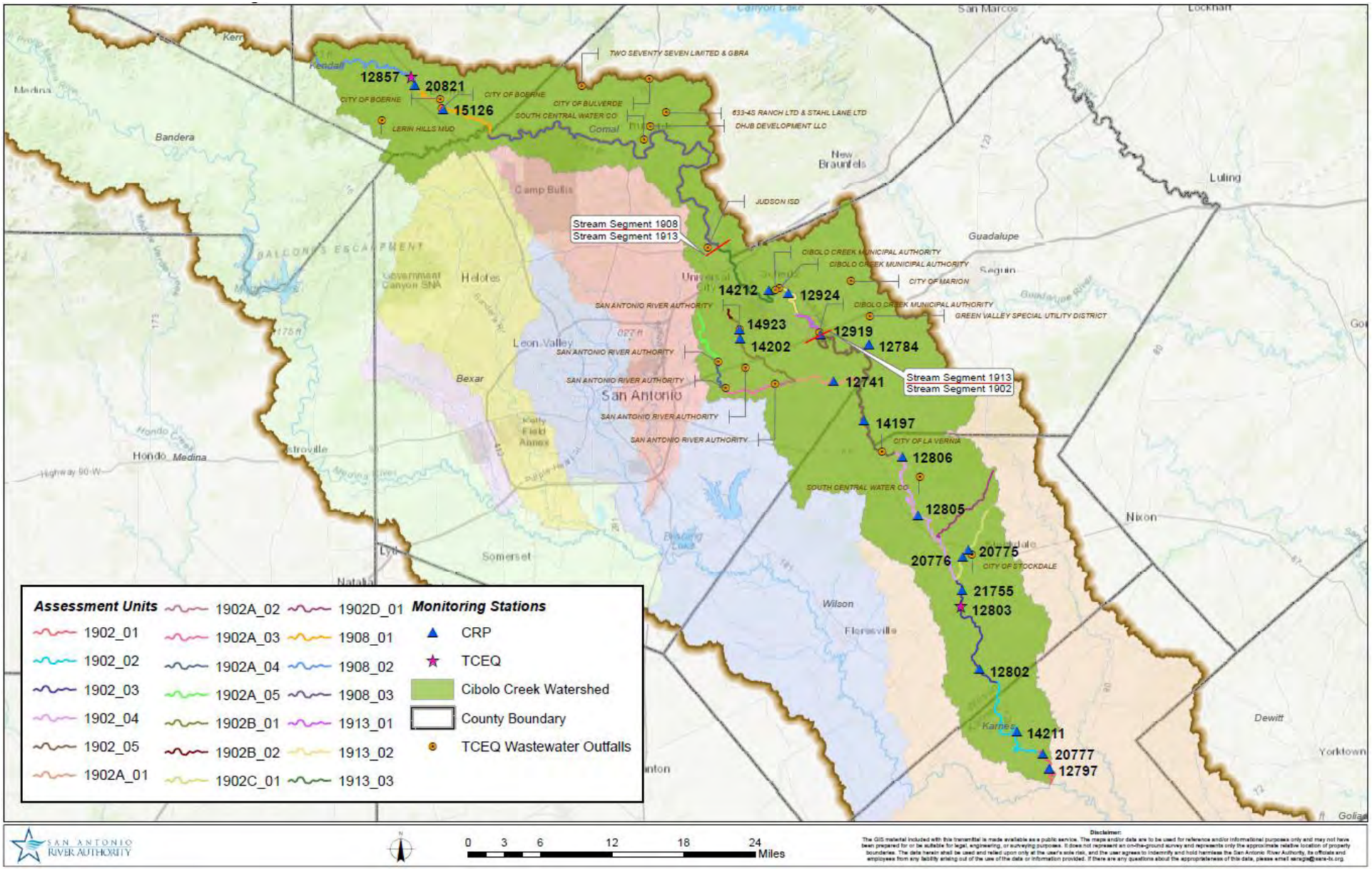

Figure 23: 2020 Monitoring Map for the Cibolo Creek Watershed

Drainage Area: 264 square miles

Aquifers: Trinity, Edwards

River Segments: 1908

Cities: Boerne

Counties: Bandera, Bexar, Comal, Kendall

EcoRegion: Edwards Plateau, Texas Blackland Prairies

Vegetation Cover: 7.68% Deciduous Forest, 37.91% Evergreen Forest, 5.13% Herbaceous, 0.03% Mixed Forest, 38.18% Shrub/Scrub

Land Uses: 0.28% Barren Land, 0.26% Cultivated Crops, 0.4% Developed, High Intensity, 2.64% Developed, Low Intensity, 1.11% Developed, Medium Intensity, 6.07% Developed, Open Space, < 0.01% Emergent Herbaceous Wetlands 0.05% Hay/Pasture, 0.25% Open Water, 0.01% Woody Wetlands

Figure 24: Cibolo Preserve, Upper Cibolo Creek Watershed

Upper Cibolo Creek – Segment 1908

The Upper Cibolo Creek Watershed covers approximately 264 square miles and contains the City of Boerne and a portion of Fair Oaks Ranch. This stream segment has intermittent flow; only the portion of the Upper Cibolo in and around the City of Boerne is perennial. Just below the Cibolo Nature Center in Boerne, the perennial creek disappears, recharging into the Edwards Aquifer. Due to significant groundwater recharge through fractures in the streambed, the lower 43 miles of this segment is often dry. This segment is in the Edwards Plateau Ecoregion. This region is commonly referred to as the Texas Hill Country. The soils are generally shallow and underlain by limestone. The limestone rock has been eroded to create the steep hills in this region. The hills are dominated by Ashe juniper, Texas red oak, stunted live oak trees, and sparse grasses. Rainfall on the Edwards Plateau drains rapidly into creeks, causing flash floods within the region and downstream. The rapid flow often causes scouring of aquatic habitat within the region. The City of Boerne is located in the upper northeastern portion of the watershed. Sheep and goat ranching are common in this area. This area is becoming more populated with small hobby ranches and has experienced an increase in residential development associated with the growth of the City of Boerne. There are no unclassified waterbodies of the Upper Cibolo Creek assessed in the 2020 Integrated Report. Details of the impairments and concerns for the Upper Cibolo Creek Watershed can be seen in Figure 26 and Table 6.

Segment 1908 – Upper Cibolo Creek: Extends from the Missouri-Pacific Railroad Bridge west of Bracken in Comal County to a point 1.5 km (0.9 miles) upstream of the confluence of Champee Springs in Kendall County. According to the 2020 Integrated Report, the Upper Cibolo Creek is identified as impaired for not supporting the primary contact recreation use due to elevated levels of *E. coli* bacteria; nitrate and total phosphorus have been listed as concerns.

Activities in the Watershed

As a result of elevated bacteria, the Upper Cibolo Creek was first identified as impaired for recreation use in the 2006 Texas Water Quality Inventory and 303(d) List. Prior to a TCEQ initiated TMDL, the City of Boerne proactively initiated the **Upper Cibolo Creek Watershed Protection Plan**[15] in August 2009. Working to address an ongoing bacteria impairment along Upper Cibolo Creek, the City of Boerne and the Upper Cibolo Creek Watershed Partnership continue to implement aspects of the Upper Cibolo Creek Watershed Protection Plan. Outreach and education remain a project focus promoted through workshops, creek clean-up events, social media and the installation of permanent signage along city trails. The City of Boerne Parks and Recreation Department continues to capture and relocate domestic waterfowl to manage populations along urban reaches of the Upper Cibolo. Currently, the greater Boerne area is experiencing significant residential growth which is expected to increase nonpoint sources of pollution. Watershed planners are applying greater focus to LID opportunities within the watershed and created the Boerne Edition of the River Authority's LID Technical Guidance Manual as a resource for stormwater management alternatives. Bacteriological monitoring in support of the WPP continues into the 2020 monitoring year.

Figure 25: Largemouth Bass (*Micropterus salmoides*); biological monitoring event at Station 20821 Cibolo Creek at Northrup Park

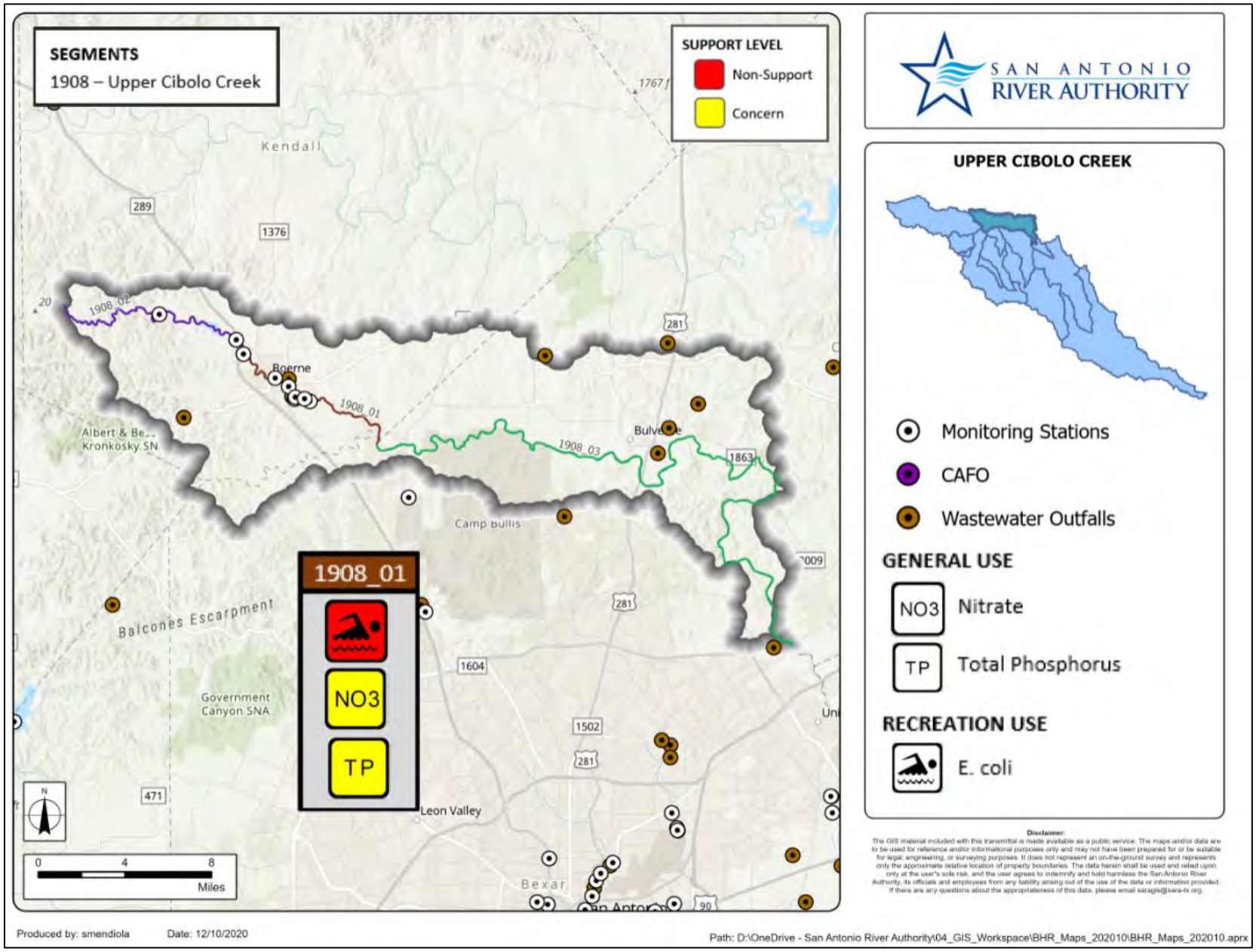

Figure 26: 2020 TCEQ Integrated Report; Impairments and Concerns in the Upper Cibolo Creek Watershed

Table 6: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1908 Upper Cibolo Creek										
Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1908 Upper Cibolo Creek										
1908_01	Recreation Use	Bacteria Geomean	*E. coli*	126	79	1	182.27	AD	**NS**	5c
	General Use	Nutrient Screening Level	Nitrate	1.95	40	21	8.85	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	69	24	1.58	AD	CS	
1908_02	No Impairments or Concerns									
1908_03	No Impairments or Concerns									

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

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ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

***** Indicates the Integrated Level of Support was carried forward from a previous assessment due to inadequate data.

Drainage Area: 43 square miles

Aquifers: Trinity, Edwards

River Segments: 1913

Cities: No major cities

Counties: Bexar, Comal, Guadalupe

EcoRegion: Texas Blackland Prairies, Edwards Plateau

Vegetation Cover: 2.92% Deciduous Forest, 6.67% Evergreen Forest, 1.96% Herbaceous. 0.39% Mixed Forest, 22.07% Shrub/Scrub

Land Uses: 0.29% Barren Land, 11.9% Cultivated Crops, 5.51% Developed, High Intensity, 14.91% Developed, Low Intensity, 13.42% Developed, Medium Intensity, 16.84% Developed, Open Space, 0.05% Emergent Herbaceous Wetlands, 0.91% Hay/Pasture, 0.25% Open Water, 1.91% Woody

Figure 27: Station 14212 Mid Cibolo Creek upstream of the Municipal WWTP

Mid Cibolo Creek – Segment 1913

The Mid Cibolo Creek watershed is 19 miles long and has an approximate drainage area of 43 square miles. The section just upstream of the Cibolo Creek Municipal Wastewater Treatment Plan to the upper end of the segment, is located in the Edwards Aquifer Recharge Zone. As a result, there is little or no flow in the upper reach of the creek during the drier portions of the year. Rainfall above and in this segment drains rapidly into the watershed, causing flash floods within the region and downstream. The Mid Cibolo is almost entirely in the Texas Blackland Prairie. This ecoregion is characterized by deep, dark-colored, rich clay soils, also known as vertisol soils, which are gently sloping to level. Vertisol soils expand and shrink with moisture, causing cracks in the soil when it is dry. The deep, rich soils make the blackland prairie ideal for row crops, but in the San Antonio River Basin, this area is dominated by urbanization. Originally a tall grassland prairie, most of the original prairie has been replaced by urbanization and agriculture. Mesquite, blackjack and post oak trees are common. There are no unclassified waterbodies of the Mid Cibolo Creek assessed in the 2020 Integrated Report. Details of the impairments and concerns for the Mid Cibolo Creek Watershed can be seen in Figure 29 and Table 7.

Segment 1913 – Mid Cibolo Creek: Extends from a point 100 meters (110 yards) downstream of IH 10 in Bexar/Guadalupe County to the Missouri-Pacific Railroad Bridge west of Bracken in Comal County. According to the TCEQ 2020 Integrated Report, the Mid Cibolo Creek is identified as having concerns for nitrate and total phosphorus.

Activities in the Watershed

The TCEQ assesses Texas waterbodies by breaking them into hydrologically and geographically unique segments. This segmenting of waterbodies allows for more precise analysis of water quality and aquatic communities. However, historic segment classifications were based on topographic maps and other desktop methods that resulted in portions of segments having separate flow regimes or no perennial connecting flow at all; the Cibolo Creek is a perfect example. The 2014 TSWQS identified the Cibolo Creek Watershed as having three classified segments all with perennial flow: the Upper Cibolo Creek (Segment 1908), Mid Cibolo Creek (Segment 1913) and Lower Cibolo Creek (Segment 1902).

In 2015, the River Authority, in collaboration with the TCEQ and the City of Boerne, initiated the **Cibolo Creek Watershed Segment Boundary Re-Definition Effort**. The purpose of the effort was to assist the TCEQ in assigning more appropriate segment boundaries, in respect to the recharge zone of the Edwards Aquifer, for the Upper, Mid and Lower Cibolo Creek Watersheds based on hydrology. Appropriate boundary adjustments to reflect flow conditions for the three segments would ensure proper aquatic life use designations and DO criteria. In 2016, the data was submitted to the TCEQ. Flow data supported the presumption of a high aquatic life use designation for the Upper and Lower Cibolo Creek. Data also supported an intermittent with pools flow designation for the Mid Cibolo Creek. The revisions were sent to the TCEQ commissioners for proposal on August 23, 2017 with a 30-day comment period to close on October 17, 2017. Final revisions were presented to the commissioners and adopted as a final rule on February 7, 2018. The final rulemaking was published in the February 23, 2018, issue of the Texas Register, and became effective as a State rule on March 1, 2018. On February 27, 2018, a submittal package in support of the adopted revisions to the 2018 Texas Stream Waters Quality Standards was sent to the EPA Region 6 for approval. As of this report, no further action has been taken by the TCEQ or EPA.

Figure 28: Station 12924 Cibolo Creek at Schaeffer Road

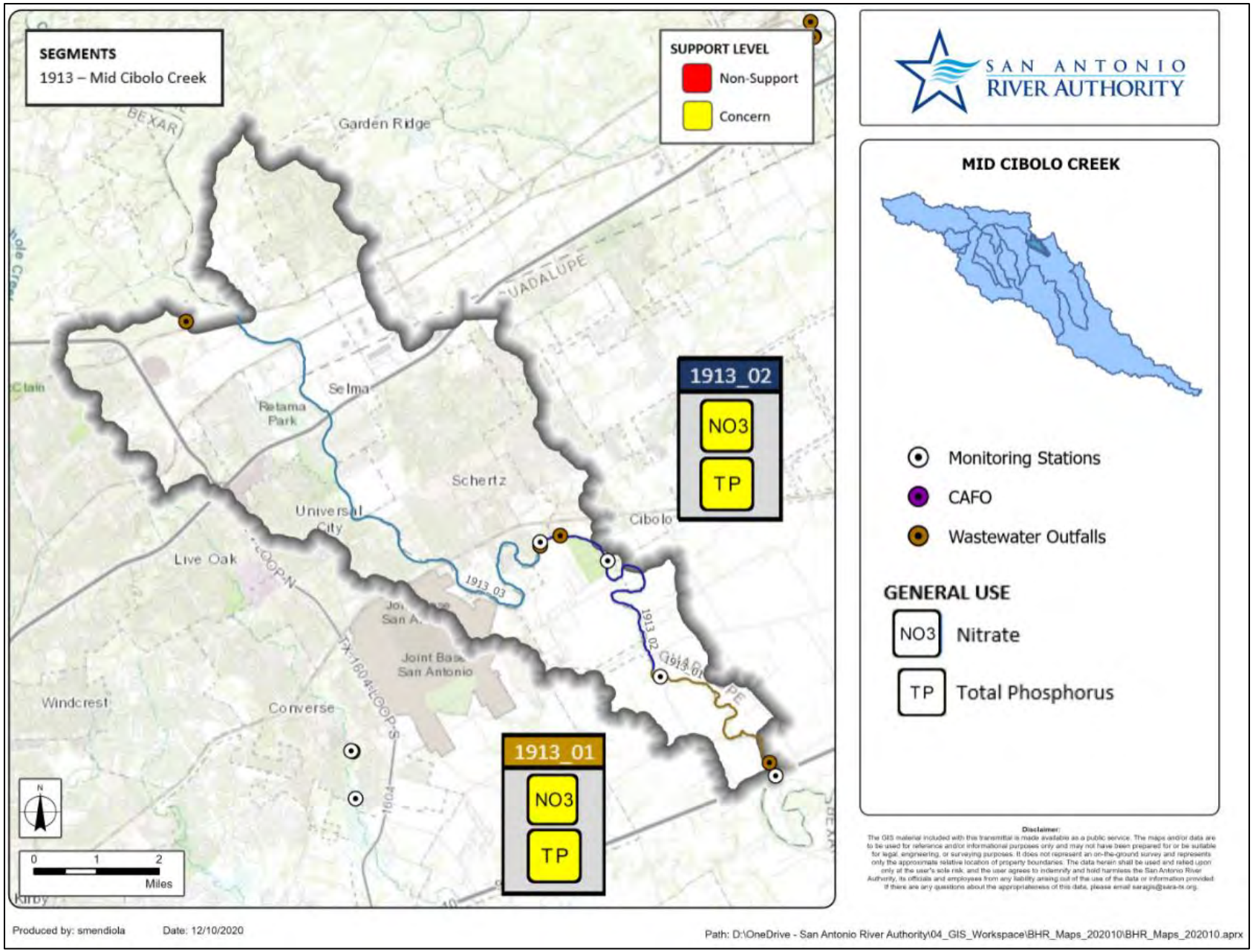

Figure 29: 2020 TCEQ Integrated Report; Impairments and Concerns in the Mid Cibolo Creek Watershed

Table 7: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1913 Mid Cibolo Creek										
Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1913 Mid Cibolo Creek										
1913_01	General Use	Nutrient Screening Level	Nitrate	1.95	17	17	10.64	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	17	14	1.16	AD	CS	
1913_02	General Use	Nutrient Screening Level	Nitrate	1.95	33	32	13.36	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	32	29	2.03	AD	CS	
1913_03	No Impairments or Concerns Identified									

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

LD - Limited Data (less than 9, greater than 3)

ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

* Indicates that the Integrated Level of Support was carried forward from a previous assessment due to inadequate data.

