Nutrient Sampling in Petronila Creek

Final Report

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Submitted to:
Coastal Bend Bays & Estuaries Program
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Acknowledgments

NRA staff would like to acknowledge the CBBEP for their continuing support for the Petronila Creek Nutrient Study. Data acquired for the study will help yield valuable information on the amounts and timing of nutrient inputs to the Baffin Bay System. NRA would also like to thank the laboratories that run the analysis on water samples including the City of Corpus Water Utilities Laboratory (WUL) and Texas A&M-Corpus Christi's Center for Coastal Studies (CCS).

Executive Summary

CBBEP Project #2133 is the continuation of Nutrient Sampling in Petronila Creek CBBEP Project #2003 that was conducted from January through December 2000. The intent of the nutrient sampling effort is to quantify the spatial and temporal distribution of nutrient parameters in the above tidal portion of Petronila Creek (TCEQ Segment 2204). Monthly surface water quality monitoring began in February 2021 and continued through July 2021 at 13 stations that are located throughout the southeastern portion of the watershed, east of US 77. Four stations are located on the main stem of the creek and nine stations are located on the tributaries of the creek. Average flow rates at the main stem creek sites average between 0.5 and 3.0 ft^3/s during normal flow conditions. Water quality monitoring conducted from February through May coincided with very low flow conditions and dry sites at four to six locations. A rain event in late May resulted in flow of approximately 1,800 ft^3/s at the USGS streamgage on Petronila Creek at FM 665. A second flow event of approximately the same magnitude of 1,870 ft^3/s occurred in early June. June's water quality monitoring was conducted on June 15th at a flow rate of 20 ft^3/s. A third high flow event occurred in early July that resulted in a peak flow of 1,990 ft^3/s. Water quality monitoring occurred on July 20th at a flow rate of approximately 38 ft^3/s at the FM 665 USGS streamgage. Nutrient parameters analyzed for the study include ammonia, nitrate nitrogen, nitrite nitrogen, total phosphorus, total kjeldahl nitrogen, dissolved kjeldahl nitrogen, chlorophyll-*a,* and pheophytin. Ammonia concentrations were very low during the study period with the majority of the results being at or below detection limits of laboratory equipment. Nitrate nitrogen concentrations rose in the spring from March through May regardless of streamflow rates while nitrite nitrogen concentrations were consistently at or near the lower detection limits of laboratory equipment. Total phosphorus concentrations were generally moderate with occasional screening level exceedances not associated with streamflow variations. The highest concentrations of total phosphorus (TP) were recorded in the upper portion of the study area on the main stem of the creek just downstream of the Driscoll WWTP outfall. Concentrations of TP decreased as the creek progressed downstream toward the bay. Dissolved and total kjeldahl nitrogen were moderately elevated at many of the tributary and main stem creek sites and decreased

as they moved downstream toward the bay. Chlorophyll-*a* concentrations were moderately high in the system throughout the study period under a variety of flow conditions.

Figure 1. Picture of Petronila Creek Above Tidal at Sunrise

Introduction

Surface water quality monitoring in Texas is routinely conducted by the Texas Commission on Environmental Quality (TCEQ) and its Clean Rivers Program (CRP) partners to assess the status of water quality in streams, rivers, lakes, and bays throughout the state. The Texas Surface Water Quality Standards establish criteria to protect the designated uses of waterbodies, including aquatic life, water supply, and recreation, against water quality degradation. The criteria for evaluating support of the designated uses include dissolved oxygen, temperature, pH, dissolved minerals, toxic substances, and bacteria. However, TCEQ does not have numerical criteria for nutrients in their surface water quality standards. In Texas, nutrient controls have taken the form of narrative criteria, watershed rules, and anti-degradation considerations in permitting actions. TCEQ screens ammonia, nitrate nitrogen, total phosphorus, and chlorophyll (Chl) monitoring data as a preliminary indication of areas of possible concern (TCEQ). The following charts explains the potential causes and impacts when water quality screening levels for certain water quality parameters are not met.

Parameter	Nutrient Screening Levels for Petronila Creek	Calculation Used for Concern
Ammonia-Nitrogen	0.33 mg/l	20% of samples are above the criteria
Nitrate	1.95 mg/l	
Total phosphorus	0.69 mg/l	
(Chl-a)	14.1 µg/l	

Figure 2. TCEQ screening levels for nutrient parameters

Figure 3. Algal growth at Tributary Station 13032

Parameter	Cause	Impact
Ammonia	Ammonia is excreted by animals and is produced during the decomposition of plants and animals. It is an ingredient in many fertilizers and is also present in sewage, storm water runoff, certain industrial wastewaters, and runoff from animal feedlots.	Elevated levels of ammonia in the environment can adversely affect fish and invertebrate reproductive capacity and reduced growth of the young.
Nitrates & Total phosphorus	Nutrients are found in effluent released from wastewater treatment plants (WWTP)s, fertilizers, and agricultural runoff carrying animal waste from farms and ranches. Soil erosion and runoff from farms, lawns, and gardens can add nutrients to the water.	These nutrients increase plant and algae growth. When plants and algae die, the bacteria that decompose them consume dissolved oxygen leaving less available for fish and other living aquatic life. High levels of nitrate 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.
Chlorophyll-*a* *(Chl a)*	Modifications to the riparian zone, human activity that causes increases in organic matter, nutrients, bacteria, and over abundant algae in water.	Chlorophyll-*a* is the photosynthetic pigment found in all green plants, algae, and cyanobacteria. Elevated levels indicate abundant plant growth which could lead to reduced DO levels.

Figure 4. Causes and impacts of excess nutrient parameters

The designated uses for Petronila Creek Above Tidal (TCEQ Segment 2204) include primary contact recreation and intermediate aquatic life use. Surface water quality monitoring assessments for Segment 2204 indicate impairments exist for total dissolved solids (TDS), sulfate, chloride, and bacteria. In response to the dissolved mineral impairments, a Total Maximum Daily Load (TMDL) project for TDS, sulfate, and chloride has been developed that includes increased water quality monitoring of the main stem and select tributary stations. The bacteria impairment will likely be analyzed through a standards-review process called a Recreation Use Attainability Analysis (RUAA) in the future. Segment 2204 also has screening level concerns for Chlorophyll-*a* which indicate a possible degradation of water quality due to excessive nutrients.

The receiving water body for Petronila Creek is Alazan Bay, a tertiary bay which flows into Baffin Bay (TCEQ Segment 2492). Surface water quality monitoring by TCEQ in Baffin Bay has identified an exceedance to the screening level for chlorophyll-a since 2002. In the last decade, water quality issues resulting in the disruptions of food webs, low dissolved oxygen events, fish kills, and excessive growth of phytoplankton

indicators including [Chl a] have led to an increase in concern and awareness from the public, academia, and governmental agencies. Scientists at the Harte Research Institute (HRI) at Texas A&M University – Corpus Christi (TAMU-CC) have determined that the primary causes of the water quality concern is due to excessive nutrients in the bay. Efforts to determine the source of nutrient enrichment have centered on the contributions of surface waters from three main tributaries: Petronila, San Fernando, and Los Olmos creeks, all of which have current quarterly water quality monitoring stations.

