Texas Clean Rivers Program

San Antonio River Basin 2018 Summary Report

SAN ANTONIO RIVER AUTHORITY BOARD OF DIRECTORS

Bexar County

District 1
Jerry G. Gonzales

District 2
Lourdes Galvan

District 3
Michael W. Lackey, P.E.

District 4
Jim Campbell

At-Large
Hector R. Morales
Deb Bolner Prost

Wilson County
John J. Flieller
Darrell T. Brownlow, Ph.D.

Karnes County
H.B. Ruckman, III
Gaylon J. Oehlke

Goliad County
James Fuller
Alicia Lott Cowley

ACKNOWLEDGEMENTS:

The San Antonio River Authority (SARA) would like to acknowledge the time and effort the Environmental Advisory Committee (EAC) spent contributing, reviewing and commenting on the 2018 Basin Summary Report.

ENVIRONMENTAL ADVISORY COMMITTEE

CO-CHAIRS
Dr. Richard Reed
Maggie Hunt

ACADEMIA
Dr. Deepti Kharod

AGRICULTURE
Claire Barnhart Korth

BAY & ESTUARY
James Dodson

BUSINESS & INDUSTRY
Ginger Coleman
Truett L. Hunt
Scott Courtney

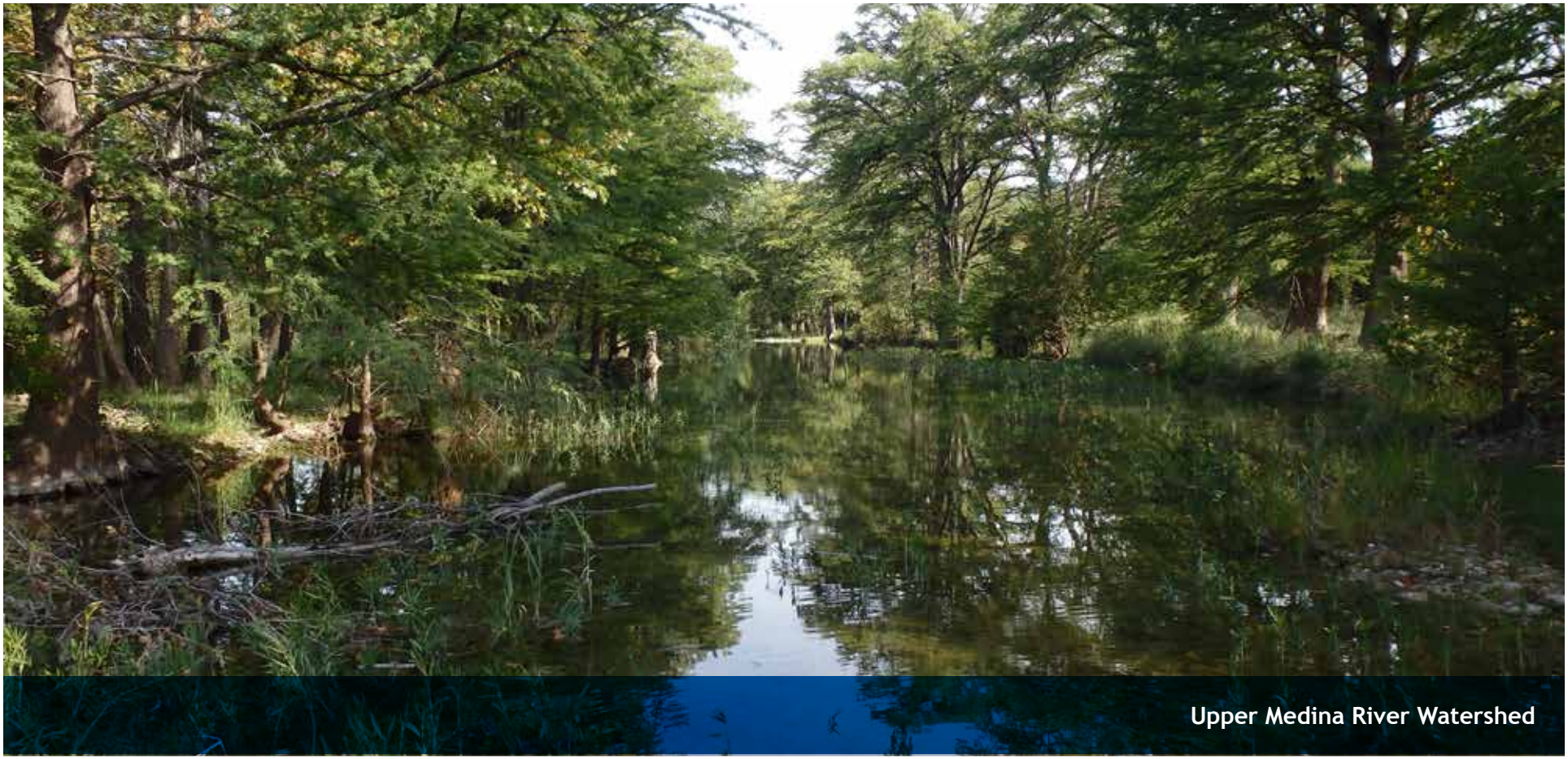
ENVIRONMENTAL
Annalisa Peace
Jason Katcmorak
Donald Ewers
David Reichert

PARKS/RECREATION
Wilfred Korth

The preparation of this report was financed through grants from and in cooperation with the Texas Commission on Environmental Quality.

COVER PICTURE: *From left to right, Clint Robertson and Travis Tidwell (Texas Parks and Wildlife Department), Chris Vaughn (San Antonio River Authority) and Gary Pandolfi (U.S. Fish & Wildlife Service). Joint mussel relocation effort of 385 native freshwater mussels near Goliad, TX in response to an environmental concern. Species included Golden Orb, Yellow Sandshell, Washboard, Threeridge, Pistolgrip and Rock Pocketbook.*

2018 San Antonio River Basin Summary Report
Executive Summary



Upper Medina River Watershed

Activities, Accomplishments and Highlights

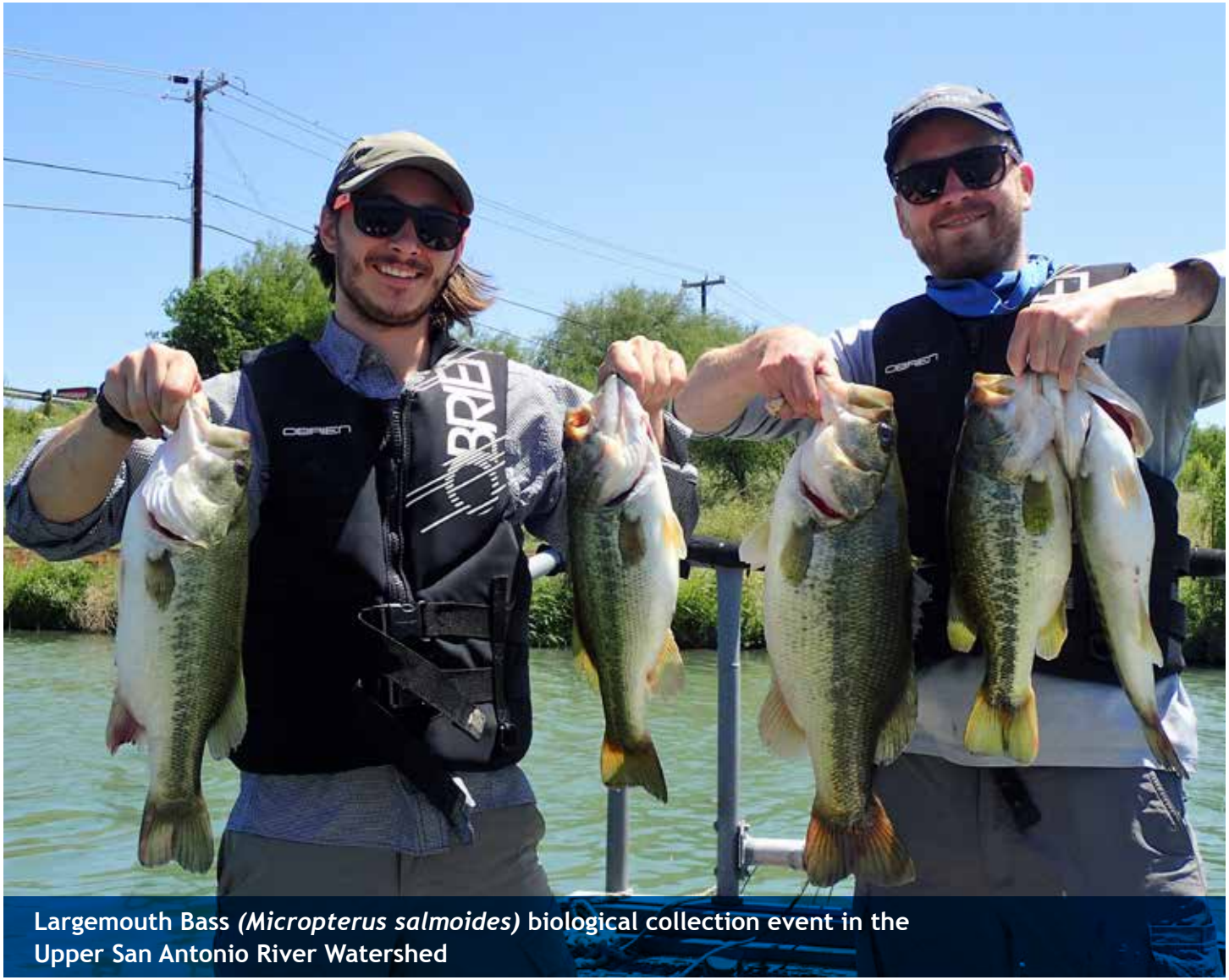
Information in the 2018 San Antonio River Basin Summary Report serves to develop a greater understanding of water quality conditions, identify significant trends, changes, and aid in making water quality decisions for each subwatershed in the San Antonio River Basin. This summary report describes water quality impairments and concerns in the basin as identified in the Texas Commission on Environmental Quality (TCEQ) 2014 Texas Integrated Report (IR) for Clean Water Act Sections 305(b) and 303(d). The San Antonio River Authority (SARA) Environmental Sciences Department administers the Texas Clean Rivers Program (CRP) through the collection and monitoring of surface water quality data within the San Antonio River Basin. As data from the CRP is used in surface water

compliance decisions and TCEQ biannual IR assessments, SARA operates under a TCEQ-approved CRP Quality Assurance Project Plan (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. The CRP QAPP can be viewed at https://www.sara-tx.org/environmental-science/clean-rivers-program/. Monitoring efforts in the San Antonio River Basin are provided by SARA, the TCEQ, and the Bandera River Authority and Ground Water District (BCRAGD). This summary report is a requirement of the CRP and was prepared by SARA staff in cooperation with the TCEQ and in accordance with the State's guidelines. A basin summary report is completed once every five years. SARA CRP Highlights and Summary Reports can be seen at SARA's website https://www.sara-tx.org/environmental-science/clean-rivers-program/.

With the high expense associated with collecting water quality data and limited funding, the importance of leveraging funds and maximizing regional efforts while minimizing duplicative efforts is paramount. To remain adaptable to economic and environmental changes, each year SARA conducts a **coordinated monitoring meeting** (CMM) with the TCEQ and other basin monitoring partners. During the CMM, resources are coordinated at the watershed level to provide spatial and temporal distribution of monitoring efforts to identify changes in the basin, identify water quality trends and to provide quality assured data to the TCEQ. For the 2018 monitoring year (September 1, 2017-August 31, 2018), there are 105 active routine and systematic water quality monitoring stations in the 13 subwatersheds of the San Antonio River Basin.

Texas Logperch *(Percina carbonaria)*

In early 2012, the **BCRAGD** expressed a desire to participate in the 2013 CRP monitoring activities within Bandera County. In a collaborative effort to maintain and improve the water quality, SARA and BCRAGD entered into an Interlocal Agreement (ILA) to monitor six water quality stations in the Upper Medina River Watershed. For the 2017 monitoring year, BCRAGD continued to expand their monitoring activities to include monitoring stations in Medina Lake and the Medina Diversion Lake Watersheds. As a result of this continued expansion, in 2018 BCRAGD will collect water quality samples at a total of 14 water quality stations in the Upper Medina, Medina Lake, and Medina Diversion Lake Watersheds. The ILA between SARA and the BCRAGD allows them to be a sub-participant under SARA's CRP QAPP and collect water quality samples in Upper Medina River, Medina Lake, and the Medina Diversion Lake Watersheds. Collected samples are submitted to SARA's Environmental Sciences NELAC-Accredited Laboratory for analysis.



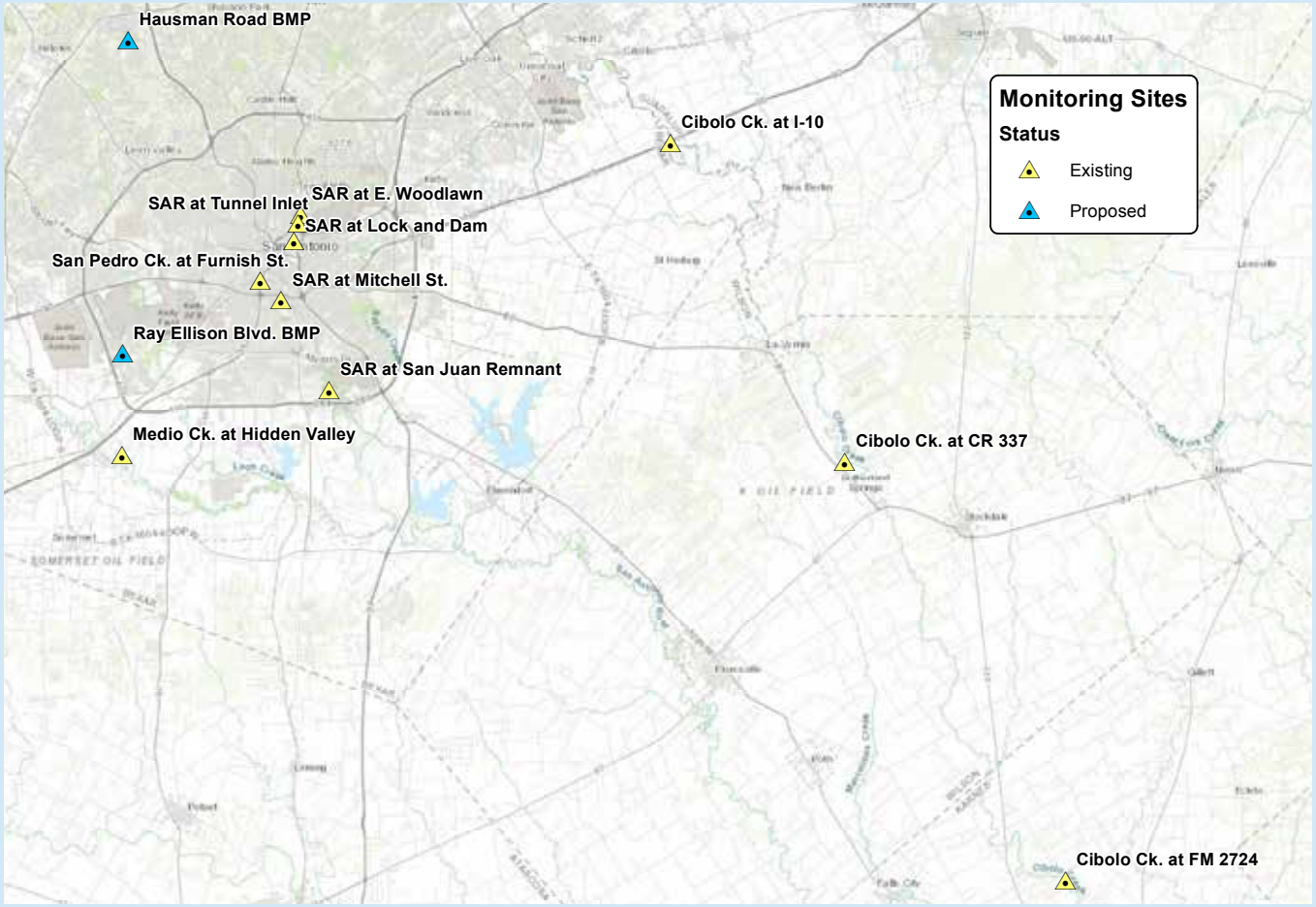
Largemouth Bass *(Micropterus salmoides)* biological collection event in the Upper San Antonio River Watershed

In addition to the CRP monitoring, SARA also conducts water quality monitoring in support of the Upper San Antonio River Watershed Protection Plan, the Implementation Plan for Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio River Watershed, and the Implementation Plan for Five Total Maximum Daily Loads for Bacteria in the Lower San Antonio River Watershed. The goal of these TCEQ water quality stakeholder driven projects are to reduce *E. coli* bacteria levels so that the Upper and Lower San Antonio River Watersheds are in compliance with the primary contact recreational use designation as stated in the Texas State Water Quality Standards (TSWQS). The primary contact criterion for all waterbodies in the San Antonio River Basin is a geometric mean of less than or equal to 126 *E. coli* colonies/100mL (≤126 *E. coli* /100mL).

As SARA is committed to innovative, collaborative, adaptive and strategic actions that result in watershed solutions, SARA has established a permanent **long-term network of automated instream stormwater stations** to help characterize stormwater runoff and determine its effect on bacterial impaired waterbodies. During storm events, *E.coli* and other contaminants concentrate and mobilize to nearby waterways overland or via stormwater infrastructure and can have negative effects on human health and aquatic ecosystems. Use of automated instream samplers enables the collection of water quality data from urban and rural waterbodies throughout the San Antonio River Watershed. The automated feature makes stormwater collection safer for field staff, more economically feasible and minimizes exposure to hazardous weather conditions. These stations capture water quality data prior to, during and after storm events.

Depending on the station, water quality samples, flow and/or field measurement are collected. Stormwater monitoring sites in the San Antonio River Basin include:

- Station 14256 San Antonio River at Mitchell Street
- Station 12908 San Antonio River at Woodlawn Avenue
- Station 12707 San Pedro Creek at Furnish Street
- Station 12806 Cibolo Creek at CR 337 Southeast of La Vernia
- Station 12919 Cibolo Creek at IH 10/US90 East Bank
- Station 20777 Cibolo Creek at FM 2724 Northeast of Panna Maria
- Station 12916 Medio Creek at Hidden Valley Campground
- Proposed SARA Stormwater BMP Stations at Hausman Road and Ray Ellison Boulevard
- Field measurement stations: San Antonio River at the tunnel inlet, San Antonio River at the Lock and Dam on the River Walk, and the San Antonio River at the San Juan Remnant



SARA Stormwater and BMP Monitoring Stations

EAC Meeting in Floresville, Texas

The **Environmental Advisory Committee (EAC)** is a comprehensive public participation group that advises SARA's departments about environmental issues within the basin. The EAC also acts as SARA's CRP Steering Committee and provides guidance and feedback on SARA's annual coordinated monitoring schedules and basin reports. To ensure different interests, concerns and priorities of each watershed are addressed, EAC membership includes volunteers from across the San Antonio Basin, representation includes academia, agriculture, bay and estuary, business and industry, the counties, environmental minded individuals or agencies, the public, and parks and recreation.

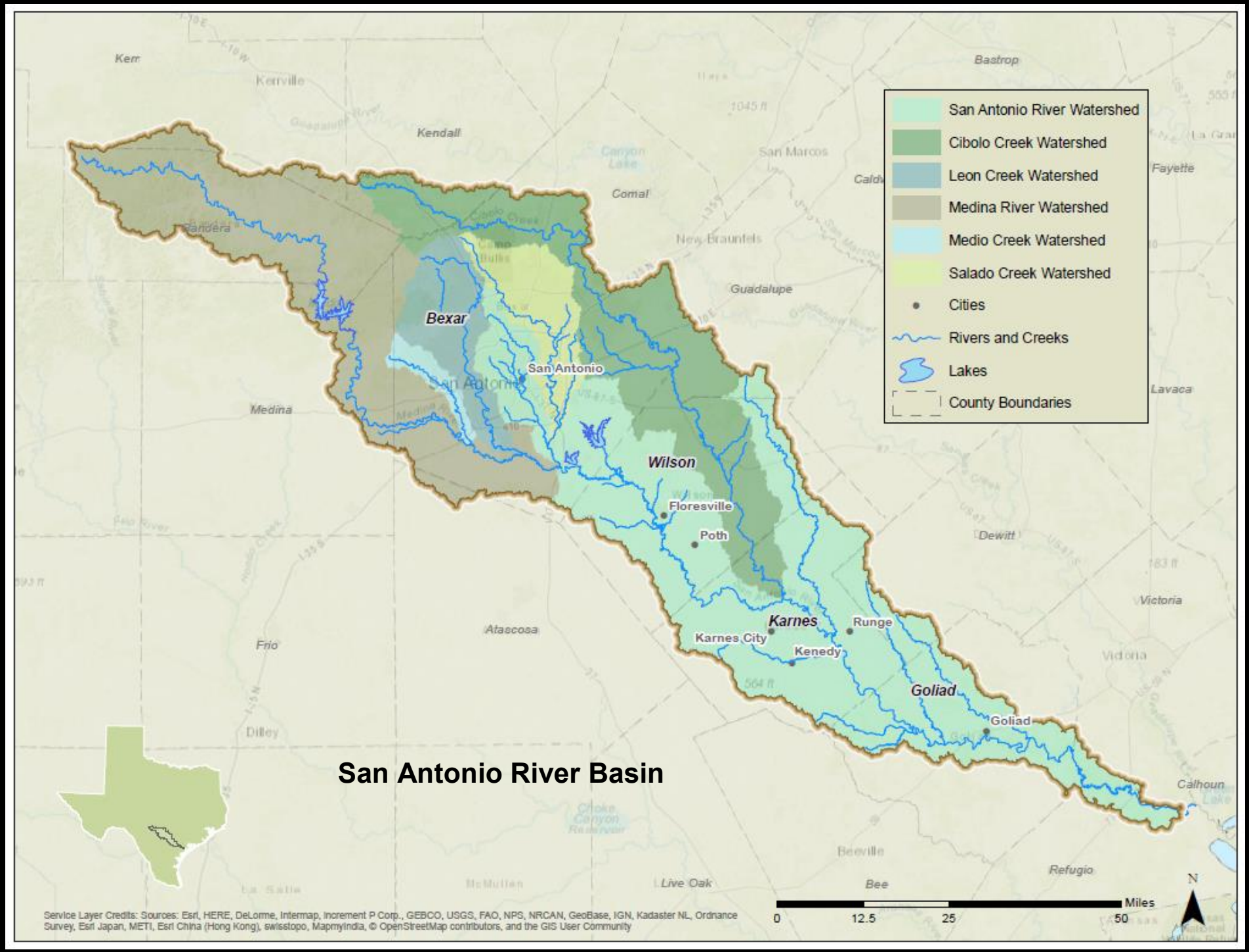
As part of SARA's Mission to protect waterbodies in the San Antonio River Basin, SARA has met with partnering agencies to discuss and implement measures design to reduce the accidental transfer of Zebra Mussels in the basin. As part of the effort, SARA and the BCRAGD have placed signage in the Upper San Antonio River Mission Reach and Upper Medina and Medina Lake Watersheds.

To assist the Texas Parks and Wildlife Department (TPWD) in monitoring Zebra Mussels, SARA biologists, together with BCRAGD and GBRA staff, have trained with TPWD staff on various Zebra Mussel sample procedures, including collection of water samples to be tested for the presence of Zebra Mussel DNA. For additional information, visit the TPWD website at https://tpwd.texas.gov/fishboat/boat/protect_water/, and the Texas Invasive website at https://www.texasinvasives.org/animal_database/detail.php?symbol=10.

Zebra Mussel *(Dreissena polymorpha)*

As SARA is committed to innovative, collaborative, adaptive and strategic actions that result in watershed solutions, SARA is leading activities within the San Antonio River Basin to promote sustainable land use. SARA's multipronged approach will work to preserve natural watershed functions that manage the quality and quantity of stormwater runoff through a balance of economic, environmental, and quality of life considerations. Several efforts and programs included in SARA's multipronged approach include: SARA's long-term network of automated instream stormwater monitoring stations, Low Impact Development (LID) Best Management Practice (BMP) Verification Project, SARA's Watershed Wise Grant Program, SARA's Watershed Wise Rebate Program and the SARA and Bexar County developed LID Training Courses for the construction, inspection and maintenance of LIDs permanent stormwater BMPs. Additional information can be found in SARA's LID Technical Guidance Manual located at https://www.sara-tx.org/wp-content/uploads/2015/05/Full-LID-Manual.pdf

Cistern at MacArthur High School



San Antonio River Basin

Significant Findings in the San Antonio River Basin

Water quality information included in this summary report was derived from two methods: comparison of water quality in the San Antonio River Basin to the Texas Surface Water Quality Standards (TSWQS) using the 2014 IR, and trend analysis performed by SARA staff. Information in the 2014 IR represents a seven to 10 year snapshot of the levels of bacteria, nutrients, aquatic life use, and other parameters at more than 190 sites throughout six watersheds in the basin. Trend analysis for selected stations used a 10 year data set containing at least 20 values, trending period covers June 1, 2006 through May 31, 2016.

Guidance developed by the U.S. Environmental Protection Agency (EPA) directs each state to document and submit the results of its water quality assessment to the EPA biennially, in even-numbered years. The Executive Summary Impairment and Concerns by Segment ES2 Table, at the end of the executive summary, represents a big-picture view of the most recent assessment of the San Antonio River Watershed, completed in 2014. The draft 2016 IR is under TCEQ review. An in-depth summary by assessment unit for each watershed in the San Antonio River Basin can be found within this summary report's individual watershed summary sections. There were 13 classified (main-stem) and 20 unclassified stream segments (tributaries) assessed in the 2014 IR. A total of 15 impairments were identified in the classified stream segments and a total of 13 impairments were identified in the unclassified stream segments of the San Antonio River Basin. Impairments include elevated bacteria levels, depressed dissolved oxygen (DO), elevated chloride, fish consumption restrictions, and impaired fish and benthic macroinvertebrate communities.

American Eel *(Anguilla rostrata)* Station 16731 San Antonio River above the Medina River Confluence

Recreational Use Designation - Bacteria

Of the 33 classified and unclassified segments assessed in the 2014 IR, 57.14% of all impairments were related to bacteria concentrations above the primary contact geometric mean criterion of ≤126 *E. coli* /100mL. Portions of the San Antonio River, Cibolo Creek, Medina River, and Salado Creek Watersheds are not meeting the primary contact recreation standard due to elevated levels of *E. coli*. Primary contact recreation includes activities that are presumed to involve a significant risk of ingestion of water (e.g., wading by children, swimming, water skiing, diving, tubing, surfing, and the whitewater activities such as kayaking, canoeing, and rafting).

The **Upper San Antonio River** and **Salado Creek** were first identified as impaired due to bacteria in the 2000 Texas Water Quality Inventory and 303(d) List (TCEQ 2000). **Walzem Creek** was added to the list in 2002. In response to the listings, the TCEQ developed several Total Maximum Daily Loads (TMDL) to establish the bacteria loading reductions necessary to bring the Upper San Antonio River, Salado Creek, and Walzem Creek into compliance with the TSWQS. The TCEQ adopted the **Three Total Maximum Daily Loads for Bacteria in the San Antonio Area** on July 25, 2007, and the EPA approved the TMDLs on September 25, 2007, at which time they became part of the State's Water Quality Management Plan.

Addendum One to the Three Total Maximum Daily Loads for the Upper San Antonio Watershed; Seven Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watershed: In April 2016, the TCEQ adopted an addendum to the Three TMDL for bacteria in the San Antonio Area and the EPA approved the addendum on August 9, 2016. The addendum can be viewed at the TCEQ's website located at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-usar_addendum_2016-04.pdf. The addendum included new bacteria information on seven additional assessment units in Menger Creek, Apache Creek, Alazan Creek, San Pedro Creek, and Sixmile Creek. As part of the project, with support from the TCEQ and the Texas A&M AgriLife Research, a stakeholder committee called the San Antonio Bacteria TMDL Advisory Group was created to develop a plan to implement the TMDLs with management measures needed to reduce bacteria, as well as a timeline for implementation.

ARA, in cooperation with local partners and the TCEQ, completed the **Upper San Antonio River Watershed Protection Plan (USAR WPP)** for the urban portion of the Upper San Antonio River above Loop 410, in December 2006. The USAR WPP was updated in 2014 and called for a 30% reduction in bacteria loading from stormwater across the watershed. The USAR WPP included water quality monitoring and recommendations for bacteria control measures to determine stormwater bacteria loads, as well as nutrient and sediment loads for subwatersheds in the Upper San Antonio River. Alazan Creek, Apache Creek, Martinez Creek, and San Pedro Creek subwatersheds were monitored as part of the USAR WPP. The USAR WPP was approved by the EPA on February 18, 2015, making the state eligible for CWA Section 319(h) funding for projects addressing nonpoint source pollution within the Upper San Antonio River Watershed. In 2013, Texas A&M AgriLife Research began working with communities, interest groups, and local organizations to involve stakeholders with the development of an **Upper San Antonio River I-Plan** that included measures for reducing pollution and a timeline for implementation. The Implementation Plan was submitted to TCEQ in the spring of 2015 and received final approval April 6, 2016.

The Lower San Antonio River was first identified as impaired for recreational use in 2000. In response to the listing, the TCEQ developed the **Lower San Antonio River Bacteria TMDL (LSAR TMDL)** to determine the amount, or loading, of a pollutant the San Antonio River could receive and still support its designated uses. The allowable load was then allocated among categories of sources within the watershed. Possible sources of contamination included discharges from wastewater treatment facilities, urban and non-urban stormwater runoff, deposition from wildlife, pets and livestock, leaking sewer infrastructure, and failing septic systems. The TCEQ adopted the LSAR TMDL on August 20, 2008, and the EPA approved it on October 20, 2008. The project continued in 2016 through the development of a stakeholder driven **Implementation Plan for Five Total Maximum Daily Loads for Bacteria in the Lower San Antonio River Watershed Segment 1901**. The LSAR I-Plan's goal is to identify measures needed to reduce pollution, including a timeline for implementation. The TCEQ TMDL Program contracted with Texas A&M AgriLife Research to work with stakeholders to develop the LSAR I-Plan.

Raccoon *(Procyon lotor)* Dinner Time

Bullhead Minnow *(Pimephales vigilax)* Pre-Dorsal Scales

In February 2015, the TCEQ, the City of Boerne, and SARA conducted a field reconnaissance at Station 12857 Cibolo Creek at IH10 to determine if the station accurately depicted the ecological health of the creek. As a result of the reconnaissance, it was determined the bacteria impairment and habitat concern were potentially related to the limited habitat and proximity of Station 12857 to IH10. In 2016, SARA, the City of Boerne, and the TCEQ initiated the **Upper Cibolo Creek Aquatic Life Monitoring** effort to test the hypothesis. The effort included several biological and routine monitoring events at Station 20821 Cibolo Creek just downstream of Northrup Park.

Although the results of the Upper Cibolo Creek Aquatic Life Monitoring effort resulted in the removal of the habitat concern, the bacteria impairment remained. To delist the bacteria impairment in the Upper Cibolo Creek, routine monitoring must be maintained at Station 12857 Cibolo Creek at IH10, in addition to Station 20821 Cibolo Creek just downstream of Northrup Park until sufficient acceptable bacterial results are obtained. No further biological monitoring is scheduled in the Upper Cibolo Creek Watershed.

In 2017, the **Mid and Lower Cibolo Creek Watershed Protection Plan** 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), 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 BMPs to ensure the bacterial and DO impairments identified in the 2014 IR, are addressed in the development of the WPP. The WPP will include 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* and other pollutant(s) loading within the watershed and act as a base of information for planning purposes.

Aquatic Life Use Designation - Dissolved Oxygen, Habitat, Fish, Benthic Macroinvertebrate, and Metals in Sediment

Guadalupe Bass *(Micropterus treculii)*

The TSWQS assigns each classified waterbody in the San Antonio River Basin an aquatic-life use (ALU) designation of exceptional, high, intermediate, limited or minimal. This designation is based on the unique physical, chemical and biological characteristics of that waterbody. To protect these ALU designations, DO criteria, habitat, fish and benthic macroinvertebrate communities are evaluated independently and an impairment or concern is identified when any one of the criterion is not attained. According to the Guidance for Assessing and Reporting Surface Water Quality in Texas (June-2014), when the habitat index indicates nonsupport, the habitat attainment status is reported as a concern. Of the waterbodies assessed in the 2014 IR, 21.43% of all impairments are related to depressed levels of DO, including portions of the Lower Leon Creek, Salado Creek, and Mid Cibolo Creek. Impaired unclassified segments include Clifton Branch, Menger Creek, and Picosa Creek. In addition, 10.72% of all impairments are related to impaired fish communities, including portions of the Upper and Lower San Antonio River and Upper Medina River. Impaired benthic macroinvertebrate communities account for 3.57% of all impairments and only exist in the Salado Creek Watershed. Habitat concerns have been identified in the Upper and Lower San Antonio River, the Medina River above Medina Lake, and the Upper Cibolo Creek.

The 2006 TCEQ Water Quality Inventory and 303(d) List identified Salado Creek as impaired due to depressed DO levels in the upper six of the eight assessment units. In response to the impairment, the TCEQ conducted a **Salado Creek Use Attainability Analysis (UAA).** The UAA was adopted by the TCEQ on June 30, 2010, and the EPA approved it on August 9, 2010. Information in the UAA indicated the upper and middle portions of Salado Creek could not support the high aquatic life use designation due to natural, ephemeral, intermittent low flow conditions. As a result of the UAA, in 2010, the TCEQ revised Salado Creek from eight to seven assessment units, and in 2014 from seven to four assessment units. Until sufficient 24-hour DO data is obtained, Salado Creek will remain on the TCEQ 303(d) List for depressed levels of DO. Due to the assessment unit revisions there was limited benthic macroinvertebrate data to assess in the 2014 IR. As a result, the benthic macroinvertebrate impairment was carried forward from the 2012 IR. To address this issue, SARA continues to collect benthic macroinvertebrate data at Station 14929 Salado Creek at Comanche Park for future TCEQ IRs.

The **Lower Leon Creek Use Attainability Analysis** (LLC UAA) was initiated in April 2014 to evaluate the appropriate aquatic life use and DO criteria for the Lower Leon Creek. Historical TMDL data indicated portions of the creek met neither the 24-hour DO average criterion (5.0 mg/L) nor the minimum criterion (3.0 mg/L) presumed for perennial streams. The TMDL also concluded a site-specific standards change may be appropriate. Conventional parameters, 24-hour DO, flow, habitat, and biological data were collected in support of the project. The report findings indicated the upper most assessment unit, 1906_06, did not meet the high aquatic life use designated for perennial waterbodies. The TCEQ LLC UAA project was conducted under a TCEQ contract with the final report

submitted to the TCEQ on March 2, 2017. When the final report was submitted, the TSWQS revision packet moved into management review within the TCEQ and no additional changes could be made. The final report is currently being reviewed for inclusion in the next triennial TSWQS revision scheduled for 2021.

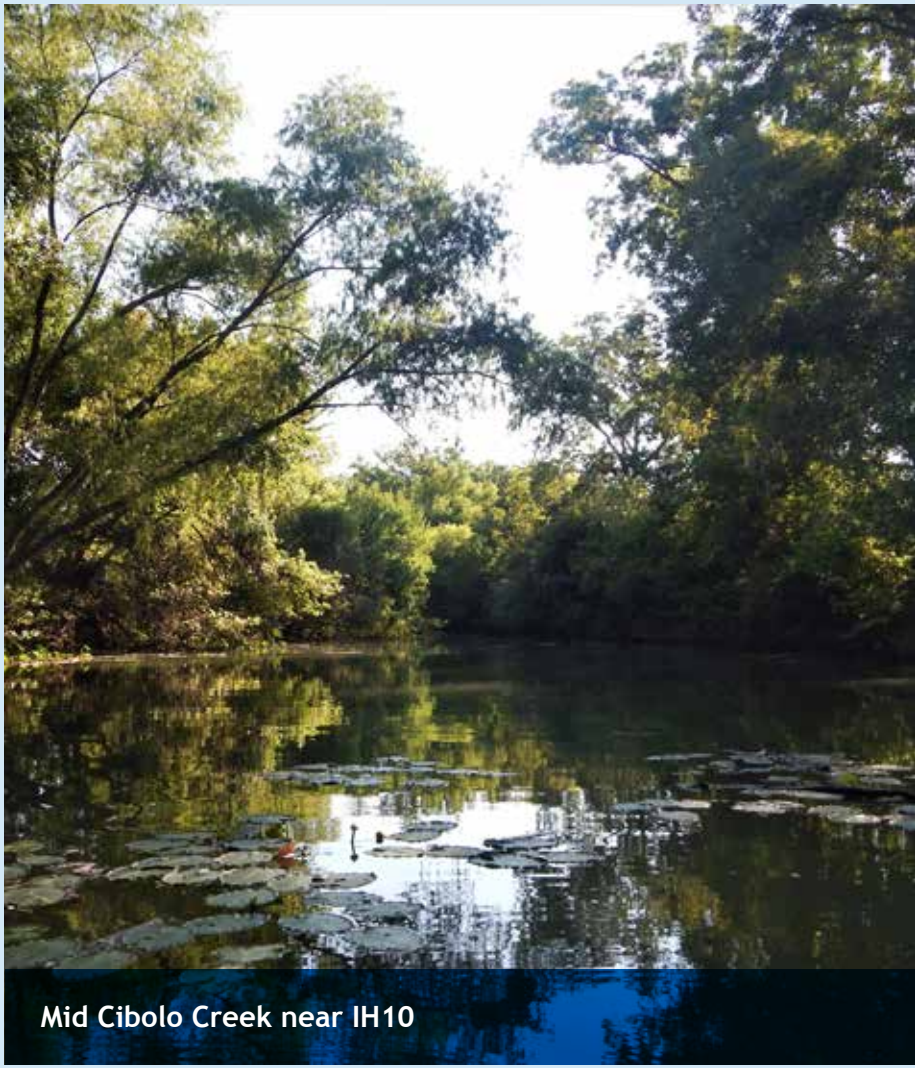
Redspotted Sunfish *(Lepomis miniatus)*

In 2015, SARA, 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 with a corresponding 24-hour DO average criterion of 5.0 mg/L and minimum criterion of 3.0 mg/L. Data also supported an intermittent with pools flow designation for the Mid Cibolo Creek with 24-hour average criterion of 3.0 mg/L and a minimum criterion 2.0 mg/L. 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 Standards was sent to the EPA Region 6 for approval. As of this report, no EPA actions or approval has been received by the TCEQ. The revisions cannot be used for federal actions, which includes permitting and the IRs, until EPA approves the revisions.

Due to the construction associated with the **San Antonio River Improvements Project (SARIP**), there was no biological monitoring conducted in assessment units 1911_09 and 1911_08 between 2006 and 2013. As a result, the 2014 IR carried forward the fish impairments and habitat concerns from the 2012 IR. In 2014, one year after the completion of the SARIP, biological monitoring stations in these assessments units were reestablished. Preliminary 2015-2017 fish and habitat data indicate slight improvement in 1911_09 and slight decline in 1911_08. As the SARIP completely transformed thirteen miles of the San Antonio River from Hildebrand Avenue south to Loop 410 South it will take many years for the riparian habitat and riparian woodland habitat to fully mature. As part of the SARIP Mission Reach Restoration efforts, approximately 113 acres of aquatic habitat and 334 acres of riparian woodland habitat was restored. Much of the landscape is still in its infancy. It will take approximately 50 years for the entire ecosystem restoration process to be completed. Over time, it is anticipated the restoration efforts associated with the SARIP will help address the aquatic life impairments and concerns identified in the reaches of Upper San Antonio River.

The fish impairment in the Lower San Antonio River, assessment unit 1901_02 is most likely due to a lack of habitat types within the sample area as reflected by the habitat concern. Given the expanse of the Lower San Antonio River and the limited access points, obtaining a representative sample has proven to be difficult because of the scale and distribution of habitat types within the watershed. To address this issue, beginning in 2014, Station 12791 San Antonio River at US 77A in Goliad was replaced with Station 12792 San Antonio River at Southern Pacific Rail Road Bridge in Goliad. Although there is limited data available for the Southern Pacific Rail Road Bridge station, preliminary fish and habitat scores are showing slight improvement.

During the initial stakeholder review of the Draft 2014 IR, SARA biologists met with BCRAGD staff to discuss the fish community impairment and habitat concern in the Upper Medina River Watershed. After several discussions with the TCEQ, the 2015 **Upper Medina River Aquatic Life Monitoring (ALM)** effort was initiated to determine if the Upper Medina River could support the exceptional aquatic life use designation as stated in the TSWQS. With support from SARA, BCRAGD, TCEQ, and the Texas Parks and Wildlife Department, there were several ALM sampling events conducted at the existing biological Station 12830 at Old English Crossing, where the impairment was originally determined in 2012, and at Station 21631 at the Mayan Ranch. The results of the effort determined the fish community impairment and a habitat concern can be attributed to a site specific limitation at Old English Crossing, bedrock substrate and limited in-stream habitat, rather than to pollution. In 2016, as a result of the ALM effort, all biological sampling was moved to Station 21631 Medina River at the north side of Mayan Ranch. Although preliminary fish IBI scores meet the exceptional ALU designation, the Habitat Quality Index (HQI) score may never attain the exceptional ALU designation due to the lack of instream and riparian habitat caused by natural scouring during high flow events.


Mid Cibolo Creek near IH10

Fish Consumption Use Designation – Toxic Substance in Fish Tissue

Approximately 3.57% of all impairments in the San Antonio River Basin are related to the impaired fish consumption use designation. As a result of polychlorinated biphenyl (PCB) in fish tissue, the Texas Department of State Health Services (DSHS) issued two fish consumption advisories for the Lower Leon Creek. The initial TDSHS advisory was issued on August 27, 2003 and the second advisory was issued on June 28, 2010. These advisories indicated that people should not consume any species of fish

from portions of the Lower Leon Creek starting at the Old US 90 bridge downstream to the Loop 410 bridge. Per the DSHS, PCBs are synthetic man-made mixtures of up to 209 individual chlorinated compounds know as congeners. PCBs were used in many commercial applications and can accumulate in fatty tissue, skin and internal organs of fish and other animals. Since 2010, there has been little to no supplemental testing to determine current levels of PCBs in fish tissue. A concern for silver in sediment is also listed in the 2014 IR as a concern.

Lower Leon Creek Watershed

General Use Designation - Chloride

Water quality criteria for several parameters are established in the TSWQS to safeguard general water quality, rather than for the protection of any one specific designated use. Chloride is one of the major inorganic ions in water and plays an important role in the protection of aquatic life, recreation, public water supply and other beneficial uses of water resources. Although chloride is necessary for biological processes, elevated levels of chloride may alter reproduction rates of freshwater organisms and plants. The average chloride concentration is used to determine compliance for the entire segment when compared to the criteria as stated in the TSWQS. The chloride impairment in the Upper Cibolo Creek represents approximately 3.57% of the total impairments in the San Antonio River Basin and is most likely due to an increase in water resource demands, drought, and ambient low flow conditions experienced in the watershed coupled with an accumulation of dissolved solids discarded from the wastewater treatment plants. The 2014 IR identifies this impairment as being in the 5c category. Category 5c indicates additional data or information will be collected and/or evaluated before a management strategy is selected.

Screening Concerns for Nutrients – Ammonia, Nitrate, Total Phosphorus and Chlorophyll-*a*

The TCEQ adopted site-specific numerical nutrient criteria for chlorophyll-*a* for 75 reservoirs in June 2010 and the EPA approved select numerical chlorophyll-*a* criteria for reservoirs in July 2013. Also in June 2010, the TCEQ completed new procedures to evaluate and control potential nutrient impacts from proposed wastewater discharge permits. Information for the new procedures can be found on the TCEQ's website located at https://www.tceq.texas.gov/waterquality/standards/WQ_stds. For all other waterbodies assessed in the San Antonio River Basin, the TSWQS includes numerical screening levels for phosphorus, nitrate nitrogen, ammonia nitrogen, and chlorophyll-*a*. For the purposes of this report, these parameters as a group will be referred to as nutrients. Additional information on the TCEQ's efforts to develop nutrient criteria can be found on their website located at https://www.tceq.texas.gov/waterquality/standards/WQ_standards_nutrient_criteria.html. Sources for elevated nutrient levels include municipal and industrial wastewater discharges, stormwater runoff, agricultural and urban application of fertilizers, and other natural and man-made sources. Nutrient concerns have been identified in the Upper and Lower San Antonio River, Lower Medina River, Upper

Cibolo Creek, Mid Cibolo Creek, Lower Cibolo Creek, Upper Medina River, Lower Medina River, Lower Leon Creek, Salado Creek, and Medio Creek Watersheds. In support of TCEQ efforts to develop nutrient criteria, SARA and partners will continue with efforts to collect nutrient information for all waterbodies in the San Antonio River Basin.

Trends in the San Antonio River Basin

Trending is an important component of water quality monitoring and environmental decision making. Trending in this report is accomplished by statistically analyzing water quality data and graphically illustrating parameter concentrations as they relate to time and to flow. Because aquatic communities are directly influenced by the transport and concentration of point source and nonpoint source pollutants, instantaneous flow measurements are collected during routine monitoring events.

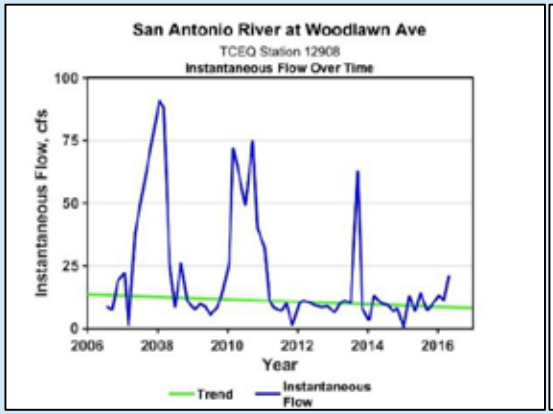
The extended drought coupled with disastrous and severe storm events throughout the trending period may have exacerbated existing --water quality impairments and concerns. In general, depending on the specific pollutant, drought and low flow conditions concentrate pollutants, while high flows typically decrease pollutant concentrations. Although not a pollutant itself, low DO levels are experienced during low flow and are normally the result of high levels of chemical and biological demanding pollutants, especially during the hotter periods of the year. High levels of demanding pollutants are pollutants or biological processes that use up/consume dissolved oxygen in waterbodies. Low DO levels adversely affect the aesthetics and biological communities of a waterbody. On the flip side, increased flows often increase DO levels and decrease chemical concentrations, but may increase pollutants such as *E. coli* and nutrients from nonpoint sources. High flows as a result of violent stormwater events can also scour stream beds and remove vital aquatic and riparian habitat. To have a lasting positive impact on water quality, flow must be maintained over an extended period of time.

Data for selected stations throughout the San Antonio River Basin was retrieved from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS). Trend analyses required the data to include a minimum of 20 samples over a 10 year period, June 1, 2006 to May 31, 2016. Additional requirements are that the data show minimal continuity disruption, and be monitored over the majority of the trending period. Significant trends ($p<0.10$) were identified as either decreasing "↓" or increasing "↑". With the exception of flows, decreasing parameter trends are generally beneficial and increasing trends are detrimental to water quality. Surface water flow magnitude, timing, duration and frequency plays a critical role in supporting the ecological integrity of streams and rivers. At certain times of the year, increasing or decreasing flows maybe beneficial or detrimental to aquatic life cycles and riparian habitat. The flow over time graphs strictly addresses quantity of water over time. Decreasing flow trends are identified as "↓" or increasing "↑". Surface water pH criterion is expressed as a range of 6.5-9.0 Standard Units (S.U.), as a result pH trends were not color coded. It should be noted that all identified pH trends are within the 6.5-9.0 S.U. criteria. Increasing DO deficit values or significant increasing trends indicate greater oxygen demanding pollutants or biological demands (e.g. aquatic plants or fish) in a waterbody. Therefore, as DO deficit values increase, the concentration of dissolved oxygen decreases. Increasing DO deficit values indicates less available dissolved oxygen and can have a negative effect on water quality. Statistically significant increasing DO Deficit values are represented by "↑" in the table below. Although ammonia was originally included in trend analysis for all stations, the majority of ammonia data was excluded from trend analysis because >50% of the ammonia measurements were below the limit of quantification and could not be reported with a high degree of confidence. Only one station contained sufficient ammonia to be trended; this is good news, as high nutrients would be an undesirable trend. Upper Leon Creek did not possess sufficient data for trending for any parameter. Significant trends at selected stations throughout the San Antonio River Basin can be seen in Table ES1.

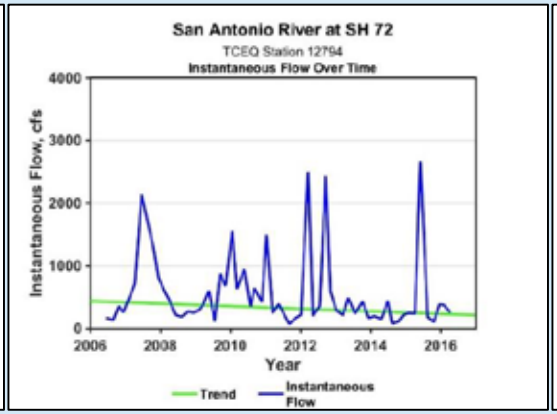
Table ES1: Significant Trends in the San Antonio River Basin

Watershed	AU	Abbreviated Descriptions	Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	*E. coli*	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-*a*
Upper San Antonio River	1911_01	Station 12879 San Antonio River at FM 791 Southwest of Falls City				↓		↑	↑			↑				
	1911_08	Station 17066 San Antonio River downstream of the SAR and San Pedro Creek Confluence				↑				↑					↑	
	1911_09	Station 12908 San Antonio River at Woodlawn	↓	↑	↑	↑	↑	↑		↑				↑	↑	
Lower San Antonio River	1901_02	Station 12791 SAR Bridge on US 77-A and 183 Southeast of Goliad									↓			↑		↓
	1901_02	Station 17859 SAR at North Riverdale Road 15 KM (9.32 miles) West of Goliad		↓		↓		↑			↓					↓
	1901_04	Station 12794 SAR at SH 72 near Runge	↓							↑	↓			↑	↑	↓
Upper Cibolo Creek	1908_01	Station 16702 Cibolo Creek SE of Boerne downstream end of City Park in the Nature Preserve									↓					
Mid Cibolo Creek	1913_03	Station 14212 Cibolo Creek Upstream of Cibolo Creek Municipal Authority's WWTP	↓		↓							↑				↓
Lower Cibolo Creek	1902_02	Station 14211 -Cibolo Creek at CR 389 near Cestohowa Texas				↓	↓		↑		↓			↑		
	1902_05	Station 14197-Cibolo Creek at Sculls Crossing		↑	↑					↑	↑					
Upper Medina River	1905_01	Station 12830 Medina River at Old English Crossing above Bandera Falls			↑							↑				
Medina Lake	1904_01	Station 12825-Medina Lake at Medina Lake Dam West of San Antonio				↑	↑									
Medina Diversion Lake	1909_01	Station 18407 Medina Diversion Lake Near Dam				↑										
Lower Medina River	1903_02	Station 12813 - Medina River at Cassin Crossing	↓	↓	↑		↑	↑			↓			↑	↑	↓
	1903_01	Station 12811 - Medina River at FM 1937			↑		↑				↓	↑	↑	↑	↑	↓
Upper Leon Creek			Insufficient Data													
Lower Leon Creek	1906_01	Station 14198 Leon Creek Upstream from Leon Creek WWTP				↓	↓	↑						↓	↓	↑
Salado Creek	1910_01	Station 12861 Salado Creek at Southton Road			↓	↓	↓			↑		↑		↓	↓	
	1910_02	Station 12870 Salado Creek at Gembler Road	↓	↓				↑		↓	↓			↓	↓	
	1910_03	Station 12874 Salado Creek at Rittiman Road	↓					↑		↓	↓	↑			↓	↓
Medio Creek	1912_01	Station 12916 Medio Creek at Hidden Valley	↓	↓		↓			↑	↑		↑				↑

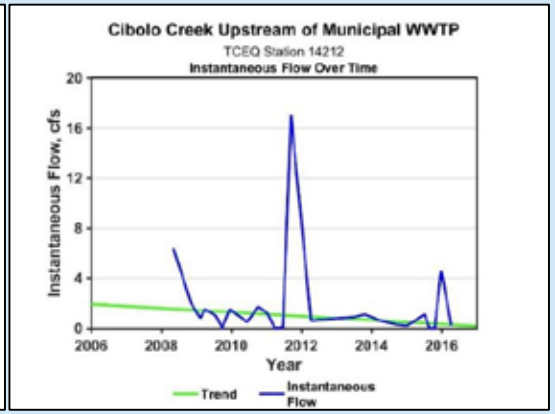
Although high in nutrient concentration (nitrate and phosphorus), effluent from wastewater discharges are critical in maintaining flow in many of the waterbodies in the San Antonio Basin. Normally, flow in effluent dominated segments such as the San Antonio River, Lower Cibolo Creek, Lower Leon Creek and Medio Creek normally are not affected as much by drought as non-effluent dominated segments. However, over the trending period, there were decreasing flow trends in the upper portions of the Upper and Lower San Antonio River Watersheds. Decreasing flow trends can also be seen in the Mid Cibolo Creek, Lower Medina River, and Medio Creek Watersheds. After the Salado Creek Farmer's Well was plugged in 1991, flow in the Salado Creek has been an issue. Although flow augmentation is normally provided at James Park, the inherent ambient low-flow conditions and the drought conditions over the assessment period may be possible sources for the DO and benthic macroinvertebrate community impairments in the Salado Creek Watershed. Stations that showed a statistically significant decreasing trend in flow over time can be seen in the Graphs A-F.



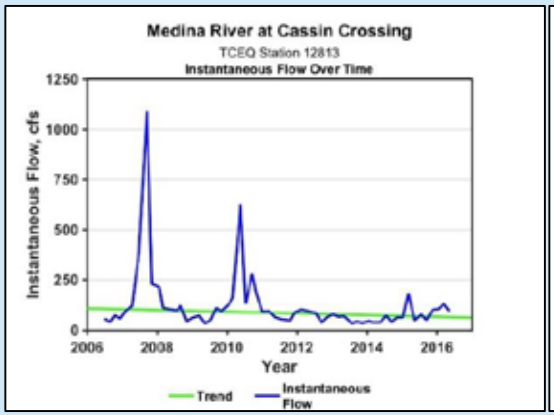
Graph A: 12908 SAR at Woodlawn



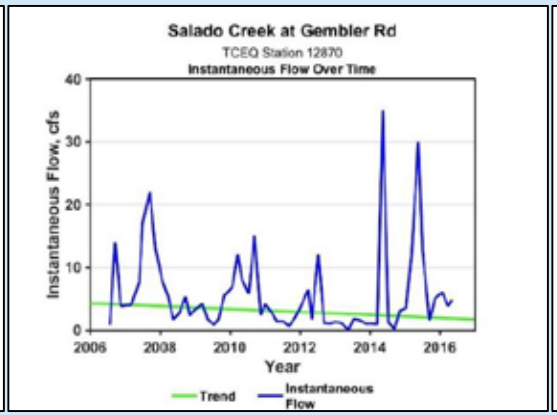
Graph B: 12794 SAR at SH 72



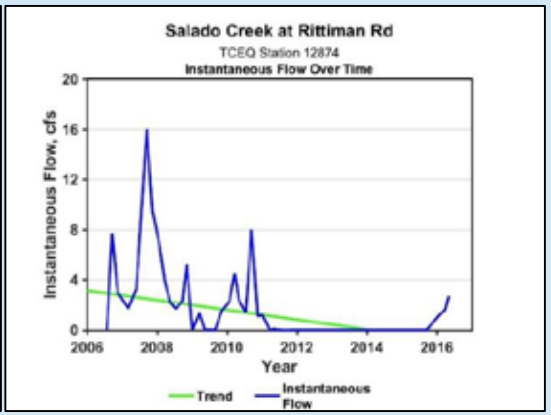
Graph C: Cibolo Creek Upstream Municipal WWTP



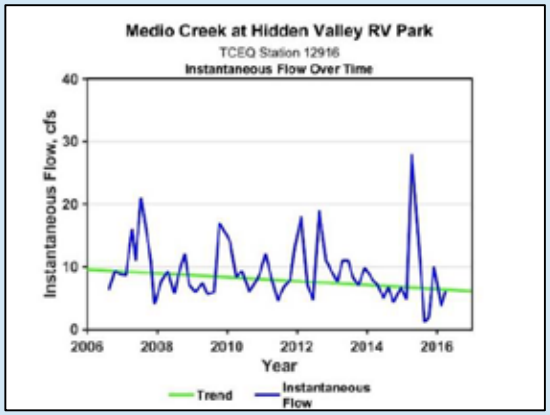
Graph D: 12813 Medina River at Cassin Crossing



Graph D: Salado Creek at Gembler Road

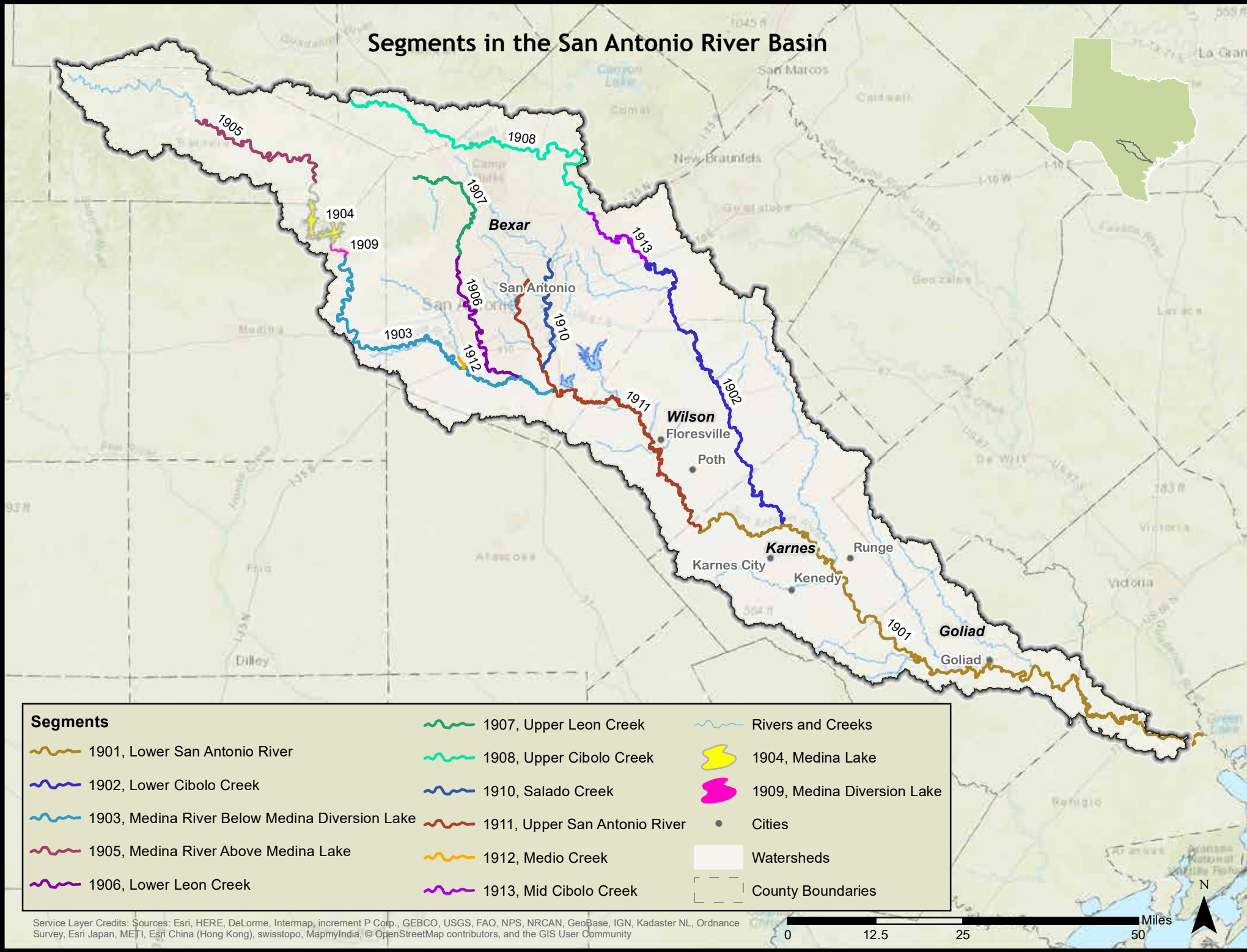


Graph E: Salado Creek at Rittiman Road



Graph F: Medio Creek at Hidden Valley RV Park

Kayaking on the San Antonio River, Mission Reach



Watershed Summaries, Conclusions and Recommendations

Watershed Summaries

Upper San Antonio River, Segment 1911

- Several portions of the watershed, including the main stem and tributaries, have issues with elevated *E. coli* levels above the primary contact geometric mean criterion of ≤126 E. *coli* colonies/100mL. According to the Three Total Maximum Daily Loads for Bacteria in the San Antonio Area and the USAR WPP, regulated and nonregulated sources have been identified, including direct and indirect stormwater runoff sources, sewer breaks and overflows, and poorly maintained septic tank systems.
- Although the upper portions of the Upper San Antonio River are highly segmented with little riparian cover and no instream cover, efforts associated with the Upper San Antonio River I-Plan and the San Antonio River Improvements Project are expected, over time, to help address the fish community impairment and habitat concern.
- Nutrient concerns are prevalent throughout the watershed and are potentially related to wastewater treatment discharges, improper use of fertilizers and organic loading as a result of stormwater runoff.
- Depressed DO in the tributaries can be attributed to shallow intermittent low flows, poor riparian buffers and channels with low sinuosity.
- SARA will continue routine and biological monitoring to provide quality assured data to the TCEQ for assessment.

Lower San Antonio River, Segment 1901

- There are bacteria and fish community impairments, and habitat concerns on the main stem. Bacteria impairments on several tributaries of the Lower San Antonio River and nutrient concerns have also been identified.
- In the 2014 IR, the average bacterial geometric mean for all three impaired assessment units of the Lower San Antonio River is 175.76 *E. coli*/100mL; only 49.76 *E. coli* colonies above the State's criterion. Efforts associated with the LSAR I-Plan are expected to restore, maintain, and improve water quality in the watershed. The fish community impairments are most likely due to limited microhabitats within the sample reach at Station 12791 San Antonio River at US 77A in Goliad, including limited riparian habitat, silty and/or sandy substrate, and extensive runs and glides. In the 2014 monitoring year, all biological collection events were moved to Station 12792 San Antonio River at Southern Pacific Railroad Bridge in Goliad. Because the Lower San Antonio River is an expansive watershed covering approximately 1,214 square miles, SARA will continue to look for more appropriate biological sampling sites.
- SARA and Guadalupe-Blanco River Authority (GBRA) will continue routine and biological monitoring to provide quality assured data to TCEQ for assessment.

Upper Cibolo Creek, Segment 1908

- The Upper Cibolo Creek is identified in the 2014 IR as having chloride and bacterial impairments; nutrients, DO grab average and habitat concerns have also been identified.
- Historical information indicates one of the stations used in the original bacteria impairment and habitat concern may not have been representative of the reach due to its proximity to IH-10. The results of the TCEQ ALM effort indicated that Station 20821 Cibolo Creek at the Northrup Park was a more appropriate biological site than Station 12857 Cibolo Creek at IH 10. The data

collected as part of the effort supports the removal of the habitat concern. Routine *E. coli* monitoring will continue at Stations 20821 and 12857 until the required number of acceptable *E.coli* values can be collected and evaluated. Until that time, the bacterial impairment will remain.

- The chloride impairment is most likely due to an increase in water resource demands and ambient low flow conditions experienced in the watershed, coupled with the concentration and discharge of dissolved solids as part of the wastewater treatment plants processes. The chloride average criterion for the segment is <50.00 mg/L, the 2014 IR identifies the Upper Cibolo as having an average chloride concentration of 62.05 mg/L. The TCEQ has assigned this impairment to Category 5c indicating that additional chloride data or information will be collected and/or evaluated before a management strategy is selected.
- The 2104 IR identifies the chloride impairment as being in Category 5c indicating that additional data or information will be collected and/or evaluated before a management strategy is selected.
- SARA will continue routine monitoring to provide quality assured data to TCEQ for assessment.

Mid Cibolo Creek, Segment 1913

- According to the 2014 IR, the Mid Cibolo Creek is impaired for 24-hour minimum DO; nutrient concerns have also been detected.
- Although this segment is classified as perennial, historical observations indicate the DO impairment is most likely due to a lack of flow associated with shallow intermittent or ephemeral waterbodies.
- Once the Cibolo Creek Watershed Segment Boundary Re-Definition Effort findings have been adopted by the TCEQ and approved by the EPA, all three segments will be reassessed using the new segment boundaries and DO criteria. It is possible the Mid Cibolo Creek DO impairment could be removed in the 2018 IR.
- The Mid and Lower Cibolo Creek Watershed Protection Plan was initiated to address bacteria and depressed DO impairments in the watersheds.
- SARA will continue biological and routine monitoring to provide quality assured data to TCEQ for assessments.

Station 12919 Cibolo at IH10

Lower Cibolo Creek, Segment 1902

- The Lower Cibolo Creek is identified in the 2014 IR as having a bacterial impairment; nutrient concerns have also been detected.
- The DO impairment in Clifton Branch can be attributed to shallow intermittent low flows.
- Possible sources for *E. coli* contamination include sewer breaks and overflows, poorly maintained septic systems, and stormwater runoff sources of fecal matter from livestock production and wildlife.

- To address the habitat concern in 1902_03, SARA will continue to conduct biological monitoring at Station 12802 Cibolo Creek at FM 541 west of Kosciusko and at Station 21755 Cibolo Creek southwest of Stockdale.
- The Mid and Lower Cibolo Creek Watershed Protection Plan was initiated to address bacteria and depressed DO impairments in the watersheds.
- SARA and the TCEQ will continue routine and biological monitoring to provide quality assured data to TCEQ for assessment.

Upper Medina River, Segment 1905

- According to the 2014 IR, a fish community impairment and habitat concern exists in the Upper Medina River.
- A TCEQ ALM effort indicated the fish community impairment was related to habitat limitations as indicated by the concern for physical habitat at Station 12830 Medina River at Old English Crossing. In response to the TCEQ ALM effort, all biological events were moved to Station 21631 Medina River Mayan Ranch. The fish community impairment and habitat concern will remain until acceptable data is obtained.
- BCRAGD and SARA will maintain routine and biological monitoring in the watershed.

Medina Lake, Segment 1904

- There are no water quality impairments or concerns in this watershed.
- BCRAGD will maintain routine monitoring collections.

Medina Diversion Lake, Segment 1909

- There are no water quality impairments or concerns in this watershed.
- BCRAGD will maintain routine monitoring collections.

Lower Medina River, Segment 1903

- The Lower Medina River is identified in the 2014 IR as having a bacterial impairment; nutrient concerns have also been detected.
- The bacterial impairment and nutrient concerns are most likely due to wildlife, sewer breaks, poorly maintained septic systems, and stormwater runoff.
- SARA should maintain routine and biological monitoring in support of any future bacterial TMDLs or WPPs.

Station 21531 Medina River Mayan Ranch

Upper Leon Creek, Segment 1907

- There are no water quality impairments or concerns in this watershed.

- Although the information in the 2014 IR identifies flow in this segment as perennial, historical field observations indicate a flow classification of intermittent with pools would be more appropriate. SARA is collecting field and flow observation to assist the TCEQ in assigning a more appropriate flow type classification for the Upper Leon Creek Watershed.
- SARA will maintain routine monitoring collections to document flow type classification in the watershed.

Lower Leon Creek, Segment 1906

- Legacy pollutants persist in the upper portions of the watershed beginning at the Old U.S. Highway 90 Bridge extending downstream to the Loop 410 Bridge. PCB concentrations in fish tissue exceed health assessment guidelines established by the DSHS and may pose a threat to human health if consumed. Per the DSHS, PCBs are a mixture of up to 209 individual chlorinated compounds commercially used as coolants and lubricants in electrical transformers and capacitors, power plant electrical and other industrial equipment, sealing and caulking compounds and ballasts in fluorescent light fixtures. The advisory will remain in effect until the DSHS rescinds or modifies it in writing. Concerns for streambed sediment silver screening levels have also been identified in 1906_06.
- A DO impairment has been identified and is most likely due to shallow low flows in the upper portions of the watershed; a chlorophyll-*a* concern has also been identified.
- The results of the Lower Leon Creek Use Attainability Analysis are currently being reviewed by the TCEQ for inclusion in the next triennial TSWQS revision scheduled for 2021.
- SARA and the TCEQ will maintain routine and biological monitoring and support projects designed to identify the source(s) of PCBs impairments and metal concerns.

Salado Creek, Segment 1910

- Salado Creek is identified in the 2014 IR as having a bacteria, DO, and benthic macroinvertebrate community impairments; a DO grab screening average and nitrite concern have also been identified.
- Although flow augmentation is provided at James Park, the inherent ambient low-flow conditions and drought conditions over the assessment period may be possible sources for the DO and benthic macroinvertebrate community impairments.

Longnose Gar gullet *(Lepisosteus osseus)*

- SARA will continue routine and biological monitoring to provide quality-assured data to TCEQ for assessment.

Medio Creek, Segment 1912

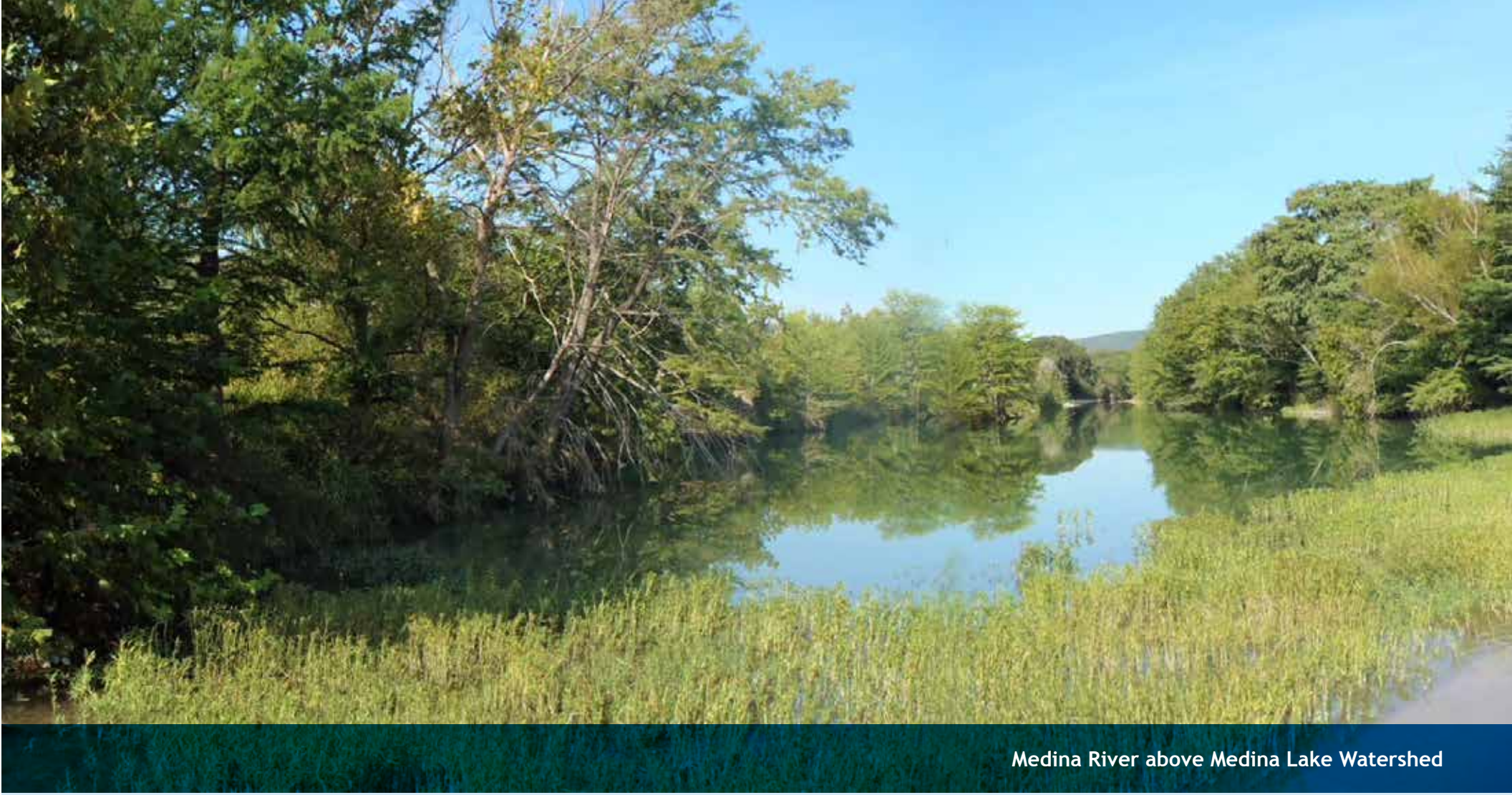
- Nutrient concerns have been identified in the Medio Creek and Upper Medio Creek Watersheds and may be related to wastewater treatment plant discharges and improper use of fertilizers.
- SARA will continue routine and biological monitoring to provide quality-assured data to TCEQ for assessment.

Conclusions and Recommendations

Since the inception of the CRP in 1991, SARA and CRP partners have made considerable progress in identifying and understanding the water quality dynamics of each watershed in the San Antonio River Basin. Although this progress has been made possible largely in part to State funding, SARA recognizes the need to supplement funding and to integrate, leverage, and coordinate the monitoring resources of the basin. Moving into the future, the CRP's watershed management approach will continue to be used to identify and evaluate water quality issues, establish priorities for corrective actions, work to implement those actions and adapt to emerging water quality issues. SARA is committed to the protection and enhancement of our creeks and rivers through service, leadership and expertise. To this end, SARA and partners will continue:

- CRP monitoring efforts to provide quality assured data to the TCEQ for use in water quality decision making.
- To conduct temporal and spatial routine and biological monitoring so that State stream standards can be assessed and trends analyzed.
- To work to identify sources of bacteria through more intensive monitoring efforts, including the use of bacterial source tracking methodologies.
- To participate in TCEQ Surface Water Quality Standards Advisory Workgroups to develop, evaluate, and assess the relationship of nutrients in waterbodies associated with stormwater, wastewater treatment, and agricultural practices.
- To implement BMPs as identified in the Watershed Master Plans, TMDLs, I-Plans and WPP in the basin.
- To conduct monitoring in support of Watershed Master Plans, TMDLs, I-Plans and WPP in the basin.
- To continue efforts to identify and locate sources of PCB contamination in the Lower Leon Creek.
- To conduct CRP Environmental Advisory Steering Committee meetings and Coordinated Monitoring Meetings.
- To enhance community engagement and appreciation for recreational uses of creeks and rivers in the basin.
- To advance and apply SARA's expertise to influence, develop, and implement watershed solutions that balance the environmental, economic and quality of life needs of our communities.

The full Clean Rivers Program San Antonio River Basin 2018 Summary Report can be downloaded online at https://www.sara-tx.org/environmental-science/basin-highlights-reports/.



Medina River above Medina Lake Watershed

Breakdown of Impairments and Concerns by Segment

Guidance developed by the EPA directs each state to document and submit the results of its water quality assessment to the EPA biennially, in even-numbered years. The Executive Summary 2014 Integrated Report Impairment and Concerns by Segment Table and the 2014 Impairment and Concerns Maps represent a big-picture view of the most recent assessment of the San Antonio River Watershed, completed in 2014. An in-depth summary by assessment unit for each watershed in the San Antonio River Basin can be found in the individual watershed summary sections. There were 13 classified (main-stem) and 20 unclassified stream segments (tributaries) assessed in the 2014 IR. A total of 15 impairments were identified in the classified stream segments and a total of 13 impairments were identified in the unclassified stream segments of the San Antonio River Basin. Impairments include elevated bacteria levels, depressed DO, elevated chloride levels, fish consumption restrictions and fish community.

