Chapter 1 Introduction to Watershed Management

The Watershed Approach

The watershed approach is widely accepted by state and federal water resource management agencies to facilitate water quality management. The U.S. Environmental Protection Agency (EPA) describes the watershed approach as "a flexible framework for managing water resource quality and quantity within a specified drainage area or watershed" (EPA 2008). The watershed approach requires engaging stakeholders to make management decisions backed by sound science (EPA 2008). One critical aspect of the watershed approach is that it focuses on hydrologic boundaries rather than political boundaries to address potential water quality impacts to all potential stakeholders.

A stakeholder is anyone who lives, works, has interest within the watershed or may be affected by efforts to address water quality issues. Stakeholders may include individuals, groups, organizations or agencies. The continuous involvement of stakeholders throughout the watershed approach is critical for effectively selecting, designing and implementing management measures that address water quality throughout the watershed.

Watershed Protection Plan

Watershed protection plans (WPPs) are locally driven mechanisms for voluntarily addressing complex water quality problems that cross political boundaries. A WPP serves as a framework to better leverage and coordinate resources of local, state and federal agencies, in addition to non-governmental organizations.

The Petronila and San Fernando Creek WPP follows the EPA's nine key elements, which are designed to provide guidance for the development of an effective WPP (EPA 2008). WPPs will vary in methodology, content and strategy based on local priorities and needs. However, common fundamental elements are included in successful plans and include (see Appendix C – Elements of Successful Watershed Protection Plans):

1: Identification of causes and sources of impairment
2: Expected load reductions from management strategies
3: Proposed management measures
4: Technical and financial assistance needed to implement management measures
5: Information, education and public participation needed to support implementation
6: Schedule for implementing management measures

7: Milestones for progress of WPP implementation

8: Criteria for determining successes of WPP implementation

9: Water quality monitoring

Adaptive Management

Adaptive management consists of developing a natural resource management strategy to facilitate decision-making based on an ongoing science-based process. Such an approach includes results of continual testing, monitoring, evaluating applied strategies and revising management approaches to incorporate new information, science and societal needs (EPA 2000).

An adaptive management strategy allows the management measures recommended in a WPP to adjust their focus and intensity as determined by the plan's success and the dynamic nature of each watershed. Throughout the life of the WPP, water quality and other measures of success will be monitored, and adjustments will be made as needed to the implementation strategy.

Education and Outreach

The development and implementation of a WPP depends on effective education, outreach and engagement efforts to inform stakeholders, landowners and residents of the activities and practices associated with the WPP. Education and outreach events provide the platform for the delivery of new and/or improved information to stakeholders through the WPP implementation process. Education and outreach efforts are integrated into many of the management measures that are detailed in this WPP.

Chapter 2 Watershed Characterization

Introduction

This chapter provides geographic, demographic, and water quality overviews of the Petronila and San Fernando Creek watershed. Development of the information within this chapter relied heavily on state and federal data resources as well as local stakeholder knowledge. The collection of this information was a critical component to the reliable assessment of potential sources of water quality impairment and the recommendation of beneficial management measures.

Watershed Description

Petronila Creek begins in western Nueces county near County Road 40 and flows approximately 44 miles downstream where it meets Tunas Creek in eastern Kleberg county. There, the creek flows into Cayo Del Mazón. San Fernando Creek begins at the confluence of the San Diego and Chiltipin creeks in Jim Wells County northeast of Alice. From there, it continues approximately 44 miles downstream to Cayo Del Grullo southeast of Kingsville. San Fernando, Petronila creek and their tributaries flow throughout portions of Duval, Jim Wells, Kleberg and Nueces counties (Table 1) and ultimately flow into Baffin Bay. The two creeks are two of three major tributaries to Baffin Bay, Los Olmos creek being the third tributary.

The watershed of San Fernando Creek is 1,270 square miles and Petronila Creek is 675 square miles for a total combined watershed area of 1,945 square miles (Figure 1). Both San Fernando and Petronila creeks are perennial freshwater streams until their last few miles which tend to be tidal. The watershed is predominately rural but does include several urban areas including the cities of Kingsville, Benavides, San Diego, Alice, Bishop, Driscoll, Aqua Dulce, Orange Grove, and a portion of Robstown. As these cities and their surrounding rural areas increase expansion of their residential and suburban landscapes, the ecological health of the water bodies within this region are facing rising potential threats. It is increasingly important to develop a plan to protect the watershed's creeks and streams.

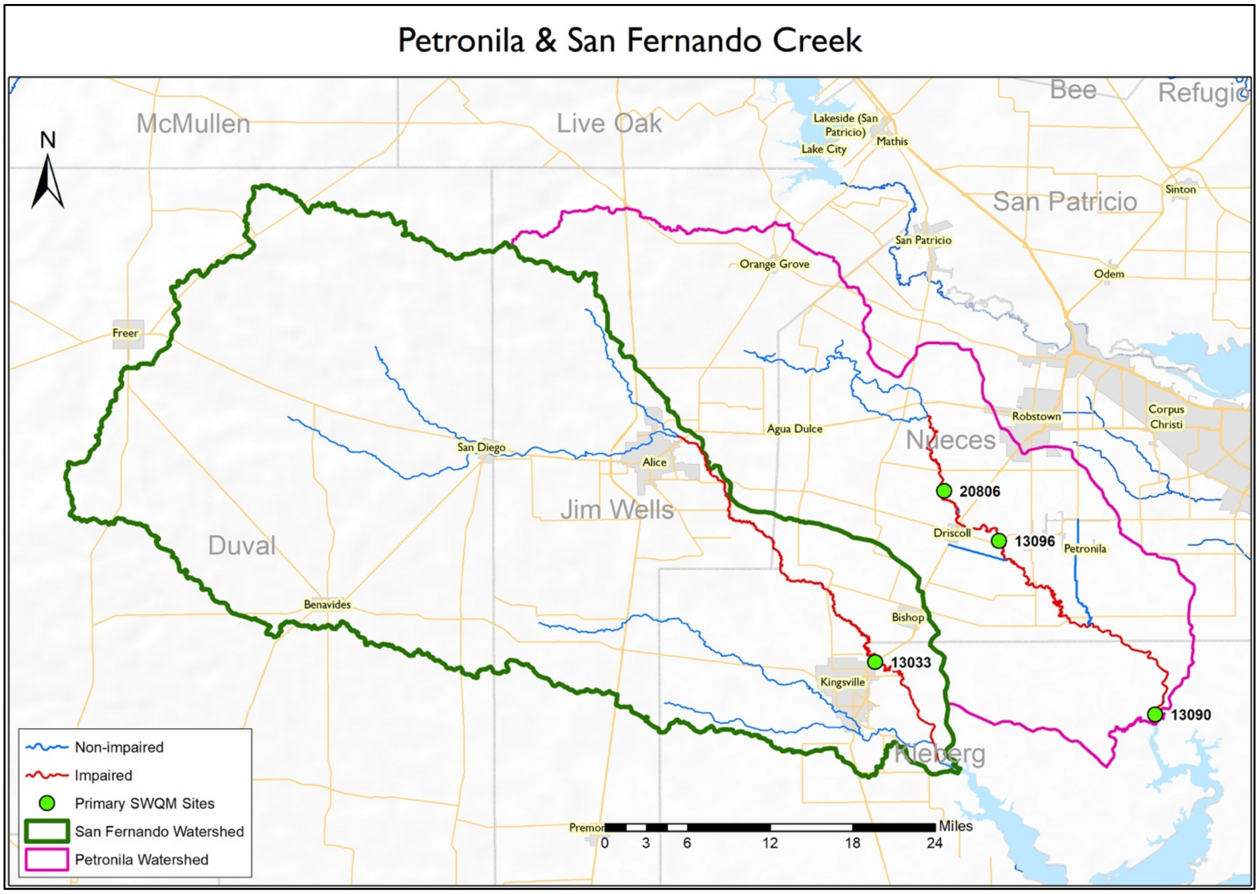


Figure 1. San Fernando and Petronila Creek watershed map.

Table 1. County and watershed area summary.

	Area of Total County (Acres)	Area of Watershed Within the County (Acres)	Percent of the Total County Within the Watershed (%)	Percent of the Watershed Within Each County (%)
Duval	1,149,259	421,469	36.7	33.8
Jim Wells	555,730	362,488	65.2	29.1
Kleberg	578,888	189,812	32.8	15.2
Nueces	549,498	273,333	49.7	21.9
Entire Watershed		1,247,102		100

Physical Characteristics

Soils and Topography

The soils and topography of a watershed are important components of watershed hydrology. Slope and elevation define where water will flow, while elevation and soil properties influence the quantity and speed at which water will infiltrate into the soil, as well as how much water will flow over or through the soil into a water body. Soil properties may also limit the types of development and activities that can occur in certain areas.

Elevation across the watershed ranges from a maximum approximate elevation of 241 feet (ft) above mean sea level (MSL) in the western part of the watershed to a minimum approximate elevation of 1 ft above MSL near the mouths of both San Fernando and Petronila creeks where they ultimately flow into Baffin Bay (Figure 2). Elevation was determined using the U.S. Geological Survey (USGS) 10-m 3D Elevation Program (3DEP, USGS 2019). Topography of the San Fernando and Petronila Creek watershed is comprised of mildly hilly terrain on the northwestern edge quickly giving way to a gradual smoothing of topography until the watershed meets the coast to the southeast.

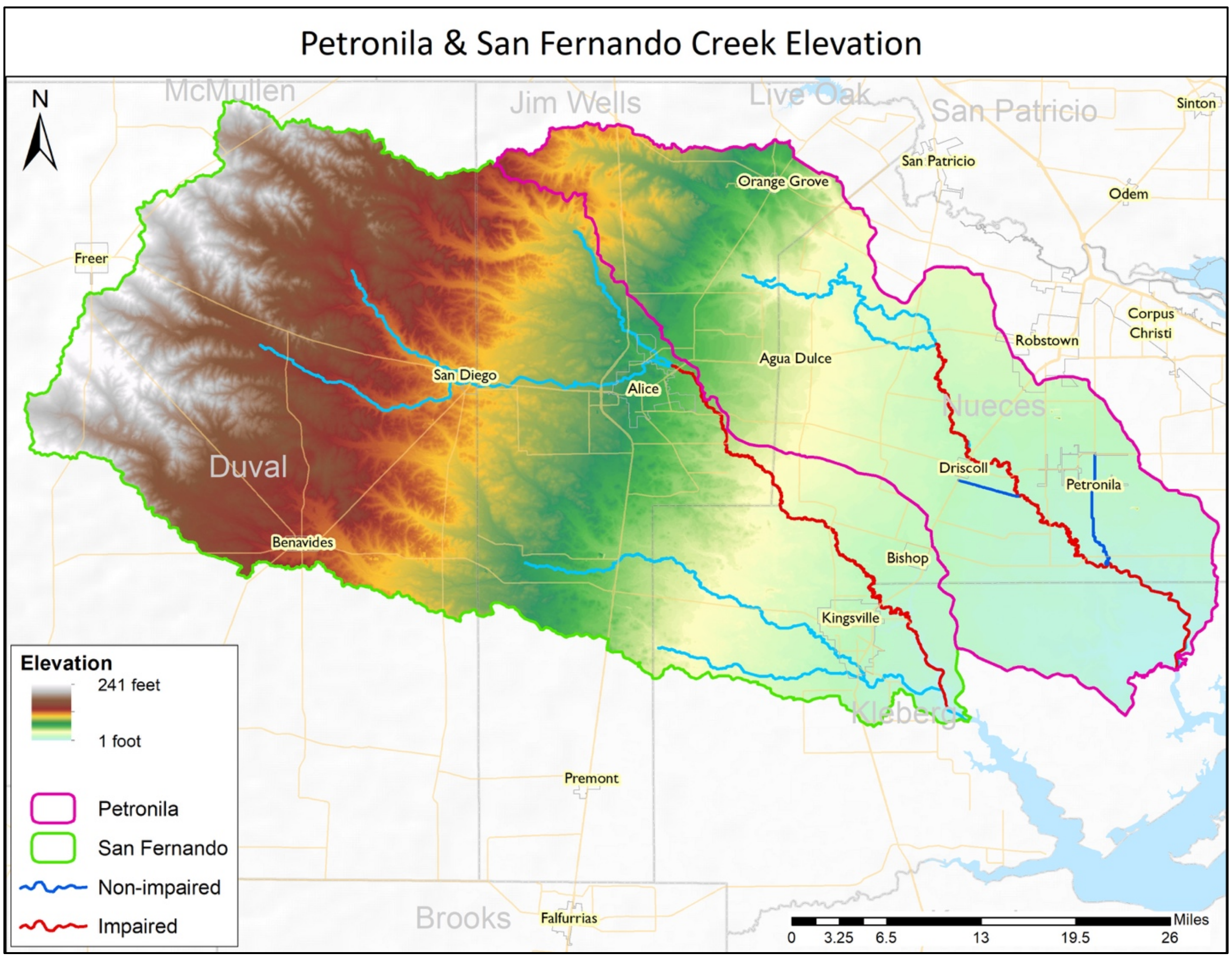


Figure 2. Watershed elevation.