Drainage Area: 546 square miles

Aquifers: Edwards, Trinity, Carrizo, Gulf Coast

River Segments: 1902, 1902A, 1902B, 1902C, 1902D

Cities: La Vernia, Stockdale

Counties: Bexar, Comal, Guadalupe, Wilson, Karnes

EcoRegion: East Central Texas Plains, Texas Blackland Prairies

Vegetation Cover: 7.59% Deciduous Forest, 0.77% Evergreen Forest, 0.55% Herbaceous, 1.43% Mixed Forest, 30.07% Shrub/Scrub

Land Uses: 0.34% Barren Land, 12.2% Cultivated Crops, 0.48% Developed, High Intensity, 2.54% Developed, Low Intensity, 1.72% Developed, Medium Intensity, 5.41% Developed, Open Space, 0.05% Emergent Herbaceous Wetlands, 35.11% Hay/Pasture, 0.25% Open Water, 1.49% Woody Wetlands

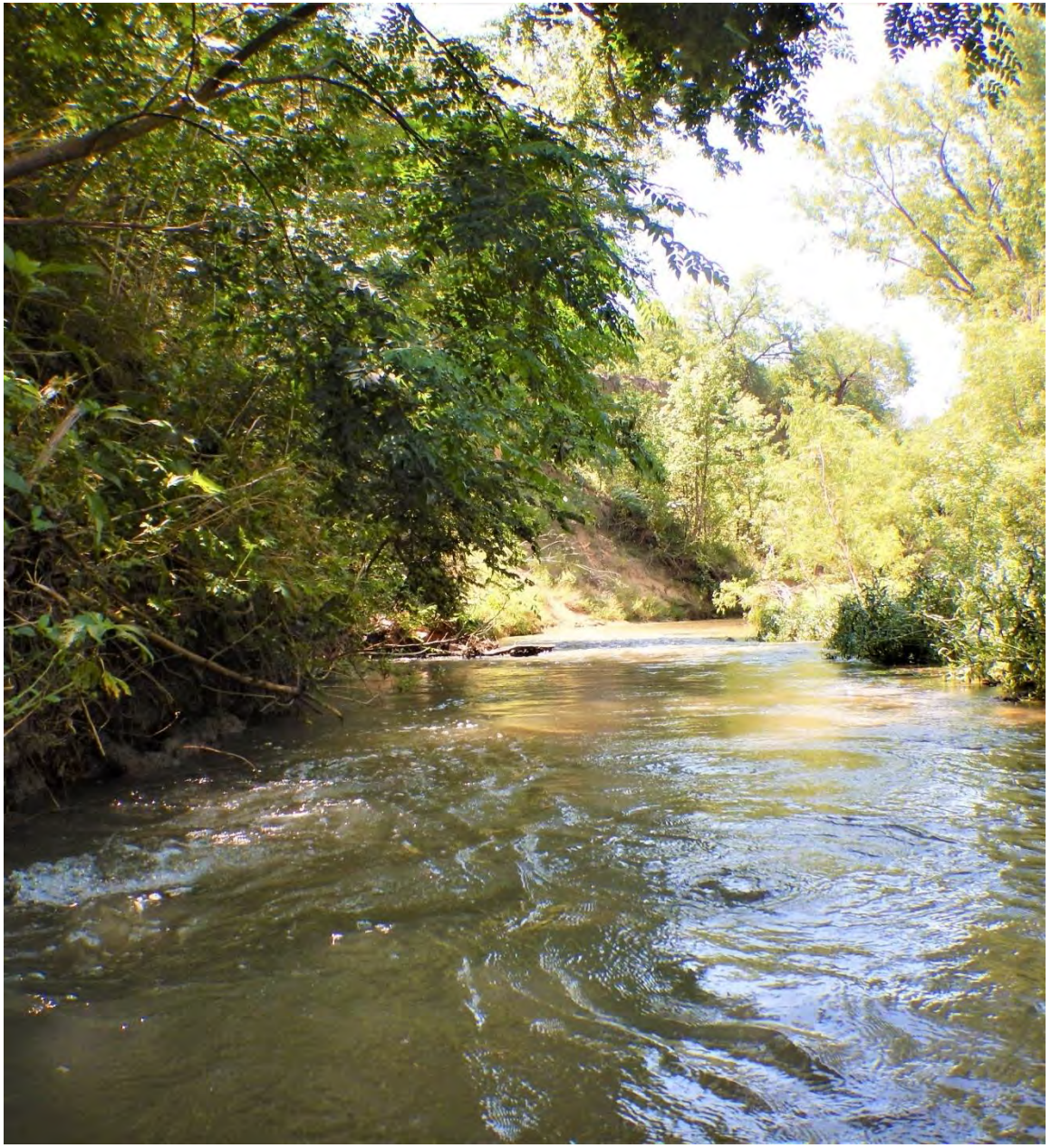

Figure 30: Station 14197 Lower Cibolo Creek at Scull Crossing

Lower Cibolo Creek – Segment 1902

The approximate drainage area of the Lower Cibolo Creek is 546 square miles. This portion of Cibolo Creek is rural and defines the Bexar/Guadalupe county line as it flows southeastward through the Gulf Coastal Plains of the Central Plains Province. Base flow for the Lower Cibolo Creek originates from spring flow southwest of the City of Schertz, Texas. Many other springs exist throughout this segment. Springs along with effluent from permitted municipal facilities contribute to the overall flow within the Lower Cibolo Creek. Most portions of the Lower Cibolo Creek are deeply entrenched, and stream banks are composed of alluvial soils. Riparian corridors are dense and wide, bordered by farm and ranch lands and provide an excellent canopy over most of the creek throughout its length. Glides dominate the aquatic habitats throughout this segment and are occasionally interrupted by riffles and runs. Unclassified waterbodies of Lower Cibolo Creek assessed in the 2020 Integrated Report include Martinez Creek, Salitrillo Creek, Clifton Branch, and Alum Creek. Details of the impairments and concerns for the Lower Cibolo Creek Watershed can be seen in Figure 32 and Table 8.

Segment 1902 – Lower Cibolo Creek: Extends from the confluence with the San Antonio River in Karnes County to a point 100 meters (110 yards) downstream of IH 10 in Bexar/Guadalupe County. According to the TCEQ 2020 Integrated Report, the Lower Cibolo Creek is identified as impaired for not supporting the primary contact recreation use due to elevated levels of *E. coli* bacteria. Nitrate, total phosphorus, habitat, and benthic macroinvertebrate communities have been listed as concerns.

Segment 1902A – Martinez Creek: Martinez Creek is a perennial stream that extends from the confluence with Lower Cibolo Creek upstream to the headwaters in Bexar County. Martinez Creek is identified as impaired for not supporting the primary contact recreation use due to elevated levels of *E. coli* bacteria. Concerns for water quality based on nitrate and total phosphorus nutrient screening levels; a concern for near nonattainment of the primary contact recreation use standard has also been identified.

Segment 1902B – Salitrillo Creek: Salitrillo Creek extends the confluence with Martinez Creek to approximately 1.3 mi (2.1 km) upstream of FM 1976. Salitrillo Creek has concerns for water quality based on nitrate, ammonia and total phosphorus nutrient screening levels.

Segment 1902C – Clifton Branch: Clifton Branch extends from the confluence of Lower Cibolo Creek upstream to the headwater 0.6 miles upstream of Wilson CR 424 north of Stockdale. Clifton Branch has been identified as impaired for not supporting the primary contact recreation use due to elevated levels of *E. coli* bacteria; 24-hour average and minimum DO impairments and DO minimum grab impairments have also been identified. Total phosphorus and DO based on screening levels have also been listed as concerns.

Segment 1902D – Alum Creek: Alum Creek extends from the confluence with Lower Cibolo Creek upstream to the headwaters approximately 1.8 km upstream of Wilson CR 429 north of Stockdale. There are no impairments or concerns identified in the TCEQ 2020 Integrated Report.

Activities in the Watershed

In 2017, the **Mid and Lower Cibolo Creek Watershed Protection Plan**[16] was initiated to address bacteria and depressed DO impairments in the watersheds. The WPP was developed by the stakeholders through the Mid and Lower Cibolo Creek Watershed Coordination Committee with support from the Texas Water Resources Institute (TWRI), the River Authority (SARA) and the Texas State Soil and Water Conservation Board (TSSWCB). The WPP, guided by stakeholder input and the best available data and science, identified best management practices to ensure the bacterial and DO impairments identified in the 2014 IR were addressed in the development of the WPP. The WPP includes three stormwater monitoring stations in the Mid and Lower Cibolo Creek at Station 12806 Cibolo Creek at CR 337 Southeast of La Vernia, Station 12919 Cibolo Creek at IH 10/US90 East Bank and Station 20777 Cibolo Creek at FM 2724 Northeast of Panna Maria. The water quality data generated will be used to estimate *E. coli*, nitrogen, phosphorus, and other pollutant(s) loading within the watershed and act as a base of information for planning purposes.

Figure 31: Young Flathead Catfish (*Pylodictis olivaris*); biological monitoring event at Station 14197 Cibolo Creek at Scull Crossing

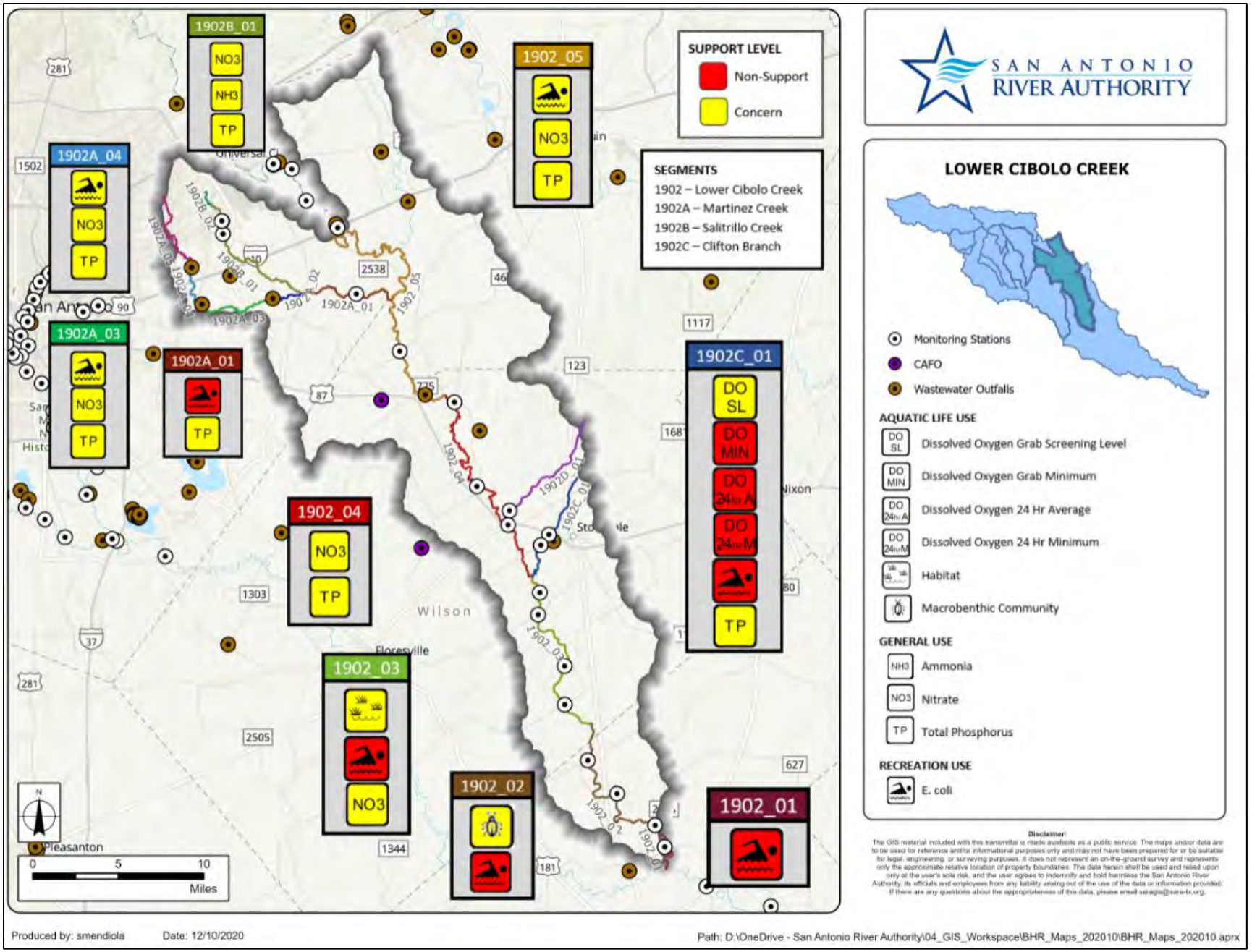

Figure 32: 2020 TCEQ Integrated Report; Impairments and Concerns in the Lower Cibolo Creek Watershed

Table 8: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1902 Lower Cibolo Creek and Tributaries										
Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1902 Lower Cibolo Creek										
1902_01	Recreation Use	Bacteria Geomean	*E. coli*	126	83	1	178.03	AD	NS	5c
1902_02	Recreation Use	Bacteria Geomean	*E. coli*	126	385	1	225.35	AD	NS	5c
	Aquatic Life Use	Macrobenthic Community	Macrobenthic Community	30	2	--	29	AD	CN	
1902_03	Aquatic Life Use	Habitat	Habitat	20	6	--	19	AD	CS	
	Recreation Use	Bacteria Geomean	*E. coli*	126	53	1	151.38	AD	NS	5c
	General Use	Nutrient Screening Level	Nitrate	1.95	26	8	2.98	AD	CS	
1902_04	General Use	Nutrient Screening Level	Nitrate	1.95	42	28	3.43	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	42	23	0.86	AD	CS	
1902_05	Recreation Use	Bacteria Geomean	*E. coli*	126	46	1	133.57	AD	CN	
	General Use	Nutrient Screening Level	Nitrate	1.95	45	27	3.86	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	46	32	1.05	AD	CS	
1902A Martinez Creek										
1902A_01	Recreation Use	Bacteria Geomean	*E. coli*	126	46	1	465.72	AD	NS	5c
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	46	40	1.38	AD	CS	
1902A_02	No Stations Assessed									
1902A_03	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	
	General Use	Nutrient Screening Level	Nitrate	1.95	--	--	--	ID	CS*	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	--	--	--	ID	CS*	
1902A_04	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	
	General Use	Nutrient Screening Level	Nitrate	1.95	--	--	--	ID	CS*	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	--	--	--	ID	CS*	
1902A_05	No Stations Assessed									
1902B Salado Creek										
1902B_01	General Use	Nutrient Screening Level	Ammonia	0.33	85	26	1.05	AD	CS	
	General Use	Nutrient Screening Level	Nitrate	1.95	85	50	4.11	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	85	85	2.67	AD	CS	
1902B_02	No Stations Assessed									
1902C Clifton Branch										
1902C_01	Recreation Use	Bacteria Geomean	*E. coli*	126	79	1	187.89	AD	NS	5c
	Aquatic Life	Dissolved Oxygen 24hr Average	Dissolved Oxygen 24hr Avg	3	8	4	1.65	LD	NS	5b
	Aquatic Life	Dissolved Oxygen 24hr Minimum	Dissolved Oxygen 24hr Min	2	8	7	1.19	LD	NS	5b
	Aquatic Life	Dissolved Oxygen Minimum	Dissolved Oxygen Grab	2	84	15	1.33	AD	NS	5b
	Aquatic Life	Dissolved Oxygen Screening Level	Dissolved Oxygen Grab	3	84	26	1.79	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	84	25	1.06	AD	CS	
1902D Alum Creek	No Impairments or Concerns Identified									

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)
LD - Limited Data (less than 9, greater than 3)
ID - Inadequate Data (less than 4)
TR - Temporally Not Representative
-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport
CS - Screening Level Concern
CN - Use Concern
NA - Not Assessed

Impairment Category

5b - Review of the standards for one or more parameters will be conducted before a management strategy is selected, including a possible revision to the

5c - Additional da+A13:K52ta or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

* Indicates the Integrated Level of Support was carried forward from a previous assessment due to inadequate data.

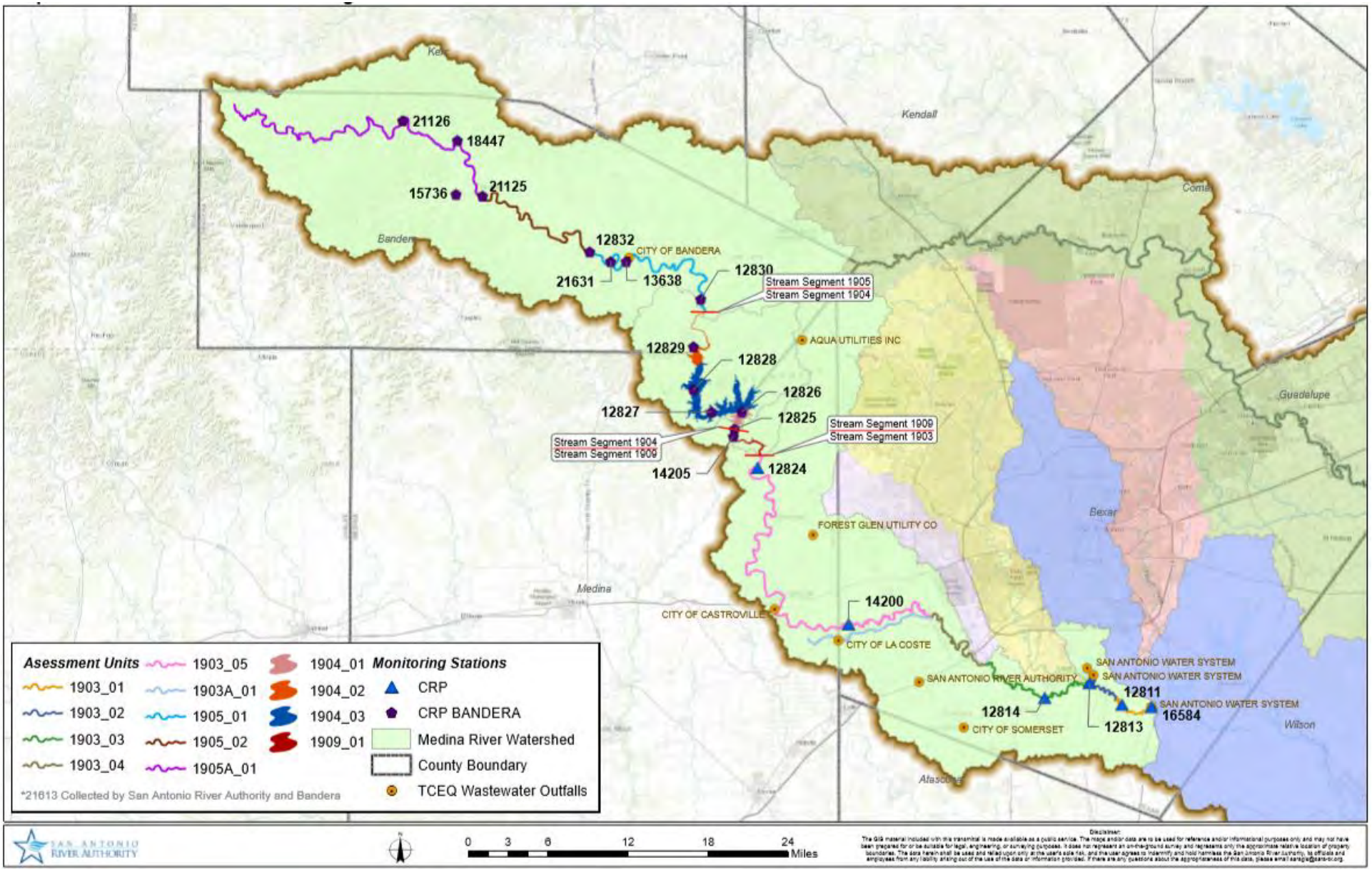

Figure 33: 2020 Monitoring Map for the Medina River Watershed

Drainage Area: 534 square miles

Aquifers: Trinity, Edwards-Trinity

River Segments: 1905, 1905A

Cities: Bandera, Medina

Counties: Bandera, Kendall, Kerr

EcoRegion: Edwards Plateau

EcoRegion: East Central Texas Plains, Texas Blackland Prairies

Vegetation Cover: 3.68% Deciduous Forest, 37.9% Evergreen Forest, 2.82% Herbaceous, 0.01% Mixed Forest, 51.67% Shrub/Scrub

Land Uses: 0.07% Barren Land, 0.18% Cultivated Crops, 0.02% Developed, High Intensity, 0.4% Developed, Low Intensity, 0.08% Developed, Medium Intensity, 2.64% Developed, Open Space, 0% Emergent Herbaceous Wetlands, 0.17% Hay/Pasture, 0.24% Open Water, 0.12% Woody Wetlands

Figure 34: North Prong of the Upper Medina River at Brewington Road

Medina River above Medina Lake – Segment 1905

This portion of the Medina River is rural and lies entirely within the Edwards Plateau. Cattle, goats, and sheep are commonly grazed throughout this region. Crop cultivation is limited to areas with alluvial soils. The immediate banks of the Upper Medina River vary from low, gently sloping, gravel-covered banks sparsely covered with native vegetation to high, steep, solid layers of limestone formations. This segment is characterized by alternating riffle, glide and pool habitats with wide, gentle curves and bends. Substrates consist of limestone bedrock covered with gravel and boulders. Large cypress tree trunks are commonly seen lying within the stream bottom. The riparian corridor varies in width and consists of willows, cypress, pecan, and oaks. Native grasses and forbs are common along the stream. The North Prong Medina River, Segment 1905A, is the only unclassified segment of the Upper Medina River assessed in the TCEQ 2020 Integrated Report. Details of the impairments and concerns for the Medina River above Medina Lake Watershed can be seen in Figure 39 and Table 9.