To provide further clarity regarding nutrient inputs into the Baffin Bay system, this study presents six months of water quality data from thirteen stations located on the main stem and tributaries of Petronila Creek Above Tidal for ammonia, total kjeldahl nitrogen (TKN), dissolved TKN, total phosphorus, nitrate nitrogen, nitrite nitrogen, and chlorophyll-*a*.

Figure 5. Algal growth at Tributary Station 21594

Methods

Study Location – Petronila Creek Above Tidal (TCEQ Segment 2204) is a shallow creek (< 2.0 m depth) that flows 44 miles from the confluence of Aqua Dulce and Banquete creeks in Nueces County to a point 0.6 miles upstream of a private road crossing near Laureles Ranch in Northern Kleberg County. Petronila Creek drains to Alazan Bay, a tertiary bay, connected to the northern portion of Baffin Bay. The study area is located east of US 77 in the southeastern portion of the watershed. Land use is dominated by cultivated cropland with cotton, corn and sorghum being the most common crops observed. The northwestern end of the watershed is a mixture of cultivated cropland, hay or pasture, shrub or scrub and mixed forest. There are nine regulated dischargers of effluent to Petronila Creek and/or the tributaries of the creek (See Appendix B).

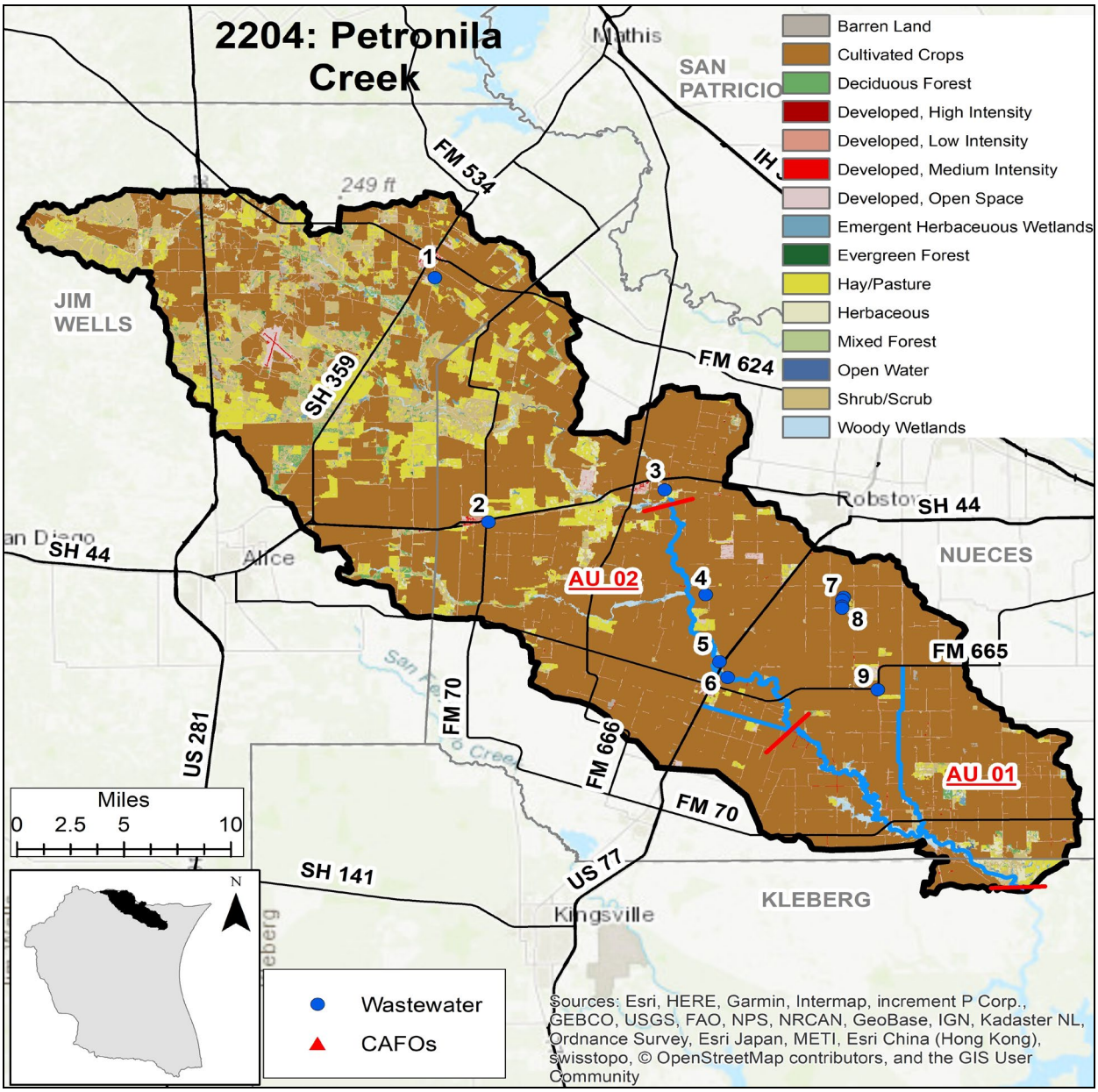

Figure 6. Land Use Land Cover and permitted dischargers to Petronila Creek

Sampling Site Locations – Sampling site locations were identified based on the current sampling locations used in the Petronila Creek Above Tidal TMDL sampling project funded by TCEQ for chloride, sulfate, and total dissolved salts (TDS). There are six tributaries sampled for the project. Three of the tributaries have two sampling stations each including 21594 & 18484, 21931 & 18642, and 21929 & 21598. The other three tributaries (13030, 21596, and 13032) are monitored by a single sampling site. Four stations (13093, 13094, 13095, and 13096) are located on the main stem of the creek. Streamflow is typically very low in the segment, often measuring between 0.5 and 3.0 ft^3/s during dry weather on the main stem of the creek. A USGS streamgage exists at Station 13096, near Driscoll, that include streamflow and gage height. In the tributaries, dry weather flows typically range from <0.1 to 0.4 ft^3/s with occasionally dry creek beds during extended dry periods. A map of sampling stations is provided below.