The dominant soils in the San Fernando and Petronila Creek watersheds are Alfisols, Inceptisols, Mollisols and Vertisols (Figure 3). Mollisoils (47%; 744,625 acres (ac)) are characterized by a dark surface layer indicative of high amounts of organic material and are very fertile and productive for agricultural uses. Vertisols (29%; 464,088 ac), most common in the eastern part of the watershed, are clay-rich and exhibit a shrinking and swelling action with changes in moisture that can lead to wide cracks forming during dry periods. Alfisols (17%; 268,115 ac) tend to be found beneath mixed vegetative cover and are the result of the weathering process leaching clay minerals beneath the surface. Alfisols tend to hold water and provide moisture to plants even during moderately dry conditions. Inceptisols (2.2%; 108,404 ac) are common in humid and subhumid regions and are sprinkled throughout the central watershed.

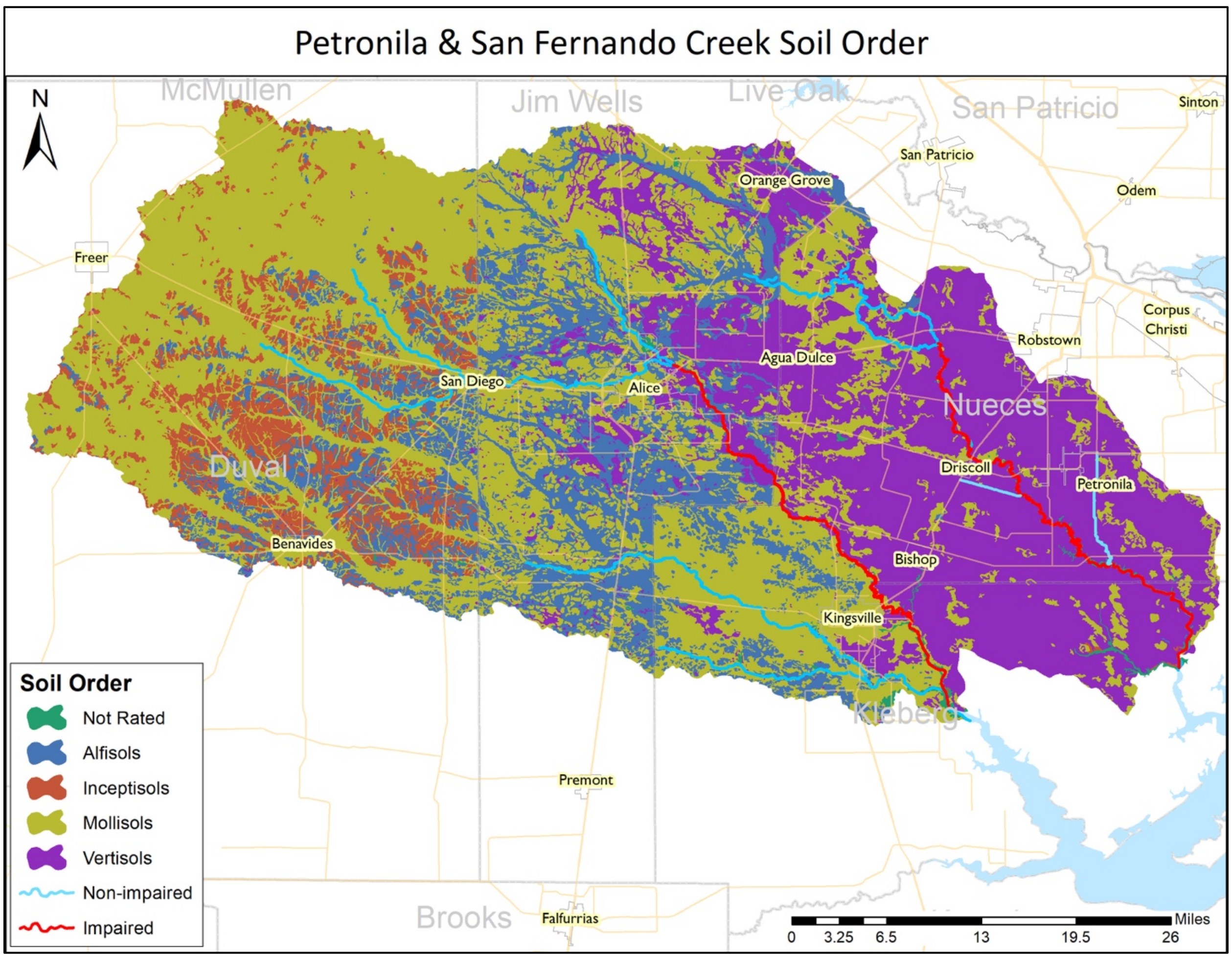


Figure 3. Watershed soil orders.

Hydrologic soil groups are groups of soil that indicate runoff potential and are determined based on the measure of precipitation, runoff and infiltration (NRCS 2009). There are four primary hydrologic soil groups. Group A is composed of sand, loamy sand or sandy loam with low runoff potential and high infiltration. Group B is well drained with silt loam or loam type soils. Group C consists of finer soils and slower infiltration. Group D has high clay content, low infiltration and high runoff potential. In the Group C/D, C represents the drained areas and D the undrained areas.

The western and central areas of the watershed contain a nearly even split between moderate and high runoff potential soils (Figure 4). The eastern portion of the watershed contains mostly slow infiltration soils with higher runoff potential. The predominate soil types in the watershed are Group C (45% of watershed soils) and Group B (29% of watershed soils). Group D soils comprise 25% of the watershed soils followed by Groups A and C/D, both at 1% of soils.

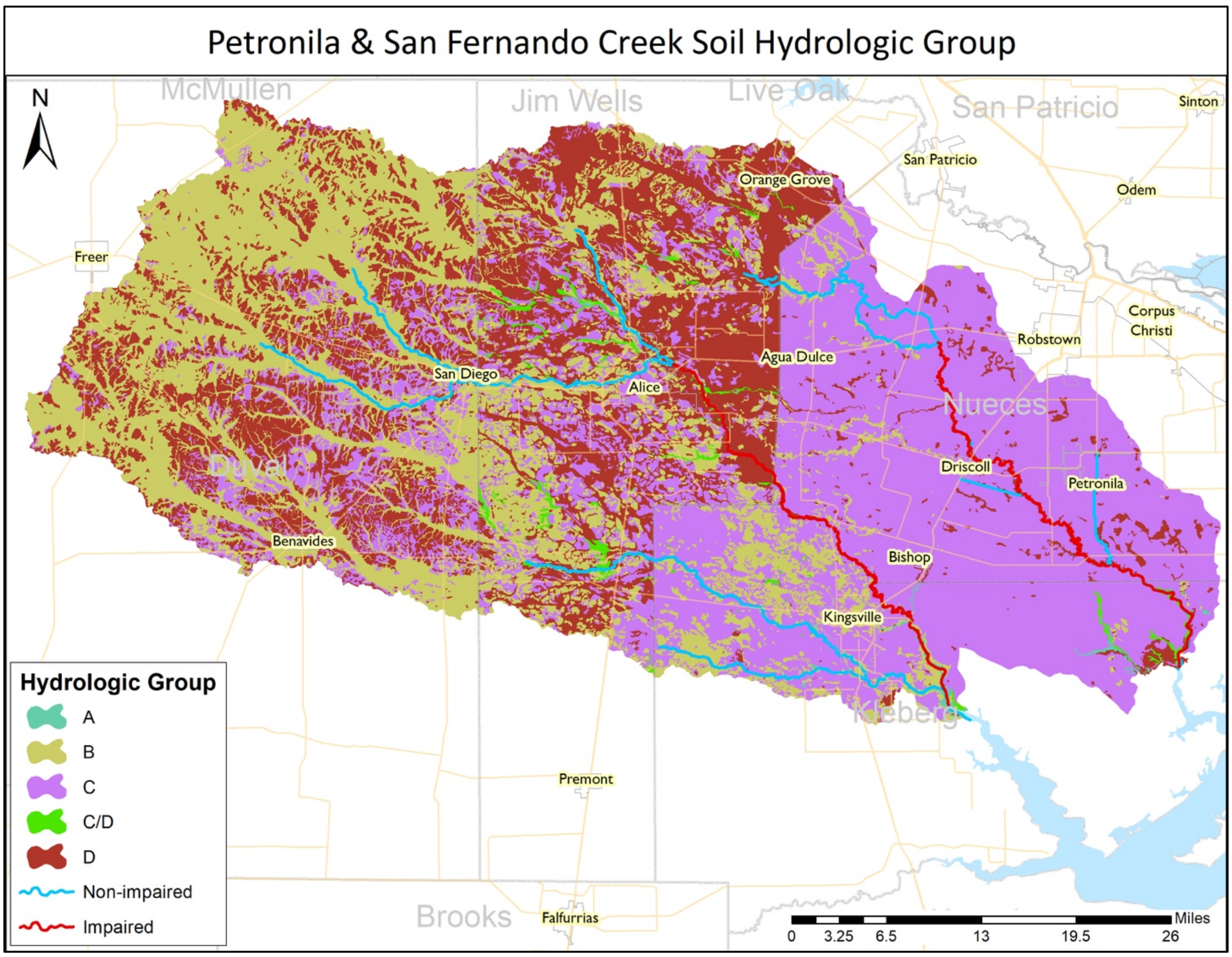


Figure 4. Hydrologic soil groups.

Land Use and Land Cover

According to 2016 National Land Cover Database (NLCD), dominant land use and land cover (LULC) categories are shrub/scrub (45.1%; 562,941 ac), cultivated crop (29.7%; 370,329 ac) and pasture/hay (15.6%; 194,917 ac) (Figure 5; Table 2). Developed, urban areas are present in the watershed, but only comprise 4.1% (51,414 ac) of the total land use.

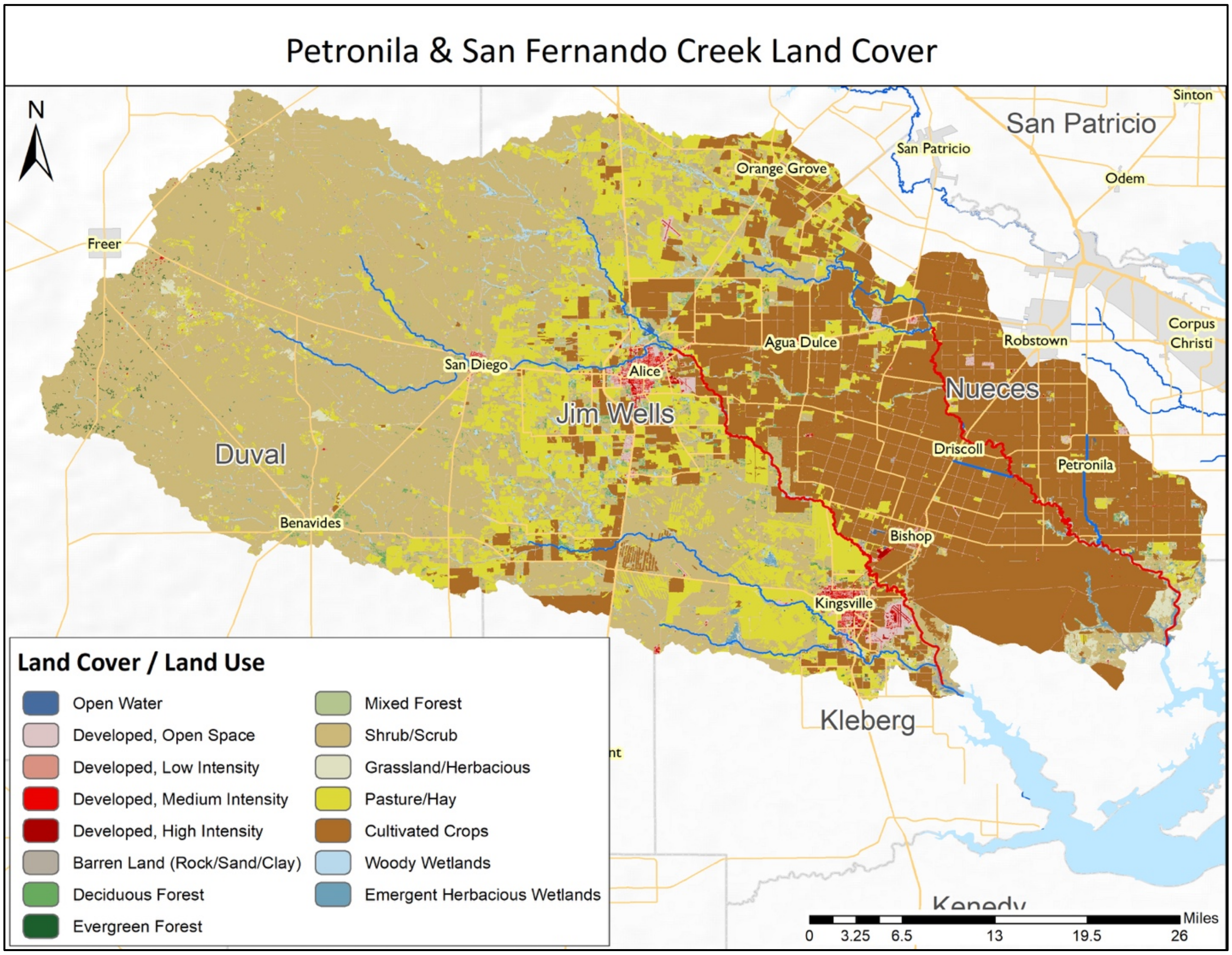


Figure 5. Watershed land use and land cover.