Segment 1905 – Medina River above Medina Lake: Segment 1905 extends from a point immediately upstream of the confluence of Red Bluff Creek in Bandera County to the confluence of the North Prong Medina River and the West Prong Medina River in Bandera County. According to the 2020 Integrated Report, the Medina River above Medina Lake is identified as impaired for not supporting the primary contact recreation use due to elevated levels of *E. coli* bacteria. Concerns for fish community and habitat have also been identified.

Segment 1905A – North Prong Medina River: Extends from the confluence with the Medina River upstream to the headwaters approximately 3.5 km east of RM 187 in Bandera County. There are no impairments or concerns identified for the entire waterbody.

Figure 35: Station 12830 Medina River at Old English Crossing above Bandera Falls

Activities in the Watershed

Bandera County River Authority and Ground Water District (BCRAGD) Arundo Control Project: Arundo, commonly known as Giant Reed, is a highly invasive, non-native grass with the potential to compromise the health and functioning of streams and rivers. Its impacts are so significant that it has been deemed a "noxious" plant species under the Texas Administrative Code. BCRAGD staff have been aware of stands of Arundo in the Upper Medina Watershed and began looking into begin a project for the control of this invasive species. BCRAGD eventually partnered with TPWD in the Healthy Creeks Initiative, which is an existing program that includes state funding for treating Arundo with approved herbicide. This project provides the control of Arundo with no cost to landowners. Treatments began in June of 2018 and have shown to be between 80-90% effective with multiple treatments being needed for larger stands.

Figure 36: A treated stand of invasive Arundo.

Upper Medina Early Flood Warning Project: The floods of recent years have shown the potential damage of floods within the Texas Hill Country and the risk of future flooding events in the Bandera County area highlights a critical need for a flood warning system. BCRAGD has partnered with the USGS to develop a tool set as a part of an overall flood warning system for Bandera County, the scope of which is a 25-mile reach of the Medina River from Medina, Texas to the Medina Reservoir. This tool set will include a continuous streamflow gage monitoring network, development of a hydraulic model of the Medina River, inclusion of newly generated flood inundation maps in the USGS Flood Inundation Mapping Initiative website, and the development of a support system to help emergency personnel to make decisions during a major flood event. In August of 2019, the system was officially launched and presented to the public.

Figure 37: BCRAGD President Don Sloan (left) and General Manager Dave Mauk (right) received a certificate of completion from Texas Water Development Board Director Kathleen Jackson (center) for their work on the Medina River Flood Early Warning System.

Figure 38: Station 21631 Medina River at Mayan Ranch, SARA and BCRAGD staff conducting a biological collection event.

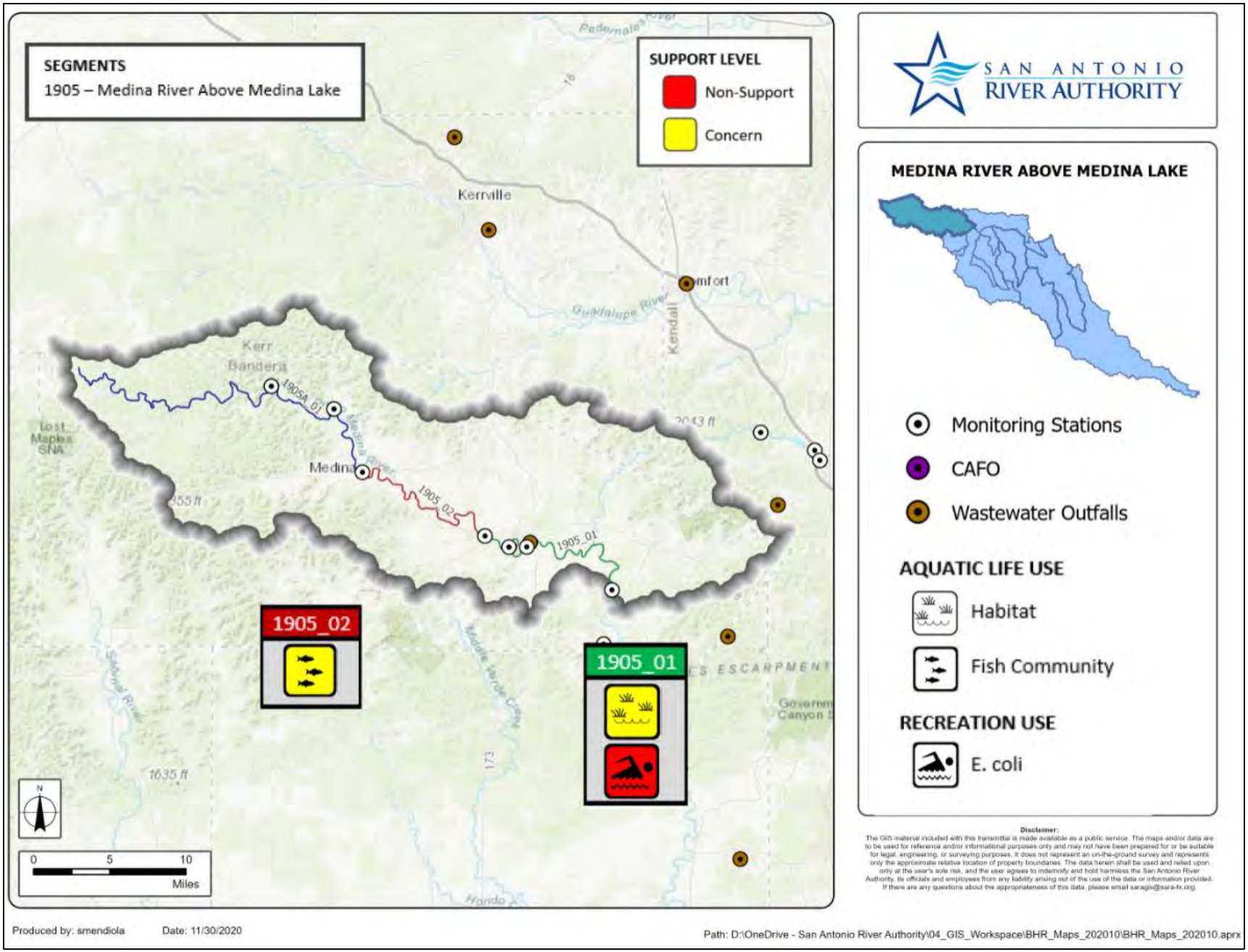

Figure 39: 2020 TCEQ Integrated Report; Impairments and Concerns in the Medina River above Medina Lake Watershed

Table 9: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1905 Medina River above Medina Lake										
Seg_AU	**Designated Use**	**Method**	**Parameter Description**	**Criteria**	**# of Samples Assessed**	**# of Samples Exceeding Criteria**	**Mean of Samples Exceeding Criteria or Bacteria Geomean**	**Data Set Qualifier**	**Integrated Level of Support**	**Impairment Category**
1905 Upper Medina River										
1905_01	Recreation Use	Bacteria Geomean	*E. coli*	126	61	1	144.95	AD	**NS**	5c
	Aquatic Life Use	Habitat	Habitat	26	6	--	21	AD	CS	
1905_02	Aquatic Life Use	Fish Community	Fish Community	52	--	--	--	ID	CN	
1905A North Prong Medina River			No Impairments Identified							

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

LD - Limited Data (less than 9, greater than 3)

ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

* Indicates that the Integrated Level of Support was carried forward from a previous assessment due to inadequate data.

Drainage Area: 99 square miles

Aquifers: Edwards, Trinity

River Segments: 1904

Cities: No major cities

Counties: Bandera, Medina

EcoRegion: Edwards Plateau

Vegetation Cover: 3.31% Deciduous Forest, 45.77% Evergreen Forest, 6.0 % Herbaceous, 0.02% Mixed Forest, 30.28% Shrub/Scrub

Land Uses: 0.15% Barren Land, 0.05% Cultivated Crops, 0.02% Developed, High Intensity, 1.46% Developed, Low Intensity, 0.26% Developed, Medium Intensity, 5.15% Developed, Open Space, 0.01% Emergent Herbaceous Wetlands, 7.52% Open Water, < 0.01% Woody Wetlands

Figure 40: Medina Lake Dam, Medina River Watershed

Medina Lake – Segment 1904

Medina Lake, located along the Medina and Bandera County line, is a reservoir created by the construction of Medina Dam that was completed in 1912. The lake was created to irrigate farmland and has become a recreational area for residents. The dam is managed by the Bexar-Medina-Atascosa Counties Water Control and Improvement District No. 1. Medina Lake is in the Edwards Plateau Ecoregion. This ecoregion is commonly referred to as the Texas Hill Country. The soils are generally shallow and underlain by limestone. The limestone rock has been eroded to create the steep hills in this region. The hills are dominated by Ashe juniper, Texas red oak, stunted live oak trees, and sparse grasses. Rainfall on the Edwards Plateau drains rapidly into creeks, causing flash floods within the region and downstream. The rapid flow often causes scouring of aquatic habitat within the region. Ranching is common; this area is becoming more populated with small hobby ranches.

Segment 1904 – Medina River above Medina Lake: Medina Lake extends from Medina Lake Dam in Medina County to a point immediately upstream of the confluence of Red Bluff Creek in Bandera County, up to the normal pool elevation of 1072 feet (impounds Medina River). The 2020 Integrated Report does not identify any impairments or concerns for the Medina Lake Watershed.

Activities in the Watershed

BCRAGD and the River Authority will continue routine monitoring and provide quality assured data to TCEQ for assessment.

Table 10: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1904 Medina Lake

Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1904 Medina Lake	No Impairments or Concerns Identified									

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)
LD - Limited Data (less than 9, greater than 3)
ID - Inadequate Data (less than 4)
TR - Temporally Not Representative
-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport
CS - Screening Level Concern
CN - Use Concern
NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.
5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.
5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

Figure 41: Medina Lake Dam, Medina Valley Irrigation Company, June 23, 1913

Drainage Area: 15 square miles

Aquifers: Trinity, Edwards

River Segments: 1909

Cities: No major cities

Counties: Medina

EcoRegion: Edwards Plateau

Vegetation Cover: 6.17% Deciduous Forest, 6.81% Evergreen Forest, 2.12% Herbaceous, 6.22% Shrub/Scrub

Land Uses: 0.1% Barren Land, 0.02% Cultivated Crops, 0.01% Developed, High Intensity, 0.37% Developed, Low Intensity, 0.06% Developed, Medium Intensity, 4.49% Developed, Open Space, 1.98% Open Water, 0.16% Woody Wetlands

Figure 42: Medina Diversion Lake Dam, Medina River Watershed

Medina Diversion Lake – Segment 1909

Segment 1909, in Medina County, extends from Medina Diversion Dam to Medina Lake Dam and reaches the normal pool elevation of 926.5 feet (impounds Medina River). This lake was built to feed a vast network of irrigation canals. The lake is owned and managed by the Bexar-Medina-Atascosa Counties Water Improvement District No. 1. While Medina Lake has numerous parks and public access areas, Medina Diversion Lake is surrounded by private property, and access to the lake is limited.

Segment 1909 – Medina Diversion Lake: Extends from Medina Diversion Dam in Medina County to Medina Lake Dam in Medina County, up to normal pool elevation of 926.5 feet (impounds Medina River). The 2020 Integrated Report does not identify any impairments or concerns for the Medina Diversion Lake Watershed.

Activities in the Watershed

BCRAGD and the River Authority will continue routine monitoring and provide quality assured data to TCEQ for assessment.

Table 11: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1909 Medina Diversion Lake

Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1909 Medina Diversion Lake	No Impairments or Concerns Identified									

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

LD - Limited Data (less than 9, greater than 3)

ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

Figure 43: Medina Diversion Lake Dam, Medina Valley Irrigation Company, year 1913

Drainage Area: 464 square miles

Aquifers: Edwards, Trinity, Carrizo

River Segments: 1903

Cities: Castroville

Counties: Bexar, Medina, Atascosa, Bandera

EcoRegion: Texas Blackland Prairies, Edwards Plateau, Southern Texas Plains, East Central Texas Plains

Vegetation Cover: 6.42% Deciduous Forest, 12.24% Evergreen Forest, 41.88% Shrub/Scrub, 2.72% Herbaceous, 1.51% Mixed Forest

Land Uses: 0.67% Barren Land, 14.89% Cultivated Crops, 0.36% Developed, High Intensity, 2.43% Developed, Low Intensity, 1.16% Developed, Medium Intensity, 5.17% Developed, Open Space, 0.14% Emergent Herbaceous Wetlands, 7.26 Hay/Pasture, 0.69% Open Water, 2.46% Woody Wetlands,

Figure 44: Station 12811 Medina River at FM 1937

Medina River below Medina Diversion Lake – Segment 1903

The approximate drainage area of the Medina River below the Medina Diversion Lake is 464 square miles and is predominately rural. The upper end of this segment flows through portions of the Edwards Plateau as it makes its way on to the Southern Gulf Coastal Plains. Due to the lack of deep organic soils, vegetation is limited along the stream within the upper reaches of this segment. Major tributaries to the Lower Medina River include Leon Creek, Geronimo Creek, and Medio Creek. Other major contributors to the Medina River include the effluent discharge from Dos Rios, Leon Creek and Medio Creek Water Recycling Center Treatment Facilities. The upper reach of this segment is characterized by excellent water clarity, moderate to swift velocity, gravel and limestone substrates, high steep limestone banks and alternating run, glide, riffle and pooled habitats. The lower reach of this segment is influenced by alluvial formations of the Southern Gulf Coastal Plains and the stream habitats alternate between runs and glides. This portion of the Medina River is characteristically deeper and more turbid. There are no unclassified waterbodies of the Lower Medina River assessed in the 2020 Integrated Report. Details of the impairments and concerns for the Medina River Watershed below Medina Diversion Lake can be seen in Figure 46 and Table 12.

Segment 1903 – Medina River below Medina Diversion Lake: Extends from the confluence with the San Antonio River in Bexar County to Medina Diversion Dam in Medina County. According to the 2020 Integrated Report, the Medina River Watershed below Medina Diversion Lake is identified as impaired for not supporting the primary contact recreation use due to elevated levels of bacteria. Concerns for total phosphorus and nitrate have also been identified.

Activities in the Watershed

The River Authority will continue routine monitoring and provide quality assured data to TCEQ for assessment.

Figure 45: Station 14200 Medina River at CR 484, Spotted Gar (*Lepisosteus oculatus*) captured and released in the Lower Medina River Watershed

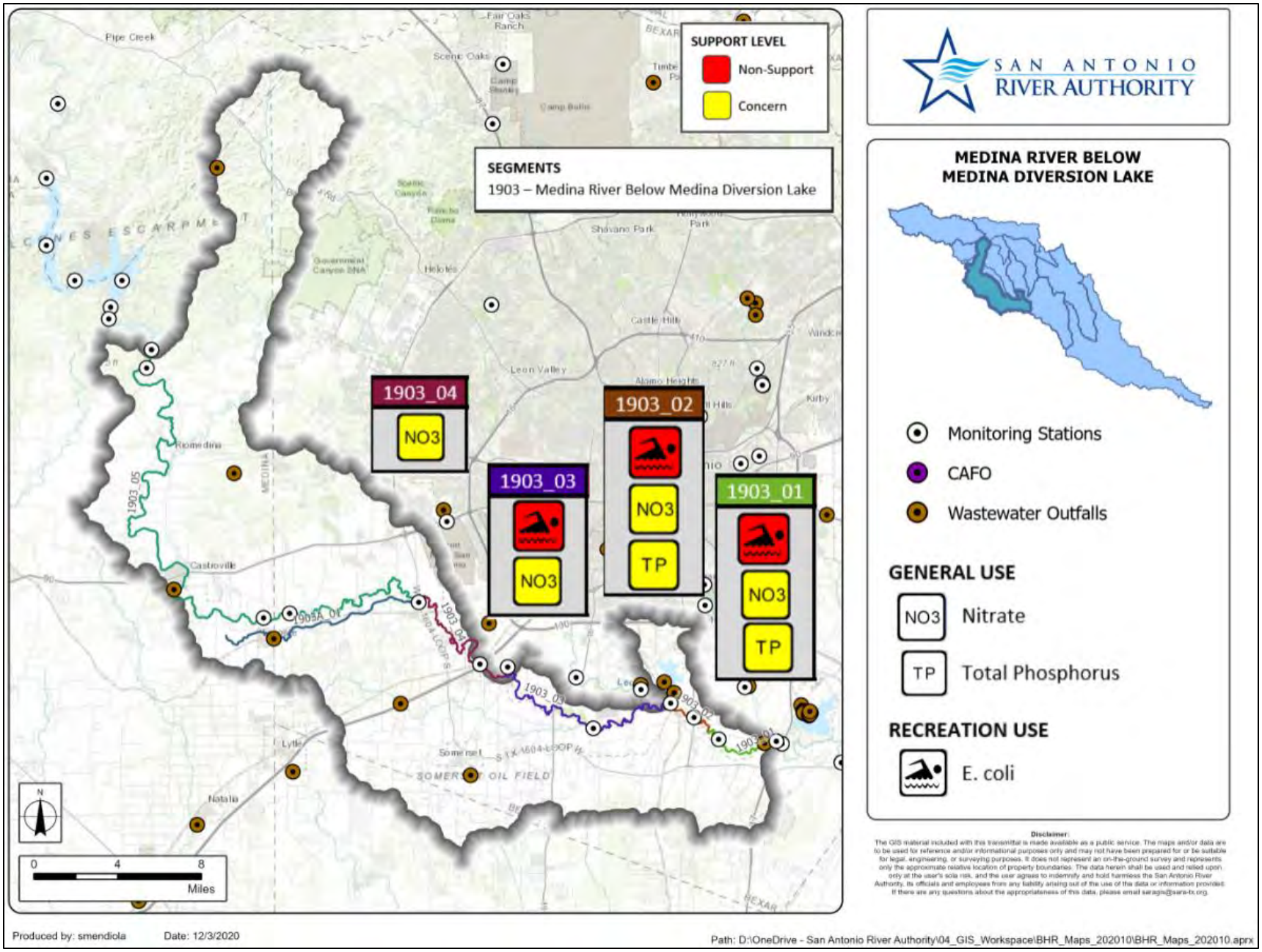

Figure 46: 2020 TCEQ Integrated Report; Impairments and Concerns in the Medina River Below Medina Diversion Lake Watershed

Table 12: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1903 Lower Medina River										
Seg_AU	**Designated Use**	**Method**	**Parameter Description**	**Criteria**	**# of Samples Assessed**	**# of Samples Exceeding Criteria**	**Mean of Samples Exceeding Criteria or Bacteria Geomean**	**Data Set Qualifier**	**Integrated Level of Support**	**Impairment Category**
1903 Lower Medina River										
1903_01	Recreation Use	Bacteria Geomean	*E. coli*	126	33	1	160.38	AD	**NS**	5c
	General Use	Nutrient Screening Level	Nitrate	1.95	34	33	10.33	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	32	28	1.48	AD	CS	
1903_02	Recreation Use	Bacteria Geomean	*E. coli*	126	55	1	199.59	AD	**NS**	5c
	General Use	Nutrient Screening Level	Nitrate	1.95	55	54	9.59	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	55	45	1.75	AD	CS	
1903_03	Recreation Use	Bacteria Geomean	*E. coli*	126	38	1	216.74	AD	**NS**	5c
	General Use	Nutrient Screening Level	Nitrate	1.95	38	21	3.19	AD	CS	
1903_04	General Use	Nutrient Screening Level	Nitrate	1.95	24	11	2.81	AD	CS	
1903_05	No Impairments or Concerns Identified									

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

LD - Limited Data (less than 9, greater than 3)

ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

* Indicates the Integrated Level of Support was carried forward from a previous assessment due to inadequate data.