Table ES2: Executive Summary 2014 Integrated Report Impairment and Concerns by Segment

Segment		Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
		Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	*Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Upper San Antonio River	1911	FS	FS	FS	NC	FS	NC	NC	FS	FS	NS	NC	CS	CS	NC	NS	CS	NA
Apache Creek	1911B	NA	NA	NA	CS	FS	NA	NA	NA	NA	NS	NC	CS	NC	NC	NA	NA	NA
Alazan Creek	1911C	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS	CS	NC	NC	CS	NA	NA	NA
San Pedro Creek	1911D	NA	NA	NA	CS	FS	NC	NC	NA	NA	NS	NC	CS	NC	NC	NA	NA	NA
Six Mile Creek	1911E	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA	NA	NA
Picosa Creek	1911H	NA	NA	NA	CS	NS	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA
Martinez Creek	1911I	NA	NA	NA	CS	FS	NA	NA	NA	NA	NS	NC	NC	NC	NC	NA	NA	NA
Lower San Antonio River	1901	FS	FS	FS	NC	FS	NC	NC	FS	FS	NS	NC	CS	CS	CS	NS	CS	NA
Escondido Creek	1901A	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS	NC	CS	CS	NC	NA	NA	NA
Cabeza Creek	1901B	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS	NC	NC	NC	NC	NA	NA	NA
Hord Creek	1901C	NA	NA	NA	NC	NC	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA
Lost Creek	1901D	NA	NA	NA	NC	NC	NA	NA	NA	NA	NC	NA	NA	NA	NA	NA	NA	NA
Upper Cibolo Creek*	1908	NS	FS	FS	CS	FS	NA	NA	FS	FS	NS	NC	NC	CS	NC	FS	CS	FS
Mid Cibolo Creek Watershed*	1913	FS	FS	FS	NC	FS	NC	NS	NA	NA	NC	NC	CS	CS	NC	NA	NA	NA
Lower Cibolo Creek	1902	FS	FS	FS	NC	FS	FS	FS	FS	FS	NS	NC	CS	CS	NC	CN	NC	NA
Martinez Creek	1902A	NA	NA	NA	NC	NC	NA	NA	NA	NA	CN	NC	CS	CS	NA	NA	NA	NA
Salitrillo Creek	1902B	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS	CS	CS	CS	NC	NA	NA	NA
Clifton Branch	1902C	NA	NA	NA	CS	NS	NA	NA	NA	NA	NS	NC	NC	CS	NA	NA	NA	NA
Medina River above Medina Lake	1905	FS	FS	FS	NC	FS	NC	NC	FS	FS	FS	NC	NC	NC	NC	NS	CS	NA
North Prong Medina River	1905A	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS	NC	NC	NC	NC	FS	NC	FS
Medina Lake*	1904	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS	NC	NC	NC	NC	NA	NA	NA
Medina Diversion Lake *	1909	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS	NC	NC	NC	NC	NA	NA	NA
Lower Medina River	1903	FS	FS	FS	NC	FS	NC	NC	FS	FS	NS	CS	CS	CS	NC	FS	NC	NA
Upper Leon Creek*	1907	NC	NC	NC	NC	NC	NA	NA	NC	NC	NC	NC	NC	NC	NC	NA	NA	NA
Lower Leon Creek**	1906	FS	FS	FS	CS	NS	CN	CN	FS	FS	FS	NC	NC	NC	CS	FS	NC	NA
Salado Creek	1910	FS	FS	FS	CS	NS	NC	NC	FS	FS	NS	NC	CS	NC	NC	FS	NC	NS
Walzem Creek	1910A	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA	NA	NA
Rosillo Creek	1910B	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS	NA	NA	NA	NA	NA	NA	NA
Salado Creek Tributary	1910C	NA	NA	NA	NC	FS	NA	NA	NA	NA	CN	NA	NA	NA	NA	NA	NA	NA
Menger Creek	1910D	NA	NA	NA	CS	NS	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA	NA	NA
Beitel Creek	1910E	NA	NA	NA	CS	FS	NA	NA	NA	NA	FS	NA	NA	NA	NA	NA	NA	NA
Upper Salado Creek	1910F	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS	NC	NC	NC	CS	NA	NA	NA
Medio Creek	1912	FS	FS	FS	NC	FS	FS	FS	FS	FS	FS	NC	CS	CS	NC	FS	NC	NA
Upper Medio Creek	1912A	NA	NA	NA	NC	FS	NC	NC	NA	NA	FS	NC	CS	CS	NC	NA	NA	NA

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

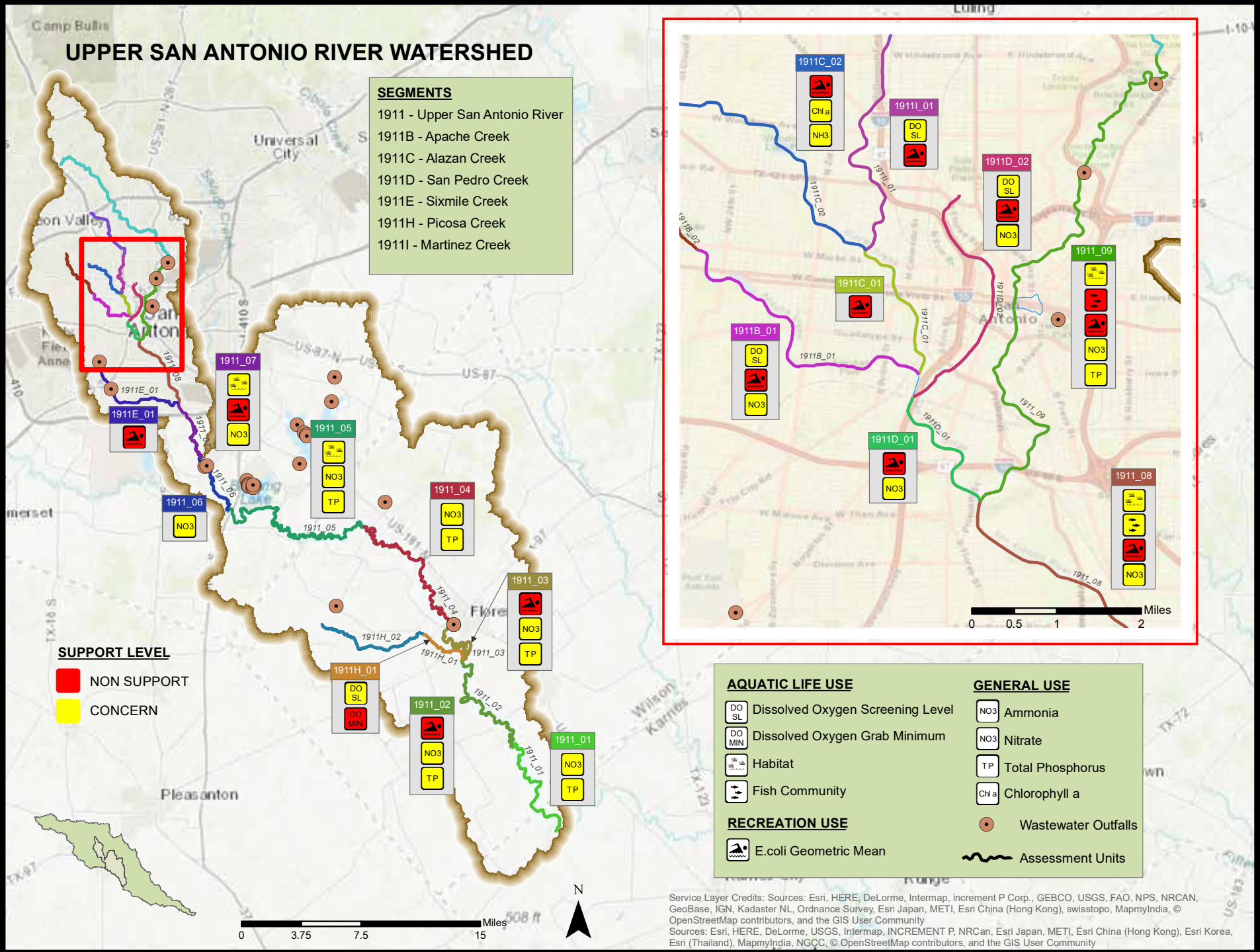
Limited Data

NA = Not Assessed

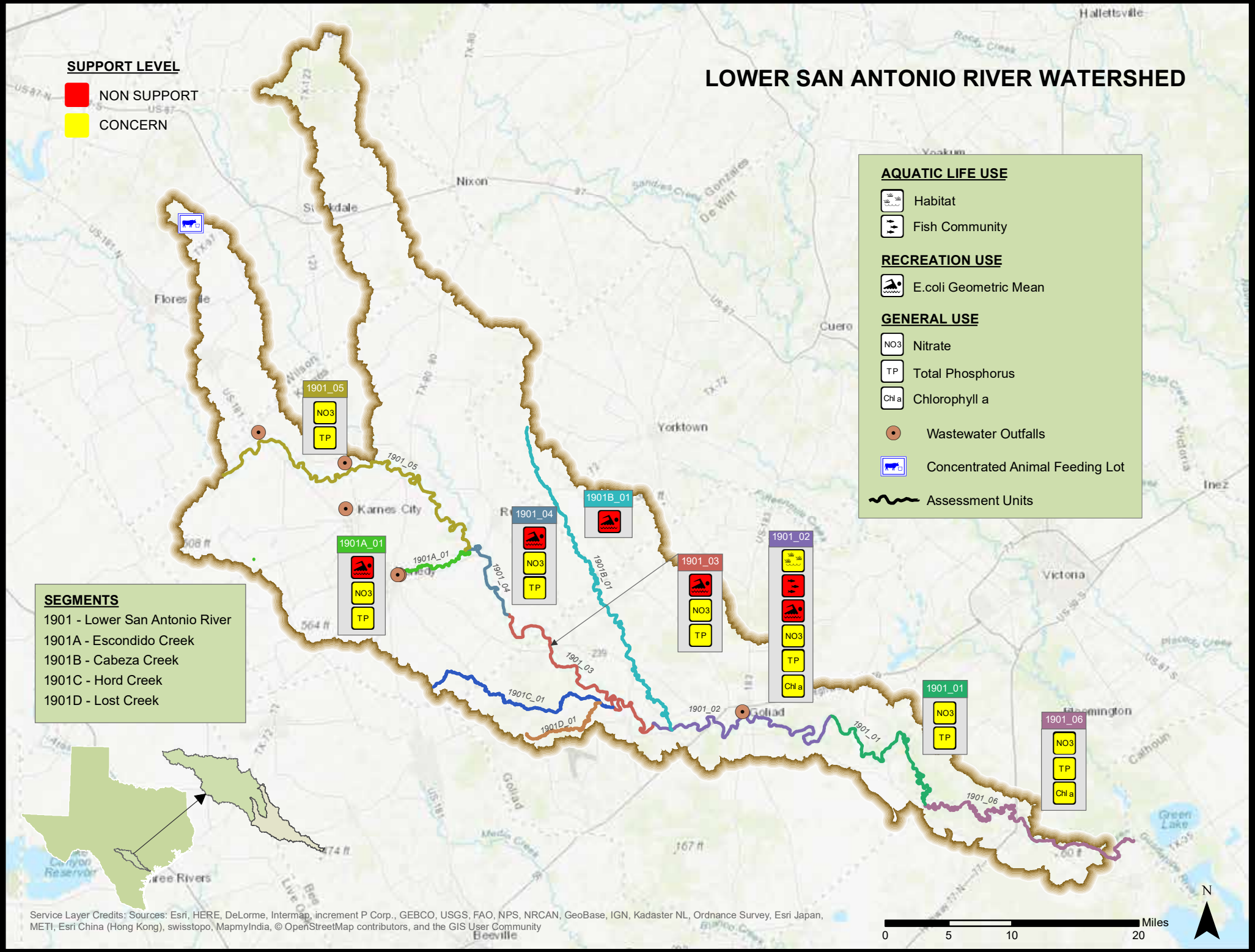
*Nitrate + nitrite is the primary method utilized for analyzing nitrate nitrogen in surface water in Segments 1904, 1907, 1908, 1909, 1913

** Lower Leon Creek also has a nonsupport for fish consumption and a concern for silver in sediment

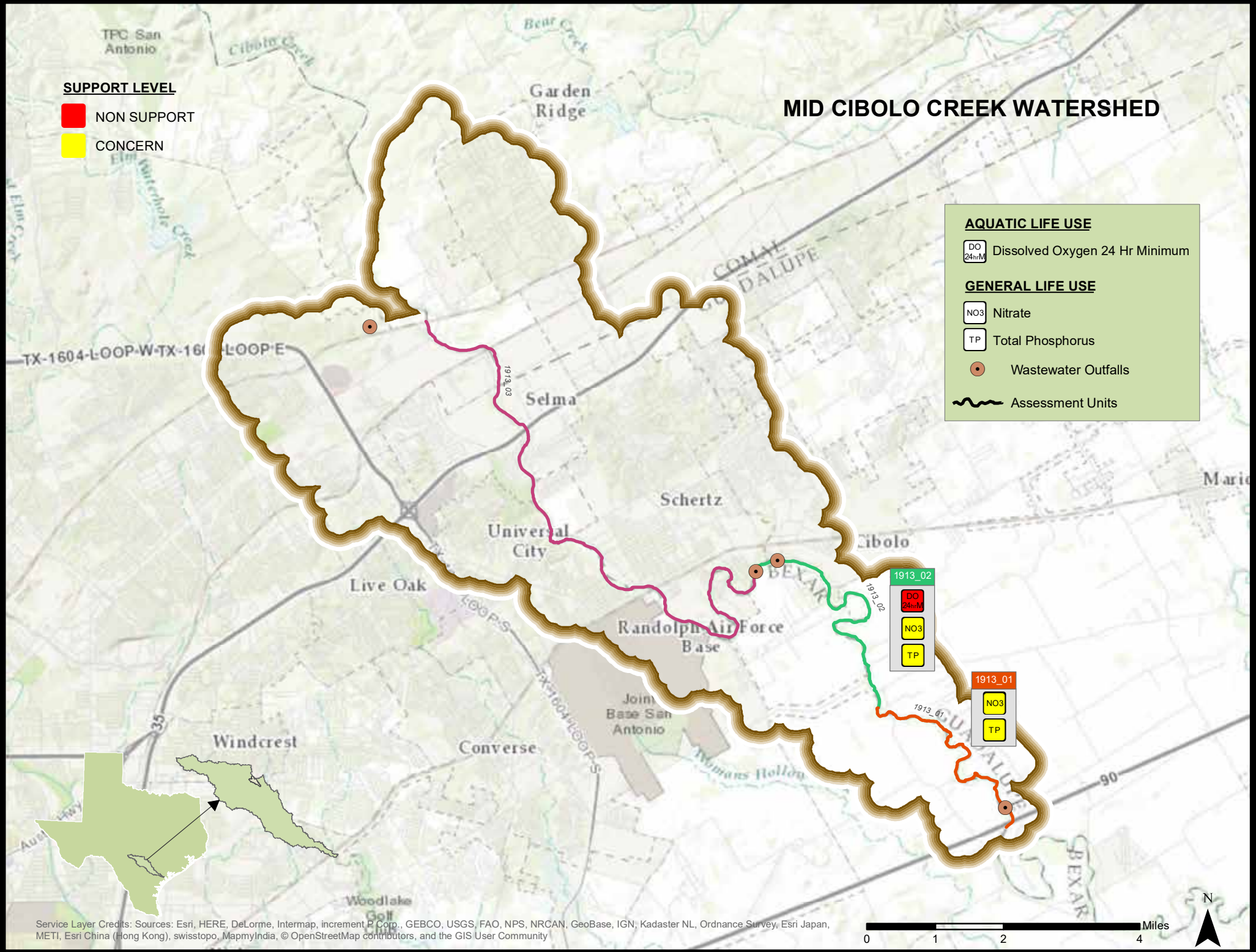
Executive Summary 2014 Integrated Report Impairments and Concern Maps; Segment 1904 Medina Lake, Segment 1909 Medina Diversion Lake, and Segment 1907 Upper Leon Creek do not have any impairments or concerns.

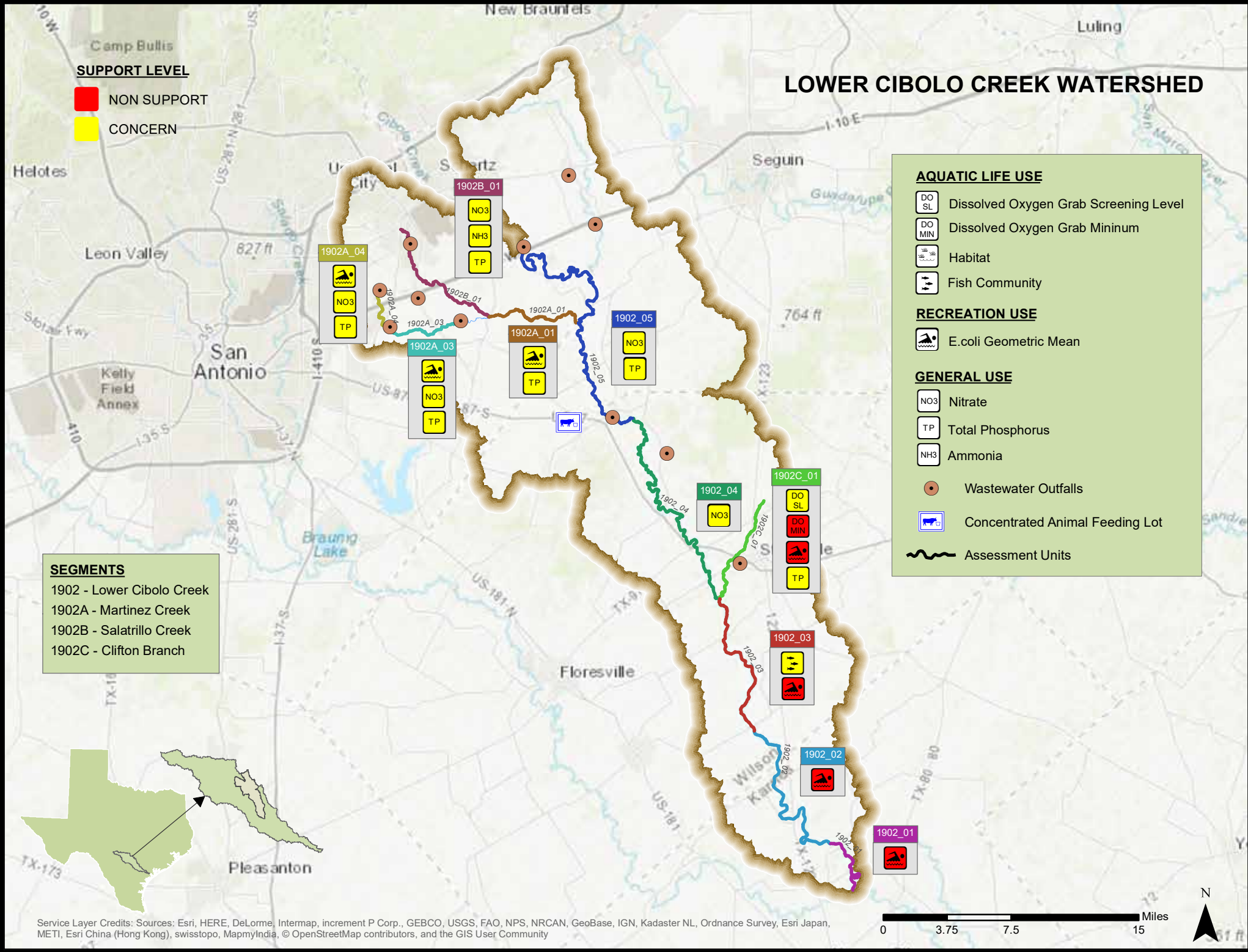


LOWER SAN ANTONIO RIVER WATERSHED




UPPER CIBOLO CREEK WATERSHED
SUPPORT LEVEL
NON SUPPORT
CONCERN
1908_02
DO SL
CI
1908_01
DO SL
CI
TP
1908_03
CI
Spring Branch
Guadalupe River SP
Honey Creek SNA
Boerne
Albert & Beasl Kronkosky SNA
Fair Oaks Ranch
Bulverde
Timberwood Park
BEXAR
Camp Stanley
Camp Bullis
Scenic Canyon
Rancho Diana
The Rim
Shavano Park
Hollywood Park
Helotes
Live Oak
AQUATIC LIFE USE
DO SL Dissolved Oxygen Grab Screening Level
Habitat
RECREATION USE
E.coli Geometric Mean
GENERAL LIFE USE
CI Chloride
TP Total Phosphorus
Wastewater Outfalls
Assessment Units
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
0 2.5 5 10 Miles
N


MID CIBOLO CREEK WATERSHED
SUPPORT LEVEL
NON SUPPORT
CONCERN
AQUATIC LIFE USE
DO 24hrM Dissolved Oxygen 24 Hr Minimum
GENERAL LIFE USE
NO3 Nitrate
TP Total Phosphorus
Wastewater Outfalls
Assessment Units
1913_01
1913_02
1913_03
NO3
TP
DO 24hrM
TPC San Antonio
Cibolo Creek
Bear Creek
Garden Ridge
Elm Waterhole Creek
Selma
Schertz
Universal City
Live Oak
Randolph Air Force Base
Joint Base San Antonio
Windcrest
Converse
Woodlake Golf
Cibolo
TX-1604-LOOP-W
TX-1604-LOOP-S
TX-1604-LOOP-E
35
90
N
0
1
2
4
Miles
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

MEDINA RIVER ABOVE MEDINA LAKE

SUPPORT LEVEL

- NON SUPPORT
- CONCERN

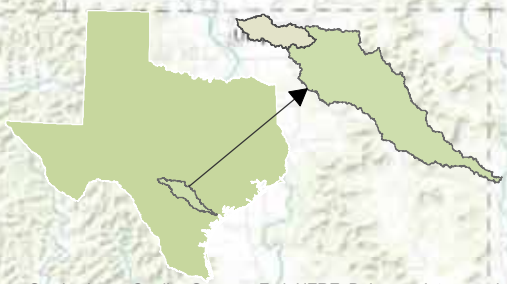
AQUATIC LIFE USE

- Habitat
- Fish Community
- Wastewater Outfalls
- Assessment Units

SEGMENTS

1905 - Medina River Above Medina Lake

1905A - North Prong Medina River

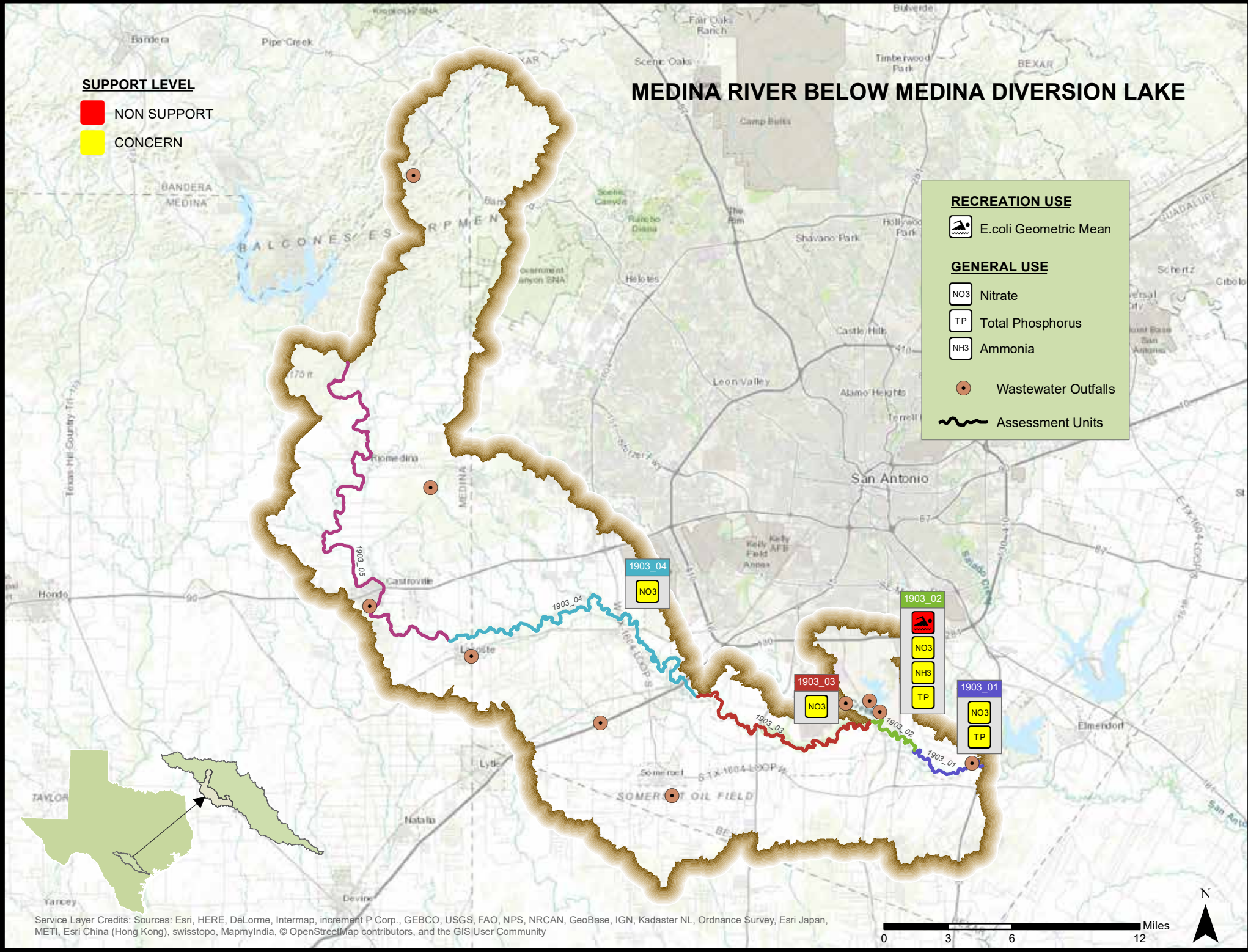


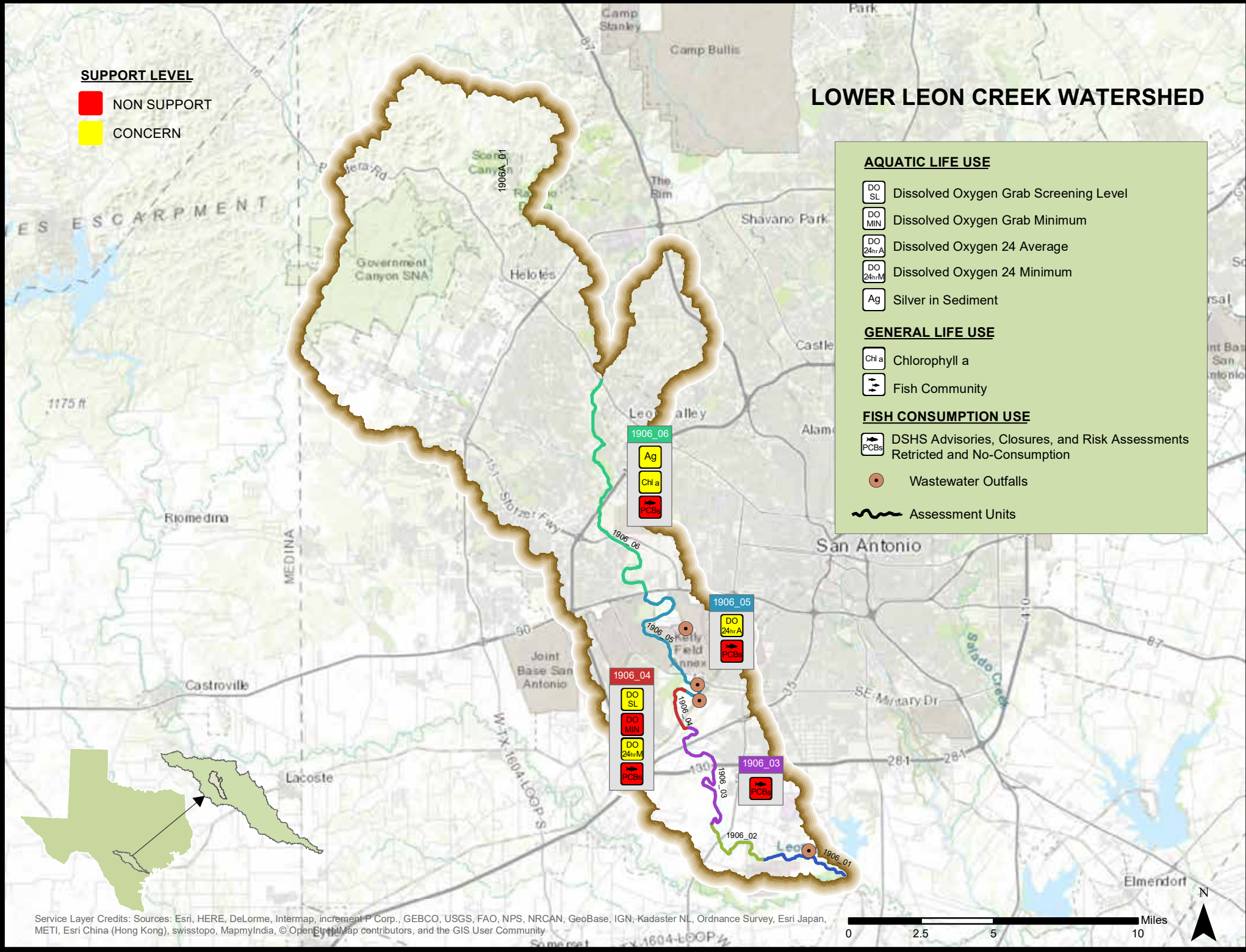
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Miles

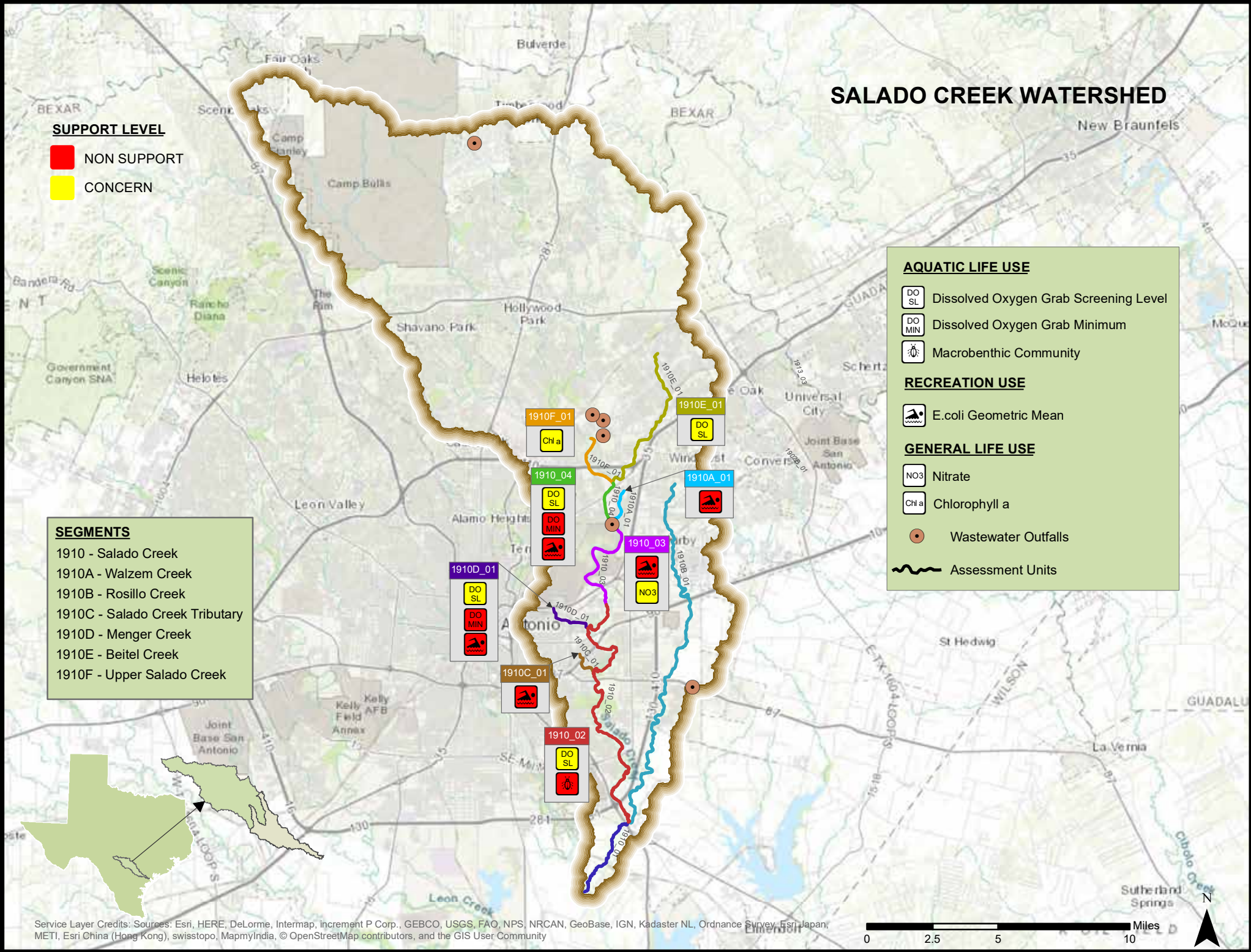
0 2.5 5 10

N

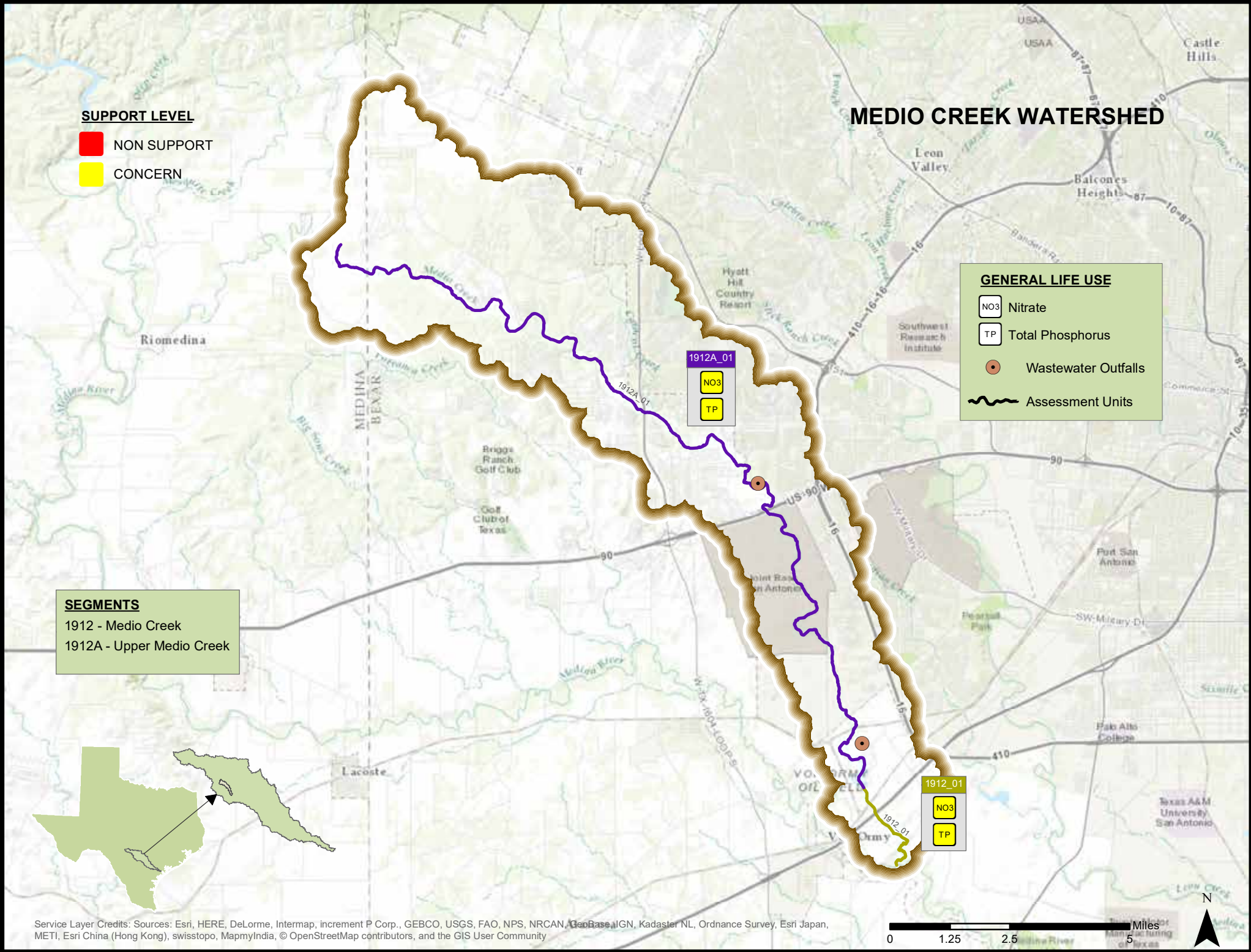

MEDINA RIVER BELOW MEDINA DIVERSION LAKE
SUPPORT LEVEL
NON SUPPORT
CONCERN
RECREATION USE
E.coli Geometric Mean
GENERAL USE
NO3 Nitrate
TP Total Phosphorus
NH3 Ammonia
Wastewater Outfalls
Assessment Units
1903_04
NO3
1903_02
NO3
NH3
TP
1903_03
NO3
1903_01
NO3
TP
1903_05
1903_04
1903_03
1903_02
1903_01
Bandera
Pipe Creek
Fair Oaks Ranch
Boerne
Scenic Oaks
Timberwood Park
BEXAR
Camp Bullis
BANDERA
MEDINA
Helotes
Shavano Park
Schertz
Castle Hills
Leon Valley
Alamo Heights
San Antonio
Kelly Field Annex
Kelly AFB
Riomedina
Castroville
Hondo
Lacoste
Somerset
SOMERSET OIL FIELD
Lytle
Natalia
Devine
Elmendorf
TAYLOR
Yancey
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
0
3
6
12
Miles
N



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


MEDIO CREEK WATERSHED
SUPPORT LEVEL
NON SUPPORT
CONCERN
GENERAL LIFE USE
NO3 Nitrate
TP Total Phosphorus
Wastewater Outfalls
Assessment Units
SEGMENTS
1912 - Medio Creek
1912A - Upper Medio Creek
1912A_01
NO3
TP
1912_01
NO3
TP
Riomedina
Lacoste
Leon Valley
Balcones Heights
Castle Hills
Hyatt Hill Country Resort
Briggs Ranch Golf Club
Golf Club of Texas
Port San Antonio
Palo Alto College
Texas A&M University San Antonio
Southwest Research Institute
US-90
Medina River
Leon Creek
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
0 1.25 2.5 5 Miles
N

Largemouth Bass *(Micropterus salmoides)* biological collection event in the Upper San Antonio River Watershed

This page has been intentionally left blank.

Texas Clean Rivers Program

San Antonio River Basin 2018 Summary Report

TABLE OF CONTENTS:

Upper Medina River Watershed

1.0 Introduction

As a result of the 72nd Legislature enactment of Senate Bill 818 in 1991, the Texas Water Commission, now known as the Texas Commission on Environmental Quality (TCEQ), implemented the Texas Clean Rivers Program. The Clean Rivers Program (CRP) 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 (SARA) was designated as the regional agency responsible for planning, coordinating, and implementing the CRP in the San Antonio River Basin. The Basin Summary Report is a requirement of the Texas CRP and was prepared by SARA staff in cooperation with the TCEQ and in accordance with the State's guidelines.

Goals and Objectives of the Texas Clean Rivers Program

The goals of the CRP are to maintain and improve the quality of water within each river basin in Texas through an ongoing partnership involving the TCEQ, river authorities, other agencies, regional entities, local governments, industry, and citizens. The program's watershed management approach will identify and evaluate water quality issues, establish priorities for corrective action, work to implement those actions, and adapt to changing priorities. In support of the CRP goals, the long-term objectives are to:

- Provide quality assured data to the TCEQ for use in water quality decision making.
- Identify and evaluate water quality issues.
- Promote cooperative watershed planning.
- Inform and engage stakeholders.
- Maintain efficient use of public funds.
- Adapt program to emerging water quality issues.

Biological Collection Event in the Upper San Antonio River Watershed

Coordination and Cooperation with Other Basin Entities

Developing a comprehensive coordinated monitoring schedule (CMS) that supports the various basin and statewide objectives requires intensive planning and coordination. Current and past CMSs are located at https://cms.lcra.org/. 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 IRs and water quality standards, annual routine monitoring decisions are directed towards:

- Completing data sets where limited information indicates that a water quality criterion shows a standard is not supported but with a limited data set.
- Concerns for waterbodies that are near nonattainment.
- Waters with known water quality concerns.
- No specific priority for bodies that have no known water quality problems or without current water quality data.

SARA's annual Coordinated Monitoring Meeting (CMM) is normally held in mid-spring. During this meeting, partnering agencies meet to discuss the monitoring needs for the San Antonio River Basin for the upcoming year. SARA would like to thank the agencies listed below for their help over the last five years. Their efforts to maximize regional monitoring sample programs while minimizing duplicative efforts is greatly appreciated.

- Austin & San Antonio Offices of Texas Commission on Environmental Quality (TCEQ)
- Bandera County River Authority and Groundwater District (BCRAGD)
- Guadalupe-Blanco River Authority (GBRA)
- Texas State Soil and Water Conservation Board (TSSWCB)
- The City of Boerne
- Texas Parks and Wildlife Department

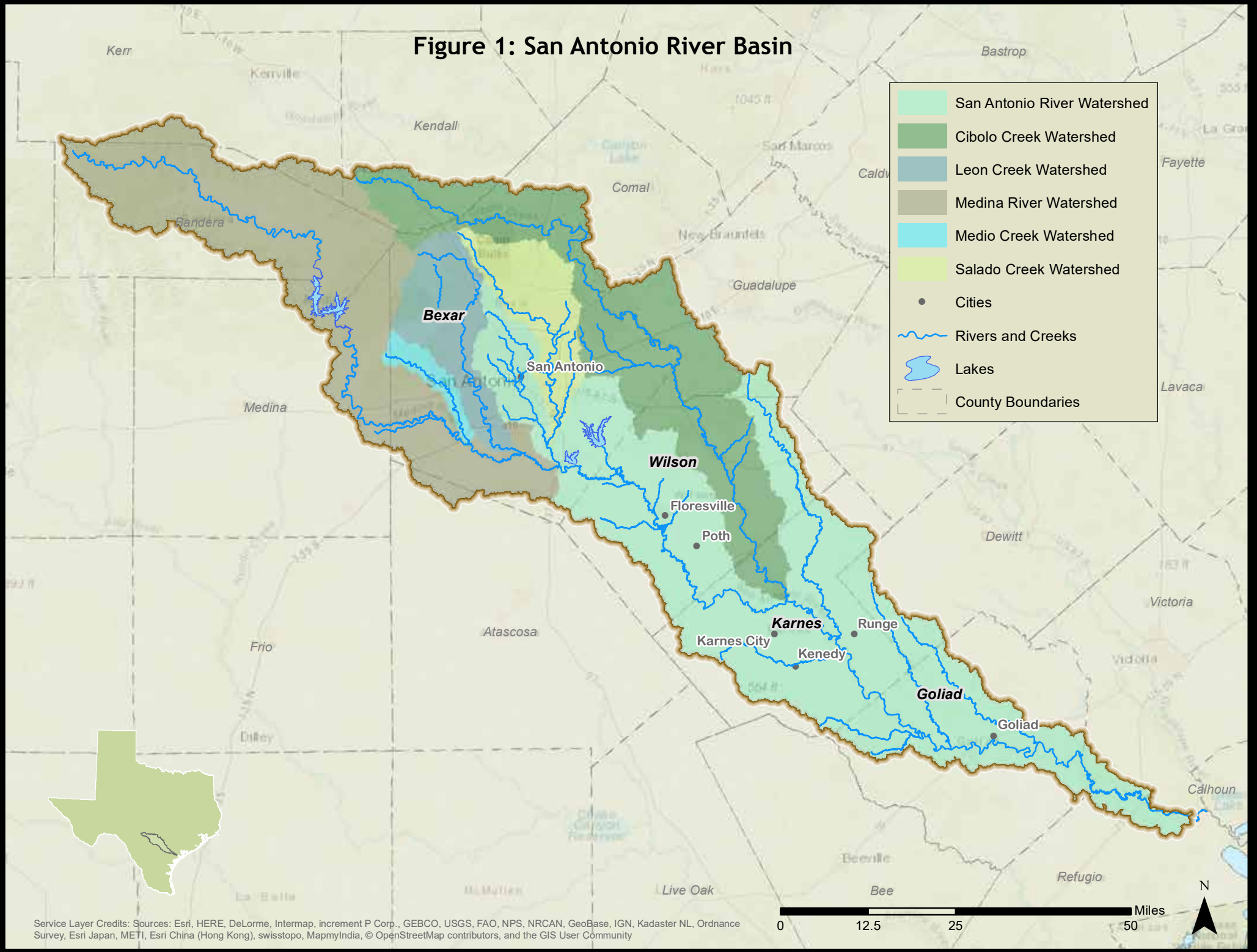
During the meetings, information from the most current biennial TCEQ Integrated Report (IR) for Clean Water Act Sections 305(b) and 303(d), CRP partners, and the Environmental Advisory Committee (EAC) is used to select stations and parameters that enhance the overall water quality monitoring coverage, and eliminate duplication of effort while addressing basin priorities.

Basin Overview

Five major perennial streams flow into the San Antonio River (Figure 1): Medina River, Cibolo Creek, Salado Creek, Leon Creek, and Medio Creek. The watersheds of these streams along with the San Antonio River Watershed make up the San Antonio River Basin. The San Antonio River Basin is located in South Central Texas and begins in the northeast corner of Bandera County. The river flows in a southeasterly direction to Goliad County, and then along the Refugio-Victoria County line where it joins the Guadalupe River. The Guadalupe River then flows approximately 10 miles before entering Guadalupe Bay, which flows into San Antonio Bay.

The northern and southern portions of the basin are mostly rural, with livestock and wildlife common in the area. Since the basin lies in a semi-arid region, with annual rainfall amounts between 26 to 38 inches, wildlife tends to congregate in riparian areas near sources of water. Feral hogs, javelina, deer, rabbits, coyotes, raccoons and opossums are common. Native birds such as turkey, quail, dove, heron, martins, song birds and migratory birds such as duck and geese are also common. Bird watching has become an important activity throughout the basin.

Figure 1: San Antonio River Basin



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

The City of San Antonio is the largest urban center in the basin and encompasses a large part of Bexar County. The U.S. Census Bureau estimates the population of Bexar County for 2016 was 1,928,680 million people. The urban portion of the basin also has abundant wildlife along the river and riparian zone. Many of the urban streams have greenways and parks. Native and migratory birds and other wildlife are attracted to these areas.

The northeast portion of the basin is in an area known as the Texas Hill Country. See Figure 2 for the ecoregions in the San Antonio River Basin. The Texas Hill Country is at the southeast portion of the Edwards Plateau and consists of limestone that has been eroded to create hills. The hills are dominated by Ashe juniper and live oak trees; soils are often thin with sparse grasses. Rainfall on the Edwards Plateau drains into creeks which then flow over the highly fractured Balcones Fault Zone. As rivers cross the Balcones Fault Zone, water is recharged into the Edwards Aquifer. Most streams go dry as they cross the recharge zone, except under very high-flow conditions.

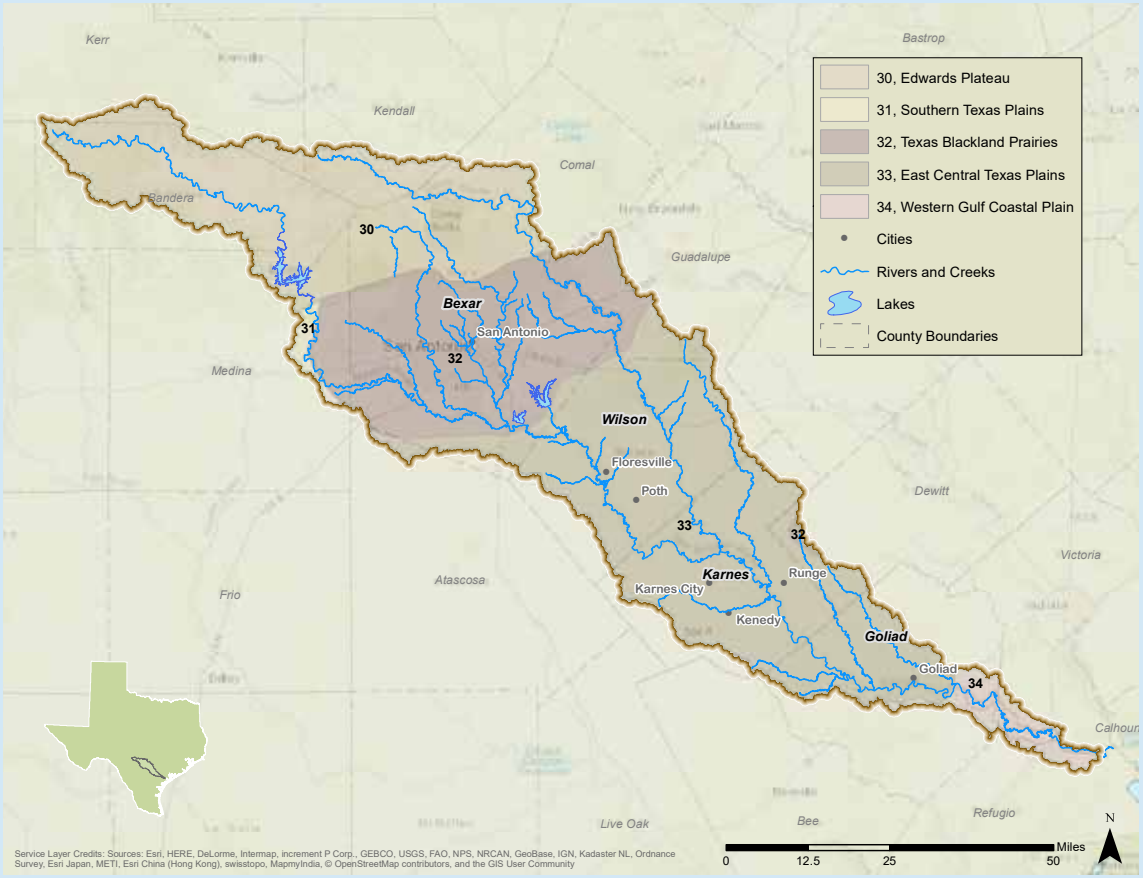


Figure 2: Ecoregions in the San Antonio River Basin

The central portion of the basin is located in the Texas Blackland Prairie. This portion is dominated by deep clay soils which are gently sloping. The deep, rich soils make the blackland prairie ideal for row crops, but in the San Antonio River Basin, this area is highly urbanized. Located in central Bexar County is the artesian zone of the Edwards Aquifer. Under normal rainfall years, springs in this area create the perennial rivers of the basin.

The combination of abundant water and deep, rich soils is what brought settlers to central Texas, where, ultimately, they created the city of San Antonio. Increased water use from the Edwards Aquifer has diminished the natural spring flow to many of the rivers and creeks in the basin. In the past, wells on Salado Creek and the San Antonio River augmented flow to these rivers. Most of these wells have been turned off to conserve drinking water in the aquifer. San Antonio Water System (SAWS) is providing recycled water to both Salado Creek and the Upper San Antonio River. Without this additional recycled water, flow would decrease in the streams, causing drops in dissolved oxygen (DO) and impairing biological communities. During drought, sections of these rivers would become dry without the augmented flow provided by SAWS.

South of the Texas Blackland Prairie is the East Central Texas Plains. This area is made up of gently sloping sandy loam and clay loam soils and is mostly rural with small towns interspersed throughout. The economy of the region is dominated by cattle ranching and the oil and gas industry, most notably the Eagle Ford Shale formation. The Carrizo Aquifer is in the northern part of this ecoregion, while the Gulf Coast Aquifer is in the southern portion. Located in southern Goliad County and along the Refugio-Victoria County line is the Western Gulf Coastal Plain. The topography of this area is mostly flat with abundant grassy areas and fewer trees than the East Central Texas Plains. Row crops are more common than in the East Central Texas Plains. Farming, ranching, and the petroleum industry make up the primary land use for this ecoregion. The Gulf Coast Aquifer is located in the southern-most portion of the San Antonio River Basin.

Summary of San Antonio River Basin Water Quality Characteristics

As the population increased, so did degradation of water quality in streams of the basin. In the 1700s and 1800s the streams and acequias (irrigation ditches) were used to distribute water for drinking and irrigation. Unfortunately, the same streams and acequias were also used to carry away waste from the City of San Antonio. In the early 1900s, steps were taken to organize the collection of waste. In 1930, the City of San Antonio opened the Rilling Road Wastewater Treatment Plant to treat the waste before discharging it into the San Antonio River.

Eventually, the wastewater generated by the increasing population of San Antonio became too much for the Rilling Road Wastewater Treatment Plant to adequately treat. The discharge from this plant caused depressed DO levels which adversely affected aquatic life. In 1987, the City of San Antonio closed the Rilling Road Wastewater Treatment Plant and opened the Dos Rios Wastewater Treatment Plant. This plant is owned and operated by San Antonio Water Systems (SAWS), which is a public utility of the City of San Antonio. SAWS is governed by a board that consists of the Mayor of San Antonio and six members that are appointed by the city council. With the closure of the Rilling Road plant and the opening of Dos Rios, DO levels in the river increased, causing aquatic life to improve. The Dos Rios Recycling Center discharges to the Lower Medina River. Dos Rios is also permitted to discharge reuse water into the Upper San Antonio River and Salado Creek. The reuse water is also sold to customers that would otherwise use water from the Edwards Aquifer for irrigation. This provides needed conservation of the Edwards Aquifer water resources for the community. Salado Creek

Water Recycling Center discharged effluent into the Upper San Antonio River until the summer of 2006. SAWS also operates the Leon Creek and Medio Creek Water Recycling Centers.

SAWS operates its plants within the specifications required by its permits and discharges a high-quality effluent into the river. Effluent discharge from SAWS plants have low biochemical oxygen demand and total suspended solids. Wastewater discharge from the City of San Antonio and surrounding areas constitutes a large portion of the water flowing downstream below Bexar County.

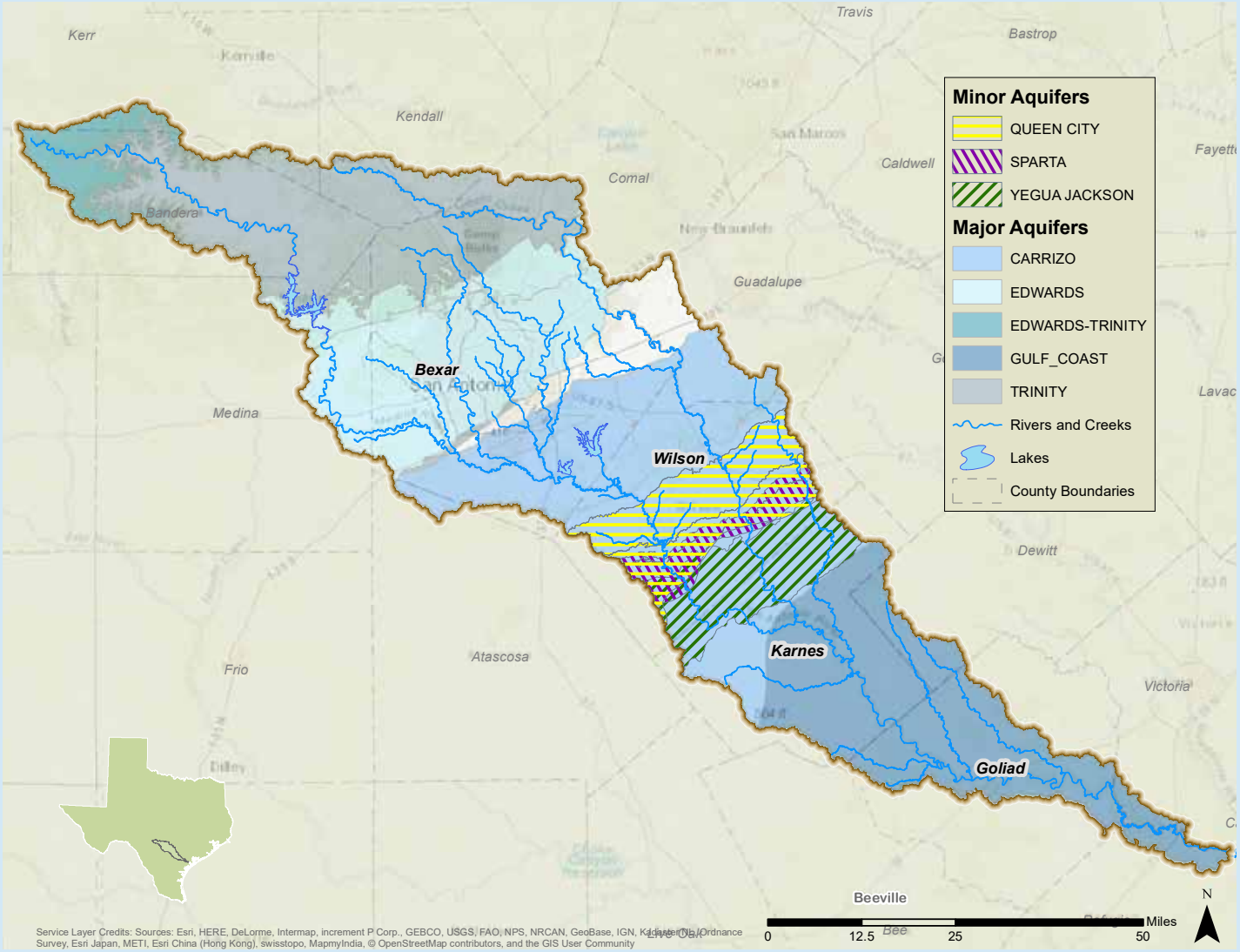


Figure 3: Aquifers in the San Antonio River Basin

Much of the ambient (non-runoff) flow in the San Antonio River Basin originates from the Edwards-Trinity Aquifer System (Figure 3). This system is composed of the Edwards, Trinity and the Edwards-Trinity aquifers (Ryder 1996). Edwards-Trinity aquifer is a karst aquifer in carbonate rock and as a result may be more vulnerable to contamination than the sand aquifers (Maupin and Barber, 2005). The water is hard, due to the limestone, and the pH tends to be above 7.0. The water clarity is good from the springs and wells. Whether from natural causes or pollution from agriculture on the Edwards Plateau, nitrate values are elevated from the springs. There are numerous large springs (e.g., Blue Hole, San Pedro Springs) and many unnamed springs and seeps from the Aquifer System that feed the streams in the basin.

Fall asters *(Symphyotrichum oblongifolium)*

While the Edwards-Trinity Aquifer System is the most well-known and studied aquifer in the basin, the San Antonio River Basin passes over several other major and minor aquifers that recharge and/or contribute water to streams in the basin. The Carrizo-Wilcox aquifer provides water for Wilson County and parts of Bexar County. The Carrizo-Wilcox is a vast sand aquifer. Martinez Springs, northeast of Saint Hedwig in east Bexar County, and Sutherland Springs, northeast Wilson County, originate from the sands of the Carrizo-Wilcox Aquifer. The Gulf Coast Aquifer provides water for both Goliad and Karnes counties. Minor aquifers in the basin include Sparta and Queen; both are sand aquifers located in Wilson County.

Due to the natural geography of the Texas Hill Country, tropical storms from the Gulf of Mexico and large air masses from the north tend to collide over this region creating very heavy rain in Central Texas and the Hill Country. This region is commonly known as Flash Flood Alley. The steep slopes of the Texas Hill Country along with thin soils, exposed bedrock and the rapid development of central Texas and the Hill Country (which has increased the amounts of impervious cover) create a situation where stormwater runoff is very rapid and potentially destructive. Apart from endangering lives and property, the rapid runoff also scours rivers, destroying or disrupting both instream and riparian habitats. Wildlife, especially fish and benthic macroinvertebrate communities, are impaired due to lack of habitat and the force of the flow.

Activities, Accomplishments and Highlights

"A Tale of Two Mussels", Native versus Invasive - The Battle for Texas Waters

Freshwater mussels are very peculiar organisms. They are rarely seen, in fact, most people do not even know there are native mussel species currently living in our creeks and rivers. They do not move much and they have very little sensory capability, yet they are well adapted to their environment and can be, if conditions are suitable, very successful and important members of our river ecosystem. They provide habitat for algae and small benthic macroinvertebrate, serve as prey to many terrestrial animals, and can improve water quality by filtering out impurities. The presence of diverse and reproducing populations of mussels indicates a healthy aquatic system which means good fishing, good water quality for waterfowl and other wildlife, as well as ensures that our waters are safe for recreational use. Conversely, when mussel populations are at risk, it can indicate problems for other fish and wildlife species.

Plain Pocketbook *(Lampsilis cardium)*, West Virginia native mussel, Mussel Fish Lure

Millions of years of adaptation have allowed them to have one of the most fascinating reproductive cycles of any organism. They are sexually dimorphic which means there are separate male and female organisms with unique sex organs. The male broadcasts its gametes into the water column and some of these cells are siphoned in by the female. The female's eggs are then fertilized. Tiny larval mussels called glochidia are formed and are stored in the female's gill pouch. These glochidia rely on a fish host(s) for survival. Some female mussels have adapted a lure type structure which often times look astonishingly similar to the prey fish living around the mussel. The mussels protrude this lure and draw predator fish in. Once the fish bites down on this lure, the glochidia are dispersed in a cloud. Other female mussels simply broadcast their glochidia into the water column where they passively find a fish host. Whichever strategy is used, the glochidia attach to their fish host's gills, fins or other body structure and parasitize the fish. They feed off of bodily fluids until they are mature enough to release themselves from the host and fall onto the substrate. It is a matter of chance whether or not the substrate they fall onto is suitable for survival.

According to the U.S. Fish and Wildlife Service, no other country in the world equals the United States in freshwater mussel variety. The U.S. has nearly 300 mussel species, while Europe has only 12 species. Unfortunately, our mussels are in trouble. It's estimated that 70% of U.S. freshwater mussels are extinct, endangered, or in need of special protection. Many of their problems stem from how they live and the changes to their river habitats. In Texas, there are 15 mussel species listed as threatened at the state level, six of which are candidates for listing under the United States Fish and Wildlife Service (USFWS) Endangered Species Act. Three Central Texas

Austin Davis, SARA Intern - Tampico Pearly Mussel *(Cyrtonaias tampicoensis tecomatensis)* pending verification

species are presently among those listed as threatened by the State of Texas, the Golden Orb (*Quadrula aurea*), the Texas Fatmucket (*Lampsilis bracteata*) and the Texas Pimpleback (*Quadrula petrina*). All are historically found within the San Antonio River Basin.
As the mussel's life and reproductive cycle relies on good water quality and the presence and migration of specific fish species, it is important to document which mussels are currently in the San Antonio River Basin and in what abundances. In an effort to determine mussel densities and species richness in the basin, SARA initiated the 2015 Holistic Freshwater Mussel Project. Data gathered as part of the project is distributed to State and Federal regulatory agencies to assist in decision-making for listing or delisting candidate mussel species. Reconnaissance efforts and intense mussel surveys were conducted on the Lower Cibolo Creek and the West Side Creeks, including Alazan, Apache, San Pedro and Martinez Creeks. Mussel population parameters such as density, abundance, and richness are used to determine and assess the condition of native mussel populations within these watersheds. In 2016 SARA biologists completed qualitative surveys on the Upper San Antonio River and in 2017, the Lower Leon Creek and Lower San Antonio River surveys were completed. Twelve mussel species were collected and identified as part of the project, including one State threatened species, the Golden Orb.

Reasons for decline in freshwater mussel populations include:

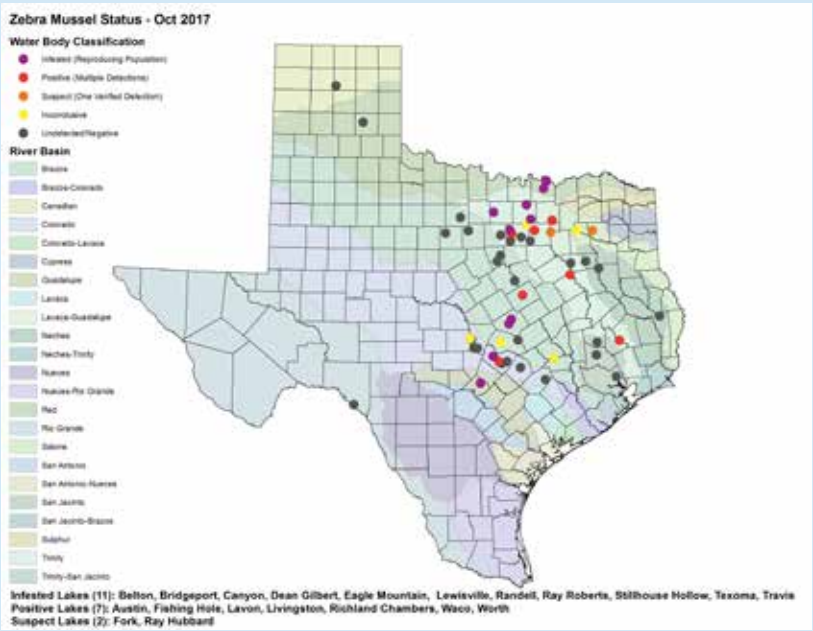
- Changes in flow rates of rivers and streams due to droughts, floods, or building of dams.
- Increased deposition of soft silt due to excessive runoff.
- Scouring of stream beds during storm events.
- Increased amounts of aquatic vegetation.
- Lack of suitable native fish hosts for larval stage.
- Aquatic contaminants.
- Competition from introduced exotic species such as the Zebra Mussel.

Zebra Mussel *(Dreissena polymorpha)*

Zebra Mussels (*Dreissena polymorpha*) are native to the drainage basins of the Aral, Black, and Caspian Seas of Europe and Asia and are considered to be one of the most damaging invasive species introduced to North America. Zebra Mussels were detected in Lake Erie and Lake St. Clair in 1988 and one year later were detected in all five Great Lakes. It is believed they came into the Great Lakes in the ballast water from tanker ships. Adult mussels are approximately one to two inches and live up to five years. The shape of a Zebra Mussels is triangular-shaped with color ranging from tan to cream to dark brown with light and dark bands. Zebra Mussel predators include diving ducks, Pumpkinseed Sunfish, Freshwater Drums, Redhorse Suckers, and Smallmouth Buffalos.

Females generally reproduce in their second year. Over 40,000 eggs can be laid in a reproductive cycle and up to one million in a spawning season which usually occurs in the spring or summer, depending on water temperature. Spawning may last longer in waters that are warm throughout the year. Unlike native freshwater mussels, Zebra Mussels do not require a fish host species to complete the reproductive process.

Zebra Mussel *(Dreissena polymorpha)* ©TPWD



Zebra Mussel larvae are microscopic and dispersal of the free-swimming larvae, called veligers, is passive and can be transported over long distances by water flow. The veligers drift in the water for several weeks and then settle out under the weight of their forming shells onto any hard surface they can find. Zebra Mussels cling to surfaces by using thread-like strands called byssal fibers. These byssal fibers are strong and possess a sticky substance that they use to attach themselves to hard surfaces, such as boat hulls, water infrastructure, and even other organisms. Zebra Mussels also can tolerate a wide range of environmental conditions and adults can even survive out of water for about 7 days.

Zebra Mussels were first discovered in Texas in 2009 at Lake Texoma in the Red River Basin. It is suspected that Zebra Mussels were brought to Texas on the hull of a recreational boat. Thirteen Texas lakes in five river basins can be classified as fully infested with Zebra Mussels, meaning the waterbody has an established, reproducing population: Belton, Bridgeport, Canyon, Dean Gilbert (a 45-acre Community Fishing Lake in Sherman), Eagle Mountain, Georgetown, Lewisville, Livingston, Randell (local Denison

access only), Ray Roberts, Stillhouse Hollow, Texoma, and Travis (TPWD, November 2017). The TPWD has developed the following classifications to waterbodies:

- **Infested Lakes:** Fully infested with Zebra Mussels, meaning the waterbody has an established and reproducing population.
- **Positive Lakes:** Zebra Mussels or their larvae have been detected on more than one occasion.
- **Suspect Lakes:** Zebra Mussels or their larvae have been found once in recent years.
- **Inconclusive Lakes:** Zebra mussel DNA or an unverified suspect organism has been found there in the past year.

According to the TPWD, Zebra Mussels can have biological, recreational and economic impact and can disrupt the ecosystems they invade. Each Zebra Mussels has the ability to filter up to one liter of water per day. Dense colonies can filter large quantities of plankton, zooplankton and algae from the water, decreasing the food supply for native mussels and other filter feeding species. As a result, the ecological balance of an entire waterbody can be disturbed, displacing native species and sport fish. As the water becomes clearer, light penetration through the water column can create conditions favoring growth of aquatic plants in areas where conditions were previously not conducive for vegetation growth. Increased vegetative growth can be beneficial to fish; however, plants can cause problems for recreational boaters. In waterbodies already impacted by invasive aquatic plants, the increase in light penetration to lower depths can significantly escalate the growth and spread of nuisance plants.

Zebra Mussel *(Dreissena polymorpha)* ©*Randy Westbrooks*

Zebra Mussels pose an economic threat to Texas' infrastructure and recreation industries. They clog pipes and intakes, impeding distribution of municipal water supplies, agricultural irrigation, and power plant operation. Zebra Mussels can also impact recreation by limiting recreational opportunities, encrusting docks and beaches, and colonizing recreational equipment including watercraft hulls, engines, and steering components.

As of July 2014, to curb the spread of Zebra Mussels, boaters and anglers in public fresh waters are required by law to drain all water from boats and onboard receptacles before leaving or approaching a waterbody. Boaters in Texas are also required by law to remove any visible plants and animals from all watercraft and trailers before leaving the vicinity of a lake, river, or bay. By following the "Clean, Drain and Dry" procedure boaters can help minimize the chances of accidental transfer of Zebra Mussels or any other exotic aquatic species:

Clean: Remove all plants, animals, and mud and thoroughly wash the boat and trailer. A quick trip to the car wash to use high-pressure spray nozzles can help clean crevices and hidden areas. Remember that boats stored on infested waters may need to be professionally decontaminated.
Drain: Pull the plug! Drain all water before leaving the area, including live wells, bilges, ballast, and engine cooling water.
Dry: Allow time for your boat to dry completely before launching in other waters. Use this calculator, located at http://www.100thmeridian.org/emersion.asp to help determine recommended drying time for your climate and season.

As part of SARA's Mission to protect waterbodies in the San Antonio River Basin, SARA has met with partnering agencies to discuss and proactively implement measures designed to reduce the accidental transfer of Zebra Mussels in the basin. Currently, Zebra Mussels have not been detected in the San Antonio River Basin. SARA and the BCRAGD have placed signage in the Upper San Antonio River Mission Reach and Upper Medina and Medina Lake Watersheds notifying boats about the concern for Zebra Mussels. To assist the TPWD monitor Zebra Mussels, SARA biologists, together with BCRAGD and GBRA staff, have trained with the TPWD on various Zebra Mussel sampling procedures, including collection of water samples to be tested for the presence of veligers and Zebra

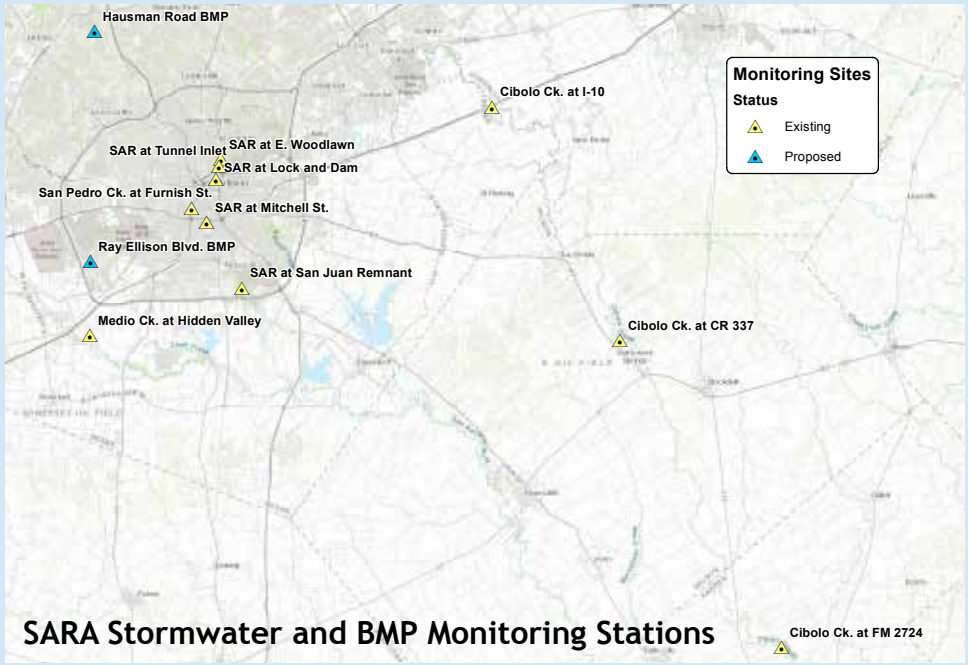
Mussel DNA. For additional information, visit the TPWD website at https://tpwd.texas.gov/fishboat/boat/protect_water/, and the Texas Invasives website at https://www.texasinvasives.org/animal_database/detail.php?symbol=10.

Zebra Mussel Advisory,
Upper San Antonio River Mission Reach

SARA Stormwater Projects and Efforts

As SARA is committed to innovative, collaborative, adaptive and strategic actions that result in watershed solutions, SARA has established a permanent **long-term network of automated instream stormwater stations** to help characterize stormwater runoff and determine its effect on bacterial impaired waterbodies. During storm events, *E.coli* and other contaminants concentrate and mobilize to nearby waterways overland or via stormwater infrastructure and can have negative effects on human health and aquatic ecosystems. Automated instream samplers enables the collection of water quality data from urban and rural waterbodies throughout the San Antonio River Watershed. The automated feature makes stormwater collection safer for field staff, more economically feasible and minimizes exposure to hazardous weather conditions. These stations capture water quality data prior to, during and after storm events. Depending on the station, water quality samples, flow and/or field measurement are collected. Stormwater monitoring sites in the San Antonio River Basin include:

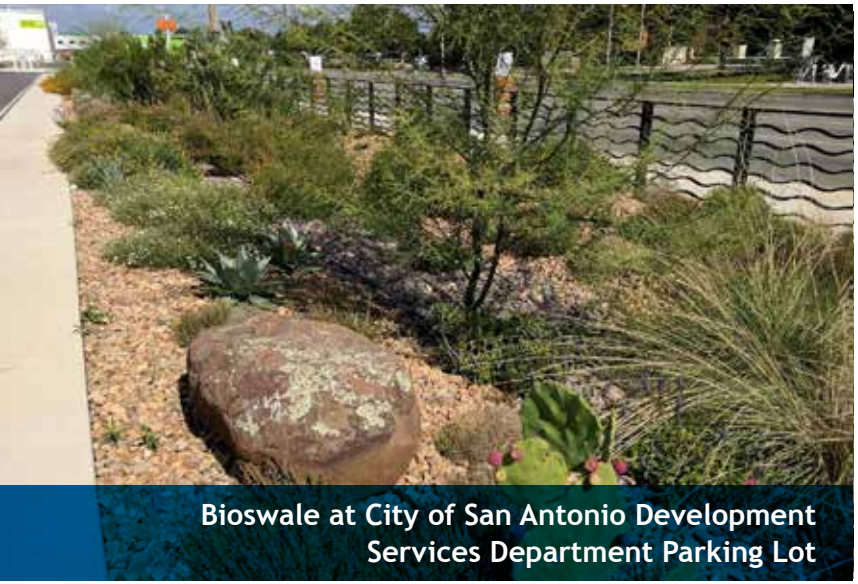
- Station 14256 San Antonio River at Mitchell Street
- Station 12908 San Antonio River at Woodlawn Avenue
- Station 12707 San Pedro Creek at Furnish Street
- Station 12806 Cibolo Creek at CR 337 Southeast of La Vernia
- Station 12919 Cibolo Creek at IH 10/US90 East Bank
- Station 20777 Cibolo Creek at FM 2724 Northeast of Panna Maria
- Station 12916 Medio Creek at Hidden Valley Campground
- Proposed SARA Stormwater BMP Stations at Hausman Road and Ray Ellison Boulevard
- Field measurement stations: San Antonio River at the tunnel inlet, San Antonio River at the Lock and Dam on the River Walk, and the San Antonio River at the San Juan Remnant



In recent years low impact development (LID) and best management practices (BMP) have been encouraged to mitigate impacts of stormwater runoff from impervious cover. SARA has implemented several programs that assist in funding the construction of various LID projects. In order to track the progress of LID implementation in our communities, the **BMP Verification Project** was initiated to develop a spatial database of stormwater BMPs and LID. This database will help track current and future LID/BMP development. The two most common BMPs are bioretention and cisterns. Bioretention BMPs can be bioswales or rain gardens that allow for filtration and bioaccumulation and biotransformation/phytoremediation by temporarily storing stormwater runoff. These are common BMPs because they are efficient in removal of suspended solids, heavy metals, adsorbed pollutants, nitrogen, phosphorus, and pathogens and are easily integrated in a variety of sites. Cisterns are another commonly used BMP strategy. Cisterns or rain barrels are used as storage devices to reduce the total runoff volume by collecting and later releasing the captured stormwater.

SARA Watershed Wise Grant provides funds to construct LID and BMPs at K-12 public schools within Bexar, Wilson, Karnes, and Goliad counties. This project began in 2015 and is projected to be completed in 2019. The purpose of this project is to educate the public about stormwater runoff and the effects on nonpoint source pollution, flooding, and erosion, while also demonstrating that these issues can be alleviated by green infrastructure. Depending on the year, anywhere from two to four grants, up to $22,000 per grant, are awarded to local schools. These projects are used by SARA educators to provide in-class presentations and activities on the importance of green infrastructure. To date, approximately $225,000 have been awarded to nine schools.

Bioretention gardens at Hector Garcia Middle School



Bioswale at City of San Antonio Development Services Department Parking Lot

SARA's Watershed Wise Rebate program provides funds to construct stormwater BMPs for new construction and retrofit of existing properties within Bexar, Wilson, Karnes, and Goliad counties. This project began in 2016 and is expected to conclude in 2020. The purpose of this project is to increase the amount of stormwater treatment in the San Antonio River basin. The rebate amount, ranging from $15,000 - $100,000, is calculated based on the type of BMP and the volume of stormwater treated. Each project may have multiple BMPs and are required to treat a minimum of 60% of stormwater generated from on-site impervious surfaces. Rebate recipients are required to operate and maintain the features for a minimum of three years. To data SARA has dedicated $1,295,000 in rebate funds during the life of this project.

To meet energy, water, and vehicle emission reduction goals on new construction and retrofits, 2030 Districts are forming nationwide. The 2030 Districts bring property owners and developers together with local governments and stakeholders to collaborate on a business model for urban sustainability. SARA was a founding member of the **San Antonio 2030 District** in 2015. SARA has assisted in the adoption of goals for increased stormwater management with the use of Low Impact Design techniques. In addition to increasing the water quality of the San Antonio River, LID helps the 2030 District achieve its goal of combating climate change by reducing water consumption and subsequently energy usage.

The San Antonio River Authority (SARA) and Bexar County developed **LID Training Courses** for the construction inspection and maintenance of LIDs permanent stormwater BMPs. The LID training program is comprised of two courses. The Construction Inspection Registration course focuses on key factors of LID BMP construction inspection to ensure proper functioning at the time of construction. The Annual Inspection and Maintenance Certification course focuses on post-construction activities to ensure proper functioning into the future. The LID BMPs addressed in the program include bioretention (e.g. rain gardens, bioswales), permeable pavement, sand filters, green roofs, vegetated swales, vegetated filter strips, stormwater wetlands, and cisterns.

The courses have been well attended by public and private sector Professional Engineers, Architects, Landscape Architects, planners, construction inspectors, contractors and maintenance personnel. SARA plans to continue offering the courses in the future and will maintain the lists of registered and certified individuals. These courses are an important step towards ensuring that LID BMPs are installed, inspected and maintained properly so they provide the critical functions necessary to benefit water quality in the San Antonio River.

Cistern at MacArthur High School

SARA Environmental and Pollution Investigations Team

One of the ways the SARA protects waterways in the San Antonio River Basin is through the Environmental Investigation team. Watersheds within the basin are frequently patrolled by vehicle and annually by air for illegal activity and environmental crimes. When an illegal activity is found, an investigation takes place to identify the responsible party and assess harmful impacts to water quality, riparian habitat, and human health and safety. The investigation team will then partner with regulatory agencies to help resolve all unauthorized and illegal activities. Investigations include, but are not limited to:

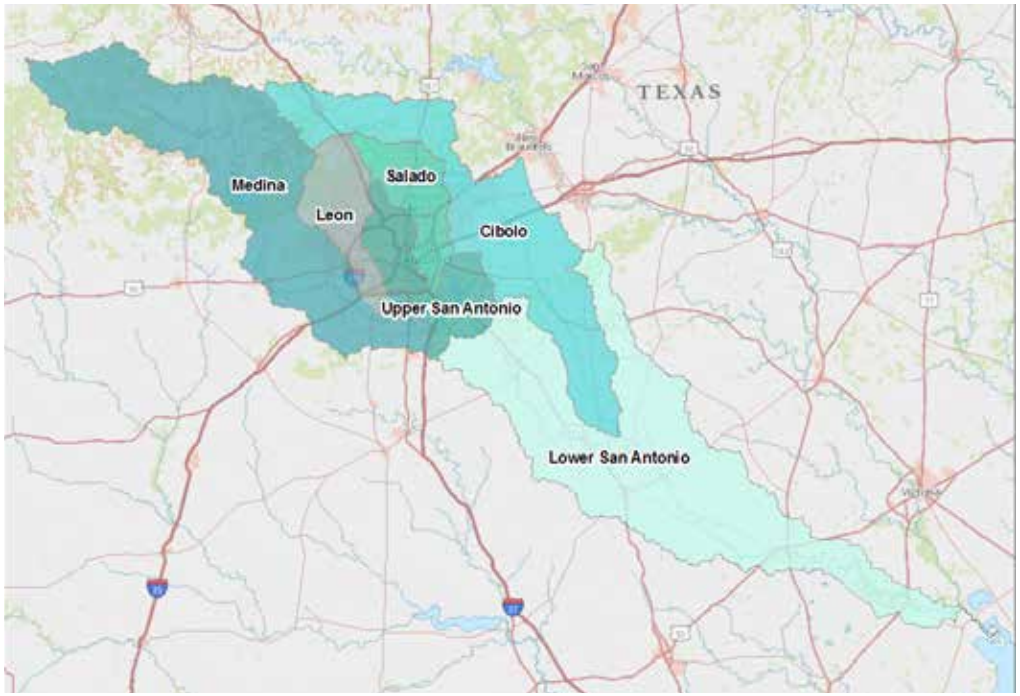
- Citizen complaints and concerns of water quality and illegal dumping
- Fish kills, permit violations, chemical and fuel spills
- Wildlife and aquatic habitat destruction
- Floodplain violation and stream encroachment
- Unauthorized and unpermitted activities

Working and communicating with the public are important duties of the investigation team. The team strives to educate the public about waterways and the harm that illegal activities can cause to wildlife habitat, aquatic ecology, and the beauty of a stream. If a citizen sees activities such as dumping of hazardous materials into a waterway, they should first call a local law enforcement officer to report the incident. A citizen can report a non-emergency incident to SARA's investigation team at (210) 227-1373 or, toll free at 1 (866) 345-7272. The team will research solutions to solve the problem and keep the caller informed of progress. The team will also make sure that the appropriate regulatory agency is contacted.

San Antonio River Basin Watershed Master Plans

SARA has been working with partner agencies since 2009 to complete watershed master plans for the Upper San Antonio River, Leon Creek, Salado Creek, Medina River, Lower San Antonio River, and Cibolo Creek watersheds. The master plans have two primary objectives:

- Identify needs and resources related to flood risk, water quality issues, low impact development, stream restoration, nature based park planning, mitigation banking, and conservation easements.
- Develop and assess proposed projects to address the identified needs and preserve identified resources.



Many of the project recommendations related to flood risk are in design or construction. Projects addressing other needs have not been as readily implemented due to high cost or broad scope. Efforts are underway to define more specific projects targeting water quality, particularly in the Leon Creek, Salado Creek, Upper San Antonio River, and Cibolo Creek Watersheds.

In addition to project recommendations, the findings of the initial master planning efforts have supported initiatives related to a variety of implementation actions from improving data resources to influencing policy. Two major findings guide many initiatives:

- Protecting the natural floodplain as a riparian buffer would provide benefits for water quality, stream stability, and flood risk.
- Retrofitting developed areas with water quality and flood control projects is expensive and constrained by limited land availability and utility conflicts. Low impact development, conservation development, and other development approaches with consideration for minimizing impacts to hydrology and water quality should be implemented for future development.

Protecting the natural floodplain provides water quality, stream stability, and flood risk benefits. Through an assessment of stream condition, stream segments within the river basin have been identified as candidates for preservation. These segments have healthy riparian buffers and no evidence of instability. These segments are recommended for protection through conservation easements and nature-based parks such as the linear creekway park system in the City of San Antonio.

Stream segments with evidence of instability but with other conditions that would allow for stream restoration have been identified as candidates for restoration or rehabilitation. These stream reaches are being prioritized as sites for mitigation banking and stream restoration through partnership programs.

Because development practices have been linked to changes in water quality, flood risk, stream stability, and retrofitting existing development is less efficient and more expensive than applying BMPs to new development, strategies for incentivizing Low Impact Development are being promoted. As a result, the City of San Antonio has updated their Unified Development Code to include Low Impact Development and to revise the section on conservation development. SARA also offers a rebate program to assist with the cost of implementation. Additional information can be seen on SARA's web site located at https://www.sara-tx.org/lid-sustainability/low-impact-development/rebate-program/.

Mission Reach of the San Antonio River

2.0 Public Involvement

San Antonio River Basin Environmental Advisory Committee (EAC)

SARA engages in numerous environmental studies and projects involving a public outreach component. Many of these studies and projects are identifying overlapping concerns and would benefit from cross-sharing the knowledge acquired. In 2005, the SARA 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 began its work in April 2005. The advisory committee consists of up to 13 members, including two co-chairs, one representing Bexar County and the other representing a downstream county. Each member serves staggered, 3-year terms determined by the SARA Board of Directors by lottery in August 2015. If deemed necessary by SARA staff to maintain a diverse and representative committee, an EAC member may serve beyond their term limit until an appropriate replacement can be approved and appointed by the SARA Board of Directors. The table below lists the interest groups represented on the EAC. Some groups have more than one seat on the committee.

General Stakeholder Categories for the Environmental Advisory Committee	
Co-Chairs	Academia
Agriculture	Bay and Estuary
Business and Industry	Counties
Environmental	Recreational

At the start of each fiscal year, SARA staff sends nomination solicitation letters to individuals and organizations who can fill vacant member positions from these general stakeholder categories. SARA staff from Intergovernmental and Community Relations, Environmental Sciences and Parks review all nominations and submit a list to the SARA Communications Committee and the full Board of Directors for approval of member appointments in the regular August board meeting. SARA is privileged to have an extraordinary group of individuals who have volunteered their time to improve the environmental health of the San Antonio River Basin.

To increase the public's knowledge and involvement in water quality issues, SARA provides public outreach materials and promotes the following educational activities:

River Reach Quarterly Newsletter

Water quality information is regularly provided to the public through SARA's quarterly newsletter, *River Reach*. Created in 2003, the newsletter also features water quality-related community events that are hosted and/or sponsored by SARA. River Reach is distributed by regular mail and email to stakeholders throughout South Central Texas, including SARA's jurisdiction of Bexar, Wilson, Karnes and Goliad counties. It is also distributed in person throughout the area at school functions, community events and public meetings. SARA's mailing list database contains more than 10,000 names and grows continually as interested stakeholders sign up to receive the newsletter. The River Reach Newsletter can also be viewed at https://www.sara-tx.org/public-information/about-sara/newsletters/.

The Watershed Wise River Discovery Project

The Watershed Wise River Discovery Project is a digital outreach project that aims to inspire actions for healthy creeks and rivers and demonstrate SARA watershed expertise by redesigning the content of the SARA website. The new content aims to encourage exploration and discovery of topics such as water quality, recreation, flood mitigation, ecology, and bay systems via interactive components; these components include dynamic maps, storytelling, educational videos, and graphics. The content will provide constituents, tourists, students, decision makers, and citizens everywhere the most up-to-date and relevant information regarding watershed management and stewardship, while also encouraging recreational use of the San Antonio River and SARA parks. The content of the topics will also pave additional avenues for constituents to take action through SARA's Watershed Wise volunteer and educational programming.

"Watershed Wise" Program

In 2013 the Be Watershed Wise education initiative led the way for the creation of the Watershed Wise Warriors, a community volunteer program that offered monthly opportunities for individuals to actively make an impact within the San Antonio River watershed through projects such as trash pick-ups, tree plantings, and educational opportunities, among others. The program has successfully recruited more than 600 volunteers as of 2017 and volunteers have helped plant thousands of trees along the Mission Reach segment and collected hundreds of tons of trash from the banks of the San Antonio River. Inspired by the success of the Watershed Wise Warrior, SARA launched the Watershed Wise program in 2016. The Watershed Wise brand features multiple ways for individuals, stakeholder groups, schools, businesses and industry professionals to get involved. Some of the groups under the Watershed Wise brand include: Warrior, Citizen Scientist, Professional, Student, Educator, Resident, Business, Agricultural and programs like the Watershed Wise Grant and Rebate. Each of the groups will provide tailored information and resources that can be applied and shared via SARA's website in addition to materials to help promote the Watershed Wise brand throughout the community.

Teacher Workshop Series

Watershed Wise Education Leaders is a free, professional development workshop for public school educators that serve Kindergarten through 12th grade in Bexar, Wilson, Karnes and Goliad Counties. SARA understands the critical importance of inspiring action for healthy creeks and rivers and knows that teachers are key in providing young citizens with the tools necessary to be innovative and take such action. Since 2015, teachers can earn State Board of Education Continuing Professional Education credits across a series of workshops that focus on watersheds, river ecology, water quality, STEM careers, aquatic science and sustainability best practices.

Mission Reach Field Trips and Guided Tours

The Mission Reach of the San Antonio River is an 8 mile ecosystem restoration project that covers 400 acres of restored riparian habitat along the San Antonio River. SARA staff provide guided tours by foot, bicycle, kayak, or motor vehicle and highlight the native vegetation that has been planted and the ongoing management of the project. SARA staff also provide field trips at different locations along the Mission Reach for K-12 students with curriculum aligned with Texas Essential Knowledge and Skills (TEKS) standards for each grade level.

Basura Bash

In partnership with the San Antonio River Foundation, the Basura Bash Planning Organization, and a host of private businesses that sponsor staff, professional services and other resources, SARA supports the citizen-led Basura Bash trash collection and recycle event. In addition to removing trash and recyclables from the banks of the San Antonio River and its 15 tributaries, the event, along with the press conference kick-off, serves to increase awareness of the need for river basin stewardship.