Table 2. LULC summary.

Land Use Class	Acreage	Percentage of Watershed
Developed Area	51,414	4.1%
Barren Land	3,694	0.3%
Forest	17,640	1.4%
Shrub/Scrub	562,941	45.1%
Grassland/Herbaceous	14,956	1.2%
Pasture/Hay	194,917	15.6%
Cultivated Crop	370,329	29.7%
Wetland	29,717	2.4%
Open Water	1,494	0.1%
Total Acreage	1,247,102	100.0%

Ecoregions

Ecoregions are land areas that contain similar quality and quantity of natural resources (Griffith 2007). Ecoregions have been delineated into four separate levels; level I is the most unrefined classification while level IV is the most refined. The watershed flows primarily through two ecoregions (level IV ecoregions), including the Texas-Tamaulipan Thornscrub (31c) throughout the western portion of the watershed in Duval and Jim Wells counties (Figure 6). From there, Southern Subhumid Gulf Coast Prairies (34b) begin and continue east through Kleberg and Nueces counties to the bay. At the southern tip of the Petronila Creek watershed, a small area of Laguna Madre Barrier Islands and Coastal Marshes (34i) exists. The dominant soil types are fine, fine-loamy to the west of the watershed transitioning to mostly fine soils to the east.

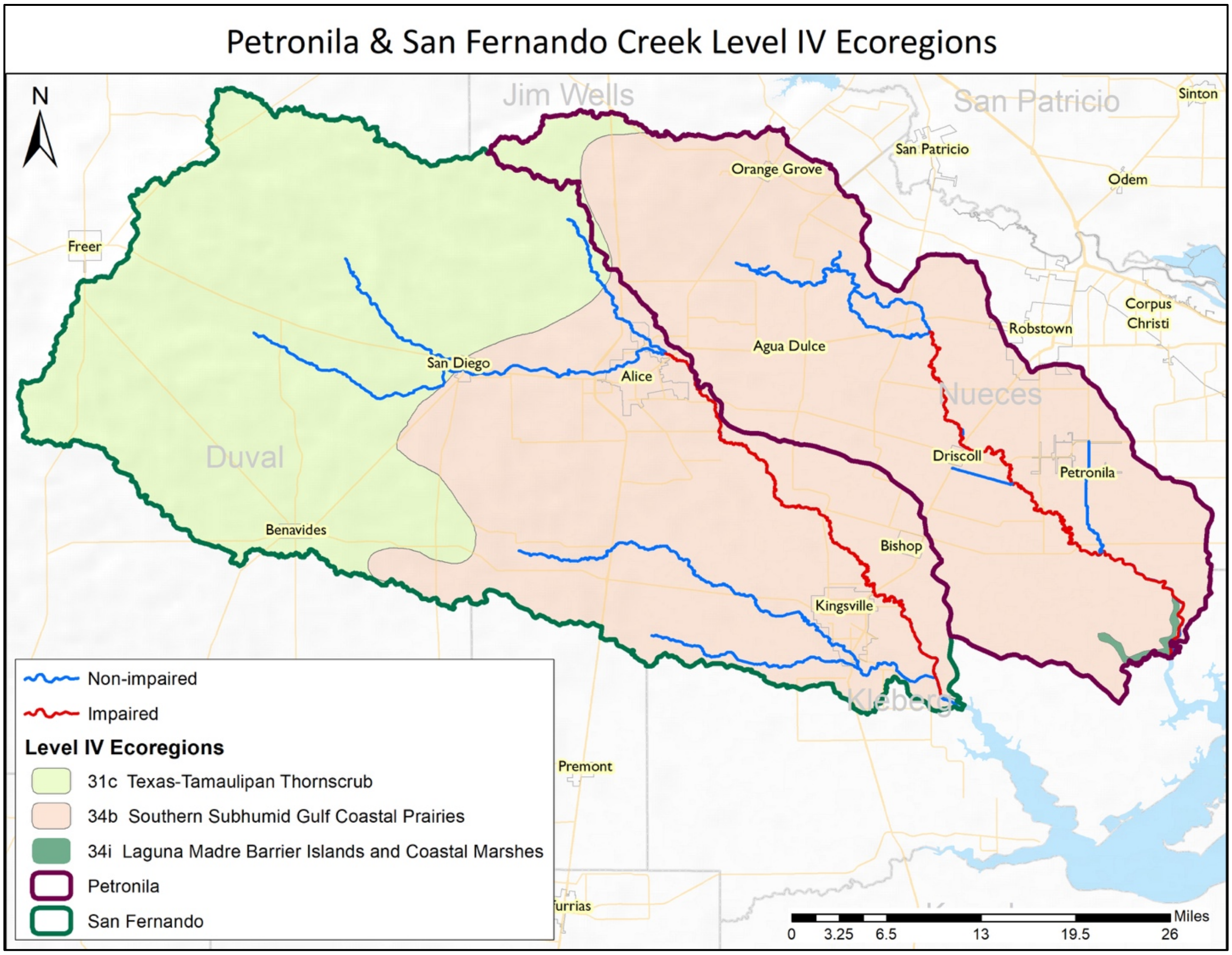


Figure 6. Level IV ecoregions.

Climate

The San Fernando and Petronila Creek watershed is characterized as a humid subtropical climate zone, with hot summers and warm or mild winters. The average annual precipitation in the watershed from 2011 to 2021 ranged between 21 inches (in) to 30 in (Figure 7). Peak monthly average precipitation occurs in May and September. The driest months are typically January, July and November. The warmest months on average are July and August with an average temperature of 97°F (Figure 8). January is the coldest month with average lows around 47°F (NOAA 2021).

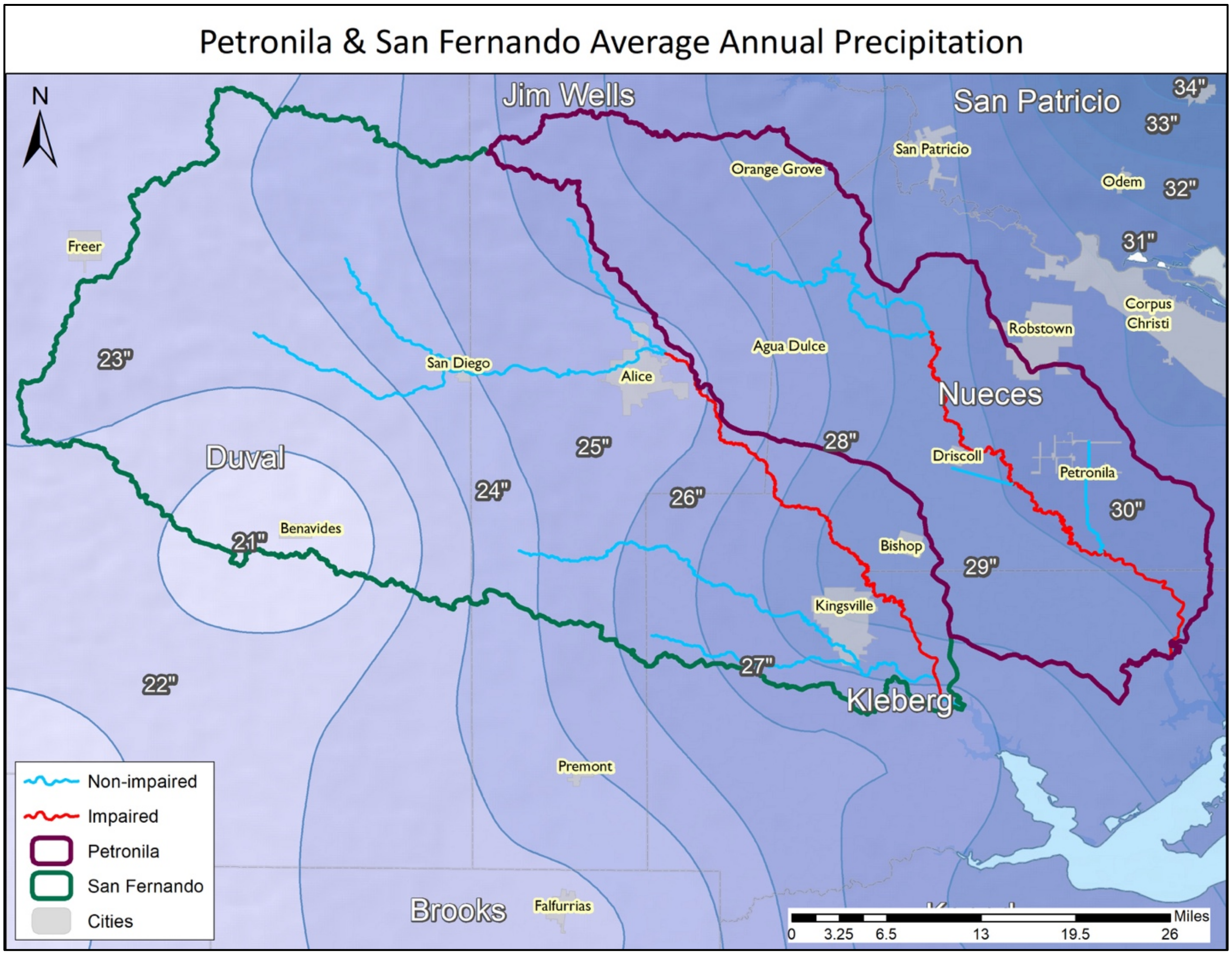


Figure 7. Annual normal precipitation in inches.

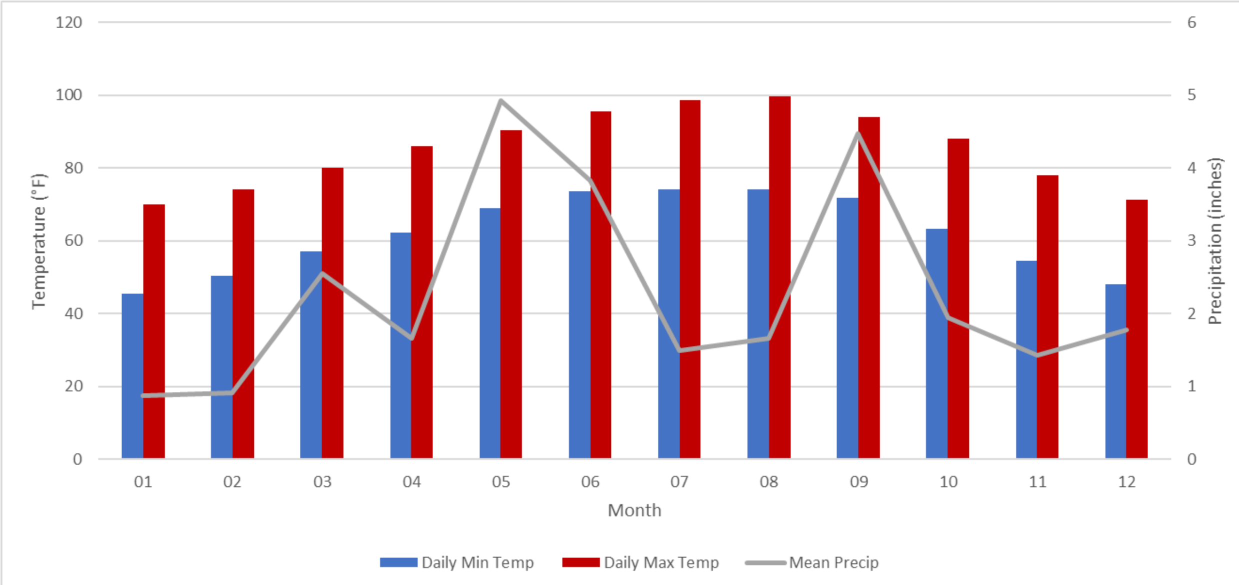


Figure 8. Monthly mean maximum and minimum air temperatures (°F) and monthly mean rainfall (inches) measured at Alice International Airport, TX (NOAA, 2021).

Population

According to 2010 Census data, the highest population densities are along SH-44, US-281, and US-77. These highways, along with ancillary roads, connect the major population concentrations found in the cities of Kingsville, Bishop, Driscoll, Petronila, Alice, Agua Dulce, Orange Grove, Banquete, Benavides, San Diego, and a small area of Robstown (Figure 9). The watershed population was approximately 83,846 based on the 2010 Census data from U.S. Census Bureau (USCB), with all watershed counties projecting population increase over the next 50 years, provided by the Office of the State Demographer and the Texas Water Development Board (TWDB).