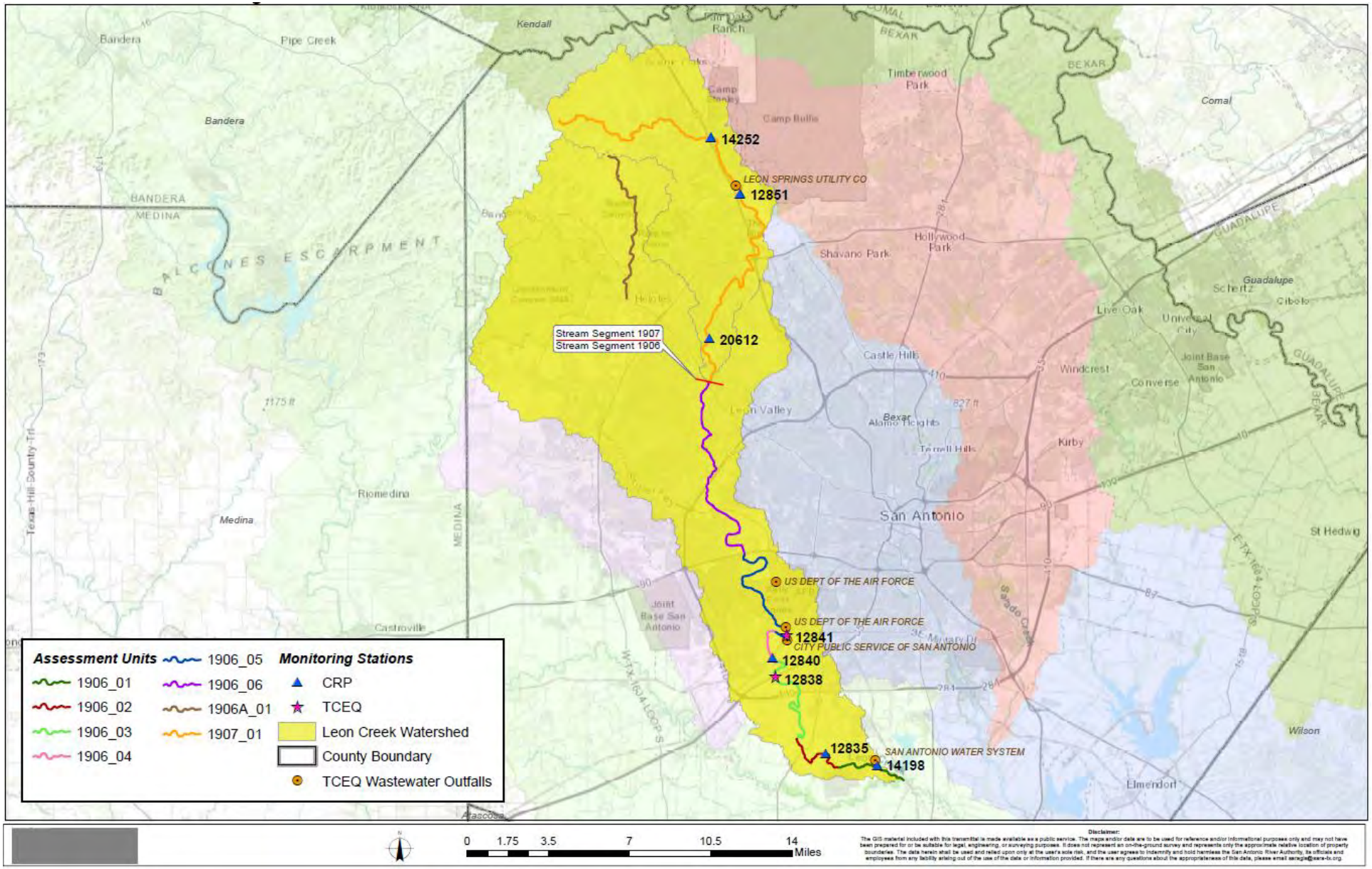

Figure 47: 2020 Monitoring Map for the Leon Creek Watershed

Drainage Area: 60 square miles

Aquifers: Trinity, Edwards

River Segments: 1907

Cities: Northwest edge of the City of San Antonio

Counties: Bexar

EcoRegion: Edwards Plateau, Texas Blackland Prairies

Vegetation Cover: 4.38% Deciduous Forest, 32.06% Evergreen Forest, 2.22% Herbaceous, 0.1% Mixed Forest, 16.52% Shrub/Scrub

Land Uses: 0.17% Barren Land, 0.02% Cultivated Crops, 3.42% Developed, High Intensity, 12.63% Developed, Low Intensity, 10.38% Developed, Medium Intensity, 18.05% Developed, Open Space, 0.03% Open Water, 0.02% Woody Wetlands

Figure 48: Just downstream of 12851 Upper Leon Creek at Raymond Russell Park

Upper Leon Creek – Segment 1907

The upstream portion of Leon Creek is in the Edwards Plateau Ecoregion. This area is commonly referred to as the Texas Hill Country. The soils are generally shallow and underlain by limestone. The limestone rock has been eroded to create the steep hills in this region. The hills are dominated by Ashe juniper, Texas red oak, stunted live oak trees, and sparse grasses. Rainfall on the Edwards Plateau drains rapidly into creeks causing flash floods within the region and downstream. The rapid flow often causes scouring of aquatic habitat within the region. Ranching is common and this area is becoming more populated with small hobby ranches. The downstream portion of this segment is in the Texas Blackland Prairie. This ecoregion is dominated by deep, dark-colored rich clay soils, also known as vertisol soils, which are gently sloping to level. Vertisol soils expand and shrink with moisture, causing cracks in the soil when it is dry. The deep, rich soils make the blackland prairie ideal for row crops, but in the San Antonio River Basin, this area is dominated by urbanization. Originally a tall grassland prairie, most of the original prairie has been replaced by urbanization and agriculture. Mesquite, blackjack and post oak trees are common.

Segment 1907 – Upper Leon Creek: Extends from a point 100 meters (110 yards) upstream of SH 16 northwest of San Antonio in Bexar County to a point 9.0 km (5.6 miles) upstream of Scenic Loop Road north of Helotes in Bexar County. The 2020 Integrated Report does not identify any impairments or concerns for the Upper Leon Creek Watershed.

Activities in the Watershed

A TCEQ Upper Leon Creek Use Attainability Analysis to further define the appropriate aquatic life use (ALU) and associated DO criteria for the segment was originally schedule for early 2020, however, due to COVID-19, the UAA was postponed until further notice. The River Authority will continue routine monitoring and provide quality assured data to TCEQ for assessment.

Table 13: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1907 Upper Leon Creek

Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1907 Upper Leon Creek			No Impairments or Concerns							

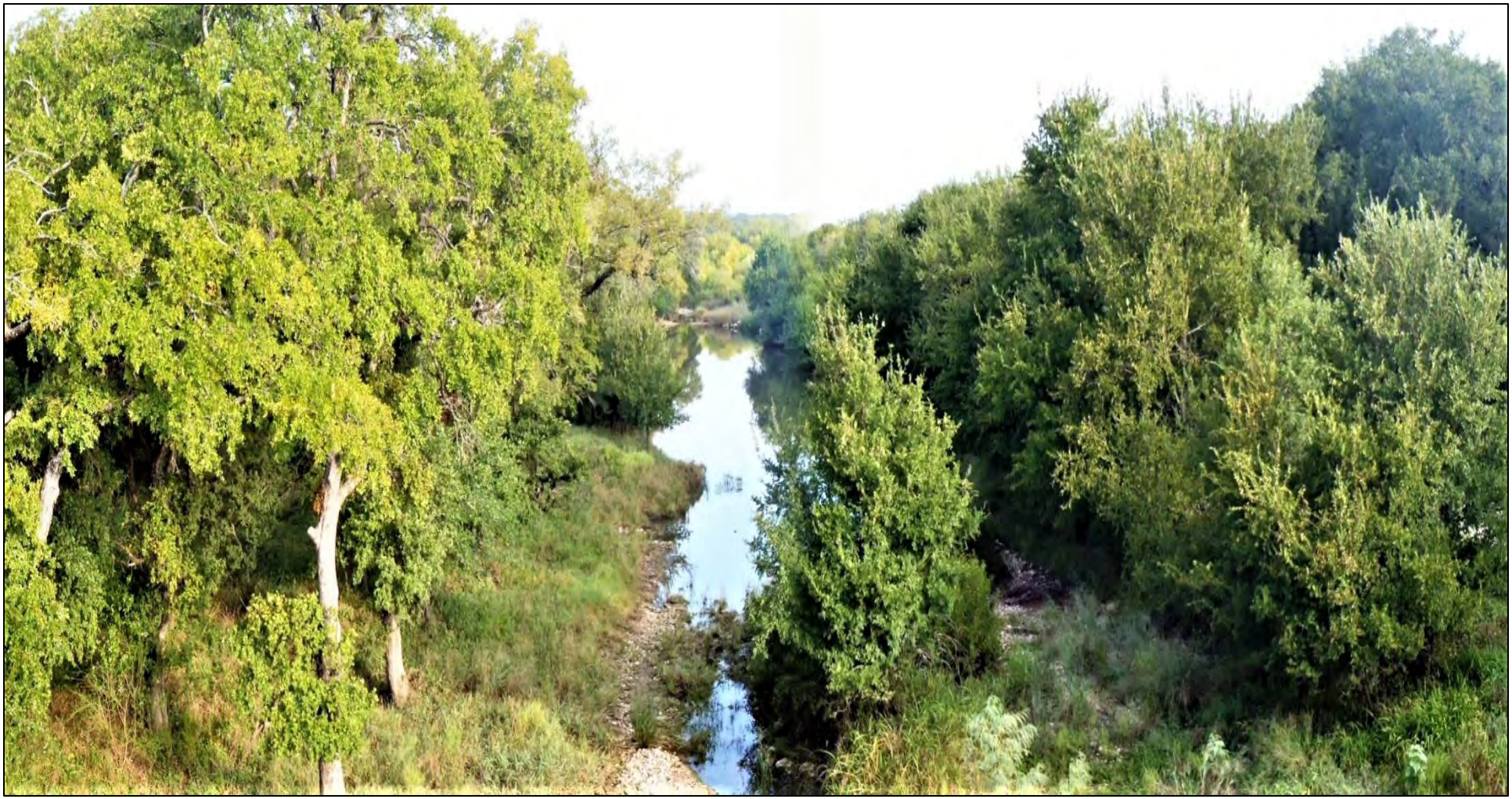

Figure 49: Upper Leon Creek at Prue Road, Upper Leon Creek Greenbelt

Drainage Area: 177 square miles

Aquifers: Trinity, Edwards, Carrizo

River Segments: 1906

Cities: Leon Valley

Counties: Bexar

EcoRegion: Texas Blackland Prairies, Edwards Plateau

Vegetation Cover: 3.49% Deciduous Forest, 21.14% Evergreen Forest, 2.49% Herbaceous, 0.39% Mixed Forest, 13.22% Shrub/Scrub

Land Uses: 0.14% Barren Land, 5.11% Cultivated Crops, 6.36% Developed, High Intensity, 14.8% Developed, Low Intensity, 14.07% Developed, Medium Intensity, 16.25% Developed, Open Space, 0.03% Emergent Herbaceous Wetlands, 0.7% Hay/Pasture, 0.12% Open Water, 1.69% Woody Wetlands

Figure 50: Station 14198 Leon Creek Upstream of the Leon Creek WWTP

Lower Leon Creek – Segment 1906

The Lower Leon Creek has a total continuous length of 32 miles and drains approximate 177 square miles. Flow in the upper two-thirds of this segment pass through heavily urbanized portions of west and southwest San Antonio in Bexar County, including the main portion of Kelly Field, formerly Kelly Air Force Base. The lower one-third continues to flow in a general southwest direction through rural farm and ranch land. The portion of this segment between State Highway 16 to Highway 151 lies within the Edwards Recharge Zone and is dry except during times of heavy precipitation. The Balcones Escarpment bisects Bexar County from the west to northeast; bottom substrates along portions of Leon Creek that cross the Edwards Recharge formation consist of boulders, cobble, gravel and flat limestone bedrock scarred by cracks and fissures. Where alluvial substrates have accumulated, sycamores, willows, and oak trees have established themselves. Below Highway 151, a noticeable change in habitat features occurs. Creek channels become narrow and deep and the surrounding geology is dominated by alluvial soils. Riparian vegetation becomes dense and dominated by stands of native hardwood trees, grasses, forbs, and shrubs. Complete canopies overshadow the creek in many areas within the lower reaches of this segment. Except during years of low precipitation, perennial seeps upstream of Old Highway 90 West maintain the base flow throughout the remainder of the Lower Leon Creek. Hilly terrain and low-permeability clay soils make this segment susceptible to stormwater runoff. Segment 1906A, Helotes Creek, is an intermittent unclassified waterbody in the Leon Creek Watershed. For the 2020 Integrated Report, there was inadequate data to assess 1906A for any use criteria. Details of the impairments and concerns for the Lower Leon Creek Watershed can be seen in Figure 52 and Table 14.

Segment 1906 – Lower Leon Creek: Extends from the confluence with the Medina River in Bexar County to a point 100 meters (110 yards) upstream of SH 16 northwest of San Antonio in Bexar County. In 2002, the Texas Department of State Health Services (TDSHS) issued Fish Consumption Advisory ADV-26 advising people not to consume any species of fish from the Lower Leon Creek as a result of concentrations of polychlorinated biphenyl (PCB) in the fish tissue that posed an unacceptable risk to consumers. Subsequent TDSHS fish tissue collections and analysis at stations along Lower Leon Creek resulted in a new fish consumption advisory being issued on June 29, 2010. Advisory ADV-42 expanded the geographic area beginning at the Old U.S. Highway 90 Bridge and extends downstream to the Loop 410 Bridge. The 2020 Integrated Report identifies the reach between the confluences with Indian Creek to a point 100 meters upstream of State Highway 16 in Northwest San Antonio as impaired for fish consumption due to PCBs in fish tissue. Concerns for 24-hour average and minimum dissolved oxygen screening levels, *E. coli*, silver in sediment, and chlorophyll-*a* have also been identified.

Activities in the Watershed

Lower Leon Creek Use Attainability Analysis Project: Lower Leon Creek was first identified in the 1999 Texas Water Quality Inventory and 303(d) List as having DO concentrations lower than the standard established to assure optimum conditions for high aquatic life. As a result of the listing, the TCEQ Total Maximum Daily Load (TMDL) Team initiated a sampling verification project in 2008 to evaluate the DO concentrations in the Lower Leon Creek. The 24-hour DO data collected as part of the project indicated a site-specific standards change may be appropriate. In 2012,

the **Lower Leon Creek Use Attainability Analysis Project**[17] was initiated to further define the appropriate aquatic life use (ALU) and associated DO criteria for the segment. To assess the ALU, 24-hour DO measurements and biological (nekton and benthic macroinvertebrate) and habitat assessments were conducted throughout the watershed. The final report was submitted to the Texas Commission on Environmental Quality on March 15, 2017. As of this report, no further action has been taken by the TCEQ or EPA.

Assessment of selected contaminants in streambed- and suspended-sediment samples collected in Bexar County, Texas Study: In 2002 and 2010, the Texas Department of State Health Services (TDSHS) issued Fish Consumption Advisory ADV-26 advising people not to consume any species of fish from the Lower Leon Creek as a result of concentrations of polychlorinated biphenyl (PCB) in the fish tissue that posed an unacceptable risk to consumers. In 2010, Advisory ADV-42 increased the geographical area of the fish consumption advisory to include the area between Old U.S. Highway 90 Bridge to the Loop 410 Bridge. In response to the 2002 impairment, the USGS, with support from the River Authority, initiated and completed the **Assessment of selected contaminants in streambed- and suspended-sediment samples collected in Bexar County, Texas, 2007-09**[18] Project. Results from the study indicated contaminants of concern are present in the Lower Leon Creek, including polychlorinated biphenyls (PCBs) (Wilson, 2011). In 2012 the USGS initiated phase II of the project, **Occurrence and concentrations of selected trace elements and halogenated organic compounds in stream sediments and potential sources of polychlorinated biphenyls, Leon Creek, San Antonio, Texas, 2012–14**[19]. The purpose of this study was to continue to characterize contaminants of concerns in the Leon Creek, between the former Kelly Air Force Base and Interstate Highway 410. Sediment samples before and after storm events were analyzed for major and trace metals, pesticides, and PCBs. The project was completed in 2016. Results from the study indicated contaminants of concern are present in the Lower Leon Creek, including pesticides, flame retardants, and polychlorinated biphenyls (PCBs). Although trace elements were identified, no adverse effects to benthic biota is expected at the concentrations detected.

Figure 51: Black bass (*Micropterus salmoides*), captured and released in the Lower Leon Creek Watershed at Station 14198 Leon Creek upstream of the Leon Creek WWTP

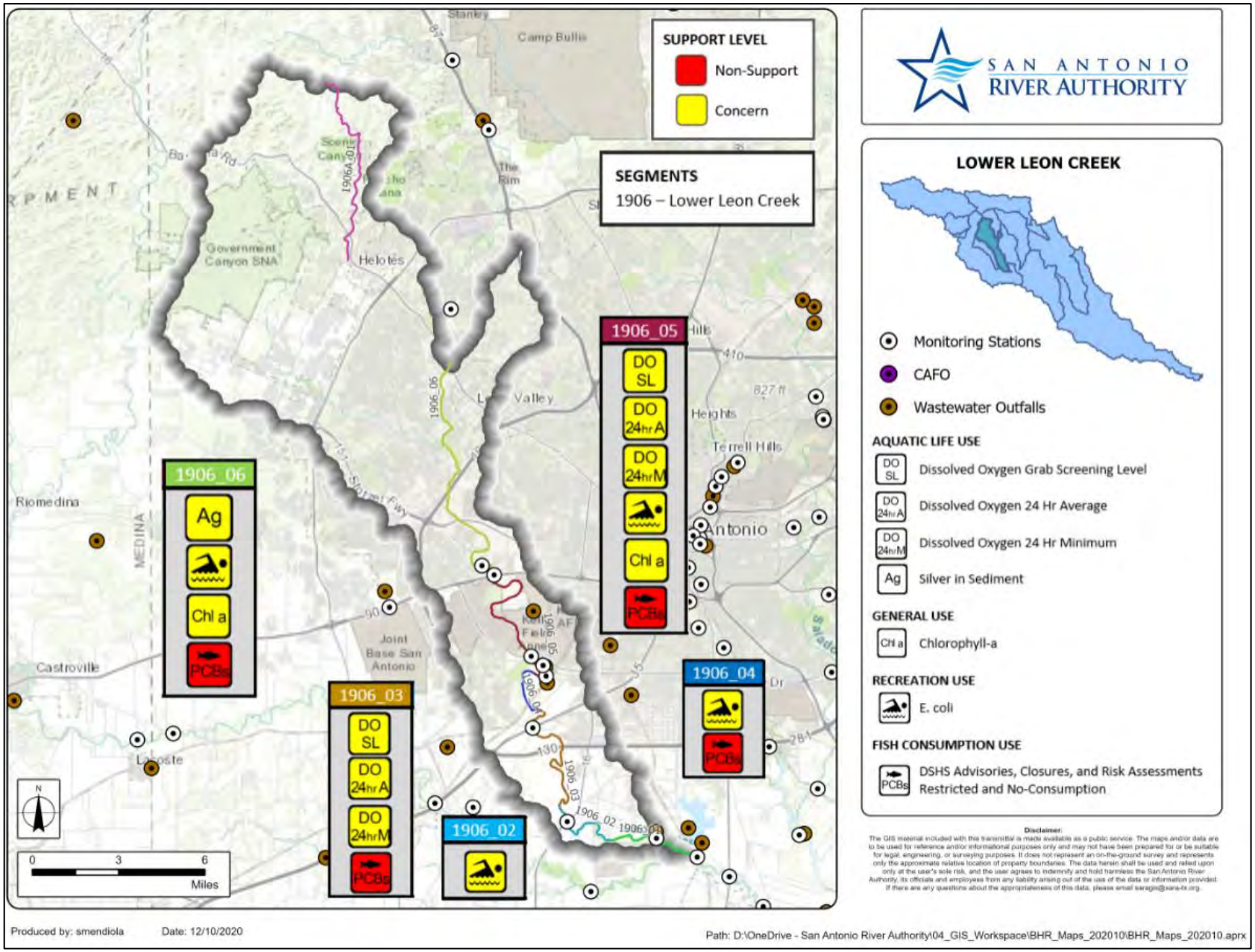

Figure 52: 2020 TCEQ Integrated Report; Impairments and Concerns in the Lower Leon Creek Watershed

Table 14: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1906 Lower Leon Creek										
Seg_AU	**Designated Use**	**Method**	**Parameter Description**	**Criteria**	**# of Samples Assessed**	**# of Samples Exceeding Criteria**	**Mean of Samples Exceeding Criteria or Bacteria Geomean**	**Data Set Qualifier**	**Integrated Level of Support**	**Impairment Category**
1906 Lower Leon Creek										
1906_01	No Impairments or Concerns Identified									
1906_02	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	4a
1906_03	Aquatic Life	Dissolved Oxygen 24hr Average	Dissolved Oxygen 24hr Avg	5	5	2	3.80	LD	CN	
	Aquatic Life	Dissolved Oxygen 24hr Minimum	Dissolved Oxygen 24hr Min	3	5	2	2.25	LD	CN	
	Aquatic Life	Dissolved Oxygen screening Level	Dissolved Oxygen Grab	5	24	5	4.30	AD	CS	
	Fish Consumption	Restricted/No Consumption	PCBs in Edible Tissue	--	--	--	--	OE	NS	5a
1906_04	Fish Consumption	Restricted/No Consumption	PCBs in Edible Tissue	--	--	--	--	OE	NS	5a
	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	
1906_05	Aquatic Life	Dissolved Oxygen 24hr Average	Dissolved Oxygen 24hr Ave	5	6	3	3.90	LD	CN	
	Aquatic Life	Dissolved Oxygen 24hr Minimum	Dissolved Oxygen 24hr Min	3	6	2	2.75	LD	CN	
	Aquatic Life	Dissolved Oxygen screening Level	Dissolved Oxygen Grab	5	34	6	3.80	AD	CS	
	Fish Consumption	Restricted/No Consumption	PCBs in Edible Tissue	--	--	--	--	OE	NS	5a
	Recreation Use	Bacteria Geomean	*E. coli*	126	21	1	143.70	AD	CN	
	General Use	Nutrient Screening Level	Chlorophyll-*a*	14.10	22	8	27.51	AD	CS	
1906_06	Aquatic Life	Toxic Substances in Sediment	Silver	1.70	4	0	--	LD	CS*	
	General Use	Nutrient Screening Level	Chlorophyll-*a*	14.10	1	0	--	ID	CS*	
	Fish Consumption	Restricted/No Consumption	PCBs in Edible Tissue	--	--	--	--	OE	NS	5a
	Recreation Use	Bacteria Geomean	*E. coli*	126	1	0	86	ID	CN*	

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)
LD - Limited Data (less than 9, greater than 3)
ID - Inadequate Data (less than 4)
TR - Temporally Not Representative
-- Not Applicable or data not provided
OE - Other information than ambient samples evaluated

Integrated Level of Support

NS - Nonsupport
CS - Screening Level Concern
CN - Use Concern
NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.
5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.
5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

* Indicates the Integrated Level of Support was carried forward from a previous assessment due to inadequate data.