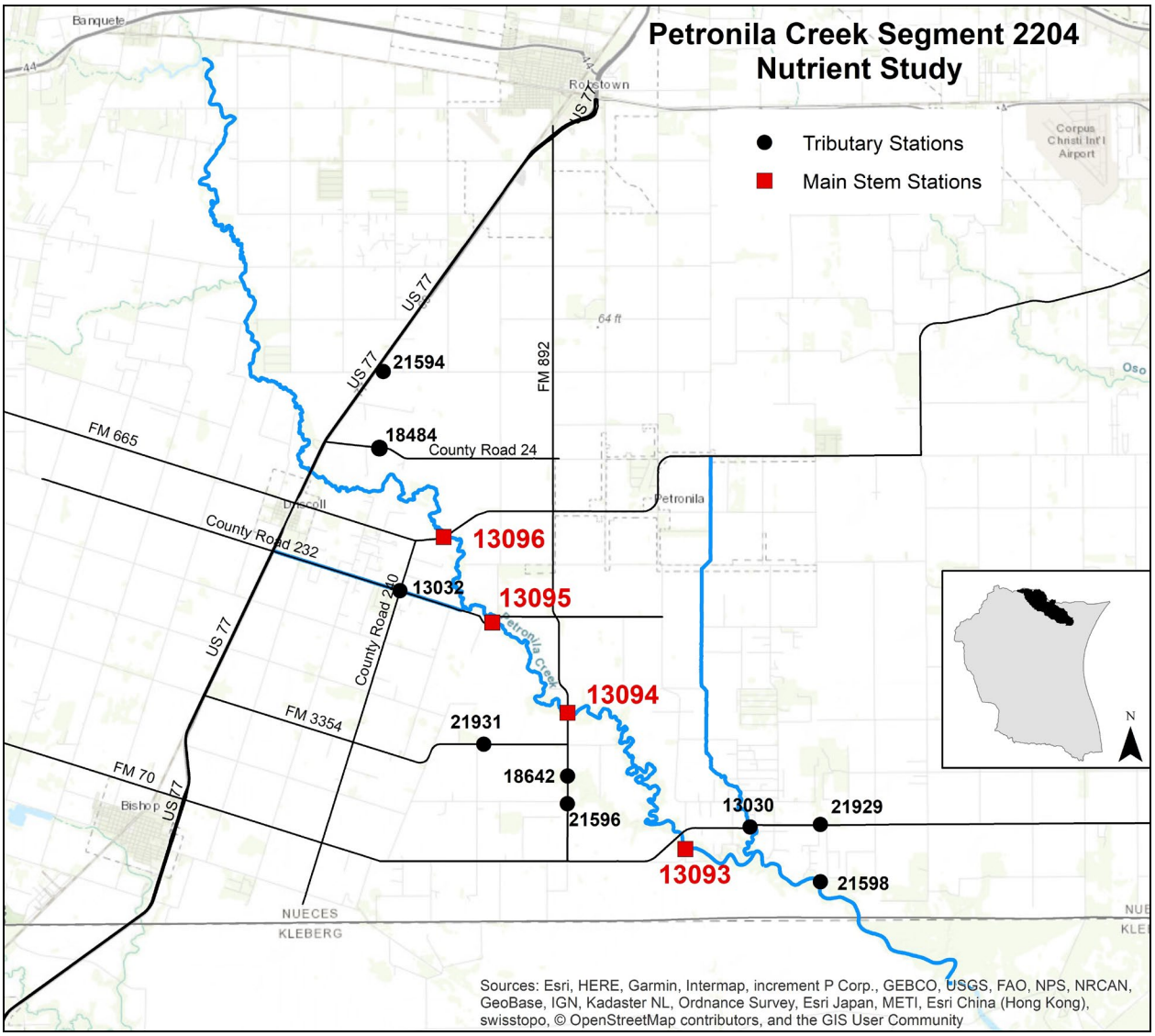

Figure 7. Map of sampling stations in Petronila Creek Above Tidal (Segment 2204)

Meteorological data – During monthly site visits at each station, NRA field staff recorded meteorological information including air temperature, wind direction, wind velocity and precipitation data including days since last precipitation, amount of precipitation in the past day and past seven days. Precipitation data from February 1st through April 30th was provided by weatherspark.com with the link provided below.

https://weatherspark.com/h/m/145903/2021/5/Historical-Weather-in-May-2021-at-Kingsville-Naval-Air-Station;-Texas;-United-States#Figures-Rainfall

Precipitation data from May 1st through July 20th were obtained from the USGS gage Station 08212820 located at FM 665 (Main Stem Station ID 13096). Monthly precipitation data before May 1 was unavailable on the USGS website.

https://waterdata.usgs.gov/tx/nwis/uv?cb_00045=on&format=gif_default&site_no=08212820&period=&begin_date=2021-08-04&end_date=2021-08-11

Sample collection – Surface water quality data including field and laboratory data were collected on a monthly basis from February through July 2021 at four sampling stations on the main stem of the creek and at nine sampling stations on the tributaries. Two sampling events occurred in April to make up for project kick off delays in January. At each sampling location, field data including water appearance/odor, water depth, water temperature, pH, dissolved oxygen and specific conductance were obtained using a Hydrolab MS5 datasonde according to TCEQ Surface Water Quality Manual Procedures (SWQM) Procedures. The datasonde was calibrated before each sampling event and post calibrated immediately after returning from the field. Water samples were taken from the centroid of flow (point of maximum flow) at each station using a sample dipper that was pre-rinsed with site sample water. Many of the stations had accessibility issues which required sampling from the bridge top by lowering a 1-gallon bucket into the stream. During high flow, samples were taken from the bridge-top at all but one station (21958) where there was no bridge. During low flow conditions, all stations but one, had sampling depths less than 0.3 m which required a sampling depth of half the total depth. Station 13093 had water deep enough (1.6 m) to require a profile of datasonde readings at 0.3 m below the water surface, at mid depth, and at 0.3 m above the bottom of the water column. Surface water quality samples were collected, preserved with acid when applicable and stored on ice and delivered to the laboratories that afternoon for analysis.

Sample Analysis – Surface water samples were collected and analyzed for nutrient components by two laboratories. Nutrient samples including ammonia, nitrate, nitrite, TKN, dissolved TKN and total phosphorus were analyzed by the City of Corpus Christi Water Utilities Lab (WUL). All analytes were analyzed by the WUL using National Environmental Laboratory Accreditation Program (NELAP) accredited methods. Chlorophyll-*a* and pheophytin samples were analyzed at the Texas A&M University Corpus Christi's Center for Coastal Studies Laboratory (CCSL). NELAP accreditation for chlorophyll-*a* and pheophytin parameters are not required.

Results

Meteorological and Hydrological – Average annual precipitation in Petronila Creek Above Tidal is 28.98 inches. Petronila Creek Above Tidal (TCEQ Segment 2204) experienced below average rainfall from January through the middle part of April 2021 resulting in very low streamflow values and multiple dry stations. In the middle part of April through early July 2021, episodic rain events, some heavy, resulted in three flood events ranging from approximately 1,800 to 2,000 ft^3/s due to surface runoff into the tributaries. These occurred in late May, early June, and early July (figure 10).