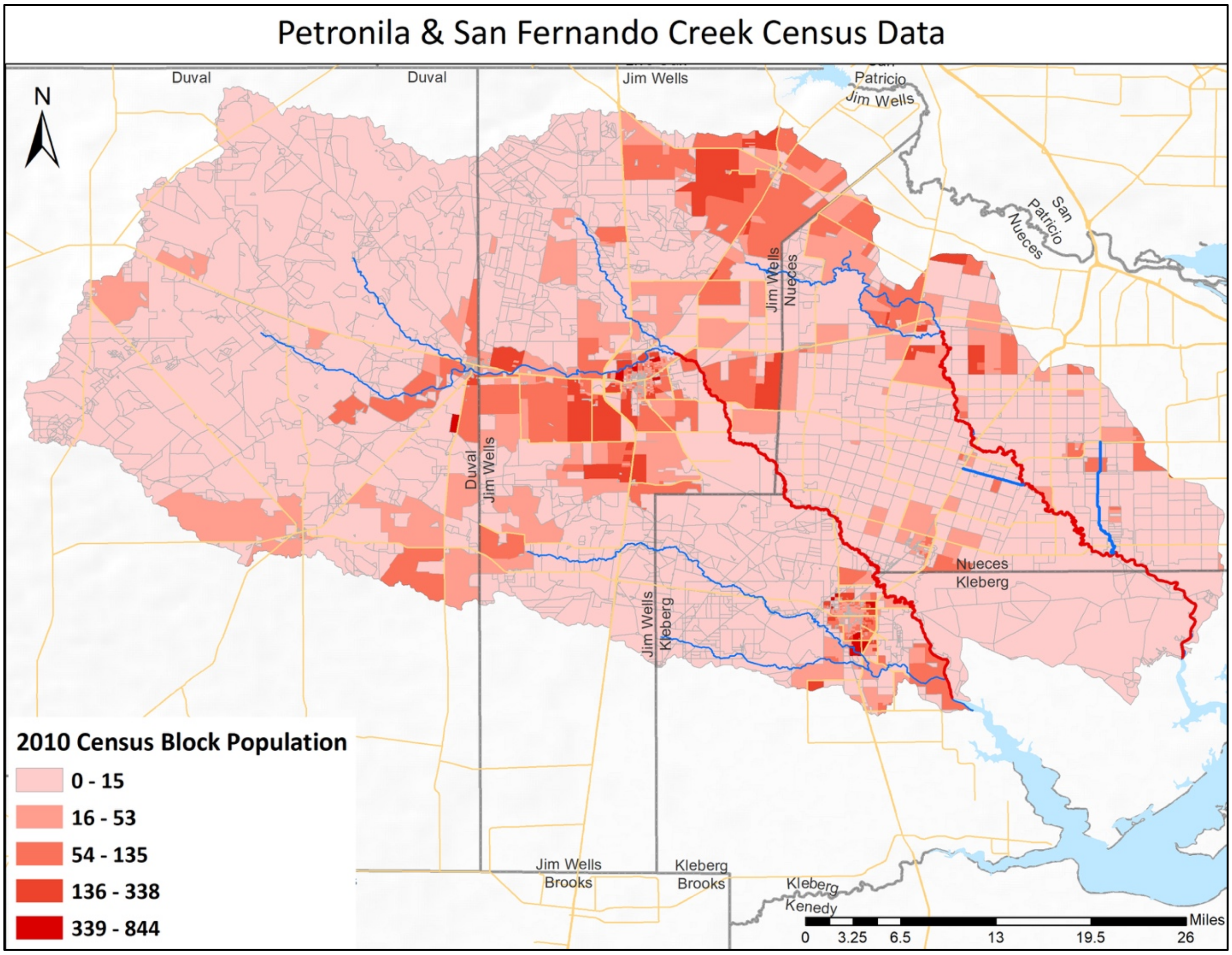


Figure 9. 2010 U.S. Census population estimates.

Between 2020 and 2070, significant population growth is expected in Duval, Jim Wells, Kleberg, and Nueces counties (Table 3). With this growth, we can expect increased residential and commercial development and further pressures on existing wastewater infrastructure.

Table 3. County population projections through 2070.

County	2020	2030	2040	2050	2060	2070	Population Increase
Duval	12,715	13,470	14,098	14,644	15,080	15,435	21%
Jim Wells	44,987	48,690	52,052	55,533	58,600	61,410	37%
Kleberg	35,567	38,963	42,202	45,324	48,251	50,989	43%
Nueces	374,157	407,534	428,513	440,797	449,936	465,056	24%
Total in Watershed	467,426	508,657	536,865	556,298	571,867	592,890	27%

Aquifers

Texas has 9 major and 22 minor aquifers, but only one lies beneath the San Fernando and Petronila Creek watershed. The Gulf Coast aquifer spans the entire substrate of the watershed. Near the Gulf Coast, the aquifer tends to yield water too high in salinity for irrigation with levels between 1,000 and 10,000 milligrams per liter of dissolved solids. As distance from the coast increases, the aquifer, less impacted by saltwater-intrusion, has a low enough salinity that it is used in groundwater irrigation systems.

Chapter 3 Water Quality

Water is monitored in Texas to ensure that its quality supports designated uses defined in the Texas Water Code. Designated uses and associated standards are developed by Texas Commission on Environmental Quality (TCEQ) to fulfill requirements of the Clean Water Act (CWA), which addresses toxins and pollution in waterways and establishes a foundation for water quality standards. It requires states to set standards that: (1) maintain and restore biological integrity in the waters, (2) protect fish, wildlife and recreation in and on the water (must be fishable/swimmable) and (3) consider the use and value of state waters for public supplies, wildlife, recreation, agricultural and industrial purposes.

The CWA (33 USC § 1251.303), administered by the EPA (40 CFR § 130.7), requires states to develop a list that describes all water bodies that are impaired and are not within established water quality standards (commonly called "303(d) list" in reference to Texas Water Quality Inventory and 303(d) List). In addition, states are required to develop total maximum daily loads (TMDLs) or other acceptable strategies to restore water quality of impaired water bodies. A TMDL is a budget that sets the maximum pollutant loading capacity of a water body and the reduction needed for a water body to meet applicable standards. The development of a stakeholder-driven WPP is another potential strategy. By encouraging stakeholders to address possible causes and threats of impairments and giving them decision-making powers to set WPP goals, WPPs can provide a comprehensive, long-term restoration plan with water body assessments and protection strategies.

Water Body Assessments

TCEQ conducts a water body assessment on a biennial basis to satisfy requirements of federal Clean Water Act Sections 305(b) and 303(d). The resulting *Texas Integrated Report of Surface Water Quality* (*Texas Integrated Report*) describes the status of water bodies throughout the state of Texas. The most recent finalized *2020 Texas Integrated Report* includes an assessment of water quality data collected from December 1, 2011 to November 30, 2018.

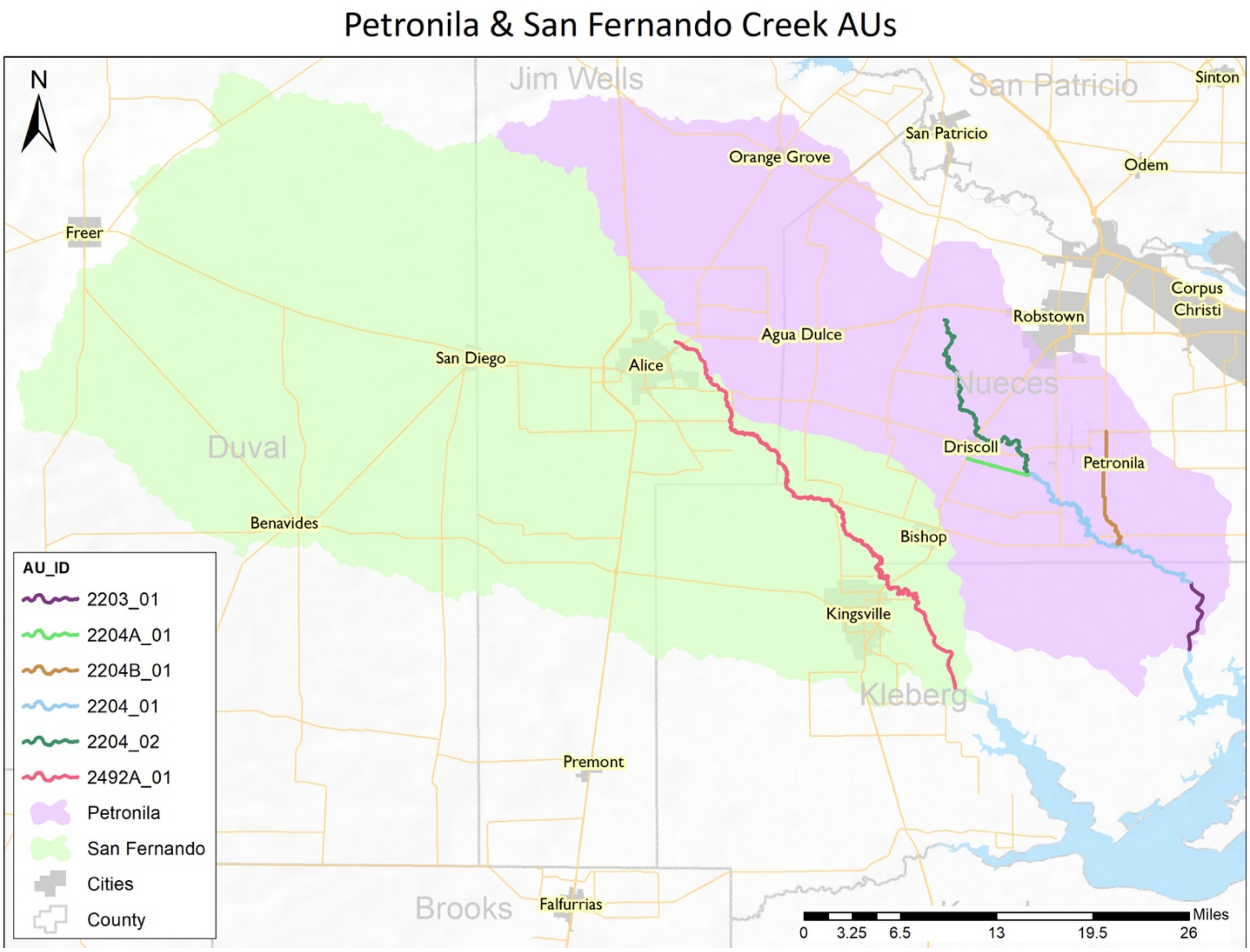


Figure 50. Petronila and San Fernando Creek Assessment Units (AU).

The *Texas Integrated Report* assesses water bodies at the Assessment Units (AU) level. An AU is a sub-area of a segment, defined as the smallest geographic area of use support reported in the assessment (TCEQ 2020). Each AU is intended to have relatively homogeneous chemical, physical and hydrological characteristics, which allows a way to assign site-specific standards (TCEQ 2020). A segment identification number and AUs are combined and assigned to each water body to divide a segment. For example, Petronila Creek is segment 2204 and it has two AUs designated 2204_01 and 2204_02. The tidal portion of Petronila Creek, which would be expected to have different characteristics than the non-tidal portions, is assigned a different segment identification number and AU, 2203_01.

In total, there are 6 AUs in the San Fernando and Petronila watershed (Figure 10). Monitoring stations are located on several of the AUs and typically allow independent water quality analysis for each AU within a segment. At least 10 data points within the most recent seven years of available data are required for all water quality parameters except bacteria, which requires a minimum of 20 samples. Water quality data from 6 monitoring stations within the San Fernando and Petronila Creek watersheds were reviewed. (Figure 11 and Table 4). For the development of this WPP, two stations have been identified for use generating load duration curves; stations 13033 and 13096. These two stations are representative of the water bodies upon which they are located.