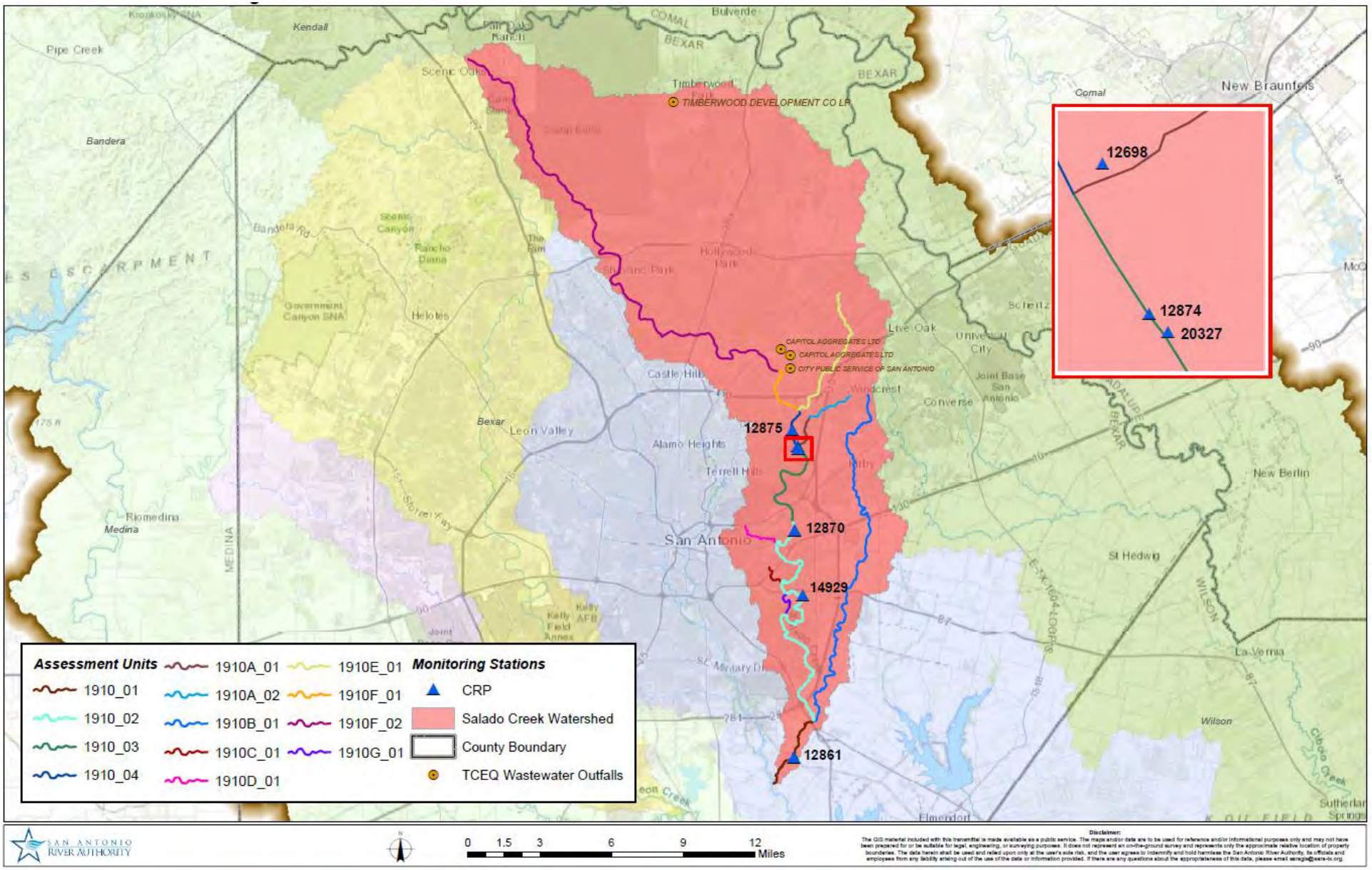

Figure 53: 2020 Monitoring Map for the Salado Creek Watershed

Drainage Area: 222 square miles

Aquifers: Trinity, Edwards, Carrizo

River Segments: 1910, 1910A, 1910B, 1910C, 1910D, 1910E, 1910F

Cities: No major cities

Counties: Bexar

EcoRegion: Edwards Plateau, Texas Blackland Prairies

Vegetation Cover: 3.74% Deciduous Forest, 14.42% Evergreen Forest, 0.8% Herbaceous, 0.26% Mixed Forest, 12.24% Shrub/Scrub

Land Uses: 0.71% Barren Land, 1.4% Cultivated Crops, 8.12% Developed, High Intensity, 19.4% Developed, Low Intensity, 16.19% Developed, Medium Intensity, 19.8% Developed, Open Space, 0.02% Emergent Herbaceous Wetlands, 0.52% Hay/Pasture, 0.15% Open Water, 2.23% Woody Wetlands

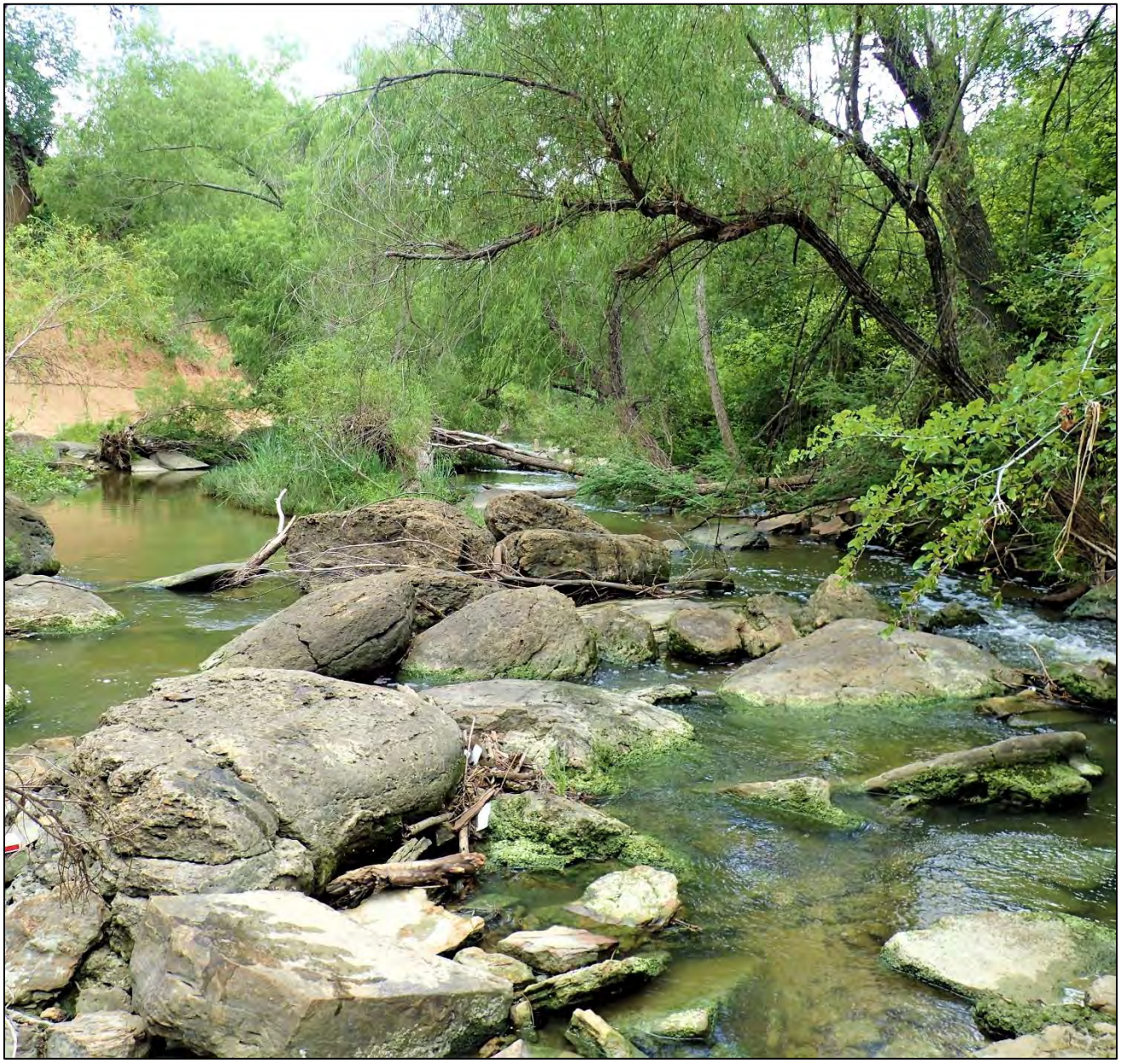

Figure 54: Station 12861 Salado Creek at Southton Road

Salado Creek – Segment 1910

Salado Creek has an approximate drainage area of 222 square miles and is predominately urban. The upper portion of Salado Creek is much wider and shallower than that of the lower portion, which is narrow and deep. Near the headwaters, the general topography of this segment is represented by steep hill country terrain to gently rolling hills of alluvial soils at its confluence with the San Antonio River. From its headwaters to approximately one-quarter mile upstream of north Loop 410, Salado Creek traverses the limestone formations of the Edwards Aquifer Recharge Zone and flows intermittently. This portion of Salado Creek flows only after major rainfall events, then quickly drains and remains dry until the next major event. Salado Creek becomes perennial from intermittent seeps and springs 0.62 miles downstream of Loop 410. Salado Creek in Bexar County is in the Texas Blackland Prairie and become more deeply entrenched as it flows to its confluence with the San Antonio River. The extreme lower reach of Salado Creek flows through rural farm and ranch land and reflects those ecological characteristics of the San Antonio River. Unclassified waterbodies of the Salado Creek assessed in the 2020 Integrated Report include Walzem Creek, Salado Creek Tributary, Menger Creek, Beitel Creek, and Upper Salado Creek. Details of the impairments and concerns for the Salado Creek Watershed can be seen in Figure 56 and Table 15. Rosillo Creek (1910B), Beitel Creek (1910E), and Salado Creek West Channel (1910G) were not assessed in the 2020 Integrated Report.

Segment 1910 – Salado Creek: Extends from the confluence with the San Antonio River in Bexar County to the confluence of Beitel Creek in Northern Bexar County. According to the 2020 Integrated Report, *E. coli*, DO grab minimum, fish and macrobenthic communities' impairments have been identified in the Salado Creek Watershed. Dissolved Oxygen 24-hour average and minimum and DO screening levels concerns have also been documented.

Segment 1910A – Walzem Creek: Extends from the confluence with Salado Creek to approximately 1.5 mi upstream of Walzem Road in San Antonio. Walzem Creek has been identified as impaired for elevated levels of *E. coli* bacteria. A concern for nitrate has also been identified.

Segment 1910C – Salado Creek Tributary: Extends from the confluence with Segment 1910 to the upper end of the waterbody. A concern for near non-attainment of the recreation use standard has been identified in the Salado Creek Tributary.

Segment 1910D – Menger Creek: Extends from the confluence with Segment 1910 to the upper end of the waterbody. According to the 2014 Integrated Report, Menger Creek is identified as impaired for not supporting the primary contact recreation use due to elevated levels of *E. coli*.

Segment 1910F – Upper Salado Creek: Upper Salado Creek from the confluence of Beitel Creek upstream to the headwater approximately 1.5 miles upstream of FM 3351 near Fair Oaks Ranch. Upper Salado Creek has concerns for water quality based on DO and chlorophyll-*a* screening levels.

Activities in the Watershed

The River Authority will continue routine monitoring and provide quality assured data to TCEQ for assessment.

Figure 55: Spotted Gar (*Lepisosteus oculatus*) at Station 12870 Salado Creek at Gembler Road, Salado Creek Watershed

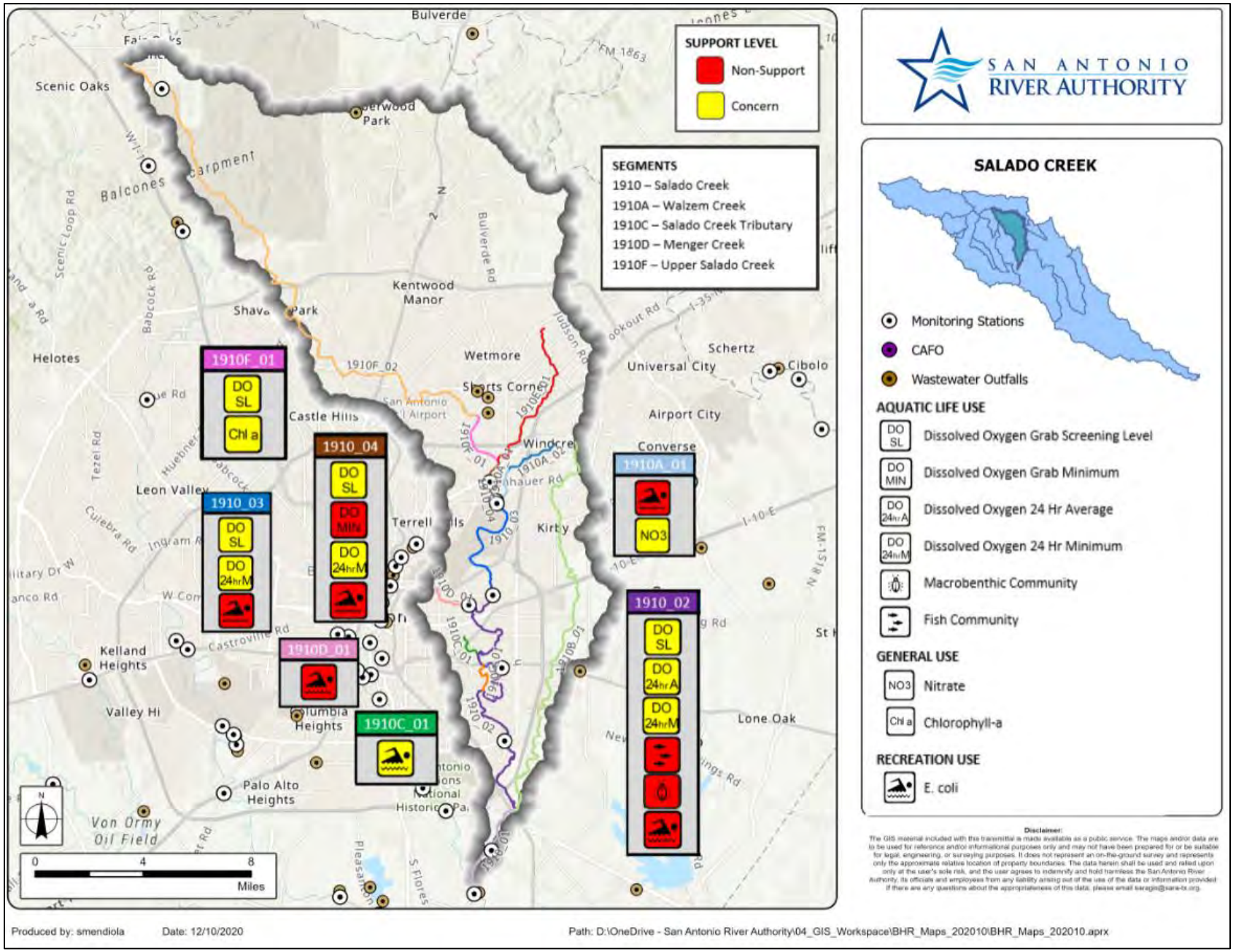

Figure 56: 2020 TCEQ Integrated Report; Impairments and Concerns in the Salado Creek Watershed.

Table 15: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1910 Salado Creek and Tributaries										
Seg_AU	**Designated Use**	**Method**	**Parameter Description**	**Criteria**	**# of Samples Assessed**	**# of Samples Exceeding Criteria**	**Mean of Samples Exceeding Criteria or Bacteria Geomean**	**Data Set Qualifier**	**Integrated Level of Support**	**Impairment Category**
1910 Salado Creek										
1910_01	No Impairments or Concerns Identified									
1910_02	Aquatic Life	Dissolved Oxygen 24hr Average	Dissolved Oxygen 24hr Avg	5	8	1	4.80	LD	CN	
	Aquatic Life	Dissolved Oxygen 24hr Minimum	Dissolved Oxygen 24hr Min	3	8	1	2.80	LD	CN	
	Aquatic Life	Dissolved Oxygen screening Level	Dissolved Oxygen Grab	5	64	18	4.38	AD	CS	
	Aquatic Life	Fish Community	Fish Community	41	14	--	40	AD	**NS**	5c
	Aquatic Life	Macrobenthic Community	Macrobenthic Community	29	10	--	28	AD	**NS**	5c
	Recreation Use	Bacteria Geomean	*E. coli*	126	92	1	142.77	AD	**NS**	4a
1910_03	Aquatic Life	Dissolved Oxygen 24hr Minimum	Dissolved Oxygen 24hr Min	3	1	0	--	ID	CN*	
	Aquatic Life	Dissolved Oxygen screening Level	Dissolved Oxygen Grab	5	19	4	3.38	AD	CS	
	Recreation Use	Bacteria Geomean	*E. coli*	126	20	1	664.56	AD	**NS**	4a
1910_04	Aquatic Life	Dissolved Oxygen 24hr Minimum	Dissolved Oxygen 24hr Min	3	9	2	1.55	LD	CN	
	Aquatic Life	Dissolved Oxygen Minimum	Dissolved Oxygen Grab	3	29	2	1.75	AD	**NS***	4a
	Aquatic Life	Dissolved Oxygen screening Level	Dissolved Oxygen screening Level	5	29	6	3.25	AD	CS	
	Recreation Use	Bacteria Geomean	*E. coli*	126	29	1	558.83	AD	**NS**	4a
1910A Walzem Creek										
1910A_01	Recreation Use	Bacteria Geomean	*E. coli*	126	2	1	207.12	ID	**NS***	4a
	General Use	Nutrient Screening Level	Nitrate	1.95	8	7	4.52	LD	CS	
1910B Rosillo Creek	No Impairments or Concerns Identified									
1910C Salado Creek Tributary										
1910C_01	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	CN*	
1910D Menger Creek										
1911D_01	Recreation Use	Bacteria Geomean	*E. coli*	126	--	--	--	ID	**NS***	4a
1910F Upper Salado Creek										
1910F_01	Aquatic Life	Dissolved Oxygen screening Level	Dissolved Oxygen Grab	4	--	--	--	ID	CS*	
	General Use	Nutrient Screening Level	Chlorophyll-*a*	14.10	--	--	--	ID	CS*	

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)
LD - Limited Data (less than 9, greater than 3)
ID - Inadequate Data (less than 4)
TR - Temporally Not Representative

Integrated Level of Support

NS - Nonsupport
CS - Screening Level Concern
CN - Use Concern
NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.
5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.
5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

-- Not Applicable or data not provided

* Indicates that the Integrated Level of Support was carried forward from a previous assessment due to inadequate data.

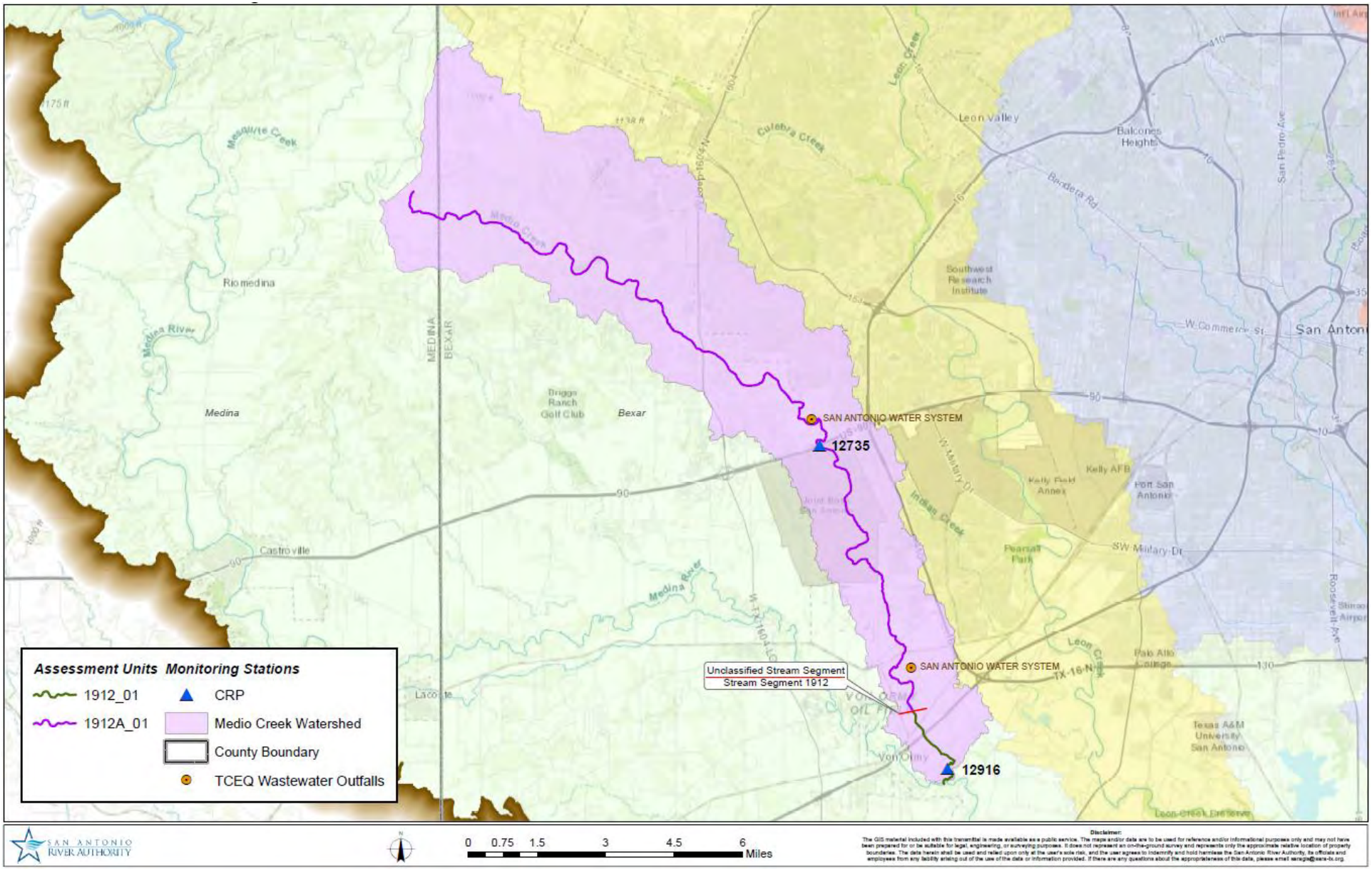

Figure 57: 2020 Monitoring Map for the Medio Creek Watershed

Drainage Are: 54 square miles

Aquifers: Trinity, Edwards

River Segments: 1912, 1912A

Cities: No major cities

Counties: Bexar, Medina

EcoRegion: Texas Blackland Prairies

Vegetation Cover: 12.05% Deciduous Forest, 5.92% Evergreen Forest, 3.71% Herbaceous, 1.0% Mixed Forest, 24.35% Shrub/Scrub

Land Uses: 0.44% Barren Land, 7.44% Cultivated Crops, 3.07% Developed, High Intensity, 13.75% Developed, Low Intensity, 12.14% Developed, Medium Intensity, 13.87% Developed, Open Space, 0.05% Emergent Herbaceous Wetlands, 0.53% Hay/Pasture, 0.28% Open Water, 1.4% Woody Wetlands

Figure 58: 12735 Medio Creek at US 90 West in the Medio Creek Watershed.