SARA-SPONSORED AND/OR ATTENDED COMMUNITY EVENTS

A list of previous SARA-Sponsored and/or Attended Community Events can be viewed in previous Basin Highlight and Summary Reports. The list below covers the time not presented in the 2016 Basin Highlight Report to the present:

July 2015
- 21 • Bat Loco Educational Talk

August 2015
- 11 • Bat Loco Bash

September 2015
- 4-6 • Labor Day Campout
- 17 • Missions Tour de Goliad
- 19 • Goliad County Hazardous Household Waste Event
- 25 • National Public Lands Day

October 2015
- 17 • Wilson County Hazardous Household Waste Event

November 2015
- 7 • Karnes County Hazardous Household Waste Event
- 14 • Pecan Jubilee

December 2015
- 5 • Museum Reach River of Lights

January 2016
- 23 • Mission Reach Tree Planting

February 2016
- 5 • Mission Reach Tree Planting
- 20 • Basura Bash
- 27 • Birds, Bass and Boats

March 2016
- 12 • Birds, Bass & Boats

April 2016
- 9 • Mission Reach Flotilla
- 16 • Birds, Bass & Boats
- 23 • Earth Day Wildflower Hike
- 30 • Watershed Wise Warriors Mission Reach Cleanup

May 2016
- 14 • Archery Day
- 20 • Watershed Wise Warriors Museum Reach Ladybug Release
- 21 • Citizen Scientist Bio Blitz

June 2016
- 9 • Environmental Film Fest
- 11 • Watershed Wise Warriors Mission Reach Cleanup
- 17 • Watershed Wise Warriors River Safari

July 2016
- 16 • Watershed Wise Warriors MROC Tour

September 2016
- 8 • San Pedro Creek Improvements Project Phase 1 Groundbreaking
- 17 • Karnes County Waste Collection Event
- 24 • Med Drop-SA
- 24 • National Public Lands Day at Acequia Park
- 24 • Become a Texas Parks and Wildlife Department-Certified Angler Education Instructor!

October 2016
- 8 • Wild for Wildlife
- 21 • SARA's Environmental Film Fest: Southern Basin Screening
- 22 • Wilson County Household Hazardous Waste Collection Event

November 2016
- 5 • Canoe Trail Goliad's 15th Annual Fall Harvest Flotilla
- 5 • River Relay & Get Outdoors Fair
- 18 • Agricultural Chemical Collection Event
- 19 • 2nd Annual Pecan Jubilee and Dessert Bake-Off Contest

December 2016
- 3 • Museum Reach River of Lights & Deck the River Contest

January 2017
- 14 • Mission Reach Volunteer Tree Planting
- 21 • MedDropSA Free Medicine Disposal
- 21 • Elmendorf Lake – Completed Improvements Celebration

February 2017
- 11 • Mission Reach Tree Planting
- 11 • Planets in the Park
- 14 • Love Bird Nature Walk
- 17-20 • Great Backyard Bird Count

March 2017
- 11 • Karnes County Household Hazardous Collection Event
- 15 • Open House at SARA Headquarters
- 25 • Snakes in the Park
- 27-28 • LID Design & Construction Inspection Registration Course

April 2017
- 1 • SARA Rain Garden Workshop
- 8 • Mission Reach Flotilla Festival
- 22 • Wilson County Hazardous Household Waste Event
- 22 • Earth Day Butterfly Walk
- 29 • Volunteer Planting Day
- 29 • Canoe Trail Goliad's Spring Flotilla

May 2017
- 1-2 • Annual Inspection & Maintenance Certification
- 6 • Piñatas in the Park – Part of the Goliad Cinco De Mayo Celebration
- 13 • Clean Up Day
- 20 • MedDropSA – Free Medicine Disposal
- 20 • SARA Rain Garden Workshop

June 2017
- 8 • SARA's 4th Annual Environmental Film Fest
- 13-16 • Watershed Wise Education Leaders – Teachers Workshop Series
- 22 • SA300 Project WET Teacher Workshop
- 22 • SARA's Environmental Film Fest – Southern Basin Screening

August 2017
- 5 • Fin Addict Angler
- 8 • Bat Loco Bash
- 30 • Sustainable Landscape Practices for Contractors Workshop

September 2017
- 6 • Watershed Health and LID Workshop with EcoCentro
- 9 • Goliad County Free Household Hazardous Waste Collection Event
- 16 • MedDropSA – Free Medicine Disposal
- 17 • LID Annual Inspection and Maintenance Course
- 17 • LID Construction Inspection Course
- 30 • National Public Lands Day at Acequia Park

Teachers Workshop Series

Mission Reach Flotilla

Watershed Wise Warriors Cleanup Event

Annual Bat Loco Event

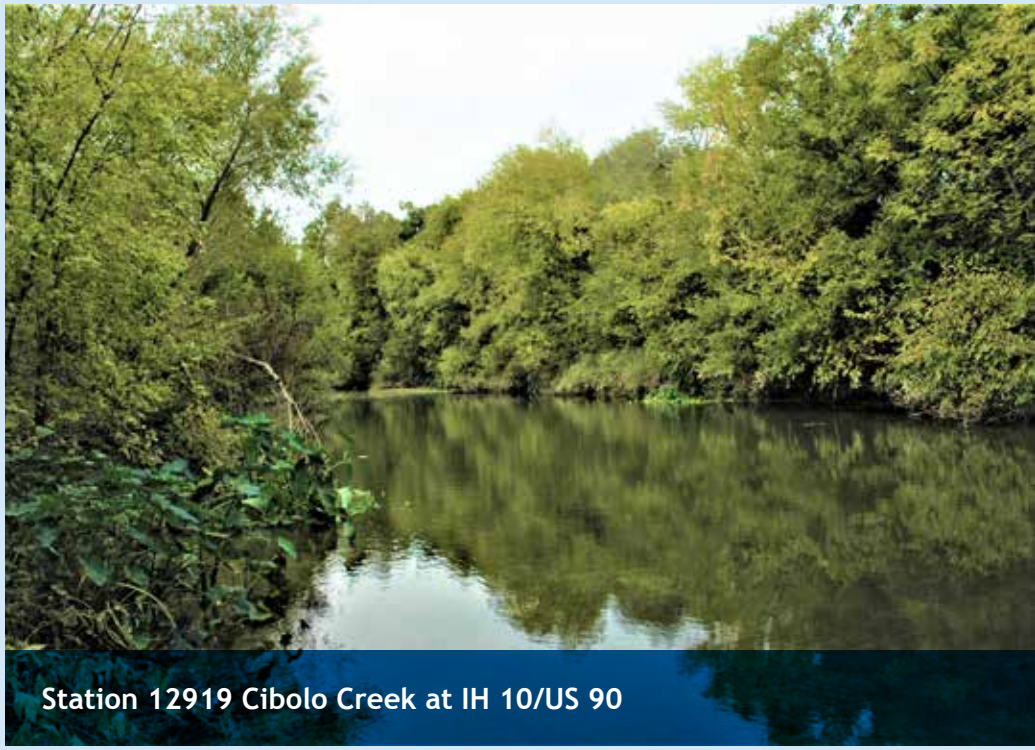
3.0 Water Quality Review

The watershed summaries in this section describe water quality based on chemical and biological data collected by the SARA, USGS, GBRA, TCEQ, and their contractors. The information represents a snapshot of the levels of bacteria, nutrients, aquatic life use, and other water quality parameters at 180 sites throughout six watersheds in the San Antonio River Basin. The data was obtained from the TCEQ surface water quality information system (SWQMIS). Water quality information in this report was derived from two assessment methods:

- A review of how the water quality in the San Antonio River Basin compares to the Texas Surface Water Quality Standards (TSWQS) using the TCEQ 2014 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d). The 2014 IR is on the TCEQ's website located at http://www.tceq.texas.gov/waterquality/assessment/305_303.html.

- Trend analysis was performed using a minimum of a 10 year data set containing at least 20 values covering the trending period. The trending period covers June 1, 2006 to May 31, 2016.

The 2014 Integrated Report assessment period of record for the last seven years is December 1, 2005 through November 30, 2012. Samples from these seven years are evaluated when available, and if necessary, the most recent samples collected in the preceding three years (December 1, 2002 through November 30, 2005) can also be included to meet the requirements for minimum sample number.


Station 12919 Cibolo Creek at IH 10/US 90

3.1 Water Quality Terminology

Prior to presenting the water quality summary for each watershed in the San Antonio River Basin, an understanding of terminology, water quality parameters and TCEQ assessment methodology and processes are needed to understand the complex issues involved in monitoring and assessing data.

In the Texas Surface Water Quality Standards, the TCEQ has assigned five categories of designated uses for all classified waterbodies in Texas: aquatic life, contact 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, contact recreation standard and general use. See Table 3.1 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: Each classified segment in the TSWQS is assigned an aquatic life use (ALU) based on physical, chemical and biological characteristics of the waterbody. The five ALU categories are exceptional, high, intermediate, limited or minimal (no significant aquatic life). Support of the ALU is based on the assessment of:

- 24-hour and grab dissolved oxygen criteria.
- Toxic substances in water and sediment criteria (metals and organics).
- Ambient water and sediment toxicity test results.
- Habitat, benthic macroinvertebrate, and fish community indices.

Provided the minimum number of samples are available, each set of criteria is generally evaluated independently of the others; an impairment of the ALU results when any of the individual criteria are not attained. For freshwater streams not classified in the TSWQS, the ALU and criteria are presumed based on the stream flow type. Stream flow type is established from flow data associated with samples, information provided by local monitoring staff, previous assessments, or recent receiving water assessments. Stream flow types include perennial, intermittent and intermittent with perennial pools.

Largemouth Bass and Sunfish

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: *Escherichia coli (E. coli)* in freshwater, and Enterococci in tidal waterbodies and certain inland waterbodies. *E. coli* is used to assess recreation use attainment in the San Antonio River Basin.

General Use: Water quality criteria for several constituents are established in the TSWQS to safeguard general water quality, rather than for protection of one specific use. Support of the General Use is based on the assessment of:

- Water temperature
- pH
- Chloride
- Sulfate
- Total dissolved solids (TDS)
- Conductivity
- Ammonia nitrogen
- Nitrite nitrogen
- Nitrate nitrogen
- Total phosphorus
- Chlorophyll-*a*
- Secchi depth

These parameters protect aquatic life, recreation, public water supply, and other beneficial uses of water resources. For the purpose of assessment, the criteria protecting these multiple uses are evaluated for attainment of a construct entitled “general use.”

Specific criteria for each of the other parameters are assigned to every classified segment in the TSWQS based on physical, chemical, and biological characteristics. Water temperature, pH, chloride, sulfate, TDS and chlorophyll-*a* criteria developed for classified segments do not apply to unclassified waterbodies.

Concerns for general uses are identified with screening levels for nutrients and chlorophyll-*a* for both classified and unclassified waterbodies with the exception of some classified reservoirs identified in the TSWQS for which chlorophyll-*a* site specific criteria were developed. Although other concerns are reported for general use, attainment of the general use for unclassified waterbodies is not assessed and therefore not reported.

Upper Medina River Watershed


Lower Cibolo Creek Watershed

Fish Consumption Use: Fish consumption use attainment and concerns are evaluated with three assessment methods:

- Advisories, Closures, and Risk Assessments.
- Human Health Criteria for Bioaccumulation and Fish Consumption Use.
- Human Health Fish Tissue Criteria Concerns.

For a full assessment of use attainment for fish consumption and a determination of fully supporting, a Texas Department of State Health Services (DSHS) risk assessment or advisory is required. Risk assessments are costly and conducted only on waterbodies where the assessment has indicated a risk from consumption. Additional information may be found on the DSHS website http://www.dshs.texas.gov/seafood/advisories-bans.aspx?terms=Leon%20Creek.

Public Water Supply Use: Public water supply use (PS) 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). Segments designated for aquifer protection (AP) are capable of recharging the Edwards Aquifer. The principal purpose of this use designation is to protect the quality of water infiltrating into and recharging the aquifer and applies to designated portions that are on the recharge zone, transition zone or contributing zone as defined in the TSWQS.

Additional information on designated uses for all classified waterbodies in Texas can be found in the 2014 Guidance for Assessing and Reporting Surface Water Quality in Texas at the TCEQ website https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_guidance.pdf.

Every five years, SARA publishes a Basin Summary Report as required by the CRP. This report, last conducted in 2013, provides a detailed review of parameters analyzed, designated uses and associated water quality concerns and impairments in the San Antonio River Basin. The SARA CRP Basin Summary and annual Basin Highlight Reports are located on the SARA website https://www.sara-tx.org/environmental-science/basin-highlights-reports/.

Table 3.1 Site-Specific Uses and Criteria for Classified Segments as identified in Appendix A in the TSWQS

Segment	Segment Description	Uses			Criteria										Nutrient Screening Levels[8]				
		Recreation	Aquatic Life Use	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] (°C)	E. coli geomean[1] (CFU/100ml)	Ammonia Nitrogen (mg/L)	Nitrate Nitrogen (mg/L)	Ortho Phosphorus (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	0.37	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	0.37	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	0.37	0.69	14.1
1904	Medina Lake[7]	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	0.05	0.20	5[9]
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	0.37	0.69	14.1
1906	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	0.37	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	0.37	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	0.37	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	0.05	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	0.37	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	0.37	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	0.37	0.69	14.1
1913	Mid Cibolo Creek	PCR1	Limited		150	150	750	3.0	2.0	3.0	2.0	6.5-9.0	32.2	126	0.33	1.95	0.37	0.69	14.1

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

2 The public water supply designation for Segment 1903 does not apply from the confluence of the San Antonio River in Bexar County upstream to a point 2.5 km (1.5 mi) 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 The public water supply designation for Segment 1906 does not apply from the confluence of the Medina River in Bexar County to a point 4.8 km (3.0 mi) upstream.

6 Temperature was coverted from °F to °C, the criteria for temperature are listed as maximum values at any site within the segment.

7 For Segment 1904 Medina Lake, assessment of nutrients (chlorophyll a, ammonia, nitrite plus nitrate, and TP) is based on exceedances of individual sample with screening levels.

8 There are no State numerical nutrient stream water quality standards, only screening criteria. Phosphorus, ammonia, nitrate, and chlorophyll-a data is utilized to indicate areas of possible concern.

9 Medin Lake chlorophyll-*a* 5µg/L is a standard approved by the U.S. EPA in June 2010.

2014 Texas Integrated Report for Clean Water Act Sections 305(b) and 303(d) (formerly called the "Texas Water Quality Inventory and 303(d) List"). The Integrated Report evaluates the quality of surface waters in Texas, and provides resource managers with a tool for making informed decisions when directing agency programs. The Texas Integrated Report describes the status of Texas' natural waters based on historical data. It identifies waterbodies that are not meeting the TSWQS. The Texas Integrated Report satisfies the requirements of federal Clean Water Act Sections 305(b) and 303(d). The TCEQ produces a new report every two years in even-numbered years, as required by law. Past and current Texas Integrated Report can be found at the TCEQ website https://www.tceq.texas.gov/waterquality/assessment. At this time, the 2014 IR is the most current IR released by the TCEQ.

Guidance for Assessing and Reporting Surface Water Quality in Texas (Guidance). In the development of the 2014 Integrated Report, specific assessment methods were utilized as described in the 2014 Guidance for Assessing and Reporting Surface Water Quality in Texas (Guidance). The Guidance is located at https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_guidance.pdf. The document 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.

Surface Water Quality Measurements. A major CRP monitoring objective is to provide the TCEQ data to support the assessment of surface water quality, water quality standards and wastewater permits. Monitoring decisions are made considering the monitoring types, parameters analyzed, and the minimum number of samples needed to assess waterbodies in the San Antonio River Basin. Under the SARA CRP, there are two types of sampling events conducted throughout the basin.

Routine Sampling (RT) events are scheduled in advance without intentionally trying to target any certain environmental conditions. With safety in mind, samples are collected regardless of the conditions encountered that day. See Appendix B for a list of water quality parameters, their impact and potential cause of impairments. Bacteria and conventional chemical parameters collected and analyzed for RT sampling events include:

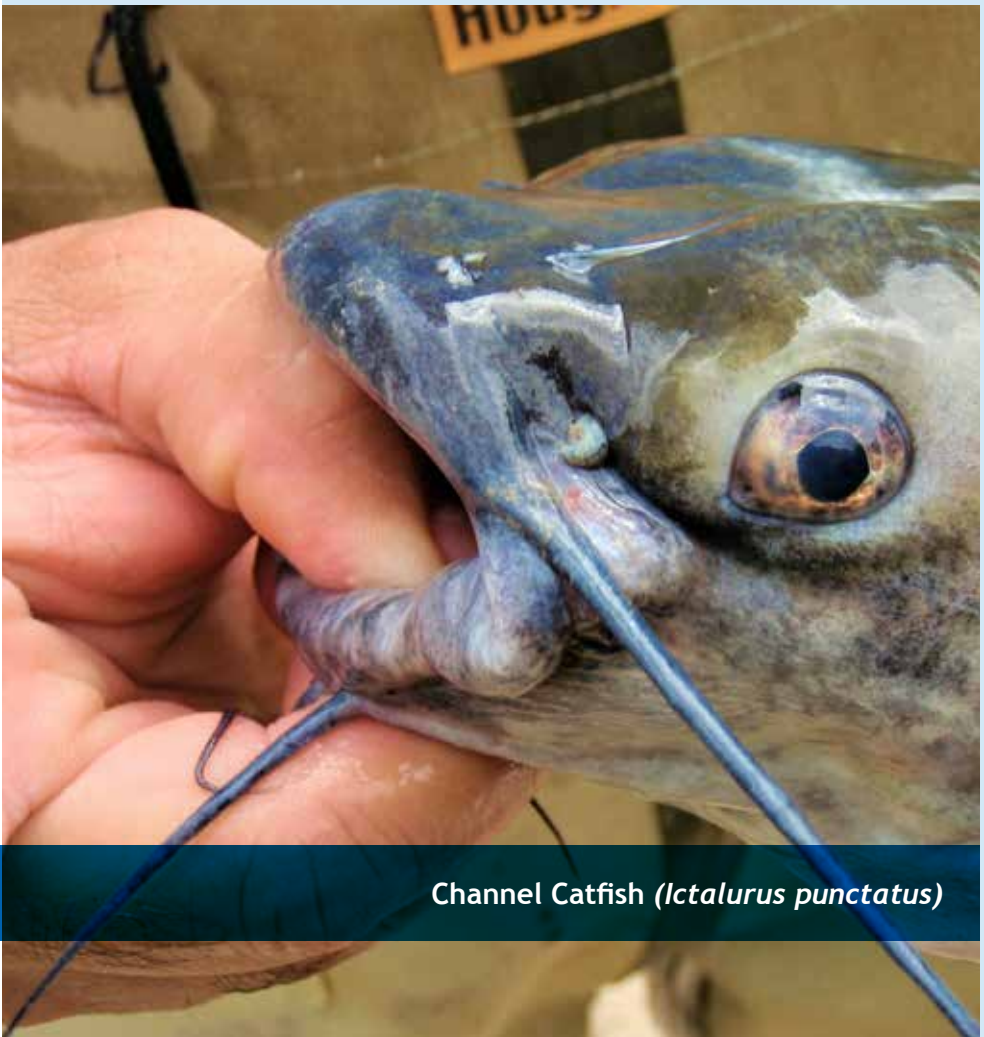
- *E. coli*
- Chloride
- Sulfate
- Total Kjeldahl nitrogen (TKN)
- Total suspended solids (TSS)
- Ammonia nitrogen
- Nitrite nitrogen
- Nitrate nitrogen
- Total phosphorus
- Chlorophyll-*a*
- Temperature
- pH
- Conductivity
- Dissolved oxygen
- Secchi depth
- Flow
- Biological Oxygen Demand and Metals in sediment (Specific sites throughout the basin)

Largemouth Bass (top) and Guadalupe Bass Fry

Biased Season (BS) sampling events are scheduled for a certain time of year and are meant to capture the conditions characteristic of that time of year. Keeping safety in mind, BS samples are collected regardless of the flow conditions encountered that day. Parameters collected and analyzed for BS sampling events include:

- Fish, benthic macroinvertebrate, and habitat
- 24 hour dissolved oxygen
- Flow measurements

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 a 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 river basin in which they are located. The last two digits distinguish individual segments within the particular basin. For example, Segment 1905 is in basin 19, San Antonio River Basin, and 05 represents the Medina River above Medina Lake 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.



Channel Catfish *(Ictalurus punctatus)*

Because of the great amount of surface waters in the State, not all bodies of water are classified in the standards. For example, when managing a classified segment of the Medina River above Medina Lake, 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 segment***. This unclassified segment will be designated with the number of the classified segment within the watershed in which it is located, along with a letter. Example 1905A North Prong Medina River is a tributary of the Medina River above Medina Lake. Unclassified segments are small and often intermittent waterbodies, normally ceasing flow for weeks or months each year, and are not typically assigned specific water quality standards. Unclassified segments are generally assessed on the flow criteria along with the classified segment into which they flow, but in some cases may be assigned specific water quality standards.

Each segment is further broken down into smaller subareas called ***assessment units*** (AU). An AU is defined as the smallest geographic area of use support reported in the assessment. Each AU within a segment is assigned a number such as 1905_01. All AUs include the underscore symbol which distinguishes them from segments. A segment may consist of more than one AU, 1905_01, 1905_02, and so on. Support of criteria and designated uses are evaluated for each AU. To address water quality regulatory activity such as permitting, standards development, and remediation, use support information applies at the AU level. The 303(d) List is reported at the AU level for each waterbody.

Trend Analyses. The statistical design for this report includes descriptive statistics and trend analyses over both time and flow. Trending over time is an important tool in assessing and understanding the condition of water resources and the pollution that affect them. This information helps water quality policymakers determine if implemented water quality management strategies are effective in achieving or maintaining water quality standards. In addition to parameter trends over time, comparisons between parameter trends and flow trends are also important trending tools used by water quality managers. Flow is an important physical property of creeks and streams and can affect the distribution of habitat, aquatic organisms and concentrations of various compounds. In the San Antonio River Basin, low flows are normally experienced during the hottest times of the year where water temperatures are at their warmest and dissolved oxygen concentrations are at their lowest. Low flows or drought conditions can also concentrate TDS, pH, nitrate, total phosphorous, chloride, sulfate and chlorophyll-*a.* Conversely, high flows have a general tendency to decrease the concentration of these parameters while increasing others such as TSS, and DO deficit. As appropriate, parameter concentration versus flow trending information may be discussed in each watershed summary. *E. coli* is one those parameters that may increase or decrease depending on environmental conditions. During drought condition, direct deposition from wildlife congregating and living in the riparian zones may increase *E. coli* concentrations in waterbodies. Conversely, periods of frequent rainfall often correlates with the highest *E. coli* concentrations as runoff from urban and rural land enters surface water.

Data for selected stations throughout the San Antonio River Basin was retrieved from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS). Analytical methodology generally followed the guidelines indicated in the CRP guidance, Task 5, Exhibit 5E. Descriptive statistics, trend analyses, and graphing were conducted using a custom function set in MATLAB® software, version R2015b. Results were exported to Microsoft Excel for formatting. Reported standards were taken from the 2014 TSWQS. Trend analyses required the dataset to include a minimum of 20 samples over a 10 year period, June 1, 2006 to May 31, 2016, to have minimal continuity disruption, and to be monitored over the majority of the trending period. Significant trends ($p<0.10$) were identified as either decreasing "↓" or increasing "↑". With the exception of flows and dissolved oxygen (DO) deficit, decreasing parameter trends are generally beneficial and increasing trends are detrimental to water quality. Surface water flow magnitude, timing, duration and frequency plays a critical role in supporting the ecological integrity of streams and rivers. At certain times of the year, increasing or decreasing flows maybe beneficial or detrimental to aquatic life cycles and riparian habitat. The flow over time graphs strictly addresses quantity of water over time. Decreasing flow trends are identified as "↓" and increasing flow trends are described as "↑". Surface water pH criterion is expressed as a range of 6.5-9.0 Standard Units (S.U.), as a result pH trends were not color coded. It should be noted that all identified pH trends are within the 6.5-9.0 S.U. criteria. Increasing DO deficit values or trends indicate greater oxygen demanding pollutants or biological demands (e.g. aquatic plants or fish) in a waterbody. Therefore, as DO deficit values increase, the concentration of dissolved oxygen decrease. Increasing DO deficit values have a negative effect on water quality and are represented by "↑" in the table below. Although ammonia was originally included in trend analysis for all stations, the majority of ammonia data was excluded from trend analysis because >50% of the ammonia measurements were below the limit of quantification and could not be

reported with a high degree of confidence. Only one station contained sufficient ammonia to evaluate trends. Upper Leon Creek did not possess sufficient data for trending for any parameter. Trending details can be seen in Appendix C at the end of this report. Trends were examined for the following water quality parameters:

- Instantaneous flow
- Temperature
- Total Dissolved Solids (TDS)
- Dissolved Oxygen (as DO Deficit)
- pH
- Total Suspended Solids (TSS)
- Total Kjeldahl Nitrogen (TKN)
- Ammonia
- Nitrate
- Total Phosphorous
- Chloride
- Sulfate
- *E. coli*
- Chlorophyll-*a*


Leon Creek Watershed

Index of Biotic Integrity. Aquatic systems provide habitat for a variety of biotic assemblages, including fish and benthic macroinvertebrates. Each of these assemblages tends to require a unique set of ecological conditions. The characteristics of each assemblage, in terms of species present, relative dominance, trophic organization, etc., vary as a result of change in ecological conditions, both natural and non-natural. Such changes in the characteristics of the biotic assemblages may be reflected in the results of the assessments of biotic integrity, the Index of Biotic Integrity or IBI. Thus, it is important to monitor more than one assemblage, since anthropogenic changes as well as natural variation in instream ecological conditions, and biotic interactions can affect each assemblage in a different way with subsequent differences in IBI results for each. Several matrices with in the IBI include intolerant and tolerant fish species. Intolerant fish species are sensitive to degradation in water quality and habitat and are usually driven from an area or killed as the result of pollution. Tolerant species have the capacity to grow and thrive even when subjected to unfavorable environmental factors.

Unlike chemical testing of water samples, which gives brief snapshots of chemical concentrations, an IBI captures an integrated net impact on a biological community structure. The complete absence, particularly a sudden disappearance of some indicator species, can constitute powerful evidence of pollution or stress factors. IBIs generally do not identify or resolve any specific cause of impairment.

In the TSWQS, an exceptional, high, intermediate, or limited Aquatic Life Use (ALU) is assigned to each classified water body, and to some unclassified water bodies, based on physical, chemical, and biological characteristics. The TCEQ uses fish and benthic macroinvertebrate assemblages as the primary biotic indicators of water quality. Both assemblages, along with physical habitat data, are used to establish the appropriate ALU category for classified waterbodies, and both assemblages are used to assess support of

designated aquatic life use for the 305(b) assessment. While physical habitat evaluation of a waterbody is an integral and required part of all biological assessment activities, when the habitat index indicates non-support, the habitat attainment status is reported as a concern. Historically, when establishing the appropriate ALU for a previously unclassified waterbody, fish have been the primary indicator, with benthic macroinvertebrate and physical habitat evaluations used as complementary information.

SARA and BCRAGD Biological Monitoring in Segment 1905, Medina River above Medina Lake

3.2 TCEQ Assessment Methodology Process

Routine surface water monitoring samples collected and analyzed under an approved TCEQ Quality Assurance Project Plan are the first steps in the State's overall strategy for managing water quality. In even-numbered years, the TCEQ will assess the routine data collected from most recent seven to ten year period and publish the findings on their website as the Texas Integrated Report of Surface Water Quality (IR).

The IR describes the surface water quality status and management strategies to the public, EPA, and other TCEQ internal agency programs. The IR will then assign each assessed waterbody to one of five categories. The five-part categorization of waters (Table 3.2) 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 preventative action. Waterbodies identified in Category 5, also known as the 303(d) List, 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 a TMDL implementation plan to implement the findings in the TMDL. Alternatively, these could also represent situations where water quality standards revisions may be needed in a specific area to better reflect ambient water quality conditions. A TCEQ Executive Summary for the 2014 Texas Integrated Report can be viewed at the TCEQ's website located at https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_exec_summ.pdf.

Table 3.2: Categories included in the Integrated Report

Category	Definition
1	Attaining the water quality standard and no use is threatened
2	Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened.
3	Insufficient or no data and information to determine if any designated use is attained. Many of these waterbodies are intermittent streams and small reservoirs.
4	Standard is not supported or is threatened for one or more designated uses but does not require the development of a Total Maximum Daily Load (TMDL). a) All TMDLs have been completed and approved by EPA. b) Other control requirements are reasonably expected to result in the attainment of all standards. c) Nonattainment is shown to be caused by pollution, not by pollutants and that the water quality conditions cannot be changed by the allocation and control of pollutants through the TMDL process.
5	The waterbody does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants. a) TMDLs are underway, scheduled, or will 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. Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected. c) Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.

Each waterbody is assigned designated uses and criteria (or parameters) consistent with the TSWQS and are evaluated against water quality data for determining support or attainment of the use. If a waterbody is meeting the assigned designated water uses it is identified as Fully Supporting (FS). If a waterbody is Nonsupporting (NS) its designated uses, the waterbody is referred to as "impaired". If close to violating the water quality standard or screening level, the waterbody is identified as a Concern for near nonattainment of the

water quality standard (CN), or as a Concern for water quality based on screening levels (CS). No Concern (NC) is used for parameters within screening levels or for parameters that have limited or inadequate data but have compelling evidence of support of the standard. A status of Not Assessed (NA) may be identified where parameters were not assessed for the 2014 IR as a result of limited data (LD), inadequate data (ID) or data that is temporally not representative (TR) of conditions in the assessment area. For biological collection events to be considered temporally representative, two events are required over one year. One event is to be conducted during the critical period, July 1 through September 30, when minimum streamflows, maximum temperatures and minimum dissolved oxygen concentrations typically occur in Texas. The other sampling event is to occur in the non-critical period of the year, March 15 through June 30 or October 1st through October 15th, with at least one month separating the sampling events.

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.

Tagged Monarch Butterfly on a Meally Blue Sage Flower

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 attain and maintain water quality standard(s) 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; however 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. EPA. 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. I-Plans are also based on TMDLs; WPPs use other environmental measures to meet goals for water quality.

3.3 Watershed Summaries

The purpose of the following watershed summary sections is to develop a greater understanding of water quality conditions, identify any trends and changes, and aid in making water quality decisions for each subwatershed in the San Antonio River Basin. The watershed summaries are arranged from upstream to downstream for the following watersheds in the San Antonio River Basin.

- San Antonio River
- Cibolo Creek
- Medina River and Lakes
- Leon Creek
- Salado Creek
- Medio Creek

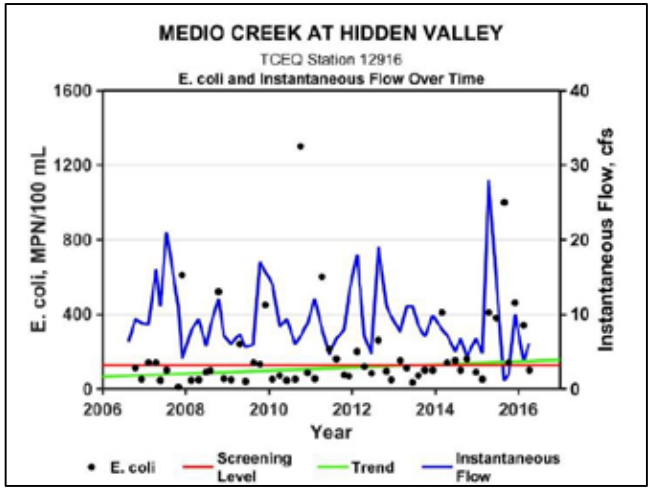
Each watershed summary contains a map, watershed characteristics, segment location description, information on special projects and technical data analysis, including a discussion on any aquatic life and habitat evaluations conducted during the 2014 IR assessment period. Each watershed summary also contains three tables.

- Municipal and Industrial Wastewater Outfall table
- Water Quality Summary by Segment Table: Impairments are in red text and concerns are in black text.
- 2014 IR Summary of Impairments, Concerns and Long-Term Trends by Segment Assessment Units

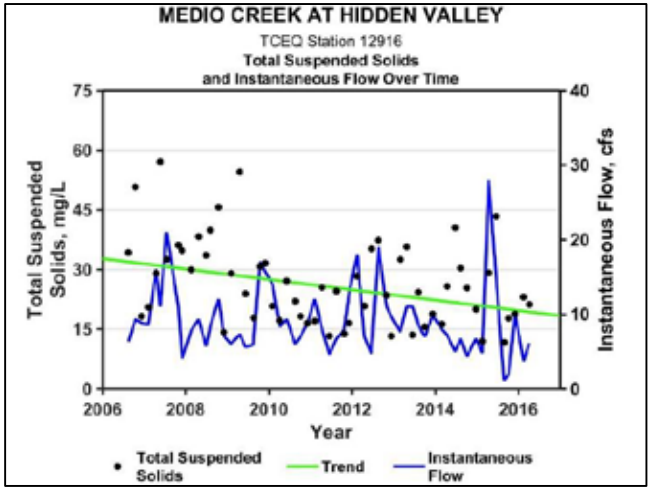
The 2014 IR Summary of Impairments, Concerns and Long-Term Trends by Segment Assessment Units Table details the level of support for each assessment unit; including all classified and unclassified water quality stations, associated surface quality standards and nutrient screening criteria, and any statistically significant water quality trends in the watershed. Specific station descriptions along with the latitude/longitude coordinates can be viewed at the TCEQ website located at http://www.tceq.texas.gov/waterquality/clean-rivers/data/station.html. If the segment AU is meeting the assigned designated water uses it is identified as Fully Supporting (FS). If an AU is Nonsupporting (NS) its designated uses, the waterbody is referred to as “impaired”. If the AU is close to violating the water quality standard or screening level, the AU is identified as a Concern for near nonattainment of the water quality standard (CN), or as a Concern for water quality based on screening levels (CS). **No Concern (NC)** is used for parameters within screening levels or for

parameters that have limited or inadequate data but have compelling evidence of support of the standard. A status of **Not Assessed (NA)** may be identified where parameters were not assessed. Limited or inadequate data are identified with a black polka dot fill-in font. A **Carried Forward** (CF) qualifier indicates the integrated level of support of CS, CN, or NS was carried forward from a previous assessment due to inadequate data for this method in this assessment.

Select station(s) with statistical significant parameter trends, either increasing or decreasing (↑ or ↓) will be discussed in each of the Watershed Quality Summaries trending sections, including the parameter concentration and flow over time, and the parameter concentration versus flow. Parameters with insufficient trending data or non-statistical significant information may also be identified and included to support possible improvement or decline of water quality. Additional statistical significant parameter trends, either increasing or decreasing (↑ or ↓) are also identified at the bottom of each 2014 IR Summary of Impairments, Concerns and Long-Term Trends by Segment Assessment Units Tables. For graphical illustrations of parameter concentration and flow values time, measured parameter values are represented by the black dots (•) and flow values are represented by the solid blue line (——). The red line (——), when applicable, represents either the parameter standard or screening level (SL). The parameter's trend-line against time is shown in green (——). Trending details can be seen in Appendix C at the end of this report. An example from Station 12916 Medio Creek at Hidden Valley Campground can be seen in Example A and B.

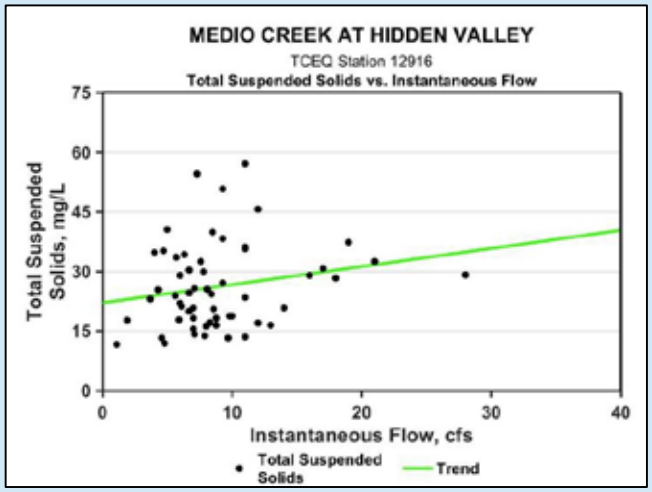


Example A: 12916 Medio Creek at Hidden Valley, E. coli over Time

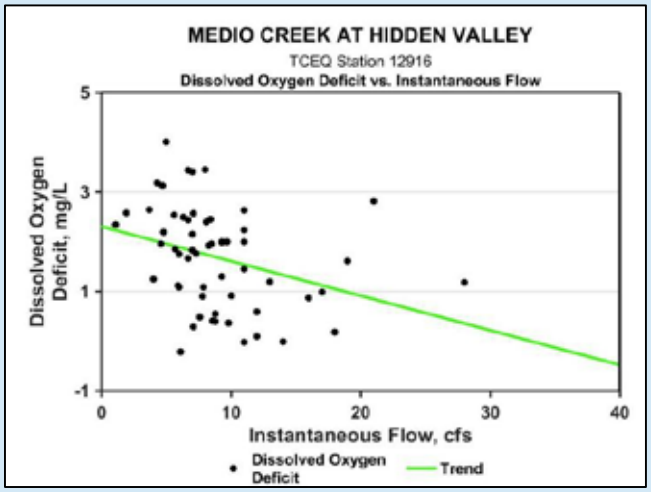


Example B: 12916 Medio Creek at Hidden Valley, TSS over Time

In the graphs displaying parameter concentrations versus flow values, measured parameter values are represented by the black dots (•). The parameter's trend-line against flow is shown in green (——). An example of parameter concentration versus flow values for Station 12916 Medio Creek at Hidden Valley Campground can be seen in Example D and E.



Example C: 12916 Medio Creek at Hidden Valley, TSS versus Flow

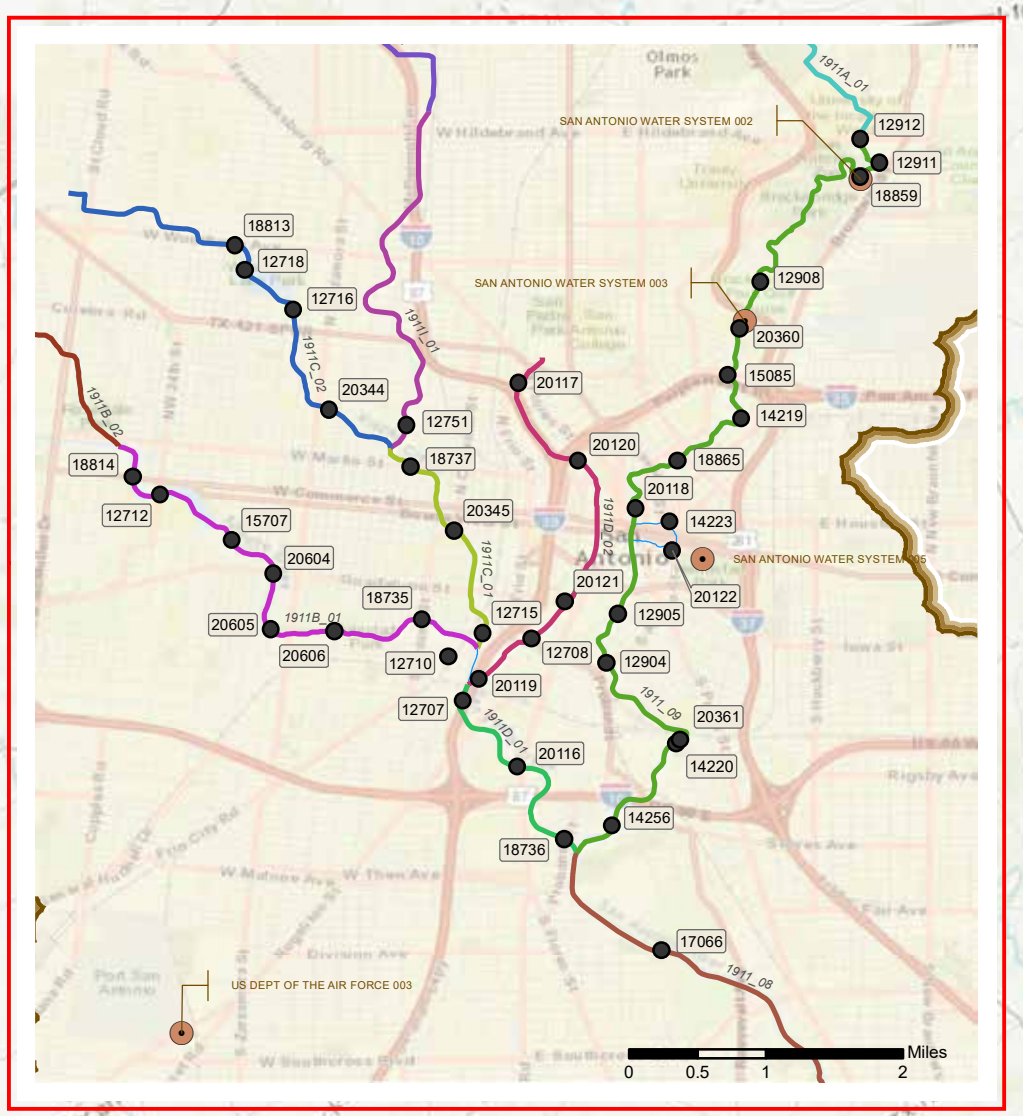


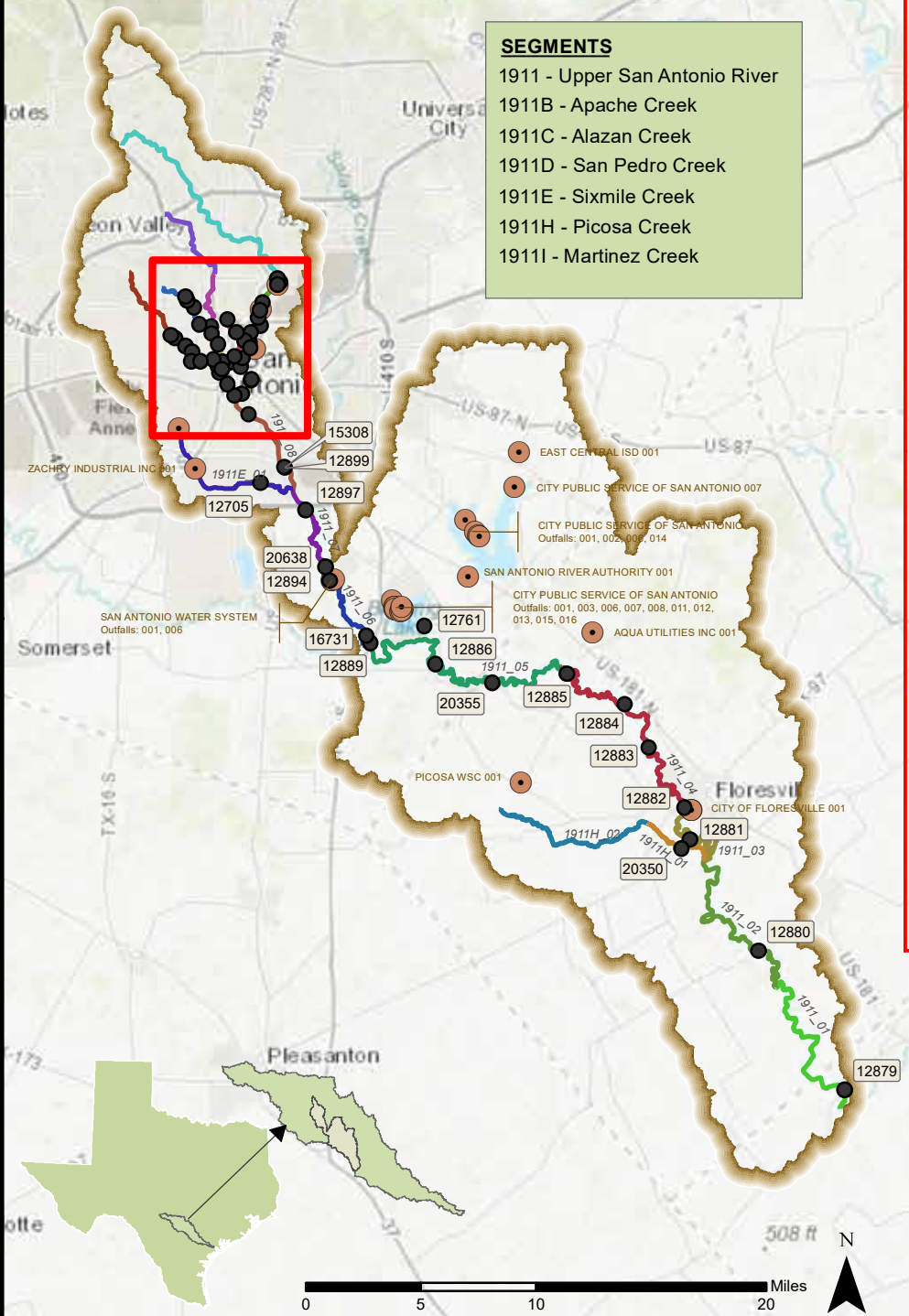
Example D: 12916 Medio Creek at Hidden Valley, DO Deficit versus Flow

UPPER SAN ANTONIO RIVER WATERSHED

SEGMENTS

1911 - Upper San Antonio River
1911B - Apache Creek
1911C - Alazan Creek
1911D - San Pedro Creek
1911E - Sixmile Creek
1911H - Picosa Creek
1911I - Martinez Creek



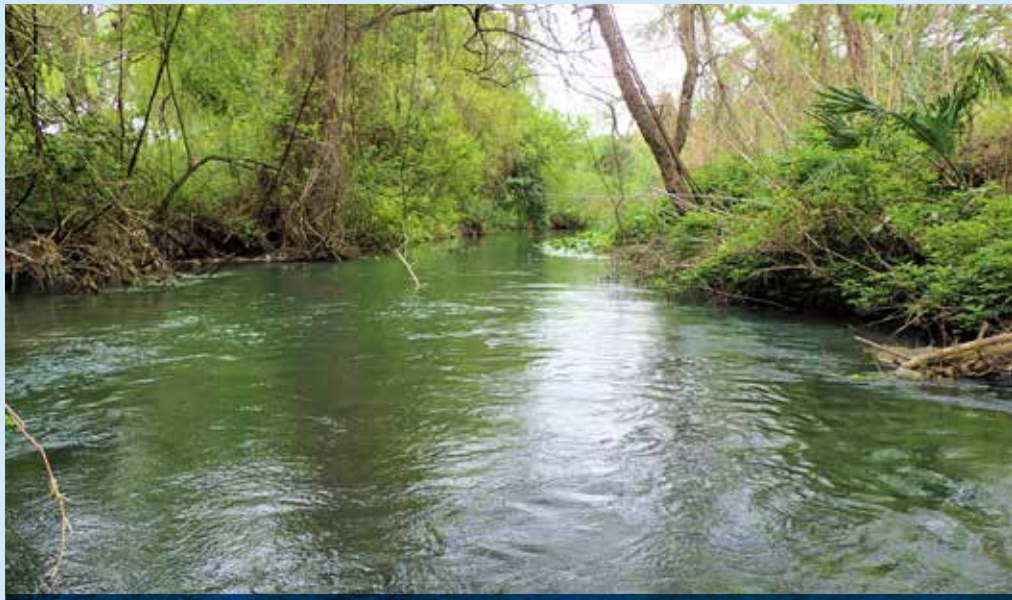


- 2014 TCEQ Integrated Report Assessed Stations
- Wastewater Outfalls
- Assessment Units

Upper San Antonio Watershed – Segment 1911

TSWQS describes the Upper San Antonio River Segment 1911 as extending 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. Approximate drainage area of the entire Upper San Antonio River Watershed is 558 square miles. Major tributaries to the Upper San Antonio River include Medina River and Salado Creek. Throughout most of its length the physical characteristics of the Upper San Antonio River are influenced by geological formations of the Gulf Coastal Plains Province. The San Antonio River originates as natural spring flow from the Edwards Aquifer south of the Balcones Fault Zone then flows over the Gulf Coastal Plains of the Central Plains Province. 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 City of San Antonio Wastewater Treatment Recycling Centers (WWTRC). The San Antonio Water System began introducing reuse water into the San Antonio River at Brackenridge Park, next to the Witte Museum in June 2000 and in the River Walk at the Henry B. Gonzales Convention Center in August 2006. Unclassified segments of the Upper San Antonio River assessed in the 2014 IR include:

- Segment 1911B Apache Creek
- Segment 1911C Alazan Creek
- Segment 1911D San Pedro Creek
- Segment 1911E Sixmile Creek
- Segment 1911H Picosa Creek
- Segment 1911I Martinez Creek



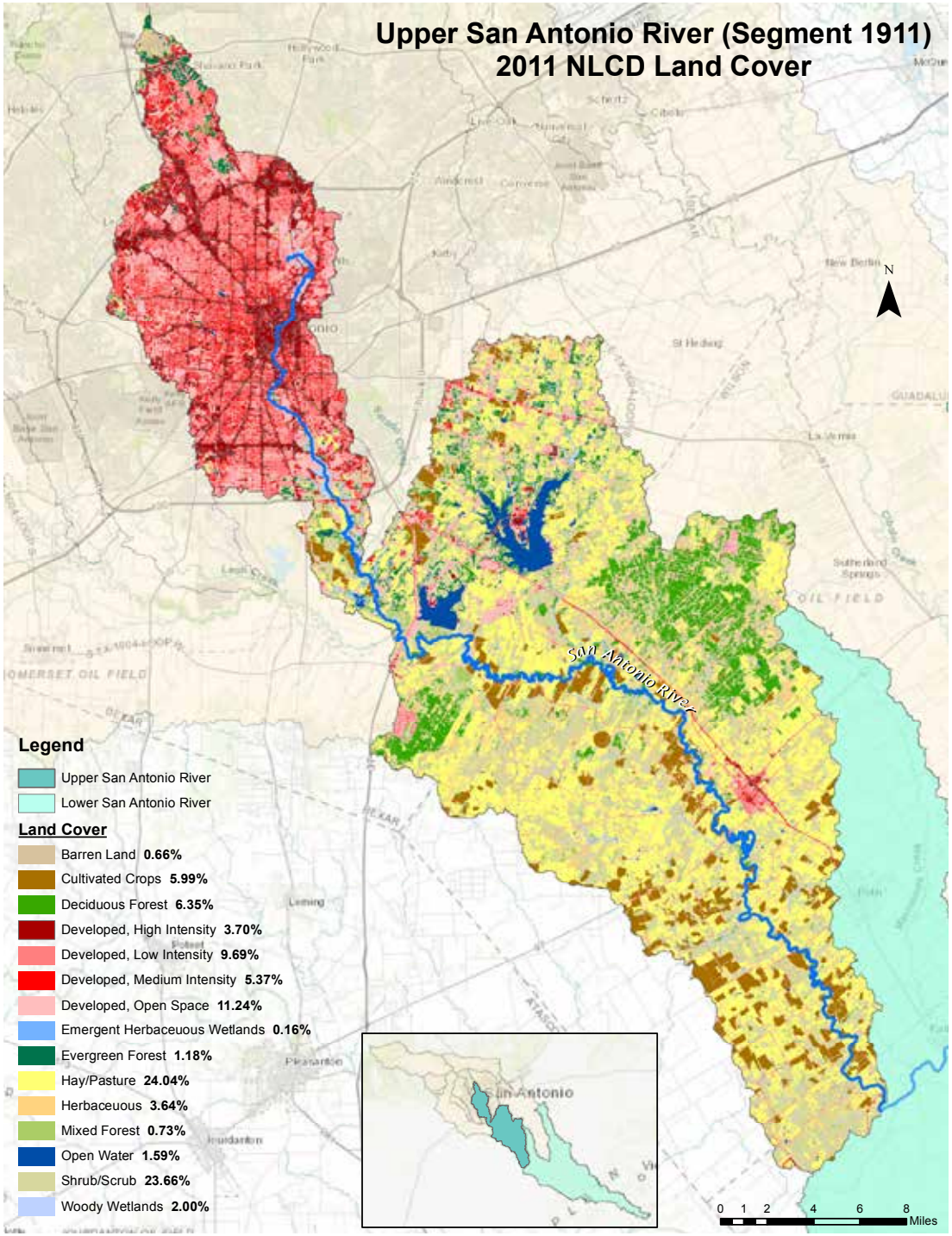
Station 12909 San Antonio River at Mulberry

As a result of insufficient data, Olmos Creek (1911A), Calaveras Reservoir (1911F) and Braunig Reservoir (1911G) were not assessed in the 2014 IR.

The San Antonio River essentially begins under another name – Olmos Creek, which has its headwaters just north of Loop 1604. 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. At this point, 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 segment, it becomes wider and deeper. Unusual features in this watershed are the flood control tunnels on the San Antonio River and San Pedro Creek. The tunnels collect flood water north of the historic downtown area and divert it underground through two 24-foot diameter tunnels and release the flood waters south of the downtown area. Five 18th century Spanish missions reside along the upper reaches of the San Antonio River, including Mission Espada, Mission Concepcion, Mission San José, and Mission San Juan Capistrano. The most famous mission is San Antonio de Valero, better known as the Alamo. The waterway is also

home to the San Antonio River Walk, one of San Antonio's primary tourist destinations and the centerpiece of the city. The Upper San Antonio River Watershed lies within Bexar, Wilson and Karnes Counties, and is characterized by a mixture of land uses and cover. Its headwaters are in southeastern Bexar County within the City of San Antonio. The river runs north to south, from the northern end of San Antonio, past Floresville and Poth, to FM 791 near Falls City in Karnes County. According to the U.S. 2016 census, the upper third of the watershed is home to the second most populous incorporated city in the State of Texas, the City of San Antonio with an estimated population of 1,492,510. Non-classified waterbodies that may contribute flow to this portion of the watershed include Apache and San Pedro Creeks. Olmos, Alazan, Sixmile, and Martinez Creeks. The lower two thirds of the watershed is characterized by a mixture of shrub/scrub, agricultural and pasture land, with medium to low urban development southwest of the City of San Antonio and around the cities of Floresville, La Vernia and Poth. There are small areas of forest throughout the middle portion of the watershed. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure USAR-1 for more detail.

The Upper San Antonio River, Segment 1911 has a high aquatic life use designation and is not classified for domestic water supply use. Like all segments in the San Antonio River Basin, this segment is designated for primary contact recreation. Primary contact activities are presumed to involve a significant risk of ingestion of water such as wading by children, swimming, water



skiing, diving, tubing, surfing, hand fishing as defined by Texas Parks and Wildlife Code, §66.115; including whitewater activities: kayaking, canoeing, and rafting. However, the City of San Antonio has an ordinance forbidding swimming in any portion of the San Antonio River within the corporate limits. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are 12 current and one pending permitted dischargers with a total of 28 outfalls in Segment 1911, Upper San Antonio River. See Table 1911-1 for details.

Table 1911-1: Municipal and Industrial Wastewater Outfalls in Segment 1911 - Upper San Antonio River

Permittee	Status	Type	County
CITY OF FLORESVILLE - Outfall 1	Current Permit	Domestic	Wilson
SAN ANTONIO WATER SYSTEM - Outfall 2, 3, 6	Current Permit	Wastewater	Bexar
ZACHRY INDUSTRIAL INC - Outfall 1	Current Permit	Stormwater	Bexar
CITY PUBLIC SERVICE OF SAN ANTONIO - Outfall 1, 2, 6, 7, 14	Current Permit	Wastewater and Stormwater	Bexar
CITY PUBLIC SERVICE OF SAN ANTONIO - Outfall 1, 3	Current Permit	Wastewater and Stormwater	Bexar
EAST CENTRAL ISD - Outfall 1	Current Permit	Domestic	Bexar
US DEPT OF THE AIR FORCE - Outfall 1	Current Permit	Groundwater	Bexar
SAN ANTONIO WATER SYSTEM - Outfall 1, 5	Current Permit	Wastewater	Bexar
TIGER SANITATION INC - Outfall 1	Pending Permit	Wastewater	Bexar
PICOSA WSC - Outfall 1	Current Permit	Domestic	Wilson
SAN ANTONIO RIVER AUTHORITY - Outfall 1	Current Permit	Domestic	Bexar
CITY PUBLIC SERVICE OF SAN ANTONIO - Outfall 6, 7, 8, 11, 12, 13, 15, 16	Current Permit	Wastewater and Stormwater	Bexar
AQUA UTILITIES INC - Outfall 1	Current Permit	Domestic	Wilson

Domestic: <1 million gallons per day (MGD) domestic sewage; Wastewater: ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Upper San Antonio River Watershed Water Quality Summary

According to the 2014 IR, bacteria impairments have been identified throughout the watershed. Some fish community and depressed DO impairments have also been documented. Habitat, nutrients, depressed dissolved oxygen and chlorophyll-*a* have been listed as concerns. Table 1911-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Impairments are in red text, concerns are in black text. Figure USAR-2 provides a visual summary of impairments and concerns by assessment units. Table 1911-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Upper San Antonio River Watershed.

Table 1911–2: Water Quality Summary for Segment 1911 – Upper San Antonio River

Water Quality Focus	Affected portion of the Segment	Possible Sources/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Upper and Lower	• Direct and indirect stormwater runoff sources of fecal matter from domestic and wild animals • Sewer breaks and overflows • Poorly maintained septic tank systems	The Upper San Antonio River WPP has been revised to include additional BMPs that would abate or control nonpoint source pollution of *E. coli* bacteria, suspended sediments and excess nutrients in the Upper San Antonio River Watershed. To document BMPs' effectiveness, monitoring of established and ongoing instream sites will continue. The Upper San Antonio River TMDL Implementation Plan was submitted to TCEQ in the spring of 2015 and received final approval April 6, 2016.
Nitrate	Entire Segment	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate and total phosphorus data is utilized to indicate areas of concern. SARA will continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria, to assess water quality conditions, and determine long-term trends in the watershed.
Total Phosphorus	Upper and Lower		

Table 1911–2: Water Quality Summary for Segment 1911 – Upper San Antonio River			
Water Quality Focus	Affected portion of the Segment	Possible Sources/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Fish Community and Habitat	Upper	In the past, the upper portions of the San Antonio River had been highly engineered for flood water conveyance. With the completion of San Antonio River Improvement Project in 2013, over 13 miles of river have under gone ecosystem restoration using a technique known as fluvial geomorphology. This technique transformed the straightened river to replicate the original flow of the river while maintaining flood control, reducing erosion, re-introducing native vegetation and creating an environment more suitable for recreation and wildlife.	Restoration efforts associated with the San Antonio River Improvement Project are expected to help oxygenate the water, reduce sediment and restore the structural diversity of the river to support a variety of ecosystem functions and aquatic wildlife. Since 2014, SARA has reestablished four biological stations in 1911_08 and 1911_09. It will take many years for the riparian habitat and riparian woodland habitat to fully mature. SARA will continue to conduct biological monitoring in these assessment units to assess aquatic communities, water quality conditions, and determine long-term trends in the watershed.

Water Quality Summary Segment 1911A – Olmos Creek Segment 1911B – Apache Creek Segment 1911C - Alazan Creek Segment 1911D - San Pedro Creek Segment 1911E - Sixmile Creek Segment 1911H - Picosa Creek Segment 1911I – Martinez Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Apache, Alazan, San Pedro, Sixmile and Martinez Creeks	• Direct and indirect (stormwater runoff) sources of fecal matter from domestic and wild animals • Sewer breaks and overflows	The Upper San Antonio River WPP has been revised to include additional BMPs that would abate or control nonpoint source pollution of *E. coli* bacteria, suspended sediments and excess nutrients in the Upper San Antonio River watershed. To document BMPs' effectiveness, monitoring of established and ongoing instream sites will continue. The Upper San
			Antonio River TMDL Implementation Plan was submitted to TCEQ in the spring of 2015 and received final approval April 6, 2016.
Depressed DO	Apache, San Pedro, Picosa and Martinez Creeks	• Intermittent low flows • poor riparian buffer vegetation • low channel sinuosity • shallow depth	Category 5c has been assigned to this impairment: additional data and information should be collected before a TMDL is scheduled.
Ammonia	Alazan Creek	• Improper use of fertilizers • Organic matter carried to river with stormwater runoff • Sewer breaks and overflows	There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate, ammonia, and chlorophyll-*a* data is utilized to indicate areas of concern. SARA will continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria, to assess water quality conditions, and determine long-term trends in the watershed.
Nitrate	Apache and San Pedro Creeks		
Chlorophyll-*a*	Alazan Creek		

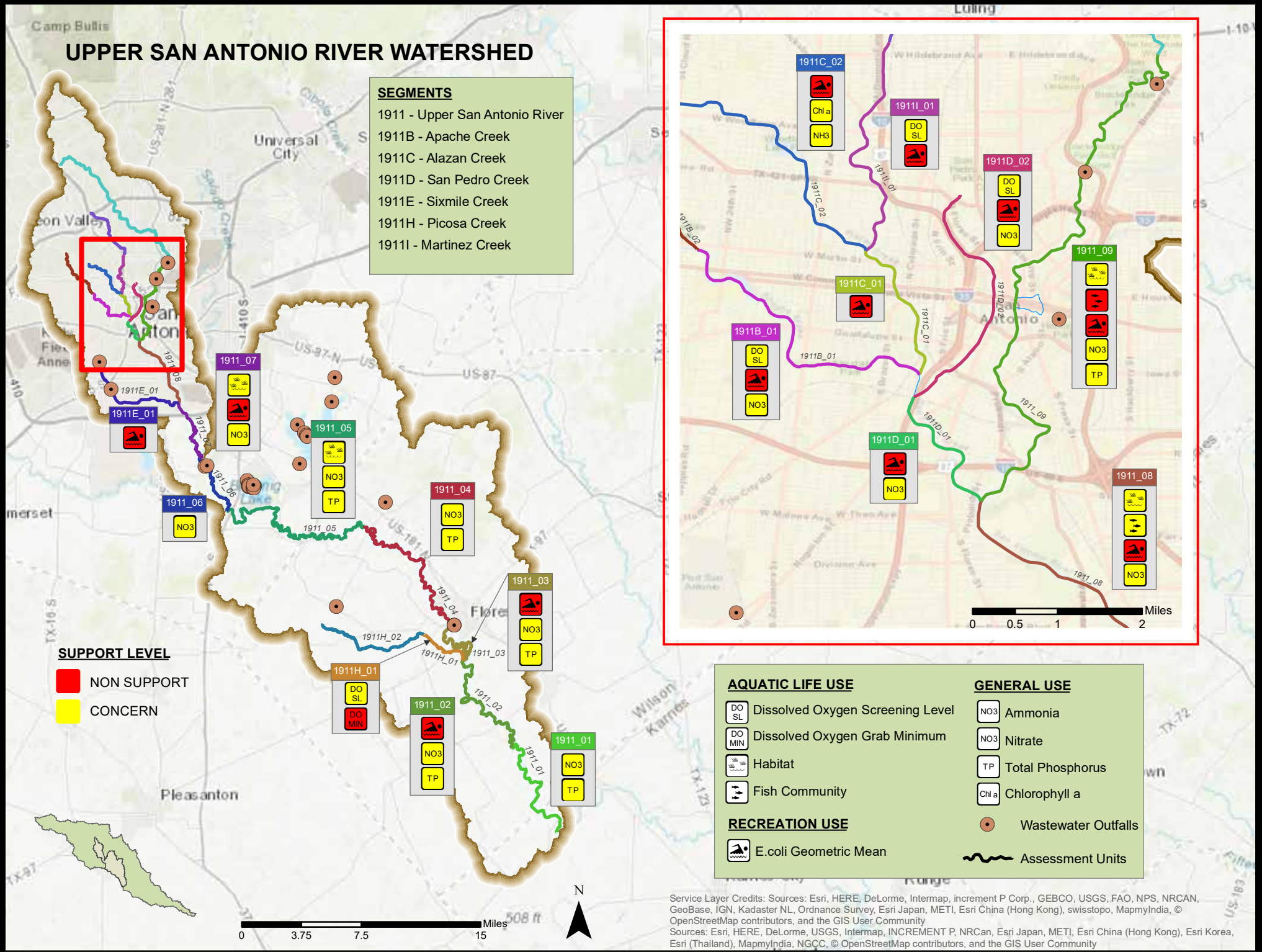


Figure USAR-2: Map of the Upper San Antonio River impairments and concerns by assessment units.

Addendum One to the Three Total Maximum Daily Loads for the Upper San Antonio Watershed; Seven Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watershed: In April 2016, the TCEQ adopted an addendum to the Three TMDLs for Bacteria in the San Antonio Area and the EPA approved the addendum on August 9, 2016. The addendum included new information on seven additional assessment units in Menger Creek, Apache Creek, Alazan Creek, San Pedro Creek and Sixmile Creek. As part of the project, with support from the TCEQ and the Texas A&M AgriLife Research, a stakeholder committee called the San Antonio Bacteria TMDL Advisory Group was created to develop a plan to implement the TMDLs with management measures needed to reduce bacteria, as well as a timeline for implementation. Additional information about this project can be found at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-usar_addendum_2016-04.pdf

Upper San Antonio River Watershed Protection Plan (EPA 319 Grant administered through the TCEQ): SARA, in cooperation with local partners and the TCEQ, completed the Upper San Antonio River Watershed Protection Plan (USAR WPP) for the urban portion of the Upper San Antonio River (above Loop 410) in December 2006. The USAR WPP was updated in 2014 and called for a 30% reduction in bacteria loading from stormwater across the watershed. The revised USAR WPP included water quality monitoring and recommendations for bacteria control measures in the Upper San Antonio River as well as Alazan Creek, Apache Creek, Martinez Creek and San Pedro Creek subwatersheds. The USAR WPP was approved by the EPA on February 18, 2015, making the State eligible for CWA Section 319(h) funding for projects addressing nonpoint source pollution within the Upper San Antonio River Watershed. Additional information about this project can be found at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34F_UpperSanAntonio_TMDLIPlan_Approved.pdf

Implementation Plan for Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watersheds Segments: 1910, 1910A, 1911: The TCEQ and Texas A&M AgriLife worked with communities, interest groups, and local organizations to involve stakeholders with the development of an Upper San Antonio River I-Plan. The ultimate goal of the I-Plan is to meet the primary contact recreation uses in Salado Creek (Segment 1910), Walzem Creek (Segment 1910A), and the Upper San Antonio River (Segment 1911), by reducing concentrations of *E. coli* bacteria to levels established in the TMDLs. The I-Plan includes 30 management measures that will be used to improve water quality and reduce *E. coli* in the watersheds. Components of the I-Plan include description of management measures to be implemented, stakeholder communication strategies, continued I-Plan review, revisions and recommendations as needed to continue water quality improvement. The I-Plan also includes post monitoring plans to determine the effectiveness of implemented management measures. On April 5, 2016, the TCEQ approved the I-Plan. Additional information about this project can be found at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34F_UpperSanAntonio_TMDLIPlan_Approved.pdf

Projects in the Upper San Antonio River Watershed

USGS and SARA Study: USGS Oil and Gas Production Constituents Phase II Project: The recent increase of oil and gas production throughout the United States has elicited a multitude of concerns regarding the potential risks to human and environmental health (U.S. Environmental Protection Agency, 2011). The Phase I study, 2011-2013, established a baseline of water quality and streambed constituents within the area of most oil and natural gas production in the San Antonio River Basin. Phase II commenced in October 2014. The project objectives included the U.S. Geological Survey revisiting a subset of the sites from Phase I to determine changes in surface water and streambed sediment quality, determining the extent of land cover change with the increase in well pads and storage ponds. In addition, the project will document new roads and collect samples at additional sites within the Lower San Antonio River Watershed, primarily in Wilson and Karnes counties, to try and determine if any correlation exists between polycyclic aromatic hydrocarbon (PAH) concentrations and impervious surface area. The project was extended a year to capture the needed sampling, complete sample analysis, and report writing. The project is scheduled to be completed September 30, 2018 with the publication of a USGS Scientific Investigations Report.

Three Total Maximum Daily Loads for Bacteria in the San Antonio Area: The Upper San Antonio River and Salado Creek were first identified as impaired due to bacteria in the 2000 Texas Water Quality Inventory and 303(d) List (TCEQ 2000). Walzem Creek was added to the list in 2002. In response to the listing, the TCEQ developed several Total Maximum Daily Loads (TMDL) to establish the bacteria loading reductions necessary to bring the Upper San Antonio River, Salado Creek and Walzem Creek into compliance with the TSWQS. The TCEQ adopted the Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watershed: Segments 1910, 1910A, and 1911 on July 25, 2007. The TMDLs were approved by the EPA on September 25, 2007. Additional information about this project can be found at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-uppersanantoniotmdl-adopted.pdf

Guadalupe Bass Reintroduction: In 2013 the San Antonio River Authority (SARA) and its partners completed the Mission Reach Restoration effort under the umbrella of the San Antonio River Improvements Project (SARIP). A portion of this ecosystem restoration focused on efforts to improve water quality, instream and riparian habitat and riparian zone ecosystem functionality. This ecological lift also includes several secondary projects such as the **Reintroduction of the Guadalupe Bass into the Upper San Antonio River, the TPWD and SARA Collaborative Fish Survey of Davis Lake** and **SARAs Upper San Antonio River and the Freshwater Mussel Survivability Study**.

Biological Collection Event in the Upper San Antonio River Watershed

Under a National Fish and Wildlife Foundation Grant, SARA, TPWD and Texas State University began reintroducing Guadalupe Bass (*Micropterus treculi*) into the Mission Reach of the Upper San Antonio River. Restocking the Guadalupe Bass serves as an opportunity to validate ecological improvement as well as to provide a valuable economic and recreational resource to the community. Young Guadalupe Bass were raised at the Texas Parks and Wildlife Heart of the Hills Fisheries Science Center in Mountain Home, Texas, before being transported to pre-designated locations along the Mission Reach of the Upper San Antonio River for release. Their survival in this young stretch of river relies heavily on habitat availability and suitable water quality. Approximately 84,000 Guadalupe Bass have been stocked at four sites on the Upper San Antonio River since 2015. SARA biologists have captured dozens of Guadalupe Bass since the stocking effort began. These fish vary in size and the recent capture of younger fish indicate these fish were possibly naturally spawned from Guadalupe Bass reintroduced as part of the effort. To confirm this, genetic information was taken by clipping a small portion of their fin in order to determine if the fish originated from the hatchery or were naturally spawned. Fin clippings from multiple fish were then sent to the TPWD for analyses. In November 2017, the genetic results were sent to SARA. All submitted samples were confirmed to be pure Guadalupe Bass, with parental lineage to the Medina River or South Llano hatchery brood stock. This is very exciting news! This is the first confirmed evidence that Guadalupe Bass are spawning in the Mission Reach. In addition to the spawning in the Mission Reach, Guadalupe Bass have also been captured during biological collection events as far down as Station 16580 San Antonio River at Conquista Crossing located in Karnes County.

Texas Parks and Wildlife Department and SARA Collaborative Fish Survey of Davis Lake, Upper San Antonio River Mission Reach: Davis Lake is a unique section of the Upper San Antonio River and is a popular recreational area including trail access for joggers and bikers as well as several water activities such as kayaking and fishing. A team of TPWD technicians joined SARA's field biologists in April 2017 for a day out on Davis Lake. The goal of the trip was to determine what fish were in this stretch of the river and in what abundance. TPWD used this data to make recommendations on how to best supplement any underrepresented fish species to increase overall health. Specialized boats sent an electric pulse into the water in a controlled manner in order to temporarily immobilize the fish and bring them to the surface. The fish were then safely scooped into nets, identified, measured and then released safely back into the water. The team netted 70 fish composed of 8 different species. This sampling effort revealed that Channel Catfish needed to be supplemented. As a result of this collaborative effort a total of 950 channel catfish were released in Davis Lake. The stocking effort not only improves recreational opportunity for anglers but also bolsters an underrepresented fish species in this portion of the Upper San Antonio River. As Channel Catfish are host species for mussel larvae, known as glochidia, the addition of Channel Catfish also plays a very important role in the Mission Reach Mussel Survivability Study.

Mission Reach Mussel Survivability Study (MRMS): It is believed freshwater mussels once inhabited the waters of the Upper San Antonio River; however, because of decreased water quality, decreased habitat, and altered flow over the years, they are mostly absent. The MRMS is the first validation study to determine if the restoration efforts have increased water and habitat quality enough for mussels to survive and thrive. Equipment has been installed at strategic points along the Mission Reach that will allow water to flow through chambers that house four different species of mussels native to the San Antonio River. These devices allow biologists to monitor the health of the mussels over time across different sites by looking at their growth rates and comparing them to the growth rates of similar captive mussels living in the very productive waters of the Lower San Antonio River. If the growth rates of mussels constrained to the Mission Reach are similar to those of the lower basin, scientists will be one step closer to reintroducing mussel species to the Upper San Antonio River Watershed.

SARA Mission Reach Avian Study: In 2015, SARA initiated a multi-year avian study within the Mission Reach to collect baseline data that can be used to document avian species and support population trends estimations over time. Data collected in this study will be used to document the ecological improvements and restored bird habitat as the result of the Mission Reach Restoration Efforts. During December 2015 through September 2017, 174 bird species and 40,648 individual birds were recorded within the project area. A variety of resident and migratory birds have been recorded including wintering species, summering species and those passing through. Among those, a variety of species indicative of the project's success have been identified including habitat generalists, habitat specialists, shy species and range restricted species. Notable records include the Interior Least Tern, a Federally-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; Tricolored Heron, a rare winter species for the area; and the Bald Eagle.

Table 1901-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Upper San Antonio Watershed by Assessment Unit

Upper San Antonio River Watershed Segment 1911 - Upper San Antonio River				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score 41**	**HBI Score 20**	**Score 29**
1911_01	12879	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS (GM=76.74)	NC	CS	CS	NC	NA	NA	NA
1911_02	12880	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS (GM=140.51)	NC	CS	CS	NC	NA	NA	NA
1911_03	12881	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS (GM=133.30)	NC	CS	CS	NC	NA	NA	NA
1911_04	12882, 12883, 12884, 12885	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS (GM=81.19)	NC	CS	CS	NA	NA	NA	NA
1911_05	12886, 12889, 20355	perennial	high	FS	FS	FS	NC	FS	FS	FS	FS	FS	FS (GM=117.36)	NC	CS	CS	NC	TR-NA (37.50)	CS (18.30)	NA
1911_06	12894; 16731	perennial	high	FS	FS	FS	NC	FS	NC	NC	FS	FS	FS (GM=97.02)	NC	CS	NC	NC	FS (42.60)	NC (21.40)	NA
1911_07	12897, 20638	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS (GM=145.23)	NC	CS	NC	NC	FS (44.60)	CS (18.70)	NA
1911_08	12899, 15308, 17066	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS (GM=205.29)	NC	CS	NC	NC	CN-CF (36.40)	CS-CF (17.00)	NA
1911_09	12904; 12905; 12908; 12911; 12912; 14219; 14220; 14223; 14256; 15085; 18859; 18865; 20118; 20122; 20360; 20361	perennial	high	FS	FS	FS	NC	FS	FS	FS	FS	FS	NS (GM=436.96)	NC	CS	CS	NC	NS-CF	CS-CF	NA

Texas Logperch *(Percina carbonaria)*

Table 1901-3 Continued: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Upper San Antonio River Watershed by Assessment Unit

Segment 1911B - Apache Creek Segment 1911C - Alazan Creek Segment 1911D - San Pedro Creek Segment 1911E - Six Mile Creek Segement 1911H - Picosa Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Apache Creek 1911B_01	12710; 12712; 15707; 18735; 18814; 20604; 20605; 20606	perennial	intermediate	NA	NA	NA	CS	FS	NA	NA	NA	NA	NS (GM=485.23)	NC	CS	NC	NC
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Alazan Creek 1911C_01	12715, 18737, 20345	intermittent w/pools	limited	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS (GM=350.33)	NC	NC	NC	NC
1911C_02	12716, 12718, 18813, 20344	intermittent w/pools	limited	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS (GM=290.15)	CS	NC	NC	CS
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
San Pedro Creek 1911D_01	12707, 18736, 20116	perennial	high	NA	NA	NA	NC	FS	NC	NC	NA	NA	NS (GM=274.14)	NC	CS	NC	NC
1911D_02	12708, 20117, 20119, 20120, 20121	perennial	high	NA	NA	NA	CS	FS	NA	NA	NA	NA	NS (GM=924.09)	NC	CS	NC	NA
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**2 mg/L**	**1.5 mg/L**	**2 mg/L**	**1.5 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Six Mile Creek 1911E_01	12705	intermittent	minimal	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS (GM=385.10)	NA	NA	NA	NA
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Picosa Creek 1911H_01	20350	intermittent w/pools	limited	NA	NA	NA	CS	NS	NA	NA	NA	NA	NC (102.50)	NA	NA	NA	NA
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Martinez Creek 1911I_01	12751	intermittent w/pools	limited	NA	NA	NA	CS	FS	NA	NA	NA	NA	NS (GM=267.68)	NC	NC	NC	NC

SARA's Trends over Time

Seg/AU	Description	Instantaneous Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	E. coli	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
1911_01	Station 12879 SAR at FM 791 Southwest of Falls City				↓		↑	↑			↑			
1911_08	Station 17066 SAR downstream of the SAR and San Pedro Creek Confluence				↑				↑				↑	
1911_09	Station 12908 SAR at Woodlawn	↓	↑	↑	↑	↑	↑		↑			↑	↑	

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

CF = The Integrated level of support of CS, CN or NS was carried forward from a previous assessment due to inadequate/no data for this method in this assessment.

TR = Temporally Not representative, used with NA

Bacteria Impairment

The Upper San Antonio River and Salado Creek were first identified as impaired due to bacteria in the 2000 Texas Water Quality Inventory and 303(d) List; Walzem Creek was added to the list in 2002. In response to the listing, the TCEQ developed several Total Maximum Daily Loads (TMDLs) to determine the maximum bacteria loading the Upper San Antonio River, Salado Creek and Walzem Creek could receive and still support the primary contact recreational use designation. Indicator bacteria such as *E. coli*, although not generally pathogenic, indicate a possible risk to public health. On July 25, 2007, the TCEQ adopted **Three Total Maximum Daily Loads for Bacteria in the San Antonio Area (Segments 1910 – Salado Creek, 1910A – Walzem Creek, and 1911 – Upper San Antonio River)**. Possible sources of bacterial contamination identified in the final TMDL report included:

- Discharges from wastewater treatment facilities and other institutions.
- Discharges from urban storm sewer systems.
- Runoff from undeveloped lands.
- Wildlife deposition.
- Pets and livestock deposition.
- Leaking sewer infrastructure.
- Failing septic systems.

At the time the TMDLs were under development, the standards to support contact recreation were in transition, so both *E. coli* and fecal coliform standards were in place. The TMDLs were developed for fecal coliform, and converted to *E. coli*. The final report indicated an overall 31% reduction in bacterial loading was required for the Upper San Antonio River. The TMDLs were approved by the U.S. EPA on September 25, 2007, at which time they became part of the State's Water Quality Management Plan.

In April 2016, the TCEQ adopted an **Addendum One to Three Total Maximum Daily Loads for the Upper San Antonio Watershed Seven Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watershed for Segments 1910D, 1911B, 1911C, 1911D, and 1911E, Assessment Units 1910D_01, 1911B_01, 1911C_01, 1911C_02, 1911D_01, 1911D_02, and 1911E_01.** The EPA approved the addendum on August 9, 2016. The addendum included new bacteria impairment information on seven additional assessment units in Menger Creek, Apache Creek, Alazan Creek, San Pedro Creek and Sixmile Creek. In addition, since the EPAs approval of the original TMDLs in August 2016, there were a number of changes that warrant refinements in how indicator bacteria data are used to support water quality assessments and TMDL development in Texas. Some key factors that influence which indicator bacteria to use for water quality assessment and TMDL development include:

- Changes in land cover and locations of Texas Pollution Discharge Elimination System (TPDES)-permitted facilities.
- A change of the indicator bacteria in the 2000 TSWQS from fecal coliform to *E. coli* for freshwater, and enterococci for marine waters.
- Refinements in TCEQ surface water quality monitoring (SWQM) procedures.
- Changes in TCEQ guidance, Assessing and Reporting Surface Water Quality in Texas.

As a result of these factors, the historical data used to support the TMDLs in the amendment were narrowed, wherever possible, to use only *E. coli* data from 2007 through 2010. The final amendment report identified the geometric mean for *E. coli* for Apache Creek (Segment 1911B), was exceeded in 48% of the samples taken, in 48% of the Alazan Creek samples (Segment 1911C), in 53% of the San Pedro Creek samples (Segment 1911D), and in 46% of the Sixmile Creek samples (Segment 1911E). Additional information can be viewed on the TCEQ's website located at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-uppersanantoniotmdl-adopted.pdf

Apache Creek, Upper San Antonio River Watershed

SARA, in cooperation with local partners and the TCEQ, completed the **Upper San Antonio River Watershed Protection Plan (USAR WPP)** for the urban portion of the Upper San Antonio River (above Loop 410) in December 2006. The USAR WPP was updated in 2014 and called for a 30% reduction in bacteria loading from stormwater across the watershed. The USAR WPP included water quality monitoring and recommendations for bacteria control measures and included monitoring activities to determine stormwater bacteria loads, as well as nutrient and sediment loads for subwatersheds in the Upper San Antonio River. Alazan Creek, Apache Creek, Martinez Creek and San Pedro Creek subwatersheds were monitored as part of the USAR WPP. The USAR WPP was approved by the EPA on February 18, 2015, making the State eligible for CWA Section 319(h) funding for projects addressing nonpoint source pollution within the Upper San Antonio River Watershed.

In 2013, Texas A&M AgriLife Research began working with communities, interest groups, and local organizations to involve stakeholders with the development of the **Implementation Plan for Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio River Watersheds Segments: 1910 – Salado Creek, 1910A – Walzem Creek and 1911 – Upper San Antonio River (USAR I-Plan).** The USAR I-Plan is a flexible tool that governmental and nongovernmental organizations voluntarily use to guide their activities to improve water quality in these watersheds. The ultimate goal of the Upper San Antonio River I-Plan is to meet primary contact recreation uses in Salado Creek (Segment 1910), Walzem Creek (Segment 1910A), and the Upper San Antonio River (Segment 1911), by reducing concentrations of *E. coli* bacteria to levels established in the TMDLs.

The Upper San Antonio River I-Plan will be implemented using an adaptive management approach in which measures are periodically assessed for efficiency and effectiveness. This adaptive management approach is one of the most important elements of the I-Plan. The iterative process of evaluation and adjustment ensures continuing progress toward achieving water quality goals, and expresses stakeholder commitment to the process. The participating partners may accomplish the management measures described in the plan through activities, guidance, or other action. This I-Plan contains the following components:

- Description of management measures that will be implemented to improve water quality.

- Follow-up tracking and monitoring plans to determine the effectiveness of the management measures undertaken.
- Identification of outcomes and other considerations that stakeholders will use to determine whether the current I-Plan improves water quality, or whether the plan needs to be modified.
- Identification of the communication strategies that TCEQ or their subcontractors will use to disseminate information to stakeholders.
- The strategy that stakeholders will use to periodically review and revise the plan to ensure there is continued progress in improving water quality.
- Recommendations for further analysis.

The USAR I-Plan is a 5-year plan that provides 30 management measures to improve water quality. Management measures were selected based on feasibility, costs, support, and timing. Activities may be implemented in phases based on the needs of the stakeholders, availability of funding, and the progress made in improving water quality. The USAR I-Plan was submitted to TCEQ in the spring of 2015 and received final approval April 6, 2016. Some of the Management Measures in the USAR I-Plan include:

- Wastewater Collection and Transmission System Operation and Maintenance Programs to Reduce Sanitary Sewer Overflows.
- San Antonio Zoo UV Treatment System Implementation.
- Advancement of Low Impact Development.
- Feral Hog and Livestock Management.
- Evaluation of Restoration of Westside Creeks.

Addition information can be viewed on the TCEQ's website located at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34F_UpperSanAntonio_TMDLIPlan_Approved.pdf.

In an effort to assist the public in recreational planning, SARA monitors three stations weekly for *E. coli* (in San Antonio, at the second crossing of Mission Road, near Floresville in Wilson County, and Southwest of Falls City in Karnes County). The data is available on SARA's Recreation website located at https://www.sara-tx.org/river-recreation/paddling-trails/current-conditions/. Over time, the data collected from these stations shows a strong relationship between stormwater runoff and elevated *E. coli* values.