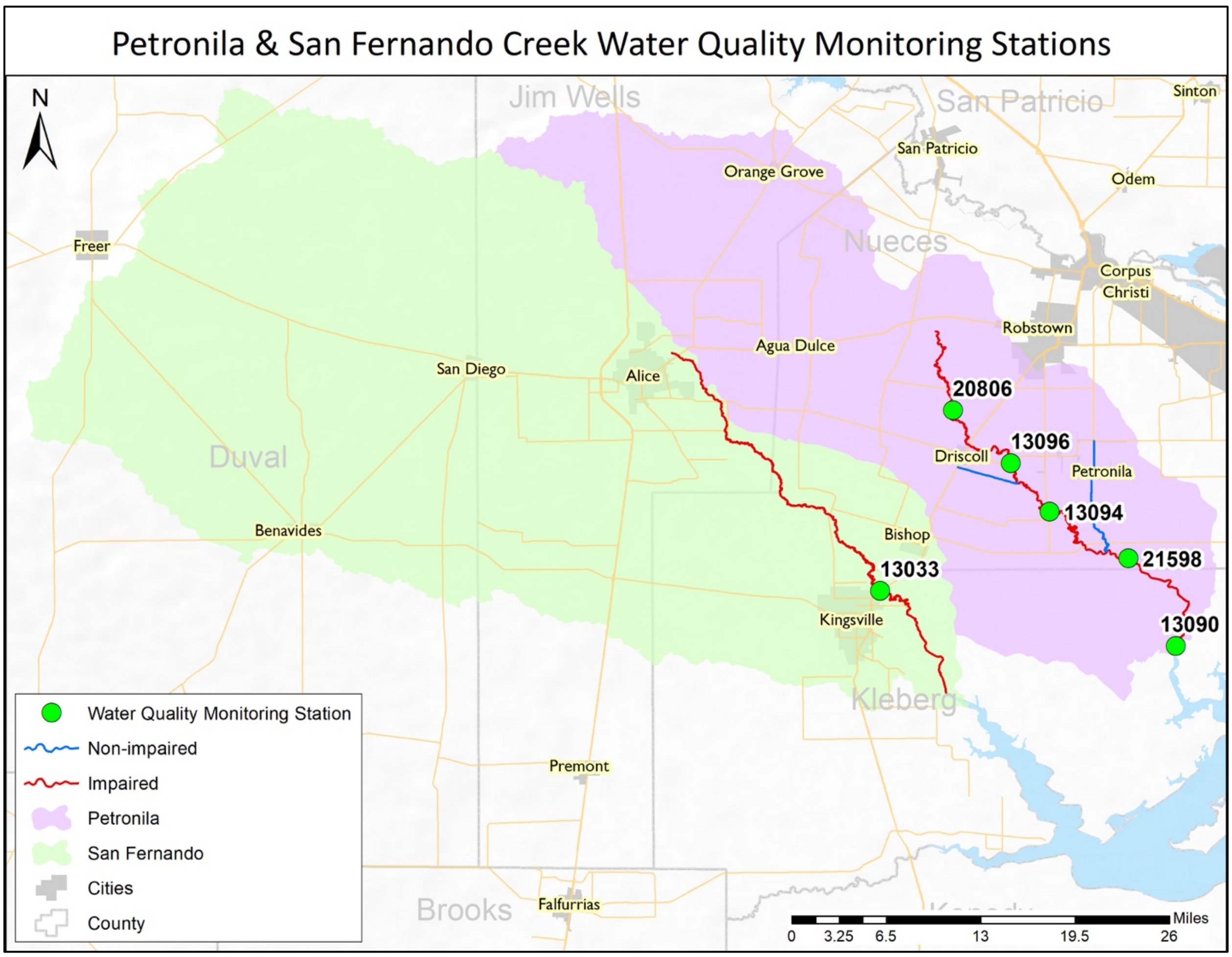


Figure 61. Water quality monitoring stations.

Table 4. Water quality monitoring station summary from December 1, 2011 to November 30, 2018.

Station	AUs	Samples	Location
13033	2492A_01	60	San Fernando Ck at US 77
13090	2203_01	42*	Petronila Ck above Tunas Confluence
13094	2204_01	41	Petronila Ck at FM 892
21598		1	Outfall ditch to Petronila Ck from Cefe Valenzuela Landfill
13096	2204_02	53	Petronila Ck at FM 665
20806		40	Petronila Ck southwest of Alice Rd & Lost Creek Rd

Sample numbers are based on reported E. coli, IDEXX-Colilert samples.
**Sample number based on enterococci, IDEXX-Enterolert samples because AU 2203_01 is a tidal segment.*

Table 5. Watershed impairments in 2020 Texas Integrated Report.

Parameter	Category	AUs	River Reach	Criteria
Bacteria	5b*	2203_01	Petronila Creek Tidal	35 cfu/100 mL
		2204_01	Petronila Creek Above Tidal	126 cfu/100 mL
		2204_02		
	5c**	2492A_01	San Fernando Creek	

Assessment unit, AU; colony forming unit, cfu; milliliter, mL
**Category 5b – 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 Texas Surface Water Quality Standards (TSWQSs).*
***Category 5c – Additional data or information will be collected and/or evaluated for one or more parameters before a management strategy is selected.*

According to the *2020 Texas Integrated Report* on surface water quality, four AUs in the watershed are impaired due to elevated bacteria (AU 2203_01, 2204_01, 2204_02 and 2492A_01) (Table 5). The criteria used for non-tidal, fresh recreational waters is 126 *E. coli* cfu / 100 mL. The criteria for marine (tidal) recreational waters is 35 *enterococci* cfu / 100 mL. Furthermore, a number of concerns are identified including nutrient and bacteria concerns in four AUs in the combined San Fernando and Petronila watershed (Table 6).

Table 6. Watershed concerns identified in the 2014 Texas Integrated Report.

Parameter	AUs	River Reach	Criteria
Bacteria	2203_01	Petronila Creek Tidal	35 cfu / 100 ml
	2204_01	Petronila Creek Above Tidal	126 cfu/100 ml
	2204_02		
	2492A_01	San Fernando Creek	
Chlorophyll-a	2203_01	Petronila Creek Tidal	>20% exceedance (0.021 mg/L Standard Screening Level)
	2204_01	Petronila Creek Above Tidal	>20% exceedance (0.0141 mg/L Standard Screening Level)
	2204_02		
	2492A_01	San Fernando Creek	
Nitrate	2492A_01	San Fernando Creek	>20% exceedance (1.95 mg/L Standard Screening Level)
Total Phosphorus	2492A_01	San Fernando Creek	>20% exceedance (0.69 mg/L Standard Screening Level)

Assessment unit, AU; colony forming unit, cfu; milliliter, mL; milligrams, mg; liter, L

3.2: Texas Surface Water Quality Standards

Water quality standards are established by the state and approved by EPA to define a water body's ability to support its designated uses, which may include: aquatic life use (fish, shellfish, and wildlife protection and propagation), primary contact recreation (swimming), public water supply and fish consumption. Water quality indicators for these uses include DO (aquatic life use), *E. coli* (primary contact recreation), pH, temperature, total dissolved solids, sulfate and chloride (general uses), and a variety of toxins (fish consumption and public water supply) (Table 7) (TCEQ 2020).

Table 7. Designated uses, use categories, and criteria for water bodies in the San Fernando and Petronila Creek Watershed.

Use	Segment Number	Use Category	Criteria	Measure
Contact Recreation	2203	Primary contact recreation 1	35 cfu / 100 ml *(enterococci)*	7-year geometric mean
	2204		126 cfu/100 mL (*E. coli*)	
	2492			
Aquatic Life Use	2203*	High	4.0/3.0 mg/L DO*	<10% exceedance based on the binomial method
	2204	Intermediate	4.0/3.0 mg/L DO	
	2492	High	5.0/3.0 mg/L DO	
General Use Standards	The criteria for the general use include aesthetic parameters, radiological substances, toxic substances, temperature (when surface samples are above 5˚F and not attained due to permitted thermal discharges) and nutrients (screening standards or site-specific nutrient criteria)			

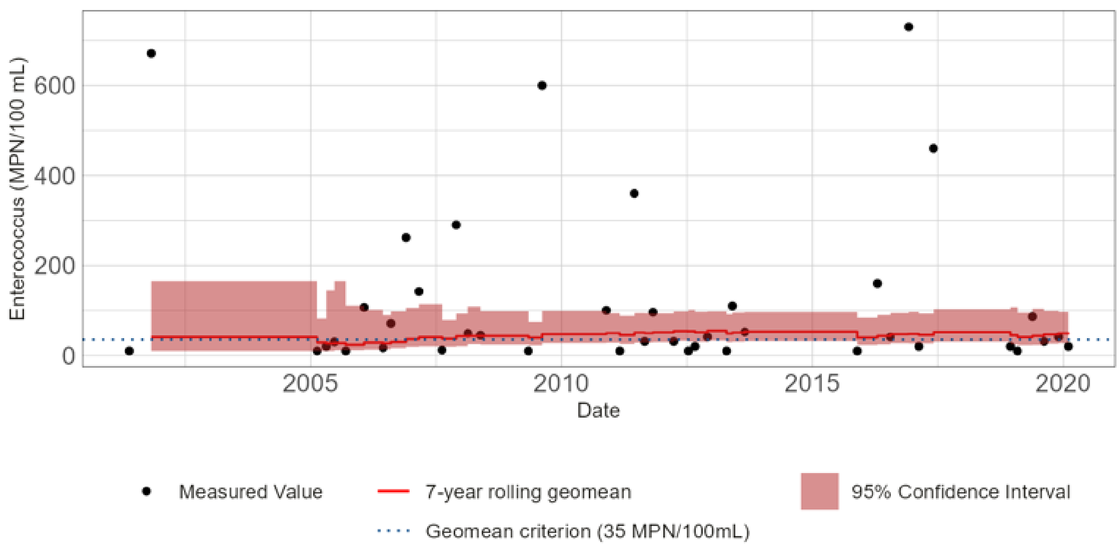
Colony forming unit, cfu; milliliter, mL; milligrams, mg; liter, L; dissolved oxygen, DO; Fahrenheit, F

**Segment 2203 is the tidal portion of Petronila Creek. Saline water has less capacity for dissolved oxygen (DO), therefore; while 4.0/3.0 mg/L DO is only considered Intermediate in freshwater, it is considered High for tidal water.*

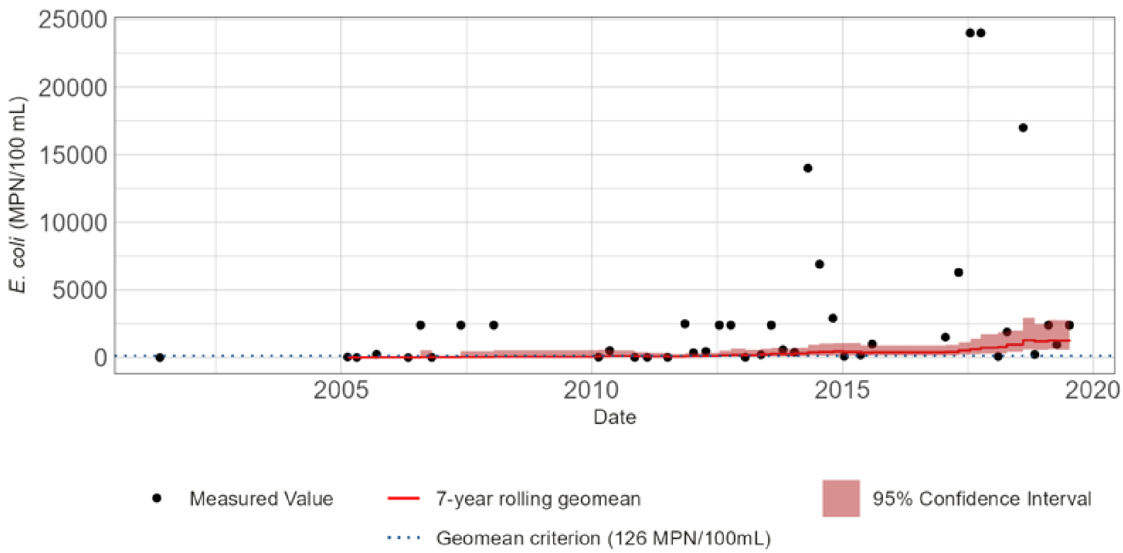
3.3: Bacteria

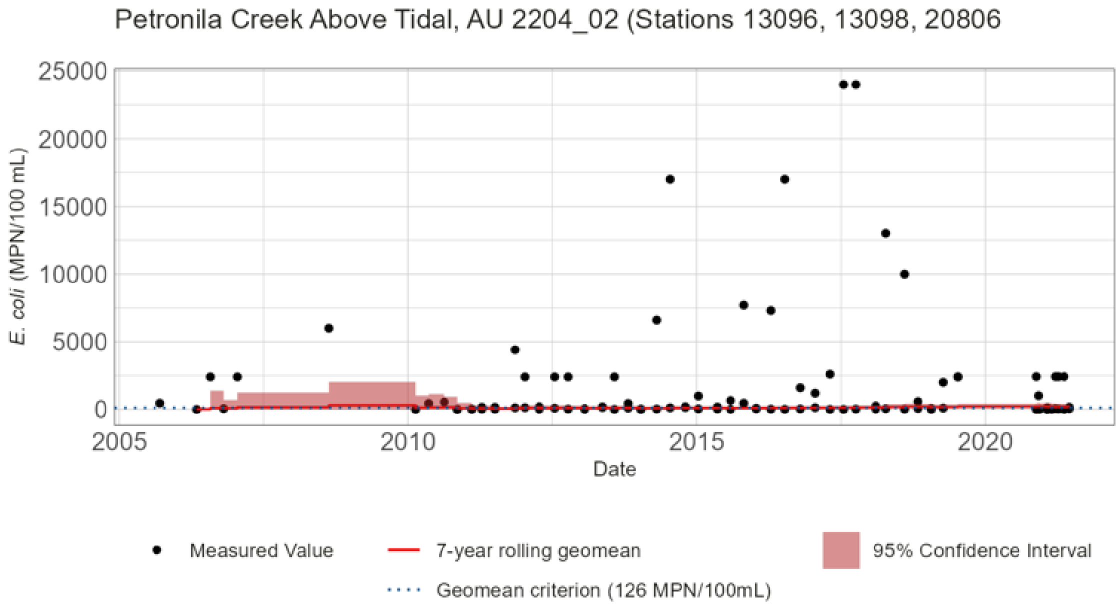
Concentrations of fecal indicator bacteria are evaluated to assess a waterbody's ability to meet its contact recreation use. In freshwater environments, concentrations of *E. coli* bacteria are measured to evaluate the presence of potential fecal contamination in water bodies. The presence of these fecal indicator bacteria may indicate that associated pathogens from the intestinal tracts of warm-blooded animals or other sources could be reaching water bodies and can cause illness in people that recreate in them. The water quality standards for bacteria in freshwater and tidal waters differ. In freshwater, the standard for primary contact recreation is a geometric mean of 126 colony forming units (cfu) of *E. coli* per 100 milliliters (mL) of water. In tidal waters, the primary contact recreation standard is 35 cfu of enterococci per 100 mL of water. Both standards must be measured from at least 20 samples (30 TAC § 307.7). Common sources that indicator bacteria can originate from include wildlife, domestic livestock, pets, malfunctioning on-site sewage facilities (OSSFs), urban and agricultural runoff, sewage system overflows and direct discharges from wastewater treatment facilities (WWTFs).Currently, four AUs are listed as impaired due to elevated indicator bacteria (TCEQ 2020).