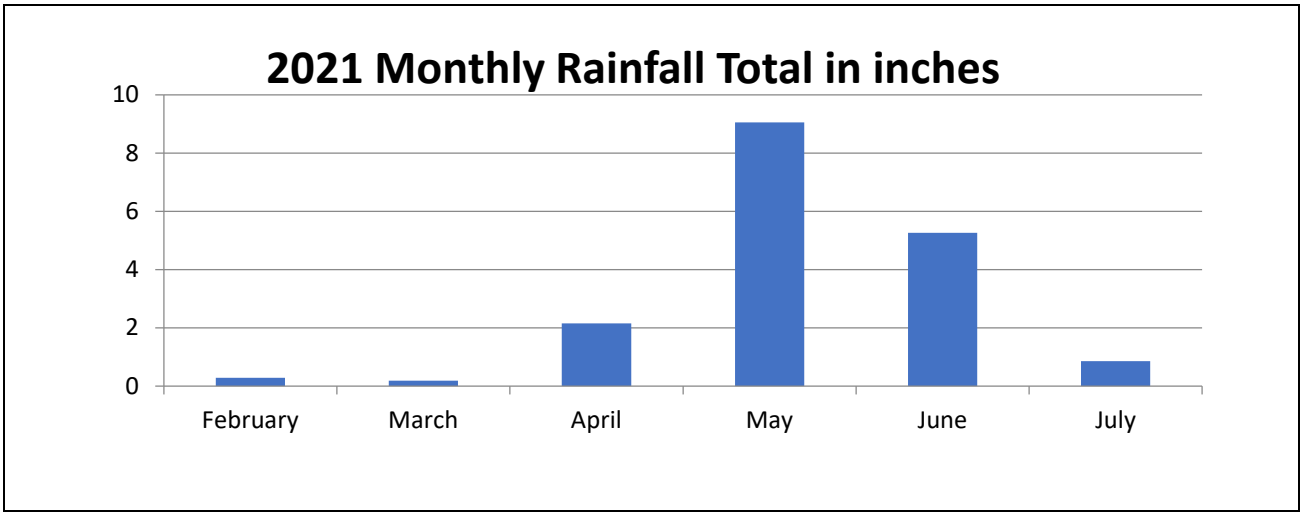

Figure 8. 2021 Monthly rainfall amounts in Petronila Creek

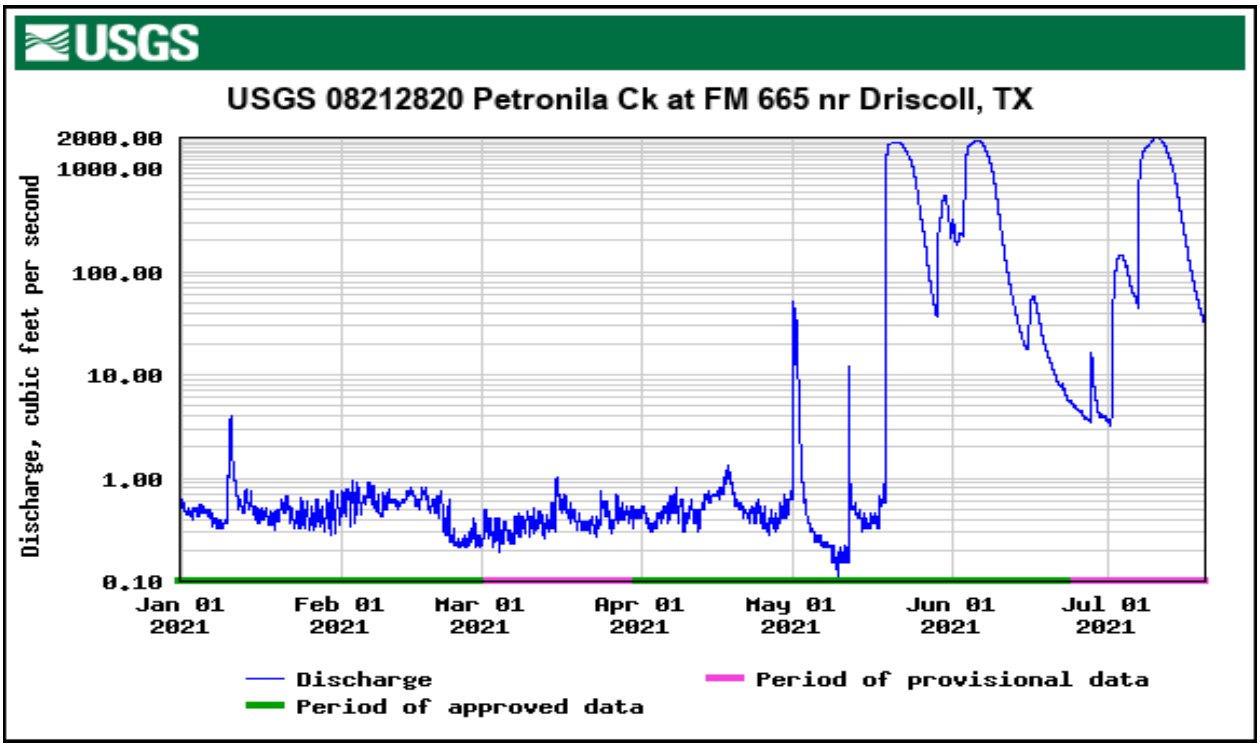

Figure 9. USGS sourced streamflow at Petronila Creek Above Tidal at FM 665

Beginning in mid-April 2021, multiple intense rainfall events occurred resulting in three high flow events ranging from approximately 1,800 to 1,990 ft^3/s in magnitude at the USGS streamgage at FM 665 near Driscoll (USGS gage 08212820) (figure 10). NRA field staff were able to collect data routine quarterly Clean River Program (CRP) data during the third event at a flow rate of approximately 1,990 ft^3/s which occurred on July 12th. Sites monitored on July 12th included only Stations 13094 and 13096. Accessibility was limited at the tributary sites and two main stem sites on July 12th due to closed roads and or muddy conditions on the roads that lead to sampling stations. Sampling on the remaining stations resumed on July 20th after the roads were open.

Figure 10. High flow event on July 12th resulted in closed roads

Figure 11. High flow at Petronila Creek Station 13093 on July 12th

Figure 12. High flow at Petronila Creek Station 13094 on July 12th

Figure 13. High flow at Petronila Creek Station 13096 on July 12th

Figure 14. Water clarity at Petronila Creek Station 13096 on July 12th

Ammonia – [Ammonia] ranged from < 0.1 mg/L to 0.41 mg/L. The limit of quantification (LOQ) for ammonia is 0.1 mg/L and the TCEQ screening level is 0.33 mg/L. Out of 69 samples submitted for analysis, 58 were below the LOQ for ammonia and one sample was above the screening level. The annual mean ammonia concentration in the main stem of Petronila Creek was 0.11 mg/L and in the tributaries, it was 0.13 mg/L. The highest concentration of 0.41 mg/L and the only ammonia reading above TCEQs screening level was found at tributary station 21929. Ammonia data from the July 12th high flow event was less than 0.1 mg/L at Stations 13094 and13096.