Medio Creek – Segment 1912

Medio Creek, Segment 1912, extends upstream from its confluence with the Medina River in southwest Bexar to a point 1.0 kilometer (0.6 miles) upstream of Interstate Highway 35 in San Antonio in Bexar County. Segment 1912A, the upper portion of Medio Creek, continues up to approximately 1.0 mile upstream of the Bexar/Medina County line. Upper Medio Creek is dry or intermittent and becomes perennial below the San Antonio Water System's Medio Creek Water Recycling Center located north of U.S. Highway 90 West. Total approximate drainage area is 53.58 square miles. Medio Creek is effluent dominated throughout its perennial reach and no major tributaries contribute to the flow within Medio Creek. Instream habitat types in Medio Creek generally alternate between pools, glides, and riffles throughout its length and some large pools are present within the perennial portion of the creek. The Upper Medio Creek is the only unclassified waterbody assessed in the 2020 Integrated Report. Details of the impairments and concerns for the Medio Creek Watershed can be seen in Figure 60 and Table 16.

Segment 1912 – Medio Creek: Medio Creek extends from the confluence with the Medina River in Bexar County to a point 1.0 km (0.6 mi) upstream of IH 35 at San Antonio in Bexar County. Medio Creek has been identified as impaired for elevated levels of *E. coli* bacteria. Concerns for water quality based on total phosphorus and nitrate nutrient screening levels.

Segment 1912A – Upper Medio Creek: Upper Medio Creek extends from approximately 1.0 kilometer (0.6 miles) upstream of IH 35 (Bexar County) to approximately 1.0 mile upstream of the Bexar/Medina County Line. Upper Medio Creek has concerns for water quality based on total phosphorus and nitrate nutrient screening levels.

Activities in the Watershed

The River Authority will continue routine monitoring and provide quality assured data to TCEQ for assessment.

Fig 59: Invasive Sailfin Catfish (Pterygoplichthys species) at Station 12916 Medio Creek at Hidden Valley Campgrounds

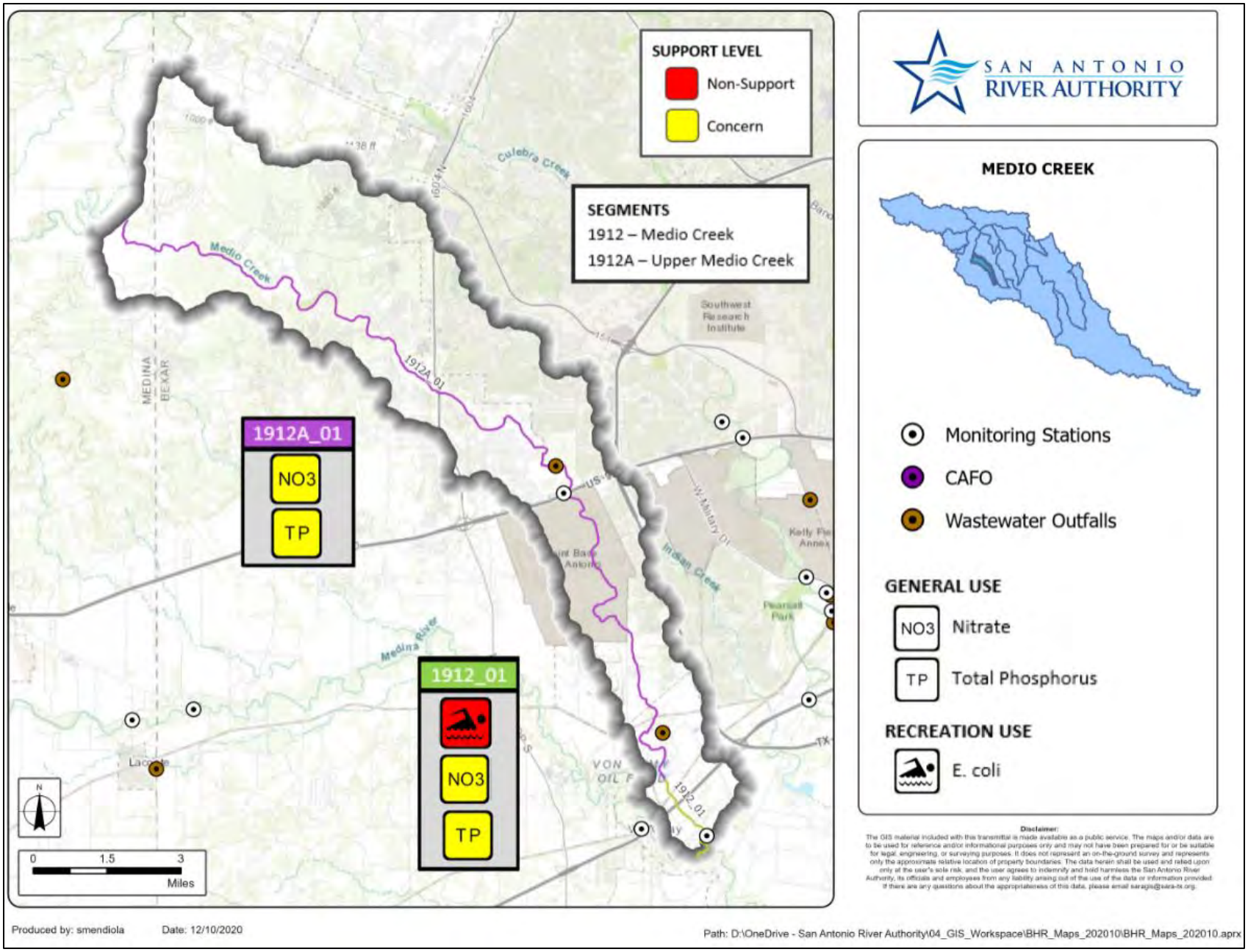

Figure 60: 2020 TCEQ Integrated Report; Impairment and Concerns in the Medio Creek Watershed

Table 16: 2020 Texas Integrated Report, Impairments and Concerns for Segment 1912 Medio Creek										
Seg_AU	Designated Use	Method	Parameter Description	Criteria	# of Samples Assessed	# of Samples Exceeding Criteria	Mean of Samples Exceeding Criteria or Bacteria Geomean	Data Set Qualifier	Integrated Level of Support	Impairment Category
1912 Medio Creek										
1912_01	Recreation Use	Bacteria Geomean	*E. coli*	126	45	1	167.37	AD	**NS**	5c
	General Use	Nutrient Screening Level	Nitrate	1.95	45	25	5.93	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	45	38	1.41	AD	CS	
1912A Upper Medio Creek										
1912A_01	General Use	Nutrient Screening Level	Nitrate	1.95	27	26	12.59	AD	CS	
	General Use	Nutrient Screening Level	Total Phosphorus	0.69	26	26	2.51	AD	CS	

Dataset Qualifier Codes

AD - Adequate Data (10 or more samples)

LD - Limited Data (less than 9, greater than 3)

ID - Inadequate Data (less than 4)

TR - Temporally Not Representative

-- Not Applicable or data not provided

Integrated Level of Support

NS - Nonsupport

CS - Screening Level Concern

CN - Use Concern

NA - Not Assessed

Impairment Category

4a - All TMDLs have been completed and approved by EPA.

5a - TMDLs are underway, scheduled, or may be scheduled for one or more parameters.

5c - Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

Figure 61: Doug Knabe and Alex Mendietta, Intensive Study in the Upper San Antonio River

Environmental Projects, Studies and Efforts

The River Authority's Environmental Sciences Department (ESD) is passionately committed to the preservation, protection, and sustainability of waterbodies in the San Antonio River Basin. Water quality issues in the basin are complex in nature, have a substantial cost to address them, and often require years of support from stakeholders, programs, and funding sources. As a result, ESD projects, studies and efforts are strategically identified and implemented to help advance, influence and develop watershed solutions in a holistic manner. The following San Antonio River Basin projects, studies, and efforts allow for an integrated evaluation of physical, chemical, and biological characteristics of aquatic systems in relation to human health concerns, ecological protection and conditions, stream standards, and designated uses.

Laboratory Analytical Expertise

The primary goal of bacterial source tracking (BST) is to identify sources of fecal contamination in surface waters so best management practices can be put in to place to increase overall water quality. Bacteria primarily found in the guts of warm-blooded animals have a similar genetic makeup, but they are not identical. There are small differences in the genetic code of these bacteria and some of those differences are influenced by the type of animal that bacteria inhabit and what those animals eat. It is through these genetic variations that BST can identify which type of animal is contributing to the pollution of a body of water.

Figure 62: Mike Martinez, Molecular Biologist, preparation of sample for EPA 1696 HF183/BacR287 assay

At the River Authority, BST consists of a series of steps and, before any testing can be done, there are two main preparatory phases that must first be completed. First, a water sample is collected from a source of interest and then 100 mL of that sample is passed through a filter funnel in order to collect the microorganisms on the filter paper. Next, the filter paper is shredded up into fine pieces then put through a chemical process that extracts all the DNA from the bacteria that was captured. Now that the DNA has been isolated and purified, it is ready to be used for quantitative (or real-time) polymerase chain reaction (qPCR). In qPCR, small fragments of DNA, known as a primer and probe set, are designed by the scientist to target a specific genetic sequence of interest. For BST, these targets of interest are those small genetic differences we mentioned earlier which identify bacteria that inhabit a particular animal. These preconstructed primers and probes will bind to and emit a fluorescent signal if the genetic target is present in the sample.

In 2016, the River Authority Regional Laboratory developed a qualitative assay that determines the presence or absence of human fecal contamination in non-potable water samples. Using a primer and probe set designed by the EPA (called HF183/BacR287), this test can detect even the smallest amounts of human fecal pollution. As useful as this test is, its main limitation is that it can only tell an individual if contamination is present or not and cannot be used to determine the degree of pollution. In order to address this issue, a quantitative assay would need to be used to calculate the number of genetic targets or DNA copies of interest.

Seeking to expand their BST capabilities, in 2019 the River Authority Regional Laboratory hired a molecular biologist to, among other tasks, develop a quantitative assay based on the EPA's Method 1696. This test uses the same primer and probe set as the previously described presence/absence method, but the data and calculations produce an estimated number of DNA copies associated with human fecal pollution. The DNA copy number estimate is obtained by using a set of DNA standards with known concentrations to generate a standard curve which is fitted with linear regression. After the calculation is complete, the result is reported as target DNA copy number/100mL. Currently, there is no set criteria for what is considered a high or low copy number reading, but continual monitoring of a site or region establishes a baseline and allows for the detection of fluctuations.

In May of 2020, development of this quantitative procedure was completed, and, by mid-July, the new methodology was put into use in its first real-world application by monitoring sites in the Mission Reach Pilot Study. The capture of data at these locations will be used to determine if they are influenced by human fecal pollution, which can then be used for future discussions regarding the use of these sites for primary contact recreation. The River Authority's BST Laboratory has identified several additional animals of interest and will begin development of those genetic markers. These markers could include canine, bovine, general ruminant, swine, and avian. Additionally, the laboratory is currently in the process of collecting fecal samples from these animals in order to extract DNA and build an environmental DNA reference library for these potential pollution sources.

Moving forward, the River Authority plans to expand the capabilities of the BST parameter in order to add new insights and a greater understanding of the potential bacterial pollutants found throughout our basin. Continuous monitoring using the HF183/BacR287 human marker and the development of non-human animal markers will allow us to establish baseline levels within the basin, which in turn, will give us the ability to assess basin wide trends and identify areas with the greatest pollution concerns. Furthermore, identification of pollutants, from any species, will allow for more educated conversations on effective best management practices. While previous, library-dependent, methods of BST have shown that human bacteria do not make up a large percentage of the microbial pollution in our basin, it is the pollution source that we generally have the greatest ability

to address. Overall, it is the intent that the BST parameter and its future developments be used to provide more definitive, scientifically backed guidance to address the bacterial impairments in the SAR Basin.

Stormwater Monitoring in the San Antonio River Basin

Instream Monitoring: Pollution can come from many various urban and rural human activities, including:

- Increasing areas of impermeable surfaces such as buildings, houses, parking lots, paved highway, and road systems;
- Oil, grease, chemicals, and heavy metals from motor vehicles;
- *E. coli* bacteria from pet waste and failing septic systems;
- Poor management of sedimentation from construction sites and agricultural activities;
- Improper application of fertilizers and pesticides from lawns, gardens, and agricultural activities; and
- Confined animal feeding operations and overgrazing

During storm events, these contaminants concentrate and mobilize to nearby waterways via stormwater infrastructure or overland flow and can have adverse effects on fish and wildlife populations, kill native vegetation, foul drinking water, and make recreational areas unsafe and unpleasant. To address these issues, and to help characterize water quality influences on streams from nonpoint sources, the River Authority has established a network of long-term automated instream stormwater monitoring stations to capture water quality data prior to, during, and after storm events. By incorporating advanced scientific water quality monitoring instrumentation and the cloud-based data hosting platform called Hydrosphere, live field parameter data (temperature, pH, specific conductance, and dissolved oxygen) as well as precipitation data at each site can be viewed from any device with access to the internet. By using Geostationary Operational Environmental Satellite (GOES), water quality data is transmitted via satellite to the Hydrosphere server hourly. The data can be viewed in both graphical and tabular format and can be downloaded as Microsoft Excel Comma Separated Values (CSV) files for further analysis. Hydrosphere allows users to create alarms to notify the River Authority staff via email or text when certain thresholds are met, thereby enabling more control and better planning and coordination regarding station monitoring and data retrieval.

Figure 63: River Authority staff collecting ambient flow measurement the day before a stormwater event.

Stormwater samples are captured using a portable auto sampler. A bubbler flow module is used in conjunction with the sampler to trigger the sampler and to monitor stream level and discharge. The sampler automatically pulls samples based on flow rate or a defined rise in water level. Once triggered, the sampler will draw four 1-liter samples at a set time interval to characterize the water quality of the stream from beginning, through the peak, and to the end of the event. Several stormwater monitoring stations are designed to capture continuous field parameter data over extended periods of time at set intervals (i.e. every 15 minutes). These stations have been installed along the San Antonio River (SAR) in areas that are prone to low flows, high temperature, and/or fish kills (SAR at Tunnel Inlet, Lock and Dam). Additionally, a monitoring station was installed in cooperation with the San Antonio Missions National Historical Park at the San Antonio River at the San Juan Remnant. This stretch of river is a remaining portion of the original channel of the San Antonio River and is a known habitat for freshwater mussels, indicators of good water quality.

Figure 64: Cibolo Creek Watershed Protection Plan instream monitoring sampling station.

Best Management Practices and Low Impact Development: One of the San Antonio River Basin's primary sources of pollution is nonpoint stormwater runoff. Low Impact Development (LID) is a set of stormwater best management practices that address stormwater runoff. Several LID stormwater LID BMPs utilized in the San Antonio River Basin include bioretention ponds, bioswales, cisterns, permeable pavement, and extended detention basins. LID treats small, frequent storm events on-site with a focus on "first flush" pollutants. These are pollutants such as oils, pesticides, *E. coli* bacteria, and other constituents that, under a traditional site-to-street-to storm drain-to-creek stormwater conveyance systems, wash off hardened surfaces and into our rivers, creeks, and streams.

In past years, the River Authority has completed preliminary studies on LID pilot project sites developed by the city of San Antonio. The Upper San Antonio Watershed Protection Plan (USAR WPP) project allowed the River Authority to implement best management practices at the Guenther and Euclid offices. These BMPs were designed to reduce pollutant loads that contribute to the water quality impairment, demonstrate the regional effectiveness of particular LID BMP features and educate skilled laborers, developers and the general public on the methods and values of these practices in our region. Ultimately, the results of this project proved the potential to reduce annual bacteria loads by diverting and slowing thousands of gallons of water entering the river by way of cisterns, permeable parking lot pavement and bioretention areas. The study also provided insight that will serve as lessons learned to the many individuals that were reached during its length.

One of the lessons the River Authority learned from the USAR WPP, as well as other projects, was the need to shift from pre and post construction sampling, to in and out sampling. Meaning, instead of monitoring events before construction of a BMP occurs and comparing those to events occurring after the BMPs are implemented, we shift towards a method that samples runoff as it enters the BMP and compare it to the resulting effluent that is released after it has flowed through the BMP. The reason for the shift was due to varying conditions in drainage areas, sampling locations, and event characteristics; an in and out sampling method eliminates those variables. The River Authority has already begun the execution of this sampling method at the Elmendorf Lake Park BMP site and has set plans in motion to utilize these methods on other future projects.

Additional Stormwater Efforts: In support of the San Pedro Creek Culture Park, the Watershed Monitoring staff has recently installed a monitoring station near Martin Street. The newly installed station will collect the standard field temperature, specific conductance, pH, and dissolved oxygen parameters, as well as *chlorophyll-a* and Blue Green Algae Phycocyanin (BGA-PC). Data collected will be used to reveal trends and identify correlations related to algae levels, algae blooms, water quality and non-point source nutrient depositions.

The River Authority has recently completed construction of a new BMP feature on the Atlanta St. parking lot at the River Authority's offices at the Euclid Location. This feature will sample runoff from the parking lot and test the water before and after it makes its way through the BMP, similar to the BMP site located at Elmendorf Lake Park. There are also plans in development for a BMP retrofit to be constructed at the newly acquired River Authority offices located on Sheridan St.

Future of Stormwater: As the River Authority's stormwater monitoring network continues to expand, the utilization of streamlined techniques will prove important and necessary. The River Authority staff has been able to retrieve live field parameter data, connect to auto samplers to adjust program settings, and determine if sampling procedure has initiated. The current remote communication system that has been utilized over the last several years has revealed a need for improvement. In order to continue acquiring data and samples in a safe, efficient and consistent manner, the

River Authority Watershed Monitoring staff has dedicated time to search for and demo new data logging platforms and field parameter equipment. This, along with the new flow weighted calculators that were developed in house, will ultimately save money by minimizing time spent on non-qualifying storm events and improving time management, sample capture, and sample preparation.

Freshwater Mussel Studies in San Antonio River Watershed

Mission Reach Mussel Survivability Study (MRMS): Freshwater mussels are one of the most vital ecological contributors in our creeks and rivers, yet most people have never seen a freshwater mussel or even know they are there. The list of ecosystem services these discrete bivalves provide is a long one but most notably includes biofiltration of pollutants like *E. coli*, river bottom stability, and even providing habitat for other aquatic species. The value they bring to our ecosystem coupled with the threats they face are a couple of the reasons that aquatic biologists at the River Authority are so devoted to researching them. Being sedentary, filter feeding organisms, freshwater mussels are highly susceptible to anthropogenic changes such as habitat loss and degradation of water quality. It is through understanding these organisms and what their current condition is within the San Antonio River Basin that we can work to protect them and ensure they are successful in providing these ecosystem services in our creeks and rivers for a very long time.

Figure 65: Chris Vaughn, Project Manager Mission Reach Mussel Survivability Study

River Authority biologists began their quest to better understand these animals in 2013 with the inception of the Holistic Mussel Project. This project set out to catalog species distribution and abundance along the entire San Antonio River as well as its major tributaries. Biologists employ several field survey techniques to best estimate numbers of both large and small mussels, so they can understand their reproductive success as well. To date, SARA biologists have kayaked the entire San Antonio River and counted thousands of mussels representing eleven species. It was no surprise the number of mussels found generally increased as you moved in a downstream direction; however, what did surprise biologists was the discovery of small relict populations of mussels in a few of the Upper San Antonio River remnant channels. These remnant channels, not too far from downtown San Antonio, were cut off from the main stem of the San Antonio River many years ago in an effort to increase flood conveyance out of the urban center. This stretch of river was later restored to provide ecological lift to the area and in doing so went through many years of intense earth work which would have removed any surviving mussels in the area. Because the remnant channels were cut off during all these years, they were largely shielded from these impacts. This discovery verified the assumption that freshwater mussels would have at some point called these far upper reaches home. Because of the Mission Reach ecosystem restoration, which was completed in 2013, biologists began to wonder if this stretch of river had matured enough to sustain a new mussel population and if a large reintroduction would be feasible.