Petronila Creek Tidal, AU 2203_01 (Stations 13090, 13091)



Petronila Creek Above Tidal, AU 2204_01 (Stations 13093, 13094, 13095





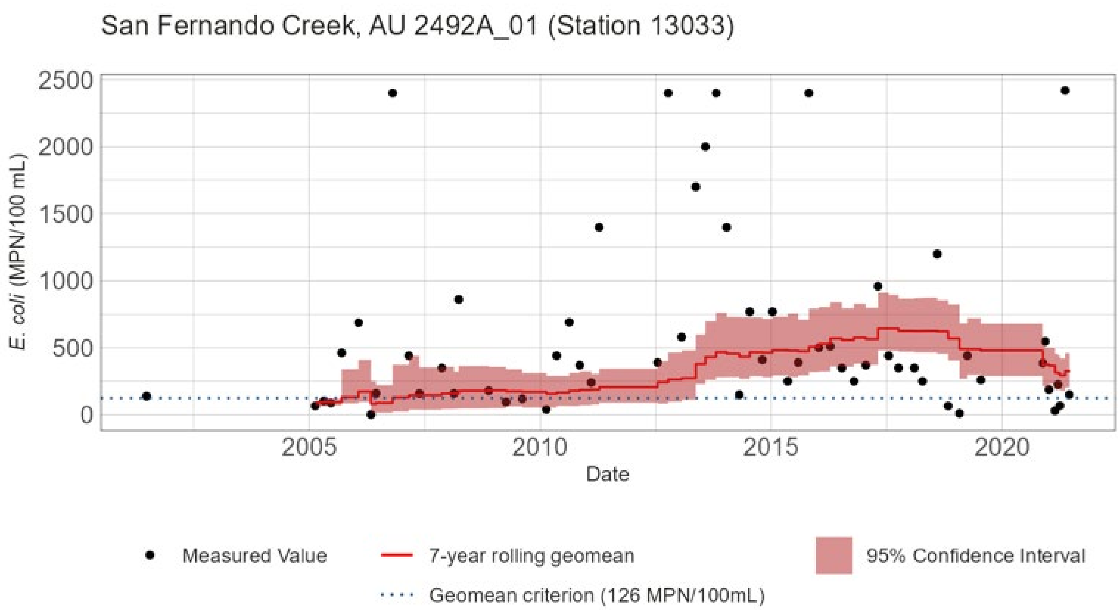


Figure 72. E. coli concentrations in impaired freshwater assessment units (AUs). Enterococci concentrations in tidal AU 2203_01.

3.4: Dissolved Oxygen

DO is the main parameter used to determine a water body's ability to support and maintain aquatic life uses. If DO levels in a water body drop too low, fish and other aquatic species will not survive. Typically, DO levels fluctuate throughout the day, with the highest levels of DO occurring in mid to late afternoon, due to plant photosynthesis. DO levels are typically lowest just before dawn as both plants and animals in the water consume oxygen through respiration. Furthermore, seasonal fluctuations in DO are common because of decreased oxygen solubility in water as temperature increases; therefore, it is common to see lower DO levels during summer.

While DO can fluctuate naturally, human activities can also cause abnormally low DO levels. Excessive organic matter (vegetative material, untreated wastewater, etc.) can result in depressed DO levels as bacteria break down the materials and subsequently consume oxygen. Excessive nutrients from fertilizers and manures can also depress DO as aquatic plant and algae growth increase in response to nutrients. The increased respiration from plants and decay of organic matter as plants die off can also drive down DO concentrations.

When evaluating DO levels in a water body, TCEQ considers that monitoring events need to be spaced over an index period and a critical period. The index period represents the warm-weather season of the year and spans from March 15th to October 15th. The critical period of the year is July 1st to September 30th and is the portion of the year when minimum streamflow, maximum temperatures and minimum DO levels typically occur across Texas. At least half of the samples used to assess a stream's DO levels should be collected during the critical period with one-fourth to one-third of the samples used coming from the index period. DO measurements collected during the cold months of the year are not considered because flow and DO levels are typically highest during the winter months (TAC §307 2014). Under the 2020 Texas Integrated Report, none of the AUs in the San Fernando or Petronila Creek watersheds were listed as impaired for depressed DO though it will be monitored in this WPP as one indicator of the overall health of each segment.

3.5: Nutrients

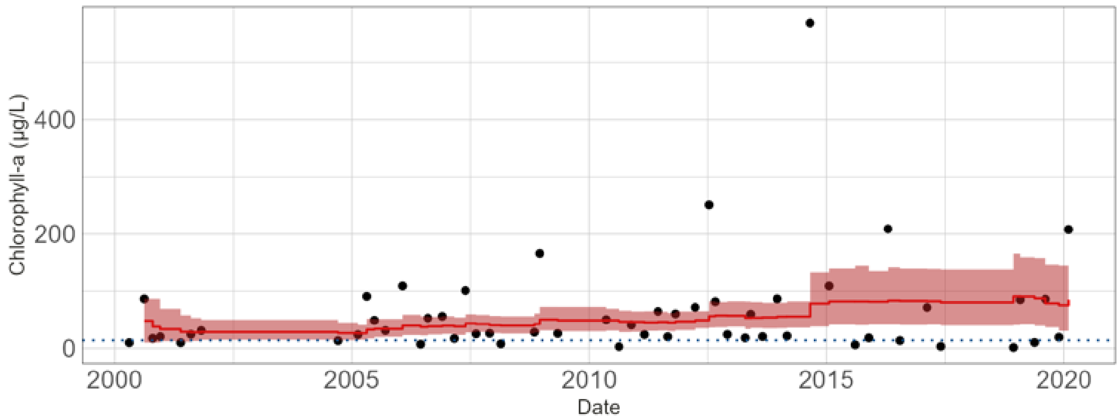
Nutrients, specifically nitrogen and phosphorous, are used by aquatic plants and algae. However, as previously mentioned, excessive nutrients can lead to plant and algal blooms, which will result in reduced DO levels. High levels of nitrates and nitrites can directly affect respiration in fish. Sources of nutrients include effluents from WWTFs and OSSFs, direct deposition of animal fecal matter, illegal dumping of refuse, groundwater return flows, and fertilizers that runoff from yards and agricultural fields. Additionally, nutrients bind to soil and sediment particles, therefore; runoff and erosion events that result in heavy loads of sediment can increase nutrient levels in water bodies.

Nutrient standards have not been set in Texas. However, nutrient screening levels developed for statewide use were established to protect water bodies from excessive nutrient loadings. Screening levels are set at the 85th percentile for parameters from similar water bodies. If more than 20% of samples from a water body exceed the screening level, that water body is on average experiencing pollutant concentrations higher than 85% of the streams in Texas and is therefore considered to have an elevated nutrient concentration concern. Screening levels have been designated for ammonia, nitrate, orthophosphorus, total phosphorus and chlorophyll-a. The current screening level in freshwater streams for chlorophyll-a is 14.1 μg/L; nitrate is 1.95 mg/L; and total phosphorous is 0.69 mg/L (Table 8). For tidal streams, the chlorophyll-a screening level is 2.1 μg/L. The nutrient levels in several AUs are analyzed and the results are shown in Figure 13 (Chlorophyll-a), Figure 14 (Nitrate), and Figure 15 (Total Phosphorus).

Table 8. Watershed nutrient screening levels and criteria.

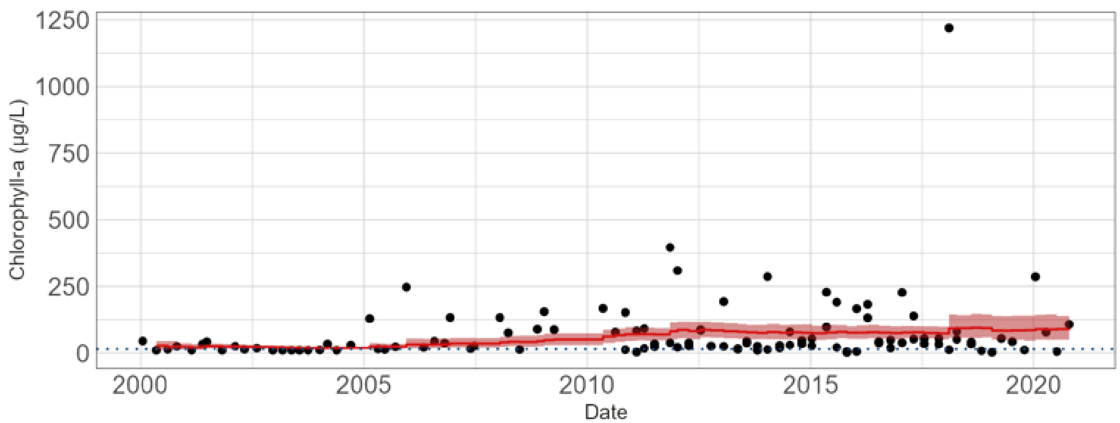
Parameter	Standard Screening Level	Criteria
Ammonia Nitrogen (NH3-N)	0.33 mg/L	> 20% exceedance
Nitrate Nitrogen (NO3-N)	1.95 mg/L	
Chlorophyll-a	14.1 μg/L 2.1 μg/L (tidal)	
Total Phosphorous (TP)	0.69 mg/L	

Petronila Creek Tidal, AU 2203_01 (Stations 13090, 13091)

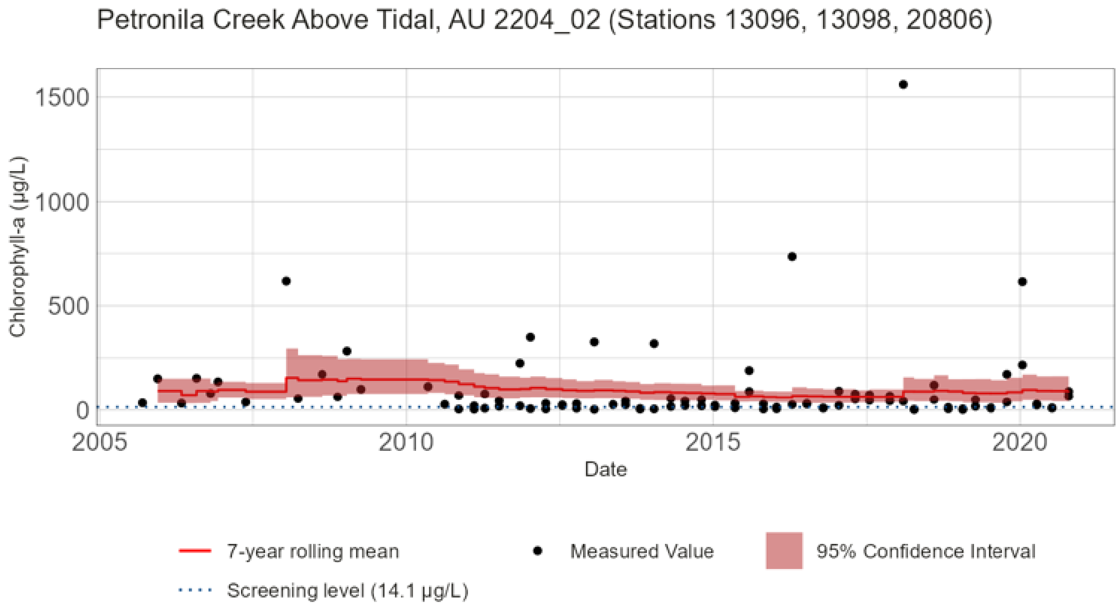


7-year rolling mean · Measured Value · 95% Confidence Interval · Screening level (14.1 µg/L)

Petronila Creek Above Tidal, AU 2204_01 (Stations 13093, 13094, 13095)



7-year rolling mean · Measured Value · 95% Confidence Interval · Screening level (14.1 µg/L)