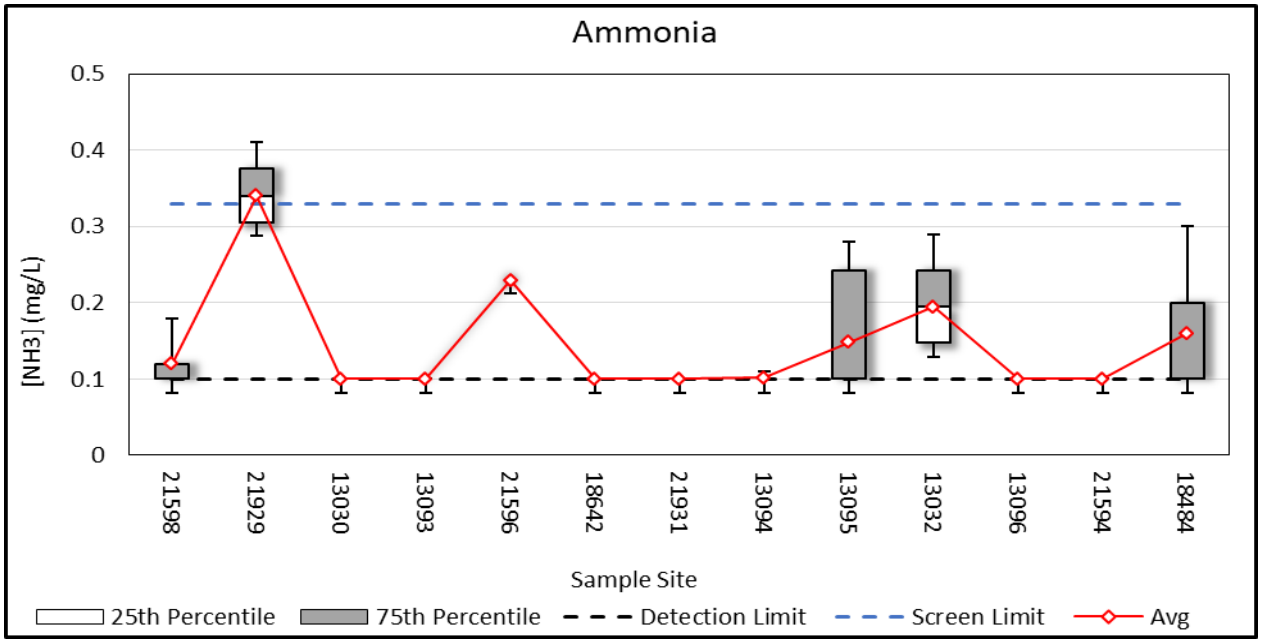

Figure 15. [Ammonia] at all stations.

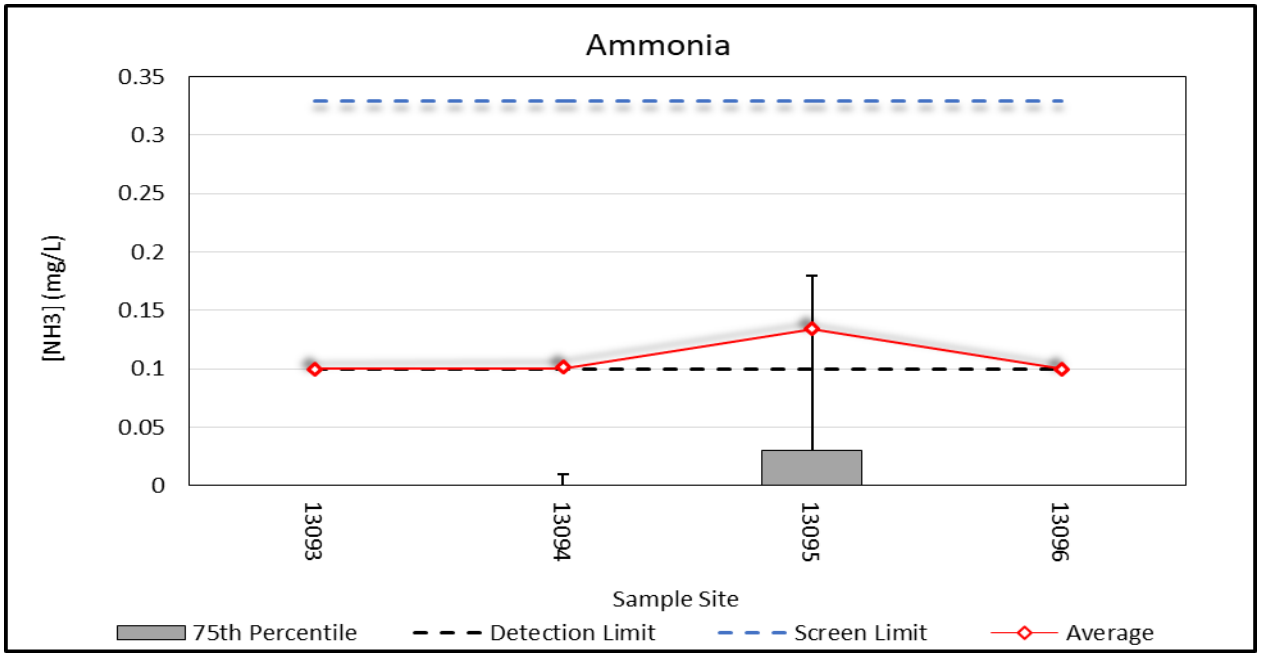

Figure 16. [Ammonia] at main stem stations.

Total Kjedahl Nitrogen (TKN) – [TKN] ranged from < 0.2 mg/L to 4.6 mg/L. The LOQ for TKN is 0.2 mg/L, however no TCEQ screening levels exist for this nutrient parameter. Out of 69 samples submitted for TKN analysis, 3 were at or below the LOQ. The annual **mean TKN concentration** in the **main stem** of Petronila Creek was **1.47 mg/**L and in the **tributaries**, it was **1.12 mg/L**. The highest TKN concentration of 4.6 mg/L was found at the tributary Station 13032 in May. The highest mean concentration was 2.3 mg/L found on the tributary Station 13032. The lowest mean annual concentration was 0.74 mg/L at tributary Station 21594. TKN data from the July 12th high flow event was 0.75 mg/L at Station 13094 and 0.79 at Station 13096.