In an effort to assist the public in recreational planning, SARA monitors a total of seven stations throughout the San Antonio River Basin for *E. coli.* The data is available on SARA's Recreation website. This website shows a strong relationship between rainfall and elevated *E. coli* values.

SARA Feral Hog Management Project: In 2015 the San Antonio River Authority partnered with Texas A&M AgriLife Extension (AgriLife) and the Texas Wildlife Services (TWS), a division of the United States Department of Agriculture, Plant and Animal Health Index to create and host a series of hands-on workshops in the district, as well as offer landowners in the district assistance with feral hog management. Feral hogs are a particular concern for the San Antonio River Authority, because hogs can impact water quality and are often drawn to riparian habitats for the abundance of resources offered there. In the first year, three workshops were held, reaching 319 landowners, land managers, and government officials. In the second year, four workshops were held, reaching 365 landowners.

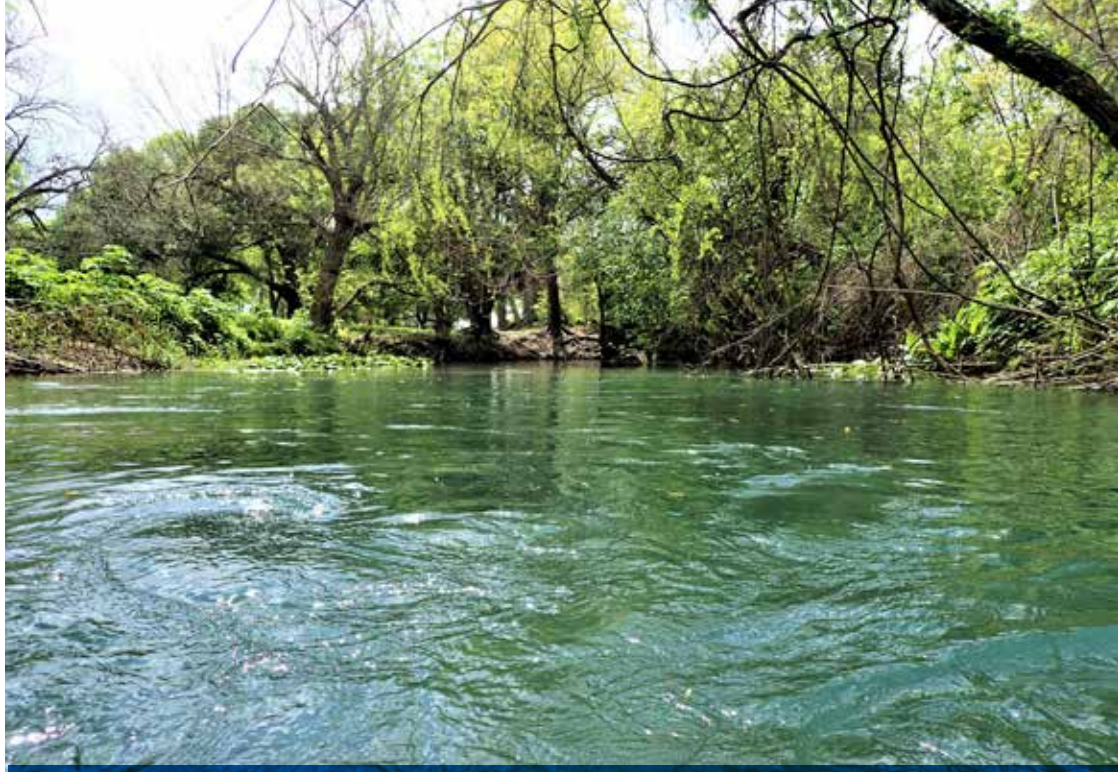
Topics at these workshops included feral hog biology, agricultural regulations regarding feral hog control, transportation regulations and disease, population dynamics and research, and novel techniques and recent technology for management. Two wildlife technicians were hired to work in Bexar, Wilson, Karnes, and Goliad counties using a variety of removal methods such as corral traps, aerial gunning, and infrared equipment. In the first year of the program TWS partnered with over 35 landowners to actively trap hogs from public and private property removing 1,099 hogs from Bandera, Bexar, Wilson, Karnes, and Goliad counties combined. In the second year of the program, TWS partnered with over 62 landowners to actively trap hogs from public and private property removing 1,447 hogs from Bandera, Bexar, Wilson, Karnes, and Goliad counties combined. Demand for assistance has been so great that the program will be adding a third technician to assist in the southern counties.

Biological Assessment

TSWQS describes the Upper San Antonio River as having a high aquatic life use designation and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average). Biological assessments for the Upper San Antonio River identify a fish community impairment and habitat concern in assessment unit 1911_09, from just upstream of the confluence with San Pedro Creek to the upper end of the segment. A concern for both fish and habitat has also been identified in 1911_08, from just upstream of the confluence with Sixmile Creek to just upstream of the confluence with San Pedro Creek. Habitat concerns were identified in assessment units 1911_05 and 1911_07. Although results identified a fish community impairment in assessment unit 1911_05, the 2014 IR did not assess the data because the samples collected were not considered to be temporally representative of long-term conditions. See Section 3.3 for a discussion on temporally representation biological events.

Station 12886, San Antonio River at Loop 1604 is in assessment unit 1911_05 and was sampled four times, once in each year between 2009 and 2012. Station 14256, San Antonio River at Mitchell Street and Station 12908, San Antonio River at East Woodlawn are in assessment unit 1911_09. Station 14256 was sampled in 2004 and 2005 and Station 12908 was sampled once in 2004. The fish Index of Biotic Integrity (IBI) scores for these assessment units ranged from 27 (limited) at the San Antonio River at Loop 1604 to 39 (intermediate) at the same station over 2014 IR assessment period. It should be noted that the 1911_09 fish community impairment was carried forward from the 2012 IR as a result of limited data for the 2014 IR assessment.

For fish community impaired assessment units there was an average of 148 individual fish and an average of 11 different species collected per sampling event. Intolerant species, fish species not tolerant to pollution, collected included the Texas Logperch, Mimic Shiner and the Tadpole Madtom. An average of 60% of the total number of fish collected were tolerant to pollution. Non-native species collected included the Redbreast Sunfish, Suckermouth Catfish and Tilapia species. Native species collected included the Blacktail Shiner, Bluegill Sunfish, Bullhead Minnow, Central Stoneroller, Channel Catfish, Flathead Catfish, Gizzard Shad, Ghost Shiner, Green Sunfish, Grey Redhorse, Largemouth Bass, Texas Logperch, Longear Sunfish, Longnose Gar, Mexican Tetra, Mimic Shiner, Red Shiner, Rio Grande Cichlid, Sailfin Catfish, Sailfin Molly, Sand Shiner, Smallmouth Buffalo, Spotted Bass, Spotted Gar, Tadpole Madtom, and the Western Mosquitofish.



Station 12909 Upper San Antonio River at Mulberry Street

The Habitat Quality Index (HQI) score ranged from 16 (intermediate) at Station 12886 San Antonio River at 1604 in 2012 to 21 (high) at the same station in 2010 with the average HQI score being 18.5 (intermediate). The Upper San Antonio River is characterized by well to poorly defined stream bends. Stream banks are gently sloping and covered with native grasses and wildflowers. The average width of the natural riparian habitat is 14 meters. The average percent tree canopy is 42% and includes pecan, hackberry, black willow, oak, and ash trees. The aquatic habitat type includes runs, riffles and glides. Sand, silt, gravel and cobble are the dominant substrate types at these locations. The average number of instream cover types is seven and includes woody debris, gravel, tree roots, litter, overhanging vegetation, and other cover types. The average percent instream cover is 29% and the average percent stream bank erosion is 25%.

Of the twenty-eight 24-hour DO measurements assessed for the Upper San Antonio River, there were no average or minimum exceedances over the 2014 IR assessment. The 24-hour DO average values ranged from 5.1 mg/L at Station 20122 San Antonio River at Little Rhein Restaurant to 12.7 mg/L at the same station. The 24-hour DO minimum values ranged from 4.5 mg/L at Station 20122 San Antonio River at Little Rhein Restaurant to 7.4 mg/L at Station 20118 San Antonio River at Houston Street.

Due to construction associated with the **San Antonio River Improvements Project (SARIP**), there was no biological monitoring conducted in assessment units 1911_09 and 1911_08 between 2006 and 2013. As a result, the 2014 IR carried forward the fish impairments and habitat concerns from the 2012 IR. In 2014, one year after the completion of the SARIP, biological monitoring stations in these assessments units were reestablished. Preliminary 2015-2017 fish and habitat data indicate a slight improvement in 1911_09 and a slight decline in 1911_08. As the SARIP completely transformed 13 miles of the San Antonio River from Hildebrand Avenue south to Loop 410 South it will take many years for the riparian habitat to fully mature. As part of the SARIP Mission Reach Restoration

efforts, approximately 113 acres of aquatic habitat and 334 acres of terrestrial habitat was restored. The landscape is still in its infancy and will take approximately 50 years for the entire ecosystem restoration process to reach maturity. Over time, it is anticipated the restoration efforts associated with the SARIP will help address the aquatic life impairments and concerns identified in the reaches of Upper San Antonio River.

Softshell Turtle *(Apalone spinifera)*

Trend Analyses

Nutrients have been identified as a concern in segments across the basin, including the Upper San Antonio Watershed. In addition to surface water quality, ground-water quality is becoming an increasingly important issue. Springs from the Edwards Aquifer, which feed the Upper San Antonio River during wet years, typically have nitrate concentrations close to the State's screening criteria. In addition, nitrate nitrogen concentrations discharged from WWTPs and reuse water are typically above the surface water screening criteria of 1.95 mg/L. Station 14256 San Antonio River at Mitchell, assessment unit 1911_09, is below the reuse water outfalls. Trend analysis over time conducted for data collected at Station 14256 indicate statistically significant increasing trends for nitrate and total phosphorous (Figures USAR 2-4); a decreasing trend over time for flow was also observed. Out of the 60 nitrate values used for trending, 83% of the values exceeded the screening level criteria of 1.95 mg/L. Out of the 58 total phosphorus values, 41% of the values exceeded the screening level criteria of 0.69 mg/L. Elevated levels of nutrients from reuse water may be the likely sources for increasing nutrient trends. Although statistically significant increasing trends over time were also detected for chloride, sulfate, total dissolved solids and pH, monitoring data indicates Station 14256 is meeting associated water quality standards for these parameters.

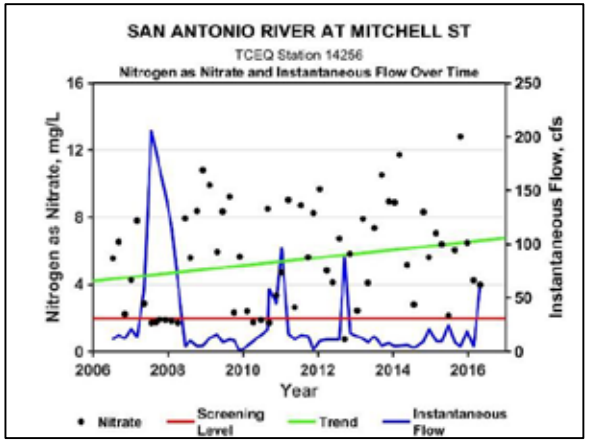


Fig. USAR 2: 14256 SAR at Mitchell St., Nitrate over Time

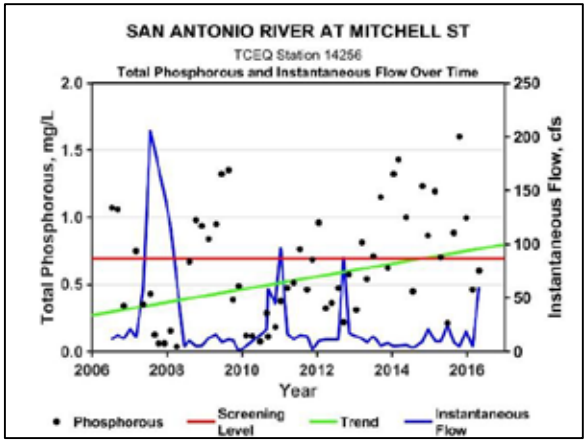


Fig. USAR 3: 14256 SAR at Mitchell St., T. Phosphorous over Time

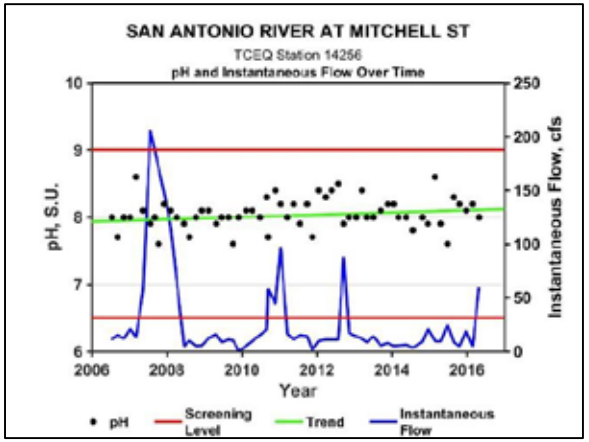


Fig. 4 USAR: 14256 SAR at Mitchell St., pH over Time

Station 17066 Upper San Antonio River at Mission Road is located in assessment unit 1911_08, below the Westside Creeks (Alazan, Apache, Martinez, and San Pedro), approximately 2 miles downstream of the San Pedro Creek confluence. While statistically significant increasing trends over time for pH, total phosphorous and sulfate have been detected (Figures USAR 5-7), 2014 IR monitoring data indicate the water quality at Station 17066 is meeting associated water quality standards for these parameters. In spite of the additional nutrient loading in the upper portions of the Upper San Antonio River by reuse water, it is important to understand the reuse water is vital to keep this portion of the San Antonio River flowing. Station 17066 is located in the San Antonio River Mission Reach area. Over time, it is anticipated the restoration efforts associated with the SARIP will restore the structural diversity of the river to support a variety of ecosystem functions and help address the impairments and concerns identified in the 2014 IR. Parameter concentration versus flow at Station 17066 indicate high flows have a tendency to decrease TDS, pH, nitrate, TKN, total phosphorous, chloride and sulfate concentrations, while increasing DO deficit concentrations (Figure USAR 8-10). High flow velocities can scour the streambed and increase the amount of sediment and debris a stream can carry or keep suspended in the water column. Stormwater events can also increase flow velocities and wash high amounts of organic and dissolved materials (DO deficit contributors) from the watershed directly into creeks and rivers.

Variability in dissolved oxygen levels due to factors such as water chemistry or pollutants can be masked by the strong inverse relationship between dissolved oxygen and water temperature (as water temperature increases, DO usually decreases). In order to more accurately represent the variability in dissolved oxygen that may be caused by factors other than water temperature, a simple DO deficit is calculated. Decreasing DO deficit values indicate fewer oxygen demanding pollutants or biological demands (e.g. aquatic plants or fish) in the waterbody. Therefore, as DO deficit values decrease, the concentration of dissolved oxygen increases.

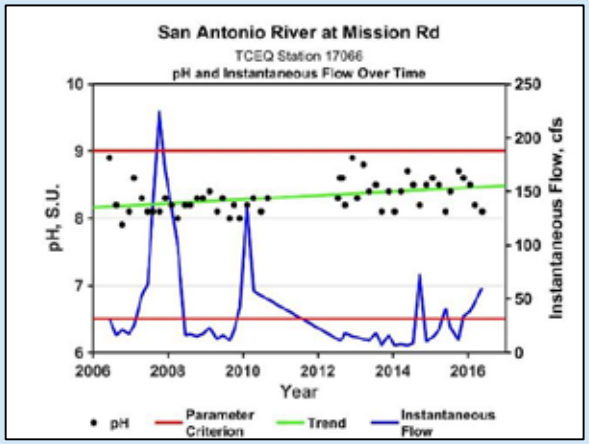


Fig. USAR 5: 17066 SAR at Mission Road, pH over Time

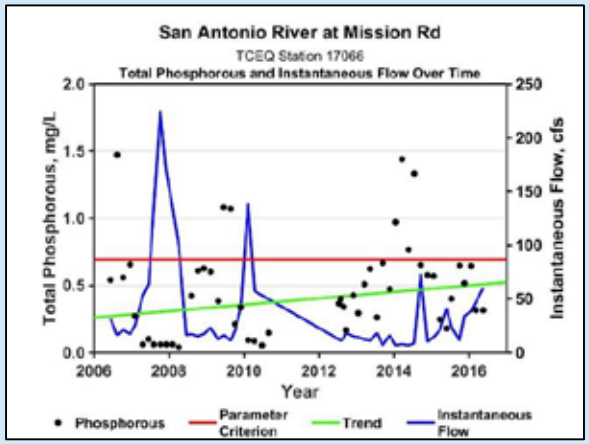


Fig. USAR 6: 17066 SAR at Mission Road, Total Phos over Time

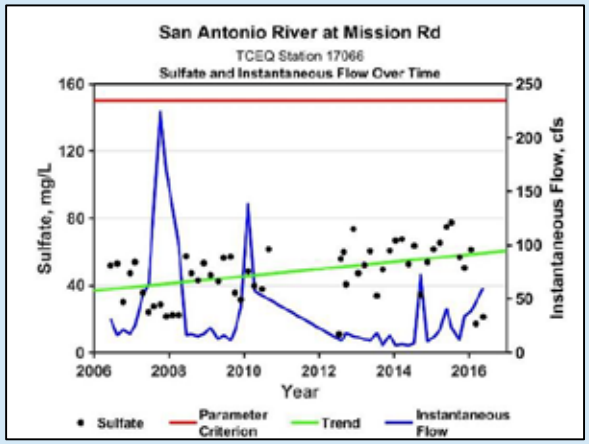


Fig. USAR 7: 17066 SAR at Mission Road, Sulfate over Time

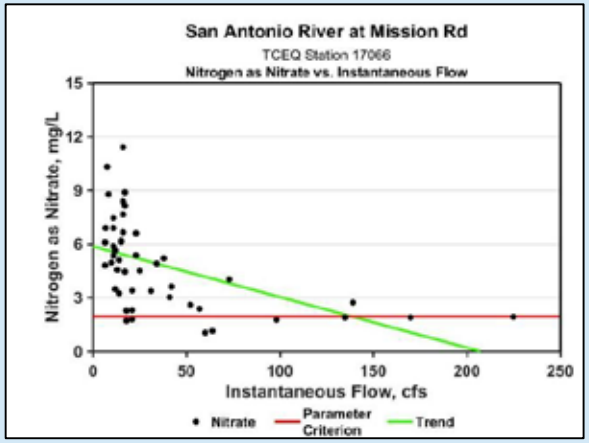


Fig. USAR 8: 17066 SAR at Mission Road, Nitrate over Flow

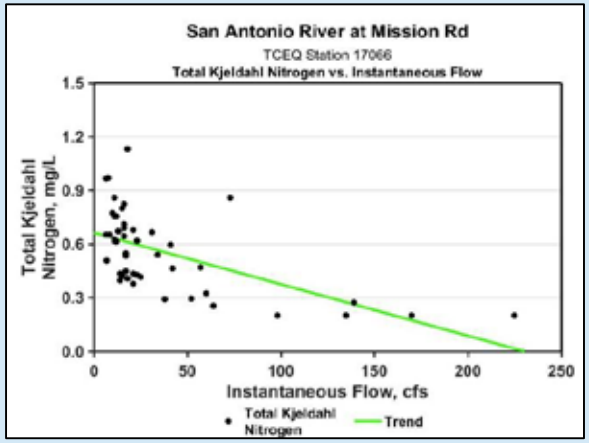


Fig. USAR 9: 17066 SAR at Mission Road, Total Phos over Flow

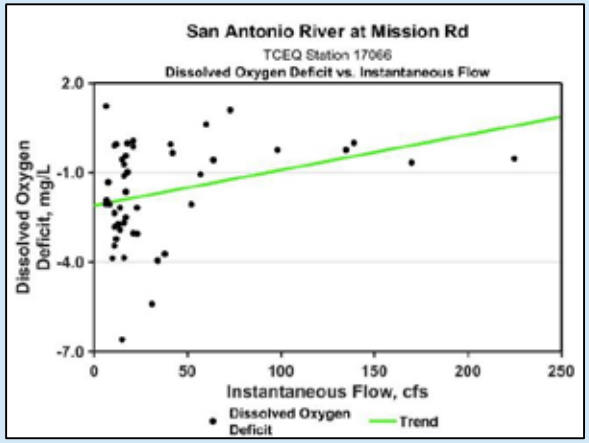


Fig. USAR 10: 17066 SAR at Mission Road, DO Deficit over Flow

Station 17066 Upper San Antonio River at Mission Road

In the 2014 IR, Station 12879 San Antonio River at FM 791 Southwest of Falls City, was the only station in assessment unit 1911_01 and was the furthest downstream monitoring station assessed in the Upper San Antonio River Watershed. Statistically significant increasing trends over time were identified for DO deficit, TKN and *E. coli*; a decreasing trend over time was detected for sulfate (Figures USAR 11-13). Although an increasing DO deficit trend indicates a decline in water quality due to increased pollutants or biological demands (e.g. aquatic plants or fish), the 2014 IR identifies 1911_01 as fully meeting the high aquatic life use designation based on grab DO samples. Out of the 117 DO grab samples assessed, there were no screening (5 mg/L) or minimum criteria (3 mg/L) exceedances. While the 2014 IR identifies assessment unit 1911_01 as fully supporting the primary contact recreation use designation, 355 *E. coli* samples assessed with a geomean of 76.74 *E. coli* /100mL, trend analysis identifies a statistically significant steadily increasing *E. coli* trend. Station 12879 is located in northern Karnes County and is in the middle of the Eagle Ford Shale region, one of the most active drilling areas in Texas. Possible sources for increasing trends over time include discharges from municipal and industrial wastewater treatment facilities, leaks and overflows from sewage lines and septic tanks, wildlife, and stormwater runoff from agricultural and urban land.

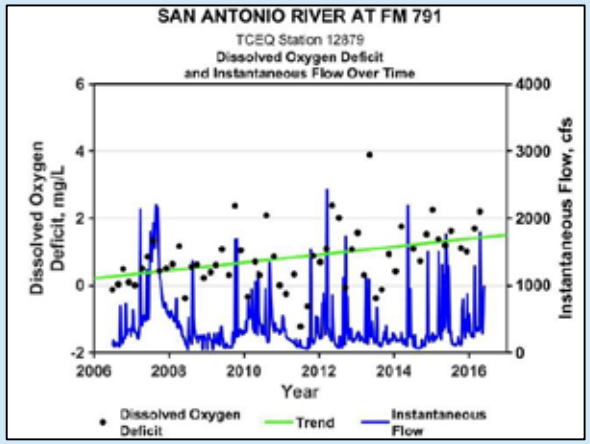


Fig. USAR 11: 12879 SAR at FM 791, DO Deficit over Time

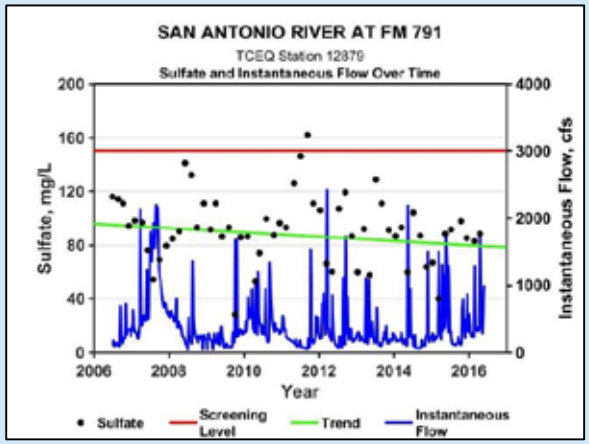


Fig. USAR 12: 12879 SAR at FM 791Sulfate over Time

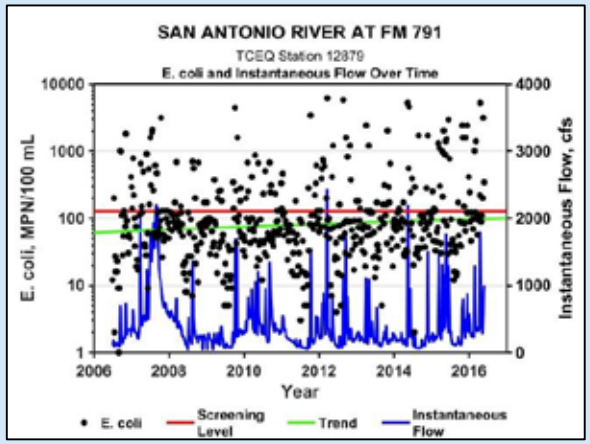
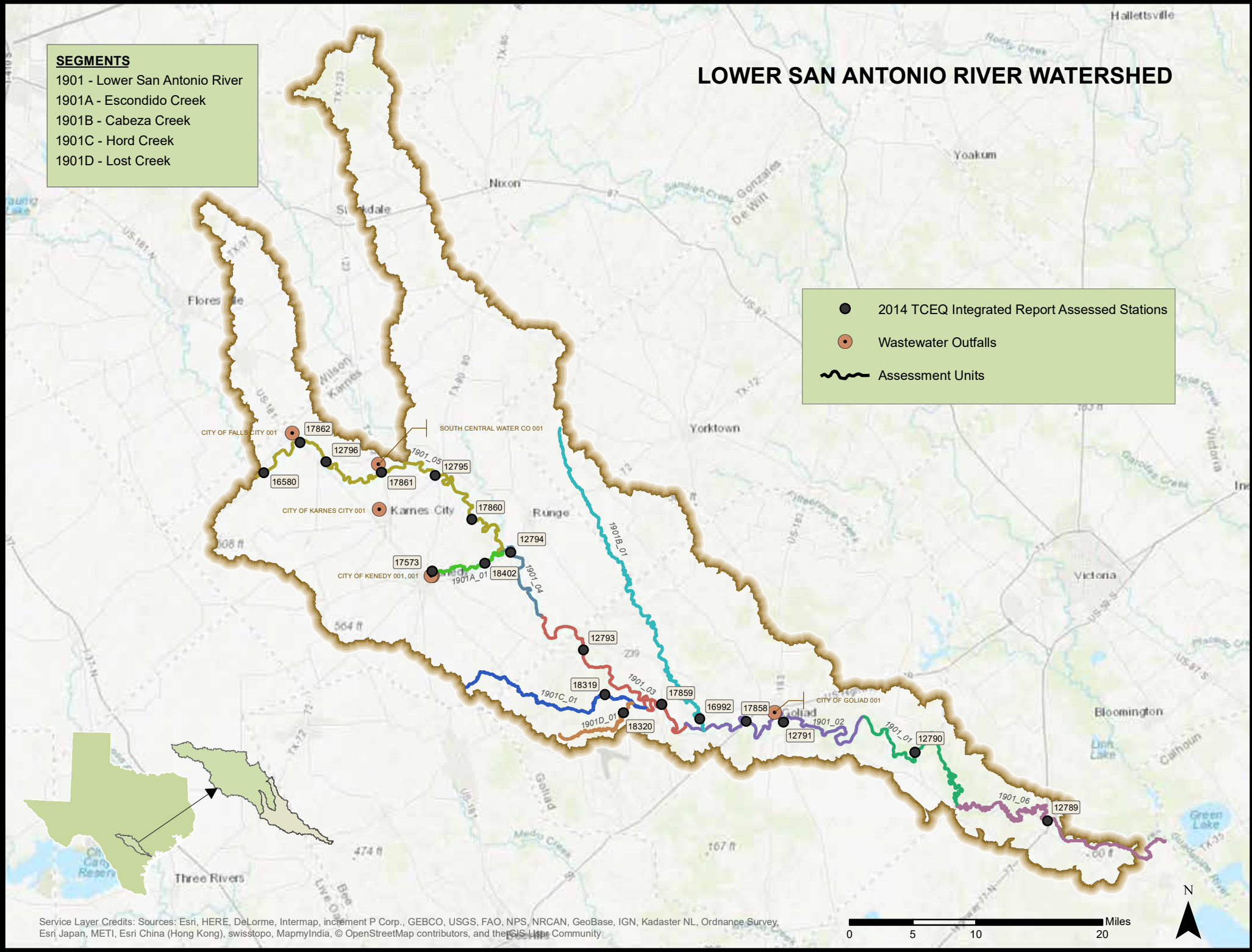


Fig. USAR 13: 12879 SAR at FM 791, *E. coli* over Time

Native Vegetation on the Mission Reach San Antonio River

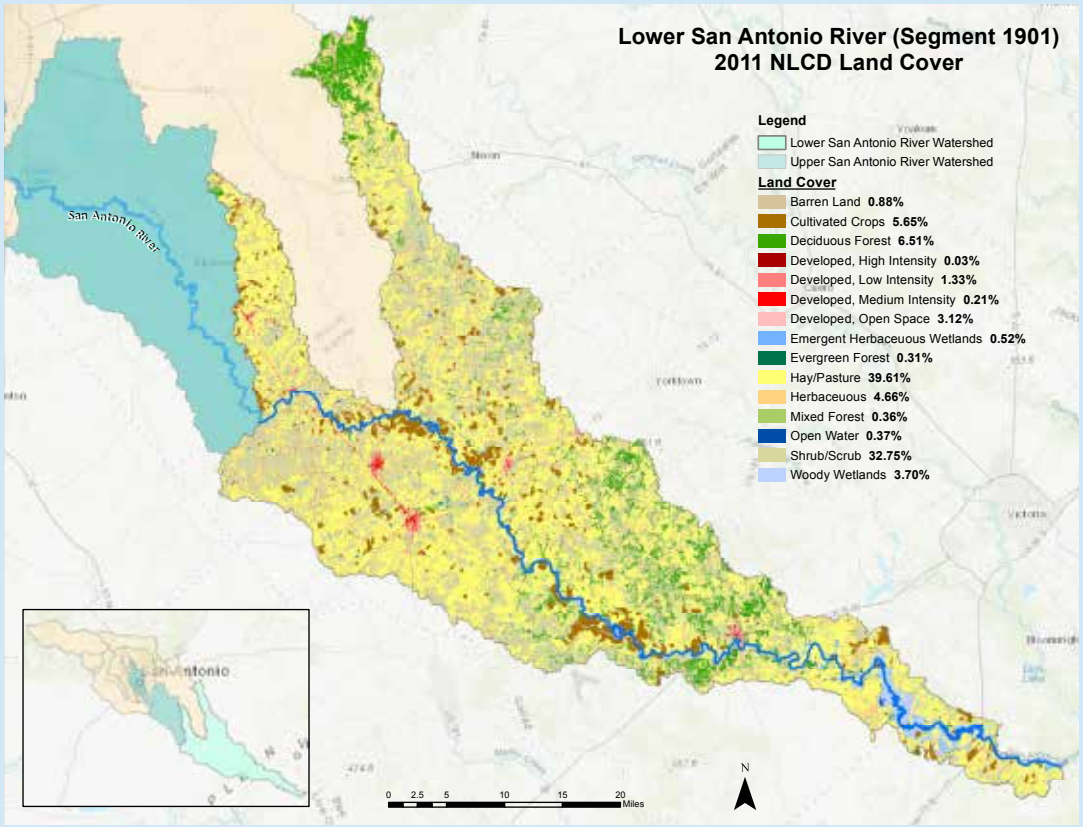

LOWER SAN ANTONIO RIVER WATERSHED
SEGMENTS
1901 - Lower San Antonio River
1901A - Escondido Creek
1901B - Cabeza Creek
1901C - Hord Creek
1901D - Lost Creek
2014 TCEQ Integrated Report Assessed Stations
Wastewater Outfalls
Assessment Units
CITY OF FALLS CITY 001
SOUTH CENTRAL WATER CO 001
CITY OF KARNES CITY 001
CITY OF KENEDY 001, 001
CITY OF GOLIAD 001
17862
12796
16580
17861
12795
17860
12794
17573
18402
12793
18319
17859
16992
17858
12791
12790
12789
18320
1901_05
1901_04
1901_03
1901_02
1901_01
1901_06
1901A_01
1901B_01
1901C_01
1901D_01
Karnes City
Runge
Yorktown
Victoria
Goliad
Bloomington
Three Rivers
Nixon
Yoakum
Hallettsville
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
0
5
10
20
Miles
N

Lower San Antonio Watershed – Segment 1901

The Lower San Antonio River 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. Segment 1901 is 153 miles long and has a watershed of approximately 1,214 square miles. The segment receives flows from two upstream segments: the Upper San Antonio River, Segment 1911, and Lower Cibolo Creek, Segment 1902. Unclassified segments of the Lower San Antonio River assessed in the 2014 IR include:

- Segment 1901A Escondido Creek
- Segment 1901B Cabeza Creek
- Segment 1901C Hord Creek
- Segment 1901D Lost Creek

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. 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.



Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure LSAR-1 for more detail.

The Lower San Antonio River, Segment 1901 has a high aquatic life use designation and is not classified for domestic water supply use. Like all segments in the San

Antonio River Basin, this segment is designated for primary contact recreation. Primary contact activities are presumed to involve a significant risk of ingestion of water such as wading by children, swimming, water skiing, diving, tubing, surfing, hand fishing as defined by Texas Parks and Wildlife Code, §66.115; including whitewater activities: kayaking, canoeing, and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are 6 current permitted dischargers in Segment 1911, Upper San Antonio River. See Table 1901-1 for details.

Table 1901-1: Municipal and Industrial Wastewater Outfalls in Segment 1901 - Lower San Antonio River

Permittee	Status	Type	County
CITY OF FALLS CITY - Outfall 1	Current Permit	Domestic	Karnes
CITY OF GOLIAD - Outfall 1	Current Permit	Domestic	Goliad
CITY OF KARNES CITY - Outfall 1	Current Permit	Domestic	Karnes
CITY OF KENEDY - Outfall 1	Current Permit	Wastewater	Karnes
SOUTH CENTRAL WATER CO - Outfall 1	Current Permit	Domestic	Karnes
CITY OF KENEDY - Outfall 1	Current Permit	Wastewater	Karnes

Domestic: <1 MGD domestic sewage; **Wastewater:** ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Lower San Antonio River Watershed Water Quality Summary

According to the 2014 IR, bacteria and fish community impairments have been identified in the Lower San Antonio River. Habitat and nutrients have been listed as concerns. Table 1901-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Impairments are in red text, concerns are in black text. Figure LSAR-2 provides a visual summary of impairments and concerns by assessment unit. Table 1901-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Lower San Antonio River Watershed.

Table 1901-2: Water Quality Summary for Segment 1901 – Lower San Antonio River

Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Middle	• Sewer breaks and overflows • Poorly maintained septic tank systems • Stormwater runoff sources of fecal matter from wild animals and intense livestock production	TCEQ completed a TMDL for bacteria on the Lower San Antonio River on August 20, 2008; EPA approved it on October 20, 2008. The project continued in 2016 through the development of a stakeholder driven Implementation Plan for Bacteria in the Lower San Antonio River Watershed (LSAR I-Plan).
Fish Community	Upper Lower	The fish impairment in the Lower San Antonio River is most likely due to a lack of habitat types at Station 12791 as reflected by the habitat concern.	In 2014, Station 12791 San Antonio River at US 77A in Goliad was replaced with Station 12792 San Antonio River at Southern Pacific Rail Road Bridge in Goliad. Since there is more diverse habitat type at Station 12792, it is believed fish and habitat scores will improve over time. SARA will continue to collect additional data.
Habitat	Upper	Given the expanse of the Lower San Antonio River and the limited access points, obtaining a representative sample has proven to be difficult given the scale and distribution of habitat types within the watershed.	SARA will continue to conduct biological monitoring at Station 12792 San Antonio River at Southern Pacific Rail Road Bridge to assess aquatic communities, water quality conditions and determine long-term trends in the watershed.
Nitrate Nitrogen	Entire	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff • Stormwater runoff sources of fecal matter from wild animals and intense livestock production	There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate, total phosphorus, and chlorophyll-*a* data is utilized to indicate areas of concern. SARA will continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria, to assess water quality conditions, and determine long-term trends in the watershed.
Total Phosphorus	Entire		
Chlorophyll-*a*	Upper and Lower		

Water Quality Summary			
Segment 1901A – Escondido Creek; Segment 1901B - Cabeza Creek; Segment 1901C - Hord Creek; Segment 1901D Lost Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Escondido Creek Cabeza Creek	• Poorly maintained septic tank systems • Stormwater runoff sources of fecal matter from wild animals and livestock production	SARA will maintain routine monitoring on Escondido Creek. Cabeza Creek was monitored in 2017 under the CRP systematic monitoring efforts to help identify the perennial and intermittent portions of the creek. By doing this, the extent and location of the *E. coli* impairment can better be determined.
			Information will be provide to the TCEQ for the 2020 Texas State Water Quality Stream Standards Revision assessment.

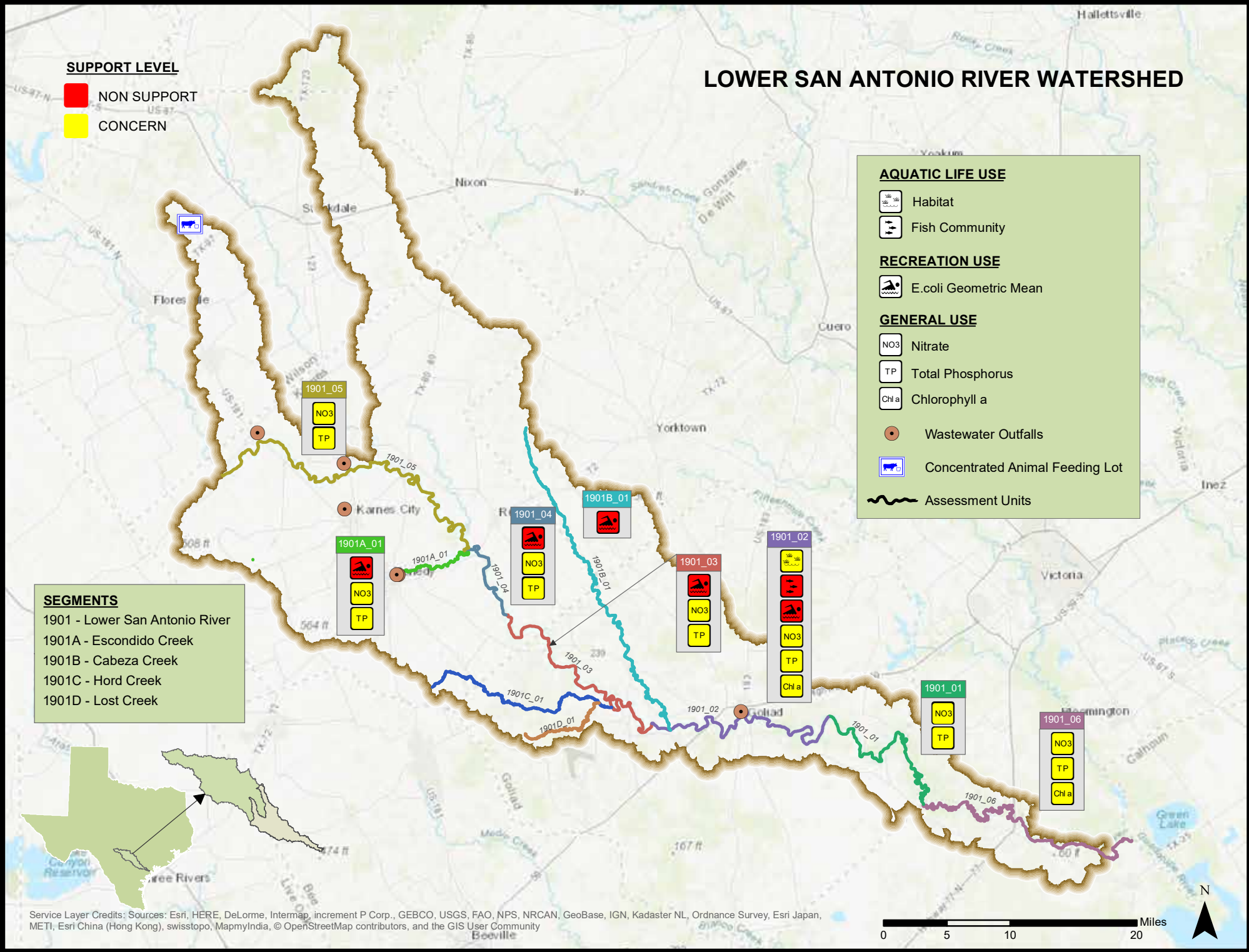
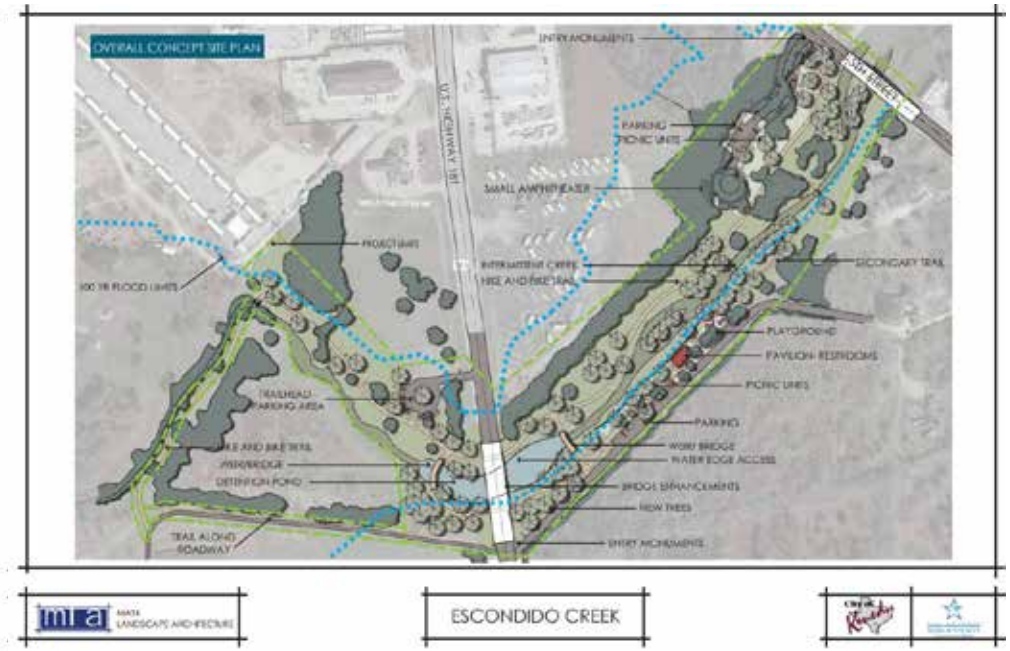


Figure LSAR-2: Map of the Lower San Antonio River impairments and concerns by assessment units.

USGS and SARA Study: USGS Oil and Gas Production Constituents Phase II Project: The recent oil and gas production increase, throughout the United States, has elicited a multitude of concerns regarding the potential risks to human and environmental health (U.S. Environmental Protection Agency, 2011). The Phase I study, 2011-2013, established a baseline of water quality and streambed constituents within the area of most oil and natural gas production in the San Antonio River Basin. Phase II commenced in October 2014. The project objectives included the U.S. Geological Survey revisiting a subset of the sites from Phase I to determine changes in surface water and streambed sediment quality, determining the extent of land cover change with the increase in well pads, storage ponds, and new roads, and collecting samples at additional sites within the lower San Antonio River Basin, primarily in Wilson and Karnes counties, to try and determine if any correlation exists between polyaromatic hydrocarbon (PAH) concentrations and impervious surface area. The project was extended a year to capture the needed sampling, complete sample analysis, and report writing. The project is scheduled to be completed September 30, 2018 with the publication of a USGS Scientific Investigations Report.



City of Kenedy Escondido Creek Parkway Project: Escondido Creek runs through the City of Kenedy and is located 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. The vision for the Escondido Creek Parkway Project is anticipated to include new concrete hike and bike trails, pavilion, native landscaping, playground, parking lot for 25 vehicles on the east end of project near 5th Street and Hwy 181, benches installed along the trail, and educational signage installed at the trail head and along the trail, water feature, weirs, and picnic tables.

Total Maximum Daily Load for Bacteria in the Lower San Antonio River (LSAR): The Lower San Antonio River was first identified as impaired for recreational use in 2000. In response to the listing, the TCEQ developed the Lower San Antonio River Bacteria TMDL (LSAR TMDL) to determine the amount, or loading, of a pollutant the San Antonio River could receive and still support its designated uses. The allowable load was then allocated among categories of sources within the watershed. Possible sources of contamination included discharges from wastewater treatment facilities, urban and non-urban stormwater runoff, contributions from wildlife, pets and livestock, leaking sewer infrastructure and failing septic systems. The TCEQ adopted the LSAR TMDL on August 20, 2008, and the EPA's approved it on October 20, 2008. The LSAR TMDL report is located at http://www.tceq.texas.gov/waterquality/tmdl/34-lowersanantoniobac.html#background.

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: The TCEQ TMDL Program contracted with Texas A&M AgriLife Research to work with stakeholders to develop a LSAR I-Plan that will describe the steps the watershed stakeholders and the TCEQ will take toward achieving pollutant reductions identified in the TMDL report, and outline the schedule for implementation activities. The ultimate goal of the LSAR I-Plan is to restore the primary contact recreation uses in Segments 1901 by reducing concentrations of bacteria to levels established in the 2008 LSAR TMDL. The TMDL document was based on segment units (Segment 1901) but the TCEQ program now uses assessment units (AUs) within segments. The LSAR I-Plan will focus on the five impaired TMDL AU watersheds within the original segment, but some information based on the TMDL covers the full segment watershed.

SARA Feral Hog Management Project: In 2015 the San Antonio River Authority partnered with Texas A&M AgriLife Extension (AgriLife) and the Texas Wildlife Services (TWS), a division of the United States Department of Agriculture, Plant and Animal Health Index to create and host a series of hands-on workshops in the district, as well as offer landowners in the district assistance with feral hog management. Feral hogs are a particular concern for the San Antonio River Authority, because hogs can impact water quality and are often drawn to riparian habitats for the abundance of resources that is offered there. In the first year, three workshops were held, reaching 319 landowners, land managers, and government officials. In the second year, four workshops were held, reaching 365 landowners. Topics at these workshops included feral hog biology, agricultural regulations regarding feral hogs, feral hog control, transportation regulations and disease, population dynamics and research, and novel techniques and recent technology for management. Two wildlife technicians were hired to work in Bexar, Wilson, Karnes, and Goliad counties using a variety of removal methods such as corral traps, aerial gunning, and infrared equipment. In the first year of the program TWS partnered with over 35 landowners to actively trap hogs from public and private property removing 1,099 hogs from Bandera, Bexar, Wilson, Karnes, and Goliad counties combined. In the second year of the program, TWS partnered with over 62 landowners to actively trap hogs from public and private property removing 1,447 hogs from Bandera, Bexar, Wilson, Karnes, and Goliad counties combined. Demand for assistance has been so great, that the program will be adding a third technician to assist in the southern counties.

Table 1901-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Lower San Antonio Watershed by Assessment Unit

Lower San Antonio River Watershed Segment 1901 -Lower San Antonio River				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score 42**	**HBI Score 20**	**Score 29**
1901_01	12790	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=109.53	NC	CS	CS	NC	NA	NA	NA
1901_02	12791; 17858	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS GM=183.05	NC	CS	CS	CS	NS-CF (34.20)	CS (15.40)	NA
1901_03	12793; 17859	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS GM=148.47	NC	CS	CS	NC	NA	NA	NA
1901_04	12794	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS GM=195.75	NC	CS	CS	NC	NA	NA	NA
1901_05	12795; 12796; 16580; 17860; 17861; 17862	perennial	high	FS	FS	FS	NC	FS	NC	NC	FS	FS	FS GM=110.67	NC	CS	CS	NC	TR-NA (30.90)	NC (20.00)	NA
1901_06	12789	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=73.77	NC	CS	CS	CS	NA	NA	NA

Segment 1901A - Escondido Creek Segment 1901B - Cabeza Creek Segment 1901C - Hord Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Escondido Creek 1901A_01	17573; 18402	perennial	high	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS GM=916.85	NC	CS	CS	NC
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Cabeza Creek 1901B_01	16992	intermittent w/pools	limited	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS GM=551.56	NC	NC	NC	NC
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Hord Creek 1901C_01	18319	intermittent w/pools	limited	NA	NA	NA	NC	NC	NA	NA	NA	NA	NC GM=20.51	NA	NA	NA	NA
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Lost Creek 1901D_01	18320	intermittent w/pools	limited	NA	NA	NA	NC	NC	NA	NA	NA	NA	NC GM=81.83	NA	NA	NA	NA

SARA's Trends over Time

Seg/AU	Description	Instantaneous Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	E. coli Grab	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
1901_02	Station 12791 SAR Bridge on US 77-A and 183 Southeast of Goliad									↓		↑		↓
1901_02	Station 17859 SAR at North Riverdale Road 15 KM (9.32 miles) West of Goliad Texas		↓		↓		↑			↓				↓
1901_04	Station 12794 SAR at SH 72 near Runge	↓							↑	↓		↑	↑	↓

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

CF = The Integrated level of support of CS, CN or NS was carried forward from a previous assessment due to inadequate/no data for this method in this assessment.

TR = Temporally Not representative, used with NA

Bacteria Impairment

The Lower San Antonio River was first identified as impaired for recreational use in the 2000. In response to the listing, the TCEQ developed the Lower San Antonio River Bacteria TMDL (LSAR TMDL) to determine the amount, or loading, of a pollutant the San Antonio River could receive and still support its designated uses. The allowable load was then allocated among categories of sources within the watershed. The TMDL identified regulated and unregulated sources of *E. coli* in the watershed that could contribute to the water quality impairment. Regulated sources identified include wastewater treatment facilities, sanitary sewer overflows (SSOs), dry weather discharges, and illicit discharges. Unregulated sources that may contribute to the bacteria load in the watersheds include domestic animals (e.g., dogs, cats, chickens, etc.), livestock (e.g., cattle, horses, goats, etc.), neglected and failing on-site sewage facilities (OSSFs), and wildlife and other unmanaged animals (e.g., deer, feral hogs, grackles and other birds). In addition, illicit dumping and unregulated urban stormwater have also been identified as potential contributors. The TCEQ adopted the LSAR TMDL on August 20, 2008, and the EPA approved it on October 20, 2008.

The project continued in 2016 through the development of a stakeholder driven Implementation Plan for Five Total Maximum Daily Loads for Bacteria in the Lower San Antonio River Watershed Segment 1901. The LSAR I-Plan's goal is to identify measures needed to reduce pollution, including a timeline for implementation. The TCEQ TMDL Program contracted with Texas A&M AgriLife Research to work with stakeholders to develop the LSAR I-Plan. The LSAR I-Plan includes management measures and control actions that will be used to reduce bacteria in the LSAR watershed. Management measures are related to managing nonpoint sources (unregulated), such as working to identify on-site sewage facilities (OSSFs) in the watershed. Control actions are related to point sources (regulated discharges), such as implementing industrial or domestic Wastewater Treatment Facilities (WWTFs) or MS4 Phase II Stormwater Management Programs.

Feral Hogs crossing the Lower San Antonio River near Goliad

Management Measures

- Develop and implement conservation plans in priority areas of the watershed; educate landowners on appropriate stocking rates and grazing plans.
- Removal and management of feral hogs.
- Identification, prioritization, and remediation of OSSFs.

- Coordinate efforts to reduce unauthorized discharges including sanitary sewer overflows (SSOs); coordinate and expand efforts to reduce stormwater inflow and infiltration; reduce Wastewater Treatment Facilities (WWTF) contributions by meeting half of the permitted bacteria limit; advocate for proper operation and maintenance (O&M) of sewer lines.
- Restore and repair riparian zones; emphasize protection of riparian zones; advocate for educational and outreach materials like "Be Watershed Wise" campaign; promote the San Antonio River Creek Book.
- Promote the improved quality and management of urban stormwater; coordinate with new development for reducing runoff pollutants; provide education programs on stormwater management; advocate for LID Best Management Practices (BMPs).
- Promote the reduction of illicit dumping and proper disposal of wastes; utilize SARA's Environmental Investigators
- Coordinate and expand existing water quality monitoring in the watershed.
- Assist the TCEQ determine the flow type of Cabeza Creek.

The elevated levels of nutrients and *E. coli* is dependent on various sources of contamination, including input from municipal and industrial wastewater facilities, and runoff from agricultural activities and wildlife. Land use for the Lower San Antonio River Watershed indicates the urban areas of the watershed account for less than five percent of the watershed. As a result of the available land, together with the drought conditions over the assessment period, livestock and wildlife concentrations normally increase along the river. SARA field biologists have documented numerous cattle crossings and feral hog wallows in the Lower San Antonio River Watershed. A helicopter survey in early 2012 identified significant numbers of feral hogs in the watershed. It was estimated that for every cow seen during the survey, 50 feral hogs were seen. Feral hogs have been identified as a key potential contributor of *E coli* and nutrients.

In an effort to assist the public in recreational planning, SARA monitors a total of seven stations throughout the San Antonio River Basin for *E. coli.* The data is available on SARA's Recreation website located at https://www.sara-tx.org/river-recreation/paddling-trails/current-conditions/. This website shows a strong relationship between rainfall and elevated *E. coli* values.

- Station 14256 San Antonio River at Mitchell Street, San Antonio, TX
- Station 17066 San Antonio River at Mission Road, San Antonio, TX
- Station 12897 San Antonio River at Interstate 410 Camino Coahuilatechan, San Antonio, TX
- Station 12881 San Antonio River at SH 97 near Floresville, TX
- Station 12879 San Antonio River at FM 791 S.W. of Falls City, TX
- Station 12791 San Antonio River at US Hwy. 77-A, Goliad, TX
- Station 14200 Cibolo Creek at CR389 near Cestohowa, TX

Biological Assessment

TSWQS describes the Lower San Antonio River as having a high aquatic life use designation and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average). Biological assessments for the Lower San Antonio River identify a fish community impairment and habitat concern in assessment unit 1901_02 and a fish community concern in assessment unit 1901_05. Station 12791 San Antonio River at US 77A in Goliad is in assessment unit 1901_02 and was sampled four times, once in each year between 2009 and 2012. Station 16580 San Antonio River at Conquista Crossing is in 1901_05 and was sampled four time times, once in 2008, once in 2010, and once in 2011.

Orangespotted Sunfish *(Lepomis humilis)*

The fish Index of Biotic Integrity (IBI) scores for both assessment units ranged from 22 (limited) at Conquista Crossing to 37 (intermediate) at the same station, with the overall IBI score of 32.55 (limited). There was an average of 365 individual fish and an average of 12 different species collected per sampling event. No intolerant species were collected and an average of 74% of the total number of fish collected were tolerant to pollution. The Suckermouth Catfish Plecostomus was the only non-native species collected. Native species collected included the Amazon Molly, Black Bullhead, Blacktail Shiner, Blue Catfish, Bluegill Sunfish, Bullhead Minnow, Burrhead Chub, Channel Catfish, Flathead Catfish, Gizzard Shad, Green Sunfish, Largemouth Bass, Longear Sunfish, Longnose Gar, Mexican Tetra, Red Shiner, Rio Grande Cichlid, Sailfin Molly, Sand Shiner, Smallmouth Buffalo, Spotted Bass, Spotted Gar and Western Mosquitofish.

Habitat Quality Index (HQI) scores ranged from 13 (limited) at San Antonio River at US 77A to 23 (high) at San Antonio River at Conquista Crossing, with the average HQI score being 17.7 (intermediate). The Lower San Antonio River stream channel is characterized by well to poorly defined stream bends. Stream banks are gently sloping to high steep banks covered with dense hardwood riparian forest. The average width of the natural riparian habitat for the sample sites is 17 meters and includes native hardwood trees, shrubs and grasses. The average percent tree canopy is 60% and includes pecan, elm, hackberry, black willow, cottonwood, and oak. Instream habitat types include riffles, runs and glides. Bedrock and sand are the dominant substrate type. The average number of instream cover types is seven and includes boulders, ledges, woody debris, tree roots, overhanging vegetation, gravel and undercut banks. The average percent instream cover is 27% and the average percent stream bank erosion is estimated to be 35%.

Although there was limited 24-hour DO data for both Station 12791 San Antonio River at US 77A in Goliad and Station 16580 San Antonio River at Conquista Crossing, of the seven 24-hour DO measurements assessed in the 2014 IR, there were no average or minimum exceedances. The 24-hour DO average values ranged from 6.2 mg/L at Station 16580 San Antonio River at Conquista

Crossing to 7.5 mg/L Station 12791 San Antonio River at US 77A in Goliad. The 24-hour DO minimum values ranged from 5.6 mg/L at Station 12791 San Antonio River at US 77A in Goliad to 6.7 mg/L at Station 16580 San Antonio River at Conquista Crossing. In addition to the 24-hour DO, there were 360 grab DO measurements collected, with no average or minimum exceedances at either station.

The fish impairment in the Lower San Antonio River, assessment unit 1901_02 is most likely due to a lack of habitat types within the sample area as reflected by the habitat concern. Station 12791 San Antonio River at US 77A in Goliad, is characterized as one big glide with no pools, runs or riffle habitats. Given the scale and distribution of habitat types within the Lower San Antonio River Watershed together with limited access points, obtaining a representative sample has proved to be difficult. To determine if the fish community impairment and habitat concern in 1901_02 are due to a site specific limitation rather than to a pollutant, beginning in 2014, Station 12791 San Antonio River at US 77A in Goliad was replaced with Station 12792 San Antonio River at Southern Pacific Rail Road Bridge in Goliad. Although there is limited data available for Station 12792, preliminary fish and habitat scores are showing slight improvement. The average fish IBI score is 37 (intermediate) and the average HQI score to 18 (intermediate).

It should be noted that the general trend in Statewide IBI scoring method is to underestimate the aquatic life use when compared to other assessment methods. Therefore, the lower Statewide IBI score generated from 1901_02 and 1901_05, as well as other waterbodies in the San Antonio River Basin, may not be indicative of the true health of the waterbody. Regional criteria that accounts for a diversity of land forms, soil types, vegetation, climatic conditions, and zoogeographic factors may provide a better representation of the integrity of the fish assemblages. Additional information regarding the Statewide IBI scoring method can seen at the TPWD website located at https://tpwd.texas.gov/publications/pwdpubs/media/pwd_rp_t3200_1086.pdf.

Lower San Antonio River Watershed

Trend Analyses

Although the 2014 IR assessed and reported a concern for chlorophyll-*a* samples collected at Station 12791 San Antonio River Bridge on US 77-A (1901_02) , trending over time has identified a significant statistical decreasing trend for chlorophyll-*a.* Chlorophyll-*a* concentrations over the trending period ranged from 1 to 57 µg/L, with a mean value of 12.3 µg/L. A significant increasing nitrate trend was also detected. Out of 59 nitrate samples assessed in the trending period, 95% of the samples exceeded the 1.95 mg/L nitrate screening criteria for freshwater streams and rivers. In spite of the elevated nitrate trend, no adverse algae blooms were recorded over the trending period. A decreasing temperature trends over time has also been detected (Figures LSAR 2-4).

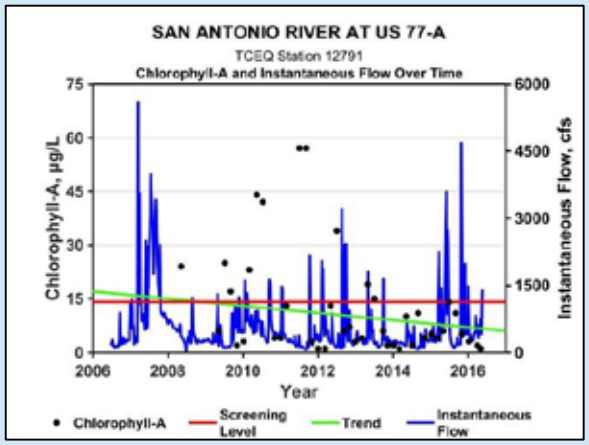


Fig. LSAR 2: 17791 SAR Bridge on US 77-A, Chlorophyll-*a* over Time

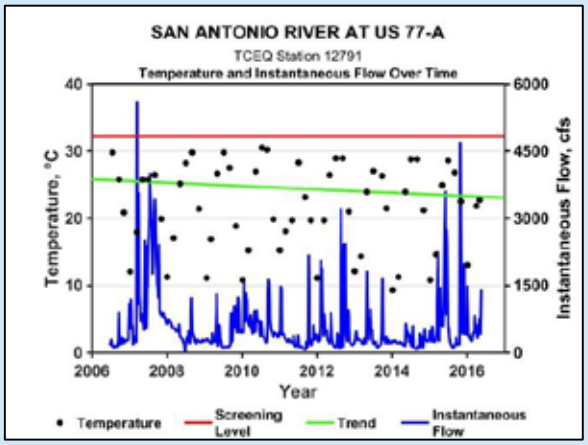


Fig. LSAR 3: 17791 SAR Bridge on US 77-A, Temperature over Time

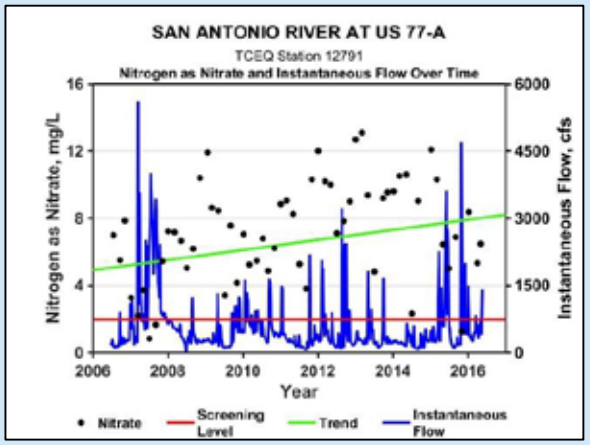


Fig. LSAR 4: 17791 SAR Bridge on US 77-A, Nitrate over Time

Station 17859 San Antonio River at Riverdale is in assessment unit 1901_03 and is located below the San Antonio River's confluence with Hord Creek (1911C) and Lost Creek (1911D). While a statistically significant increasing trend for DO deficit has been identified, the 2014 IR identifies 1901_03 as meeting the high aquatic life use designation based on grab DO samples. Out of the 178 DO grab samples assessed, there were no screening (5 mg/L) or minimum criteria (3 mg/L) exceedances. Decreasing trends for temperature, total suspended solids, sulfate and chlorophyll-*a* have also been identified (Figure LSAR 5-7).

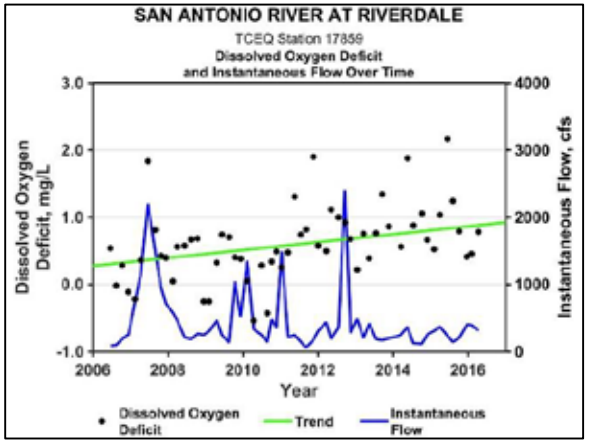


Fig. LSAR 5: 17859 SAR at Riverdale, DO Deficit over Time

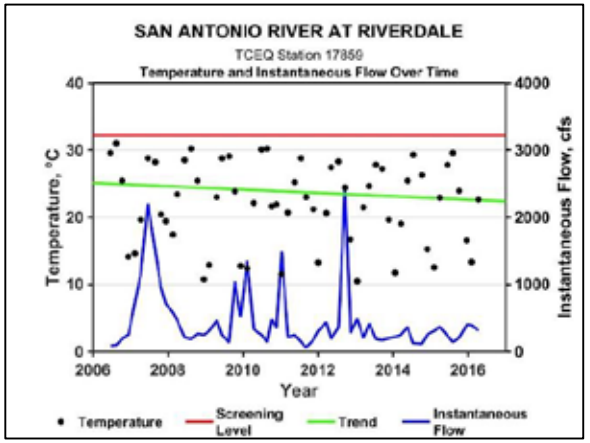


Fig. LSAR 6: 17859 SAR at Riverdale, Temperature over Time

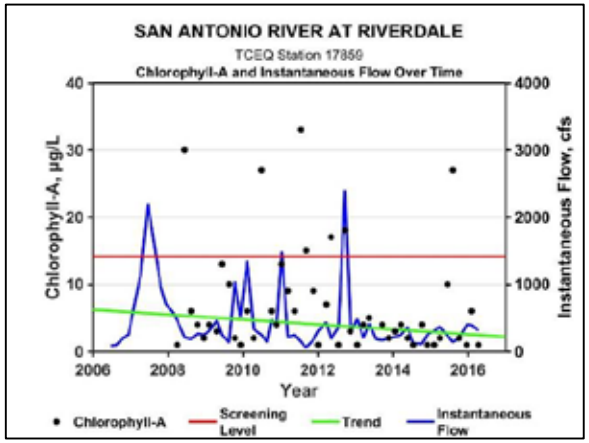


Fig. LSAR 4: 17859 SAR at Riverdale, Chlorophyll-*a* over Time

For the 2014 IR, Station 12794 San Antonio River at SH 72 near Runge was the only station assessed in assessment unit 1901_04. The sampling station is located below the Karnes City and Kenedy WWTPs. Assessment unit 1901_04 fully supports its general and aquatic life designated uses according to the 2014 IR. However, with a geometric mean of 195.75 *E.coli* /100mL, it does not support contact recreation based on a geometric mean above the State Water Quality Standard of 126 E. coli /100mL. In spite of the E. coli impairment listing, there were no statistical significant increasing or decreasing *E. coli* trends over the trending period. Statistical significant increasing trends for pH, nitrate and total phosphorous were identified; statistically significant decreasing trends in flow, temperature and chlorophyll-*a* were also detected (Figure LSAR 8-10).

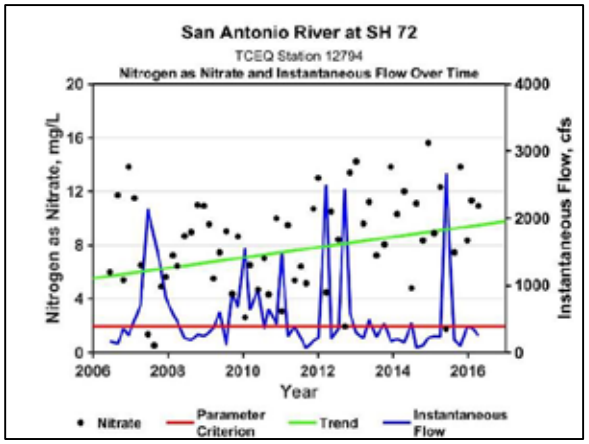


Fig. LSAR 8: 12794 SAR at SH72, Nitrate over Time

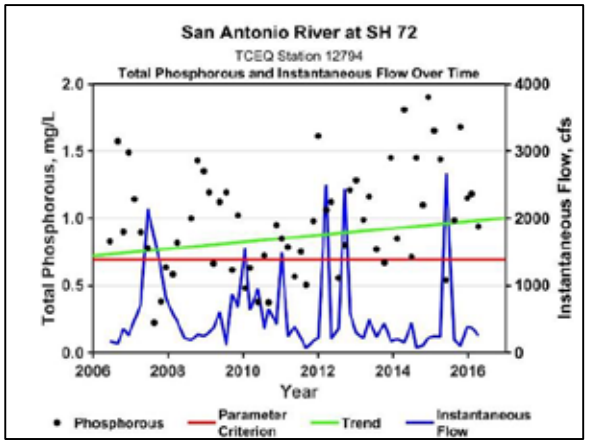
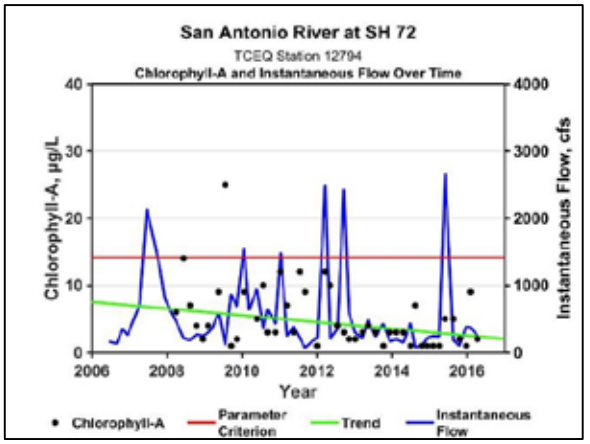
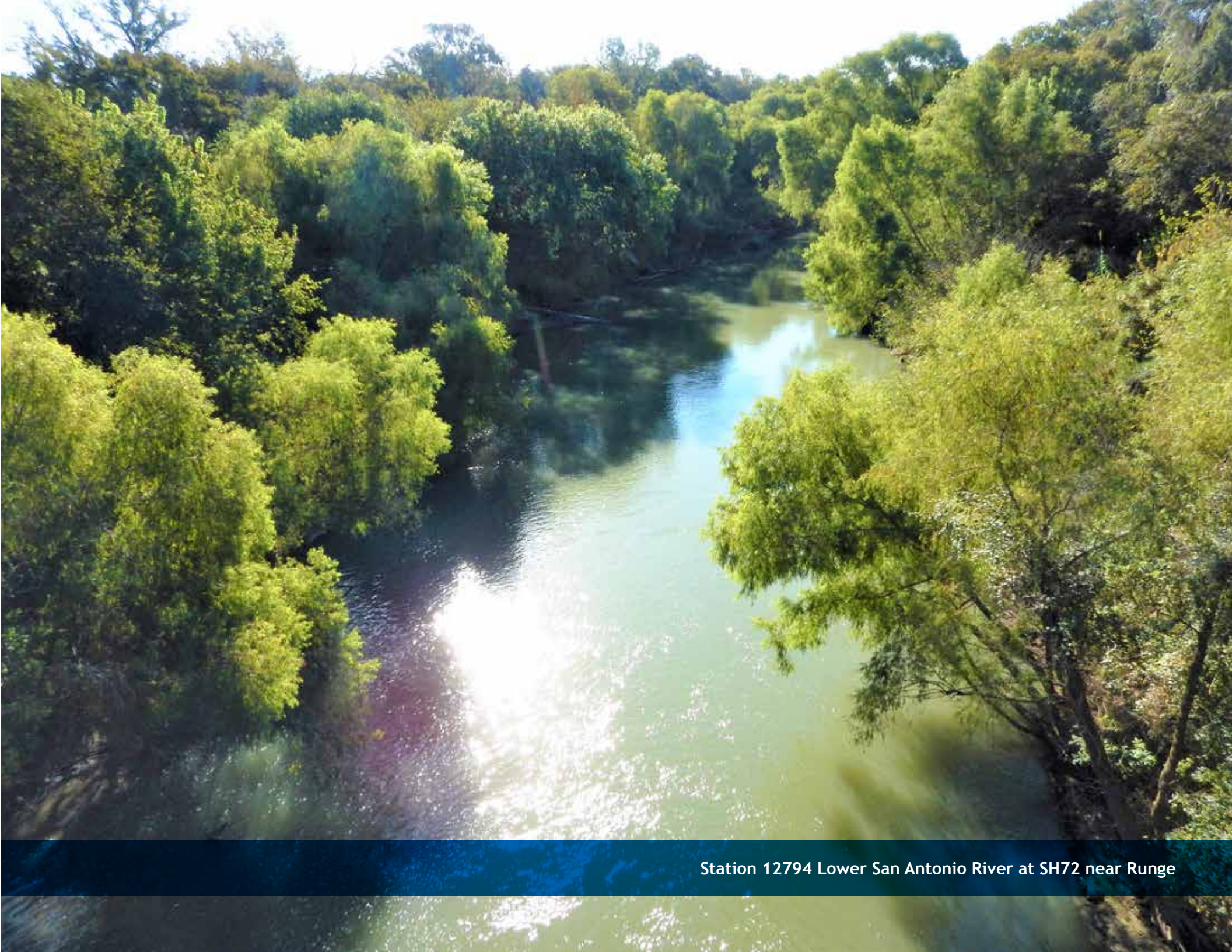


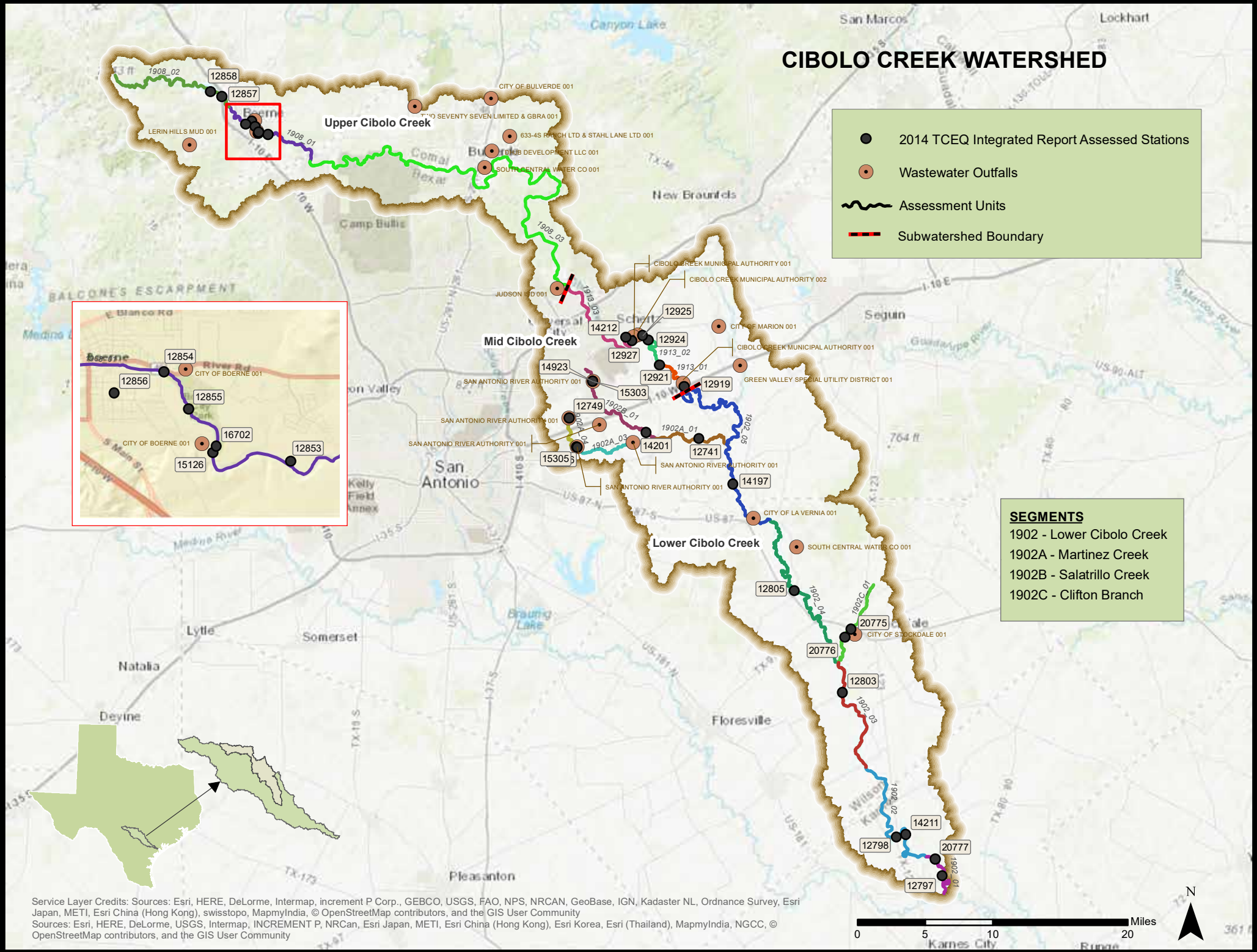
Fig. LSAR 9: 12790 SAR at SH72, Total Phosphorous over Time



Figs LSAR 10: 12794 SAR at SH72, Chlorophyll-*a* over Time



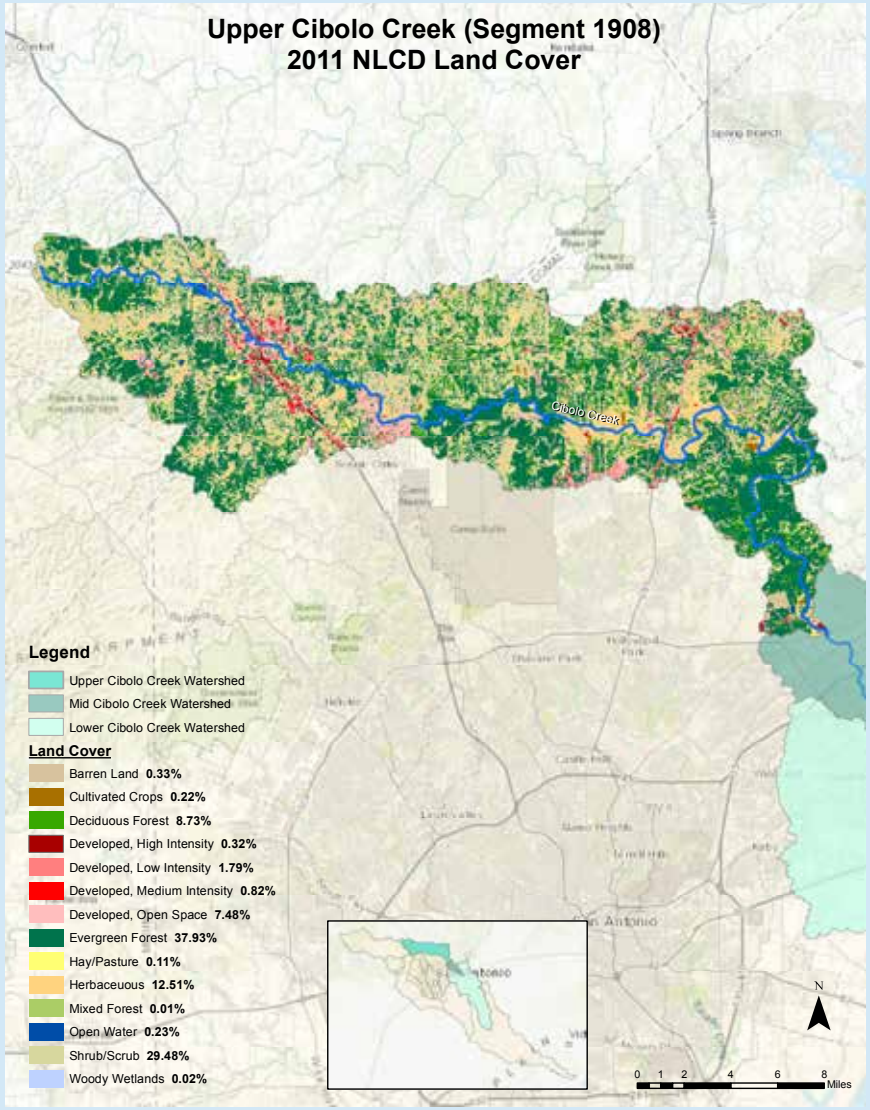
Station 12794 Lower San Antonio River at SH72 near Runge



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Upper Cibolo Creek Watershed – Segment 1908

Segment 1908 starts a little more than 10 miles northwest of the City of Boerne, approximately one mile upstream of the confluence of Champee Springs in Kendall County, and ends at the Missouri-Pacific Railroad Bridge west of Bracken, Texas. The Upper Cibolo Creek Watershed covers approximately 228 square miles and contains the City of Boerne. 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. The watershed has an average yearly rainfall of 28 to 36 inches. There are no unclassified segments of the Upper Cibolo Creek identified in the 2014 IR.



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 and 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 is 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. According to U.S. Census Bureau information, the population of the City of Boerne has increased 38.1% between 2010 and 2016. As of July 1, 2016, the estimated population of the City of Boerne is 14,725.

This segment is largely a mixture of forest, shrub/scrub and herbaceous areas with the higher intensity development around the City of Boerne, Fair Oaks Ranch, Bulverde and northern Timberwood Park. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure UCC-1 for more detail.

The Upper Cibolo Creek has a high aquatic life use designation. It is also designated for use as a public water supply. Aquifer protection use applies to this segment because it contributes to recharge of the Edwards

Aquifer. Like all segments in the San Antonio River Basin, TCEQ has designated this segment for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are five current permitted domestic and wastewater and two pending domestic dischargers in Segment 1908, Upper Cibolo Creek. See Table 1908-1 for details.

Table 1908-1: Municipal and Industrial Wastewater Outfalls in Segment 1908 - Upper Cibolo Creek

Permittee	Status	Type	County
SOUTH CENTRAL WATER CO - Outfall 1	Current Permit	Domestic	COMAL
CITY OF BOERNE - Outfall 1	Current Permit	Wastewater	KENDALL
LERIN HILLS MUD - Outfall 1	Current Permit	Domestic	KENDALL
633-4S RANCH LTD & STAHL LANE LTD - Outfall 1	Pending permit	Domestic	COMAL
DHJB DEVELOPMENT LLC - Outfall 1	Pending permit	Domestic	COMAL
TWO SEVENTY SEVEN LIMITED & GBRA - Outfall 1	Current Permit	Domestic	COMAL
CITY OF BOERNE - Outfall 1	Current Permit	Wastewater	KENDALL

Domestic: <1 MGD domestic sewage; **Wastewater:** ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Station 20821 Upper Cibolo Creek at Northrup Park, Upper Cibolo Creek Watershed

Upper Cibolo Creek Watershed Water Quality Summary

According to the 2014 IR, bacteria and chloride impairments have been identified in the Upper Cibolo Creek Watershed. Total phosphorus, dissolved oxygen grab screening average, and habitat have been listed as concerns. Table 1908-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Impairments are in red text, concerns are in black text. Figure UCC-2 provides a visual summary of impairments and concerns by assessment unit. Table 1908-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Upper Cibolo Creek Watershed.

Table 1908-2: Water Quality Summary for Segment 1908 – Upper Cibolo Creek

Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Middle	• Stormwater runoff sources of fecal matter from livestock production and wild animals • Local and migratory birds	The City of Boerne, in partnership with the Cibolo Nature Center and local stakeholders, is developing a WPP to restore the contact recreation uses of the creek and to prevent pollution that could result from population growth in the watershed.
Chloride	Entire	• Wastewater treatment plant discharge • Low flows and natural weathering and leaching of sedimentary rocks, soils and salt deposits can release chloride into the environment	Chloride values for all sites within the segment are averaged and used to determine TSWQS compliance for the entire segment. The TCEQ has assigned this impairment to Category 5c indicating that additional chloride data or information will be collected and/or evaluated before a management strategy is selected.
Total Phosphorus	Middle	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	There are no State numerical nutrient stream water quality standards, only screening criteria. Total phosphorus data is utilized to indicate areas of concern. SARA and the TCEQ will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.

Table 1908-2: Water Quality Summary for Segment 1908 – Upper Cibolo Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Depressed DO	Middle	Intermittent low flows over the assessment period, poor riparian buffer vegetation and shallow depth.	SARA will continue to conduct monitoring to assess aquatic communities, water quality conditions and determine long-term trends in the watershed.
Habitat	Upper	A previous Aquatic Life Monitoring effort resulted in the habitat concern. Review of data and field notes indicate that one of the stations (12857 Cibolo Creek at IH10) was not representative of the reach due to its proximity to the interstate highway bridge crossing.	In 2016 SARA and the TCEQ completed the Upper Cibolo Creek Aquatic Life Monitoring effort to address the habitat concern. The results of the effort have been submitted to the TCEQ for further review. No biological monitoring is scheduled for the Upper Cibolo Creek Watershed.