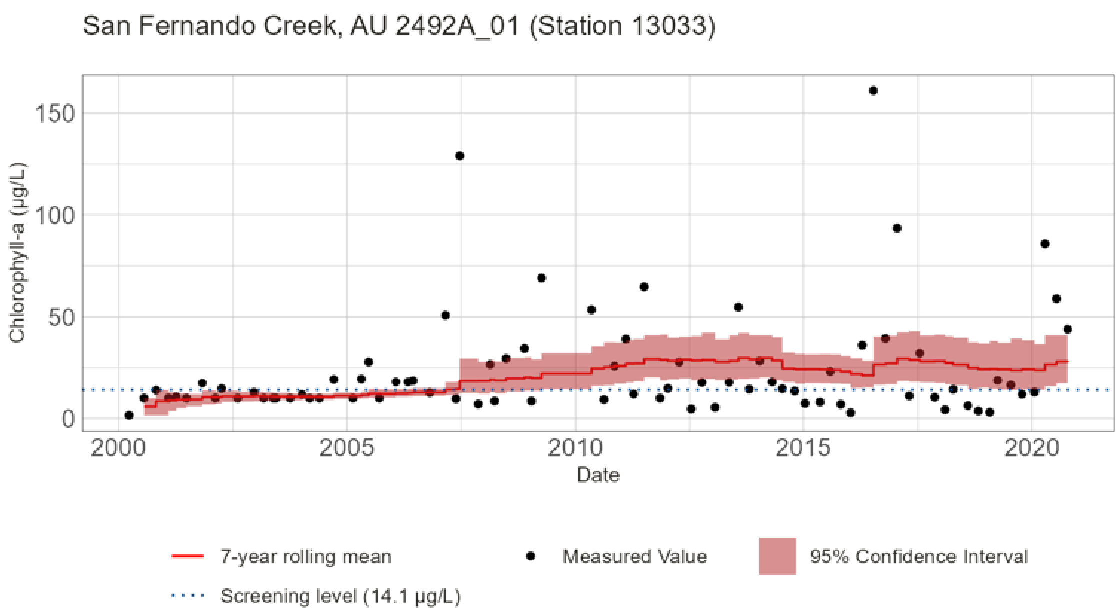
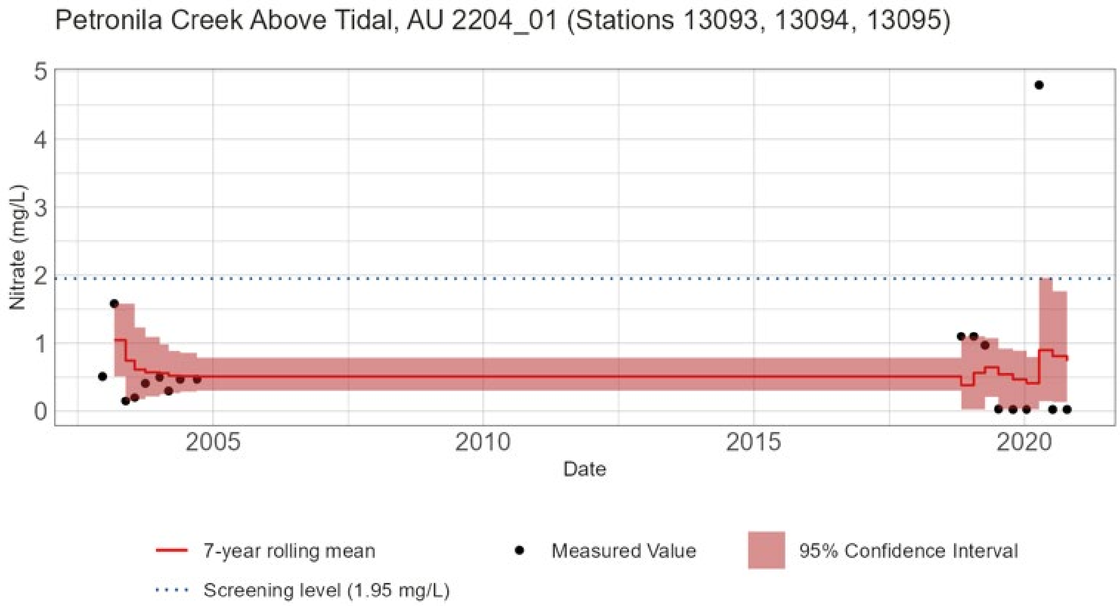
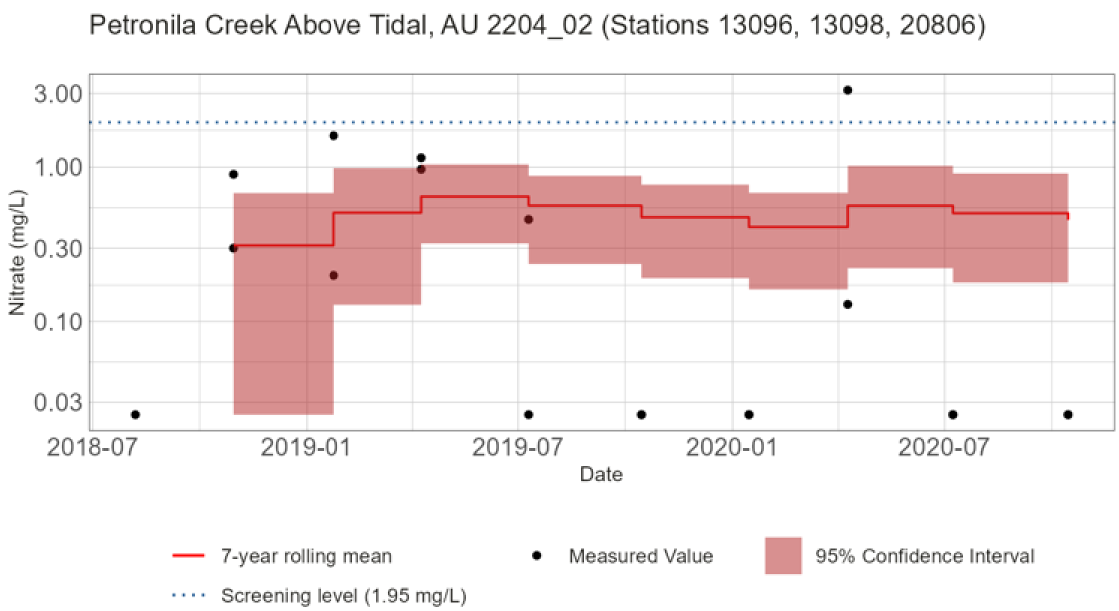


Figure 83. Chlorophyll-a concentrations.


Petronila Creek Above Tidal, AU 2204_01 (Stations 13093, 13094, 13095)
Nitrate (mg/L)
0
1
2
3
4
5
2005
2010
2015
2020
Date
7-year rolling mean
Measured Value
95% Confidence Interval
Screening level (1.95 mg/L)


Petronila Creek Above Tidal, AU 2204_02 (Stations 13096, 13098, 20806)
Nitrate (mg/L)
0.03
0.10
0.30
1.00
3.00
2018-07
2019-01
2019-07
2020-01
2020-07
Date
7-year rolling mean
Measured Value
95% Confidence Interval
Screening level (1.95 mg/L)

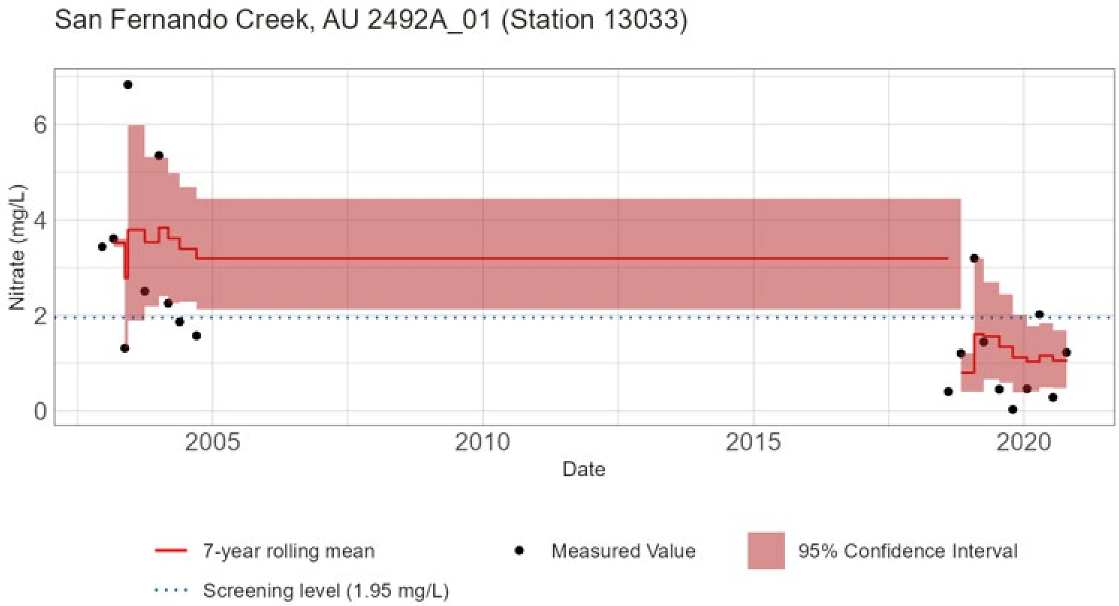
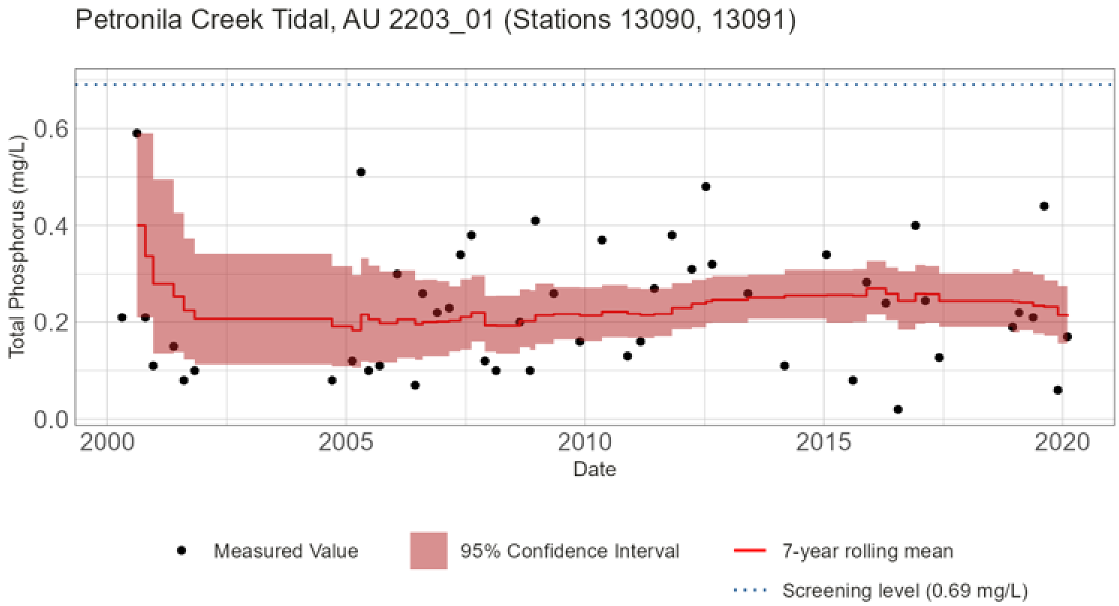
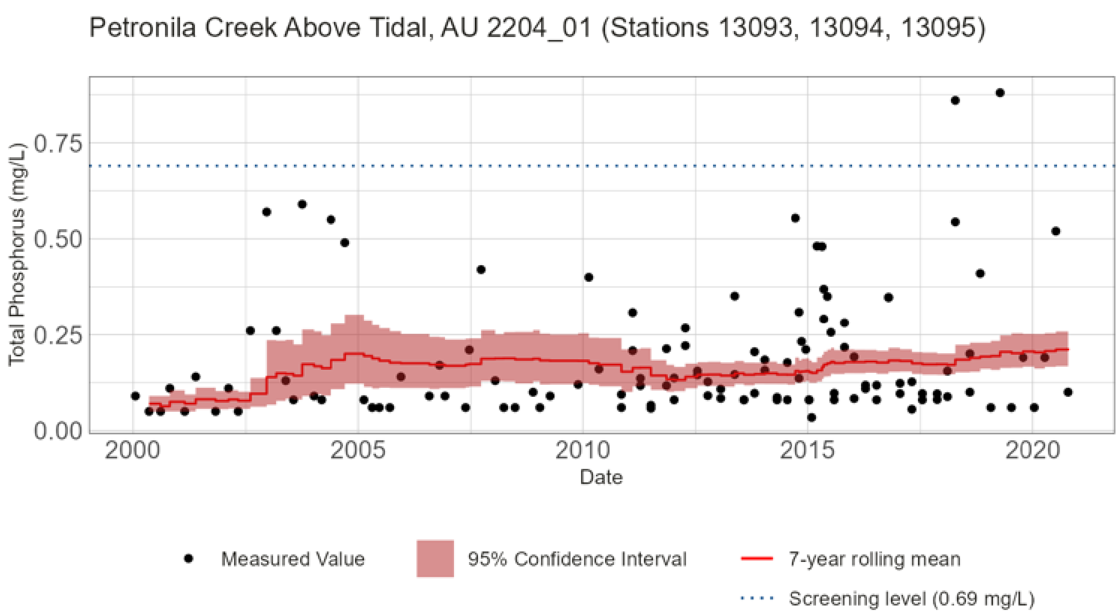
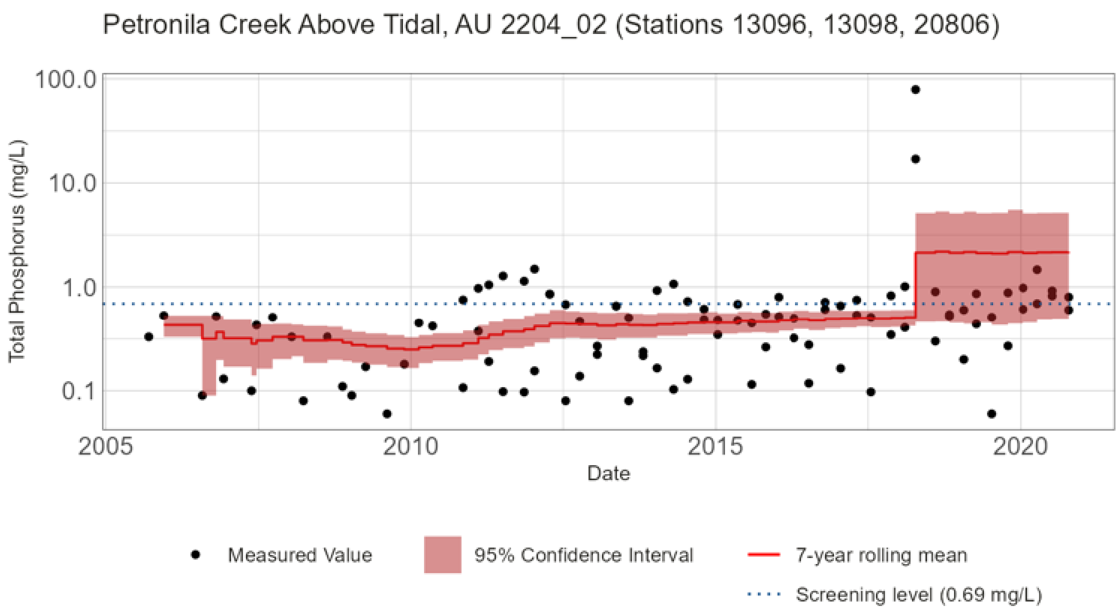