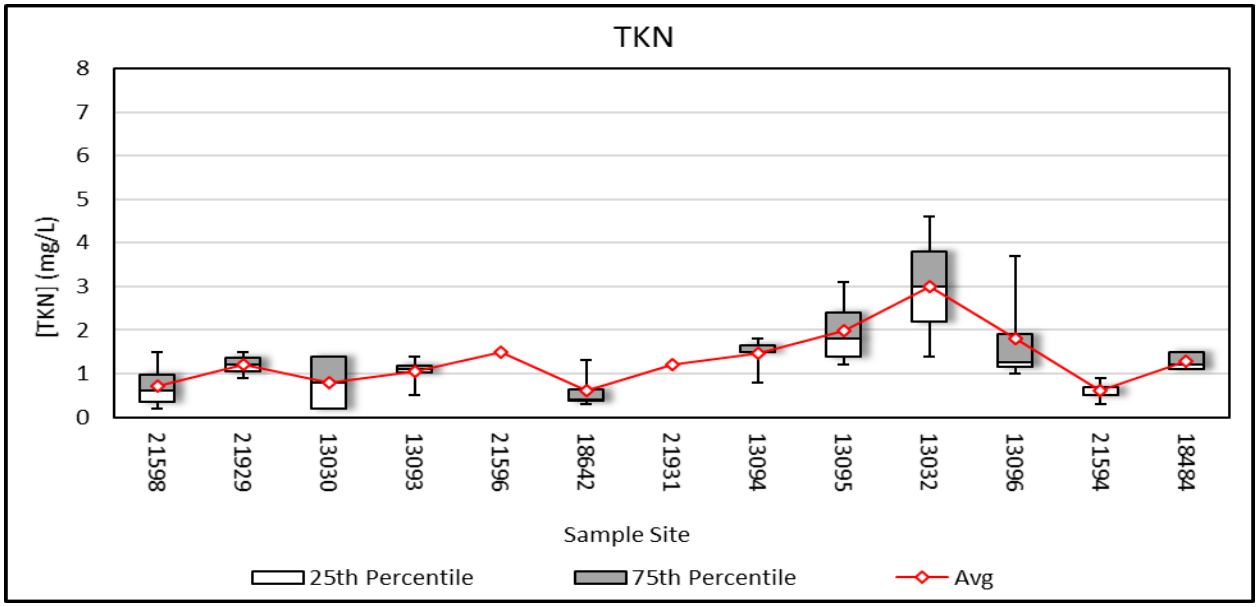

Figure 17. [Total Kjeldahl Nitrogen] at all stations

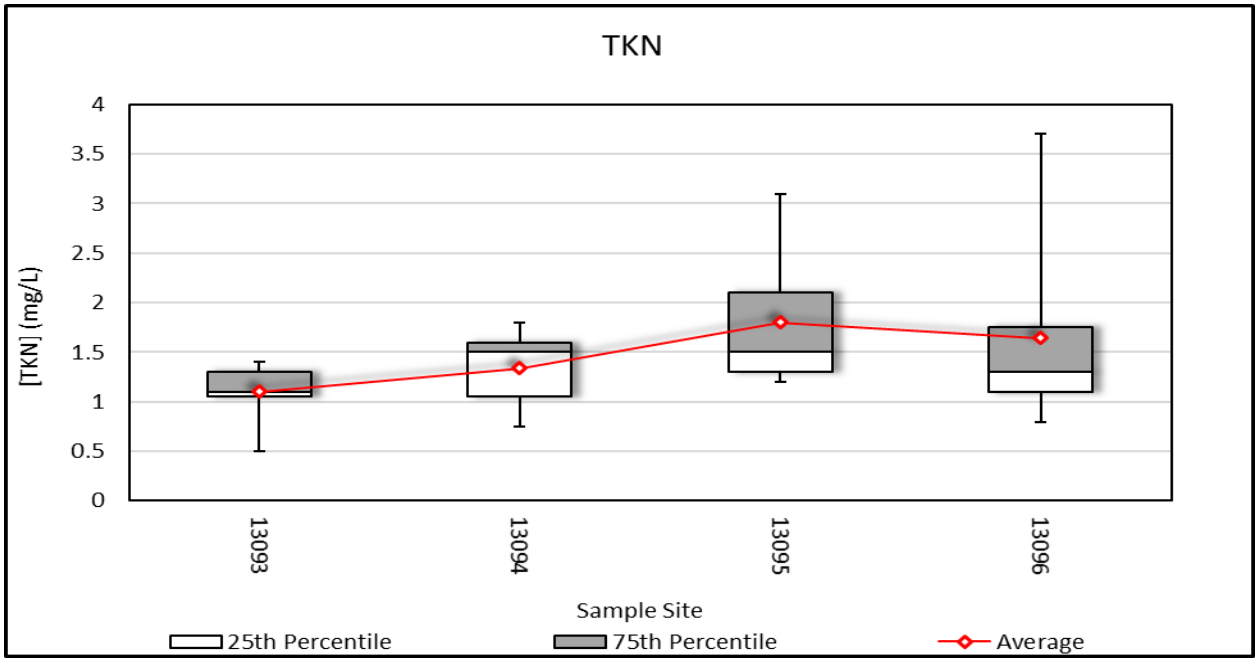

Figure 18. [Total Kjeldahl Nitrogen] at main stem stations

Dissolved Total Kjedahl Nitrogen (Dissolved TKN) – Dissolved [TKN] ranged from < 0.2 mg/L to 3.0 mg/L. The LOQ for dissolved [TKN] is 0.2 mg/L, however no TCEQ screening levels exist for this nutrient parameter. Out of 65 samples submitted for analysis, 4 analysis results were below the LOQ. **Mean dissolved [TKN]** in the **main stem** of Petronila Creek was **0.90 mg/L** and in the **tributaries**, it was **0.93 mg/L**. The highest concentration of 3.0 mg/L was found at tributary Station 13032 in April. The highest annual mean concentrations were found at Station 13032 (1.6 mg/L), Station 21929 (1.50 mg/L), and Station 21596 (1.20 mg/L). The lowest annual mean concentration was found at Station 18642 (0.58 mg/L).