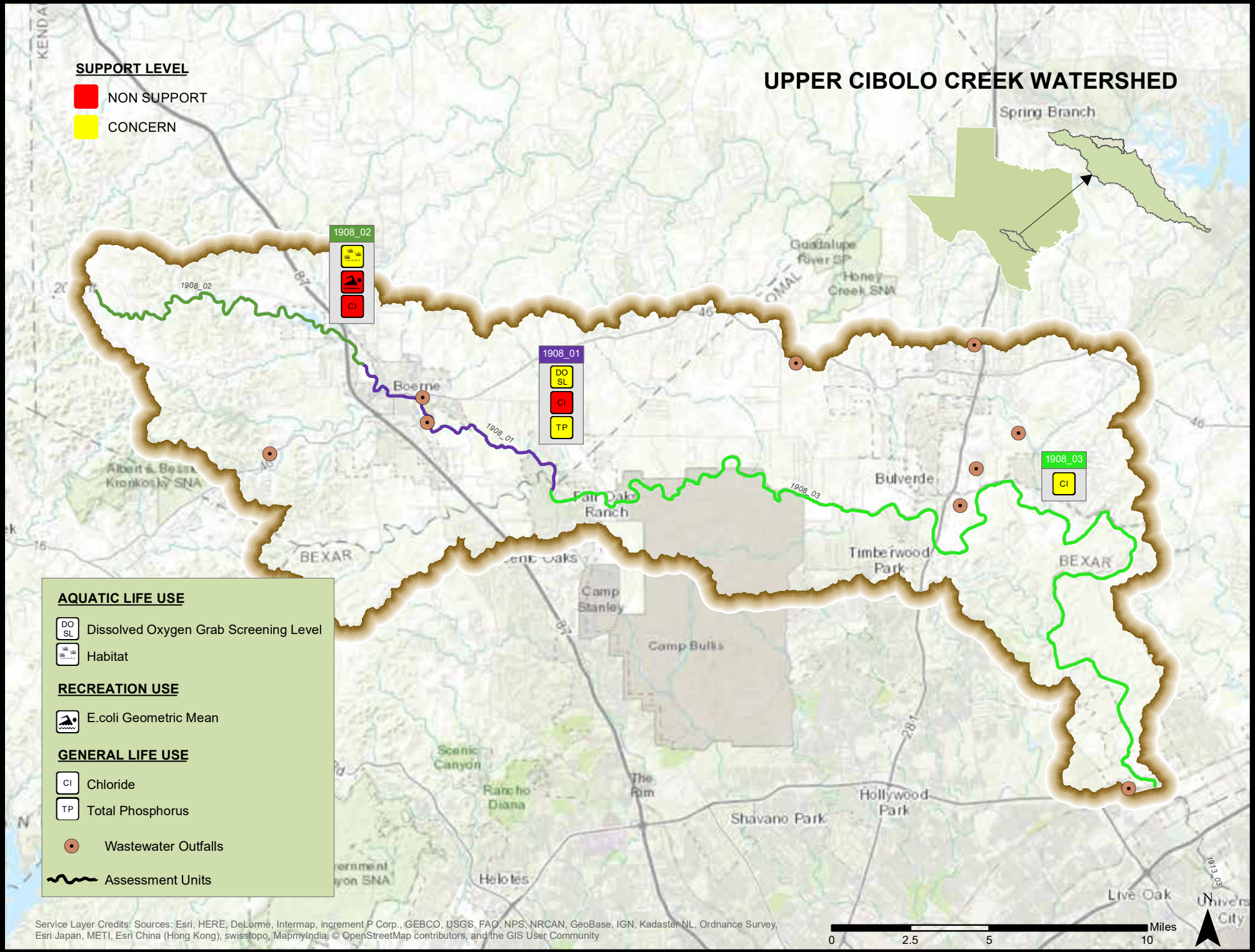


Figure UCC-2: Map of the Upper Cibolo Creek impairments and concerns by assessment unit.

In 2015, SARA, 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 with a corresponding 24-hour DO average criterion of 5.0 mg/L and minimum criterion of 3.0 mg/L. Data also supported an intermittent with pools flow designation for the Mid Cibolo Creek with 24-hour average criterion of 3.0 mg/L and a minimum criterion 2.0 mg/L. 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 Standards was sent to the EPA Region 6 for approval. As of this report, no EPA actions or approval has been received by the TCEQ. The revisions cannot be used for federal actions, which includes permitting and the IRs, until EPA approves the revisions.

Table 1908-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Upper Cibolo Creek Watershed by Assessment Unit

Upper Cibolo Creek Watershed Segment 1908 - Upper Cibolo Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**50 mg/L**	**100 mg/L**	**600 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	IBI Score 42	HBI Score 20	Score 29
1908_01	12853, 12854, 12855, 12856, 15126, 16702	perennial	high	NS	FS	FS	CS	FS	NA	NA	FS	FS	FS GM=74.16	NC	NC	CS	NC	FS (51.00)	NC **(23.00)**	FS (39.00)
1908_02	12857, 12858	perennial	high	NS	FS	FS	NA	NA	NA	NA	NA	NA	NS GM=180.00	NA	NA	NA	NA	NA	CS -CF	NA
1908_03	No Stations	perennial	high	NS	FS	FS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

SARA's Trends over Time														
Seg/AU	**Description**	**Instantaneous Flow**	**TSS**	**Chloride**	**Sulfate**	**Total Dissolved Solids**	**Dissolved Oxygen Deficit**	**TKN**	**pH Range**	**Temperature**	**E. coli**	**Nitrate + Nitrite Nitrogen***	**Total Phosphorus**	**Chlorophyll-a**
1908_01	Station 16702 Cibolo Creek SE of Boerne downstream end of City Park in the Nature Preserve									↓				

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

CF = The Integrated level of support of CS, CN or NS was carried forward from a previous assessment due to inadequate/no data for this method in this assessment.

*Nitrate + nitrite is the primary method utilized for analyzing surface water in Segment 1908

Boerne City Lake, Upper Cibolo Creek Watershed

Bacteria Impairment

As a result of elevated bacteria, the Upper Cibolo Creek was identified as impaired for recreational 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 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 remains 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 SARA's LID Technical Guidance Manual as a resource for stormwater management alternatives.

The 2016 Upper Cibolo Creek Aquatic Life Monitoring (ALM) joint effort also addressed the bacterial impairment in 1908_02. Although the findings of the ALM effort resulted in the removal of the habitat concern, the bacteria impairment remains. To delist the bacteria impairment in the Upper Cibolo Creek, routine monitoring will have to be maintained at Station 12857 Cibolo Creek at IH10 in addition to Station 20821 Cibolo Creek just downstream of Northrup Park until sufficient acceptable bacterial results (≤126 *E. coli*/100mL) are obtained.

Chloride Impairment

Water quality criteria for several constituents are established in the TSWQS to safeguard general water quality, rather than for protection of one specific use. Water temperature, pH, chloride, sulfate, total dissolved solids and chlorophyll-*a* are parameters that

protect aquatic life, recreation, public water supply and other beneficial uses of water resources. For the purpose of TCEQ IR assessment, the criteria protecting these multiple uses are evaluated for attainment of the general use designation. Due to the infrequent monitoring and absence of stream flow information at many sites, requirements as stated in the *Guidance for Assessing and Reporting Surface Water Quality in Texas* indicate that all chloride values are averaged for all sites within the segment. The average concentration is then used to determine compliance for the entire segment. The average chloride concentration criterion for the Upper Cibolo Creek is 50.0 mg/L. With an average chloride concentration of 62.05 mg/L, the 2014 identifies the Upper Cibolo Creek as not meeting its general use designation.

When flash flooding occurs during heavy rainfall events, the high velocity of water tends to scour the streambed down to bedrock. Although the chloride impairment may be partially attributed to the dissolution of minerals from naturally occurring geologic deposits, the water quality is most likely due to an increase in water resource demands, drought, and ambient low flow conditions experienced in the watershed coupled with an accumulation and concentration of chloride discarded from the wastewater treatment plants (USGS, 2015). The TCEQ has assigned the chloride impairment to Category 5c indicating that additional chloride data or information will be collected and/or evaluated before a management strategy is selected.

Biological Assessment

TSWQS describes the Upper Cibolo Creek as having a high aquatic life use designation, and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average). The biological assessment for the Upper Cibolo Creek, assessment unit 1908_01, indicates fish and benthic macroinvertebrate communities and habitat are meeting the high aquatic life use designation; a concern for DO grab screening levels has also been documented. Stations assessed in 1908_01 included 15126 Cibolo Creek below Menger Creek Confluence, Station 12853 Cibolo Creek Southeast of Boerne and Station 20649 Cibolo Creek at low water crossing Linde Ranch. Each of the three stations was sampled twice, once in August 2006 and once in June 2008 for a total of six biological events. All the stations are located within the Cibolo Nature Preserve in the City of Boerne and were part of a TCEQ Aquatic Life Monitoring survey to determine the overall health of the creek.

According to information provided by the TCEQ, the fish Index of Biotic Integrity (IBI) score for all three stations was 51 (high), the benthic macroinvertebrate score was 39 (excellent) and the habitat quality index (HQI) score was 23 (high). Although the 2014 IR did not assess 24 hour dissolved oxygen due to limited data, historical information between January 2003 and September 2005 identify sixteen 24-hour collection events with no 24-hour average or minimum exceedances. However, until sufficient acceptable grab DO average or current 24-hour data is obtained, the concern for DO average will remain. The area along Cibolo Creek within the Cibolo Nature Center and the Cibolo Preserve is composed of diverse habitats including long open runs, deep shaded pools, riffles, springs, groundwater recharge features, and exposed fossil beds.

Trend Analyses

A statistically significant decreasing temperature trend over time was identified at Station 16702, Upper Cibolo Creek 1.6 meters downstream of SH 46 (Figure UCC 2). When comparing parameter concentrations against flow, decreasing trends were observed for total dissolved solid, total phosphorous, chloride and sulfate (Figure UCC 3 and 4).

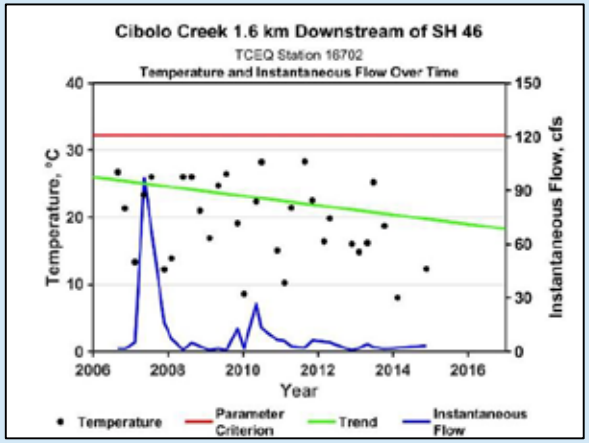


Fig. UCC 2: 16702 UCC downstream of SH46, Temp over Time

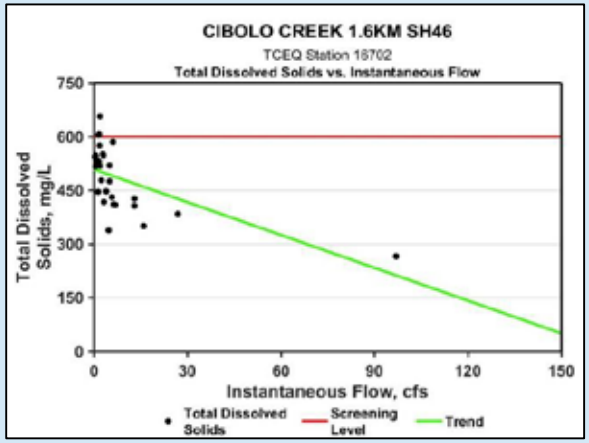


Fig. UCC 3: 16702 UCC downstream of SH46, TDS over Flow

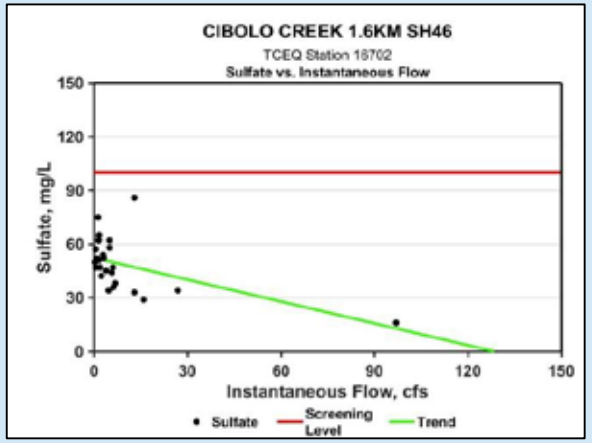
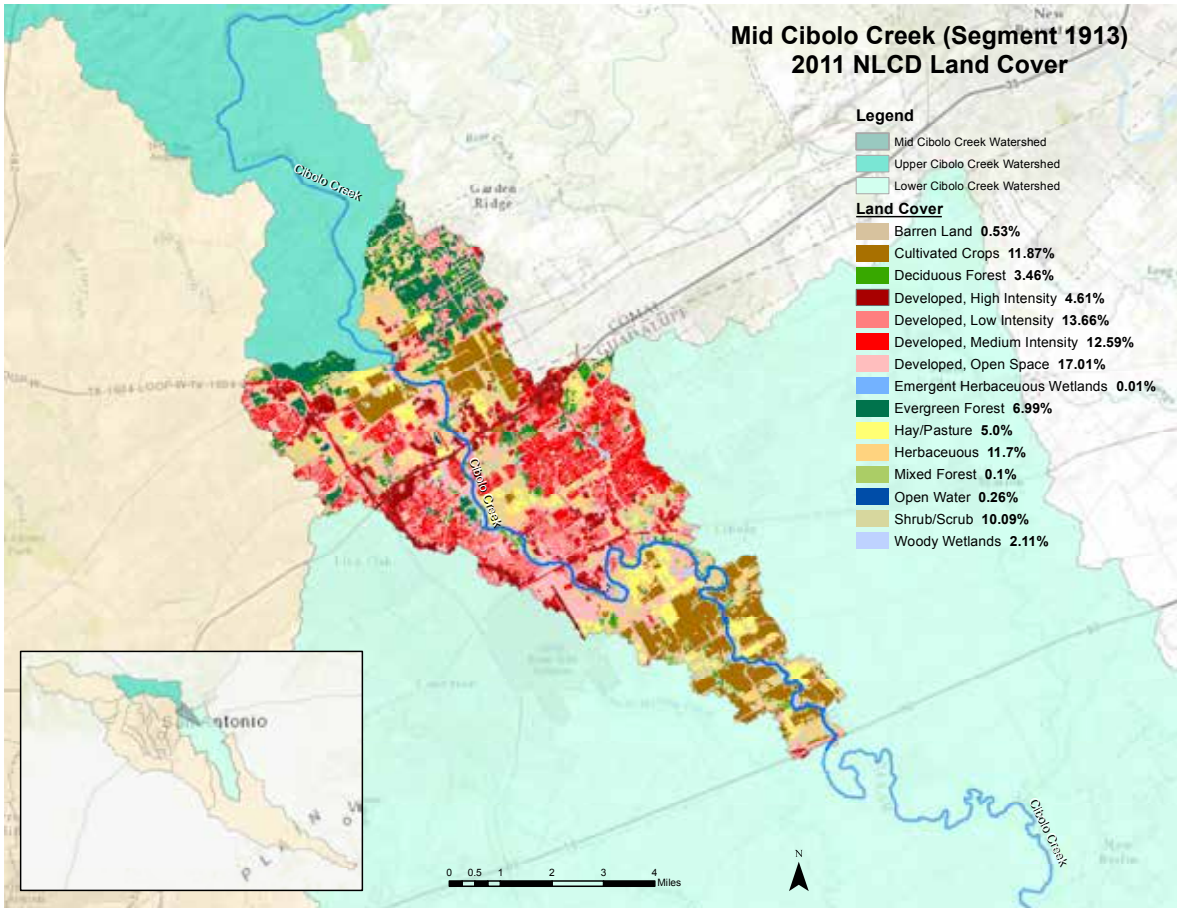


Fig. UCC 4: 16702 UCC downstream of SH46, Sulfate over Flow

Mid Cibolo Creek Watershed – Segment 1913

Mid Cibolo Creek, Segment 1913, begins at the Missouri-Pacific Railroad Bridge west of the City of Bracken and ends 110 yards downstream of IH-10. This segment of the Cibolo acts as the county boundary between Bexar and Comal County and Bexar and Guadalupe County. The watershed is approximately 19 miles long and has an approximate drainage area of 46 square miles. Segment 1913_03, from a point 100 meters (110 yards) upstream of the Cibolo Creek Municipal WWTP up 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 Mid Cibolo Creek during the drier portions of the year.

The Mid Cibolo is almost entirely on 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. This segment is mostly a mixture of pasture and cultivated crops in the upper and lower portions of the watershed with higher intensity development around the Cities of Selma, Live Oak, Universal City, Schertz and Randolph Air Force Base. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure MCC-1 for more detail.



This segment has a limited aquatic life use designation and is not classified for domestic water supply use. Like all segments in the San Antonio River Basin, TCEQ has designated this section for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are three current permitted domestic and wastewater and one pending wastewater discharger in Segment 1913, Mid Cibolo Creek. See Table 1913-1 for details.

Table 1913-1: Municipal and Industrial Wastewater Outfalls in Segment 1913 - Mid Cibolo Creek			
Permittee	Status	Type	County
CIBOLO CREEK MUNICIPAL AUTHORITY - Outfall 2	Current Permit	Wastewater	BEXAR
CIBOLO CREEK MUNICIPAL AUTHORITY - Outfall 1	Pending permit	Wastewater	
CIBOLO CREEK MUNICIPAL AUTHORITY - Outfall 1	Current Permit	Wastewater	BEXAR
JUDSON ISD - Outfall 1	Current Permit	Domestic	BEXAR

Domestic: <1 MGD domestic sewage; Wastewater: ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Mid Cibolo Creek Watershed Water Quality Summary

According to the 2014 IR, a depressed DO impairment has been identified in the Mid Cibolo Creek Watershed; nutrients have been listed as concerns. Table 1913-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Impairments are in red text, concerns are in black text. Figure MCC-2 provides a visual summary of impairments and concerns by assessment unit. Table 1913-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Mid Cibolo Creek Watershed.

Table 1913-2: Water Quality Summary for Segment 1913 – Mid Cibolo Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Depressed DO	Middle	• Elevated Nutrients • Low Flows	Once the Cibolo Creek Watershed Segment Boundary Re-Definition Effort findings have been adopted by the TCEQ and approved by the EPA, all three Cibolo Creek segments will be reassessed using the new segment boundaries and DO criteria. It is possible the Mid Cibolo Creek DO impairment could be removed for the 2018 IR. In 2017, the Mid and Lower Cibolo Creek Watershed Protection Plan was initiated to address bacteria and depressed DO impairments in the watersheds. As of this report, the Mid and Lower Cibolo Creek WPP is ongoing. Until that time, SARA will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.
Nitrate	Lower and Middle		There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate and total phosphorus data is utilized to indicate

Total Phosphorus	Lower and Middle	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	areas of concern. Continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria and determine long-term trends in the watershed.

Olivia Ybarra, 2016 Environmental Science Intern, Channel Catfish *(Ictalurus punctatus)*

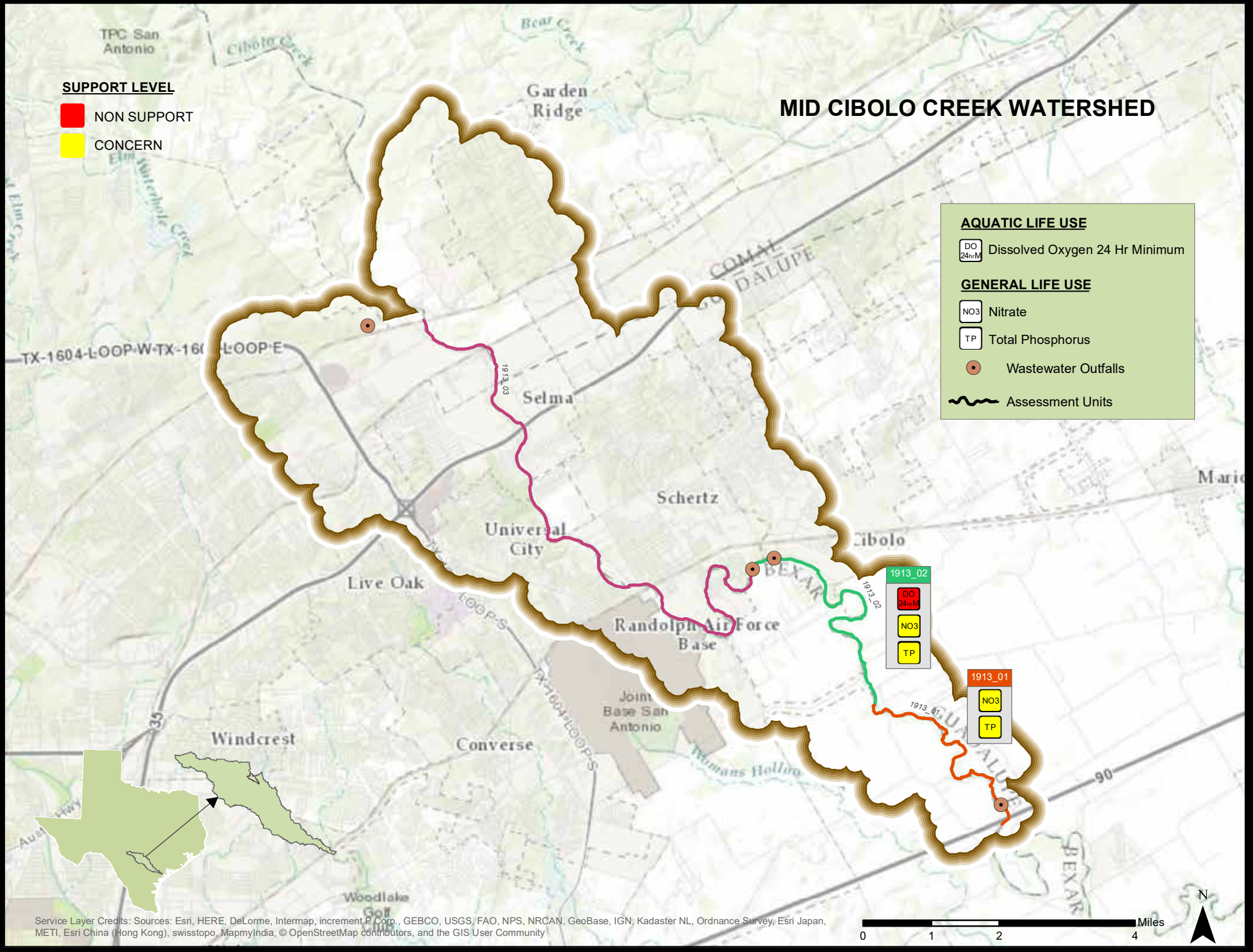


Figure MCC-2: Map of the Mid Cibolo Creek impairments and concerns by assessment unit.

Projects in the Mid Cibolo Creek Watershed

In 2015, SARA, 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 with a corresponding 24-hour DO average criterion of 5.0 mg/L and minimum criterion of 3.0 mg/L. Data also supported an intermittent with pools flow designation for the Mid Cibolo Creek with 24-hour average criterion of 3.0 mg/L and a minimum criterion 2.0 mg/L. 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 Standards was sent to the EPA Region 6 for approval. As of this report, no EPA actions or approval has been received by the TCEQ. The revisions cannot be used for federal actions, which includes permitting and the IRs, until EPA approves the revisions.

In 2017, the **Mid and Lower Cibolo Creek Watershed Protection Plan** 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), 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 BMPs to ensure the bacterial and DO impairments identified in the 2014 IR are addressed in the development of the WPP. The WPP will include three stormwater monitoring stations in the Mid and Lower Cibolo Creek at Station12806 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* and other pollutant(s) loading within the watershed and act as a base of information for planning purposes. As of this report the project is ongoing.

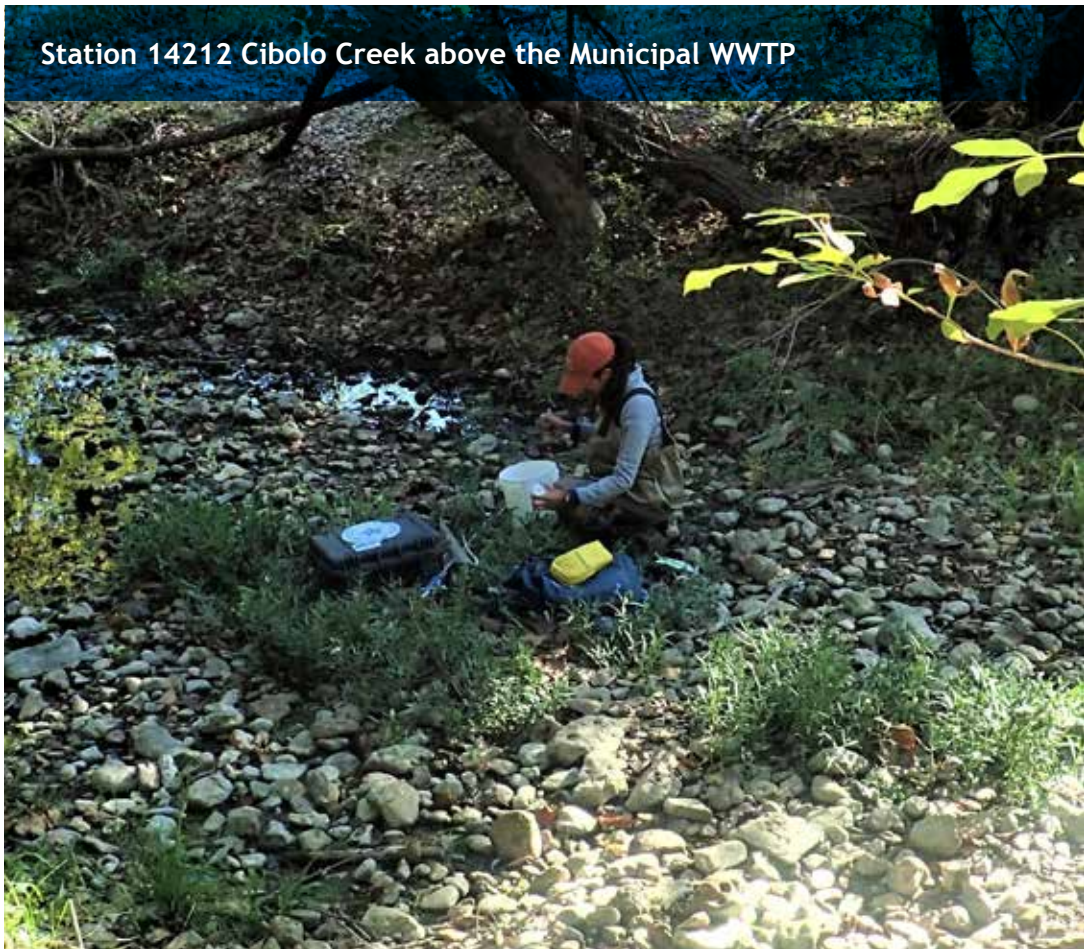

Station 14212 Cibolo Creek above the Municipal WWTP

Table 1913-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Mid Cibolo Creek Watershed by Assessment Unit

Mid Cibolo Creek Watershed Segment 1913 - Middle Cibolo Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
1913_01	12919 12921	perennial	limited	FS	FS	FS	NC	FS	NC	NC	NA	NA	FS GM=77.45	NC	CS	CS	NC
1913_02	12924, 12925	perennial	limited	FS	FS	FS	NC	FS	NC	NS	NA	NA	NC GM=42.62	NC	CS	CS	NC
1913_03	12927; 14212	perennial	limited	FS	FS	FS	NC	FS	NA	NA	NA	NA	FS GM=70.23	NC	NC	NC	NC

SARA's Trends over Time

Seg/AU	Description	Instantaneous Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	E. coli	Nitrate + Nitrite Nitrogen*	Total Phosphorus	Chlorophyll-a
1913_03	Station 14212 Cibolo Creek Upstream of Cibolo Creek Municipal Authority's WWTP	↓		↓							↑			↓

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

*Nitrate + nitrite is the primary method utilized for analyzing surface water in Segment 1913

DO Impairment

The Mid Cibolo Creek Watershed was first identified as impaired due to depressed oxygen levels in the 1999 Texas Water Quality Inventory and 303(d) List. In response to the listing, the TCEQ initiated the Mid Cibolo Creek TMDL project in September 2005. However, upon completion of the draft TMDL, the TCEQ determined a municipal point source discharge was likely to be the primary source of the impairment. As a result, it was not necessary to complete and submit a TMDL to the EPA. Instead, improvement in the quality of the Mid Cibolo Creek could be accomplished through requirements in the municipal point source discharge facility's permit. The dissolved oxygen impairment was assigned to Category 4b, which is the classification for waterbodies in which a standard is not met, but for which a TMDL is not required because other control requirements are reasonably expected to result in the attainment of the standards. In spite of the TCEQ's 2005 findings, the 24-hr DO minimum impairment for 1913_02, 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 remains on the 2014 IR and is qualified as being carried forward from previous assessment due to inadequate data.

In 2015, SARA, 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 with a corresponding 24-hour DO average criterion of 5.0 mg/L and minimum criterion of 3.0 mg/L. Data also supported an intermittent with pools flow designation for the Mid Cibolo Creek with 24-hour average criterion of 3.0 mg/L and a minimum criterion 2.0 mg/L. 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 Standards was sent to the EPA Region 6 for approval. As of this report, no EPA actions or approval has been received by the TCEQ. The revisions cannot be used for federal actions, which includes permitting and the IRs, until EPA approves the revisions.

Upper Cibolo Creek is immediately above Mid Cibolo Creek and is included in the Edwards Aquifer recharge and contributing zones; as a result, there is typically no flow from the headwaters into Mid Cibolo Creek under normal conditions. Change in land use due to residential development associated with the growth of San Antonio, ambient low flows and effluent discharge, coupled with the drought conditions experienced over the assessment period are possible reasons for the 24-hour minimum DO impairment and nutrient concerns.

Trend Analyses

Trend analyses for Station 14212 Cibolo Creek upstream of the Municipal WWTP identified statistically significant decreasing trends over time for flow, chloride and chlorophyll-*a*; a statistically significant increasing *E. coli* trend was also detected (Figures MCC 2 and 3). Statistically significant increasing trends against flow for TKN, chloride and chlorophyll-*a* were more than likely the result of one or two elevated measurements collected during higher flows (Figures MCC 4). Graphs MCC 2 and MCC 3 identify an increase flow in the later part of 2011 into 2012 as a result of storm events experienced in the watershed.

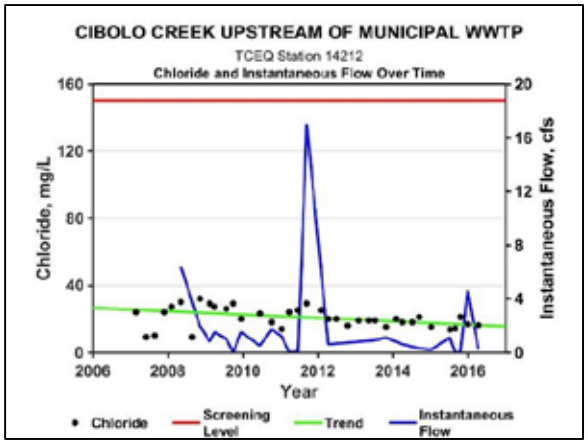


Fig. MCC 2: 14212 MCC upstream of WWTP, flow over Time

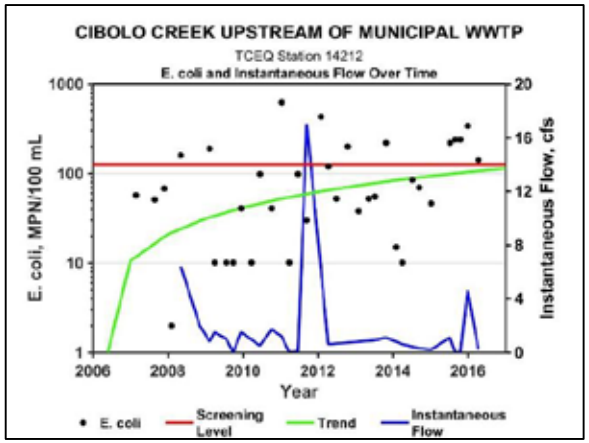


Fig. MCC 3: 14212 MCC upstream of WWTP, *E. coli* over Time

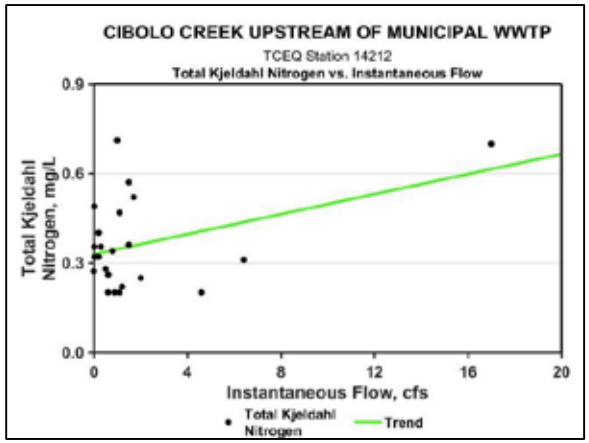


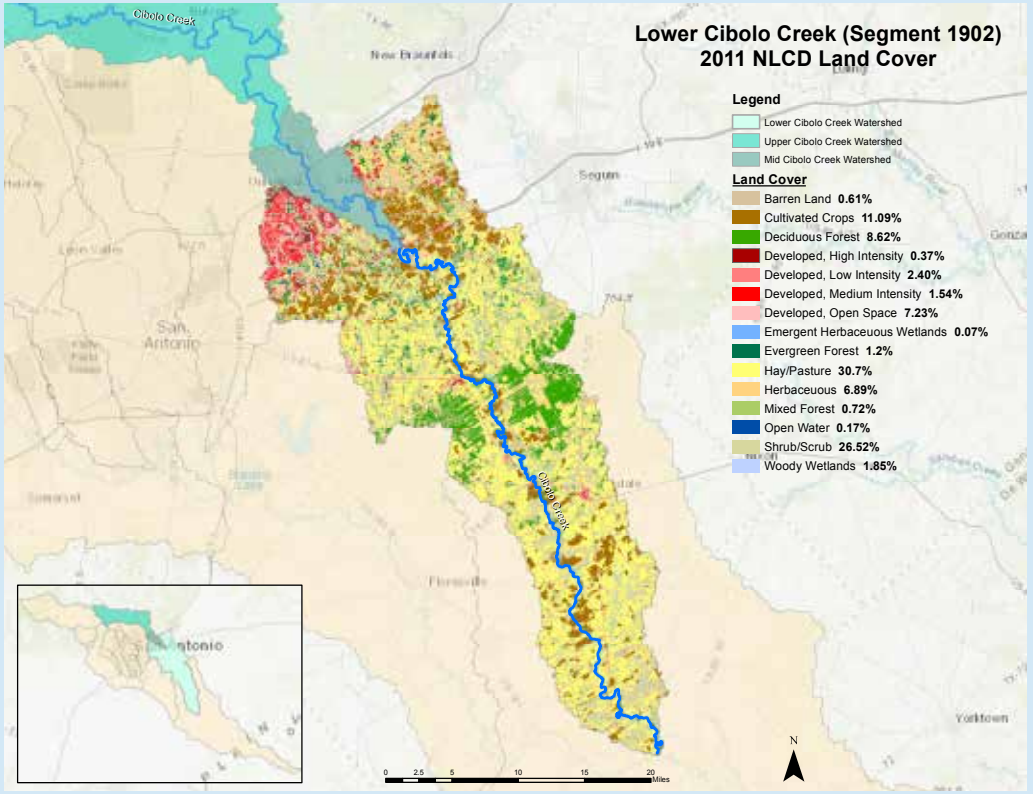
Fig. MCC 4: 14212 MCC upstream of WWTP, TKN over Flow

Lower Cibolo Creek Watershed – Segment 1902

Segment 1902 extends from the confluence with the Lower San Antonio River in Karnes County to a point 100 meters (110 yards) downstream of IH-10 in Bexar/Guadalupe County. The approximate drainage area of the Lower Cibolo Creek is 580 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 contributes 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.

Martinez Creek, Segment 1902A; Salitrillo Creek, Segment 1902B; and Clifton Branch, 1902C are unclassified segments of the Lower Cibolo Creek assessed in the 2014 IR.

The upper portion of the watershed is a mixture of pasture and cultivated crops with higher intensity development around the Cities of Universal City, Schertz and North-northeast San Antonio. The middle and southern portions are predominately pasture, cultivated crops with deciduous forest area in the middle portion. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure LCC-1 for more detail.



This segment has a high aquatic life use designation and is not classified for domestic water supply use. Like all segments in the San Antonio River Basin, TCEQ has designated this section for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are five current permitted domestic, four current wastewater, and one pending wastewater dischargers in Segment 1902, Lower Cibolo Creek. See Table 1902-1 for details.

Table 1902-1: Municipal and Industrial Wastewater Outfalls in Segment 1902 - Lower Cibolo Creek			
Permittee	**Status**	**Type**	**County**
SAN ANTONIO RIVER AUTHORITY - Outfall 1	Current Permit	Domestic	BEXAR
SAN ANTONIO RIVER AUTHORITY - Outfall 1	Current Permit	Wastewater	BEXAR
SAN ANTONIO RIVER AUTHORITY - Outfall 1	Current Permit	Wastewater	BEXAR
SAN ANTONIO RIVER AUTHORITY - Outfall 1	Current Permit	Wastewater	BEXAR
SAN ANTONIO RIVER AUTHORITY - Outfall 1	Current Permit	Wastewater	BEXAR
CITY OF STOCKDALE - Outfall 1	Current Permit	Domestic	WILSON
CITY OF MARION - Outfall 1	Current Permit	Domestic	GUADALUPE
GREEN VALLEY SPECIAL UTILITY DISTRICT - Outfall 1	Pending permit	Wastewater	GUADALUPE
CITY OF LA VERNIA - Outfall 1	Current Permit	Domestic	WILSON
SOUTH CENTRAL WATER CO - Outfall 1	Current Permit	Domestic	WILSON
Domestic: <1 MGD domestic sewage; **Wastewater:** ≥1 MGD domestic sewage or process water including water treatment plant discharge.			

Lower Cibolo Creek Watershed Water Quality Summary

According to the 2014 IR, a bacteria impairment, fish community and nutrient concerns have been identified in the Lower Cibolo Creek Watershed. Bacteria and depressed DO impairments, bacteria, DO, and nutrient concerns have been identified in the unclassified segment of the waters. Table 1902-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Impairments are in red text, concerns are in black text. Figure LCC-2 provides a visual summary of impairments and concerns by assessment unit. Table 1902-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Lower Cibolo Creek Watershed.

Table 1902-2: Water Quality Summary for Segment 1902 – Lower Cibolo Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Lower Middle	• Sewer breaks and overflows • Poorly maintained septic tank systems • Stormwater runoff sources of fecal matter from intense livestock production and wild animals	In 2017, the Mid and Lower Cibolo Creek Watershed Protection Plan was initiated to address bacteria and depressed DO impairments in the watersheds. As of this report, the Mid and Lower Cibolo Creek WPP is ongoing. Continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed
Fish Community	Lower	Fish community in the 1902_02 of the Lower Cibolo contains several sensitive species. The concern for fish community in 1902_03 is based on inadequate data and/or carried forward	Continue to collect temporal biological samples.
Nitrate Nitrogen	Upper	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate and total phosphorus data is utilized to indicate areas of concern. SARA and the TCEQ will continue to conduct monitoring to
Total Phosphorus	Upper		
			assess water quality conditions and determine long-term trends in the watershed.

Water Quality Summary Segment 1902A – Martinez Creek Segment 1902B – Salitrillo Creek Segment 1902C – Clifton Branch			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Martinez Creek and Clifton Branch	• Sewer breaks and overflows • Poorly maintained septic tank systems • Stormwater runoff sources of fecal matter from intense livestock production and wildlife	Continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.
Depressed DO	Clifton Branch Creek	• Improper use of fertilizers • Organic matter carried to river with stormwater runoff	Continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.
Nitrate Nitrogen	Martinez and Salitrillo Creeks	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	There are no nutrients State water quality standards, only screening criteria. Nitrate, total phosphorus, and ammonia data is utilized to indicate areas of concern. Continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria.
Total Phosphorus	Martinez, Salitrillo and Clifton Branch Creeks		
Ammonia	Salitrillo Creek		

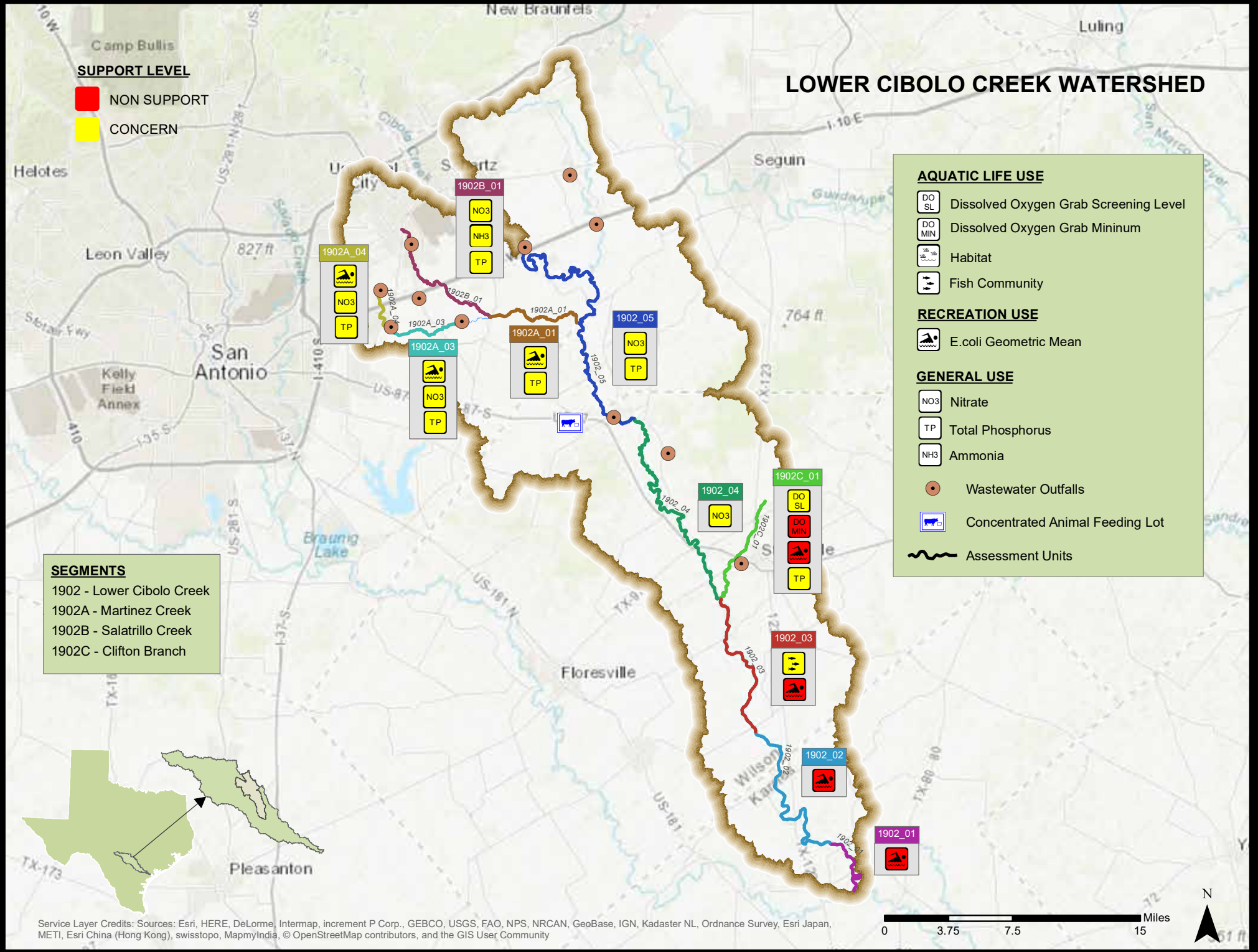


Figure LCC-2: Map of the Mid Cibolo Creek impairments and concerns by assessment unit.

Projects in the Lower Cibolo Creek Watershed

In 2015, SARA, 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 with a corresponding 24-hour DO average criterion of 5.0 mg/L and minimum criterion of 3.0 mg/L. Data also supported an intermittent with pools flow designation for the Mid Cibolo Creek with 24-hour average criterion of 3.0 mg/L and a minimum criterion 2.0 mg/L. 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 Standards was sent to the EPA Region 6 for approval. As of this report, no EPA actions or approval has been received by the TCEQ. The revisions cannot be used for federal actions, which includes permitting and the IRs, until EPA approves the revisions.

In 2017, the **Mid and Lower Cibolo Creek Watershed Protection Plan** 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), 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 BMPs to ensure the bacterial and DO impairments identified in the 2014 IR, are addressed in the development of the WPP. The WPP will include 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* and other pollutant(s) loading within the watershed and act as a base of information for planning purposes. As of this report the project is ongoing.

Station 12805 Cibolo Creek at FM539,
Lower Cibolo Creek Watershed

Lower Cibolo Creek Bacterial Source Tracking: Since 2013, the SARA has conducted bacterial source tracking (BST) in the San Antonio River, Escondido Creek, Martinez Creek, Clifton Branch, San Pedro Creek and the Lower Cibolo Creek. The Lower Cibolo Creek BST effort was conducted from December 2014 through December 2015 and included four ambient collection events and two high-flow collection events. Three stations were on the main stem while the other three were collected from tributaries (Clifton Branch, Martinez Creek and an Unnamed Tributary west of Stockdale, TX) of the Lower Cibolo Creek. Ambient bacteria samples had a mean average of 73.7 to 653.3 *E. coli* /100 mL, while the high-flow event mean averages ranged from 370 to 12,350 *E. coli*/100 mL. After samples were collected and filtered they were sent to Texas A&M AgriLife Research Extension where ERIC-PCR and RiboPrinting methods were employed, resulting in library-dependent BST results.

BST samples can be analyzed two separate ways, 3-way and 7-way splits. The 3-way split groups bacterial as either wildlife, human, livestock/domesticated animal, unidentified bacteria sources, and has a high level of confidence level. Grouping by the 7-way split identifies sources or species of bacteria as non-avian, avian, cattle, other livestock, human, pets, other livestock, and unidentified, but has a lower confidence level. The 3-way split for the Lower Cibolo Creek showed that wildlife bacteria was by far the most common source accounting for 54% of the 250 isolates analyzed. Non-avian wildlife was the most common source in the 7-way split (41%), unidentified isolates were the second most common (16%). Although 7-way split classifies species has a lower confidence levels, species classifications are still useful as a guideline to what is most likely producing the sampled isolates. Opossum, feral hogs, cattle, and raccoons were the most common species origins of the 32 species observed during the study. These results can be used to inform future management decisions in the continual effort to reduce bacterial loading into Cibolo Creek.

Wild Flowers on the Mission Reach San Antonio River

Table 1902-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Lower Cibolo Creek Watershed by Assessment Unit

Lower Cibolo Creek Watershed Segment 1902 - Lower Cibolo Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Total Phosphorus	Nitrate Nitrogen	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**170 mg/L**	**275 mg/L**	**900 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**0.69 mg/L**	**1.95 mg/L**	**14.1µg/L**	**IBI Score 42**	**HBI Score 20**	**Score 29**
1902_01	12797, 20777	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	NS GM=198.46	NC	NC	NC	NC	NA	NA	NA
1902_02	12798, 14211	perennial	high	FS	FS	FS	NC	FS	FS	FS	FS	FS	NS GM=162.17	NC	NC	NC	NC	FS (41.30)	NC (19.90)	NA
1902_03	12803	perennial	high	FS	NA	FS	NC	FS	NA	NA	FS	FS	NS GM=126.37	NC	NC	NC	NC	CN-CF	NA	NA
1902_04	12805	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=57.73	NC	NC	CS	NC	NA	NA	NA
1902_05	14197	perennial	high	FS	FS	FS	NC	FS	FS	FS	FS	FS	FS GM=103.50	NC	CS	CS	NC	FS (45.50)	NC (22.20)	NA

Segment 1902A - Martinez Creek Segment 1902B - Salatrillo Creek Segment 1902C - Clifton Branch				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Total Phosphorus	Nitrate Nitrogen	Chlorophyll-a
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**0.69 mg/L**	**1.95 mg/L**	**14.1µg/L**
Martinez Creek 1902A_01	12741	perennial	high	NA	NA	NA	NC	FS	NA	NA	NA	NA	CN GM=292.88	NC	CS	NC	NA
1902A_02	14203	perennial	high	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1902A_03	15306	perennial	intermediate	NA	NA	NA	4 mg/L NC	3 mg/L NC	4mg/L NA	3 mg/L NA	NA	NA	CN GM=390.58	NC	CS	CS	NA
1902A_04	15305	perennial	intermediate	NA	NA	NA	4 mg/L NC	3 mg/L NC	4mg/L NA	3 mg/L NA	NA	NA	CN GM=137.71	NC	CS	CS	NA
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**0.69 mg/L**	**1.95 mg/L**	**14.1µg/L**
Salatrillo Creek 1902B_01	14201; 14923; 15303	intermittent w/pools	limited	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS GM=15.86	CS	CS	CS	NC
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**0.69 mg/L**	**1.95 mg/L**	**14.1µg/L**
Clifton Branch 1902C_01	20775, 20775	perennial	high	NA	NA	NA	CS	NS	NA	NA	NA	NA	NS GM=137.93	NC	CS	NC	NA

SARA's Trends over Time

Seg/AU	Description	Instantaneous Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	E. coli	Total Phosphorus	Nitrate Nitrogen	Chlorophyll-a
1902_02	Station 14211 -Cibolo Creek at CR 389 near Cestohowa Texas				↓	↓		↑		↓		↑		
1902_05	Station 14197-Cibolo Creek at Sculls Crossing		↑	↑					↑	↑				

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

CF = The Integrated level of support of CS, CN or NS was carried forward from a previous assessment due to inadequate/no data for this method in this assessment.

Bacteria Impairment

The lower 29 miles of Lower Cibolo Creek, from the confluence with Clifton Branch to the confluence with the San Antonio River, is listed in the 2014 Texas 303(d) List as impaired for contact recreation due to *E. coli* geometric means above the 126 *E. coli*/100mL criterion. In addition to this segment being effluent-dominated, this area is mostly rural and is influenced by wildlife, ranching and agricultural activities. SARA field biologists have documented numerous cattle crossings, large rookeries of black vultures, and feral hog wallows in the Lower Cibolo Creek Watershed. Until a TMDL or WPP can be scheduled, SARA monitoring efforts will continue to investigate impairments and concerns in the Lower Cibolo Creek Watershed.

Biological Assessment

TSWQS describes the Lower Cibolo Creek as having a high aquatic life use (ALU) designation and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average). Biological assessments for Stations 14211 Cibolo Creek at CR 389 near Cestohowa and 14197 Cibolo Creek at Scull Crossing are meeting the high ALU designation as stated in the standards. Station 14211 Cibolo Creek at CR 389 near Cestohowa is in assessment unit 1902_02 and was sampled seven times, once in each year between 2006 and 2012. Station 14197. Cibolo Creek at Scull Crossing is in assessment unit 1902_02 and was sampled six times, once in 2006 and once in each year between 2008 and 2012. The 2014 IR also identifies a fish community concern in assessment unit 1905_03.

In the 2014 IR, the fish Index of Biotic Integrity (IBI) scores for 1902_02 and 1902_05 ranged from 30 (limited) at Station 14211 Cibolo Creek at CR 389 near Cestohowa to 45 (high) at the same station and at Station 14197 Cibolo Creek at Scull Crossing in 2012. The overall IBI score for both assessment units was 42.75 (high). There was an average of 238 individual fish and an average of 13 different species collected per sampling event. There were three intolerant species collected, including the Texas Logperch, Mimic Shiner and Tadpole Madtom. No non-native species were collected and an average of 52% of total number of fish collected were tolerant to pollution. Native species collected included the Amazon Molly, Blackstripe Topminnow, Bluegill Sunfish, Bullhead Minnow, Channel Catfish, Ghost Shiner, Green Sunfish, Grey Redhorse, Largemouth Bass, Texas Logperch, Longear Sunfish, Mexican Tetra, Mimic Shiner, Red Shiner, Rio Grande Cichlid, River Darter, Sailfin Molly, Sand Shiner, Spotted Bass, Spotted Gar, Tadpole Madtom, Warmouth, Weed Shiner, Western Mosquitofish and Yellow Bullhead.

Smallmouth Buffalo *(Ictiobus bubalus)*

Habitat Quality Index (HQI) scores for both assessment units ranged from 18 (intermediate) at Cibolo Creek at CR 389 to 26 (excellent) at Cibolo Creek at Scull Crossing, with an overall average HQI score of 21.05 (high). The Lower Cibolo Creek Watershed is characterized by well-to poorly defined stream bends. Stream banks are gently sloping within the upper reaches of the segment and

high steep vertical banks within the lower reaches. The average width of the natural riparian habitat within Segment 1902 is 17 meters and includes native hardwood trees, shrubs and grasses. Average percent tree canopy is 68% and includes pecan, elm, hackberry, black willow, cottonwood, oak, and ash trees. Instream habitat types include riffles, runs, and glides. Sand, gravel, bedrock, cobble, mud silt, and boulders are the dominant substrate in the Lower Cibolo Creek. The average number of instream cover types is nine and includes boulders, gravel, ledges, litter, macrophytes, overhanging vegetation, tree roots, undercut banks and woody debris. The average percent instream cover is 29% and the average percent stream bank erosion is 36%.

Of the twenty 24-hour DO measurements assessed, there were no average or minimum exceedances. The 24-hour DO average values ranged from 6.7 mg/L at Station 14197 Cibolo Creek at Scull Crossing to 9.7 mg/L at Station 14211 Cibolo Creek at CR 389 near Cestohowa. The 24-hour DO minimum values ranged from 5 mg/l at Station 14197 Cibolo Creek at Scull Crossing to 7.2 mg/L at the same station.

The 1902_03 fish community concern identified in the 2014 IR was based on limited data carried forward from the TCEQ 2008 assessment. To determine if the concern was the result of site specific limitations rather than a pollutant, in 2016, SARA added biological monitoring at Station 12802 Cibolo Creek at FM 541 West of Kosciusko and Station 21755 Cibolo Creek Upstream of FM 537 Southwest of Stockdale. Both stations are in assessment unit 1902_03. Preliminary data indicates the fish community is meeting the high ALU designation with a fish Index of Biotic Integrity (IBI) score of 41.

Trend Analyses

In addition to statistically significant increasing TKN and total phosphorous trends over time at Station 14211 Lower Cibolo Creek at CR 389, statistically significant decreasing trends for temperature, TDS and sulfate have also been identified (Figure LCC 2 and 3). Station 14211 is in assessment unit 1902_02. Although the 2014 IR identifies 1902_02 as being impaired for bacteria levels above the 126 *E. coli*/100 mL primary contact recreational standard, trending over time for Station 14211 does not show any significant statistical increasing or decreasing trend over the trending period. When graphing *E. coli* concentration against flow, a statistical significant increasing trend is observed (Figure LCC 4).

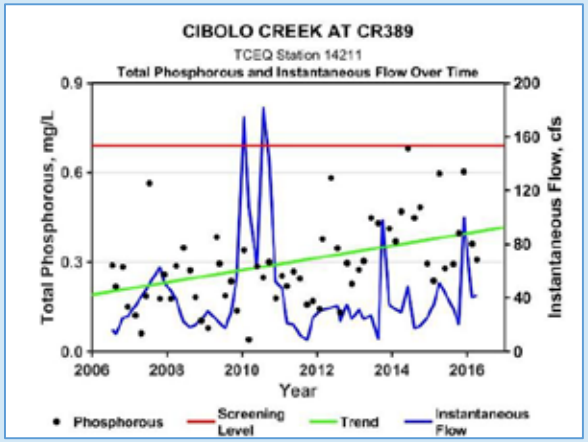


Fig. LCC 2: 14211 LCC at CR 389, Total Phos over Time

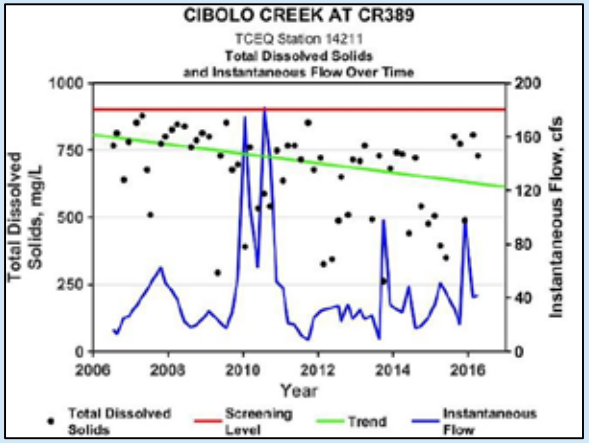


Fig. LCC 3: 14211 LCC at CR 389, TDS over Time

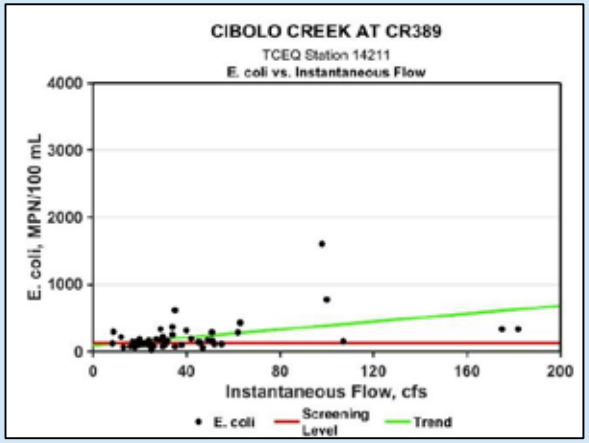


Fig. LCC 4: 14211 LCC at CR 389, *E. coli* against Flow

Although there are statistically significant increasing trends over time at Station 14197 Cibolo Creek at Scull Crossing for temperature, pH, TSS, and chloride all values over the trending period are within TSWQS criteria (Figures LCC 5 and 6). Trend analysis from Station 14197 indicates a statistically significant nitrate, sulfate, and *E. coli* increase with increasing flow. Out of the 58 *E. coli* values used for trending 40% of the values exceeded the primary contact recreational standard of 126 *E. coli*/100 mL. As can be seen in the land use map, Figure LCC-1, over 90% of the Lower Cibolo Creek Watershed is rural. Factors affecting bacteria and nutrient loading include direct deposition from wildlife and livestock, failing septic systems, sanitary overflows, and stormwater runoff transporting wildlife feces to streams and re-suspending bacteria (Figure LCC 7).

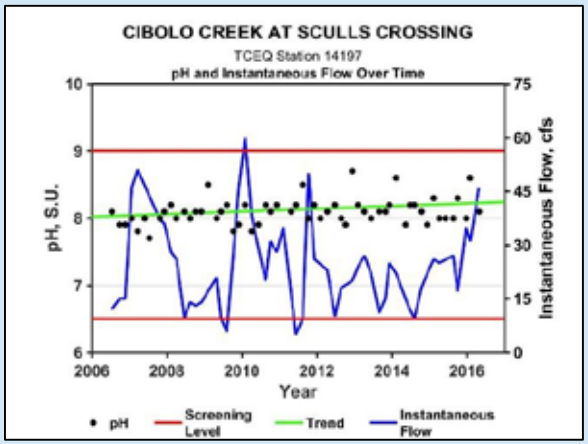


Fig. LCC 5: 14197 Cibolo Creek Scull Crossing, pH over Time

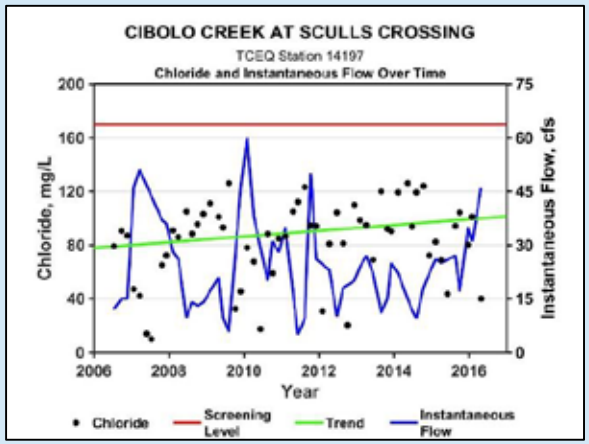


Fig. LCC 6: 14197 Cibolo Creek Scull Crossing, Chloride over Time

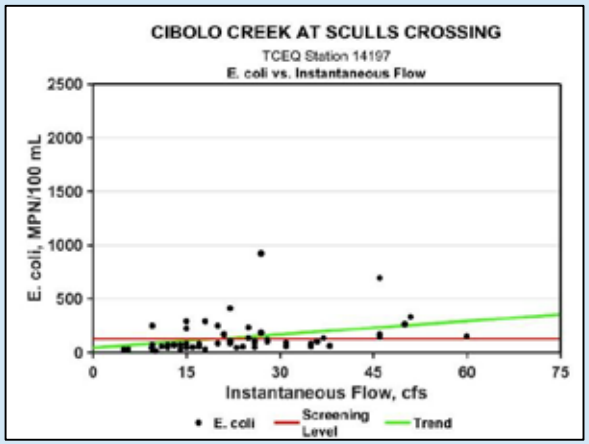
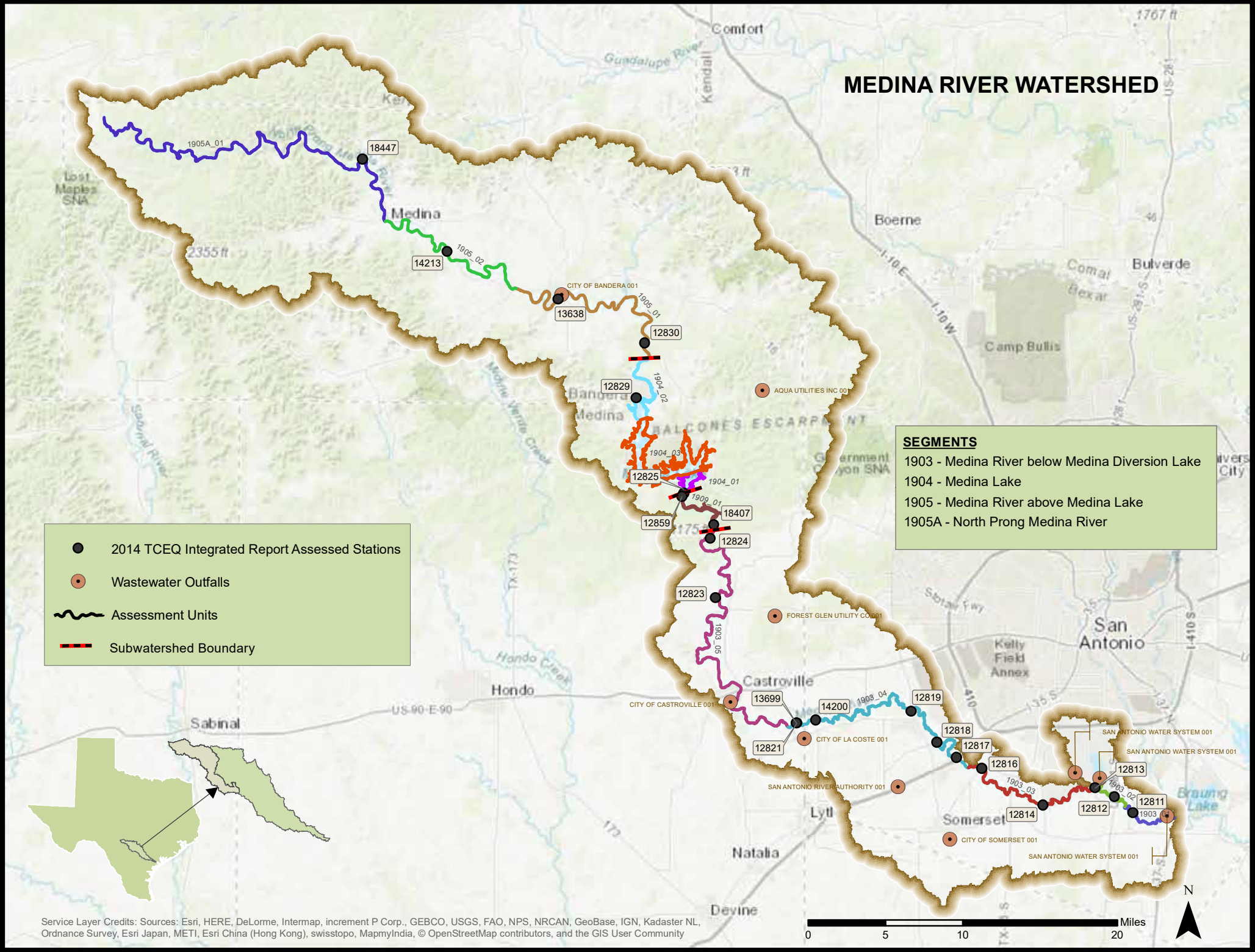


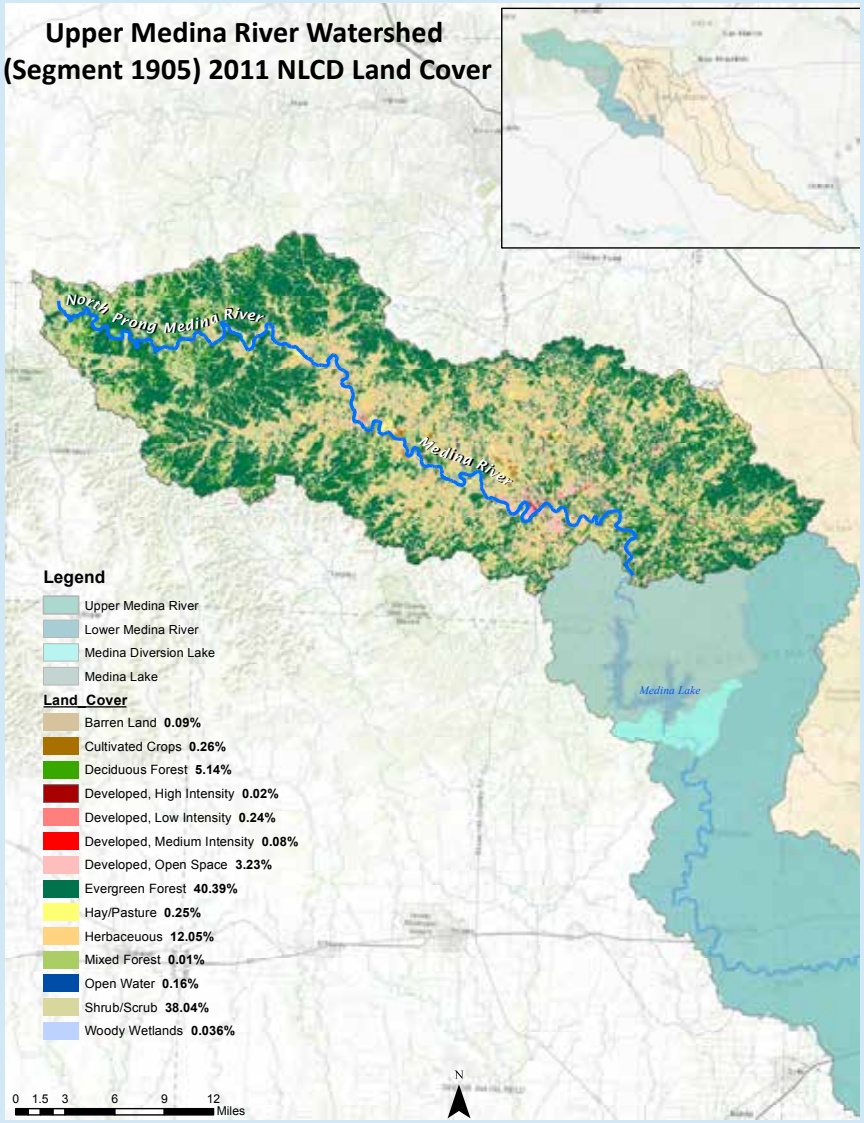
Fig. LCC 7: 14197 Cibolo Creek Scull Crossing, *E. coli* against Flow


MEDINA RIVER WATERSHED
SEGMENTS
1903 - Medina River below Medina Diversion Lake
1904 - Medina Lake
1905 - Medina River above Medina Lake
1905A - North Prong Medina River
2014 TCEQ Integrated Report Assessed Stations
Wastewater Outfalls
Assessment Units
Subwatershed Boundary
18447
14213
13638
12830
12829
12825
12859
18407
12824
12823
13699
14200
12821
12819
12818
12817
12816
12814
12813
12812
12811
1905A_01
1905_02
1905_01
1904_02
1904_03
1904_01
1909_01
1903_05
1903_04
1903_03
1903_02
1903
CITY OF BANDERA 001
AQUA UTILITIES INC 001
FOREST GLEN UTILITY CO 001
CITY OF CASTROVILLE 001
CITY OF LA COSTE 001
SAN ANTONIO RIVER AUTHORITY 001
CITY OF SOMERSET 001
SAN ANTONIO WATER SYSTEM 001
SAN ANTONIO WATER SYSTEM 001
SAN ANTONIO WATER SYSTEM 001
Comfort
Boerne
Bulverde
Medina
Bandera
Castroville
Hondo
Sabinal
Lytle
Somerset
Natalia
Devine
San Antonio
Kelly Field Annex
Camp Bullis
Lost Maples SNA
Braunig Lake
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
0
5
10
20
Miles
N

Medina River above Medina Lake Watershed – Segment 1905

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 West Prong Medina River in Bandera County. The North Prong Medina River, Segment 1905A, is the only unclassified segment of the Upper Medina River assessed in the 2014 TCEQ Integrated Report.

This portion of the Medina River is rural and lies entirely within the Edwards Plateau. 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 riffles, glides and pooled 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 willow, cypress, pecan, and oaks. Native grasses and forbs are common along the stream. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure UMR-1 for more detail.



The Upper Medina River has an exceptional aquatic life use designation. Exceptional is the highest aquatic life use given by the state. It is also designated for use as a public water supply. Aquifer protection use applies to this segment because it contributes to recharge of the Edwards Aquifer. Like all segments in the San Antonio River Basin, TCEQ has designated this section for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there is one current permitted domestic dischargers in Segment 1905, Upper Medina River. See Table 1905-1 for details.

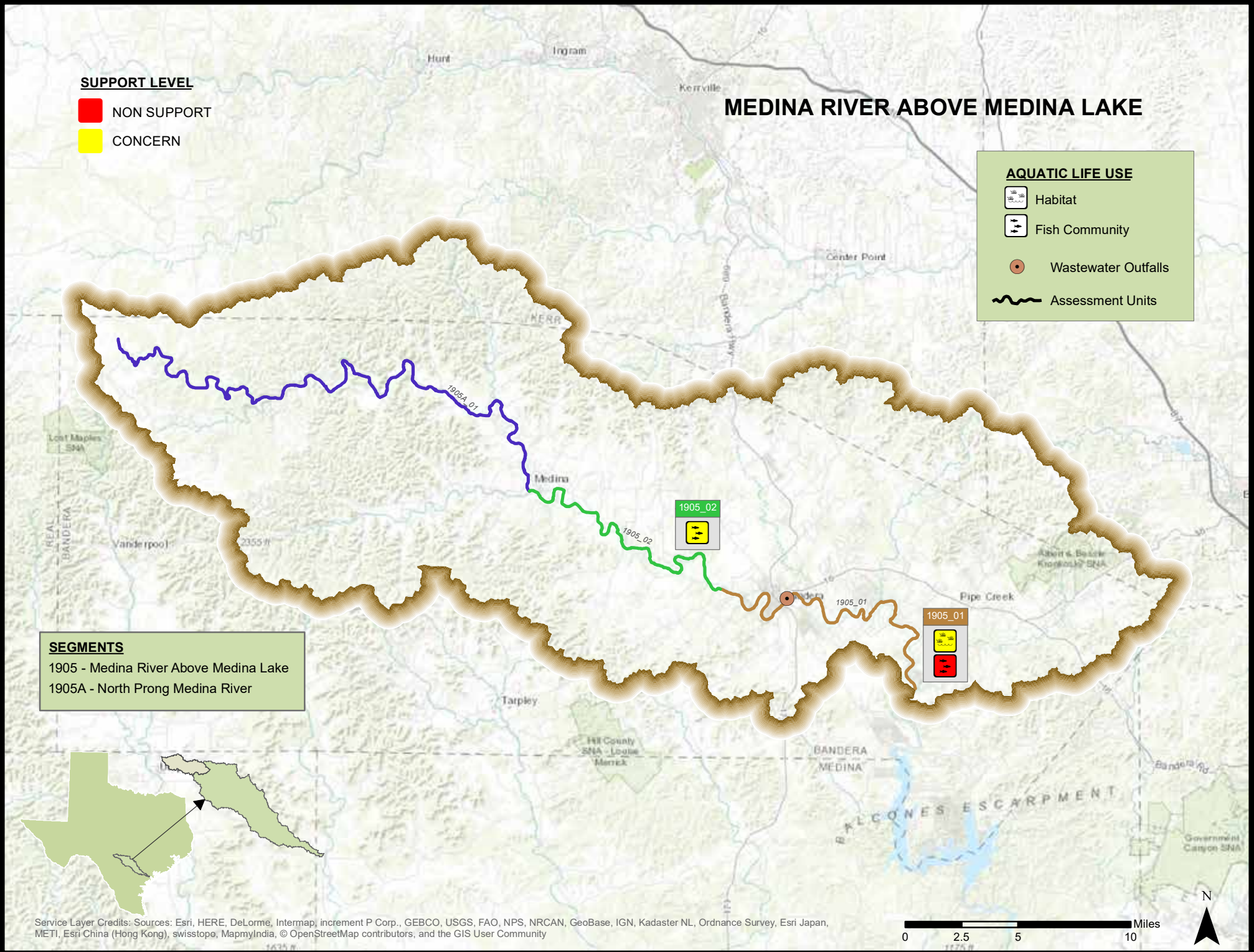
Table 1905-1: Municipal and Industrial Wastewater Outfalls in Segment 1905 - Medina River above Medina Lake			
Permittee	**Status**	**Type**	**County**
CITY OF BANDERA - Outfall 1	Current Permit	Domestic	BANDERA

Domestic: <1 MGD domestic sewage; **Wastewater:** ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Medina River above Medina Lake Watershed Water Quality Summary

According to the 2014 IR, a fish community impairment has been identified in the Upper Medina River; fish community and habitat concerns have also been identified. Table 1905-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Figure UMR-2 provides a visual summary of impairments and concerns by assessment unit. Impairments are in red text, concerns are in black text. Table 1905-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Medina River above Medina Lake Watershed.

Table 1905-2 Water Quality Summary for Segment 1905 – Medina River above Medina Lake			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Fish Community and Habitat	Lower	The fish community impairment and habitat concern are attributed to a site specific limitation at Old English Crossing (bedrock substrate and limited in stream habitat) rather than to any specific pollutant(s).	As a result of the ALM effort, all biological sampling events were moved from 12830 Old English Crossing to Station 21631 Medina River at the north side of Mayan Ranch. Fish IBI scores during the ALM achieved the exceptional ALU designation. SARA and BCRAGD will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure UMR-2: Map of the Upper Medina River impairments and concerns by assessment unit.

Projects in the Medina River above Medina Lake Watershed

SARA and Bandera County River Authority and Groundwater District (BCRAGD) Collaborative Effort in Segment 1905: In early 2012, BCRAGD expressed a desire to participate in the 2013 CRP activities within Bandera County. In a collaborative effort to maintain and improve the water quality, SARA and BCRAGD entered into an Interlocal Agreement (ILA) to monitor six water quality stations in the Upper Medina River Watershed. For the 2017 monitoring year, BCRAGD continued to expand their monitoring activities to include monitoring stations in Medina Lake and the Medina Diversion Lake Watersheds. As a result of this continued expansion, in 2018 BCRAGD will collect water quality samples at a total of 14 water quality stations in the Upper Medina, Medina Lake and Medina Diversion Lake Watersheds. The ILA between SARA and the BCRAGD allows them to be a sub-participant under SARA's CRP Quality Assurance Project Plan (QAPP) and collect water quality samples in the Upper Medina River, Medina Lake and Medina Diversion Lake Watersheds. Collected samples are submitted to SARA's Environmental Sciences NELAC-Accredited Laboratory for analysis.

Flood preparedness and flood education is important to BCRAGD. The District received the Texas Floodplain Managers Association's 2017 John Patton Community Service Award for excellence in flood education, community outreach and were one of 17 recipients of a flood protection grant through the Texas Water Development Board. The District is partnering with USGS to develop an Early Flood Warning System which will include a continuous streamflow-gage monitoring network, a Hydrologic Engineering Center River Analysis System (HEC-RAS) model of the Medina River, and a generated flood inundation map in the USGS Flood Inundation Mapping Initiative website to assist Emergency Managers to better protect the lives of citizens in the area. Construction began in the spring of 2017 and will be completed by August 2019.

Upper Medina River Aquatic Life Monitoring (ALM): During the initial stakeholder review of the Draft 2014 IR, SARA biologists met with the BCRAGD to discuss the fish community impairment and habitat concern in the Upper Medina River Watershed. After several discussions with the TCEQ, the 2015 **Upper Medina River Aquatic Life Monitoring (ALM)** effort was initiated to determine if the Upper Medina River could support the exceptional aquatic life use designation as stated in the TSWQS. With support from SARA and BCRAGD, the TCEQ, and TPWD, several ALM sampling events were conducted at the existing biological Station 12830 Old English Crossing, where the impairment was originally determined in 2012 and at Station 21631 on the Mayan Ranch. The results of the effort determined the fish community impairment and a habitat concern may be attributed to a site specific limitation at Old English Crossing, bedrock substrate and limited instream habitat, rather than to a specific pollutant(s). In 2016, as a result of the ALM effort, all biological sampling was moved to Station 21631 Medina River at the north side of Mayan Ranch. SARA and BCRAGD will continue biological and routine monitoring at Station 21631 to assess water quality conditions and determine long-term trends in the watershed.

Biological Monitoring Event at Station 21631 Medina River Mayan Ranch, SARA and BCRAGD Staff

Table 1905-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Medina River above Medina Lake Watershed by Assessment Unit

Medina River above Medina Lake Watershed Segment 1905 - Medina River above Medina Lake				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**50 mg/L**	**150 mg/L**	**400 mg/L**	**6 mg/L**	**4 mg/L**	**6 mg/L**	**4 mg/L**	**6.5-9.0 SU**	**31.1 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score 52**	**HBI Score 26**	**Score >36**
1905_01	12830, 13638	perennial	exceptional	FS	FS	FS	NC	FS	NC	NC	FS	FS	FS GM=45.90	NC	NC	NC	NC	NS (46.40)	CS (18.80)	NA
1905_02	14213	perennial	exceptional	FS	FS	FS	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	CN-CF	NA	NA

Segment 1905A - North Prong Medina River				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score 42**	**IBI Score 20**	**IBI Score 29**
1905A_01	18447	perennial	high	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS GM=33.80	NC	NC	NC	NC	FS (50.40)	NC (21.80)	FS (33.90)

SARA's Trends over Time													
Seg/AU	**Description**	**Instantaneous Flow**	**TSS**	**Chloride**	**Sulfate**	**Total Dissolved Solids**	**Dissolved Oxygen Deficit**	**TKN**	**pH Range**	**Temperature**	**E. coli**	**Nitrate Nitrogen**	**Total Phosphorus**	**Chlorophyll-a**
1905_01	Station 12830 Medina River at Old English Crossing above Bandera			↑							↑			

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

CF = The Integrated level of support of CS, CN or NS was carried forward from a previous assessment due to inadequate/no data for this method in this assessment.

Biological Assessment

TSWQS describes Medina River above Medina Lake as having an exceptional aquatic life use (ALU) designation and 24-hour dissolved oxygen criteria of 4.0 mg/L (minimum) and 6.0 mg/L (average). Biological assessments for the segment identify a fish community impairment and habitat concern in assessment unit 1905_01 and a fish community concern in assessment unit 1905_02 that was carried over from previous IRs. Station 12830, Medina River at Old English Crossing is in assessment unit 1905_01 and was sampled six times, once in 2006 and once in each year between 2008 and 2012. Station 18447 North Prong Medina River (aka Wallace Creek upstream of SH16) is in 1905A_01 and was sampled once in 2008 and once in 2012. No impairments or concerns were identified in the North Prong Medina River.

The fish Index of Biotic Integrity (IBI) scores for both assessment units ranged from 37 (intermediate) at Medina River at Old English Crossing to 50 (high) at the North Prong Medina River, with the overall IBI score of 48.41 (High). There was an average of 137 individual fish and an average of 14 different species collected per sampling event. There were three intolerant species collected, including the Greenthroat Darter, Guadalupe Bass, and Mimic Shiner. An average of 36% of the fish collected were tolerant to pollution.

The Common Carp and the Redbreast Sunfish were the only non-native species collected. Native species included the Black Bullhead, Blacktail Shiner, Central Stoneroller, Channel Catfish, Flathead Catfish, Green Sunfish, Greenthroat Darter, Grey Redhorse, Guadalupe Bass, Largemouth Bass, Longear Sunfish, Mexican Tetra, Mimic Shiner, Orangethroat Darter, Pallid Shiner, Red Shiner, Rio Grande Cichlid, Spotted Bass, Texas Shiner, Warmouth, Weed Shiner, Western Mosquitofish and Yellow Bullhead.

The Habitat Quality Index (HQI) score ranged from 16 (intermediate) at Old English Crossing to 21.5 (high) at the North Prong Medina River, with the average HQI score being 20.3 (high). The Upper Medina River is characterized by well to poorly defined stream bends. Stream banks of the Upper Medina River vary from low-lying, gently sloping banks to high, steep, solid limestone formations. Many of the low-lying banks consist of gravel sparsely covered with native grasses and wildflowers. The dominant substrate type throughout the Upper Medina River is gravel, cobble, and bedrock. The average width of the natural riparian habitat within the Medina River above Medina Lake is 17 meters and includes native hardwood trees, shrubs and grasses. The average percent tree canopy is 41% and includes cypress, sycamore, willow, pecan, and oaks. Instream habitat types include riffles, runs, and glides. The average number of instream cover types is six and includes boulders, gravel, macrophytes, overhanging vegetation, tree roots, and woody debris. The average percent instream cover is 26%. The average percent stream bank erosion is 27%.


Medina Watershed

Although there was limited 24-hour DO data for the 2014 IR for both stations, of the eight 24-hour DO measurements assessed, there were no average or minimum exceedances. The 24-hour DO average values ranged from 6.2 mg/L in 2012 at Station 18447 North Prong Medina River to 8.8 mg/L at Station 12830 Medina River at Old English Crossing. The 24-hour DO minimum values ranged from 4.5 mg/L at Station 12830 Medina River at Old English Crossing to 6.4 mg/L. In addition to the 24-hour DO, there were 80 DO grab measurements collected, with only four screening level exceedances. With respect to the limited 24-hr DO data, TCEQ assessment protocols indicate there must be at least ten 24-hour DO measurement over the assessment period for the assessment of aquatic life use attainment. Since there were only eight measurements over the assessment period, the TCEQ qualifies the 24-hr DO average and minimum data set as limited, and since there were no average or minimum exceedances, the TCEQ identifies the level of support as No Concern.

As a result of the collaborative ALM effort, it was determined Station 12830 Medina River at Old English Crossing did not accurately depict the ecological health of the river. Beginning in 2016, Station 12830 Medina River at Old English Crossing was replaced with Station 21631 Medina River at the Mayan Ranch; both stations are in 1905_01. Although there is limited data available for Station 21631, preliminary fish and habitat scores show improvement. The fish IBI score is 51.5 (high) and the HQI score is 21.5 (high). Although the fish IBI score may be rounded up to 52, which meets the exceptional ALU designation, the habitat HQI score may never

attain the exceptional ALU designation due to the lack of instream and riparian habitat caused by natural scouring during high flow events. Although biological monitoring will continue in 1905_01, no further biological monitoring has been scheduled in assessment unit 1905_02.