Figure 94. Nitrate concentrations.


Petronila Creek Tidal, AU 2203_01 (Stations 13090, 13091)
Total Phosphorus (mg/L)
0.0
0.2
0.4
0.6
2000
2005
2010
2015
2020
Date
Measured Value
95% Confidence Interval
7-year rolling mean
Screening level (0.69 mg/L)


Petronila Creek Above Tidal, AU 2204_01 (Stations 13093, 13094, 13095)
Total Phosphorus (mg/L)
0.00
0.25
0.50
0.75
2000
2005
2010
2015
2020
Date
Measured Value
95% Confidence Interval
7-year rolling mean
Screening level (0.69 mg/L)



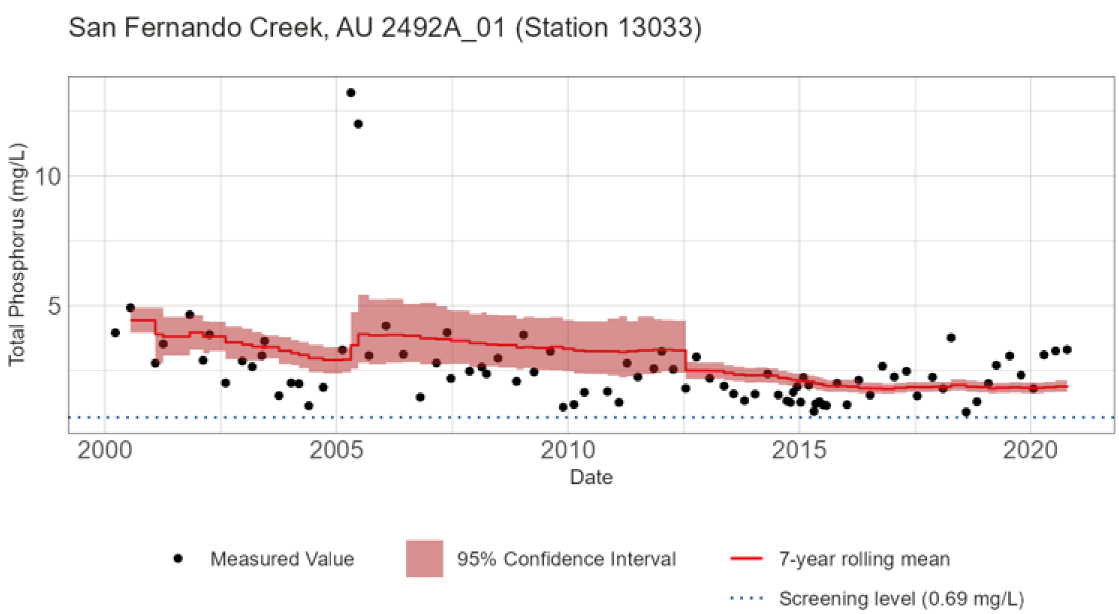


Figure 105. Total Phosphorous concentrations.

3.6: Flow

Generally, streamflow (the amount of water flowing in a river at a given time) is dynamic and always changing in response to both natural (e.g. precipitation events) and anthropogenic (e.g. changes in land cover or wastewater discharges) factors. From a water quality perspective, streamflow is important because it influences the ability of a water body to assimilate pollutants.

There are four USGS streamflow gages located within the watershed (Figure 16). One gage is decommissioned (USGS-8211900), and one is not located on either San Fernando or Petronila Creek (USGS-8211800). Of the two remaining active gages, USGS-08212000 is on San Fernando Creek, and USGS-08212820 is on Petronila Creek. These two gages provide the long-term instantaneous daily streamflow information used in this report. Over the previous 10 years, mean monthly stream flows rose sharply in May, peaking in June near 32.5 cfs and then returning to mean levels below 5 cfs until the next May. Though the monthly means are presented here, it must not be discounted that the watershed's proximity to the Gulf of Mexico subjects it to periods of heavy precipitation events that typically occur between May and July.

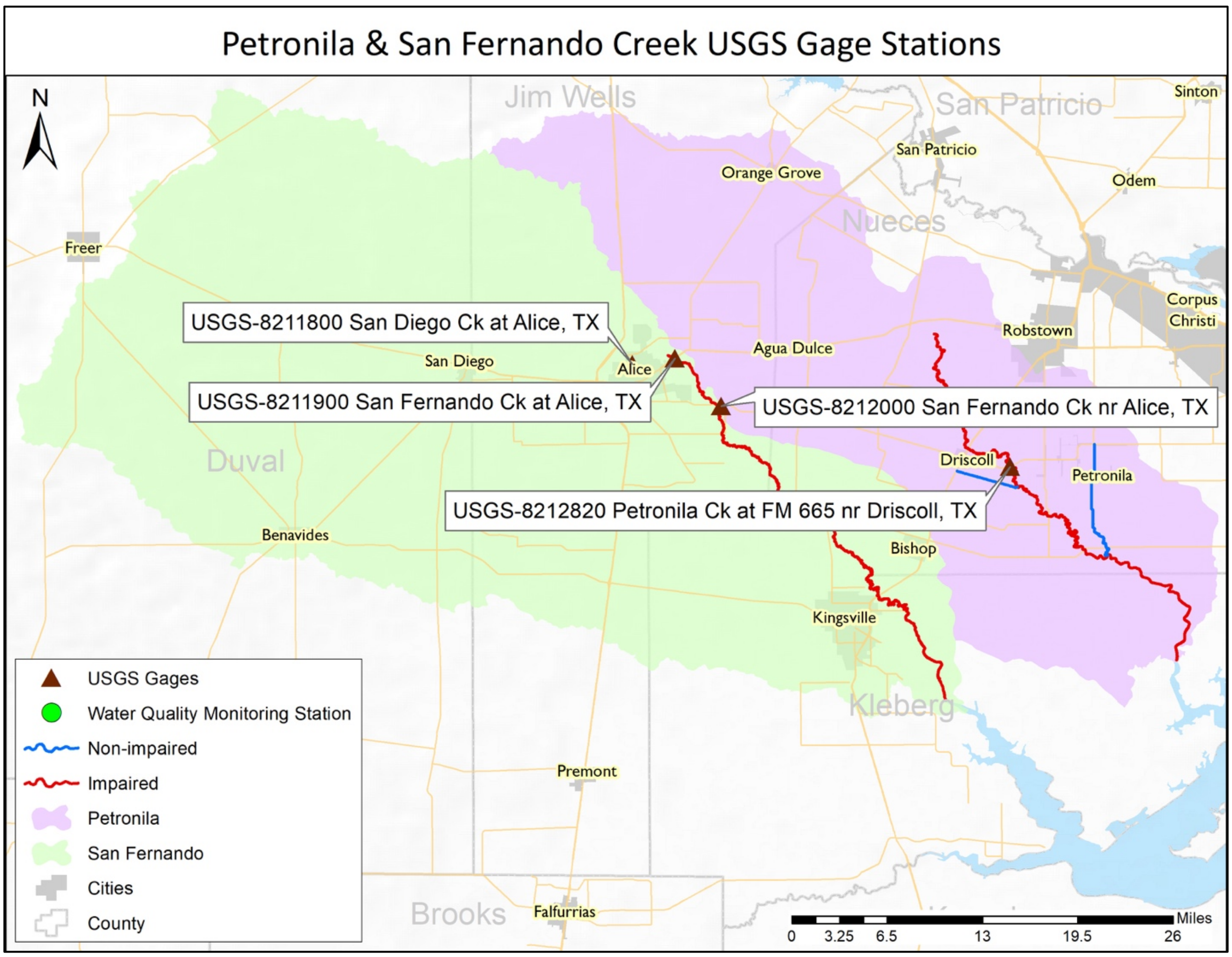


Figure 116. USGS streamflow gages.

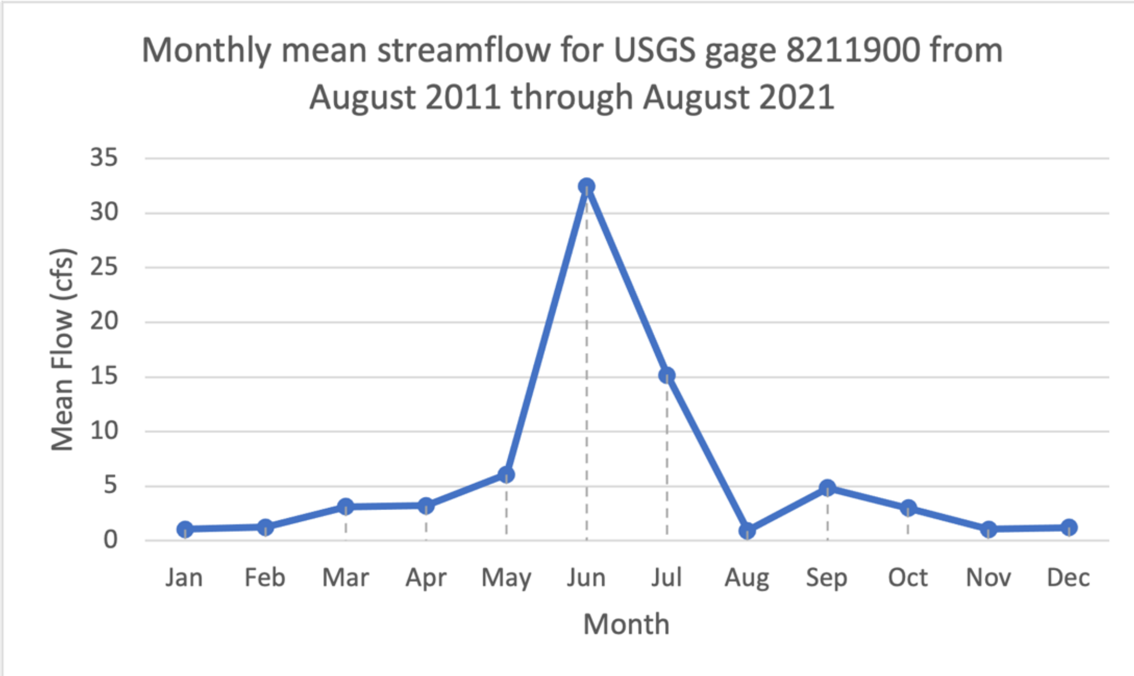


Figure 127. Mean monthly streamflows (cfs), August 2011 through August 2021.