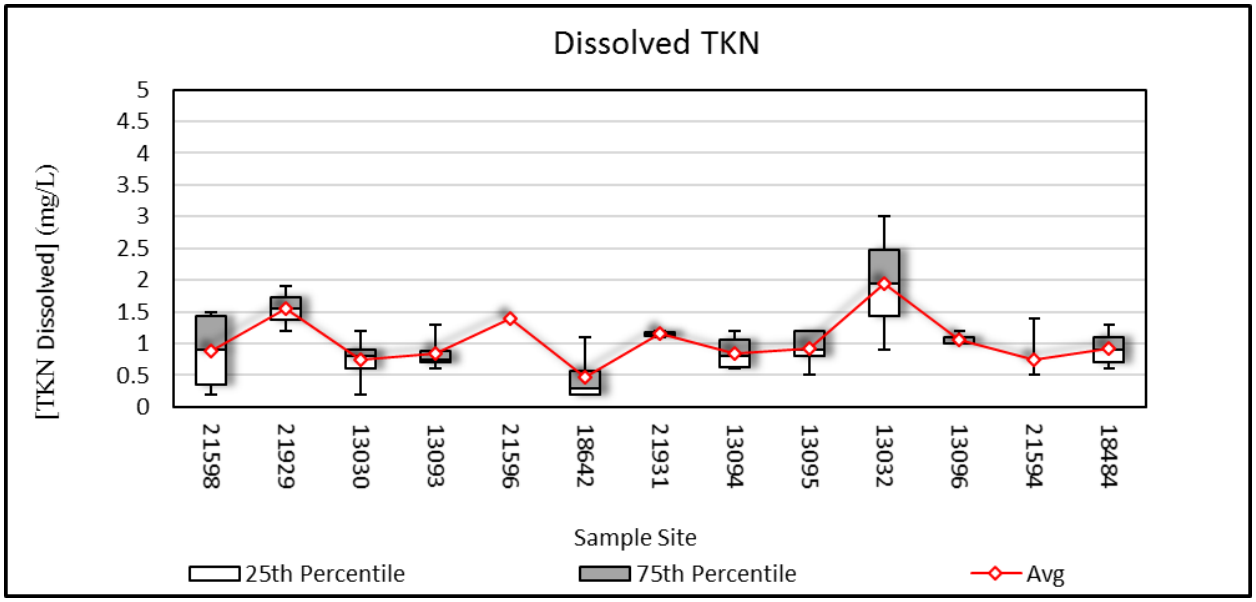

Figure 19. [Dissolved Total Kjeldahl Nitrogen] at all stations

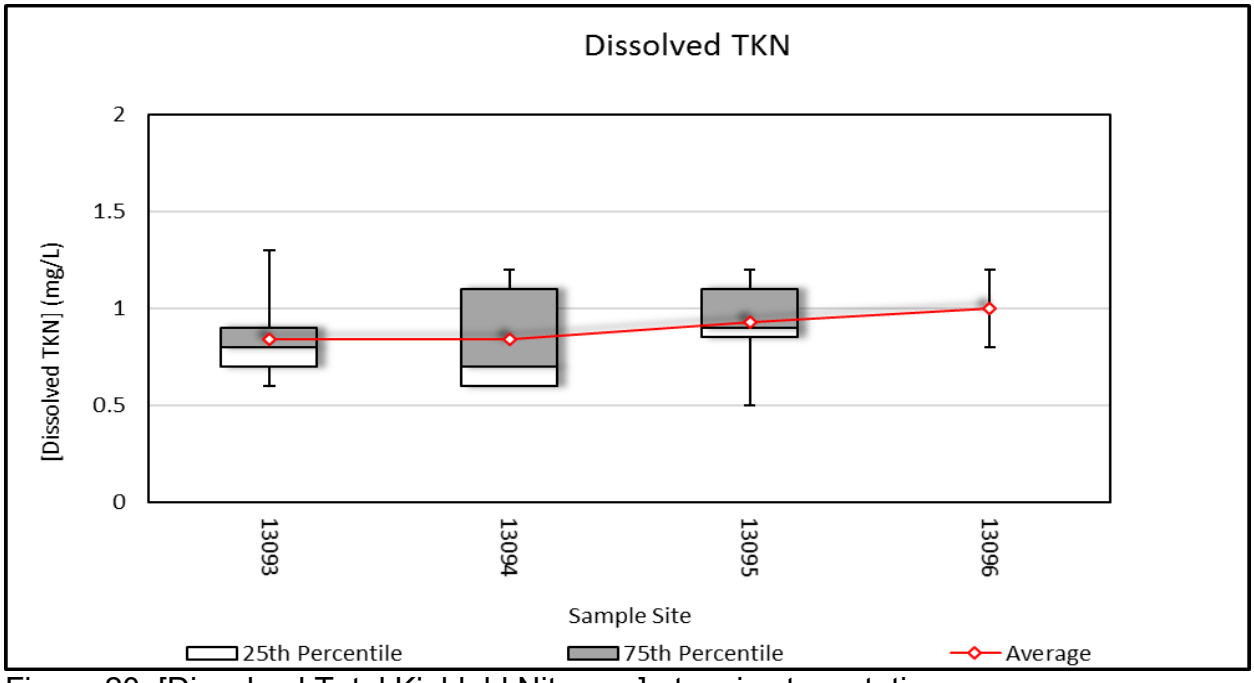

Figure 20. [Dissolved Total Kjeldahl Nitrogen] at main stem stations

Nitrate Nitrogen – [Nitrate-nitrogen] ranged from < 0.025 mg/L to 38.0 mg/L. The LOQ for nitrate-nitrogen is 0.025 mg/L and the TCEQ screening level is 1.95 mg/L. Out of 68 nitrate samples collected, 23 were below the LOQ and 13 were above the screening level of 1.95 mg/L. **Mean [Nitrate-nitrogen]** in the **main stem** of Petronila Creek was **2.74 mg/L** and in the **tributaries**, it was **1.72 mg/L**. The highest concentrations occurred in April under low flow conditions. Station 13030 drains cropland and originates near the Café Valenzuela Landfill and is located in the lower end of the watershed. Nitrate-nitrogen data from the July 12th high flow event was 0.08 mg/L at Station 13094 and less than 0.025 mg/L at Station 13096.