Figure 66: Threeridge mussel (*Amblema plicata*) is one of the mussel species used in the study as seen through the holding cage.

In order to answer this question, the River Authority biologists started the Mission Reach Mussel Survivability Study which took adult threeridge, pimpleback, yellow sandshell, and pistol grip mussels from the Lower San Antonio River and placed them in unique holding cages designed to determine their survival and growth over a 3 year span at two sites in the Mission Reach. This survival and growth data are compared to that of mussels housed in similar gear types at a control site in the lower basin. Growth and survival data for the Mission Reach study mussels has looked very promising as the project comes to a close early 2021. This, along with several other pieces of evidence, gives biologists a lot of confidence that a reintroduction into the San Antonio River Mission Reach is in fact feasible.

However, in order to have a successful reintroduction you must first have young mussels to introduce. The River Authority has a partnership with the United Sates Fish and Wildlife Service who is researching propagation techniques for spawning large numbers of juvenile mussels across four target species. Researchers on this project are working tirelessly to determine the best methods for successfully hatching and growing out the healthiest and most abundant stock of juvenile mussels possible so as to give a reintroduction the highest likelihood for success. This work is being done in conjunction with genetic analysis of the mussels across our basin, so we can ensure the current genetic diversity and potential genetic population structure is maintained.

It is through these efforts by River Authority biologists we can better understand what the current mussel populations look like as well as work to restore the Upper San Antonio River population. The ecosystem services provided to this stretch of river would be immense and would bring the ecosystem closer to its natural state.

Figure 67: SARA Aquatic Biologists maintaining Silo Units used to house live mussels during the study.

Freshwater Mussel Propagation and Production Project: Results from the MRMS study suggest that both water and sediment quality are sufficient to sustain the four species assessed. As the MRMS study comes to completion, biologists will be able to make more definitive conclusions on overall health and viability of the mussels and ultimately speak to the possibility of species re-introduction. In order to prepare for this potential re-introduction, it is critical to develop propagation methodology for all four species included in the MRMS study, and subsequently use reared individuals to assess instream juvenile survivability. While propagation methodologies for many species have been developed, there has been little to no work done on the species with the conditions present in the San Antonio River Basin. The project has five major objectives:

1) Develop propagation methodology for Pimpleback (*Cyclonaias Aurea*), Pisolgrip (*Tritogonia Verrucose*), Yellow Sandshell (*Lampsilis Teres),* and Threeridge (*Amblema Plicata)* to include information on host fish, feeding regimen, grow out equipment, etc.
2) Develop and evaluate feasibility of methods for inducing captive spawning.
3) Conduct applied research on physiological limitations of mussels to potential pollutants and general water quality to aid in restoration and habitat management.
4) Develop re-introduction genetic management plan for all species deemed viable for re-introduction.
5) Determine size at release for each species and approximate amount of time needed to reach viable stocking size.

Figure 68: Gravid (carrying young) female Yellow Sandshell (*Lampsilis Teres*) used to produce hundreds of juvenile mussels; the structure protruding from the shell is the gill holding thousands of larval mussels

In order to accomplish these objectives, River Authority staff have partnered with three United States Fish & Wildlife Service (USFWS) facilities; 1) the San Marcos Aquatic Resource Center (SMARC) in San Marcos, TX, 2) the Inks Dam National Fish Hatchery (IDNFH) in Burnet, TX, and 3) the Southwestern Native Aquatic Resource and Recovery Center (SNARRC) in Dexter, New Mexico. SMARC will be focusing on propagation methodology and conducting applied research on physiological limitations, SNARRC will conduct genetic sequencing on mussels found in the San Antonio River basin to establish genetic diversity and structure and IDNFH will serve as the production facility should River Authority staff decide to move forward with a full scale re-introduction.

Over the past few months, IDNFH staff have been able to transform larval mussels (also known as glochidia) to juvenile mussels for all four species. This process is done by putting glochidia in the water with host fish species and allowing the glochidia to attach to the gills and fins of the fish. Host fish species for the study include flathead and channel catfish, spotted gar, and green sunfish. The glochidia extract nutrients from the host fish and transform into juveniles; once the transformation is complete, the juveniles drop off the fish and continue the development to adults by extracting nutrients from the water. The next steps in the project include toxicology trials and continued juvenile development.

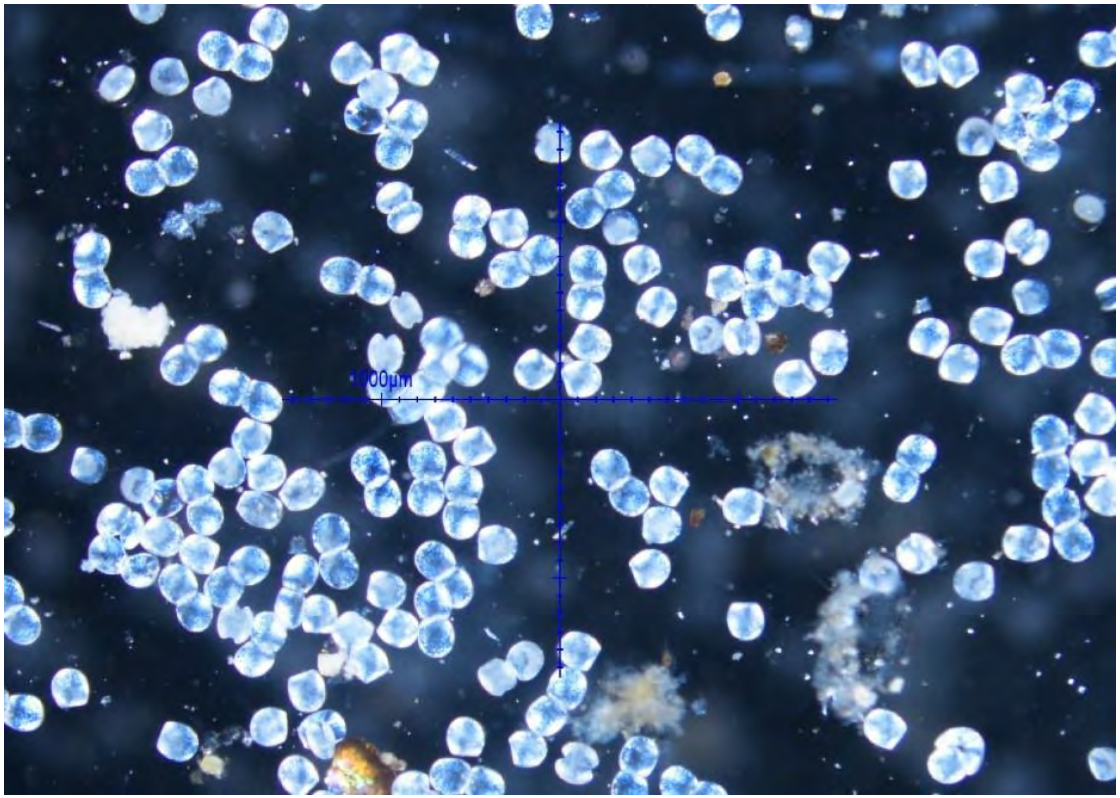

Figure 69: Threeridge (*Amblema plicata*) glochidia prior to fish exposure; each glochidia is around 200 µm (micrometers) in size, or about the width of four human hairs

Protecting the Edwards Aquifer/San Antonio River Basin System

In April 2016, the River Authority and the City of San Antonio (City) entered into an interlocal agreement under which the River Authority project manages **The City of San Antonio Edwards Aquifer Protection Program's Water Quality Project**[20] component. Funded at $10 million through the Program's voter-approved Proposition 1 venue tax for the period 2015 – 2020, the water quality projects component provides funding for projects in the Edwards Aquifer recharge and contributing zones in urban Bexar County.

Funding applications must demonstrate projects will have a positive impact on water quality, with construction project applications required either to exceed current Edwards rules or bring grandfathered development to current standards. This broad approach has allowed the market to drive the kinds of projects that are funded and has resulted in research, education, monitoring, retrofit, and BMP construction projects being funded. The current project portfolio consists of ten projects collectively funded at $8,857,908.

In their various ways, all projects are attempting to understand and/or better address the impacts of human development on the Edwards Aquifer. Most of the projects address stormwater runoff. And, since the aquifer/river basin system is ultimately one system, the projects will help provide valuable information about how to protect waterbodies in the San Antonio River Basin.

Figure 70: Education Classroom Summer Camp; filtration exercise.

Figure 71: Education Summer Camp; Low Impact Development test bed

Planning for Watershed and Community Health in a Growing Region

For the past several years the River Authority has been assisting the City of San Antonio Planning Department (Planning Department) with the implementation of their regional centers through a coordinated effort to uncover new ways to reduce and/or mitigate future increases in impervious cover—roads, parking lots, and rooftops. These regional centers are primed to accept the majority of the approximately 1.1 million new residents expected to call San Antonio home in the coming decades.

With the support of a consultant team and in-house technical experts, the River Authority modeled possible impacts to local creeks and rivers from future development. Some of the findings highlighted the potential for degradation to these important cultural and ecological waterways from upturns in trash, bacteria (e.g. *E.coli)*, sediment, and increased flooding. The team then modeled a future scenario where a toolkit of mitigation strategies has been implemented, such as more parks and open space, green complete streets, smaller parking lots, more trees, and the use of low impact development methods like rain gardens, bioretention basins, and cisterns to intercept and treat rainfall before entering the creeks and rivers, all while retaining the same number of housing units needed to absorb future residents.

The findings have been very positive thus far. In most scenarios, pollutants and flooding would be greatly reduced while providing a multitude of community benefits, also known as the triple bottom line, such as additional green space, shade, and cooler summer temperatures.

Ultimately, the results of these studies can help guide the language and goals for each of the regional centers, helping to ensure future growth sustains both river and community health. The River Authority plans to continue its partnership with the Planning Department as the next few phases of Regional Center planning are rolled out in the coming years.

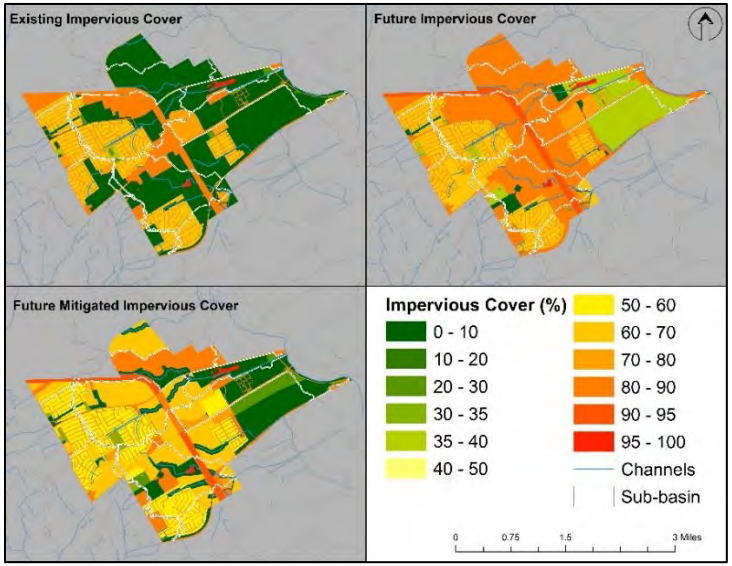

Figure 72: Existing and future mitigation efforts to reduce and/or mitigate future increases in impervious cover.

SARA's Watershed Wise Rebate Program[21] seeks to reduce the impact of pollution from stormwater runoff by expanding the use of on-site Green Stormwater Infrastructure (GSI) using LID principles to design and build best management practices (BMPs). The rebate program is available in Bexar, Wilson, Karnes and Goliad counties. BMPs must be designed using sizing and material specifications from the Low Impact Development Technical Design Guidance Manual. Projects are required to have a minimum rebate request of $15,000. The River Authority's Watershed Wise Rebate Program is open to design professionals, government entities, neighborhood associations and non-profits. Types of construction include commercial, multi-use, right of ways, schools and neighborhood common space. Multiple BMPs types qualify for a rebate at different rates depending on design details. Unit rebate amount is determined by BMP type and volume treated or area of BMP. LID is not a new way to manage stormwater runoff, but it is relatively new to the San Antonio River watershed. The rebate program incentivizes design professionals to become familiar with the site analysis, design and construction processes, and the maintenance associated with LID BMPs.

The Watershed Wise Rebate Program is celebrating its seventh year with a combined budget of over $2.5 million. As of March 16, 2021, the program has 33 completed projects with several additional projects scheduled to be completed by June 2021. The dashboard is multifunctional and maintains a running count of projects as they are completed, including updating the volume of stormwater treated and the amount of sediment and bacteria removed on a real time basis. The benefits of the completed projects have been estimated based on typical rainfall, stormwater pollutant concentration and BMP removal rates. The 33 completed projects collectively treat 1,683,513 cubic feet of stormwater annually, resulting in the removal of 4,408 pounds of sediment and 18,650 billion bacteria colonies per year that would have otherwise ended up in local waterways. A map of the completed projects with pictures and detailed calculated benefits for each project are published on **San Antonio River Basin Green Infrastructure Dashboard**[22].

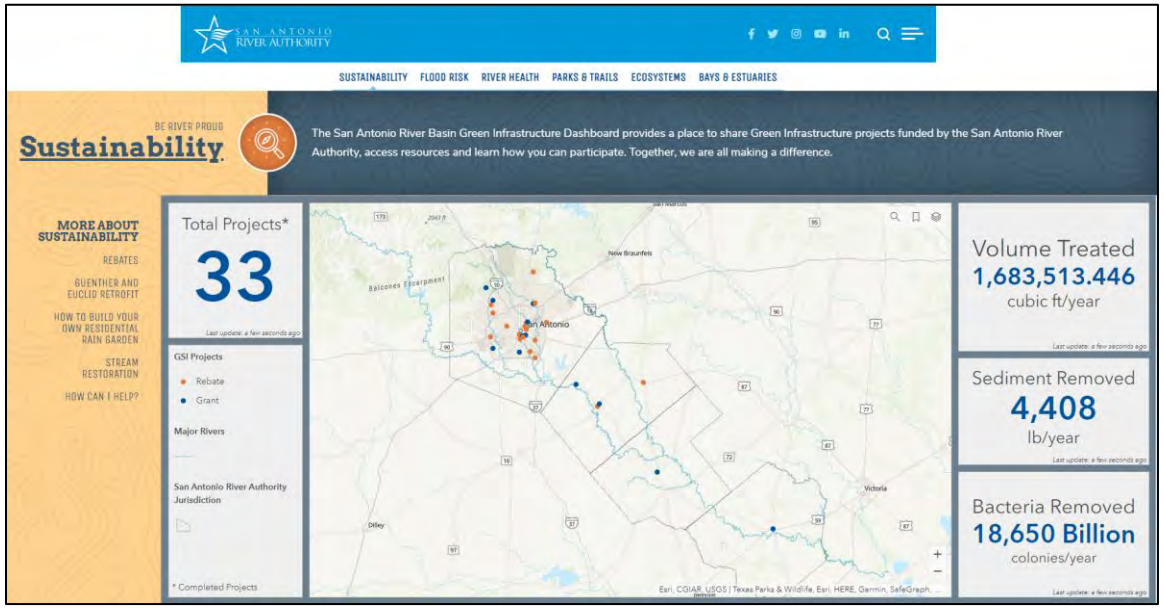

Figure 73: SARA's Green Stormwater Infrastructure Dashboard

The fiscal year 2020-21 budget for this project is $500,000.00. Applications were accepted from October 1 through October 30, 2019. Applications were scored using a rubric with six categories, including Project Description, Amount of Treatment, Impact on Receiving Body, Operation and Maintenance, Location, and Commitment. Project applications are approved based on rubric score and available budget. Projects for fiscal year 2020-21 must be completed by June 2022. The Watershed Wise Rebate Program is supported by an education program to teach design principles and certify inspection of construction, operation, and maintenance. Projects that receive rebate funds are required to maintain operation of BMPs for 5 years and post interpretive signage.

Figure 74: Hector Garcia Middle School – Bioretention Area

Figure 75: Neighborhood Place Community Center – Bioretention

Figure 76: Rudder Middle School – Swale and Bioretention Areas

Figure 77: Leon Vista Trailhead – Permeable Parking

Mission Reach Avian Study: During 2015, the River Authority began a multi-year study to document the abundance and diversity of birds using the restored habitat in the Mission Reach Ecosystem Restoration and Recreation Project along the San Antonio River. Point count and incidental survey data were collected for a 3-year period from December 2015 through December 2018, and periodic incidental surveys are ongoing. The data indicate the restored urban river habitat is providing opportunities for birds throughout the year and throughout the Mission Reach project area.

A total of 202 bird species and over 64,000 individuals have been recorded actively using the restored habitat in and along the San Antonio River. Noteworthy records include Interior Least Tern, a Federally listed Endangered subspecies of Least Tern; Black-capped Vireo, a State-listed Endangered Species; Cassin's Kingbird, a western species that had only been recorded once in Bexar County prior to the recorded observation in the study; Lazuli Bunting, a passage migrant that is very rare in the eastern 2/3 of the state; Hooded Oriole, a scarce resident in southern Texas that is a rare visitor as far north as San Antonio; Black-billed Cuckoo, a scarce coastal migrant that is very rare inland; Cerulean Warbler, a Federally listed Species of Concern that is a declining coastal migrant and rarely detected in Bexar County; and Bald Eagle, a low-density resident in the region that is rarely seen in large cities. Additionally, a variety of other species indicative of the habitat restoration's success have been identified during the study including range-restricted species, wary species, and habitat specialists.

The diversity of restored habitat types that vary from aquatic environments to prairie, savanna, scrub shrub, and young woodland is providing opportunities for a wide variety of birds. At any time of year, many different birds can be readily heard and seen from the trail along the Mission Reach. Although there are great opportunities to find birds throughout the year, some general patterns have emerged from the study which show increased presence of species during annual migrations including April and May in the spring, and September in the fall. These periods also tend to be the best time to see the many wildflowers and the pollinators they attract in the restored habitats.

The study has helped us understand the Mission Reach river ecosystem better and provides a foundation for future surveys in order to continue documenting and assessing the benefits being provided for birds by the restoration and management activities through time. Limited surveys are scheduled to continue in the short term, and more detailed surveys are anticipated to be completed in the future for comparative analysis of the data.

Additional information on the avian study, as well as other studies and effort can be seen can be seen on the **River Authority's Mission Reach Ecosystem Restoration web page**[23]. Photos for the Avian Study appearing in this report were taken by Mr. Martin Reid, Avian Study Consultant.

Figure 78: A Green Kingfisher perching in a Black Willow

Figure 79: An American Redstart perching in a Black Willow

Figure 80: A Blackburnian Warbler perching in a Retama tree in the San Antonio River Mission Reach area during the 2019 spring migration.

Green Stormwater Infrastructure Master Plan: The Upper San Antonio River Watershed Green Stormwater Infrastructure Master Plan Project is an EPA/TCEQ Clean Water Act 319(h) Grant Project to implement the Upper San Antonio River Watershed Protection Plan by developing a master plan for the use of GSI. The plan will incorporate and build upon stakeholder input to develop common goals and investment priorities for implementing GSI. This three-year project will guide decision-makers on where and how to apply limited resources in the upcoming years to maximize water quality benefits. It will also integrate water quality with water quantity concerns, providing recommendations on best management practices that can achieve both results. An interactive map of the project sub-basins being studied can be seen at the **San Antonio River Authority Green Stormwater Infrastructure**[24] website.

The River Authority's watershed scale models have identified sub-basin areas with the highest potential pollutant loads. This project will use existing data and modeling tools to identify and prioritize sites within those areas that have the highest potential for GSI implementation effectiveness due to:

- The probability each site is a significant source of non-point source pollutants according to water quality data and geospatial data on soils, land use, etc.
- The suitability of each site for GSI implementation according to geospatial data on existing stormwater infrastructure, topography, impervious cover, etc.
- The availability of each property for GSI implementation; promising categories include public lands, schools, capital improvement projects, city planning areas, and neighborhoods with supportive stakeholders such as homeowners' association partners.