As mentioned earlier in this report, the general trend in Statewide IBI scoring method is to underestimate the aquatic life use when compared to other assessment methods (TPWD 2002). Therefore, the lower Statewide IBI score generated from 1901_02 and 1901_05, as well as other waterbodies in the San Antonio River Basin, may not be indicative of the true health of the waterbody. Regional criteria that account for a diversity of land forms, soil types, vegetation, climatic conditions, and zoogeographic factors may provide a better representation of the integrity of the fish assemblages (TPWD 2002).

Trend Analyses

The Upper Medina River, Segment 1905, is one of the most pristine waterways in the entire San Antonio River Basin and is the only waterbody in the San Antonio River Basin to have an exceptional aquatic life designation. This portion of the Medina River has some of the clearest water in the State. Trending analysis for Station 12830 Medina River at Old English Crossing could not be conducted for TSS, ammonia, TKN and Total Phosphorous because sample concentrations for these parameters were as a result of sample concentrations less than the limit of quantitation (LOQ). The LOQ is a term the laboratory uses to describe the smallest concentration that can be reliably and confidently measured and reported by the analytical procedures employed in the laboratory. Of all the total suspended solids samples analyzed, 92.5% of the measurements were below the LOQ. In addition, 98.1% of ammonia samples, 66.7% of TKN samples, and 88.7% of the total phosphorous samples were also less than the LOQ. Trending analysis over time did reveal statistical significant increasing trend for chloride and *E. coli* (Figure UMR 1 and 2). However, both parameters are well within the standards. Of the 48 chloride measurements assessed in the 2014 IR, no chloride measurement exceeded the 50.0 mg/L criterion. The 2014 IR also documented an *E. coli* geometric mean of 45.9 *E. coli* colonies/100 for assessment unit 1905_01.

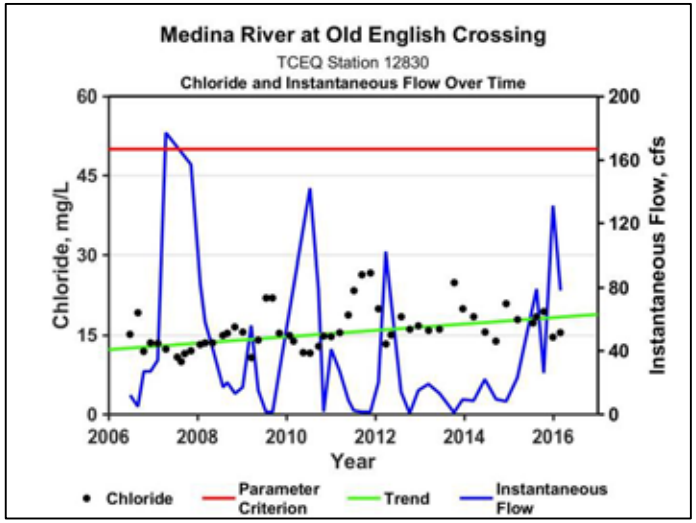


Fig. UMR 2: 12830 Medina River at Old English Crossing, Chloride over Time

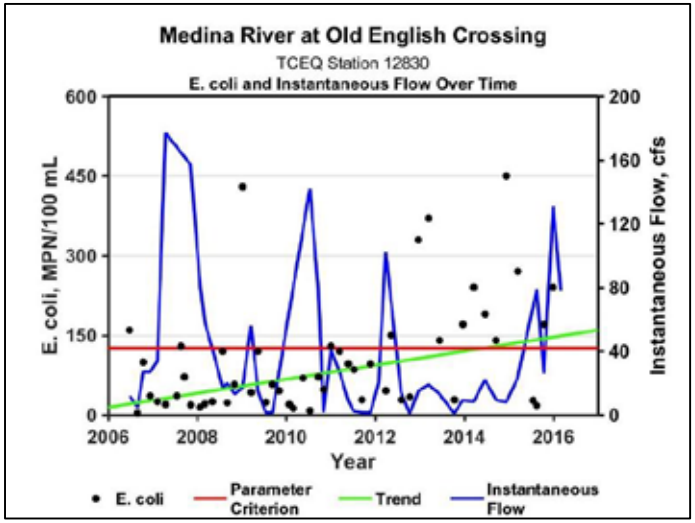
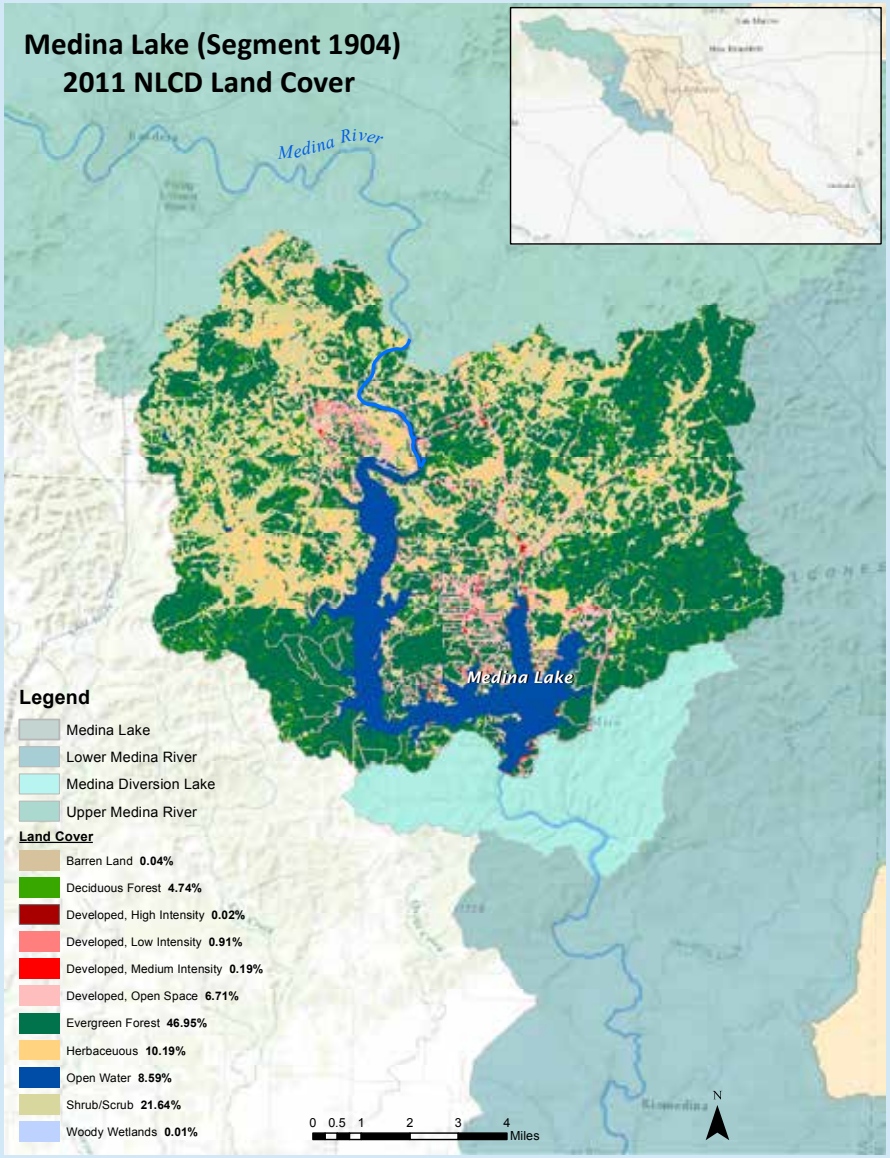


Fig. UMR 3: 12830 Medina River at Old English Crossing, *E. coli* over Time

Medina Lake – Segment 1904

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 1064.2 feet. Medina Lake, located along the Medina/Bandera County line, is a reservoir created by the construction of Medina Dam, completed in 1912. The lake was created to irrigate farmland and has become a recreational area for local residents. The dam is managed by the Bexar-Medina-Atascosa Counties Water Control and Improvement District No. 1.



Medina Lake is located 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 and 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. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure ML-1 for more detail.

Medina Lake has a high aquatic life use designation. It is also designated for use as a public water supply. Aquifer protection use applies to this segment because it contributes to recharge of the Edwards Aquifer. Like all segments in the San Antonio River Basin, TCEQ has designated this section for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are no pending or current permitted domestic or wastewater dischargers in Segment 1904 Medina Lake.

Medina Lake Watershed Water Quality Summary

The 2014 IR does not list any impairments or concerns for any portion of the Medina Lake Watershed, Tables 1904-1 and 1904-2. There were no biological or habitat assessments conducted for the 2014 IR.

Table 1904-1 Water Quality Summary for Segment 1904 – Medina Lake			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
No impairments or concerns identified.			

Projects in the Medina Lake Watershed

Bandera County River Authority Groundwater District (BCRAGD) Educational Efforts: BCRAGD has given educational talks on how to identify and properly treat *Arundo donax* as well as how to identify and prevent the spread of Zebra Mussels. The District worked with the TCEQ and Texas Parks and Wildlife to post signs to inform boaters to "Clean, Drain, and Dry" all watercrafts entering and leaving Medina Lake to prevent spread of Zebra Mussels. In the future, BCRAGD aims to expand its efforts in aquatic invasive species control by partnering with private landowners and other interested parties to locate and treat *Arundo donax*. BCRAGD staff also attended training through the TPWD so the District will be able to detect Zebra Mussels in Medina Lake and the rest of the watershed.

TPWD/BCRAGD Clean, Drain, and Dry Campaign in the Medina River Watershed

A major part of BCRAGD's mission, to preserve and protect the natural resources in Bandera County, is accomplished through water quality monitoring, illegal dumping investigations and mitigation, invasive species mitigation and brush control, and outreach programs aimed at educating citizens of the public. BCRAGD monitors the surface water and groundwater throughout

Bandera County. Water quality in Medina Lake is a high priority. BCRAGD plans to partner with the United States Geological Survey (USGS) in 2018 to conduct a comprehensive study of the surface and subsurface water quality of Medina Lake using an automated underwater vehicle to develop a cross-sectional profile of the lake.

Table 1904-2: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Medina Lake Watershed by Assessment Unit

Medina Lake Watershed Segment 1904 - Medina Lake				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**80 mg/L**	**75 mg/L**	**350 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**31.1 °C**	**126 CFU/100ml**	**0.11 mg/L**	**0.37 mg/L**	**0.20 mg/L**	**26.7 µg/L**
1904_01	12825	reservoir	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=3.43	NC	NC	NC	NC
1904_02	12829	reservoir	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=3.92	NC	NC	NC	NC

SARA's Trends over Time													
Seg/AU	**Description**	**Instantaneous Flow**	**TSS**	**Chloride**	**Sulfate**	**Total Dissolved Solids**	**Dissolved Oxygen Deficit**	**TKN**	**pH Range**	**Temperature**	**E. coli**	**Nitrate + Nitrite Nitrogen***	**Total Phosphorus**	**Chlorophyll-a**
1904_01	Station 12825-Medina Lake at Medina Lake Dam West of San				↑	↑								

FS = Fully Supporting the Water Quality Standard	NS = Not Supporting the Water Quality Standard	CN = Concern for near-nonattainment of the Water Quality Standard			
CS = Concern for water quality based on screening levels	NC = No Concern	NA = Not Assessed	Limited/Inadequate Data	↓ = Decreasing Trend	↑ = Increase Trend

*Nitrate + nitrite is the primary method utilized for analyzing surface water in Segment 1904

Depth profiles are typically taken to assess water quality in reservoirs. According to the *Guidance for Assessing and Reporting Surface Water Quality in Texas*, the first surface profile measurement is used to evaluate temperature, sulfate, chloride, TDS, nutrients and chlorophyll-*a*. If the lake is stratified, DO and pH are measured at the mixed surface layer only. The TCEQ identifies the mixed surface layer as the measurements taken from the surface to where the temperature decreases by more than 0.5 °C. The average DO values and the median pH values of the mixed surface layer are compared to the State standard. If the reservoir is not stratified, the DO and pH measurements for each profile of the entire mixed water column are compared to the criteria.

Trend Analyses

Although available data for Station 12825 Media Lake at Medina Lake Dam identified statistically significant increasing trends over time for sulfate and total dissolved solids (Figure ML 2 and 3), it is likely the result of the drought conditions experienced over the trending period. Trend analysis could not be run for TSS, ammonia, total phosphorous, *E. coli* and chlorophyll-*a* due to greater than 50% of sample measurements below the LOQ. According to the 2014 IR, Medina Lake is meeting all TSWQS and screening criterion. As a

result of unsafe conditions in accessing the sample site on the Medina Lake Dam, the TCEQ halted sample collections between 2012 and 2016. In 2017, BCRAGD began picking up samples at Station 12825 Media Lake at Medina Lake Dam.

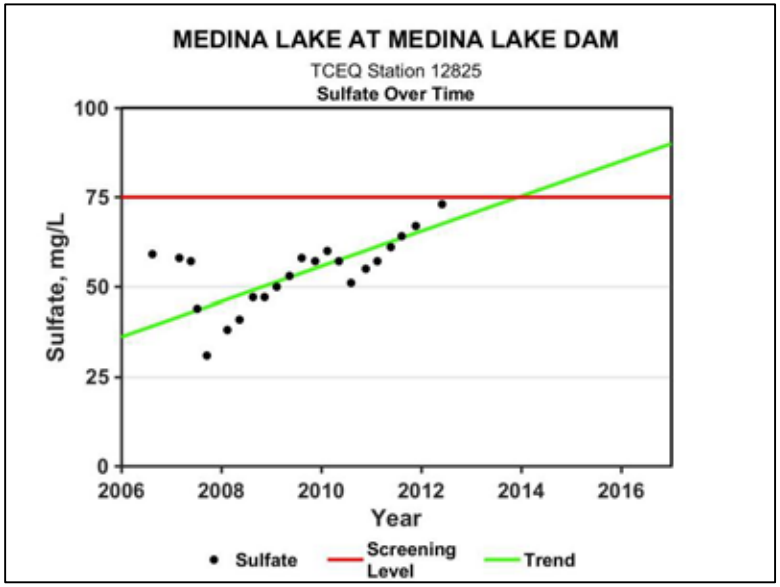


Fig. ML 2: 12825 Medina Lake at the Medina Lake Dam, Sulfate over Time

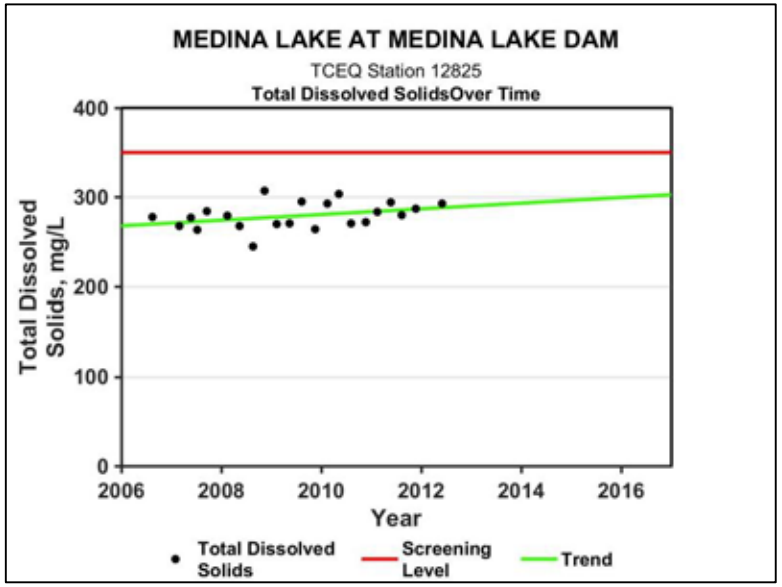


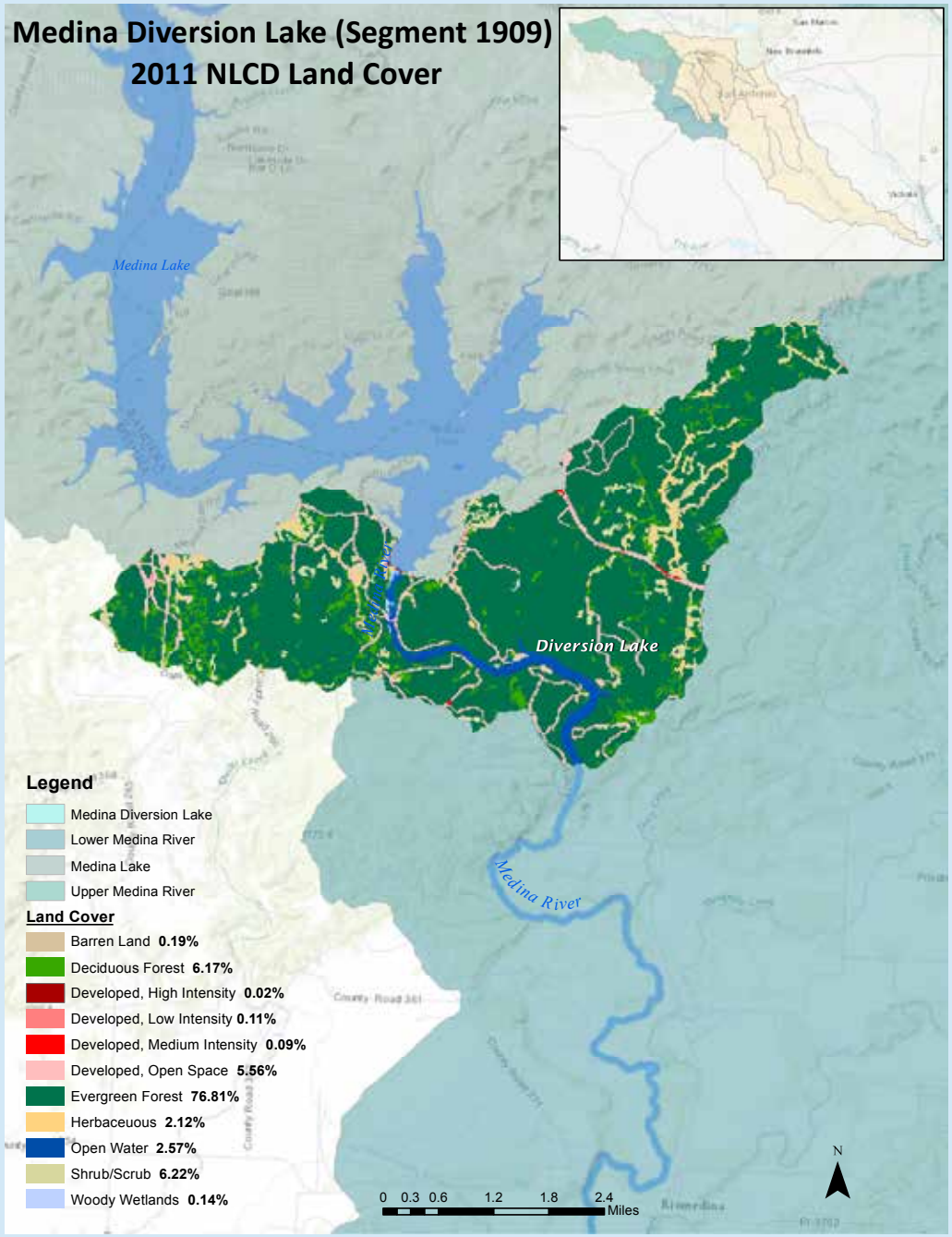
Fig. ML 3: 12825 Medina Lake at the Medina Lake Dam, TDS over Time

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 (impounding the 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.

Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure MDL-1 for more detail.

This segment has a high aquatic life use designation. It is also designated for use as a public water supply. Aquifer protection use applies to this segment because it contributes to recharge of the Edwards Aquifer. Like all segments in the San Antonio River Basin, TCEQ has designated this section for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing, and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are no pending or current permitted domestic or wastewater dischargers in Segment 1909 Medina Diversion Lake.



Medina Diversion Lake Watershed Water Quality Summary

The 2014 IR does not list any impairments or concerns for any portion of the Medina Diversion Lake Watershed, Tables 1909-1 and 1902-2. There were no biological or habitat assessments conducted for the 2014 IR.

Table 1909-1 Water Quality Summary for Segment 1909 – Medina Diversion Lake			
Water Quality Focus	Affected Area of Watershed	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
No impairments or concerns identified.			

Table 1909-2: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Medina Diversion Lake Watershed by Assessment Unit

Medina Diversion Lake Watershed Segment 1909 - Medina Diversion Lake				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**50 mg/L**	**75 mg/L**	**400 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.11 mg/L**	**0.37 mg/L**	**0.20 mg/L**	**26.7 µg/L**
1909_01	12859, 18407	reservoir	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=11.26	NC	NC	NC	NC

SARA's Trends over Time														
Seg/AU	**Description**	**Instantaneous Flow**	**TSS**	**Chloride**	**Sulfate**	**Total Dissolved Solids**	**Dissolved Oxygen Deficit**	**TKN**	**pH Range**	**Temperature**	**E. coli**	**Nitrate + Nitrite Nitrogen***	**Total Phosphorus**	**Chlorophyll-a**
1909_01	Station 18407 Medina Diversion Lake Near Dam				↑									

FS = Fully Supporting the Water Quality Standard	NS = Not Supporting the Water Quality Standard		CN = Concern for near-nonattainment of the Water Quality Standard		
CS = Concern for water quality based on screening levels	NC = No Concern	NA = Not Assessed	Limited/Inadequate Data	↓ = Decreasing Trend	↑ = Increase Trend

*Nitrate + nitrite is the primary method utilized for analyzing surface water in Segment 1909

Trend Analyses

Trending for Station 18407 Medina Diversion Lake near the dam identified a statistical significant increasing trend over time for sulfate (Figure MDL 2). Although naturally occurring, the source for the increasing sulfate trend is not specifically known. Trend analysis could not be run on the majority of the parameters due to greater than 50% of sample measurements below the LOQ; there was insufficient *E. coli* data available for trending. According to the 2014 IR, Medina Diversion Lake is meeting all TSWQS and screening criteria. As a result of unsafe conditions in accessing the sample site on the Medina Diversion Lake Dam, the TCEQ halted sample collections between 2012 and 2016. In 2017, BCRAGD began picking up samples at Station 18407 Media Diversion Lake near the Medina Lake Dam. However, with property fences and unsafe conditions for launching kayaks off the bridge, access to the Medina Diversion Lake Dam continues to be an issue. BCRAGD continues to look for access sites further down the river for easier and safer access.

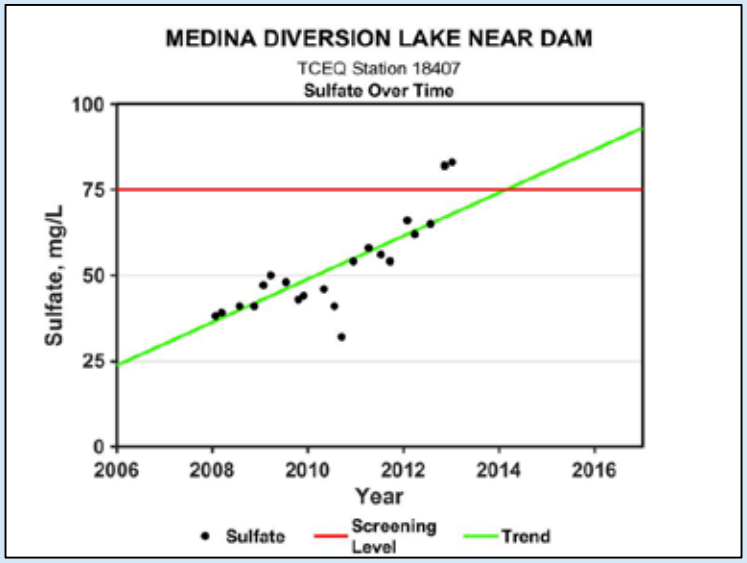
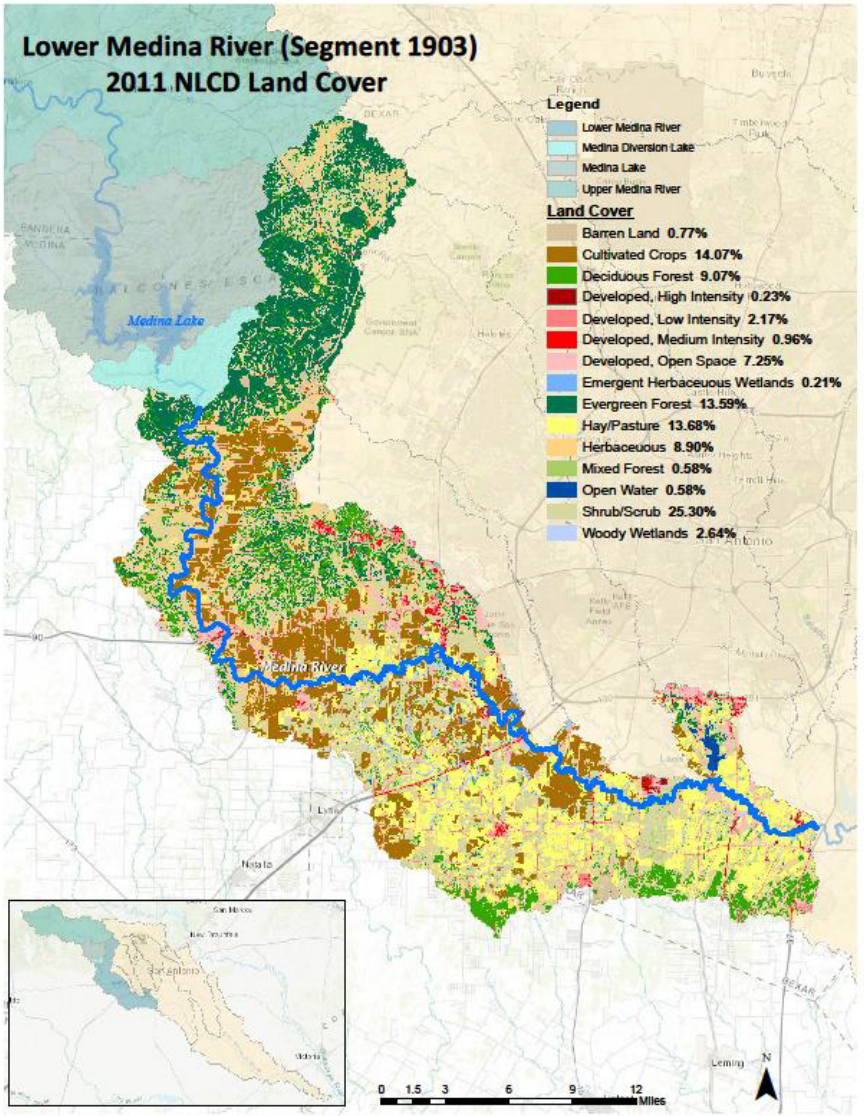


Fig. MDL 2: 18407 Medina Diversion Lake at the Medina Lake Dam, Sulfate over Time

Medina Diversion Lake Watershed

Lower Medina River – Segment 1903

Segment 1903 extends upstream from its confluence with the San Antonio River in southeast Bexar County to the Medina Diversion Dam in Medina County. The approximate drainage area is 376 square miles and it is predominately rural. The upper end of this segment flows through portions of the Edwards Plateau as it makes its way on to the Gulf Coastal Plains of the Central Plains Province. 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 Water Recycling Center, 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 Gulf Coastal Plains, and the stream habitats alternate between runs and glides. This portion of the Medina River is characteristically deeper and more turbid.



This segment contains a great variety of land uses and cover types. The upper portion east and southeast of the Medina Diversion Lake is predominately deciduous forest and with pockets of herbaceous vegetation. The area immediately west and south of San Antonio has varying levels of development and open spaces. The lower part of the segment is mostly rural with cultivated crops and pasture land. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure LMR-1 for more detail.

The Lower Medina River has a high aquatic life use designation. It is also designated for use as a public water supply. Aquifer protection use applies to this segment because it contributes to recharge of the Edwards Aquifer. Like all segments in the San Antonio River Basin, TCEQ has designated this segment for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing, and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at

http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are nine current permitted domestic and wastewater dischargers in Segment 1903 Lower Medina River. See Table 1903-1 for details.

Table 1903-1: Municipal and Industrial Wastewater Outfalls in Segment 1903 - Lower Medina River

Permittee	Status	Type	County
AQUA UTILITIES INC - Outfall 1	Current Permit	Domestic	MEDINA
SAN ANTONIO WATER SYSTEM - Outfall 2	Current Permit	Wastewater	BEXAR
SAN ANTONIO WATER SYSTEM - Outfall 1	Current Permit	Domestic	BEXAR
SAN ANTONIO WATER SYSTEM - Outfall 1	Current Permit	Wastewater	BEXAR
SAN ANTONIO RIVER AUTHORITY - Outfall 1	Current Permit	Domestic	BEXAR
CITY OF SOMERSET - Outfall 1	Current Permit	Domestic	BEXAR
FOREST GLEN UTILITY CO - Outfall 1	Current Permit	Domestic	MEDINA
CITY OF LA COSTE Outfall 1 - Outfall 1	Current Permit	Domestic	MEDINA
CITY OF CASTROVILLE - Outfall 1	Current Permit	Domestic	MEDINA

Domestic: <1 MGD domestic sewage; **Wastewater:** ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Lower Medina River Watershed Water Quality Summary

According to the 2014 IR, a bacteria impairment has been identified in the Lower Medina River Watershed; nutrient concerns have also been documented. Table 1903-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Impairments are in red text, concerns are in black text. Figure LMR-2 provides a visual summary of impairments and concerns by assessment unit. Table 1903-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Lower Medina River Watershed.

Table 1903-2 Water Quality Summary for Segment 1903 – Lower Medina River			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Lower	• Sewer breaks and overflows • Poorly maintained septic tank systems • Stormwater runoff sources of fecal matter from intense livestock production and wild animals	Before a TMDL is scheduled, SARA and the TCEQ will continue to monitor and assess the data in Segment 1903. In the 2014 IR, the TCEQ has assigned this impairment to Category 5c – additional data or information will be collected and/or evaluated before a management strategy is selected.
Nitrate Nitrogen	Entire		There are no State numerical nutrient stream water quality standards, only

Table 1903-2 Water Quality Summary for Segment 1903 – Lower Medina River			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Total Phosphorus	Lower	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	screening criteria. Nitrate, total phosphorus, and ammonia data is utilized to indicate areas of concern. Continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria. SARA will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.
Ammonia	Lower		

Spotted Bass (Micropterus punctulatus)

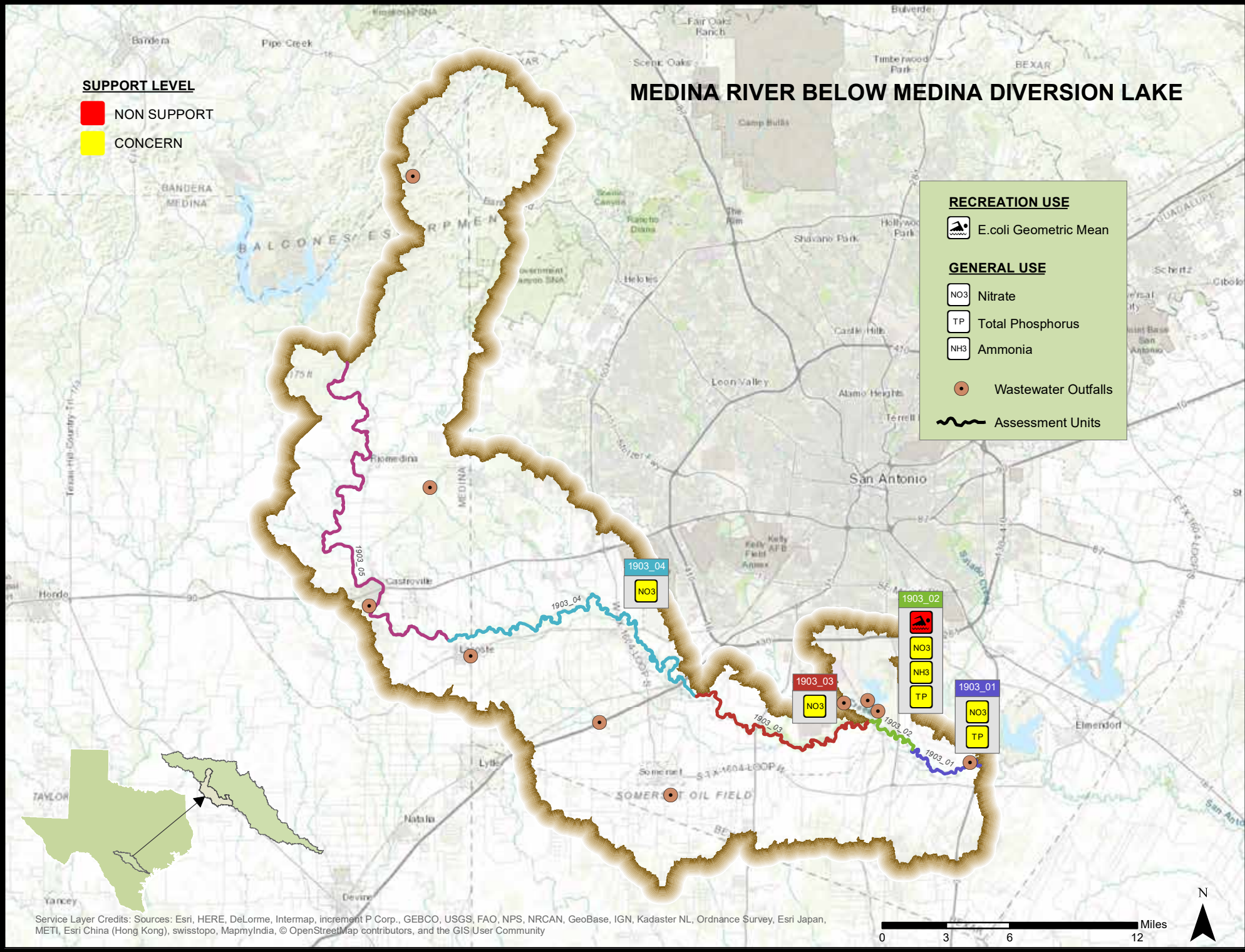


Figure LMR-2: Map of the Lower Medina River impairments and concerns by assessment unit.

Table 1903-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Lower Medina River Watershed by Assessment Unit

Lower Medina River Watershed Segment 1903 - Medina River Below Medina Diversion Lake				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**120 mg/L**	**120 mg/L**	**700 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score 42**	**HBI Score 20**	**Score 29**
1903_01	12811	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=109.60	NC	CS	CS	NC	NA	NA	NA
1903_02	12812, 12813	perennial	high	FS	FS	FS	NC	FS	NC	NC	FS	FS	NS GM=142.10	CS	CS	CS	NC	NA	NA	NA
1903_03	12814, 12816	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=93.85	NC	CS	NC	NC	NA	NA	NA
1903_04	12817, 12818, 12819, 12821, 13699, 14200	perennial	high	FS	FS	FS	NC	FS	NC	NC	FS	FS	FS GM=88.90	NC	CS	NC	NC	FS (43.50)	NC (20.00)	NA
1903_05	12823, 12824	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=12.61	NC	NC	NC	NC	NA	NA	NA

SARA's Trends over Time

Seg/AU	Description	Instantaneous Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	E. coli	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
1903_02	Station 12813 - Medina River at Cassin Crossing	↓	↓	↑		↑	↑			↓			↑	↑	↓
1903_01	Station 12811 - Medina River at FM 1937			↑		↑				↓	↑	↑	↑	↑	↓

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

*Nitrate + nitrite was the primary method utilized for analyzing surface water at Station 12811 Medina River at FM 1937

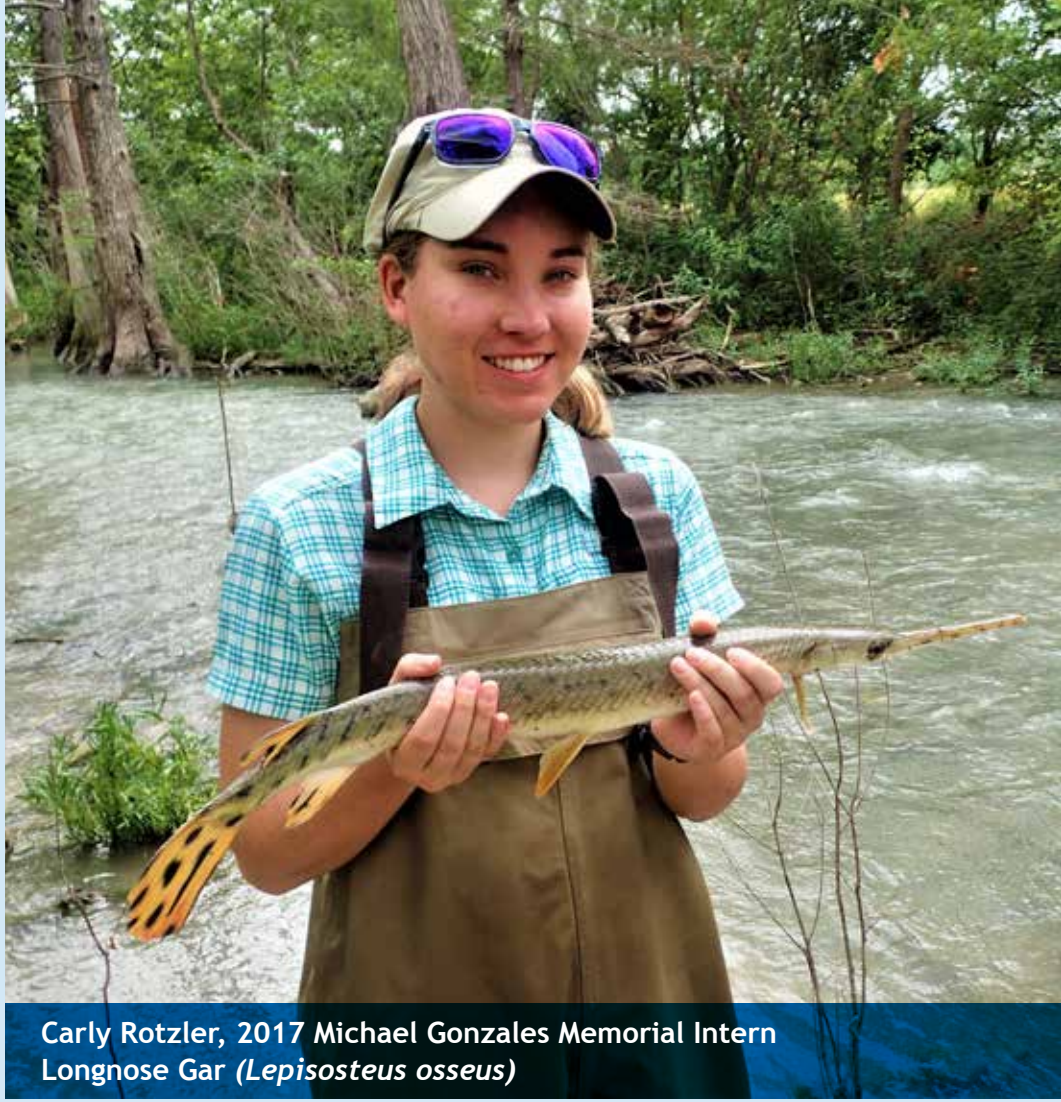
Bacteria Impairment

Assessment unit 1903_02, from five miles upstream of the San Antonio River to one and a half miles upstream of Leon Creek, was first identified as impaired for recreational use in the 2010 Texas Water Quality Inventory and 303(d) List. Based on the 2014 IR, the geometric mean in assessment unit 1903_02 is 161 *E. coli*/100 mL. Possible sources of *E. coli* contamination include stormwater runoff from agricultural activities and wildlife, improper and failing septic tank systems and sewer breaks, and overflows. Until a TMDL is initiated, SARA will continue to monitor and assess the data in the Lower Medina River Watershed.

Biological Assessment

TSWQS describes the Lower Medina River as having a high aquatic life use (ALU) designation and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average). Biological assessments for the Lower Medina River did not identify any impairments or concerns for fish communities, habitat or dissolved oxygen. Station 14200 Medina River at County Road 484, located in assessment unit 1903_04, was sampled once in 2006 and once each year from 2008 to 2012.

The fish Index of Biotic Integrity (IBI) scores for Station 14200 Medina River at County Road 484 ranged from 33 (limited) to 44 (high) at the same station, with the overall IBI score of 43.2 (high). There was an average of 98 individual fish and an average of 10 different species collected per sampling event. There were three intolerant species collected, including the Guadalupe Bass, Mimic Shiner, and the Texas Logperch. An average of 10% of total number fish collected were tolerant to pollution. The Redbreast Sunfish was the only non-native species collected. Native species included the Blacktail Shiner, Bluegill Sunfish, Bullhead Minnow, Central Stoneroller, Channel Catfish, Flathead Catfish, Green Sunfish, Grey Redhorse, Guadalupe Bass, Longear Sunfish, Longnose Gar, Mexican Tetra, Mimic Shiner, Red Shiner, Rio Grande Cichlid, Sailfin Molly, Sand Shiner, Spotted Bass, Spotted Sunfish, Texas Logperch, Texas Shiner, Warmouth, Weed Shiner, and Western Mosquitofish.



Carly Rotzler, 2017 Michael Gonzales Memorial Intern
Longnose Gar *(Lepisosteus osseus)*

The Habitat Quality Index (HQI) score ranged from 18 (intermediate) to 23 (high) with an overall average HQI score of 20.0 (high). The stream channel is well-defined with moderately and poorly defined stream bends. Stream banks are gently sloping and covered with hardwood riparian forest. The average width of the natural riparian habitat is 14 meters and includes native hardwood trees, shrubs, and grasses. The average percent tree canopy is 88% and includes cypress, ash, pecan, elm, hackberry, black willow, cottonwood, and oak. The aquatic habitat is dominated by runs but also includes riffles and glides. Gravel and cobble are the dominant substrate type at this location. The average number of instream cover types is six and includes gravel, litter, macrophytes, overhanging vegetation, tree roots, and woody debris. The average percent instream cover is 32% and the average percent stream bank erosion is 21%.

Although there was limited 24-hour DO data for Station 14200 Medina River at County Road 484, of the six 24-hour DO measurements assessed, there were no average or minimum exceedances. The 24-hour DO average values ranged from 6.6 mg/L to 7.7 mg/over the

2014 IR assessment period. The 24-hour DO minimum values ranged from 5.9 mg/L in 2012 to 7.2 mg/L in 2011. In addition to the 24-hour DO measurements, there were 80 DO grab measurements collected, with no screening or minimum exceedances.

Trend Analyses

Although the Medio Creek and Leon Creek Water Recycling Centers (WRC) do not discharge directly into the Medina River, both the Medio and Leon Creeks are tributaries of the Lower Medina River. Effluent discharges from these WRCs could possibly affect the water quality at Station 12813 Medina River at Cassin Crossing and Station 12811 Medina River at FM 1937. Also, as indicated by the land use map, this portion of the watershed is predominantly rural with cultivated crops and pasture land. Agricultural runoff during stormwater events could also affect the nutrient loading of the Lower Medina River Watershed. Trending at Station 12813 Medina River at Cassin Crossing (1903_02) identifies a statistically significant increasing trends for TDS, DO deficit, nitrate, total phosphorous, and chloride; statistically significant decreasing flow, temperature, TSS, and chlorophyll-*a* trends over time have been observed (Figure LMR 2-4). It should be noted that chlorides are not created by the wastewater treatment process, but are concentrated in the effluent discharge as a byproduct of the wastewater treatment process.

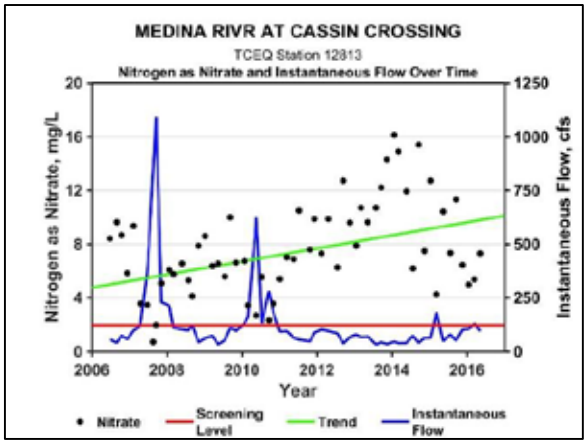


Fig. LMR 2: 12813 Medina River at Cassin, Nitrate over Time

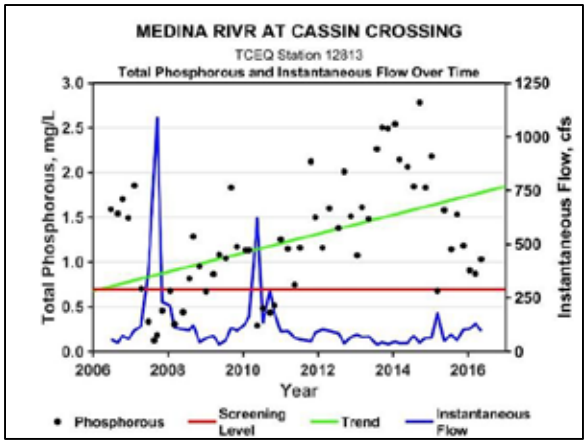


Fig. LMR 3: 12813 Medina River at Cassin, T Phos over Time

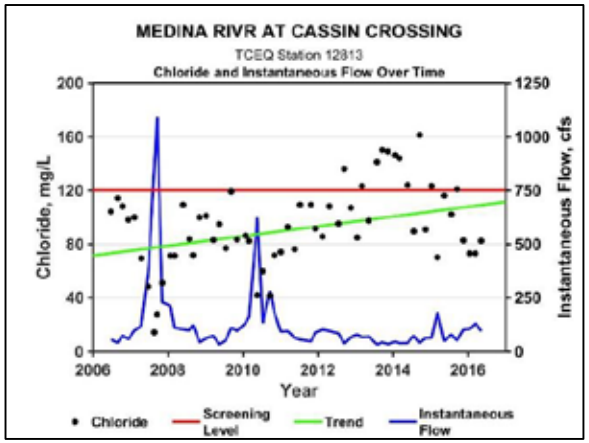


Fig. LMR 4: 12813 Medina River at Cassin Chloride over Time

Trend analysis for Station 12811 Medina River at FM 1937 in assessment unit 1903_01 identifies increasing statistical significant trends for TDS, ammonia, nitrate+nitrite, total phosphorous, chloride, and *E. coli* over time; statistical significant decreasing trends over time were also identified for temperature and chlorophyll-*a* (Figure LMR 5-7) It should be noted that Station 12811 did have sufficient ammonia concentration above the LOQ to be trended.

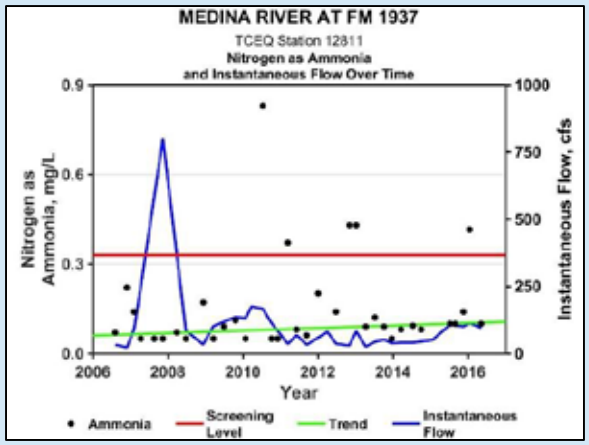


Fig. LMR 5: 12811 Medina River at FM1937, Ammonia over Time

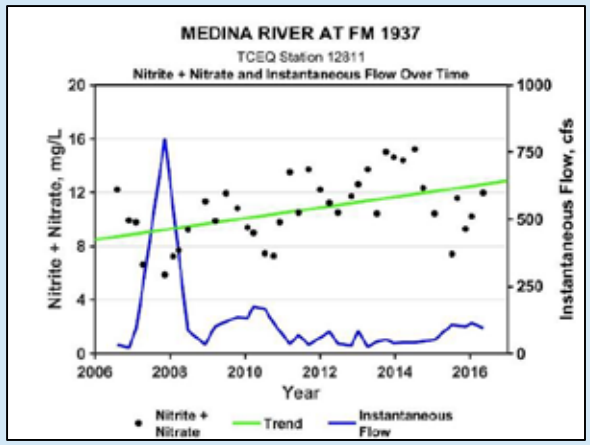


Fig. LMR 6: 12811 Medina River at FM1937, Nitrate+Nitrite over Time

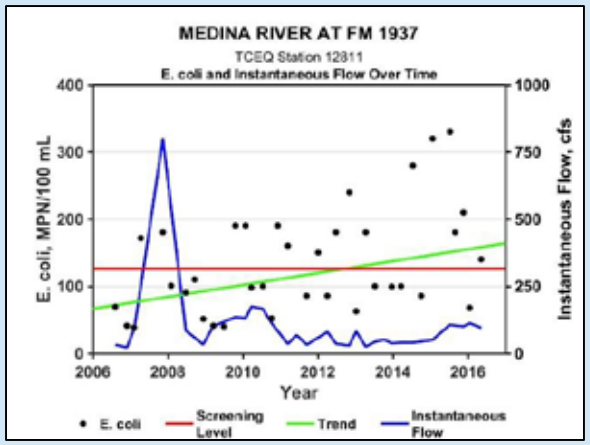
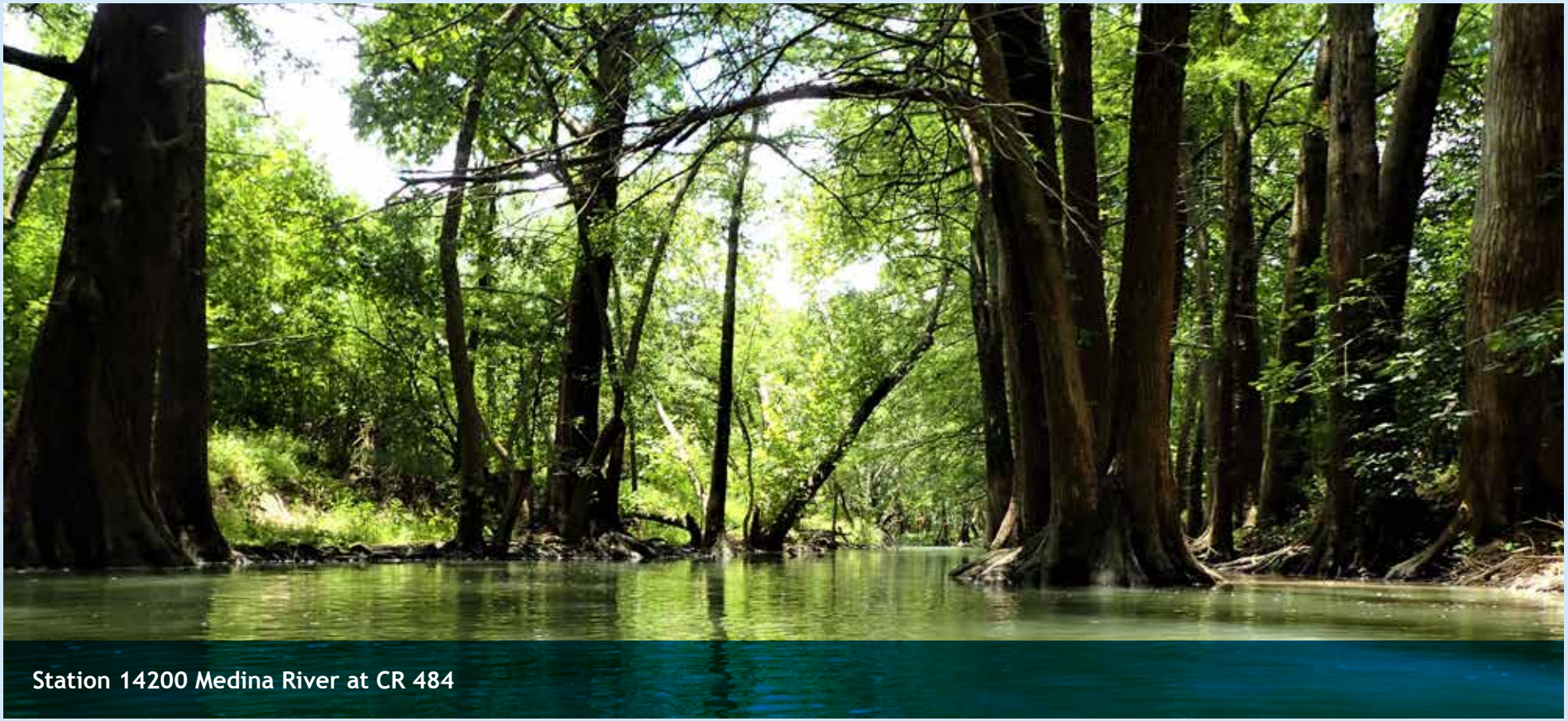
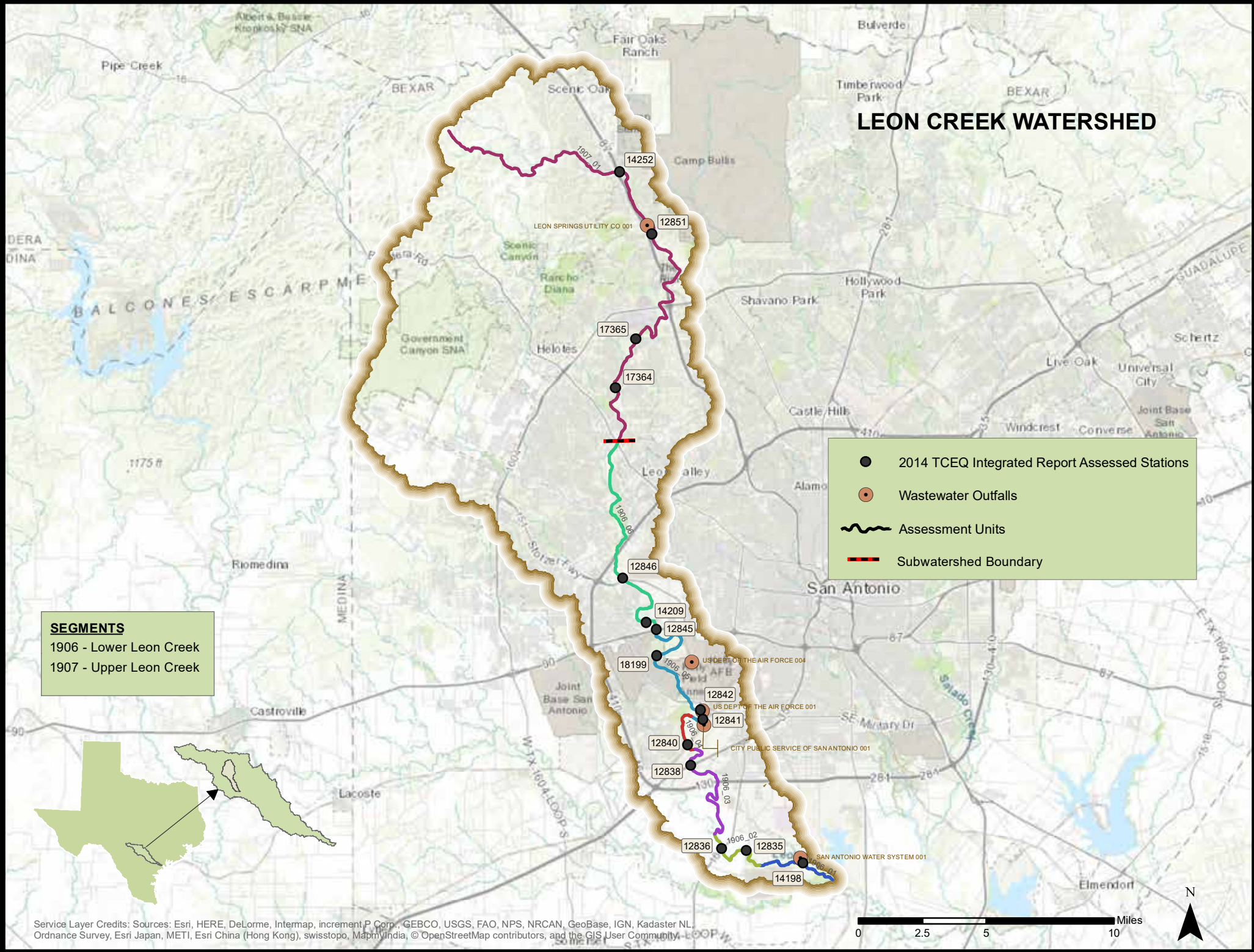


Fig. LMR 7: 12811 Medina River at FM1937, *E coli* over Time

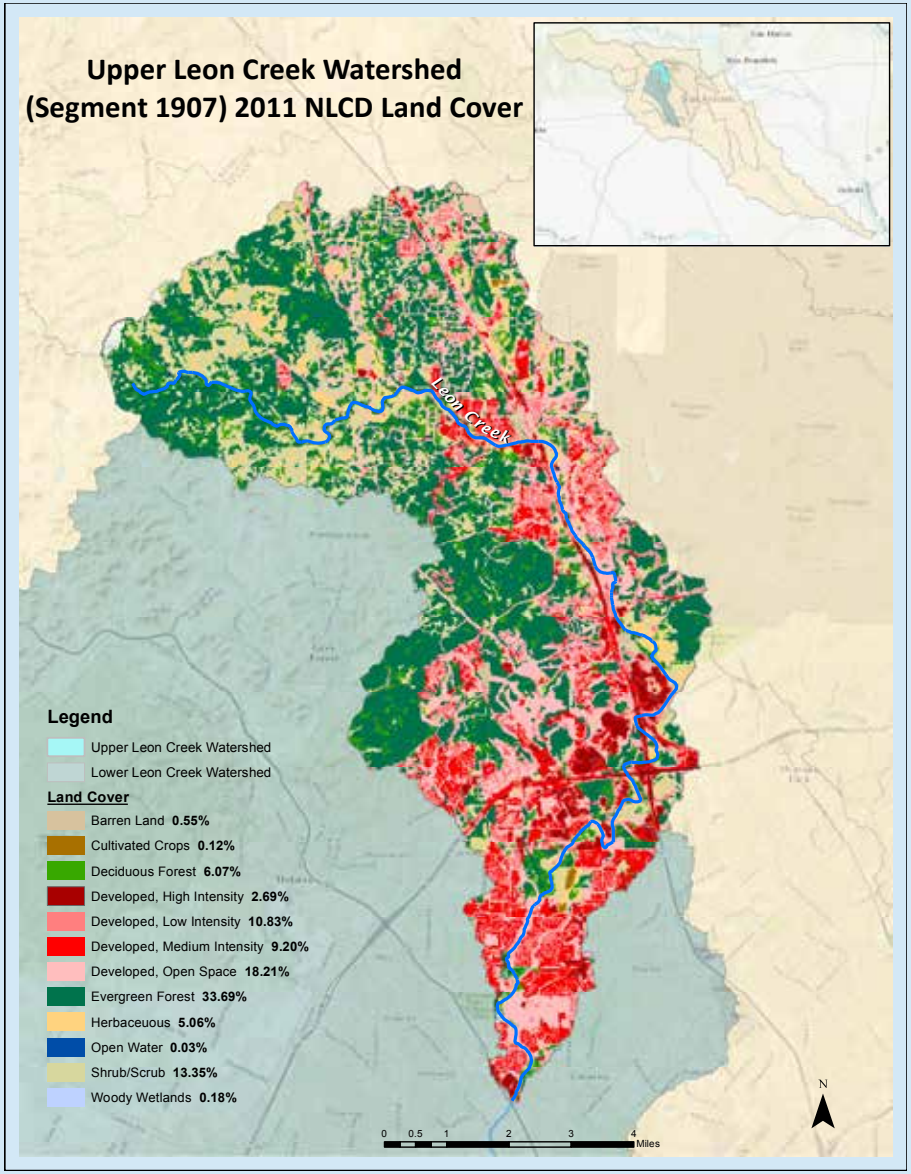




Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Upper Leon Creek Watershed – Segment 1907

Segment 1907, Upper Leon Creek, extends from a point 110 yards upstream of SH-16 (Bandera Road) northwest of San Antonio in Bexar County to a point 5.6 miles upstream of Scenic Loop Road north of Helotes in Bexar County. The upstream portion of this 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 and 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 oak, and post oak trees are common.



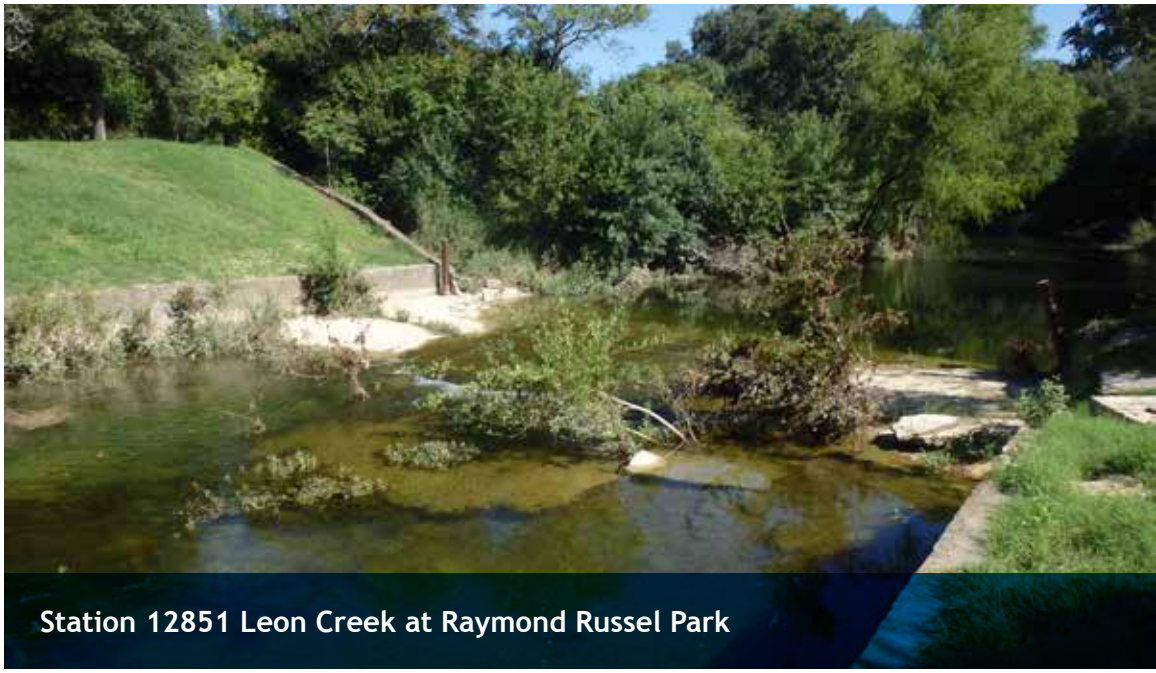
Land use in the segment varies greatly from mostly natural with only scattered development in the upper part of the segment to dense, widespread development in the middle and lower portions of the segment. The upper quarter of the segment, upstream of Boerne Stage Road, is mostly a mixture of pasture, scrub, and forested land. The remainder of the segment transitions from moderately developed near the creek, with scattered vegetated areas closer to the edges of the watershed, to higher intensity development across the watershed with only scattered, small vegetated areas adjacent to the creek. Areas of higher intensity development include Northwest San Antonio including the area around the University of San Antonio, the City of Helotus, City of Leon Valley, and Leon Springs. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure ULC-1 for more detail.

This segment has a high aquatic life use designation. It is also designated for use as a public water supply. Aquifer protection use applies to this segment because it contributes to recharge of the Edwards Aquifer. Like all segments in the San Antonio River Basin, TCEQ has designated this section for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing, and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there is one current permitted discharger with a single outfall in Segment 1907 Upper Leon Creek. See Table 1907-1 for details.

Table 1907-1: Municipal and Industrial Wastewater Outfalls in Segment 1907 – Upper Leon Creek

Permittee	Status	Type	County
LEON SPRINGS UTILITY COMPANY	Current Permit	Domestic	Bexar

Domestic: <1 MGD domestic sewage;
Wastewater: ≥1 MGD domestic sewage or process water including water treatment plant discharge.



Station 12851 Leon Creek at Raymond Russel Park

Upper Leon Creek Watershed Water Quality Summary

The 2014 IR does not list any impairments or concerns for any portion of the Upper Leon Creek Watershed, Tables 1907-2 and 1907-3. There were no biological or habitat assessments conducted for the 2014 IR.

Table 1907-2 Water Quality Summary for Segment 1907 – Upper Leon Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
No impairments or concerns identified.			

Special Projects

SARA Stream Flow Type Assessment: Upper Leon Creek is included in the Edwards Aquifer recharge zone; as a result, there is typically little to no flow in the segment. Although the information in the 2014 IR identifies flow in this segment as perennial, information from SARA and TCEQ field staff indicate flow in this segment is minimal even during normal precipitation years. Previous and ongoing field observations have indicated a flow classification of intermittent with pools would be more appropriate. Starting with the 2017 monitoring year, SARA started collecting field and flow information at 3 water quality monitoring stations throughout the Upper Leon Creek Watershed. Information will be presented to the TCEQ with the goal of assigning a more appropriate flow type classification for the Upper Leon Creek Watershed.

Station 14252 Leon Creek at Leon Springs

SARA, contracted by the TCEQ in 2012**,** conducted a **Lower Leon Creek Use Attainability Analysis** (UAA) to evaluate and further define the appropriate ALU and associated DO criteria for Segment 1906. In support of the project, 24-hr DO measurements were performed at 10 stations with at least one in each assessment unit; biological (nekton and benthic macroinvertebrate) and habitat assessments were performed at seven sites with all but one in the assessment units represented. Dissolved oxygen 24-hour criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average) were supported in all assessment units throughout the watershed with the exception of the upper 5.0 miles of the segment in assessment unit 1906_06. Biological and benthic macroinvertebrate Index of Biotic Integrity (IBI) scores did not meet the high criteria at Station 20518 Leon Creek at Old Highway 90

West located in assessment unit 1906_06. In addition, flow measurements taken during the two year study period suggest that AU 1906_06 does not have perennial flow, and would be more appropriately described as intermittent with perennial pools. Although the UAA was specific to the Lower Leon Creek, depending on TCEQ evaluation of data, the UAA could possibly affect the flow type designation of the Upper Leon Creek Watershed.

Table 1907-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Upper Leon Creek Watershed by Assessment Unit

Upper Leon Creek Watershed Segment 1907 - Upper Leon Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**55 mg/L**	**240 mg/L**	**550 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
1907_01	12851, 14252, 17364, 17365	perennial	high	NC	NC	NC	NC	NC	NA	NA	NC	NC	NC GM=66.01	NC	NC	NC	NC
SARA's Trends over Time																	
Seg/AU	**Description**	**Instantaneous Flow**	**TSS**	**Chloride**	**Sulfate**	**Total Dissolved Solids**	**Dissolved Oxygen Deficit**		**TKN**	**pH Range**	**Temperature**	**E. coli**	**Nitrate + Nitrite Nitrogen***		**Total Phosphorus**	**Chlorophyll-a**	
		Insufficient Data															

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

*Nitrate + nitrite is the primary method utilized for analyzing surface water in Segment 1907

To analyze for trends, there must be at least 20 samples collected throughout a 10 year period. None of the stations in Upper Leon Creek had sufficient data for trend analysis.

Station 14252 Leon Creek at Leon Springs

Lower Leon Creek Watershed – Segment 1906

Lower Leon Creek Segment 1906 extends from the confluence with the Medina River in Bexar County to a point 100 meters (110 yards) upstream of State Highway 16 northwest of San Antonio in Bexar County. The approximate drainage area of the Lower Leon Creek is 228 square miles and has a total continuous length of 32 miles. Segment 1906A, Helotes Creek, is an unclassified waterbody in the Leon Creek Watershed. For the 2014 IR, there was inadequate data to assess Helotes Creek for any use criteria.

Flows 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 USA, formerly Kelly Air Force Base. The lower one-third continues to flow in a general southeast direction through rural farm and ranch land. The portion of this segment between State Highway 16 and 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 Lower Leon Creek. Hilly terrain and low-permeability clay soils make this segment susceptible to stormwater runoff.

Station 12836 Leon Creek at SH 16

Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data.

The extreme northwestern portion of the watershed of Segment 1906 is dominated by evergreen forest with scattered areas of herbaceous vegetation and pasture, primarily in close proximity to tributaries. The majority of Lower Leon Creek's Watershed is dominated by moderate development with only small, very scattered areas of deciduous forest and pasture. The southern portion of the watershed gradually transitions from moderate to low intensity development before giving way to a scattered mix of primarily pasture and cultivated crops. See Figure LLC-1 for more detail.

This segment has a high aquatic life use designation. The upper 29 miles of this segment are designated for use for public water supply; the lower three miles are not designated for public water supply use. Like all segments in the San Antonio River Basin, this segment is designated for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing, and rafting. According to the TCEQ Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there is one current permitted groundwater discharger and two current permitted wastewater dischargers in Segment 1906 Upper Leon Creek. See Table 1906-1 for details.

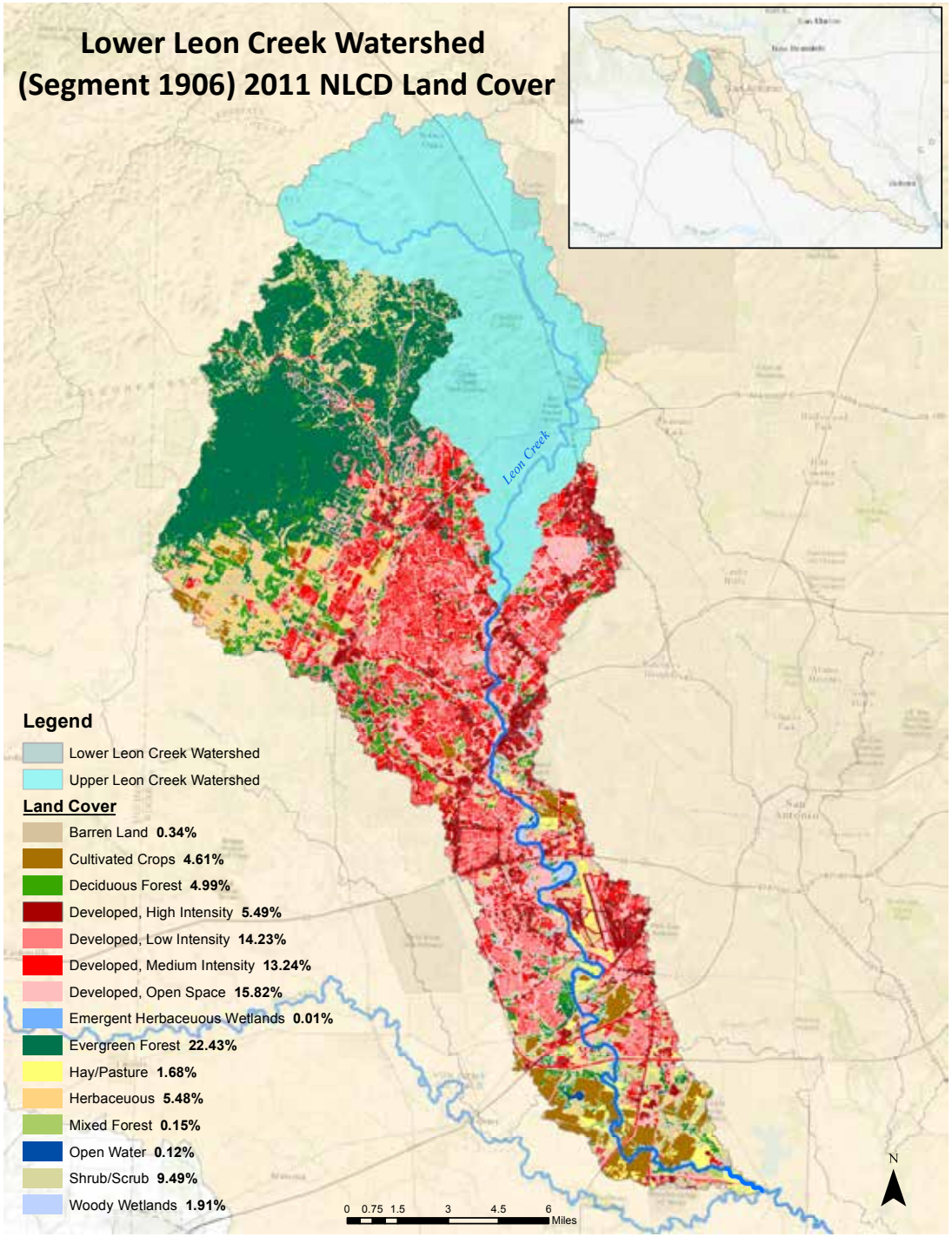


Table 1906-1: Municipal and Industrial Wastewater Outfalls in Segment 1906 – Lower Leon Creek			
Permittee	**Status**	**Type**	**County**
US DEPT OF THE AIR FORCE – Outfall 1, 4	Current Permit	Groundwater	BEXAR
SAN ANTONIO WATER SYSTEM	Current permit	Wastewater	BEXAR
CITY PUBLIC SERVICE OF SAN ANTONIO	Current Permit	Wastewater	BEXAR

Domestic: <1 MGD domestic sewage; **Wastewater:** ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Lower Leon Creek Watershed Water Quality Summary

The 2014 IR lists impairments in Lower Leon Creek for depressed dissolved oxygen and PCBs in fish tissue; there are also concerns for silver in sediment and nutrients. Table 1906-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Figure LLC-2 provides a visual summary of impairments and concerns by assessment unit. Impairments are in red text, concerns are in black text. Table 1906-3 provides a detailed summary of impairments and concerns by assessment unit, including long-term trends at selected stations in the Lower Leon Creek Watershed.

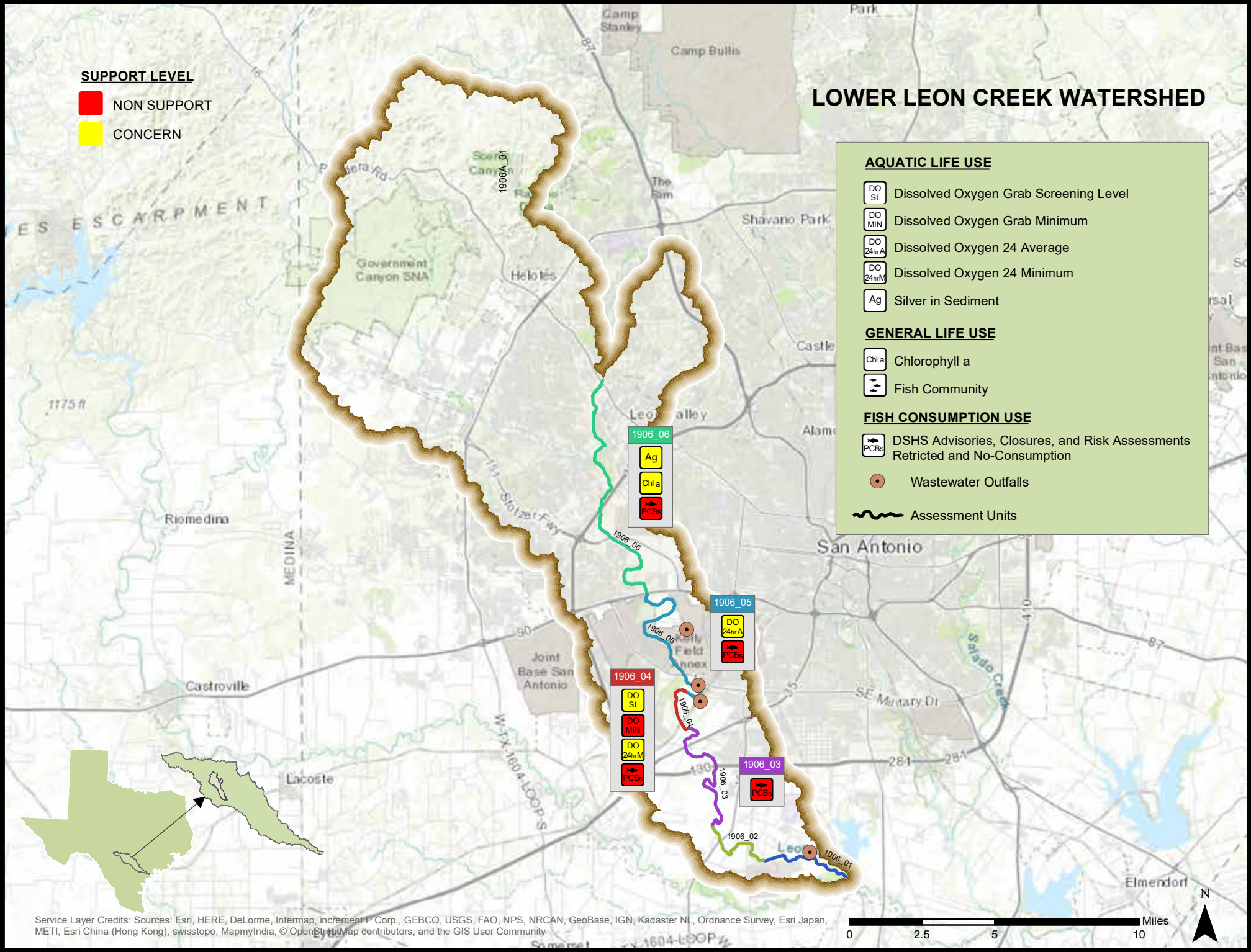
Table 1906-2: Water Quality Summary for Segment 1906 – Lower Leon Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Elevated Polychlorinated Biphenyls (PCBs) in Fish Tissue	Upper and Middle (From the confluence with Indian Creek through the remainder of the segment)	Illegal disposal of transformers, capacitors, hydraulic fluids, lubricants, preservatives and sealants containing PCBs	The impairments for PCBs in fish tissue are based on data that has been carried forward from the 2010 IR. The USGS, sponsored by SARA, have completed two characterization studies in the Lower Leon Creek Watershed. Sediment, trace elements, and polychlorinated biphenyls were studied between the former Kelly Air Force Base and Interstate Highway 410.
Depressed DO	Middle	• Organic matter carried to river with stormwater runoff • Low flows	The impairment listed for dissolved oxygen grab minimum in AU 1906_04 is based on data that has been carried forward. SARA and the TCEQ will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.

Table 1906-2: Water Quality Summary for Segment 1906 – Lower Leon Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Chlorophyll-*a*	Upper	• Improper use of fertilizers • Organic matter carried to river with stormwater runoff • No flow resulting in pooling	There are no State numerical nutrient stream water quality standards, only screening criteria. Chlorophyll-a data is utilized to indicate areas of concern. SARA and the TCEQ will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.
Elevated Silver in Sediment	Upper	• Industrial wastewater discharge • Stormwater runoff over industrial area	The concern for silver in sediment is based on data that has been carried forward from the 2008 IR. SARA and the TCEQ are collecting and analyzing metals in sediment to assess water quality conditions and determine long-term trends in the watershed.

Projects in the Lower Leon Creek Watershed

SARA, contracted by the TCEQ in 2012**,** conducted a **Lower Leon Creek Use Attainability Analysis** (UAA) to evaluate and further define the appropriate ALU and associated DO criteria for Segment 1906. In support of the project, 24-hr DO measurements were performed at 10 stations with at least one in each assessment unit; biological (nekton and benthic macroinvertebrate) and habitat assessments were performed at seven sites with all but one of the assessment units represented. Dissolved oxygen 24-hour criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average) were supported throughout the watershed with the exception of the upper 5.0 miles of the segment, assessment unit 1906_06. Fish and benthic macroinvertebrate Index of Biotic Integrity (IBI) scores did not meet the high criteria for the same assessment. In addition, flow measurements taken during the two year study period indicate that AU 1906_06 does not have perennial flow, and would be more appropriately described as intermittent with perennial pools.

20518 Leon Creek at Old Hwy 90 West



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Figure LCC-2: Map of the Lower Leon Creek impairments and concerns by assessment unit.

USGS 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: In October 2012, SARA and USGS initiated the Leon Creek Sediment Analysis Study to better characterize the source for PCBs in the Leon Creek Watershed upstream from the former Kelley AFB to Interstate Highway 410. Streambed sediment and suspended sediment samples were collected to investigate the relation between storm flow and base flow sediment concentrations. Existing and new sample sites were studied to add to the understanding of PCB concentrations in the study area. https://pubs.usgs.gov/sir/2016/5039/sir20165039.pdf.

Table 1906-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Lower Leon Creek Watershed by Assessment Unit

Lower Leon Creek Watershed Segment 1906 - Lower Leon Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological			*Aquatic Life	*Fish Consumption
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic		
Segment_AU	Stations in the Segment	Flow Type	Aquatic Life Use	120 mg/L	120 mg/L	700 mg/L	5 mg/L	3 mg/L	5 mg/L	3 mg/L	6.5-9.0 SU	35 °C	126 CFU/100ml	0.33 mg/L	1.95 mg/L	0.69 mg/L	14.1µg/L	IBI Score 41	HBI Score 20	Score 29	Toxicity in Sediment	DSHS Advisories, Closures, Risk Assessments
1906_01	14198	perennial	high	FS	FS	FS	NC	FS	NC	NC	FS	FS	FS GM=25.47	NC	NC	NC	NC	FS (44.00)	NC (24.40)	NA	--	--
1906_02	12835, 12836	perennial	high	FS	FS	FS	NC	FS	FS	FS	FS	FS	FS GM=67.17	NA	NA	NA	NA	NA	NA	NA	--	--
1906_03	12838	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=92.14	NC	NC	NC	NC	NA	NA	NA	NA	CF-NS
1906_04	12840	perennial	high	FS	FS	FS	SM	CF-NS	FS	CN	FS	FS	FS GM=107.96	NA	NA	NA	NA	NA	NA	NA	--	CF-NS
1906_05	12841, 18199; 12842	perennial	high	FS	FS	FS	NC	FS	CN	NA	FS	FS	FS GM=72.60	NC	NC	NC	NC	NA	NA	NA	NC	CF-NS
1906_06	12845, 14209, 12846	perennial	high	FS	FS	FS	NC	FS	NA	NA	FS	FS	FS GM=72.57	NC	NC	NC	CS	NA	NA	NA	CF-CS-Silver Sediment	CF-NS

SARA's Trends over Time

Seg/AU	Description	Instantaneous Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	E. coli	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
1906_01	Station 14198 Leon Creek Upstream from Leon Creek WWTP				↓	↓	↑					↓	↓	↑

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

CF = The Integrated level of support of CS, CN or NS was carried forward from a previous assessment due to inadequate/no data for this method in this assessment.

SM = Superseded by another method

***Fish Consumption and Toxicity in Sediment:** Due to the number of organic constituents and sampling locations, together with the varying amount of data (insufficient, limited, adequate data), only the assessment unitssegments with adequate data and specific impairments were identified in the table.

Fish Consumption Impairment

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 2014 IR identifies assessment units 1906_03 through 1906_06 as impaired for fish consumption.

According to the EPA, PCBs belong to a broad family of man-made organic chemicals known as chlorinated hydrocarbons. PCBs were domestically manufactured from 1929 until their manufacture was banned in 1979. PCBs vary in consistency from thin, light-colored liquids to yellow or black waxy solids. Due to their non-flammability, chemical stability, high boiling point, and electrical insulating properties, PCBs were used in hundreds of industrial and commercial applications including electrical, heat transfer, and hydraulic equipment; plasticizers in paints, plastics, and rubber products; in pigments, dyes, and carbonless copy paper; and many other industrial applications. Prior to the 1979 ban, PCBs entered the environment during their manufacture and use in the United States. Today PCBs can still be released into the environment from poorly maintained hazardous waste sites that contain PCBs; illegal or improper dumping of PCB wastes; leaks or releases from electrical transformers containing PCBs; and disposal of PCB-containing consumer products into municipal or other landfills not designed to handle hazardous waste. PCBs may also be released into the environment by the burning of some wastes in municipal and industrial incinerators.

Department of Health Consumption Advisory Sign

Once in the environment, PCBs do not readily break down and therefore may remain for long periods. PCBs can accumulate in the leaves and above-ground parts of plants and food crops. They are also taken up into the bodies of small organisms and fish. As a result, people who ingest fish may be exposed to PCBs that have bioaccumulated in the fish they are ingesting.