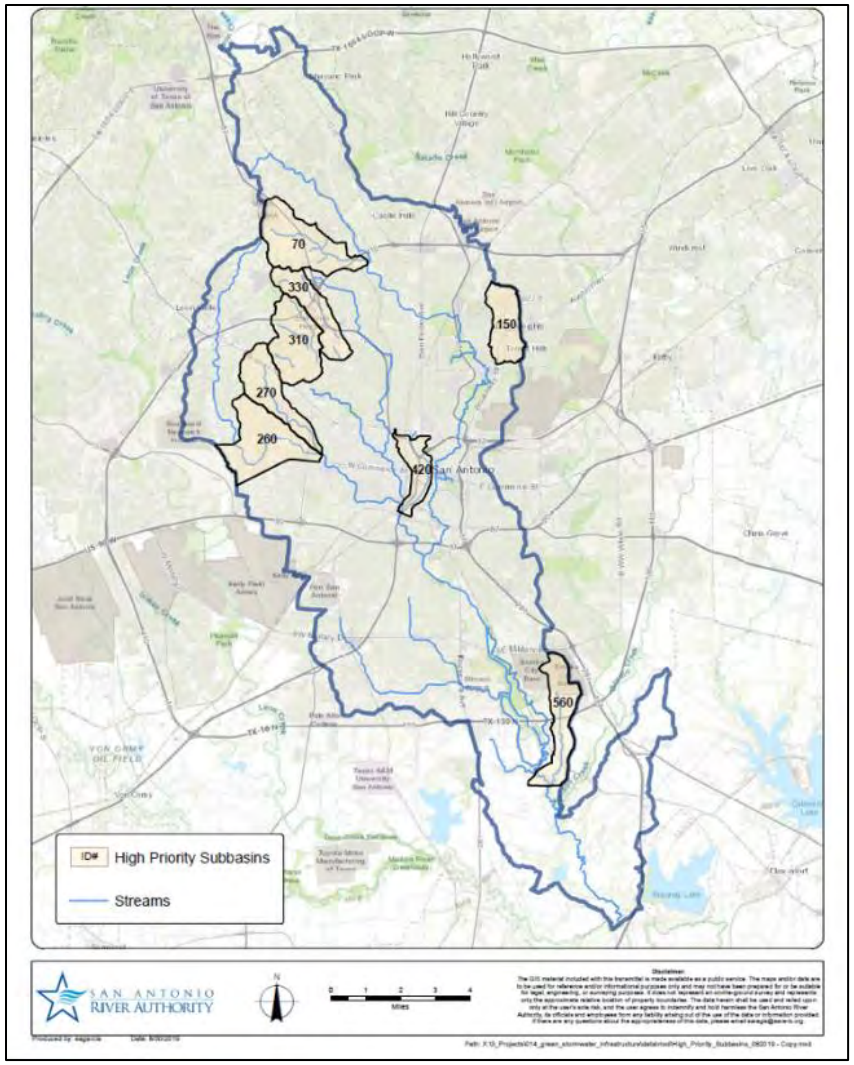

Figure 81: High Priority Sub-basins in the Upper San Antonio River Watershed

The River Authority will score and prioritize potential projects based on costs, water quality and other benefits, site restrictions, and stakeholder input. For the recommended sites, the River Authority will develop site-scale models, concept-level designs, and cost estimates. Using an existing model, the River Authority will estimate the pollutant load reductions these projects would achieve across the watershed. In coordination with watershed stakeholders, the River Authority will develop an Upper San Antonio River Watershed GSI Master Plan including a recommended schedule of implementation, addressing the stakeholder process, costs, funding considerations, and the overall evaluation and prioritization process.

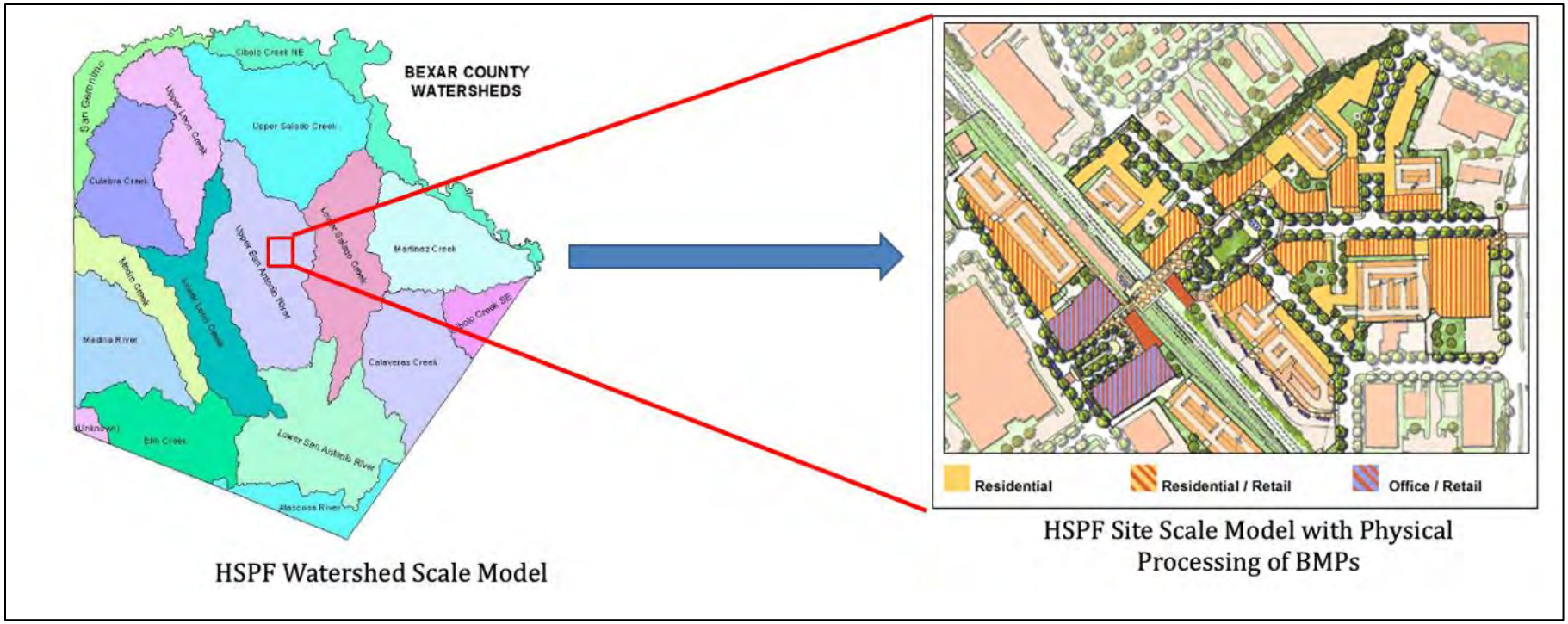

Figure 82: Concept of Watershed to Site-scale Modeling

The Upper San Antonio River Watershed GSI Master Plan will also include an evaluation of triple bottom line (TBL) benefits (social, environmental, economic) and sustainable return on investment (SROI). TBL evaluation monetizes the benefits and costs of activities in three functions: economic, social, and environmental. The TBL framework has been implemented by governments, policy makers, and economic development practitioners seeking to incorporate social and environmental benefits along with economic benefits to decision-making.

The Upper San Antonio River Watershed GSI Master Plan, completed in August 2021, can become a template for future implementation in other watersheds in the San Antonio River Basin and beyond.

San Antonio 2030 District: The River Authority joined the **San Antonio 2030 District**[25] (SA 2030 District) as a founding member in 2011. Across the nation 2030 Districts form as part of the Architecture 2030 Challenge for Planning. Initiated by property managers and owners, community organizations, and service providers, the District's goal is to ensure San Antonio is resilient, livable, and vibrant into the year 2030. To achieve these goals, members work to reduce their building's energy and water use, transportation-related carbon emissions, and in San Antonio, to reduce stormwater runoff. Business leaders work to achieve these goals through public and private partnerships that connect building owners and property

managers with local businesses, community stakeholders and governments to provide the business case for sustainability in the urban core through collaboration, shared resources, and leveraging financing. The River Authority participates in the SA 2030 District in several ways:

- The River Authority owns, operates, and benchmarks three properties within the SA 2030 District boundary;
- Assistant General Manager, Steve Graham, helped start SA 2030 and served as the board chair;
- Provide in-kind technical and other support creating a dashboard and maps, volunteering for events, and working on database management; and
- Grant support to launch the SA 2030 District.

Figure 83: 2018 San Antonio 2030 District Annual Report

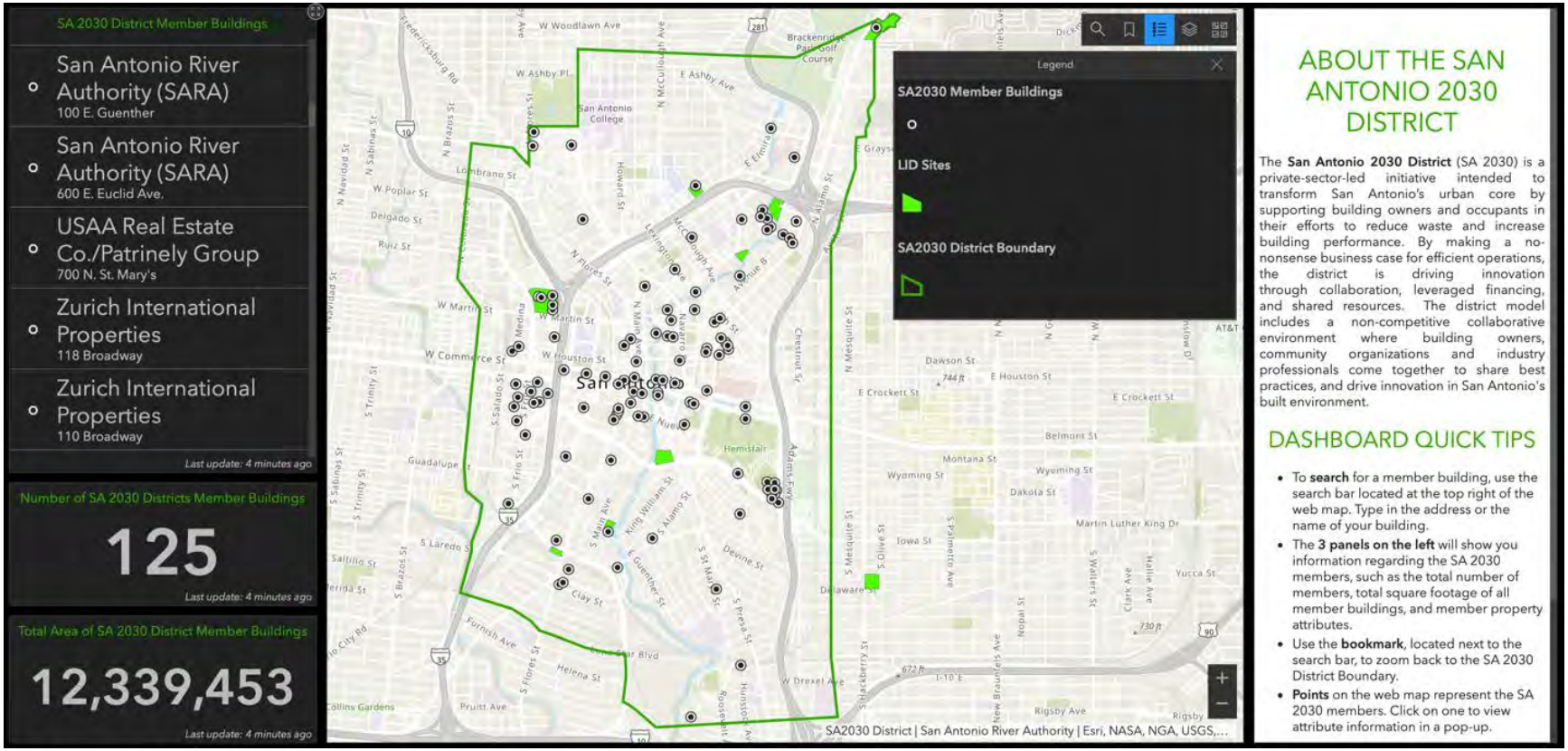

Figure 84: SA 2030 District Interactive web map, including an onsite stormwater Low Impact Development Best Management Practices layer.

Member properties to-date are capturing and treating more than six million gallons of stormwater runoff annually. Through their BMPs they are keeping pollutants like oils and grease, pesticide and herbicide, cat and dog feces, sediment, *E. coli* bacteria, natural debris, heavy metals, and trash out of our creeks and rivers; adding green space to roofs, parking lots, sidewalks and roadways, and helping cool the dense urban environment, while mitigating greenhouse gas emissions.

As a member of the SA 2030 District committee, River Authority staff work to benchmark and achieve all 2030 District goals as well as manage the stormwater runoff reduction goal's progress, education, and outreach.

Stakeholder Participation and Public Outreach Stakeholder Participation

In 2005, the San Antonio River Authority (River Authority) Board of Directors approved the creation of an Environmental Advisory Committee (EAC) to serve as an umbrella committee dedicated to understanding, identifying, and addressing the environmental strengths and weaknesses within the San Antonio River Basin. The EAC serves as a comprehensive public participation group that reviews and provides input on environmental studies and programs at the River Authority. EAC members are approved and appointed by the River Authority's Board of Directors, and each member is intended to represent a larger stakeholder interest group. EAC members are expected to share information they receive from EAC meetings with the interest groups they represent. This will include, but not be limited to, the River Reach quarterly newsletter, news releases, Be River Proud promotions, River Warrior volunteer information and public meeting and event notices. The EAC also acts as the River Authority's Clean Rivers Program (CRP) Steering Committee, providing guidance and feedback on River Authority's annual Basin Highlight and Summary Reports and Coordinated Monitoring Schedules. The advisory committee can have a maximum of 13 members, including co-chairs, but the number of members may vary from time to time. Currently, there are 12 members comprising the committee, each representing a distinct stakeholder group. The table below lists the interest groups represented on the EAC.

Stakeholder Interest Groups for the Environmental Advisory Committee	
Co- Chairs	Business & Industry
Academia	Environmental
Agriculture	Recreation
Bay & Estuary	

The River Authority CRP EAC Steering Committee receives presentations on:

- Overview of the CRP goals, objectives, and funding sources
- Water quality objectives and priorities for the San Antonio River Basin
- Annual Basin Summary/Highlights Reports and any special study reports or updates
- Work plans and allocation of resources
- Public participation and announcements of upcoming events, public outreach, and educational activities
- Identification, selection, and status of special study projects
- TCEQ Integrated Reports and Texas Surface Water Quality Standards

If you would like more information about the Clean Rivers Program, **Environmental Advisory Committee**[26],or are interested in becoming a member, please contact Jeanette Gonzalez at (210) 227-1373. If you wish to be placed on the mailing list for the River Reach Newsletter, please contact the River Authority's Government Affairs and Community Relations Technician at (210) 227-1373, toll free (866) 345-7272 or visit the River Authority's **River Reach Newsletter**[27] website.

Figure 85: Popular event, Planets in the Park, hosted NASA Astronaut, Loral O'Hara, who gave a presentation and answered questions from the audience.

The River Authority's Response to COVID-19

The COVID-19 pandemic caused all of us to dramatically alter our daily life and caused the San Antonio River Authority (River Authority) to alter its regular business operations. The River Authority has closely monitored the updates and recommendations regarding the COVID-19 virus from the Centers for Disease Control and Prevention (CDC), City of San Antonio Metro Health, Bexar County, and the State of Texas. Following CDC recommendations and guidance for social distancing, the River Authority staff began working remotely on March 17. Additionally, the River Authority cancelled in-person public and community meetings and events through the end of the calendar year and has altered some to be conducted virtually. The River Authority staff has remained very active and engaged while working remotely. Staff continues responding to calls and emails; holding meetings through tele- and video-conference technology; meeting deadlines; and processing all the regular business functions of the agency. The essential community function provided by our wastewater treatment plants also continues uninterrupted. In alignment with actions taken by local city and county officials, River Authority park trails, bathrooms and green spaces currently remain open as an outdoor resource for the community to

use while still practicing social distancing. However, River Authority park amenities such as playgrounds, basketball courts and pavilions are closed until further notice. The health, safety and well-being of our constituents and staff is of paramount importance.

Public Outreach, Education, & Events

Public outreach and educational activities are an integral part of River Authority's objective to protect, enhance and generate lasting and recognized improvements to the health and safety of our rivers, creeks, bays and estuaries. Most recently, the River Authority has launched the Be River Proud campaign to encourage public engagement with the San Antonio River. The Be River Proud initiative is integrated in outreach efforts, education themes, and in River Authority events with the goal of inspiring actions that give the audience a feeling of river pride.

Figure 86: San Antonio River Authority's Be River Proud Campaign Brand: Kayaking Event series included the first ever night paddle along the San Antonio River Museum Reach on December 19, 2020 to a crowd of 100 kayakers.

Household Hazardous Waste Collection Event

According to the Environmental Protection Agency (EPA), the average household can generate more than 20 pounds of household hazardous waste per year. Pouring household hazardous waste down the drain, into storm sewers, on the ground, or in household trash are improper disposal methods that can be harmful to the environment and our health. To reduce the amount of household hazardous waste that ends up in our creeks and rivers, the River Authority has teamed up with local partners to host semiannual Household Hazardous Waste (HHW) Collection events in Wilson, Karnes, and

Goliad Counties. Items collected include paint, motor oil and filters, cleaning products, tires without the rim, small electronic appliances, computer components, and pharmaceuticals. During the 2019/2020 fiscal year, the River Authority hosted 5 HHW events collecting 93,945 pounds of household hazardous waste, 63,808 of E-waste, and 600 pounds of pharmaceuticals. These events have gained popularity and have aided in the efforts to keep the San Antonio River safe, clean and enjoyable in the Southern Basin.

Figure 88: Semiannual Household Hazardous Waste Collection events in Wilson, Karnes, and Goliad Counties

Virtual Programming

River Camp Virtual Education Series[28] is a compilation of K-12 education resources and a result of the COVID-19 restructured public education strategy. Families are facing a new norm with their kitchen table education programs and virtual schooling. We are proud to offer families, teachers, and students a host of river-centric, interactive activities and lessons that can take place across a kitchen table, in the outdoors, and online. We are actively creating this series that aims to provide the at-home student and family avenues to connect to rivers and nature from their homes during the COVID-19 pandemic. To view all River Camp! videos, please visit the Education page on our website at sariverauthority.org.

Figure 89: The River Authority's Virtual Programming Educational Series

Other virtual programming launched on River Authority social media channels included **River Proud Rhythms**[29] and **Through the Eyes of an Artist**[30], a summer art series.

River Proud Rhythms was a compilation of recorded videos featuring musicians from the River Authority's four county jurisdiction. During these unprecedented times, the videos brought a sense of unity through music and quickly became a popular series. A few known artists that joined River Proud Rhythms included Small Town Habit, Los Texmaniacs, and Mariachi Los Galleros. The River Authority continues to engage new audiences to bring awareness and appreciation for all types of recreation on the San Antonio River. The 2020 summer art series titled, San Antonio River: Through the Eyes of an Artist did just that. This series not only reached the general public, but also the local art community in our four-county jurisdiction with time lapse videos highlighting local artists painting their inspiration along different locations of the San Antonio River. This series also brought two virtual guided painting classes which allowed the public to paint the San Antonio River from the comfort of their own home. To take part in the education and music series follow the River Authority on social media – **Facebook**, **Instagram** and **Twitter**.

Figure 20: The River Authority's River Proud Rhythms and Through the Eyes of an Artist, a summer art series.

Escondido Creek Parkway

In 2017, the Kenedy Chamber of Commerce and the 4B Community Development Corporation announced a $1.2 million dollar investment in support of the **Escondido Creek Parkway**[31] Project in Kenedy, TX. The donated funds have been utilized towards the design and development of the Escondido Creek Parkway Project which will be managed by the San Antonio River Authority (River Authority). Escondido Creek runs through the City of Kenedy and is a significant tributary in the southern basin of the San Antonio River Watershed. The Escondido Creek Parkway Project, under Hwy 181, will provide safe passage and recreational enjoyment for children and adults traveling between 5th Street, near the center of Kenedy, and Joe Gulley Park, on the west side of Kenedy. Daily, from dawn to dusk, the Escondido Creek Parkway (ECP) will provide residents with 1.5 miles of hike and bike trails, shaded playgrounds, a splash pad with 20 spray features, a skate park, two ADA public restrooms, an amphitheater and a pavilion. The county's strong historical ties will be honored with a windmill and a pump jack as well as a horned toad habitat as a nod to Kenedy's designation as the Horn Toad Capital of Texas by the State legislature. Escondido Creek Parkway will also feature a donor wall to highlight the many trees, benches, and other park features that were donated by partners throughout the development of the park.

Figure 89: Escondido Creek Parkway splash pad.

San Pedro Creek Phase II

In late Fall of 2021, the second segment of San Pedro Creek Culture Park will open to the public. This new segment from Houston Street to Nueva Street includes the soon-to-be restored Alameda Theater, the new headquarters of Texas Public Radio, the Spanish Governor's Palace historic site, and the new University of Texas at San Antonio downtown campus. Needless to say, it is a very culturally significant segment of the park! Further adding to the rich history of this area, recent construction unearthed the foundation and cornerstone of the first African Methodist Church in San Antonio, called St. James Chapel. This discovery, along with other industrial infrastructure like the Alamo Ice & Brewing Company, will provide ample inspiration for future programs and events. In addition, this segment of the park will include two new public art projects. The first is an interactive sculpture that allows the viewer to activate lights and sounds on a 250-foot water wall. The second is a faux bois and mosaic mural spanning an entire block. Both projects are currently under design and will be unveiled next year. In April, we conducted a full-scale mockup of the water wall that will become the interactive sculpture designed by artist Adam Frank. The sculpture consists of a cast bronze microphone with a live microphone inside which is linked to drivers that control the lights and will be activated when a person makes noise in close proximity. This allows the viewer to affect the light display in real time, turning the water wall into a monumental live sound visualizer. The artist was inspired by the musical and performative history of the Alameda Theater and feels his artwork, titled Stream, will be a venue for people to express themselves and provide an interactive backdrop for their own performance. Additional **San Pedro Creek Culture Park**[32] can be found on the River Authority's website.

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    - Assessment Units – TCEQ Integrated Reports 2020; San Antonio River Authority.
    - Wastewater Treatment Facilities – Environmental Protection Agency; Envirofacts
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