In response to the 2002 TDSHS fish consumption advisory ADV-26, the USGS with support from SARA, initiated and completed analyses, which included major and trace elements and organic compounds including PCBs and metals. The final USGS report is located at http://pubs.usgs.gov/fs/2011/3090/FS11-3090.pdf. The study identified the presence of trace elements, pesticides and PCBs in Lower Leon Creek and below at the former Kelly Air Force Base (AFB).

In order to further investigate the findings of the original study completed in 2009, the USGS with support from SARA, initiated the 2012 *USGS Occurrence and Concentrations of Selected Trace Elements and Halogenated Organic Compounds in Stream Sediments and Potential Sources of Polychlorinated Biphenyls.* The final USGS report is located at https://pubs.usgs.gov/sir/2016/5039/sir20165039.pdf. This study was designed to characterize contaminants of concern between the

former Kelly Air Force Base and Interstate Highway 410. The study approach included streambed sediment and stormwater sediment sampling. Specific attention was given to suspended sediments transported during storm events. Streambed sediment samples were collected to investigate the relation between storm flow and base flow sediment concentrations (i.e., what is transported from upstream and what is deposited in the streambed). By sampling at both new and established sites, the study was able to add to the current understanding of PCB concentrations in the study area. Samples were analyzed for major and trace elements, pesticides, and PCBs.

Biological Assessment

TSWQS describes the Lower Leon Creek as having a high aquatic life use (ALU) designation and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average). Biological assessments for the Lower Leon Creek did not identify any impairments or concerns for fish communities or habitat; depressed levels of dissolved oxygen were below the grab minimum of 3.0 mg/L in assessment units 1906_04 and 1906_05. Fish community and habitat data was collected in assessment unit 1906_01 at Station 14198 Leon Creek upstream of Leon Creek Wastewater Treatment Plant and was sampled six times once each year from 2006 to 2012.

The fish Index of Biotic Integrity (IBI) scores for Station14198 Leon Creek upstream of Leon Creek Wastewater Treatment Plant ranged from 31 (limited) to 47 (high) in 2008, with an overall IBI score of 44.0 (high). There was an average of 518 individual fish and an average of 14.7 different species collected per sampling event. There were two intolerant species collected, including the Mimic Shiner and Texas Logperch. An average of 48% of total number of fish collected were tolerant to pollution. The Blue Tilapia and the Redbreast Sunfish were the only non-native species collected. Native species collected included the Amazon Molly, Blacktail Shiner, Bluegill Sunfish, Bullhead Minnow, Central Stoneroller, Channel Catfish, Common Carp, Flathead Catfish, Gizzard Shad, Green Sunfish, Grey Redhorse, Largemouth Bass, Longear Sunfish, Mexican Tetra, Mimic Shiner, Red Shiner, Rio Grande Cichlid, Sailfin Molly, Sand Shiner, Spotted Bass, Spotted Gar, Texas Logperch, Warmouth, Weed Shiner, and Western Mosquitofish.

Spotted Bass *(Micropterus punctulatus)*

The Habitat Quality Index (HQI) score ranged from 21 (high) to 26.5 (exceptional), with the overall average HQI score of 24.5 (high). Lower Leon Creek is characterized by well-to poorly defined stream bends. Stream banks of the Lower Leon

Creek vary from low-lying, gently sloping banks to high, steep banks. Portions of the stream are bordered with large sandstone boulders and gravel. Some high, steep banks of unconsolidated soils are also present. Many of the low-lying banks are covered with native grasses, forbs and wildflowers. The average width of the natural riparian habitat that borders Lower Leon Creek is 20 meters and includes trees, shrubs, and grasses. The average percent tree canopy is 50% and includes black willow, pecan, ash, sycamore, oak, and cottonwood trees. Instream habitat types include glides and runs. The dominant substrate type throughout the Lower Leon Creek are gravel and large boulders. The average number of instream cover types is nine and includes gravel, macrophytes, overhanging vegetation, tree roots, woody debris, ledges, undercut banks, boulders, and other types of instream cover. The average instream cover is 34% and the average percent stream bank erosion is 26%.

Station 12835 Leon Creek at Applewhite Road

Lower Leon Creek, assessment unit 1906_04, from Highway 353 to a point 2 miles southeast of Pearsall Park, was first identified in the 1999 Texas Water Quality Inventory and 303(d) List as having grab DO minimum concentrations lower than the standard established to assure optimum conditions for aquatic life. However, because some of the older DO minimum listings may have been made by comparing grab DO minimum (3 mg/L) data to the average 24-hour criterion (5 mg/L), a step-wise procedure for evaluating the older DO carry forward listings was made in 2008. Until sufficient acceptable 24-hour DO data is obtained, existing grab DO impairments and concerns will be carried over to future IRs. As the 2014 IR still indicates a concern for 24-hour minimum in 1906_04, the original grab DO minimum impairment remains in effect.

In April 2014, the TCEQ and SARA initiated the Lower Leon Creek Use-Attainability Analysis (UAA) to evaluate the appropriate aquatic life use and DO criterion for the Lower Leon Creek. Results from the project indicated the Lower Leon Creek was attaining the high aquatic life use designation and 24-hour DO criteria except for the upper most part of the Creek, 1906_06. The final report is currently being reviewed for inclusion in the next triennial TSWQS revision scheduled for 2021. In addition to the Leon Creek UAA and as a

result of the carried forward DO grab minimum impairment and the 24-hour DO minimum concern, beginning in 2014 SARA added 24-hour DO collection events at Station 12840 Leon Creek at Quintana Road.

Trend Analyses

Trend analyses was conducted for Station 14198 Leon Creek Upstream of Leon Creek WWTP. Four parameters were found to have statistically significant decreasing trends over time (Total Dissolved Solids, Nitrate, Phosphorous, and Sulfate). Two parameters, DO Deficit and chlorophyll-*a*, were found to have statistically significant increase over time (Fig. LLC 2 and 3). While the 2014 IR identifies a DO impairment and concerns for DO and chlorophyll-*a* in the segment, there are no impairments or concerns identified for 1906_01, the assessment unit where Station 14198 is located. It should be noted that there is a limited amount of data from the latter half of the trending period for chlorophyll-*a*, and that the vast majority of values are still below the screening level. A considerable number of sulfate values were above the screening level, but not only has the number of exceedances decreased over time, the overall mean is below the screening level and there is a statistically significant decrease over time (Fig LLC 4). The reason for the decreasing sulfate trend is unknown.

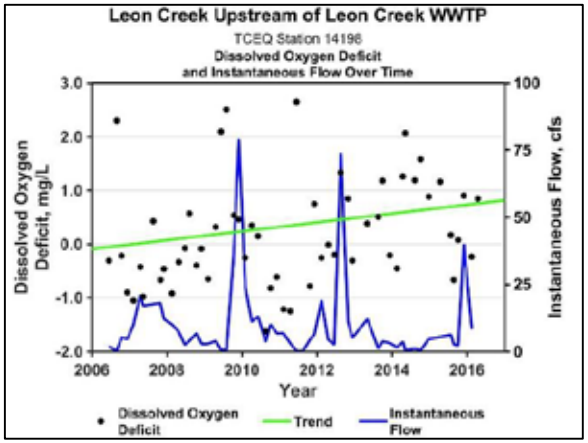


Fig. LLC 2: 14198 Leon Ck Upstream Leon WWTP, DO Deficit Over Time

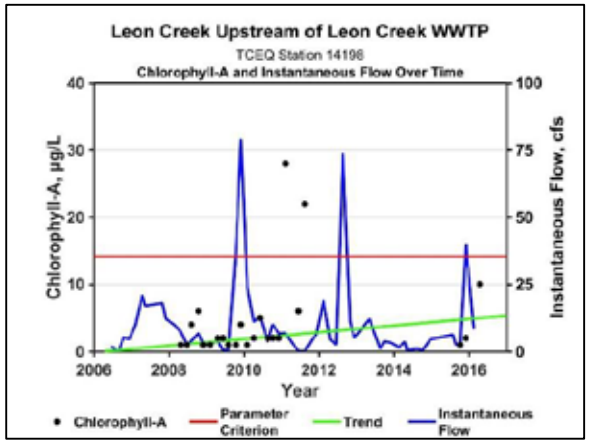


Fig. LLC 3: 14198 Leon Ck Upstream Leon WWTP, Chlorophyll-*a* Over Time

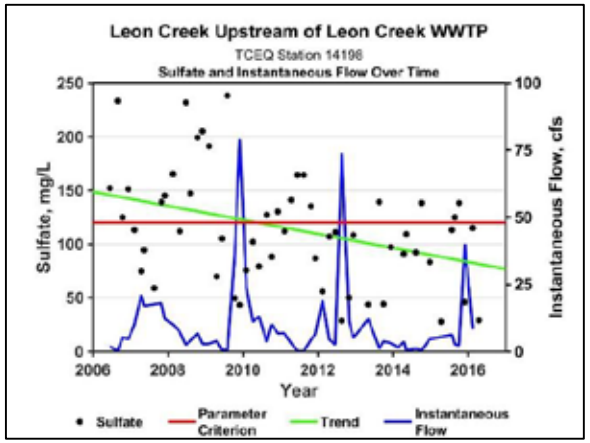
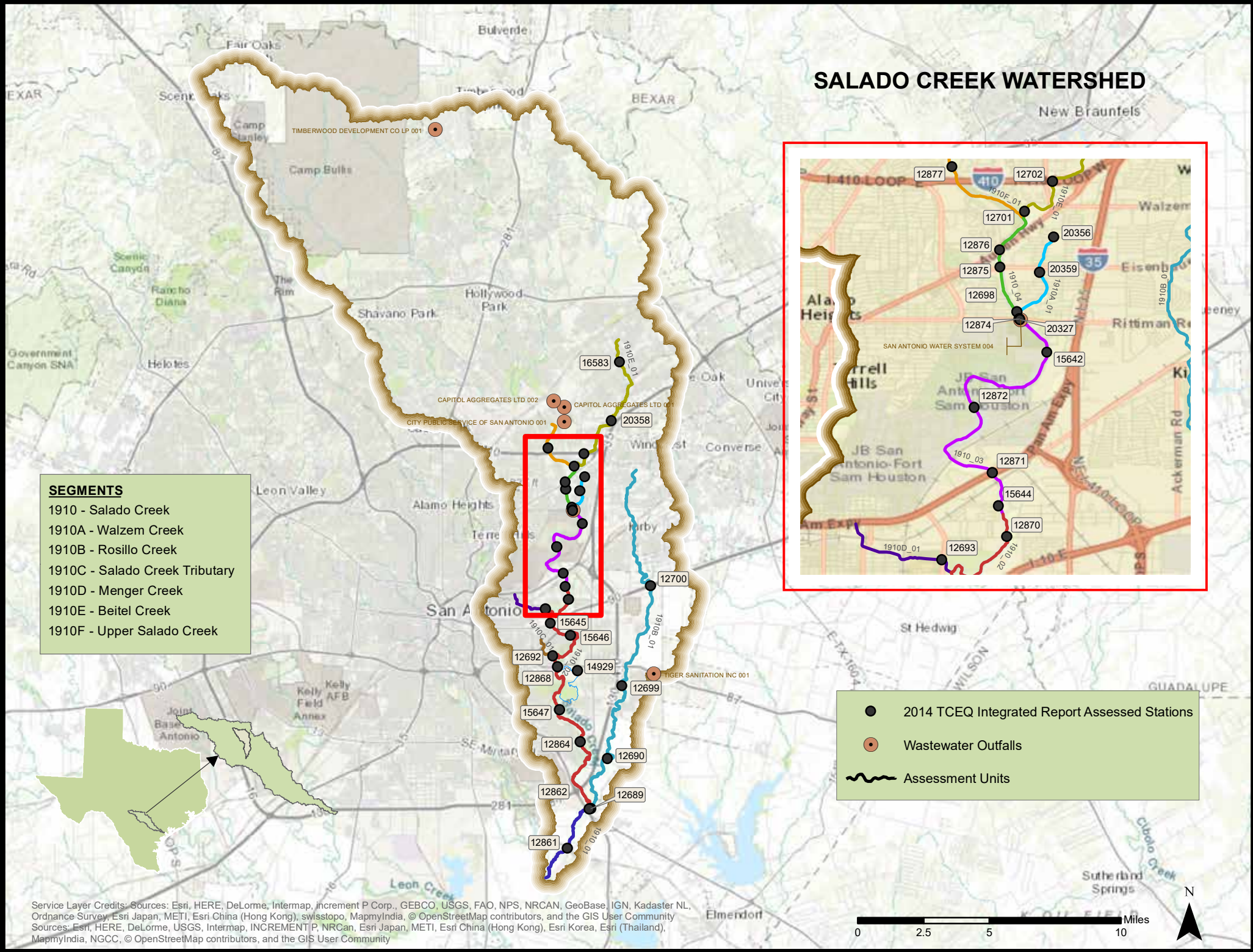


Fig. LLC 4: 14198 Leon Ck Upstream Leon WWTP, Sulfate Over Time



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Salado Creek Watershed

Salado Creek extends from the confluence with the San Antonio River in Bexar County to the confluence of Beitel Creek in Bexar County. 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. The remaining portions of Salado Creek take on the alluvial characteristics of the Gulf Coastal Plains 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 segments of the Salado Creek Watershed assessed in the 2014 IR include:

Segment 1910A Walzem Creek
Segment 1910B Rosillo Creek
Segment 1910C Salado Creek Tributary
Segment 1910D Menger Creek
Segment 1910E Beitel Creek
Segment 1910F Upper Salado Creek

Land use in the Salado Creek watershed is primarily developed to varying degrees. In the far northwestern part of the watershed, the land is primarily forest with scattered scrub and light development. The lack of development can be attributed to the land being part of Camp Bullis and other U.S. Military installations. The north-central portion of the watershed is moderately developed, with the amount of interspersed natural areas increasing eastward. The entire central portion of the watershed is densely developed to varying degrees with very limited interspersion of natural areas. The southeastern

Electrofishing at Station 12870 Salado Creek at Gembler Rd, Common Carp *(Cyprinus carpio)* shown

edge of the watershed has a moderate amount of scattered natural areas, with this pattern continuing to the confluence with the San Antonio River. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure SC-1 for more detail.

Salado Creek has a high aquatic life use designation. It is also designated for use as a public water supply. Aquifer protection use also applies to this segment because the upper portion of Salado Creek contributes to recharge of the Edwards Aquifer. Like all streams in the San Antonio River Basin, this segment is designated for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing, and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are three current permitted wastewater dischargers and one pending domestic discharger in the watershed. See Table 1910-1 for details.

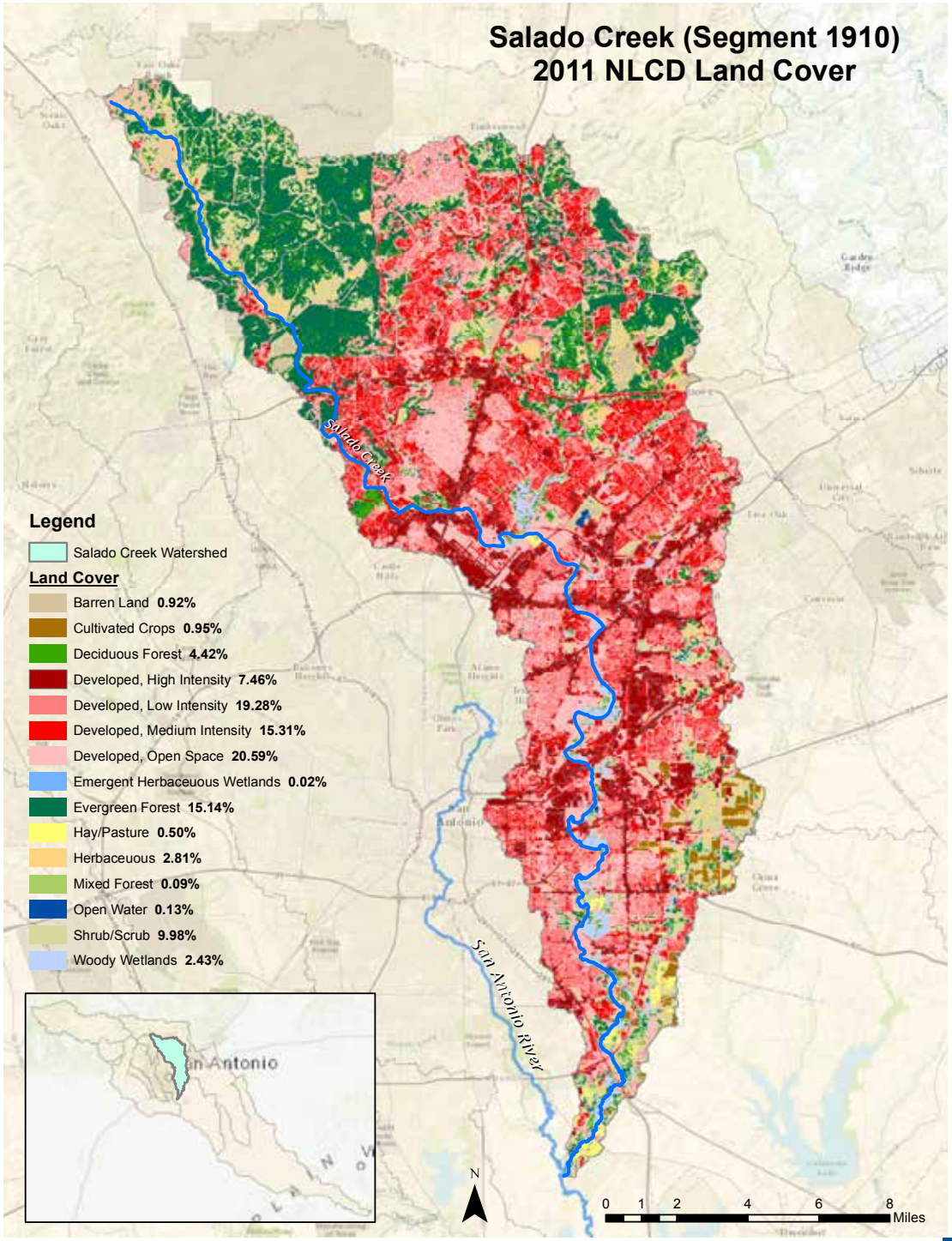


Table 1910-1: Municipal and Industrial Wastewater Outfalls in the Salado Creek watershed			
Permittee	**Status**	**Type**	**County**
SAN ANTONIO WATER SYSTEM - Outfall 4	Current Permit	Wastewater	BEXAR
CAPITOL AGGREGATES LTD - Outfall 1 and 2	Current Permit	Wastewater	BEXAR
TIMBERWOOD DEVELOPMENT CO LP - Outfall 1	Pending Permit	Domestic	BEXAR
CITY PUBLIC SERVICE OF SAN ANTONIO - Outfall 1	Current Permit	Wastewater	BEXAR

Domestic: <1 MGD domestic sewage; **Wastewater:** ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Salado Watershed Water Quality Summary

According to the 2014 IR, bacteria, DO, and benthic macroinvertebrate community impairments have been identified in the Salado Creek Watershed. DO, bacteria, nitrate and chlorophyll-*a* concerns have also been detected. Table 1910-2, provides a big-picture view of impairments and concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Impairments are in red text, concerns are in black text. Figure SC-2 provides a visual summary of impairments and concerns by assessment unit.
Table 1910-3 provides a detailed summary of impairments and concerns by assessment units, including long-term trends at selected stations in the Salado Creek Watershed.

Largemouth Bass *(Micropterus salmoides)*

Table 1910-2: Water Quality Summary for Segment 1910 – Salado Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Upper	• Direct and indirect (stormwater runoff) sources of fecal matter from domestic and wild animals • Sewer breaks and overflows • Poorly maintained septic tank systems	The Upper San Antonio River TMDL Implementation Plan was submitted to TCEQ in the spring of 2015 and received final approval April 6, 2016.
Depressed DO	Middle and Upper	• Organic matter carried to river with stormwater runoff • Low flows	SARA will continue monitoring and assessing water quality conditions and determine long-term trends in the watershed.
Nitrate	Middle	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate data is utilized to indicate areas of concern. Continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria. SARA will continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria, to assess water quality conditions, and determine long-term trends in the watershed.
Benthic Macroinvertebrate	Middle	• Depressed DO • Remnant contamination • Sewer breaks and overflows	Benthic macroinvertebrate can be very sensitive to poor water quality. The nonsupport designation is based on data that is carried forward from the 2012 IR. SARA will continue to conduct biological monitoring in these assessment units to assess aquatic communities, water quality conditions, and determine long-term trends in the watershed. The TCEQ has assigned this impairment to Category 5c indicating that additional chloride data or information will be collected and/or evaluated before a management strategy is selected.

Table 1910-2: Water Quality Summary Unclassified Segments in the Salado Creek Watershed			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
E. coli	Walzem Creek, Rosillo Creek, Salado Creek Tributary, Menger Creek	• Direct and indirect (stormwater runoff) sources of fecal matter from domestic and wild animals • Sewer breaks and overflows • Poorly maintained septic tank systems	The Upper San Antonio River WPP has been revised to include additional BMPs that what would abate or control nonpoint source pollution of *E. coli*, suspended sediments, and excess nutrients in the Upper San Antonio River Watershed. To document BMPs' effectiveness, monitoring of established and ongoing instream sites will continue. The Upper San Antonio River TMDL Implementation Plan was submitted to TCEQ in the spring of 2015 and received final approval April 6, 2016.
Chlorophyll-*a*	Upper Salado Creek	• Improper use of fertilizers • Organic matter carried to river with stormwater runoff • Low flow resulting in pooling	There are no State numerical nutrient stream water quality standards, only screening criteria. Chlorophyll-*a* data is utilized to indicate areas of concern. SARA will continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria, to assess water quality conditions, and determine long-term trends in the watershed.
Depressed DO	Menger Creek, Beitel Creek	• Organic matter carried to river with stormwater runoff • Low flows	Additional 24 hour DO monitoring was conducted in 2014 and 2015 on Menger Creek to address the nonsupport designation. As the budget allows, SARA will add monitoring stations to assess water quality conditions and determine long-term trends in the watershed.

Projects in the Salado Creek Watershed

Three Total Maximum Daily Loads for Bacteria in the San Antonio Area: The Upper San Antonio River and Salado Creek were first identified as impaired due to bacteria in the 2000 Texas Water Quality Inventory and 303(d) List (TCEQ 2000). Walzem Creek was added to the list in 2002. In response to the listing, the TCEQ developed several Total Maximum Daily Loads (TMDL) to establish the bacteria loading reductions necessary to bring the Upper San Antonio River, Salado Creek, and Walzem Creek into compliance with

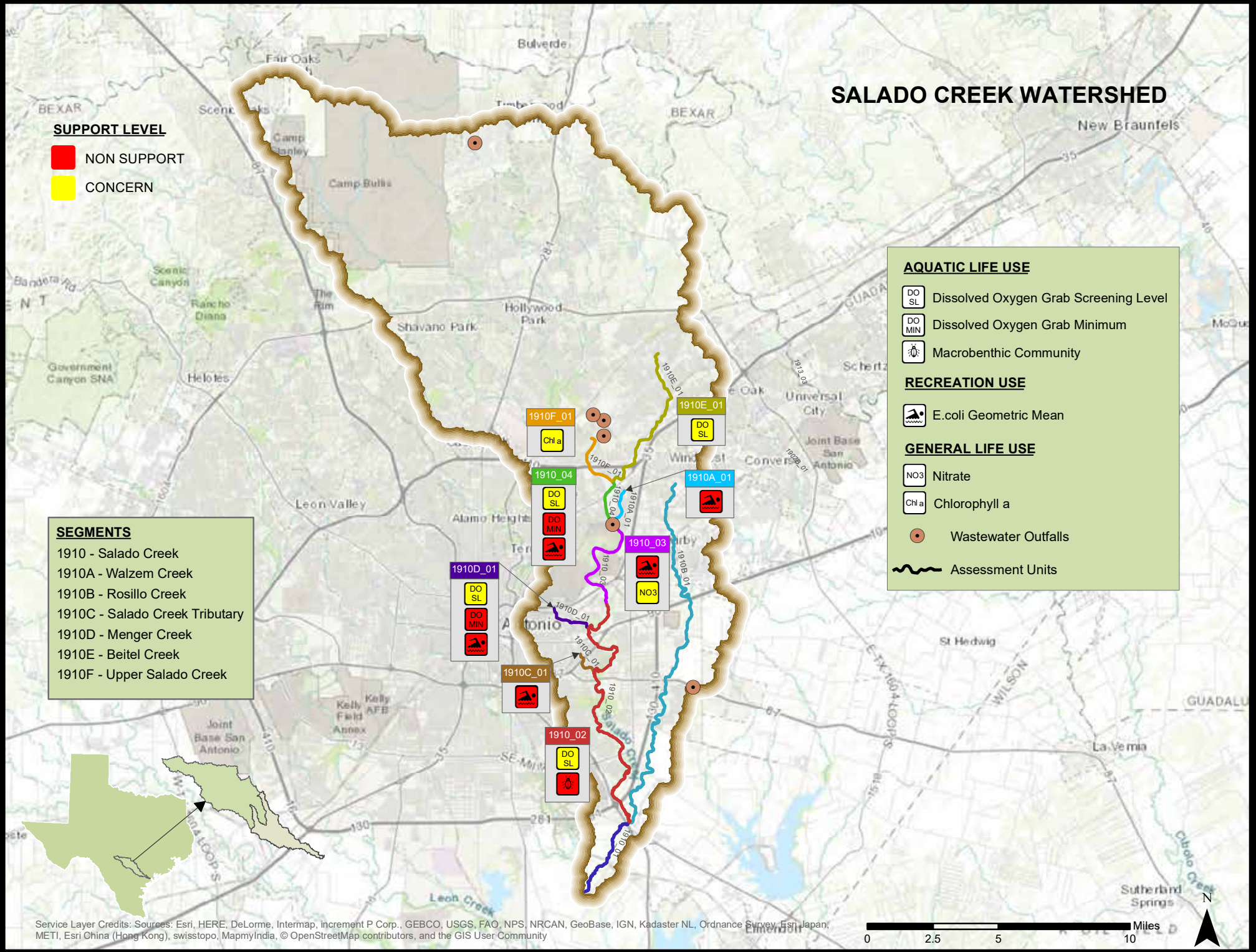


Figure SC-2: Map of the Salado Creek impairments and concerns by assessment unit.

the TSWQS. The TCEQ adopted the Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watershed: Segments 1910, 1910A, and 1911 (TCEQ 2007) on July 25, 2007. The TMDLs were approved by the EPA on September 25, 2007. Additional information can be found at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-uppersanantoniotmdl-adopted.pdf.

Addendum One to the Three Total Maximum Daily Loads for the Upper San Antonio Watershed; Seven Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watershed: In April 2016, the TCEQ adopted an addendum to the Three TMDL for bacteria in the San Antonio area and the EPA approved the addendum on August 9, 2016. The addendum included new information on seven additional assessment units in Menger Creek, Apache Creek, Alazan Creek, San Pedro Creek and Sixmile Creek. As part of the project, with support from the TCEQ and Texas A&M AgriLife Research, a stakeholder committee called the San Antonio Bacteria TMDL Advisory Group was created to developed a plan to implement the TMDLs with management measures needed to reduce bacteria, as well as a timeline for implementation. https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-usar_addendum_2016-04.pdf

Longear Sunfish *(Lepomis megalotis)*

Implementation Plan for Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio Watersheds Segments: 1910, 1910A, 1911: The TCEQ and Texas A&M AgriLife worked with communities, interest groups, and local organizations to involve stakeholders with the development of a Upper San Antonio River I-Plan. The ultimate goal of the I-Plan is to meet the primary contact recreation uses in Salado Creek (Segment 1910), Walzem Creek (Segment 1910A), and the Upper San Antonio River (Segment 1911), by reducing concentrations of *E. coli* bacteria to levels established in the TMDLs. The I-Plan includes 30 management measures that will be used to improve water quality and reduce *E. coli* in the watersheds. Components of the I-Plan include description of management measures to be implemented along with monitoring plan to monitor effectiveness, stakeholder communication strategies, continued I-Plan review, revisions and recommendations as needed to continue water quality improvement. On April 5, 2016, the TCEQ approved the I-Plan. Additional information can be found at https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34F_UpperSanAntonio_TMDLIPlan_Approved.pdf

Table 1910-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Salado Creek Watershed by Assessment Unit

Salado Creek Watershed Segment 1910 - Salado Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**140 mg/L**	**200 mg/L**	**600 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score 41**	**HBI Score 20**	**Score 29**
1910_01	12861, 12862	perennial	high	FS	FS	FS	NC	FS	NC	NC	FS	FS	FS Gm=53.11	NC	NC	NC	NC	FS (41.00)	NC (21.90)	NA
1910_02	12864, 12868, 12870, 14929, 15645, 15646, 15647	perennial	high	FS	FS	FS	CS	FS	FS	FS	FS	FS	FS GM=114.63	NC	NC	NC	NC	FS (41.40)	NC (22.60)	NS-CF (26.0)
1910_03	12871, 12872, 12874, 15642, 15644, 20327	perennial	high	FS	FS	FS	NC	FS	NC	NC	FS	FS	NS GM=145.94	NC	CS	NC	NC	TR-NA (40.1)	NC (22.10)	NA
1910_04	12875; 12876	perennial	high	FS	FS	FS	CS	NS	NA	NA	FS	FS	NS GM=160.09	NC	NC	NC	NA	NA	NA	NA

Segment 1910A - Walzem Creek Segment 1910B - Rosillo Creek Segment 1910C - Salado Creek Tributary Segment 1910D - Menger Creek Segment 1910E - Beitel Creek 1910F - Upper Salado Creek Segment				Surface Water Quality Standards and Criteria										Nutrient Screening Levels			
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Walzem Creek 1910A	12698, 20356, 20359	perennial	high	NA	NA	NA	NC	FS	NA	NA	NA	NA	NS GM=289.93	NA	NA	NA	NA
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Rosillo Creek 1910B	12689, 12690, 12699, 12700	intermittent w/pools	limited	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS GM=60.23	NA	NA	NA	NA
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**2 mg/L**	**1.5 mg/L**	**2 mg/L**	**1.5 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Salado Creek Tributary 1910C	12692	intermittent	minimal	NA	NA	NA	NC	FS	NA	NA	NA	NA	CN GM=146.92	NA	NA	NA	NA
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**5 mg/L**	**3 mg/L**	**5 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Menger Creek 1910D	12693	perennial	high	NA	NA	NA	CS	NS	NA	NA	NA	NA	NS GM=608.68	NA	NA	NA	NA
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**3 mg/L**	**2 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Beitel Creek 1910E	12701, 12702, 16583, 20358	intermittent w/pools	limited	NA	NA	NA	CS	FS	NA	NA	NA	NA	FS GM=125.25	NA	NA	NA	NA
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**4 mg/L**	**3 mg/L**	**3 mg/L**	**2 mg/L**	**6.5-9.0 SU**	**32.2 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**
Upper Salado Creek 1910F	12877	intermittent w/pools	limited	NA	NA	NA	NC	FS	NA	NA	NA	NA	FS GM=38.8	NC	NC	NC	CS

SARA's Trends over Time

Seg/AU	Description	Instantaneous Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	E. coli	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a
1910_01	Station 12861 Salado Creek at Southton Road			↓	↓	↓			↑		↑	↓	↓	
1910_02	Station 12870 Salado Creek at Gembler Road	↓	↓				↑		↓	↓		↓	↓	
1910_03	Station 12874 Salado Creek at Rittiman Road	↓					↑		↓	↓	↑		↓	↓

FS = Fully Supporting the Water Quality Standard

NS = Not Supporting the Water Quality Standard

CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels

NC = No Concern

NA = Not Assessed

Limited/Inadequate Data

↓ = Decreasing Trend

↑ = Increase Trend

CF = The Integrated level of support of CS, CN or NS was carried forward from a previous assessment due to inadequate/no data for this method in this assessment.

TR = Temporally Not representative, used with NA

Bacteria Impairment

Within the Salado Creek Watershed, there are bacteria impairments listed for the main creek as well as its tributaries. There are no impairments in the lower or upper portions of the watershed. The central part of the watershed where these impairments are found, has a much higher incidence of high intensity development, including large industrial areas, and a lower incidence of natural areas or other vegetation, such as greenbelts and lawns, compared to the rest of the watershed. This increase in impervious cover and resulting increase in unchecked stormwater runoff together with domestic and wildlife depositions in areas with minimal vegetation or natural areas are the likely reasons for the increased bacteria levels. It should also be noted that the unclassified segments which have impairments or concerns are those which consist largely or entirely of concrete-lined channels.

The Three Total Maximum Daily Loads for Bacteria in the San Antonio Area (Segments 1910 – Salado Creek, 1910A – Walzem Creek, and 1911 – Upper San Antonio River), the **Amended TMDL** and the **Implementation Plan for Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio River Watersheds Segments:** 1910 – Salado Creek, 1910A – Walzem Creek and 1911 – Upper San Antonio River (USAR I-Plan) have been put in place to address the practices needed to reduce the bacteria levels in this watershed.

Biological Assessment

TSWQS describes Salado Creek as having a high aquatic life use (ALU) designation and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 5.0 mg/L (average). Existing biological data indicates benthic macroinvertebrates are not meeting the high ALU criterion as stated in the standards; a DO grab minimum impairment also exists in 1910_04. For fish community and habitat sampling events, Station 12861 Salado Creek at Southton Road is in assessment unit 1910_01 and was sampled six times in the 2014 assessment period. Stations 12870 Salado Creek at Gembler Road and Station 14929 Salado Creek at Comanche Park are in assessment unit 1910_02 and were sampled a total of 11 times in the 2014 assessment period.

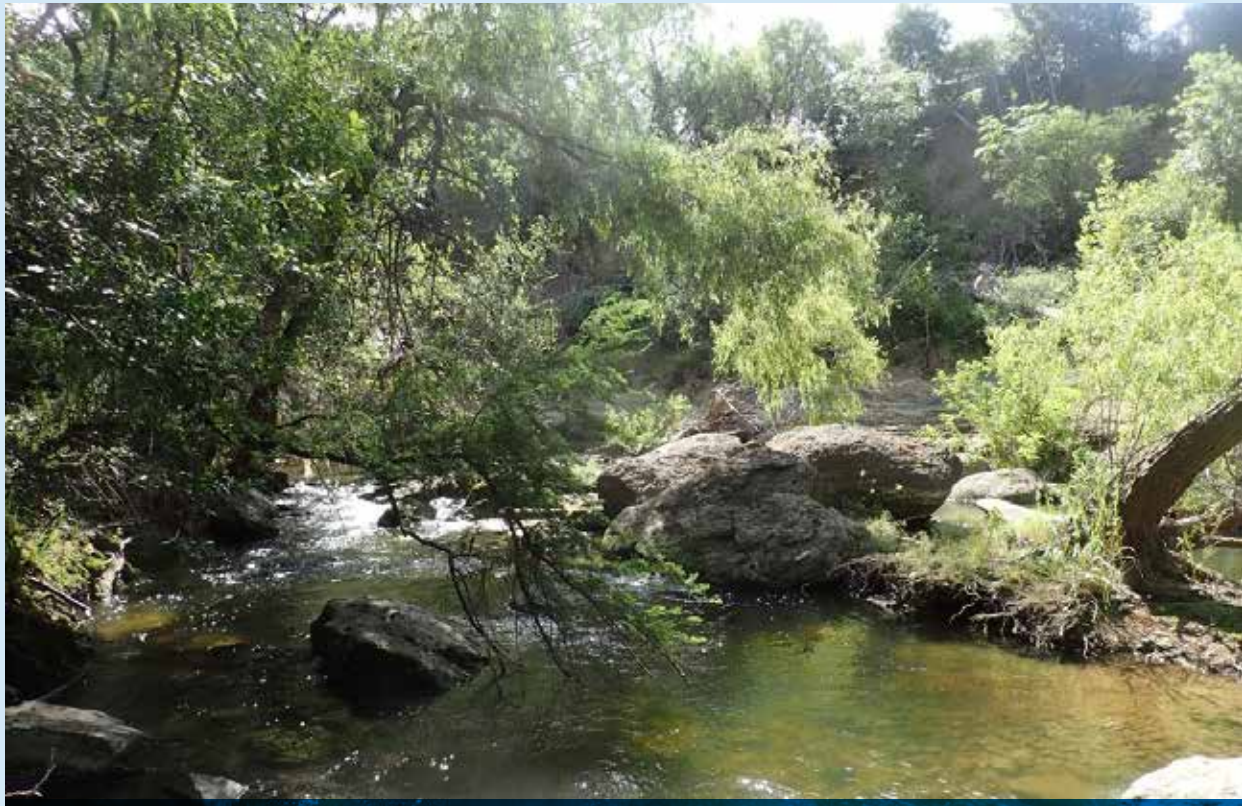
For the 2014 IR assessment period, the fish Index of Biotic Integrity (IBI) scores for all three stations ranged from 33 (limited) at Station 14929 Salado Creek at Comanche Park to 44 (high) at the same station. The overall average IBI score was 41.19 (high). The average IBI score was 41.19 (high). There was an average of 224 individual fish and an average of 14 different species collected per sampling event. There were three intolerant species collected, including the Mimic Shiner, Texas Logperch, and Tadpole Madtom. An average of 14% of the total number fish collected were tolerant to pollution. The Redbreast Sunfish was the only non-native species collected. Native species included the Amazon Molly, Blackstripe Topminnow, Bluegill Sunfish, Bullhead Minnow, Central Stoneroller, Channel Catfish, Flathead Catfish, Ghost Shiner, Green Sunfish, Grey Redhorse, Largemouth Bass, Texas Logperch, Longear Sunfish, Mexican Tetra, Mimic Shiner, Red Shiner, Redspotted Sunfish, Rio Grande Cichlid, Sailfin Molly, Sand Shiner, Spotted Bass, Spotted Gar, Spotted Sunfish, Tadpole Madtom, Texas Logperch, Warmouth, Weed Shiner, Western Mosquitofish, and Yellow Bullhead.

The Habitat Quality Index (HQI) score for Station 12861, 12870 and 14929 ranged from 17 (intermediate) to 26 (exceptional). The stream channel is well-defined with moderately and poorly defined stream bends. Stream banks are gently sloping and covered with hardwood riparian forest. The average width of the natural riparian habitat is 15 meters and includes native hardwood trees, shrubs, and grasses. The average percent tree canopy is 79% and includes cypress, ash, pecan, elm, hackberry, black willow, cottonwood, and

oak. The aquatic habitat is dominated by runs but a few smaller riffles and glides are present. Gravel, cobble, boulder, and sand are the dominant substrate type at these location. Instream cover types include gravel, macrophytes, overhanging vegetation, tree roots, woody debris, undercut banks, litter, boulders, and other forms of instream cover types. The average percent instream cover is 36% and the average percent stream bank erosion is 32%.

Due to the Salado Creek UAA assessment unit revisions, there was limited benthic macroinvertebrate data to assess in the 2014 IR. As a result, the benthic macroinvertebrate impairment was carried forward from the 2012 IR. To address this issue, SARA continues to collect benthic macroinvertebrate data at Station 14929 Salado Creek at Comanche Park for future TCEQ IRs.

Although the 2014 IR indicates there is insufficient 24-hour DO data for the assessment, the available data suggests Salado Creek is meeting the high ALU criteria. The 2014 IR does identify a DO grab minimum impairment in assessment unit 1910_04 based on carried forward data. The benthic macroinvertebrate impairment and depressed DO concentrations in the Salado Creek Watershed are likely associated with ambient low-flow conditions exacerbated by the drought over the 2014 assessment period. To supplement the existing routine water-quality sampling efforts in assessment unit 1910_04, starting in 2014, SARA has included additional 24-hour DO collection events at Station 12875 Salado Creek at Eisenhauer Road. Until there is sufficient 24-hour data for 1910_04, the impairment will remain.



Station 12861 Salado Creek at Southton Road

Trend Analyses

Station 12861 Salado Creek at Southton Road is in assessment unit 1910_01 and was analyzed for trends over time. Although there are no impairments or concerns listed for this assessment unit, *E. coli* has a statistically significant increasing over time (Fig SC 2). There are several data points for TDS that are above the screening level, but these are early in the dataset, and there is a statistically significant decreasing trend (Fig SC 3). There are also statistically significant decreasing trends for chloride, sulfate (Fig SC 4), total dissolved solids, and total phosphorous.

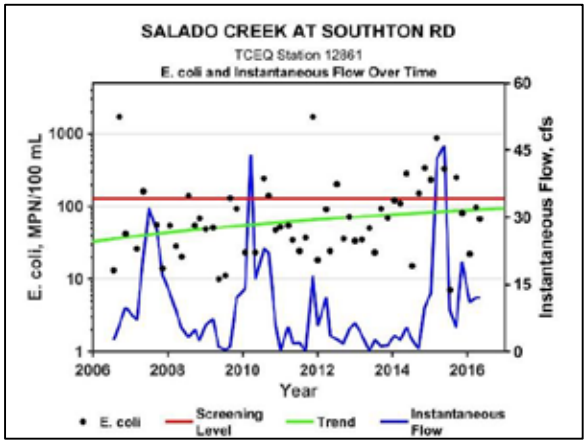


Fig. SC 2: 12861 Salado Creek at Southton, *E. coli* Over Time

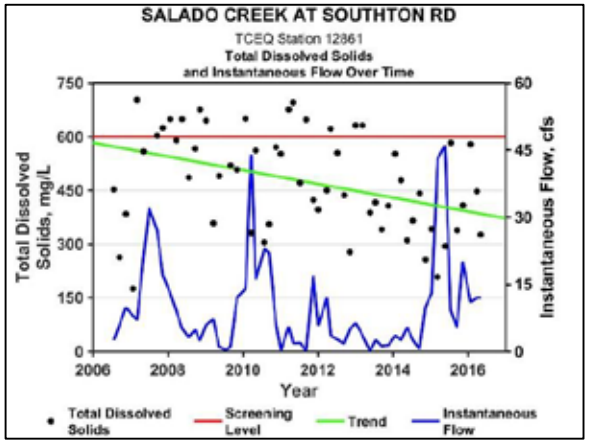


Fig. SC 3: 12861 Salado Creek at Southton, TDS Over Time

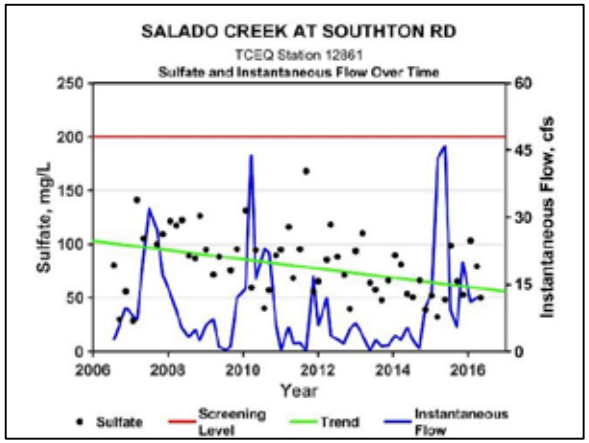


Fig. SC 4: 12861 Salado Creek at Southton, Sulfate Over Time

For assessment unit 1910_02, Station 12870 Salado Creek at Gembler Road was analyzed as the representative station. This assessment unit has a listed concern for depressed dissolved oxygen, and also a carry-forward impairment for benthic macroinvertebrates. Analyses show a statistically significant decreasing trends in flow over time (Figure SC 5) as well as a statistically significant increase trend in the DO deficit (Figure SC 6). The other statistically significant trends are all decreasing and include total suspended solids, temperature, nitrate (Figure SC 7), and phosphorous. The decreasing trends in nitrate and instantaneous flow are likely tied to the lack of discharge at James Park by SAWS near the upstream end of assessment unit 1910_03 from October 2012 through February 2015. This change likely affected other parameters, but the most obvious effect is on nitrate levels. While the impairment for benthic macroinvertebrates is carried forward, the increased dissolved oxygen deficit and decreased flow would likely be detrimental to recovery of their population.

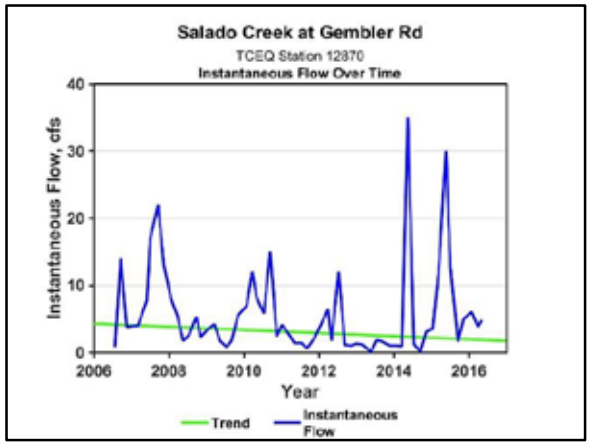


Fig. SC 5: 12870 Salado Creek at Gembler, Instantaneous Flow Over Time

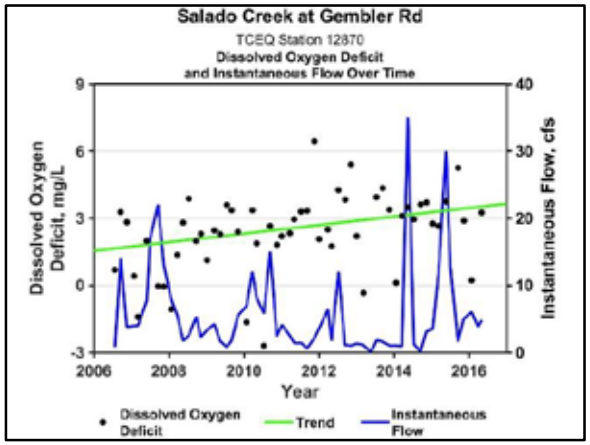


Fig. SC 6: 12861 Salado Creek at Gembler, DO Deficit Over Time

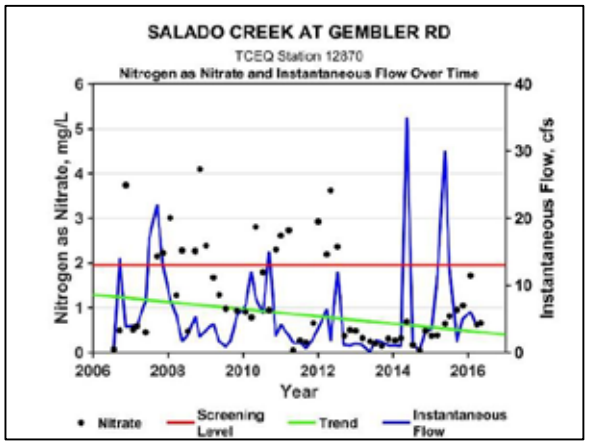


Fig. SC 7: 12870 Salado Creek at Gembler, Nitrate Over Time

Station 12874 Salado Creek at Rittiman was analyzed for trends to represent assessment unit 1910_03. Statistically significant increases trends over time were found for *E. coli* levels (Figure SC 8) and dissolved oxygen deficit (Figure SC 9). Flow, temperature, pH, total phosphorous (Figure SC 10), and chlorophyll-*a* all decreased over time. This station was the site of a major construction project, which, combined with the 2011 drought, resulted in very low flows at the station, and a complete lack of data from July 2012 until September 2015. While there is a concern for nitrate levels in this assessment unit, there was not a significant trend over time. Due to the large gap in data collection, it is difficult to confidently discern the driving factors behind the significant trends seen at this station.

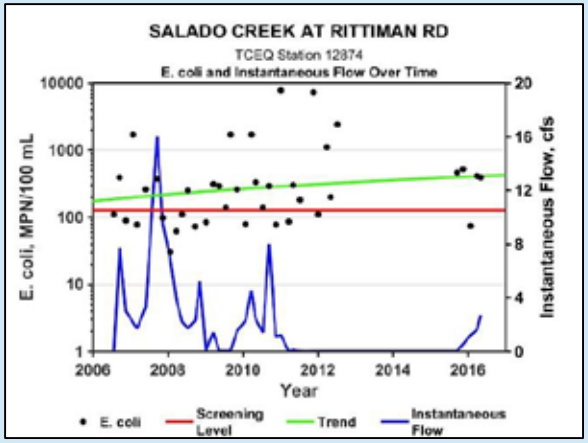


Fig. SC 8: 12874 Salado Creek at Rittiman, *E. coli* Over Time

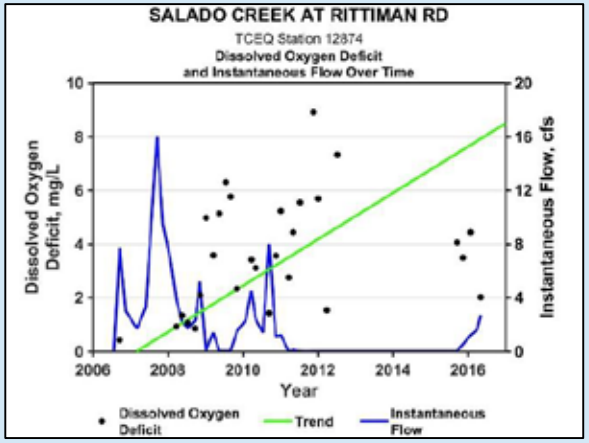


Fig. SC 9: 12874 Salado Creek at Rittiman, DO Deficit Over Time

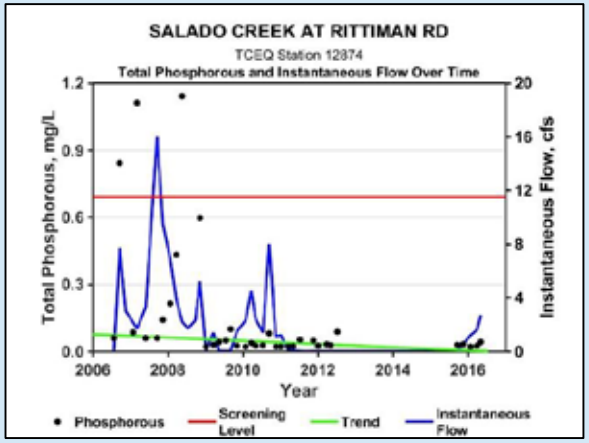
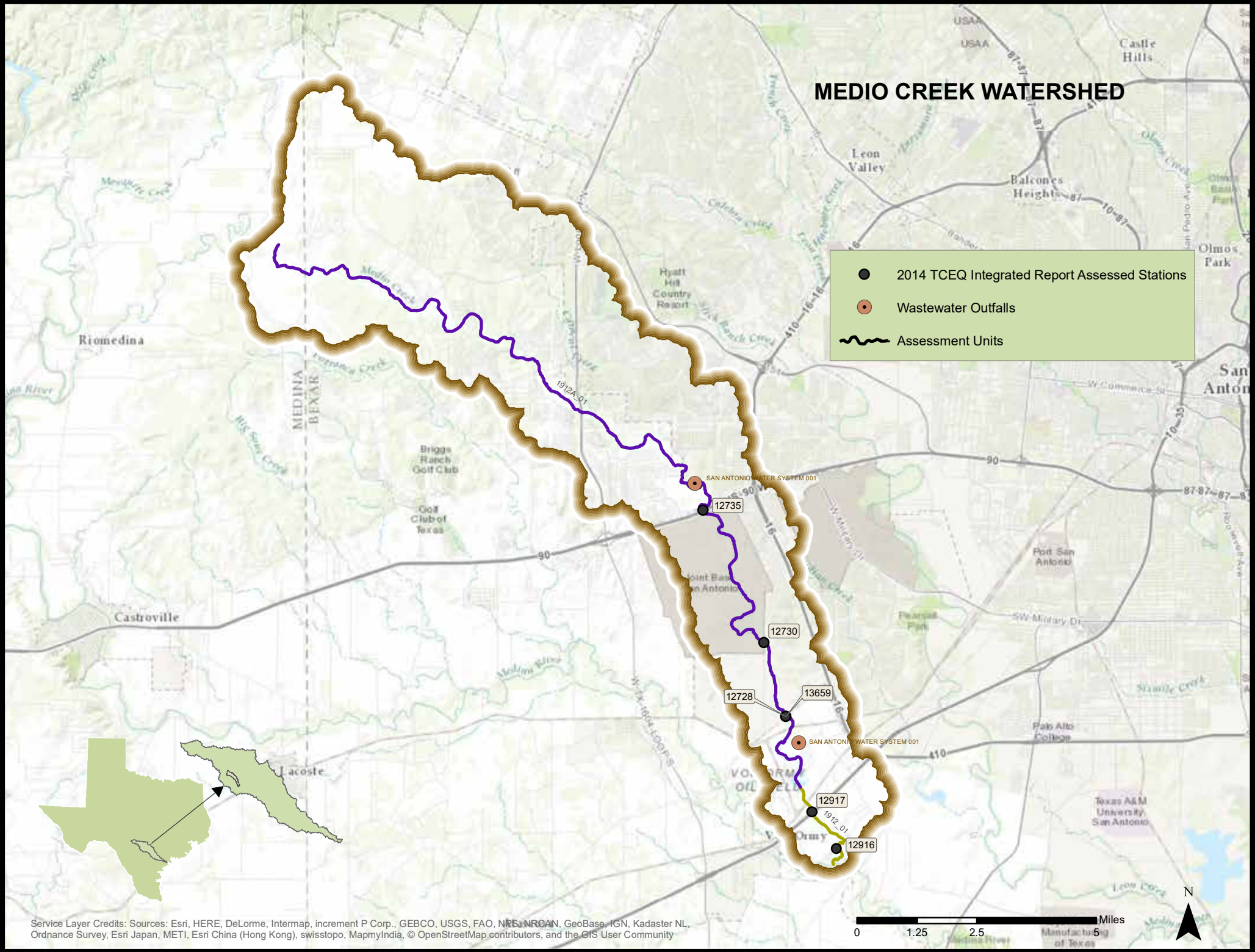


Fig. SC 10: 12874 Salado Creek at Rittiman, Phosphorous Over Time

Eastern Musk Turtle *(Sternotherus odoratus)*

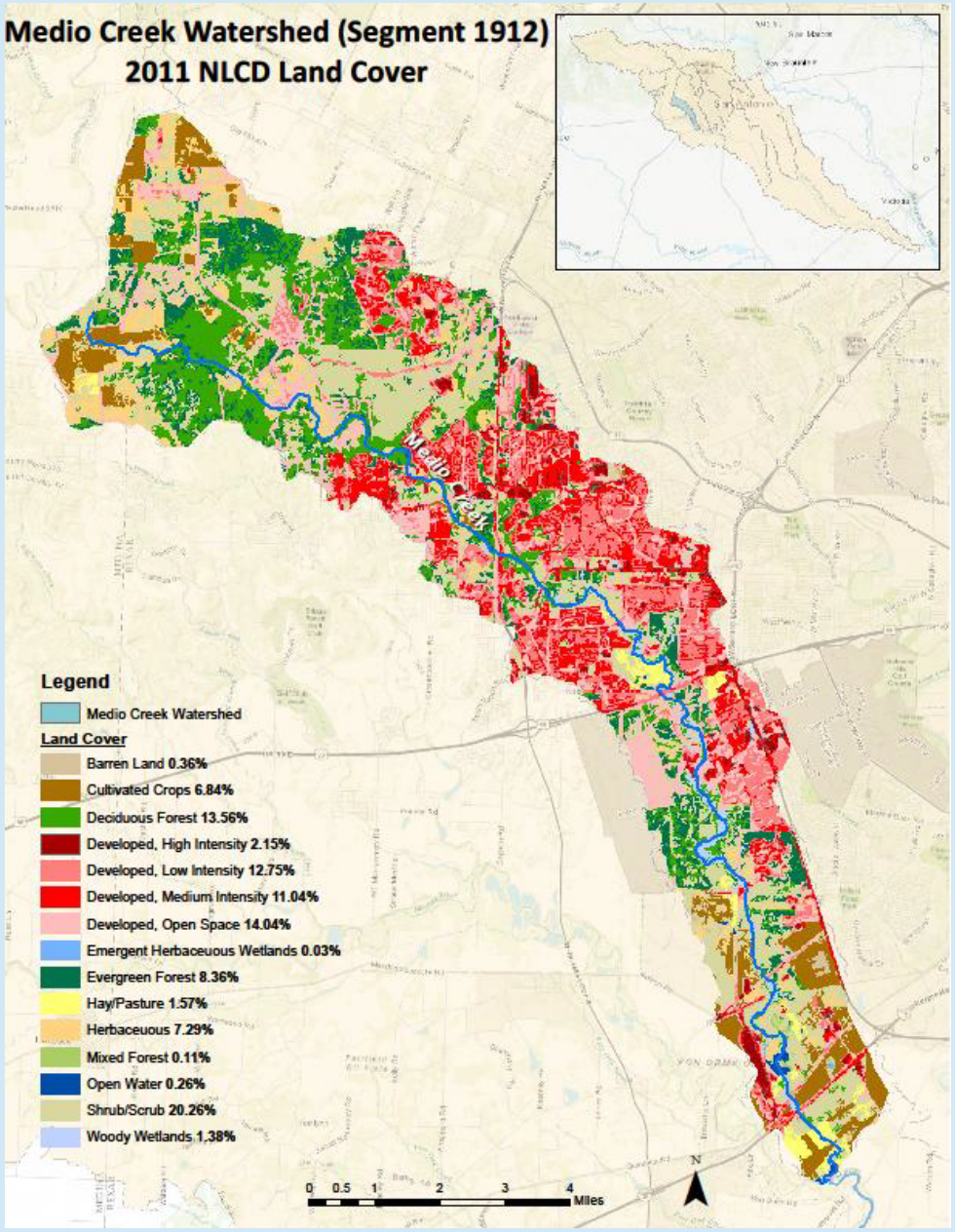


Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Medio Creek Watershed – 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 IH 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 53.6 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 impoundments are present within the perennial portion of the creek. The San Antonio Water System's Medio Creek Water Recycling Center is the major contributor in the segment and is located less than 2 miles north of Highway 90.

The Medio Creek Watershed is characterized by a mixture of land uses and cover. The upper and lower portions of the watershed are characterized by larger areas of forest, shrub, herbaceous and agricultural areas. Higher levels of development occur in the middle portion along Loop 1604 to south of Interstate Highway 90 East through the City of Von Ormy. Information used to generate the Land Cover Maps was obtained from the SARA GIS Department, and includes National Land Cover Database (NLCD) 2011 data created by the Multi-Resolution Land Characteristics (MRLC) Consortium at http://www.mrlc.gov/nlcd2011.php, and TCEQ Assessment Units data created by the TCEQ http://www.tceq.state.tx.us/gis/download-tceq-gis-data. See Figure MC-1 for more detail.



Medio Creek has an intermediate aquatic life use designation and is not designated for domestic water supply use. Like all segments in the San Antonio River Basin, TCEQ has designated this segment for primary contact recreation. This includes activities such as swimming, wading by children, diving, tubing, surfing, kayaking, canoeing, and rafting. According to the TCEQ Permitted Wastewater Outfalls shapefile located at http://www.tceq.state.tx.us/gis/download-tceq-gis-data, there are two current waste discharges in Segment 1913 Medio Creek. See Table 1912-1 for details.

Table 1912-1: Municipal and Industrial Wastewater Outfalls in Segment 1913 - Medio Creek			
Permittee	Status	Type	County
SAN ANTONIO WATER SYSTEM - Outfall 1	Current Permit	Wastewater	BEXAR
SAN ANTONIO WATER SYSTEM - Outfall 1	Current Permit	Wastewater	BEXAR

Wastewater: ≥1 MGD domestic sewage or process water including water treatment plant discharge.

Medio Creek Watershed Water Quality Summary

According to the 2014 IR, nutrient concerns have been identified in the Medio Creek Watershed. Table 1912-2 provides a big-picture view of the concerns in the watershed, possible sources and any solutions/actions taken to assess the issues. Figure MC-2 provides a visual summary of impairments and concerns by assessment unit. Table 1912-3 provides a detailed summary of the concerns by assessment units, including long-term trends at selected stations in the Medio Creek Watershed.

Table 1912-2 Water Quality Summary for Segment 1912 – Medio Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Nitrate Total Phosphorus	Entire	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate and total phosphorus data is utilized to indicate areas of concern. Continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria. SARA will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.

Water Quality Summary Segment 1912A – Upper Medio Creek			
Water Quality Focus	Affected portion of the Segment	Possible Influences/ Comments Voiced by Stakeholders	Possible Solutions / Actions Taken
Nitrate Total Phosphorus	Entire Segment	• Wastewater treatment plant discharge • Improper use of fertilizers • Organic matter carried to river with stormwater runoff	There are no State numerical nutrient stream water quality standards, only screening criteria. Nitrate and total phosphorus data is utilized to indicate areas of concern. Continue monitoring in support of the TCEQ efforts to establish freshwater stream nutrient criteria. SARA will continue to conduct monitoring to assess water quality conditions and determine long-term trends in the watershed.

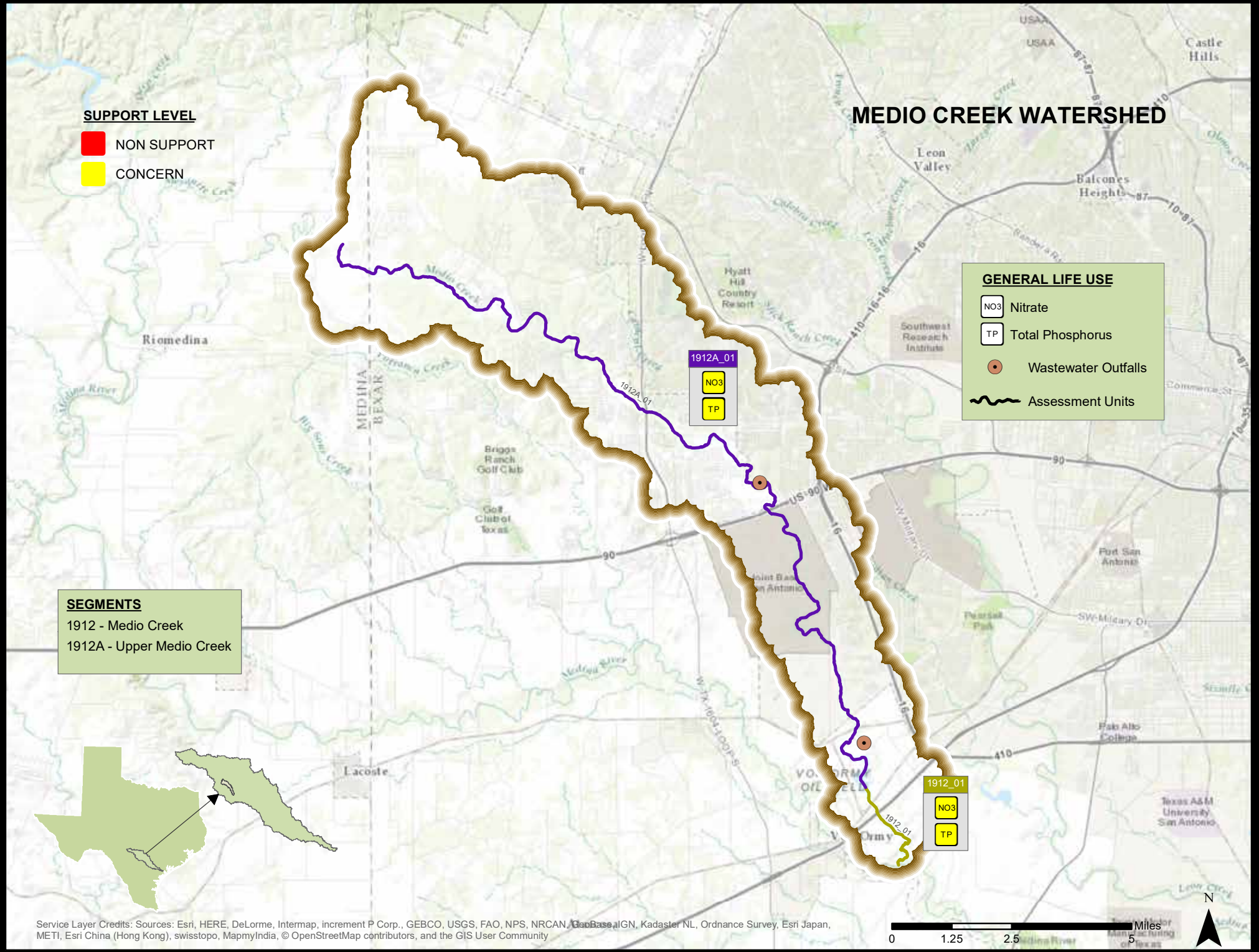


Figure MC-2: Map of the Medio Creek impairments and concerns by assessment unit.

Table 1912-3: 2014 TCEQ Integrated Report Summary of Impairments, Concerns and Long-Term Trends for the Medio Creek Watershed by Assessment Unit

Medio Creek Watershed Segment 1912A - Upper Medio Creek Segment 1912 - Medio Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	Fish	Habitat	Macro Benthic
Segment/AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**4 mg/L**	**3 mg/L**	**4 mg/L**	**3 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score 35**	**HBI Score 14**	**Score 22**
1912_01	12917, 12916	perennial	intermediate	FS	FS	FS	NC	FS	FS	FS	FS	FS	FS (GM=100.12)	NC	CS	CS	NC	FS (41.20)	NC (22.20)	NA

Segment 1912A - Upper Medio Creek				Surface Water Quality Standards and Criteria										Nutrient Screening Levels				Biological		
				Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Grab Screening Average	Dissolved Oxygen Grab Minimum	24 Hour Dissolved Oxygen Average	24 Hour Dissolved Oxygen Minimum	pH Range	Temperature	E. coli geomean	Ammonia Nitrogen	*Nitrate Nitrogen	Total Phosphorus	Chlorophyll-a	**Fish**	**Habitat**	**Macro Benthic**
Segment_AU	**Stations in the Segment**	**Flow Type**	**Aquatic Life Use**	**150 mg/L**	**150 mg/L**	**750 mg/L**	**2 mg/L**	**1.5 mg/L**	**2 mg/L**	**1.5 mg/L**	**6.5-9.0 SU**	**35 °C**	**126 CFU/100ml**	**0.33 mg/L**	**1.95 mg/L**	**0.69 mg/L**	**14.1µg/L**	**IBI Score <35**	**HBI Score ≤13**	**Score <22**
1912A_01	12735, 12730, 12728, 13659	perennial	high	NA	NA	NA	NC	FS	NC	NC	NA	NA	FS (GM=76.03)	NC	CS	CS	NC	NA	NA	NA

SARA's Trends over Time													
Seg/AU	**Description**	**Instantaneous Flow**	**TSS**	**Chloride**	**Sulfate**	**Total Dissolved Solids**	**Dissolved Oxygen Deficit**	**TKN**	**pH Range**	**Temperature**	**E. coli**	**Nitrate + Nitrite Nitrogen***	**Total Phosphorus**	**Chlorophyll-a**
1912_01	Station 12916 Medio Creek at Hidden Valley	↓	↓		↓			↑	↑		↑			↑

FS = Fully Supporting the Water Quality Standard | NS = Not Supporting the Water Quality Standard | CN = Concern for near-nonattainment of the Water Quality Standard

CS = Concern for water quality based on screening levels | NC = No Concern | NA = Not Assessed | Limited/Inadequate Data | ↓ = Decreasing Trend | ↑ = Increase Trend

*Nitrate + nitrite is the primary method utilized for analyzing surface water in Segment 1912A

Biological Assessment

TSWQS describes Medio Creek as having an intermediate aquatic life use (ALU) designation and 24-hour dissolved oxygen criteria of 3.0 mg/L (minimum) and 4.0 mg/L (average). Biological assessments indicated Medio Creek meets the intermediate ALU for fish, habitat, and 24-hour DO criteria. Both biological stations assessed were in assessment unit 1912_01. Station 12916 Medio Creek at Hidden Valley was sampled one each year between 2006 and 2012. Station 12917 Medio Creek at IH 35 was sampled once in 2006

The fish Index of Biotic Integrity (IBI) scores for both stations ranged from 31 (low) at Station 12916 Medio Creek at Hidden Valley to 45 (High) at the same station. The overall IBI score for both stations was 41.22 (high). There was an average of 109 individual fish and an average of 14 different species collected per sampling event. There were no intolerant species collected and 57% were tolerant to pollution. The tolerant species included the Amazon Molly, Blacktail Shiner, Bluegill Sunfish, Bullhead Minnow, Central Stoneroller,

Channel Catfish, Common Carp, Flathead Catfish, Gizzard Shad, Green Sunfish, Inland Silversides, Largemouth Bass, Longear Sunfish, Mexican Tetra, Mozambique Tilapia, Red Shiner, Redbreast Sunfish, Rio Grande Cichlid, Sailfin Molly, Sand Shiner, Spotted Bass, Spotted Sunfish, Warmouth, Western Mosquitofish, and Yellow Bullhead.

The Habitat Quality Index (HQI) score for both stations ranged from 15 (intermediate) at Station 12916 Medio Creek at Hidden Valley to 27 (exceptional) at Station 12916 Medio Creek at Hidden Valley. The average HQI score was 22.19 (High). The stream channel is well-defined with moderately and poorly defined stream bends. Stream banks are gently sloping and covered with hardwood riparian forest. The average width of the natural riparian habitat is 16 meters and includes native hardwood trees, shrubs, and grasses. The average percent tree canopy is 85% and includes cypress, ash, pecan, elm, hackberry, black willow, cottonwood, and oak. The aquatic habitat is dominated by runs and glides. Gravel and mud silt are the dominant substrate type at these locations. The instream cover types includes gravel, overhanging vegetation, undercut banks, woody debris, and tree roots. The average percent instream cover is 85% and the average percent stream bank erosion is 29%.

Of the ten 24-hour DO measurements assessed, there were no average or minimum exceedances. The 24-hour DO average values ranged from 4.4 mg/L at Station 12917 Medio Creek at IH 35 to 6.2 mg/L at Station 12916 Medio Creek at Hidden Valley. The 24-hour DO minimum values ranged from 3.2 mg/l at Station 12917 Medio Creek at IH 35 to 5.3 mg/L at Station 12916 Medio Creek at Hidden Valley.

Trend Analyses

While the data collected at Station 12916 Medio Creek at Hidden Valley identifies statistically significant increasing trends over time for pH, TKN, and chlorophyll-*a* (Figure MC 2), the 2014 IR identifies these parameters as meeting associated water quality standards and screen criteria. Trend analyses over time identify a statistically significant decreasing trend for flow, TSS (Figure MC 3), and sulfate. Although the 2014 IR identifies Medio Creek as meeting its primary contact recreational use designation, a statistically significant increasing *E. coli* trend over time has been detected (Figure MC 4). Within the trending period, there were 58 *E. coli* samples with values ranged from 10 to 1300 *E. coli* /100 mL, with a geometric mean (GM) of 120.1 *E. coli* /100 mL. In addition to this trend over time, there also appears to be an increasing *E. coli* trend when looking at past TCEQ IR assessments to the present. In the 2008 TCEQ IR assessment, the *E. coli* GM was 69.17, in 2010 the GM was 78.67, in 2012 the GM was 81.04 and in the current 2014 TCEQ IR assessment the reported GM was 100.12 *E. coli* /100 mL.

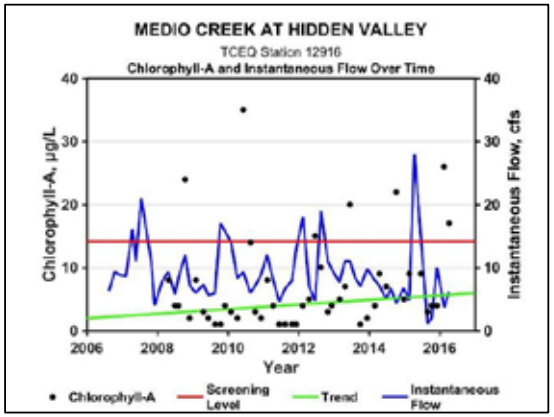


Fig. MC 2: 12906 Medio Creek Hidden Valley, Chlorophyll-*a* over

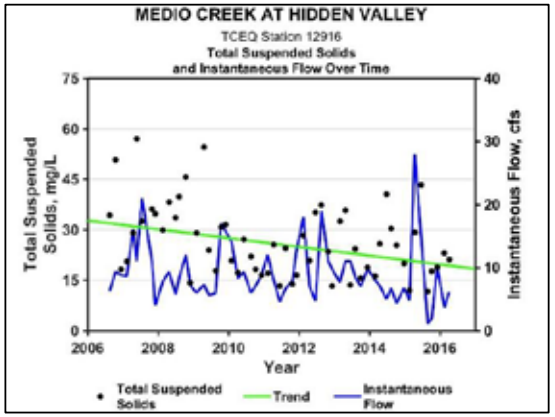


Fig. MC 3: 12906 Medio Creek Hidden Valley, TSS over Time

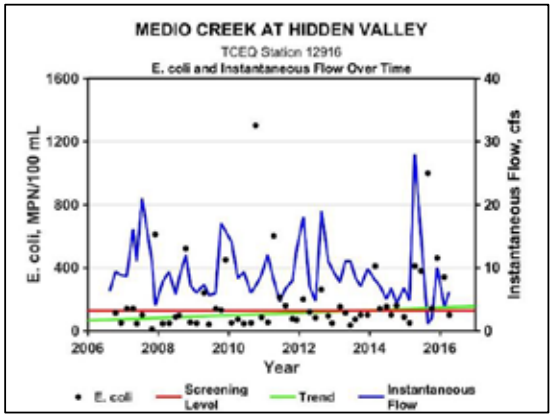


Fig. MC 4: 12906 Medio Creek Hidden Valley,, *E coli* over Time

Olivia Ybarra, 2016 Environmental Science Intern Spotted Gar *(Lepisosteus oculatus)*

4.0 Watershed Summaries, Conclusions and Recommendations

Water quality information in this report was derived from two assessment methods:

- A review of how the water quality in the San Antonio River Basin compares to the Texas Surface Water Quality Standards (TSWQS) using the 2014 Texas Integrated Report (IR) for Clean Water Act Sections 305(b) and 303(d). The 2014 IR assessment period covers the most recent seven to 10 year period from December 1, 2002 through November 30, 2012. The 2014 IR can be found on the TCEQ's website located at http://www.tceq.texas.gov/waterquality/assessment/305_303.html.
- Trend analysis by SARA was performed using a minimum of 10 years of data containing at least 20 values covering the majority of the 10-year time period. The 10 year trending period covers June 1, 2006 to May 31, 2016.

Information in the Basin Summary Report serves to develop a greater understanding of water-quality conditions, identify any trends and changes, and aid in making water-quality decisions for each subwatershed in the San Antonio River Basin. Information in this report, the 2014 Texas Integrated Report, together with stakeholder comments will be used to set the priorities and coordinated monitoring schedules for subsequent years.

4.1 Watershed Summaries

Upper San Antonio River; Segment 1911

Watershed Summary

- Several portions of the watershed, including the main stem and tributaries, have issues with *E. coli* elevated levels above the primary contact geometric mean criterion of ≤126 E. *coli*/100mL. Regulated and nonregulated sources have been identified, including direct and indirect stormwater runoff sources, sewer breaks and overflows, and poorly maintained septic tank systems.
- Although the upper portions of the Upper San Antonio River are highly segmented with little riparian and no instream cover, efforts associated with the Upper San Antonio River I-Plan and the San Antonio River Improvements Project are expected, over time, to help address the fish community impairment and habitat concern.
- Nutrient concerns prevalent throughout the watershed are potentially related to wastewater treatment discharges, improper use of fertilizers, and organic loading as a result of stormwater runoff.
- Depressed DO in the tributaries can be attributed to shallow intermittent low flows, poor riparian buffers and channels with low sinuosity.
- SARA should continue routine and biological monitoring to provide quality assured data to the TCEQ for assessment.

Lower San Antonio River; Segment 1901

- There are bacteria and fish community impairments and habitat concerns on the main stem, as well as, bacterial impairments on several tributaries of the Lower San Antonio River; nutrient concerns have also been identified.
- The average bacterial geometric mean for all three impaired assessment units of the Lower San Antonio River is 175.76 *E. coli*/100mL; only 49.76 *E. coli* colonies above the State's criterion. Efforts associated with the LSAR I-Plan are expected to restore, maintain, and improve water quality of the watershed.

- The fish community impairments are most likely due to limited microhabitats within Station 12791 San Antonio River at US 77A in Goliad sampling reach. In 2014 all biological collection events were moved to Station 12792 San Antonio River at Southern Pacific Rail Road Bridge in Goliad. Because the Lower San Antonio River is an expansive watershed covering approximately 1,214 square miles, SARA will continue to look for more appropriate biological sample sites.
- SARA and Guadalupe-Blanco River Authority (GBRA) should continue routine and biological monitoring to provide quality assured data to TCEQ for assessment.

Upper Cibolo Creek; Segment 1908

- The Upper Cibolo Creek is identified in the 2014 IR as having chloride and bacterial impairments; nutrients, DO grab average, and habitat concerns have also been identified.
- Historical information indicates one of the stations used in the original bacteria impairment and habitat concern may not have been representative of the reach due to its proximity to IH-10. The results of the TCEQ ALM monitoring study indicated that Station 20821 Cibolo Creek at the Northrup Park was a more appropriate biological site than Station 12857 Cibolo Creek at IH-10. Routine *E. coli* monitoring will continue at both Stations 20821 and12857 until the required number of successful *E.coli* values can be collected and evaluated. Until that time, the bacterial impairment will remain.
- The chloride impairment is most likely due to an increase in water resource demands and ambient low flow conditions experienced in the watershed coupled with the concentration and discharge of dissolved solids as part of the wastewater treatment plants processes. The chloride average criterion for the segment is <50.00 mg/L, the 2014 IR identifies the Upper Cibolo as having an average of 62.05 mg/L.
- SARA and the TCEQ should continue routine monitoring to provide quality assured data to TCEQ for assessment.

Mid Cibolo Creek; Segment 1913

- According to the 2014 IR, the Mid Cibolo Creek is impaired for 24-hour minimum DO; nutrient concerns have also been detected.
- Although this segment is classified as perennial, historical observations indicate the DO impairment is most likely due to a lack of flow associated with shallow intermittent ephemeral waterbodies.
- Once the Cibolo Creek Watershed Segment Boundary Re-Definition Effort findings have been adopted by the TCEQ and approved by the EPA, all three segments will be reassessed using the new segment boundaries and DO criteria. It is possible the Mid Cibolo Creek DO impairment could be removed from the 2018 IR.
- SARA should continue routine monitoring and provide quality assured data to TCEQ for assessment.

Station 12919 Cibolo at IH10

Lower Cibolo Creek; Segment 1902

- The Lower Cibolo Creek is identified in the 2014 IR as having a bacterial impairment; nutrient concerns have also been detected.
- The DO impairment in Clifton Branch can be attributed to shallow intermittent low flows.
- Possible sources for *E. coli* contamination include sewer breaks and overflows, poorly maintained septic systems, and stormwater runoff sources of fecal matter from intense livestock production and wildlife.
- To address the habitat concern in 1902_03, SARA will continue to conduct biological monitoring at Station 12802 Cibolo Creek at FM 541 west of Kosciusko and at Station 21755 Cibolo Creek southwest of Stockdale.
- Until a bacterial TMDL or WPP can be scheduled, SARA should continue routine and biological monitoring and provide quality assured data to TCEQ for assessment.

Station 21531 Medina River Mayan Ranch

Upper Medina River; Segment 1905

- According to the 2014 IR, a fish community impairment and habitat concern exists in the Upper Medina River.
- A TCEQ aquatic life monitoring effort indicated the fish community impairment was related to habitat limitations as indicated by the concern for physical habitat at Station 12830 Medina River at Old English Crossing. In response to the TCEQ ALM effort, all biological events were moved to Station 21631 Medina River Mayan Ranch. The fish community impairment and habitat concern will remain until successful data is obtained.
- BCRAGD and SARA should maintain routine and biological monitoring in the watershed.

Medina Lake; Segment 1904

- There are no water quality impairments or concerns in this watershed.
- BCRAGD should maintain routine monitoring collections.

Medina Diversion Lake; Segment 1909

- There are no water quality impairments or concerns in this watershed.
- BCRAGD should maintain routine monitoring collections.

Lower Medina River; Segment 1903

- The Lower Medina River is identified in the 2014 IR as having a bacterial impairment; nutrient concerns have also been detected.
- The bacterial impairment and nutrient concerns are most likely due to wildlife, sewer breaks, poorly maintained septic systems, and stormwater runoff.
- SARA should maintain routine and biological monitoring in support of any future bacterial TMDLs or WPPs.

Upper Leon Creek: Segment 1907

- There are no water quality impairments or concerns in this watershed.
- Although the information in the 2014 IR identifies flow in this segment as perennial, historical field observations indicate a flow classification of intermittent with pools would be more appropriate. SARA is collecting field and flow observation to present to the TCEQ with the goal of assigning a more appropriate flow type classification for the Upper Leon Creek Watershed.
- SARA will maintain routine monitoring collections to document flow type classification in the watershed.

Lower Leon Creek; Segment 1906

- Legacy pollutants are a problem in the upper portions of the watershed beginning at the Old U.S. Highway 90 Bridge extending downstream to the Loop 410 Bridge. PCB concentrations in fish tissue exceed health assessment guidelines established by the DSHS and may pose a threat to human health if consumed. Per the DSHS, PCBs are a mixture of up to 209 individual chlorinated compounds commercially used as coolants and lubricants in electrical transformers and capacitors, power plant electrical and other industrial equipment, sealing and caulking compounds, and ballasts in fluorescent light fixtures. The advisory will remain in effect until the DSHS rescinds or modifies it in writing. Since 2010, there have been little to no supplemental testing to determine current levels of PCBs in fish tissue.
- A DO impairment has been identified and is most likely due to shallow low flows in the upper portions of the watershed; a chlorophyll-*a* concern has also been identified.
- The results of the LLC UAA are in review at the TCEQ for inclusion in the triennial TSWQS revision scheduled for 2021.

Longnose Gar gullet *(Lepisosteus osseus)*

- SARA and the TCEQ should maintain routine and biological monitoring and support projects designed to identify the source(s) of PCBs impairments and metal concerns.

Salado Creek; Segment 1910

- Salado Creek is identified in the 2014 IR as having a bacterial, DO and benthic macroinvertebrate community impairments; a DO grab screening average and nitrite concern have also been identified.
- Although flow augmentation is provided at James Park, the inherent ambient low-flow conditions and the drought conditions over the assessment period may be possible sources for the DO and benthic macroinvertebrate community impairments.
- SARA should continue routine and biological monitoring to provide quality-assured data to TCEQ for assessment.

Medio Creek; Segment 1912

- Nutrient concerns have been identified in the Medio Creek and Upper Medio Creek Watersheds and are more than likely due to wastewater treatment plant discharges and improper use of fertilizers.
- SARA should continue routine and biological monitoring to provide quality-assured data to TCEQ for assessment.

4.2 Summary of significant trends in the San Antonio River Basin

Trending is an important component of water quality monitoring and environmental decision making. Trending in this report is accomplished by statistically analyzing water quality data and graphically illustrating parameter concentrations as they relate to time and to flow. Because aquatic communities are directly influenced by the transport and concentration of point source and nonpoint source pollutants, instantaneous flow measurements are collected during routine monitoring events.

The extended drought coupled with disastrous and severe storm events throughout the trending period may have exacerbated existing water quality impairments and concerns. In general, depending on the specific pollutant, drought and low flow conditions concentrate pollutants, while high flows typically decrease pollutant concentrations. Although not a pollutant itself, low DO levels are experienced during low flow and are normally the result of high levels of chemical and biological demanding pollutants, especially during the hotter periods of the year. High levels of demanding pollutants are pollutants or biological processes that use up/consume dissolved oxygen in waterbodies. Low DO levels adversely affect the aesthetics and biological communities of a waterbody. On the flip side, increased flows often increase DO levels and decrease chemical concentrations, but may increase pollutants such as *E. coli* and nutrients from nonpoint sources. High flows as a result of violent stormwater events can also scour stream beds and remove vital aquatic and riparian habitat. To have a lasting positive impact on water quality, flow must be maintained over an extended period of time.

Data for selected stations throughout the San Antonio River Basin was retrieved from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS). Trend analyses required the data to include a minimum of 20 samples over a 10 year period, June 1, 2006 to May 31, 2016. Additional requirements are that the data show minimal continuity disruption, and be monitored over the majority of the trending period. Significant trends ($p<0.10$) were identified as either decreasing "↓" or increasing "↑". With the exception of flows, decreasing parameter trends are generally beneficial and increasing trends are detrimental to water quality. Surface water flow

magnitude, timing, duration and frequency plays a critical role in supporting the ecological integrity of streams and rivers. At certain times of the year, increasing or decreasing flows maybe beneficial or detrimental to aquatic life cycles and riparian habitat. The flow over time graphs strictly addresses quantity of water over time. Decreasing flow trends are identified as "↓" or increasing "↑". Surface water pH criterion is expressed as a range of 6.5-9.0 Standard Units (S.U.), as a result pH trends were not color coded. It should be noted that all identified pH trends are within the 6.5-9.0 S.U. criteria. Increasing DO deficit values or significant trends indicate greater oxygen demanding pollutants or biological demands (e.g. aquatic plants or fish) in a waterbody. Therefore, as DO deficit values increase, the concentration of dissolved oxygen decrease. Increasing DO deficit values mean there is less dissolved oxygen and can have a negative effect on water quality. Statistically significant increasing DO Deficit values are represented by "↑" in the table below. Although ammonia was originally included in trend analysis for all stations, the majority of ammonia data was excluded from trend analysis because >50% of the ammonia measurements were below the limit of quantification and could not be reported with a high degree of confidence. Only one station contained sufficient ammonia to be trended; this is good news, as high nutrients would be an undesirable trend. Upper Leon Creek did not possess sufficient data for trending for any parameter. Significant trends at selected stations throughout the San Antonio River Basin can be seen in Table ES1.

Table ES1: Significant Trends in the San Antonio River Basin

Watershed	AU	Abbreviated Descriptions	Flow	TSS	Chloride	Sulfate	Total Dissolved Solids	Dissolved Oxygen Deficit	TKN	pH Range	Temperature	*E. coli*	Ammonia Nitrogen	Nitrate Nitrogen	Total Phosphorus	Chlorophyll-*a*
Upper San Antonio River	1911_01	Station 12879 San Antonio River at FM 791 Southwest of Falls City				↓		↑	↑			↑				
	1911_08	Station 17066 San Antonio River downstream of the SAR and San Pedro Creek Confluence				↑				↑					↑	
	1911_09	Station 12908 San Antonio River at Woodlawn	↓	↑	↑	↑	↑	↑		↑				↑	↑	
Lower San Antonio River	1901_02	Station 12791 SAR Bridge on US 77-A and 183 Southeast of Goliad									↓			↑		↓
	1901_02	Station 17859 SAR at North Riverdale Road 15 KM (9.32 miles) West of Goliad		↓		↓		↑			↓					↓
	1901_04	Station 12794 SAR at SH 72 near Runge	↓							↑	↓			↑	↑	↓
Upper Cibolo Creek	1908_01	Station 16702 Cibolo Creek SE of Boerne downstream end of City Park in the Nature Preserve									↓					
Mid Cibolo Creek	1913_03	Station 14212 Cibolo Creek Upstream of Cibolo Creek Municipal Authority's WWTP	↓		↓							↑				↓
Lower Cibolo Creek	1902_02	Station 14211 -Cibolo Creek at CR 389 near Cestohowa Texas				↓	↓		↑		↓			↑		
	1902_05	Station 14197-Cibolo Creek at Sculls Crossing		↑	↑					↑	↑					
Upper Medina River	1905_01	Station 12830 Medina River at Old English Crossing above Bandera Falls			↑							↑				
Medina Lake	1904_01	Station 12825-Medina Lake at Medina Lake Dam West of San Antonio				↑	↑									
Medina Diversion Lake	1909_01	Station 18407 Medina Diversion Lake Near Dam				↑										
Lower Medina River	1903_02	Station 12813 - Medina River at Cassin Crossing	↓	↓	↑		↑	↑			↓			↑	↑	↓
	1903_01	Station 12811 - Medina River at FM 1937			↑		↑				↓	↑	↑	↑	↑	↓
Upper Leon Creek			Insufficient Data													
Lower Leon Creek	1906_01	Station 14198 Leon Creek Upstream from Leon Creek WWTP				↓	↓	↑						↓	↓	↑
Salado Creek	1910_01	Station 12861 Salado Creek at Southton Road			↓	↓	↓			↑		↑		↓	↓	
	1910_02	Station 12870 Salado Creek at Gembler Road	↓	↓				↑		↓	↓			↓	↓	
	1910_03	Station 12874 Salado Creek at Rittiman Road	↓					↑		↓	↓	↑			↓	↓
Medio Creek	1912_01	Station 12916 Medio Creek at Hidden Valley	↓	↓		↓			↑	↑		↑				↑

Although high in nutrient concentration, effluent from wastewater discharges are critical in maintaining flow in many of the waterbodies in the San Antonio Basin. Normally, flow in effluent dominated segments such as the San Antonio River, Lower Cibolo Creek, Lower Leon Creek and Medio Creek normally are not affected as much by drought as non-effluent dominated segments. However, over the trending period, there were decreasing flow trends in the upper portions of the Upper and Lower San Antonio River Watersheds. Decreasing flow trends can also be seen in the Mid Cibolo Creek, Lower Medina River, and Medio Creek Watersheds. After the Salado Creek Farmer's Well was plugged in 1991, flow in the Salado Creek has been an issue. Although flow augmentation is normally

provided at James Park, the inherent ambient low-flow conditions and the drought conditions over the assessment period may be possible sources for the DO and benthic macroinvertebrate community impairments in the Salado Creek Watershed.

4.3 Conclusions and Recommendations

Since the inception of the CRP in 1991, SARA and CRP partners have made considerable progress in identifying and understanding the water quality dynamics of each watershed in the San Antonio River Basin. Although this progress has been made possible largely in part to State funding, SARA recognizes the need to supplement funding, integrate, leverage, and coordinate the monitoring resources of the basin. Moving into the future, the CRP's watershed management approach will continue to be used to identify and evaluate water quality issues, establish priorities for corrective actions, work to implement those actions, and adapt to emerging water quality issues. SARA is committed to the protection and enhancement of our creeks and rivers through service, leadership, and expertise. To this end, SARA and its partners should continue:

- CRP monitoring efforts to provide quality assured data to the TCEQ for use in water quality decision making.
- To conduct temporal and spatial routine and biological monitoring so that State stream standards can be assessed and trends analyzed.
- To work to identify sources of bacteria through more intensive monitoring efforts, including the use of bacterial source tracking methodologies.
- To participate in TCEQ Surface Water Quality Standards Advisory Workgroups to develop, evaluate, and assess the relationship of nutrients in waterbodies associated with stormwater, wastewater treatment, and agricultural practices.
- To implement BMPs as identified in the Watershed Master Plans, TMDLs, I-Plans, and WPPs in the basin.
- To conduct monitoring in support of Watershed Master Plans, TMDLs, I-Plans and WPPs in the basin.
- To continue efforts to identify and locate sources of PCB contamination in the Lower Leon Creek.
- To conduct CRP Environmental Advisory Steering Committee meetings and Coordinated Monitoring Meetings.
- To enhance community engagement and appreciation for recreational uses of creeks and rivers in the basin.
- To advance and apply SARA's expertise to influence, develop, and implement watershed solutions that balance the environmental, economic, and quality of life needs of our communities.

Although impairments and concerns are direct factors influencing water quality, existing and future funding to maintain or expand the Clean Rivers Program monitoring efforts in the San Antonio River Basin may ultimately be the largest limiting factor. As such, Clean Rivers Program partners should continue to leverage resources and conduct routine and biological monitoring to provide quality-assured data to the TCEQ for assessments. Collaborative efforts like the Upper Medina River Aquatic Life Monitoring effort, Upper Cibolo Creek Aquatic Life Monitoring effort, BCRAGD/SARA monitoring efforts in the Medina River Water have added a great amount of quality-assured data to the TCEQ's database at minimal cost to the State. The CRP partners should continue to seek opportunities to leverage funds and resources to maximize efforts to implement water-quality improvement projects in the San Antonio River Basin.

The full Clean Rivers Program San Antonio River Basin 2018 Summary Report can be downloaded online at https://www.sara-tx.org/environmental-science/basin-highlights-reports/.

Appendix A
List of Acronyms

AgriLIfe	Texas A&M AgriLife Extension
ALM	Aquatic Life Monitoring
ALU	Aquatic Life Use
AU	Assessment Unit
Ave	Average
BCRAGD	Bandera River Authority and Ground Water District
BMP	Best Management Practice
BS	Biased Season
C°	Celsius
CF	Carried Forward
cfs	Cubic Feet Per Second
CMM	Coordinated Monitoring Meeting
CMS	Coordinated Monitoring Schedule
CN	Concern for Designated Use
CRP	Clean Rivers Program
CS	Concern for Screening
CWA	Clean Water Act
DO	Dissolved Oxygen
DSHS	Department of State Health Services
EAC	Environmental Advisory Committee
EPA	U.S. Environmental Protection Agency
F	Fahrenheit
FS	Fully Supporting
GIS	Geographical Information System
GBRA	Guadalupe-Blanco River Authority
HQI	Habitat Quality Index
IBI	Index of Biotic Integrity
ID	Inadequate Data
ILA	Interlocal Agreement
I-Plan	Implementation Plan
IR	Texas Integrated Report of Surface Water Quality
LCC	Lower Cibolo Creek
LD	Limited Data
LID	Low Impact Development
LLC	Lower Leon Creek
LMR	Lower Medina River
LSAR	Lower San Antonio River
MC	Medio Creek
MCC	Mid Cibolo Creek
MDL	Medina Diversion Lake
mg/L	Milligrams Per Liter
ML	Medina Lake
MPN	Most Probable Number
MRLC	Multi-Resolution Land Characteristics
NA	Not Assessed
NC	No Concern
NLCD	National Land Cover Database
NS	Nonsupporting
O&M	Operation and Maintenance
OSSF	On-Site Sewage Facilities
QAPP	Quality Assurance Project Plan
RCS	Remote Communication System
RT	Routine
SARIP	San Antonio River Improvements Project
SC	Salado Creek
SSO	Sanitary Sewer Overflows
S.U.	Standard Units
SWQM	Surface Water Quality Monitoring
SWQMIS	Surface Water Quality Monitoring Information System
TCEQ	Texas Commission on Environmental Quality
TDS	Total Dissolved Solid
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TPWD	Texas Parks and Wildlife Department
TR	Temporally Not Representative
TSS	Total Suspended Solids
TSSWCB	Texas State Soil and Water Conservation Board
TSWQS	Texas Surface Water Quality Standards
TWDB	Texas Water Development Board
UAA	Use Attainability Analysis
UCC	Upper Cibolo Creek
ULC	Upper Leon Creek
UMR	Upper Medina River
USAR	Upper San Antonio River
USFWS	United States Fish and Wildlife Service
USGS	Unite States Geological Survey
WPP	Watershed Protection Plan
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant
WWTRC	Wastewater Treatment Recycling Centers

Appendix B

List of water quality parameters, their impact and potential cause of impairments

Monitoring Parameters and What They Mean		
Parameter	Potential Impacts	Potential Causes Impairments
Temperature	Water temperature affects the oxygen content of the water, with warmer water unable to hold as much oxygen. When water temperature is too cold, cold-blooded organisms may either die or become weaker and more susceptible to other stresses, such as disease or parasites.	Colder water can be caused by reservoir releases. Warmer water can be caused by removing trees from riparian zone, soil erosion, or use of water by industry to cool equipment.
Total Dissolved Solids (TDS)	High total dissolved solids may affect the aesthetic quality of the water; interfere with washing clothes and corroding plumbing fixtures. High total dissolved solids in the environment can also affect the permeability of ions in aquatic organisms.	Mineral springs, carbonate deposits, salt deposits, and sea water intrusion are sources for naturally occurring high concentrations of TDS. Other sources can be attributed to oil exploration, drinking water treatment, chemicals, stormwater and agricultural runoff and, wastewater discharges.
Dissolved Oxygen (DO)	Organisms that live in the water need oxygen to live. In stream segments where DO is low, organisms may not have sufficient oxygen to survive.	Modifications to the riparian zone; human activity that causes water temperatures to increase; and increases in organic matter, bacteria, and over-abundant algae may cause DO levels to decrease.
pH	Most aquatic life is adapted to live within a narrow pH range. Different organisms can live at and adjust to differing pH ranges, but most fish die if pH is below 4 (the acidity of orange juice) or above 12 (the pH of ammonia).	Industrial and wastewater discharge, runoff from quarry operations and accidental spills.

Monitoring Parameters and What They Mean		
Parameter	Potential Impacts	Potential Causes Impairments
Nutrients: • Nitrogen • Nitrate nitrogen • Nitrite nitrogen • Total Phosphorus • Total Kjeldahl Nitrogen (TKN-organic nitrogen)	Nutrients, including total phosphorus, increase plant and algae growth. When plants and algae die, the bacteria that decompose them use oxygen. This reduces the DO in the water. High levels of nitrates and nitrites can produce Nitrite Toxicity, or “brown blood disease” in fish. This disease reduces the ability of blood to transport oxygen throughout the body.	Sources of nitrogen include: wastewater treatment plants, runoff from fertilized lawns and croplands, failing septic systems, runoff from animal manure and storage areas, and industrial discharges that contain corrosion inhibitors.
Ammonia	Elevated levels of ammonia in the environment can adversely affect fish and invertebrate reproductive capacity and reduce the growth of young.	Ammonia is excreted by animals and is produced during the decomposition of plants and animals. Ammonia is an ingredient in many fertilizers and is also present in sewage, stormwater runoff, certain industrial wastewaters, and runoff from animal feedlots.
Bacteria: *Escherichia coli* (*E.coli*)	Most strains of *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.	Present in all warm-bodied animals, these bacteria are common in polluted waters. Poorly maintained or ineffective septic systems, overflow of domestic sewage, nonpoint sources, wildlife, and runoff from animal feedlots can elevate bacteria levels.
Chloride	Chloride is an essential element for maintaining normal physiological functions in all organisms. Elevated chloride concentrations can disrupt osmotic pressure, water balance, and acid/base balances in aquatic organisms which can adversely affect survival, growth, and/or reproduction.	Natural weathering and leaching of sedimentary rocks, soils, and salt deposits can release chloride into the environment. Other sources can be attributed to oil exploration and storage, wastewater and industrial discharges, runoff from dumps and landfills, and saltwater intrusion.
Sulfate	Effects of high sulfate levels in the environment have not been fully documented; however, sulfate contamination may be contributing to the declines of native plants by altering chemical conditions in the sediment.	Due to abundance of elemental and organic sulfur; and sulfide mineral, soluble sulfate occurs in almost all natural water. Other sources are the burning of sulfur containing fossil fuels, steel mills, and fertilizers.

Monitoring Parameters and What They Mean		
Parameter	Potential Impacts	Potential Causes Impairments
Total Suspended Solids (TSS)	Increased turbidity reduces light and decreases the production of oxygen by plants. Suspended solids can also clog fish gills, reduce growth rates, and prevent fish egg and larval development. Eventually, the suspended solids settle to the bottom of the stream or lake, creating sediment. Excessive sediment can cover instream habitat, smother benthic macroinvertebrate organisms and fish eggs.	Excessive TSS is the result of accelerated erosion and is often associated with high flows, where river banks are cut, or sediment is re-suspended. It can also be the result of sheet erosion, where overland flow of water causes a thin layer of soil to be carried by the water to the stream. Disturbing vegetation, without proper barrier to slow down overland flow (such as construction sites or row cropping), increase TSS.
24-Hour DO	The amount of DO in a waterbody is critical to aquatic life. As a result of diurnal fluctuations throughout the day, it is important to measure DO concentrations over a 24-hour period at regular intervals. The segment's support of the aquatic life use designation is based on the assessment of 24-hour average and absolute minimum criterion. 24-hour DO monitoring is conducted frequently with biological and habitat assessments. Oxygen is depleted by both natural functions and pollution.	Natural functions including water temperature, photosynthesis, and respiration by aquatic plants and animals, breakdown of organic matter, flow and water mixing, and daily and seasonal cycles. Sources of pollution including excessive nutrients and chemicals, thermal contamination and removal of vegetation.
Metals and Organics in water and sediment	Typically exist in low concentrations but can be toxic to aquatic life or human health when levels exceed established acute and/or chronic criterion.	Illegal disposal of transformers, capacitors, hydraulic fluids, lubricants, industrial wastewater discharge, stormwater runoff, preservatives and sealants containing PCBs through dumping or disposal down a sanitary sewer.

APPENDIX C
Trend Analysis

Datasets for each site were analyzed for statistically significant trends in parameter values over time and flow. Data was retrieved from the TCEQ Surface Water Quality Monitoring Information System (SWQMIS) for at least one monitoring station in each classified segment and selected unclassified segments. Analytical methodology generally followed the guidelines indicated in the CRP guidance, Task 5, Exhibit 5E. Descriptive statistics, trend analyses, and graphing were conducted using a custom function set in MATLAB® software, version R2015b. Results were exported to Microsoft Excel for final formatting. Reported standards are taken from the 2014 Texas Surface Water Standards (TSWQS).

Statistical design for this report includes descriptive statistics and trend analyses, over both time and flow. Trend analyses required that the data included a minimum of 20 samples over a 10 year period, June 1, 2006 to May 31, 2016, had minimal continuity disruption, and was monitored over the majority of the specified date range. Trend analyses for parameter values over time were conducted using either a Mann-Kendall test or a Seasonal Mann-Kendall test, depending on seasonality of the parameter at a station. The Kruskal-Wallis test was used to check for a statistically significant ($p<0.10$) seasonal component in the data. If the test for seasonality was not significant, a Mann-Kendall test was used for trend analyses. In the event that the seasonality was statistically significant, a Seasonal Mann-Kendall test was used, as seasonality can cause unreliable test results with the Mann-Kendall test. It should be noted that the Kruskal-Wallis test does not quantify which season is different or what the seasonality pattern is; it only detects the presence or absence of a significant difference between the defined seasons (i.e. seasonality).

Seasons were defined as Non-Index (October 16 – March 14), Non-Critical (March 15-June 30, October 1–October 15), and Critical (July 1–September 30), following the seasons defined in TCEQ Surface Water Quality Procedures Manual, May 2012. The correlation coefficient for both the Mann-Kendall and the Seasonal Mann-Kendall test is τ (tau), and indicates how the trend is increasing or decreasing. "τ" ranges from -1 to 1; values closer to zero indicate less consistent trends, while positive (increasing) and negative (decreasing) indicate the direction of the relationship between the parameter and time.

Linear regression was used for analysis of parameter values vs. flow. For linear regression, r^2 is a statistical measure of what percentage of the variation in the parameter values can be explained by the variation in flow. Values closer to 1 indicate that variation in parameter values is more dependent on flow, whereas values nearer to 0 indicate that the variation in parameter values is less dependent on flow. The slope value from the linear regression identifies both magnitude and direction of the trend. A negative slope indicates a decreasing (downward) trend and a positive slope indicates a positive (upward) trend.

Significant trends ($p < 0.10$) were also identified as either decreasing "↓" or increasing "↑". With the exception of flow, decreasing parameter trends are generally beneficial and increasing trends are detrimental to water quality. The magnitude, timing, duration, and frequency of surface water flows all play a critical role in supporting the ecological integrity of streams and rivers. Depending on the time of the year, changing flows may be beneficial or detrimental to aquatic life cycles and riparian habitat. For the purposes of this report, flow trends over time strictly address the quantity of water flow over time; where decreasing flow trends "↓"are considered detrimental and increasing flow trends "↑"are considered beneficial. Surface water pH criterion is expressed as a range of 6.5-9.0

Standard Units (S.U.). As a result, pH trends were not color coded. It should be noted that all identified pH trends in the San Antonio River Basin are within the 6.5-9.0 S.U. criterion. Trends were examined for the following water quality parameters:

- Instantaneous flow
- Temperature
- Total Dissolved Solids
- Dissolved Oxygen (as DO Deficit)
- pH
- Total Suspended Solids
- Nitrate and/or Nitrite+Nitrate
- Total Kjeldahl Nitrogen
- Total Phosphorous
- Chloride
- Sulfate
- *E. coli*
- Chlorophyll-*a*

Variability in dissolved oxygen levels due to factors such as water chemistry or pollutants can be masked by the strong inverse relationship between dissolved oxygen and water temperature (as water temperature increases, DO usually decreases). In order to more accurately represent the variability in dissolved oxygen that may be caused by factors other than water temperature, a simple DO deficit is calculated as the difference between the potential and actual dissolved oxygen level at that temperature. DO Deficit was calculated as

$$DO\ Deficit = [500/(Temperature + 35)] - DO.$$

Decreasing DO deficit values reflect an increase in dissolved oxygen relative to temperature, often due to changes in chemical (e.g. pollutants) or biological demands (e.g. aquatic plants or fish).

Due to variations in data collection methodology, timing, and reporting, the following qualifiers for trend analyses and descriptive statistics apply:

- Values exceeding 3 standard deviations from the mean (geomean for *E. coli* values) were identified as statistical outliers and excluded from analyses.
- For values less than the LOQ, the reported value was replaced with the LOQ in place at that time. Values greater than the maximum reportable values were replaced with the maximum reportable value at that time. No further standardization of values due to changes in LOQ or maximum reportable value was conducted.
    - Ammonia: LOQ changed from 0.02 to 0.1 on 9/1/2007.

    - Nitrate: LOQ changed from 0.02 to 0.05 on 9/1/2007.
    - Chloride and Sulfate: LOQ changed from 1 to 5 on 9/1/2007.
    - Total Phosphorus: LOQ changed from 0.06 to 0.02 on 9/1/2007.
- When > 50% of reported values for a given parameter at a site were below the LOQ or above the maximum reportable value, no trend analyses were conducted due to the unreliability and inaccuracy of the statistical analyses for that type of dataset.
- In accordance with the TCEQ Surface Water Quality Procedures Manual, 2012, Total Dissolved Solids (TDS) was calculated as

$$TDS = Specific\ Conductance * 0.65$$

    - For consistency, calculated TDS was used in lieu of the reported TDS whenever possible.
    - The following equivalent TDS methods were combined for trend analysis:
        - 70294 Residue, Total Dissolved, Unspec Calc based on Cond
        - 70300 Residue, Total Filtrable (dried at 180 C) (replaced with 70294 when possible)
- For stations where SARA was not the primary sampling entity, nitrite+nitrate values were utilized for trending over time and flow. For sites where nitrite+nitrate was the primary value reported, nitrite+nitrate was calculated from available nitrite and nitrate data when necessary. The previously described method for handling values below the LOQ was applied before calculation of nitrite+nitrate.
- Data for equivalent chlorophyll-*a* methods were combined for trend analysis, including:
    - 32211 chlorophyll-*a*, Spectrophotometric (Acidified)
    - 70953 chlorophyll-*a*, Fluorometric Method
- When more than one sample was collected during a given time period, generally bi-monthly, the sampling event with the most data was retained. In the event that multiple equally complete samples were collected in the same time period, the sample with a collection date and time most closely matching the dominant temporal pattern was retained (e.g. odd months, same day of week, same time of day). This selection was on a parameter-by-parameter basis, with each site being considered independently of other sites. It should be noted that some sites had different temporal patterns of collection for different parameters (e.g. *E. coli*).
- When necessary due to a high range of values, flow data was plotted on a log scale axis.
- *E. coli* graphs were produced with *E. coli* values plotted on a log scale axis.

APPENDIX D
References

SARA. San Antonio River Authority Clean Rivers Program. https://www.sara-tx.org/environmental-science/clean-rivers-program/

SARA. Upper San Antonio River Watershed Protection Plan. http://www.bexarfloodfacts.org/watershed_protection_plan/

SARA. San Antonio River Improvements Project. http://sanantonioriver.org/

SARA. River Recreation Currently Conditions. https://www.sara-tx.org/river-recreation/paddling-trails/current-conditions/

SARA. San Antonio River Basin Low Impact Development Technical Guidance Manual. https://www.sara-tx.org/wp-content/uploads/2015/05/Full-LID-Manual.pdf

TCEQ. Nutrient Criteria Development. https://www.tceq.texas.gov/waterquality/standards/WQ_standards_nutrient_criteria.html

TCEQ. Implementing the Surface Water Quality Standards in Permitting. https://www.tceq.texas.gov/waterquality/standards/WQ_stds

TCEQ. 2014 and past TCEQ Integrated Reports. Texas Water Quality Inventory and 303(d) List. http://www.tceq.texas.gov/waterquality/assessment/305_303.html.

TCEQ. Texas Clean Rivers Program. https://www.tceq.texas.gov/waterquality/clean-rivers

TCEQ. July 25, 2007. Three Total Maximum Daily Loads for Bacteria the Upper San Antonio Area. https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-uppersanantoniotmdl-adopted.pdf

TCEQ. April 2016. Addendum One to Three Total Maximum Daily Loads for the Upper San Antonio Watershed. https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34-usar_addendum_2016-04.pdf

TCEQ. August 2008. One Total Maximum Daily Load for Bacteria in the Lower San Antonio River. https://www.tceq.texas.gov/waterquality/tmdl/34-lowersanantoniobac.html

TCEQ. April 6, 2016. Implementation Plan for Three Total Maximum Daily Loads for Bacteria in the Upper San Antonio River Watershed. https://www.tceq.texas.gov/assets/public/waterquality/tmdl/34uppersa/34F_UpperSanAntonio_TMDLIPlan_Approved.pdf

TCEQ. June, 2015. 2014 Guidance for Assessing and Reporting Surface Water Quality in Texas. https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_guidance.pdf

TCEQ. 2014 and past Standards. TCEQ Texas Surface Water Quality Standards. https://www.tceq.texas.gov/waterquality/standards

TCEQ. Executive Summary 2014 Texas Integrated Report for Clean Water Act Sections 305(h) and 303(d). https://www.tceq.texas.gov/assets/public/waterquality/swqm/assess/14txir/2014_exec_summ.pdf

TCEQ. Coordinated Monitoring Schedule, LCRA Host Website. https://cms.lcra.org/schedule.aspx?basin=19&FY=2018

TCEQ. TCEQ Surface Water Quality Monitoring Sampling Stations. http://www.tceq.texas.gov/waterquality/clean-rivers/data/station.html

TDSHS. 2013. Texas Department of State Health Services Fish Advisories, Bans, and Rescinded Orders http://www.dshs.texas.gov/seafood/advisories-bans.aspx?terms=Leon%20Creek

TPWD. 2002. Regionalization of the Index of Biotic Integrity for Texas Streams. Gordon W. Linam, Leroy J. Kleinsasser, and Kevin B. Mayes, Resource Protection Division. River Studies Report No. 17. June 2002. https://tpwd.texas.gov/publications/pwdpubs/media/pwd_rp_t3200_1086.pdf

Zebra Mussel Information

TPWD. Protect Our Waters. Zebra Mussels. https://tpwd.texas.gov/fishboat/boat/protect_water/
Texas Invasives. Stop Zebra Mussels. https://www.texasinvasives.org/

U.S. Census Bureau Quick Facts Bexar County, accessed on July 1, 2016. https://www.census.gov/quickfacts/fact/table/sanantoniocitytexas/PST045216

U.S. Fish & Wildlife Service. Endangered Species. https://www.fws.gov/midwest/endangered/clams/mussels.html

USGS. 2011. USGS Assessment of Selected Contaminants in Streambed and Suspended Sediment Samples Collected in Bexar County, Texas, 2007-09. http://pubs.usgs.gov/fs/2011/3090/FS11-3090.pdf.

USGS. 2012. USGS 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 https://pubs.usgs.gov/sir/2016/5039/sir20165039.pdf.

USGS. 2015. Methods for Evaluating Potential Sources of Chloride in Surface Waters and Groundwaters of the Conterminous United States. https://pubs.usgs.gov/of/2015/1080/ofr20151080.pdf.

Appendix E
Trend Analysis Statistics Summary

Segment 1911 - Upper San Antonio River Station 12879 San Antonio River at FM 791 AU ID: 1911_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	503	--	24.00	151.00	248.00	402.25	2430.00	373.83	--	390.51	<0.001	Yes	-0.148	0.281	No	--	--	--	--
Temperature, °C	32.20	59	3	11.10	17.53	23.20	28.90	32.70	23.13	--	6.05	<0.001	Yes	-0.134	0.347	No	0.009	-0.002	0.225	No
Total Dissolved Solids, mg/L	750.00	58	19	318.50	578.50	692.25	747.50	890.50	658.14	--	123.21	0.058	Yes	0.072	0.605	No	0.411	-0.189	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	58	--	-1.23	0.30	0.69	1.19	3.89	0.80	--	0.89	0.380	No	0.303	<0.001	Yes↑	0.098	0.001	0.011	Yes↑
pH, S.U.	6.5 to 9	59	0	7.60	8.00	8.00	8.18	8.50	8.03	--	0.16	0.115	No	-0.071	0.420	No	0.224	0.000	<0.001	Yes↓
Total Suspended Solids, mg/L	--	57	--	7.80	16.03	22.70	40.80	1120.00	78.31	--	189.06	0.122	No	0.056	0.540	No	0.716	0.393	<0.001	Yes↑
Nitrogen as Ammonia, mg/L	0.33	58	5	0.02	0.10	0.10	0.10	0.44	0.12	--	0.08	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	59	97	1.70	7.78	10.40	13.05	17.60	10.24	--	3.77	0.142	No	0.102	0.258	No	0.251	-0.004	<0.001	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	57	--	0.45	0.69	0.79	0.91	1.33	0.83	--	0.20	0.828	No	0.167	0.068	Yes↑	0.002	0.000	0.302	No
Total Phosphorous, mg/L	0.69	59	85	0.35	0.80	1.20	1.52	2.18	1.19	--	0.48	0.523	No	0.134	0.136	No	0.015	0.000	0.177	No
Chloride, mg/L	150.00	59	12	14.90	91.53	127.00	146.75	187.00	117.23	--	37.23	0.018	Yes	0.197	0.159	No	0.365	-0.051	<0.001	Yes↓
Sulfate, mg/L	150.00	59	2	28.30	80.30	91.50	106.75	162.00	91.72	--	25.08	0.004	Yes	-0.265	0.055	Yes↓	0.443	-0.039	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	510	28	1.00	40.00	75.00	140.00	6100.00	--	85.98	708.09	<0.001	Yes	0.296	0.034	Yes↑	0.375	1.068	<0.001	Yes↑
Chlorophyll-*a*, µg/L	14.10	44	7	1.00	1.00	3.00	5.50	31.00	5.00	--	6.62	0.009	Yes	-0.019	0.888	No	-0.018	-0.001	0.629	No

Segment 1911 - Upper San Antonio River Station 17066 San Antonio River at Mission Rd AU ID: 1911_08	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	47	--	6.60	12.25	17.00	40.25	225.00	36.79	--	45.86	0.289	No	-0.206	0.042	Yes↓	--	--	--	--
Temperature, °C	32.20	52	4	11.20	19.40	25.05	28.30	33.10	23.58	--	5.77	<0.001	Yes	-0.165	0.232	No	-0.018	-0.009	0.655	No
Total Dissolved Solids, mg/L	750.00	52	0	97.50	346.13	424.13	518.38	625.95	421.79	--	118.43	0.633	No	0.032	0.740	No	0.174	-1.003	0.002	Yes↓
Dissolved Oxygen Deficit, mg/L	--	51	--	-6.60	-2.72	-1.32	-0.16	1.21	-1.54	--	1.68	0.456	No	-0.071	0.470	No	0.086	0.012	0.027	Yes↑
pH, S.U.	6.5 to 9	52	0	7.90	8.10	8.30	8.50	8.90	8.33	--	0.24	0.618	No	0.252	0.008	Yes↑	0.068	-0.002	0.043	Yes↓
Total Suspended Solids, mg/L	--	51	--	1.50	4.00	4.40	11.83	61.30	11.46	--	13.38	0.699	No	-0.002	0.993	No	-0.003	-0.035	0.359	No
Nitrogen as Ammonia, mg/L	0.33	52	0	0.02	0.10	0.10	0.10	0.18	0.09	--	0.03	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	52	77	0.94	2.29	4.53	6.15	11.40	4.59	--	2.56	0.313	No	0.026	0.788	No	0.250	-0.028	<0.001	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	52	--	0.20	0.40	0.57	0.70	1.24	0.57	--	0.25	0.067	Yes	0.181	0.191	No	0.334	-0.003	<0.001	Yes↓
Total Phosphorous, mg/L	0.69	51	14	0.04	0.19	0.40	0.62	1.47	0.46	--	0.36	0.600	No	0.168	0.083	Yes↑	0.251	-0.004	<0.001	Yes↓
Chloride, mg/L	150.00	52	0	6.81	34.10	63.55	83.45	115.00	59.95	--	30.17	0.623	No	0.078	0.421	No	0.312	-0.363	<0.001	Yes↓
Sulfate, mg/L	150.00	52	0	10.70	34.75	49.85	58.50	77.30	46.89	--	15.98	0.813	No	0.286	0.003	Yes↑	0.314	-0.185	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	51	63	8.00	80.00	190.00	640.00	27000.00	--	261.55	4153.76	0.820	No	-0.004	0.974	No	-0.009	5.134	0.439	No
Chlorophyll-*a*, µg/L	14.10	27	4	1.00	2.00	3.00	7.00	18.00	4.81	--	4.22	0.084	Yes	-0.072	0.469	No	-0.038	-0.011	0.729	No

Segment 1911 - Upper San Antonio River Station 12908 San Antonio River at Woodlawn Ave AU ID: 1911_09	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	57	--	0.20	8.25	10.00	21.25	91.00	19.35	--	21.72	0.555	No	-0.132	0.150	No	--	--	--	--
Temperature, °C	32.20	59	0	12.40	20.63	22.90	25.40	28.90	22.92	--	3.60	<0.001	Yes	0.074	0.621	No	-0.017	-0.007	0.772	No
Total Dissolved Solids, mg/L	750.00	60	3	126.75	349.05	579.48	644.80	793.00	516.74	--	158.38	0.888	No	0.309	<0.001	Yes↑	0.391	-4.591	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	58	--	0.13	1.79	3.13	4.06	5.72	2.95	--	1.45	0.057	Yes	0.353	0.014	Yes↑	0.407	-0.040	<0.001	Yes↓
pH, S.U.	6.5 to 9	59	0	7.30	7.50	7.60	7.70	7.80	7.56	--	0.13	0.764	No	-0.165	0.060	Yes	0.242	0.003	<0.001	Yes↑
Total Suspended Solids, mg/L	--	59	--	1.60	4.00	4.00	4.20	11.70	4.41	--	1.75	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Ammonia, mg/L	0.33	59	2	0.02	0.10	0.10	0.14	0.34	0.13	--	0.06	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	59	80	0.77	3.47	11.90	14.70	18.90	9.71	--	5.77	0.920	No	0.150	0.094	Yes↑	0.472	-0.178	<0.001	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	60	--	0.20	0.45	0.75	0.89	1.56	0.69	--	0.32	0.309	No	0.179	0.044	Yes↑	0.435	-0.009	<0.001	Yes↓
Total Phosphorous, mg/L	0.69	60	63	0.03	0.29	1.09	1.75	2.43	1.08	--	0.76	0.970	No	0.354	<0.001	Yes↑	0.432	-0.023	<0.001	Yes↓
Chloride, mg/L	150.00	60	3	9.83	30.75	102.00	127.00	244.00	88.24	--	52.04	0.970	No	0.327	<0.001	Yes↑	0.424	-1.543	<0.001	Yes↓
Sulfate, mg/L	150.00	60	0	11.30	25.20	47.05	56.50	68.30	43.26	--	16.88	0.787	No	0.392	<0.001	Yes↑	0.485	-0.532	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	58	98	110.00	260.00	490.00	880.00	3700.00	--	502.77	670.93	0.760	No	0.035	0.702	No	0.024	6.619	0.134	No
Chlorophyll-*a*, µg/L	14.10	48	0	1.00	1.00	1.00	1.00	2.00	1.02	--	0.14	--*	--*	--*	--*	--*	--*	--*	--*	--*

Segment 1901 - Lower San Antonio River Station 12791 San Antonio River at US 77A AU ID: 1901_02	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	504	--	3.30	198.00	307.00	557.00	5610.00	516.85	--	637.05	<0.001	Yes	-0.071	0.606	No	--	--	--	--
Temperature, °C	32.20	60	0	9.30	16.95	22.15	26.85	30.50	21.58	--	6.33	<0.001	Yes	-0.239	0.095	Yes↓	-0.013	-0.001	0.605	No
Total Dissolved Solids, mg/L	750.00	59	41	208.00	576.71	721.50	793.00	1033.50	684.51	--	182.03	0.553	No	0.006	0.953	No	0.329	-0.111	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	59	--	-0.53	0.11	0.46	0.86	1.90	0.53	--	0.59	<0.001	Yes	0.152	0.280	No	0.052	0.000	0.048	Yes↑
pH, S.U.	6.5 to 9	59	0	7.50	8.00	8.20	8.30	8.60	8.16	--	0.23	0.432	No	0.053	0.554	No	0.160	0.000	0.001	Yes↓
Total Suspended Solids, mg/L	--	58	--	9.40	38.70	68.40	128.00	1040.00	118.77	--	167.63	0.003	Yes	-0.221	0.125	No	0.252	0.161	<0.001	Yes↑
Nitrogen as Ammonia, mg/L	0.33	59	0	0.02	0.10	0.10	0.10	0.16	0.09	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	59	95	0.83	5.23	7.11	9.32	13.10	7.19	--	2.95	0.001	Yes	0.338	0.016	Yes↑	0.127	-0.001	0.004	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	58	--	0.20	0.69	0.81	0.91	2.90	0.87	--	0.38	0.007	Yes	-0.015	0.918	No	0.060	0.000	0.039	Yes↑
Total Phosphorous, mg/L	0.69	60	68	0.09	0.59	0.85	1.23	2.37	0.99	--	0.50	0.126	No	0.123	0.168	No	0.006	0.000	0.248	No
Chloride, mg/L	180.00	60	17	20.30	100.75	133.50	167.00	256.00	132.55	--	48.14	0.338	No	0.112	0.207	No	0.297	-0.029	<0.001	Yes↓
Sulfate, mg/L	140.00	60	10	23.70	80.10	106.50	123.50	201.00	104.31	--	36.04	0.313	No	-0.105	0.241	No	0.260	-0.021	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	509	57	3.00	82.00	150.00	290.00	5800.00	--	178.41	842.68	0.001	Yes	0.094	0.510	No	0.238	0.634	<0.001	Yes↑
Chlorophyll-*a*, µg/L	14.10	42	26	1.00	3.00	6.00	15.00	57.00	12.29	--	14.72	<0.001	Yes	-0.226	0.079	Yes↓	-0.012	-0.005	0.468	No

Segment 1901 - Lower San Antonio River Station 17859 San Antonio River at Riverdale Rd AU ID: 1901_03	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	56	--	57.00	190.00	268.50	443.50	2400.00	434.34	--	470.41	0.003	Yes	-0.068	0.626	No	--	--	--	--
Temperature, °C	32.20	60	0	10.40	17.05	22.95	27.80	31.00	22.06	--	6.15	<0.001	Yes	-0.329	0.017	Yes↓	0.005	-0.002	0.266	No
Total Dissolved Solids, mg/L	750.00	60	48	313.95	624.98	744.25	815.75	1020.50	703.84	--	159.46	0.103	No	-0.053	0.557	No	0.449	-0.225	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	59	--	-0.54	0.34	0.56	0.82	2.16	0.61	--	0.54	0.014	Yes	0.394	0.004	Yes↑	-0.014	0.000	0.623	No
pH, S.U.	6.5 to 9	60	0	7.70	8.10	8.20	8.30	8.60	8.17	--	0.19	0.691	No	0.131	0.135	No	0.223	0.000	<0.001	Yes↓
Total Suspended Solids, mg/L	--	58	--	11.70	30.70	56.05	95.20	770.00	94.80	--	133.28	0.003	Yes	-0.394	0.004	Yes↓	0.495	0.195	<0.001	Yes↑
Nitrogen as Ammonia, mg/L	0.33	58	0	0.02	0.10	0.10	0.10	0.17	0.09	--	0.03	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	60	95	1.81	5.56	7.74	10.15	13.20	7.82	--	2.92	0.032	Yes	0.174	0.206	No	0.209	-0.003	<0.001	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	58	--	0.32	0.71	0.80	0.95	1.90	0.86	--	0.29	0.109	No	-0.060	0.511	No	0.182	0.000	<0.001	Yes↑
Total Phosphorous, mg/L	0.69	59	73	0.36	0.63	0.93	1.19	1.58	0.93	--	0.35	0.167	No	0.123	0.170	No	-0.003	0.000	0.372	No
Chloride, mg/L	180.00	60	12	42.10	105.05	140.50	168.50	256.00	134.96	--	46.14	0.139	No	0.044	0.623	No	0.468	-0.065	<0.001	Yes↓
Sulfate, mg/L	140.00	60	13	40.20	83.30	107.50	128.00	208.00	108.25	--	33.87	0.070	Yes	-0.252	0.067	Yes↓	0.298	-0.039	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	58	38	19.00	66.00	100.00	170.00	1700.00	--	115.96	343.36	0.016	Yes	-0.097	0.482	No	0.211	0.449	<0.001	Yes↑
Chlorophyll-*a*, µg/L	14.10	47	15	1.00	2.00	4.00	9.00	33.00	7.11	--	8.13	0.030	Yes	-0.249	0.065	Yes↓	-0.010	0.002	0.450	No

Segment 1901 - Lower San Antonio River Station 12794 San Antonio River at SH 72 AU ID: 1901_04	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	57	--	66.00	204.50	347.00	605.75	2670.00	547.70	--	614.44	0.301	No	-0.163	0.075	Yes↓	--	--	--	--
Temperature, °C	32.20	60	0	9.70	18.35	22.70	27.45	30.50	22.19	--	5.92	<0.001	Yes	-0.328	0.019	Yes↓	-0.017	0.000	0.834	No
Total Dissolved Solids, mg/L	750.00	60	42	203.45	565.83	708.50	786.50	1033.50	671.07	--	179.38	0.785	No	0.030	0.740	No	0.577	-0.217	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	57	--	-1.63	0.21	0.48	1.00	2.79	0.52	--	0.72	<0.001	Yes	0.186	0.185	No	0.055	0.000	0.049	Yes↑
pH, S.U.	6.5 to 9	60	0	7.70	8.10	8.20	8.30	8.50	8.16	--	0.17	0.929	No	0.193	0.026	Yes↑	0.300	0.000	<0.001	Yes↓
Total Suspended Solids, mg/L	--	58	--	6.40	20.80	39.50	77.30	636.00	88.33	--	126.27	0.003	Yes	-0.194	0.159	No	0.824	0.203	<0.001	Yes↑
Nitrogen as Ammonia, mg/L	0.33	59	0	0.02	0.10	0.10	0.10	0.17	0.09	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	60	93	0.50	5.45	8.37	10.95	15.60	8.21	--	3.57	0.017	Yes	0.290	0.035	Yes↑	0.449	-0.004	<0.001	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	57	--	0.36	0.71	0.79	0.94	1.79	0.84	--	0.25	0.277	No	0.021	0.820	No	0.205	0.000	<0.001	Yes↑
Total Phosphorous, mg/L	0.69	59	75	0.22	0.68	0.95	1.19	1.90	0.98	--	0.39	0.030	Yes	0.252	0.067	Yes↑	0.141	0.000	0.003	Yes↓
Chloride, mg/L	180.00	60	10	20.40	92.45	131.50	163.50	249.00	126.87	--	47.96	0.841	No	0.105	0.241	No	0.552	-0.056	<0.001	Yes↓
Sulfate, mg/L	140.00	60	10	23.00	77.30	100.50	124.00	209.00	102.69	--	36.58	0.900	No	-0.140	0.117	No	0.372	-0.035	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	58	43	23.00	56.00	105.00	310.00	4900.00	--	147.47	891.91	0.806	No	-0.048	0.601	No	0.500	1.158	<0.001	Yes↑
Chlorophyll-*a*, µg/L	14.10	46	2	1.00	2.00	3.00	7.00	25.00	5.15	--	4.69	0.058	Yes	-0.406	0.005	Yes↓	-0.006	0.001	0.396	No

Segment 1908 - Upper Cibolo Creek Station 16702 Cibolo Creek 1.6 km Downstream of SH 46 AU ID: 1908_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	28	--	0.30	1.55	3.10	6.20	97.00	8.39	--	18.32	0.361	No	-0.111	0.418	No	--	--	--	--
Temperature, °C	32.20	31	0	8.00	14.85	19.80	25.08	28.30	19.38	--	5.98	<0.001	Yes	-0.426	0.023	Yes↓	-0.026	0.034	0.584	No
Total Dissolved Solids, mg/L	600.00	31	10	265.20	409.34	474.50	545.84	656.50	470.94	--	97.27	0.846	No	0.049	0.708	No	0.344	-3.054	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	30	--	-3.23	0.60	1.62	2.28	3.92	1.55	--	1.47	0.433	No	0.177	0.175	No	-0.013	-0.013	0.423	No
pH, S.U.	6.5 to 9	31	0	7.30	7.60	7.80	7.90	8.30	7.76	--	0.22	0.181	No	-0.146	0.246	No	-0.033	0.001	0.712	No
Total Suspended Solids, mg/L	--	28	--	4.00	4.00	4.00	5.00	13.00	4.86	--	2.22	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Ammonia, mg/L	0.33	29	0	0.05	0.05	0.05	0.06	0.13	0.06	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrite + Nitrate, mg/L	--	27	--	0.20	0.39	0.64	1.62	10.10	1.86	--	2.59	0.037	Yes	-0.049	0.798	No	-0.010	-0.064	0.387	No
Total Kjeldahl Nitrogen, mg/L	--	26	--	0.24	0.46	0.57	0.69	0.79	0.56	--	0.17	0.124	No	-0.015	0.930	No	-0.026	-0.001	0.524	No
Total Phosphorous, mg/L	0.69	27	59	0.06	0.32	1.11	2.73	3.85	1.45	--	1.24	0.399	No	0.091	0.518	No	0.124	-0.024	0.051	Yes↓
Chloride, mg/L	50.00	30	57	13.00	43.00	64.50	89.00	136.00	66.30	--	33.94	0.515	No	0.159	0.225	No	0.194	-0.850	0.014	Yes↓
Sulfate, mg/L	100.00	31	0	16.00	39.00	48.00	54.00	86.00	47.84	--	14.57	0.480	No	0.030	0.825	No	0.246	-0.407	0.005	Yes↓
E. coli, MPN/100 mL	126.00	27	26	10.00	37.00	75.00	155.00	840.00	--	70.29	175.94	0.087	Yes	0.036	0.858	No	-0.045	-0.343	0.954	No
Chlorophyll-*a*, µg/L	14.10	26	0	0.42	2.89	3.00	4.52	11.90	3.70	--	2.44	0.223	No	-0.160	0.246	No	-0.039	-0.013	0.646	No

Segment 1913 - Mid Cibolo Creek Station 14212 Cibolo Creek Upstream of Municipal WWTP AU ID: 1913_03	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	25	--	0.00	0.20	0.80	1.50	17.00	1.76	--	3.49	0.713	No	-0.307	0.033	Yes↓	--	--	--	--
Temperature, °C	32.20	37	0	10.60	18.28	21.80	26.08	29.20	21.67	--	5.00	<0.001	Yes	-0.216	0.120	No	-0.023	0.197	0.502	No
Total Dissolved Solids, mg/L	750.00	37	0	220.35	424.78	461.50	474.99	604.00	442.97	--	78.20	0.139	No	0.014	0.917	No	-0.043	-0.002	1.000	No
Dissolved Oxygen Deficit, mg/L	--	36	--	-5.24	-0.18	1.09	2.53	5.50	0.92	--	2.41	0.091	Yes	0.029	0.833	No	0.007	-0.157	0.291	No
pH, S.U.	6.5 to 9	36	0	7.00	7.30	7.40	7.70	8.10	7.49	--	0.27	0.692	No	-0.181	0.120	No	-0.017	0.011	0.450	No
Total Suspended Solids, mg/L	--	35	--	1.00	4.00	4.00	5.75	22.00	5.70	--	4.31	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Ammonia, mg/L	0.33	37	0	0.05	0.05	0.05	0.08	0.11	0.07	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrite + Nitrate, mg/L	--	36	--	0.04	0.61	1.34	1.78	5.13	1.37	--	1.06	0.035	Yes	-0.198	0.163	No	-0.042	-0.013	0.850	No
Total Kjeldahl Nitrogen, mg/L	--	37	--	0.20	0.26	0.32	0.49	0.72	0.37	--	0.15	0.155	No	-0.185	0.110	No	0.125	0.017	0.051	Yes↑
Total Phosphorous, mg/L	0.69	31	0	0.02	0.05	0.06	0.07	0.15	0.06	--	0.02	0.304	No	-0.110	0.388	No	-0.055	0.000	0.953	No
Chloride, mg/L	150.00	37	0	9.00	16.15	20.00	25.00	32.00	20.44	--	5.96	0.662	No	-0.303	0.008	Yes↓	0.079	0.553	0.093	Yes↑
Sulfate, mg/L	150.00	36	0	15.00	37.50	43.50	47.50	86.00	43.56	--	12.69	0.153	No	0.044	0.713	No	-0.044	-0.090	0.862	No
E. coli, MPN/100 mL	126.00	35	31	2.00	32.00	57.00	182.50	620.00	--	59.29	134.62	0.271	No	0.277	0.019	Yes↑	-0.044	-1.475	0.863	No
Chlorophyll-*a*, µg/L	14.10	33	9	0.66	1.94	3.00	4.39	30.60	5.55	--	6.97	0.027	Yes	-0.551	<0.001	Yes↓	0.522	1.594	<0.001	Yes↑

Segment 1902 - Lower Cibolo Creek Station 14211 Cibolo Creek at CR 389 AU ID: 1902_02	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	54	--	8.40	22.00	30.50	47.00	182.00	42.32	--	37.08	0.007	Yes	0.076	0.616	No	--	--	--	--
Temperature, °C	32.20	61	0	9.70	18.10	22.90	27.53	29.80	22.19	--	5.65	<0.001	Yes	-0.265	0.069	Yes↓	-0.009	-0.016	0.464	No
Total Dissolved Solids, mg/L	900.00	61	0	260.00	527.48	721.50	775.13	877.50	659.84	--	162.87	0.649	No	-0.272	0.002	Yes↓	0.206	-1.783	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	61	--	-2.57	0.08	0.77	1.26	3.12	0.57	--	1.11	<0.001	Yes	0.034	0.806	No	0.056	-0.008	0.048	Yes↓
pH, S.U.	6.5 to 9	59	0	7.70	8.00	8.10	8.20	8.70	8.10	--	0.20	0.034	Yes	0.281	0.135	No	0.138	-0.002	0.004	Yes↓
Total Suspended Solids, mg/L	--	59	--	4.00	6.48	12.10	24.30	197.00	24.04	--	35.27	0.005	Yes	-0.029	0.838	No	0.474	0.302	<0.001	Yes↑
Nitrogen as Ammonia, mg/L	0.33	61	0	0.02	0.10	0.10	0.10	0.17	0.09	--	0.03	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	59	8	0.05	0.43	0.80	1.19	3.16	0.95	--	0.72	0.006	Yes	0.205	0.167	No	0.060	0.006	0.042	Yes↑
Total Kjeldahl Nitrogen, mg/L	--	60	--	0.22	0.49	0.57	0.72	1.29	0.61	--	0.21	0.089	Yes	0.241	0.086	Yes↑	0.059	0.001	0.044	Yes↑
Total Phosphorous, mg/L	0.69	60	0	0.04	0.18	0.28	0.36	0.68	0.29	--	0.14	0.024	Yes	0.407	0.004	Yes↑	-0.017	0.000	0.726	No
Chloride, mg/L	170.00	61	0	31.10	75.93	118.00	133.25	162.00	105.25	--	35.84	0.298	No	-0.110	0.211	No	0.388	-0.529	<0.001	Yes↓
Sulfate, mg/L	275.00	61	0	40.10	113.75	154.00	185.25	246.00	146.80	--	48.38	0.446	No	-0.340	<0.001	Yes↓	0.145	-0.459	0.003	Yes↓
E. coli, MPN/100 mL	126.00	60	63	20.00	110.00	155.00	290.00	2400.00	--	186.29	466.37	0.136	No	0.118	0.186	No	0.167	2.936	0.001	Yes↑
Chlorophyll-*a*, µg/L	14.10	39	0	1.00	1.00	2.00	3.75	10.00	2.82	--	2.27	0.224	No	0.022	0.851	No	0.413	0.035	<0.001	Yes↑

Segment 1902 - Lower Cibolo Creek Station 14197 Cibolo Creek at Scull Crossing AU ID: 1902_05	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	52	--	5.00	14.50	22.00	29.50	60.00	23.75	--	12.67	0.002	Yes	0.125	0.384	No	--	--	--	--
Temperature, °C	32.20	58	0	8.80	15.80	22.30	27.50	30.90	21.36	--	6.57	<0.001	Yes	0.295	0.039	Yes↑	0.270	-0.281	<0.001	Yes↓
Total Dissolved Solids, mg/L	900.00	57	0	213.20	507.65	546.00	591.18	633.10	520.71	--	102.36	0.399	No	-0.036	0.695	No	0.247	-2.387	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	57	--	-3.08	-0.20	0.74	1.23	2.82	0.43	--	1.19	<0.001	Yes	-0.172	0.220	No	-0.002	-0.013	0.350	No
pH, S.U.	6.5 to 9	58	0	7.70	8.00	8.10	8.20	8.70	8.10	--	0.20	0.085	Yes	0.570	0.005	Yes↑	0.038	-0.004	0.092	Yes↓
Total Suspended Solids, mg/L	--	57	--	3.60	7.40	12.80	23.45	155.00	20.64	--	24.81	0.002	Yes	0.294	0.041	Yes↑	0.003	0.117	0.286	No
Nitrogen as Ammonia, mg/L	0.33	58	0	0.02	0.10	0.10	0.10	0.14	0.09	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	59	44	0.05	0.97	1.66	3.07	6.07	2.11	--	1.48	<0.001	Yes	0.200	0.155	No	0.139	0.047	0.004	Yes↑
Total Kjeldahl Nitrogen, mg/L	--	57	--	0.34	0.54	0.65	0.73	1.23	0.66	--	0.16	0.259	No	0.021	0.826	No	0.005	-0.002	0.266	No
Total Phosphorous, mg/L	0.69	58	64	0.29	0.59	0.84	1.09	1.48	0.83	--	0.29	0.117	No	0.130	0.151	No	0.218	-0.010	<0.001	Yes↓
Chloride, mg/L	170.00	59	0	10.00	68.95	88.30	102.50	126.00	82.27	--	29.62	0.439	No	0.156	0.082	Yes↑	0.479	-1.175	<0.001	Yes↓
Sulfate, mg/L	275.00	56	0	38.80	57.65	60.50	65.15	85.00	61.32	--	8.23	0.076	Yes	-0.206	0.152	No	0.082	0.175	0.022	Yes↑
E. coli, MPN/100 mL	126.00	58	40	17.00	54.00	91.00	230.00	2100.00	--	113.27	357.65	0.101	No	0.111	0.219	No	0.084	4.100	0.021	Yes↑
Chlorophyll-*a*, µg/L	14.10	46	7	1.00	1.00	2.50	4.00	30.00	4.43	--	6.38	0.352	No	-0.069	0.497	No	-0.024	-0.022	0.803	No

Segment 1905 - Upper Medina River Station 12830 Medina River at Old English Crossing AU ID: 1905_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	47	--	0.50	8.98	20.00	52.25	177.00	36.95	--	43.74	0.264	No	-0.111	0.275	No	--	--	--	--
Temperature, °C	31.10	54	0	10.60	15.00	21.00	25.20	30.40	20.39	--	5.24	<0.001	Yes	-0.118	0.422	No	0.007	-0.020	0.258	No
Total Dissolved Solids, mg/L	400.00	53	26	250.25	354.09	371.80	402.03	490.75	377.88	--	39.49	0.057	Yes	0.171	0.265	No	0.040	-0.233	0.096	Yes↓
Dissolved Oxygen Deficit, mg/L	--	52	--	-2.75	0.03	0.70	1.14	2.62	0.54	--	1.04	0.600	No	0.029	0.770	No	-0.022	-0.001	0.810	No
pH, S.U.	6.5 to 9	53	0	7.40	7.78	7.90	7.90	8.30	7.83	--	0.19	0.555	No	-0.179	0.049	Yes	-0.019	0.000	0.695	No
Total Suspended Solids, mg/L	--	52	--	1.00	4.00	4.00	4.00	4.00	3.54	--	1.04	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Ammonia, mg/L	0.33	54	0	0.02	0.10	0.10	0.10	0.12	0.09	--	0.03	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	53	0	0.11	0.24	0.35	0.45	0.98	0.38	--	0.19	0.165	No	-0.035	0.718	No	0.010	0.001	0.238	No
Total Kjeldahl Nitrogen, mg/L	--	53	--	0.20	0.20	0.20	0.24	0.41	0.22	--	0.04	--*	--*	--*	--*	--*	--*	--*	--*	--*
Total Phosphorous, mg/L	0.69	53	0	0.02	0.02	0.02	0.05	0.08	0.03	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Chloride, mg/L	50.00	54	0	10.00	13.50	15.30	18.40	26.70	16.09	--	3.91	0.816	No	0.363	<0.001	Yes↑	0.294	-0.049	<0.001	Yes↓
Sulfate, mg/L	150.00	54	4	34.20	80.80	99.30	119.00	188.00	99.95	--	29.76	0.005	Yes	0.228	0.120	No	0.061	-0.179	0.051	Yes↓
E. coli, MPN/100 mL	126.00	52	31	4.00	26.00	63.50	140.00	450.00	--	62.03	107.94	0.119	No	0.302	0.002	Yes↑	0.036	-0.619	0.111	No
Chlorophyll-*a*, µg/L	14.10	40	0	1.00	1.00	1.00	1.00	4.00	1.35	--	0.74	0.436	No	-0.026	0.760	No	-0.003	-0.003	0.347	No

Segment 1904 - Medina Lake Station 12825 Medina Lake at Medina Lake Dam AU ID: 1904_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	31.10	22	0	9.80	13.00	18.65	26.90	29.30	19.22	--	7.25	<0.001	Yes	0.157	0.350	No	--	--	--	--
Total Dissolved Solids, mg/L	350.00	22	0	245.05	269.75	278.53	292.50	307.45	279.32	--	14.77	0.641	No	0.290	0.063	Yes↑	--	--	--	--
Dissolved Oxygen Deficit, mg/L	--	22	--	-2.08	0.96	2.09	5.96	9.68	3.22	--	3.19	0.593	No	0.004	1.000	No	--	--	--	--
pH, S.U.	6.5 to 9	22	0	7.10	7.70	8.00	8.20	8.40	7.93	--	0.35	0.095	Yes	0.272	0.121	No	--	--	--	--
Total Suspended Solids, mg/L	--	21	--	4.00	4.00	4.00	4.00	6.00	4.14	--	0.48	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Ammonia, mg/L	0.11	18	0	0.05	0.05	0.05	0.05	0.05	0.05	--	<0.001	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrite + Nitrate, mg/L	--	21	--	0.04	0.04	0.08	0.19	0.50	0.14	--	0.13	0.343	No	-0.100	0.533	No	--	--	--	--
Total Kjeldahl Nitrogen, mg/L	--	22	--	0.20	0.26	0.29	0.33	0.53	0.31	--	0.08	0.317	No	0.117	0.462	No	--	--	--	--
Total Phosphorous, mg/L	0.20	19	0	0.02	0.04	0.06	0.06	0.06	0.05	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Chloride, mg/L	80.00	21	0	9.00	11.00	12.00	13.00	14.00	12.05	--	1.36	0.738	No	0.124	0.432	No	--	--	--	--
Sulfate, mg/L	75.00	22	0	31.00	47.00	57.00	59.00	73.00	53.86	--	9.73	0.729	No	0.472	0.002	Yes↑	--	--	--	--
E. coli, MPN/100 mL	126.00	18	0	1.00	1.00	6.00	10.00	10.00	--	3.29	4.58	--*	--*	--*	--*	--*	--*	--*	--*	--*
Chlorophyll-*a*, µg/L	26.70	16	0	1.27	2.98	3.00	3.00	4.39	2.84	--	0.79	--*	--*	--*	--*	--*	--*	--*	--*	--*

Segment 1909 - Medina Diversion Lake Station 18407 Medina Diversion Lake near Dam AU ID: 1909_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Temperature, °C	32.20	19	0	10.90	14.93	18.60	22.10	26.60	18.58	--	4.69	--	--	--	--	--	--	--	--	--
Total Dissolved Solids, mg/L	400.00	20	0	221.00	278.85	288.28	307.13	356.20	293.35	--	28.62	0.747	No	0.253	0.127	No	--	--	--	--
Dissolved Oxygen Deficit, mg/L	--	19	--	-0.47	0.50	0.93	1.46	1.98	0.92	--	0.71	--	--	--	--	--	--	--	--	--
pH, S.U.	6.5 to 9	19	0	7.60	7.80	8.00	8.20	8.60	8.00	--	0.27	--	--	--	--	--	--	--	--	--
Total Suspended Solids, mg/L	--	19	--	4.00	4.00	4.00	4.00	5.00	4.16	--	0.37	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Ammonia, mg/L	0.11	20	0	0.05	0.05	0.05	0.05	0.07	0.05	--	0.01	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrite + Nitrate, mg/L	--	20	--	0.05	0.13	0.22	0.31	0.69	0.24	--	0.16	0.190	No	-0.079	0.649	No	--	--	--	--
Total Kjeldahl Nitrogen, mg/L	--	18	--	0.20	0.25	0.31	0.44	0.70	0.35	--	0.14	--	--	--	--	--	--	--	--	--
Total Phosphorous, mg/L	0.20	19	0	0.02	0.02	0.05	0.06	0.06	0.04	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Chloride, mg/L	50.00	19	0	8.00	11.00	12.00	12.75	15.00	11.74	--	1.91	--	--	--	--	--	--	--	--	--
Sulfate, mg/L	75.00	21	10	32.00	41.00	48.00	59.00	83.00	51.90	--	13.67	0.629	No	0.676	<0.001	Yes↑	--	--	--	--
E. coli, MPN/100 mL	126.00	17	0	2.00	10.00	10.00	10.00	63.00	--	9.32	13.78	--	--	--	--	--	--	--	--	--
Chlorophyll-*a*, µg/L	26.70	20	0	0.44	3.00	3.00	3.07	5.53	2.82	--	1.22	--*	--*	--*	--*	--*	--*	--*	--*	--*

Segment 1903 - Lower Medina River Station 12813 Medina River at Cassin Crossing AU ID: 1903_02	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	58	--	32.00	51.00	78.00	110.00	1090.00	119.90	--	160.42	0.678	No	-0.183	0.043	Yes↓	--	--	--	--
Temperature, °C	32.20	60	0	10.50	17.55	22.90	28.15	30.20	22.69	--	5.53	<0.001	Yes	-0.439	0.001	Yes↓	-0.015	0.002	0.689	No
Total Dissolved Solids, mg/L	700.00	59	12	312.65	544.21	585.00	656.50	760.50	593.53	--	90.97	0.731	No	0.148	0.099	Yes↑	0.388	-0.330	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	58	--	-0.48	0.43	0.80	1.17	1.95	0.78	--	0.53	<0.001	Yes	0.407	0.004	Yes↑	0.021	-0.001	0.146	No
pH, S.U.	6.5 to 9	58	0	7.70	7.90	8.00	8.10	8.50	8.00	--	0.13	0.303	No	0.048	0.582	No	0.091	0.000	0.014	Yes↓
Total Suspended Solids, mg/L	--	59	--	4.30	13.85	22.70	38.18	77.50	28.23	--	18.13	0.002	Yes	-0.252	0.067	Yes↓	0.193	0.052	<0.001	Yes↑
Nitrogen as Ammonia, mg/L	0.33	58	28	0.02	0.10	0.16	0.43	1.64	0.34	--	0.40	0.365	No	-0.033	0.717	No	-0.004	0.000	0.383	No
Nitrogen as Nitrate, mg/L	1.95	60	97	0.70	5.47	7.16	9.88	16.10	7.67	--	3.41	0.828	No	0.292	0.001	Yes↑	0.257	-0.011	<0.001	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	57	--	0.20	0.77	0.96	1.18	2.66	1.08	--	0.52	0.449	No	0.003	0.978	No	0.076	-0.001	0.023	Yes↓
Total Phosphorous, mg/L	0.69	60	78	0.12	0.78	1.17	1.66	2.78	1.27	--	0.65	0.319	No	0.299	<0.001	Yes↑	0.254	-0.002	<0.001	Yes↓
Chloride, mg/L	120.00	60	18	14.30	73.45	92.10	109.00	161.00	93.48	--	30.18	0.727	No	0.231	0.009	Yes↑	0.377	-0.112	<0.001	Yes↓
Sulfate, mg/L	120.00	59	0	51.00	81.00	88.60	93.80	108.00	86.07	--	12.11	0.277	No	0.015	0.870	No	0.321	-0.044	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	59	56	45.00	96.00	140.00	217.50	700.00	--	148.68	139.15	0.797	No	0.052	0.565	No	-0.012	0.069	0.559	No
Chlorophyll-*a*, µg/L	14.10	46	0	1.00	1.00	2.00	3.00	8.00	2.00	--	1.38	0.139	No	-0.358	<0.001	Yes↓	0.083	0.005	0.030	Yes↑

Segment 1903 - Lower Medina River Station 12811 Medina River at FM 1937 AU ID: 1903_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	32	--	22.00	37.00	74.00	109.00	800.00	101.22	--	137.69	0.712	No	-0.052	0.685	No	--	--	--	--
Temperature, °C	32.20	38	0	13.60	19.70	23.00	28.50	30.80	23.29	--	4.88	<0.001	Yes	-0.235	0.076	Yes↓	-0.025	-0.003	0.634	No
Total Dissolved Solids, mg/L	700.00	39	23	330.85	620.59	650.00	695.50	773.50	642.79	--	91.61	0.308	No	0.260	0.020	Yes↑	0.530	-0.465	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	38	--	-0.93	0.57	1.12	1.39	2.48	1.02	--	0.71	0.015	Yes	-0.168	0.205	No	0.010	-0.001	0.261	No
pH, S.U.	6.5 to 9	38	0	7.60	7.90	8.00	8.00	8.40	7.99	--	0.16	0.725	No	0.013	0.916	No	0.009	0.000	0.267	No
Total Suspended Solids, mg/L	--	36	--	7.00	14.00	19.00	25.50	46.80	20.73	--	9.38	0.001	Yes	0.103	0.478	No	-0.034	0.001	0.904	No
Nitrogen as Ammonia, mg/L	0.33	35	14	0.05	0.05	0.09	0.14	0.83	0.15	--	0.16	0.202	No	0.203	0.085	Yes↑	-0.033	0.000	0.735	No
Nitrite + Nitrate, mg/L	--	38	--	5.85	9.25	10.50	12.20	15.20	10.72	--	2.42	0.553	No	0.303	0.008	Yes↑	0.326	-0.011	<0.001	Yes↓
Total Kjeldahl Nitrogen, mg/L	--	34	--	0.53	0.70	0.94	1.12	1.67	0.94	--	0.27	0.847	No	0.100	0.415	No	-0.036	0.000	0.805	No
Total Phosphorous, mg/L	0.69	34	91	0.18	0.95	1.27	1.67	2.73	1.34	--	0.59	0.808	No	0.344	0.004	Yes↑	0.171	-0.002	0.019	Yes↓
Chloride, mg/L	120.00	35	23	56.00	95.50	105.00	119.75	152.00	105.95	--	19.95	0.329	No	0.395	<0.001	Yes↑	0.408	-0.092	<0.001	Yes↓
Sulfate, mg/L	120.00	38	0	62.00	80.00	85.25	90.60	99.00	85.50	--	8.92	0.135	No	0.087	0.450	No	0.001	-0.013	0.315	No
E. coli, MPN/100 mL	126.00	36	44	38.00	77.50	100.50	180.00	330.00	--	112.84	77.57	0.509	No	0.270	0.021	Yes↑	-0.024	0.060	0.584	No
Chlorophyll-*a*, µg/L	14.10	36	0	0.75	1.50	2.80	3.00	8.76	2.83	--	1.77	0.721	No	-0.556	<0.001	Yes↓	0.218	0.007	0.005	Yes↑

Segment 1906 - Lower Leon Creek Station 14198 Leon Creek Upstream of Leon Creek WWTP AU ID: 1906_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	55	--	0.00	2.43	4.50	10.75	79.00	9.86	--	15.48	0.005	Yes	-0.067	0.645	No	--	--	--	--
Temperature, °C	35.00	57	0	9.30	15.78	22.60	28.48	33.80	22.01	--	6.81	<0.001	Yes	-0.194	0.173	No	0.044	-0.111	0.070	Yes↓
Total Dissolved Solids, mg/L	700.00	57	12	200.20	428.84	530.40	627.09	819.00	525.11	--	152.94	0.171	No	-0.207	0.023	Yes↓	0.258	-4.956	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	56	--	-1.63	-0.46	-0.05	0.84	2.65	0.20	--	0.99	0.013	Yes	0.384	0.006	Yes↑	-0.019	0.002	0.840	No
pH, S.U.	6.5 to 9	56	0	7.60	7.90	7.90	8.00	8.20	7.93	--	0.13	0.382	No	-0.132	0.135	No	0.038	-0.002	0.087	Yes↓
Total Suspended Solids, mg/L	--	54	--	4.00	6.20	10.45	16.00	53.50	13.55	--	10.84	0.172	No	-0.013	0.899	No	0.111	0.272	0.009	Yes↑
Nitrogen as Ammonia, mg/L	0.33	55	0	0.02	0.10	0.10	0.10	0.18	0.09	--	0.03	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	55	0	0.05	0.18	0.40	0.55	1.73	0.45	--	0.38	0.017	Yes	-0.476	0.013	Yes↓	0.003	0.004	0.293	No
Total Kjeldahl Nitrogen, mg/L	--	53	--	0.20	0.28	0.36	0.42	0.91	0.37	--	0.14	0.254	No	0.116	0.222	No	0.006	0.002	0.259	No
Total Phosphorous, mg/L	0.69	55	0	0.02	0.02	0.04	0.06	0.14	0.05	--	0.03	0.983	No	-0.215	0.019	Yes↓	0.302	0.001	<0.001	Yes↑
Chloride, mg/L	120.00	56	13	12.50	45.95	73.80	96.25	183.00	75.32	--	37.59	0.154	No	-0.107	0.246	No	0.319	-1.343	<0.001	Yes↓
Sulfate, mg/L	120.00	56	41	27.70	77.20	111.50	140.00	238.00	113.15	--	51.94	0.159	No	-0.248	0.007	Yes↓	0.274	-1.712	<0.001	Yes↓
E. coli, MPN/100 mL	126.00	55	18	1.00	10.25	21.00	50.00	1400.00	--	30.22	298.26	0.657	No	0.091	0.330	No	0.763	17.838	<0.001	Yes↑
Chlorophyll-*a*, µg/L	14.10	23	9	1.00	1.00	2.00	4.75	28.00	4.65	--	6.86	0.816	No	0.308	0.034	Yes↑	-0.037	-0.042	0.616	No

Segment 1910 - Salado Creek Station 12861 Salado Creek at Southton Rd AU ID: 1910_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	56	--	0.03	2.50	5.85	13.00	46.00	10.06	--	11.03	0.117	No	-0.034	0.713	No	--	--	--	--
Temperature, °C	32.20	59	0	7.40	15.58	21.20	26.28	29.50	20.55	--	6.50	<0.001	Yes	-0.136	0.350	No	0.009	-0.097	0.230	No
Total Dissolved Solids, mg/L	600.00	58	24	174.85	358.15	474.50	589.55	702.00	476.00	--	138.30	0.604	No	-0.244	0.007	Yes↓	0.095	-4.132	0.013	Yes↓
Dissolved Oxygen Deficit, mg/L	--	55	--	-2.01	0.05	0.59	0.95	3.07	0.52	--	0.91	0.029	Yes	0.015	0.918	No	0.015	-0.016	0.194	No
pH, S.U.	6.5 to 9	58	0	7.50	7.90	8.00	8.10	8.30	7.96	--	0.17	0.500	No	0.295	<0.001	Yes↑	-0.012	0.001	0.539	No
Total Suspended Solids, mg/L	--	56	--	2.80	4.05	5.70	11.55	37.40	9.14	--	7.41	0.005	Yes	0.103	0.462	No	0.050	0.198	0.057	Yes↑
Nitrogen as Ammonia, mg/L	0.33	55	0	0.03	0.10	0.10	0.10	0.10	0.10	--	0.01	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	58	0	0.05	0.05	0.36	0.67	1.76	0.46	--	0.44	0.396	No	-0.273	0.002	Yes↓	0.078	0.013	0.023	Yes↑
Total Kjeldahl Nitrogen, mg/L	--	59	--	0.20	0.29	0.40	0.53	0.86	0.43	--	0.16	0.225	No	0.065	0.472	No	0.025	0.003	0.128	No
Total Phosphorous, mg/L	0.69	57	0	0.02	0.03	0.06	0.09	0.25	0.07	--	0.05	0.706	No	-0.161	0.077	Yes↓	0.394	0.002	<0.001	Yes↑
Chloride, mg/L	140.00	59	2	11.10	40.68	63.40	81.90	142.00	62.29	--	26.91	0.980	No	-0.179	0.045	Yes↓	0.150	-0.992	0.002	Yes↓
Sulfate, mg/L	200.00	58	0	28.30	56.00	80.50	98.30	168.00	80.53	--	30.08	0.608	No	-0.263	0.004	Yes↓	0.059	-0.750	0.043	Yes↓
E. coli, MPN/100 mL	126.00	57	26	7.00	25.50	54.00	132.50	1700.00	--	64.32	325.21	0.969	No	0.172	0.060	Yes↑	0.158	10.983	0.002	Yes↑
Chlorophyll-*a*, µg/L	14.10	46	4	1.00	1.00	2.00	4.00	21.00	3.80	--	4.48	<0.001	Yes	-0.128	0.427	No	0.061	-0.116	0.056	Yes↓

Segment 1910 - Salado Creek Station 12870 Salado Creek at Gembler Rd AU ID: 1910_02	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	59	--	0.05	1.45	3.50	6.78	35.00	5.77	--	6.94	0.693	No	-0.153	0.089	Yes↓	--	--	--	--
Temperature, °C	32.20	59	0	8.10	15.63	20.90	25.50	30.10	20.20	--	5.77	<0.001	Yes	-0.297	0.035	Yes↓	-0.011	0.069	0.528	No
Total Dissolved Solids, mg/L	600.00	59	3	171.60	324.84	459.55	509.44	630.50	431.29	--	114.68	0.753	No	-0.111	0.216	No	0.143	-6.424	0.002	Yes↓
Dissolved Oxygen Deficit, mg/L	--	56	--	-2.72	1.77	2.64	3.37	6.42	2.33	--	1.77	0.018	Yes	0.426	0.003	Yes↑	-0.015	-0.017	0.638	No
pH, S.U.	6.5 to 9	58	0	7.30	7.50	7.70	7.80	8.10	7.68	--	0.18	0.234	No	-0.230	0.010	Yes↓	0.088	-0.009	0.014	Yes↓
Total Suspended Solids, mg/L	--	57	--	1.10	4.00	4.00	6.03	17.50	5.36	--	3.54	0.487	No	-0.340	<0.001	Yes↓	0.124	0.211	0.005	Yes↑
Nitrogen as Ammonia, mg/L	0.33	55	0	0.06	0.10	0.10	0.10	0.14	0.10	--	0.01	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	58	28	0.05	0.37	0.73	2.19	4.09	1.20	--	1.07	0.107	No	-0.200	0.027	Yes↓	-0.014	0.010	0.636	No
Total Kjeldahl Nitrogen, mg/L	--	57	--	0.20	0.35	0.44	0.55	1.10	0.47	--	0.17	0.249	No	0.013	0.896	No	-0.014	0.002	0.644	No
Total Phosphorous, mg/L	0.69	55	0	0.02	0.08	0.13	0.18	0.58	0.15	--	0.10	0.429	No	-0.200	0.032	Yes↓	-0.019	0.000	0.897	No
Chloride, mg/L	140.00	59	0	9.18	30.70	49.40	66.18	127.00	51.18	--	25.49	0.799	No	-0.120	0.182	No	0.183	-1.631	<0.001	Yes↓
Sulfate, mg/L	200.00	58	0	20.80	38.60	51.60	62.50	81.10	51.44	--	15.88	0.648	No	0.032	0.727	No	0.092	-0.741	0.012	Yes↓
E. coli, MPN/100 mL	126.00	56	36	7.00	40.00	71.50	180.00	3400.00	--	96.20	646.60	0.721	No	0.025	0.788	No	0.249	47.659	<0.001	Yes↑
Chlorophyll-*a*, µg/L	14.10	46	0	1.00	1.00	1.00	2.00	13.00	2.00	--	2.10	0.988	No	0.064	0.474	No	-0.010	-0.034	0.462	No

Segment 1910 - Salado Creek Station 12874 Salado Creek at Rittiman Rd AU ID: 1910_03	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	38	--	0.00	0.03	1.45	3.00	16.00	2.46	--	3.35	0.839	No	-0.373	0.001	Yes↓	--	--	--	--
Temperature, °C	32.20	40	0	8.50	16.85	21.25	25.15	31.00	20.83	--	5.57	<0.001	Yes	-0.255	0.066	Yes↓	0.002	0.275	0.305	No
Total Dissolved Solids, mg/L	600.00	40	3	177.45	365.30	410.48	469.95	650.00	417.85	--	93.25	0.763	No	-0.047	0.675	No	-0.028	-0.540	0.898	No
Dissolved Oxygen Deficit, mg/L	--	37	--	-3.22	0.24	2.33	4.57	8.91	2.37	--	2.95	0.983	No	0.443	<0.001	Yes↑	0.289	-0.464	<0.001	Yes↓
pH, S.U.	6.5 to 9	38	0	7.50	7.60	7.70	7.80	8.10	7.73	--	0.16	0.474	No	-0.202	0.071	Yes↓	0.042	0.012	0.122	No
Total Suspended Solids, mg/L	--	40	--	1.00	4.00	4.00	8.10	23.90	7.05	--	5.93	0.833	No	-0.110	0.294	No	0.061	-0.536	0.076	Yes↓
Nitrogen as Ammonia, mg/L	0.33	38	0	0.02	0.10	0.10	0.10	0.20	0.09	--	0.03	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	39	33	0.05	0.60	1.13	3.28	11.40	2.39	--	2.98	0.877	No	-0.175	0.118	No	0.005	0.164	0.283	No
Total Kjeldahl Nitrogen, mg/L	--	38	--	0.20	0.30	0.39	0.58	1.09	0.47	--	0.25	0.021	Yes	-0.157	0.259	No	0.068	-0.023	0.071	Yes↓
Total Phosphorous, mg/L	0.69	37	8	0.02	0.03	0.04	0.09	1.14	0.15	--	0.29	0.210	No	-0.351	0.002	Yes↓	0.009	0.017	0.264	No
Chloride, mg/L	140.00	39	0	7.65	23.70	31.30	52.85	88.60	38.30	--	21.30	0.336	No	-0.158	0.160	No	-0.017	-0.682	0.518	No
Sulfate, mg/L	200.00	40	0	20.10	40.25	47.45	58.20	97.80	50.18	--	17.77	0.919	No	0.154	0.166	No	0.168	-2.217	0.007	Yes↓
E. coli, MPN/100 mL	126.00	39	64	30.00	91.25	260.00	405.00	7700.00	--	267.67	1675.89	0.335	No	0.216	0.054	Yes↑	-0.013	-63.201	0.467	No
Chlorophyll-*a*, µg/L	14.10	28	0	1.00	1.00	2.00	4.00	14.00	3.00	--	3.03	0.078	Yes	-0.232	0.090	Yes↓	0.005	-0.340	0.300	No

Segment 1912 - Medio Creek Station 12916 Medio Creek at Hidden Valley AU ID: 1912_01	TSWQS	Number of Samples	% N Exceeding TSWQS	Min	25th percentile	Median	75th percentile	Max	Mean	Geomean	Standard Deviation	Seasonality p-Value	Seasonal	Kendall's Tau τ (trend strength)	p-value (against time)	Significant Trend Over Time	r^2	slope	p-Value (against flow)	Significant Trend against Flow
Instantaneous Flow, cfs	--	57	--	1.10	6.08	8.00	11.00	28.00	8.97	--	4.73	0.291	No	-0.184	0.044	Yes↓	--	--	--	--
Temperature, °C	34.00	59	0	8.90	14.85	22.60	27.40	30.40	20.98	--	6.53	<0.001	Yes	0.030	0.843	No	-0.006	-0.151	0.418	No
Total Dissolved Solids, mg/L	750.00	59	0	276.25	536.25	611.65	645.13	695.50	572.30	--	103.11	0.778	No	-0.075	0.406	No	0.232	-10.361	<0.001	Yes↓
Dissolved Oxygen Deficit, mg/L	--	59	--	-0.23	0.90	1.76	2.43	4.00	1.64	--	1.03	0.003	Yes	0.145	0.303	No	0.089	-0.070	0.014	Yes↓
pH, S.U.	6.5 to 9	59	0	7.60	8.10	8.20	8.40	8.80	8.21	--	0.26	0.109	No	0.196	0.027	Yes↑	0.006	-0.008	0.257	No
Total Suspended Solids, mg/L	--	59	--	11.60	17.90	24.50	33.23	57.00	26.55	--	10.74	0.208	No	-0.244	0.006	Yes↓	0.023	0.456	0.132	No
Nitrogen as Ammonia, mg/L	0.33	56	0	0.03	0.10	0.10	0.10	0.15	0.10	--	0.02	--*	--*	--*	--*	--*	--*	--*	--*	--*
Nitrogen as Nitrate, mg/L	1.95	59	61	0.11	0.80	2.60	7.85	15.00	4.37	--	4.22	<0.001	Yes	0.159	0.259	No	-0.007	0.096	0.431	No
Total Kjeldahl Nitrogen, mg/L	--	58	--	0.42	0.78	0.87	1.01	1.32	0.88	--	0.18	0.675	No	0.220	0.015	Yes↑	0.005	0.006	0.262	No
Total Phosphorous, mg/L	0.69	58	91	0.34	1.14	1.40	1.73	2.78	1.42	--	0.50	0.079	Yes	-0.126	0.376	No	-0.001	-0.014	0.339	No
Chloride, mg/L	150.00	59	2	37.70	97.40	114.00	138.75	159.00	112.97	--	30.21	0.287	No	0.089	0.320	No	0.331	-3.609	<0.001	Yes↓
Sulfate, mg/L	150.00	59	0	31.80	57.00	61.50	68.68	86.80	61.86	--	11.41	0.154	No	-0.203	0.023	Yes↓	0.002	-0.329	0.293	No
E. coli, MPN/100 mL	126.00	58	43	10.00	53.00	100.00	200.00	1300.00	--	120.07	235.63	0.685	No	0.208	0.022	Yes↑	-0.010	-4.448	0.511	No
Chlorophyll-*a*, µg/L	14.10	46	15	1.00	2.00	4.00	9.00	35.00	7.20	--	7.62	0.615	No	0.182	0.074	Yes↑	-0.020	-0.122	0.699	No

*No trending analysis due to >50% of data below the LOQ

This page has been intentionally left blank.

SAN ANTONIO
RIVER AUTHORITY

100 E. GUENTHER ST.
SAN ANTONIO, TX 78204
PHONE (210) 227-1373
TOLL FREE (866) 345-7272
WWW.SARA-TX.ORG