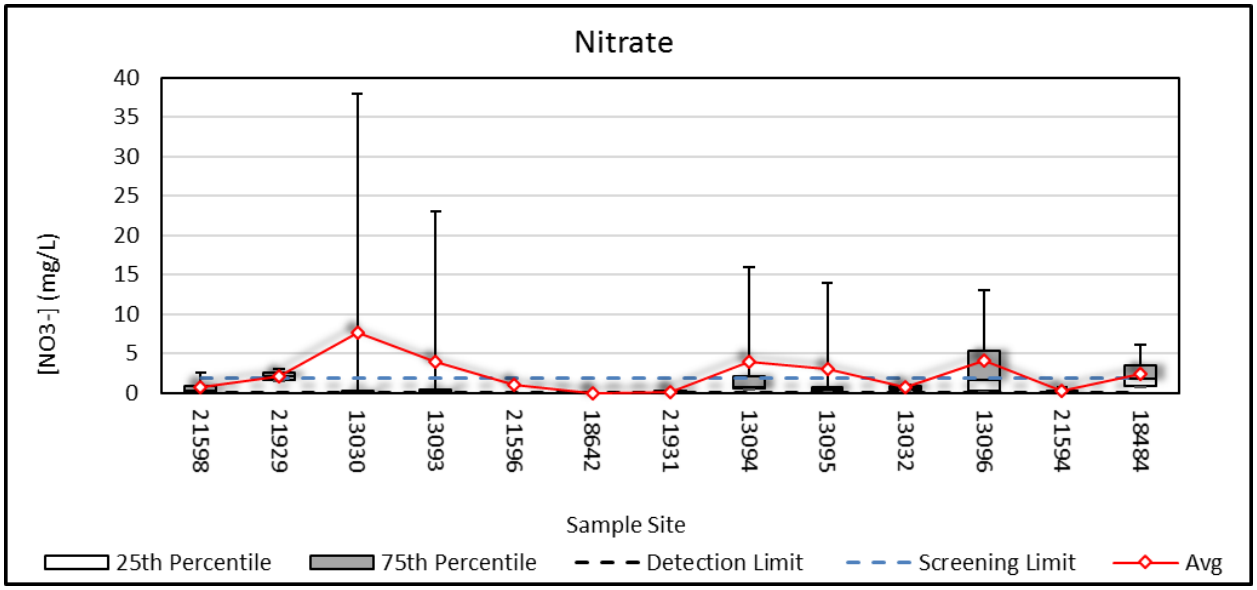

Figure 21. [Nitrate-Nitrogen] at all stations

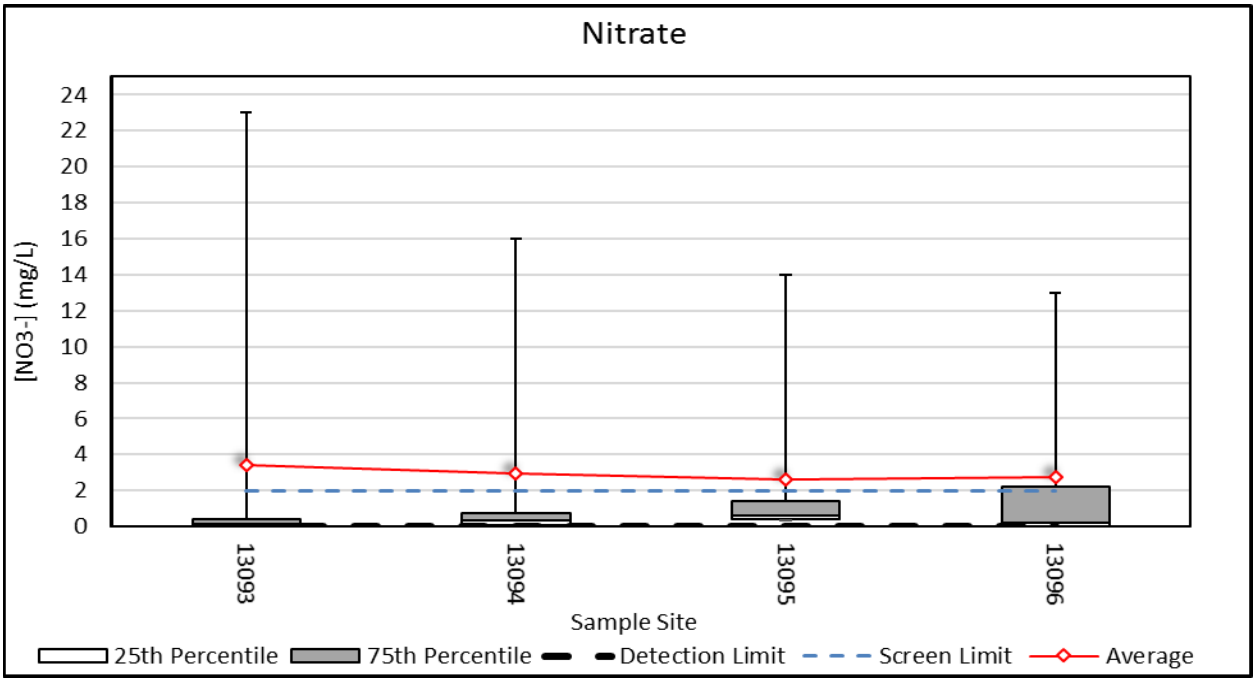

Figure 22. [Nitrate-Nitrogen] at main stem stations

Nitrite-nitrogen – [Nitrite-nitrogen] ranged from < 0.02 mg/L to 13.8 mg/L. The LOQ for [nitrite-nitrogen] is 0.02 mg/L, however no TCEQ screening level exists for this parameter. Out of 69 samples submitted for nitrite nitrogen analysis, 37 were at or below the LOQ. The highest concentration, 13.8 mg/L, occurred at tributary Station 13030 in May under low flow conditions. **Mean [nitrite-nitrogen]** in the **tributaries** was **0.41 mg/L**. It is important to note that Station 13030 is located in the lower end of the watershed and did not contribute high nitrite numbers to the main stem sampling stations. The highest concentrations on the main stem stations (13093, 13094, 13095, and 13096) also occurred in May. Mean **[nitrite-nitrogen]** on the **main stem** stations was **1.02 mg/L**. Nitrite-nitrogen data from the July 12th high flow event was 0.05 mg/L at Station 13094 and 0.03 mg/L at Station 13096.

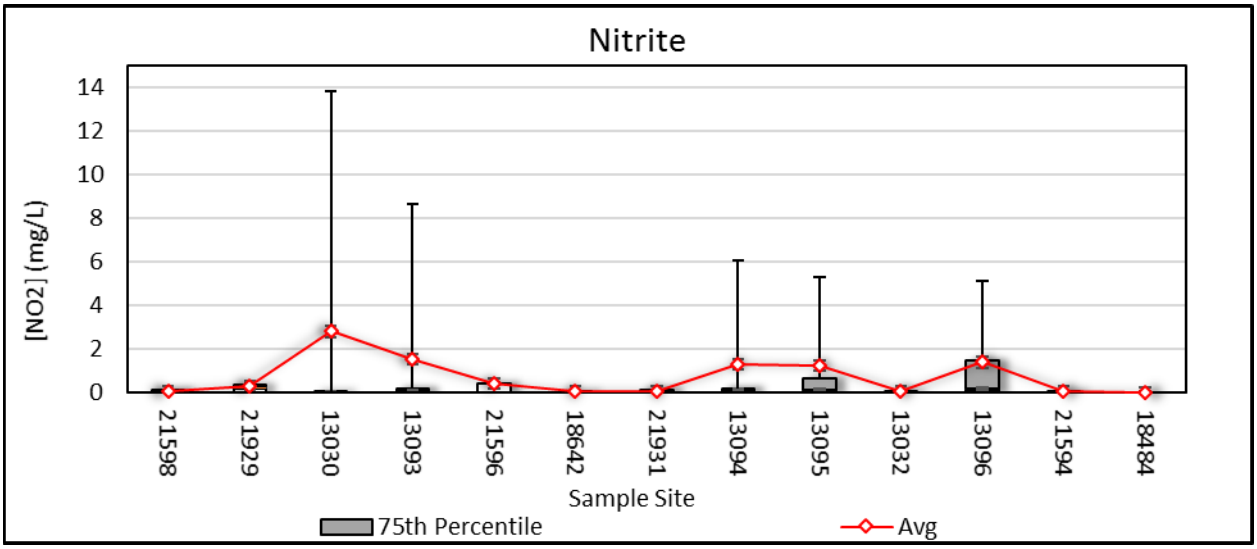

Figure 23. [Nitrite-nitrogen] at all stations

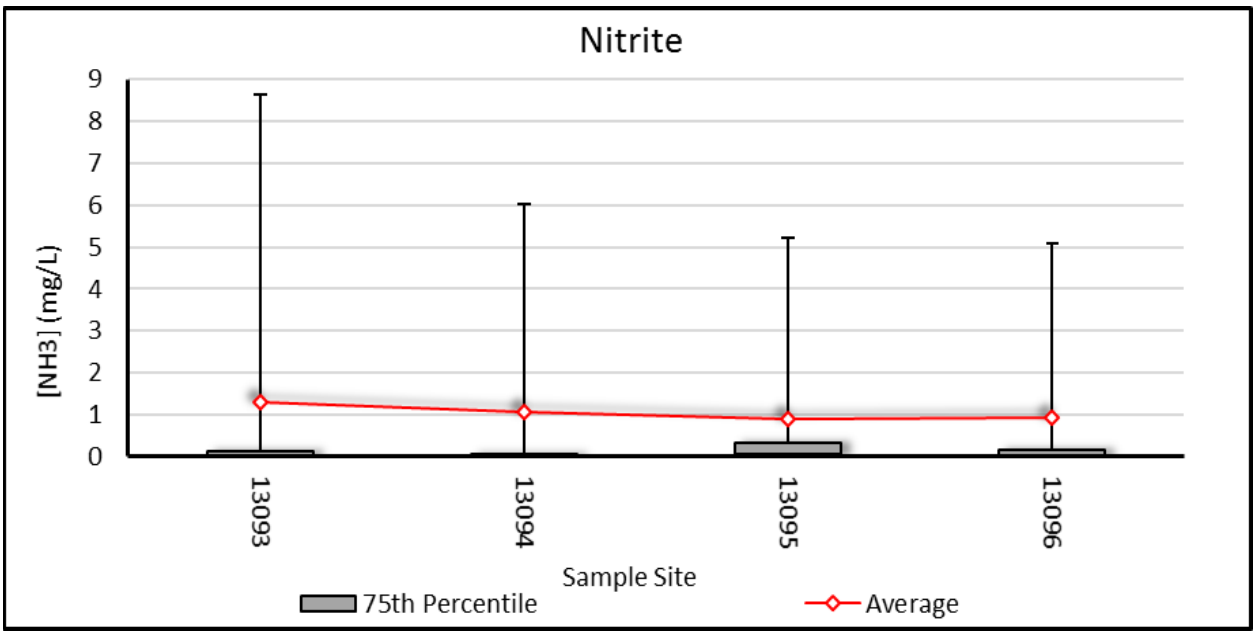

Figure 24. [Nitrite-nitrogen] at main stem stations

Total Phosphorus (TP) – [TP] ranged from < 0.06 mg/L to 4.75 mg/L. The LOQ for TP is 0.06 mg/L and the TCEQ screening level is 0.69 mg/L. Out of 69 TP samples submitted for analysis, 10 were at or below the LOQ and only 3 were above of the screening level. The highest concentration of 4.75 mg/L at main stem Station 13095 occurred in June at a flow rate of 20 ft^3/s following a high flow event. The second highest concentration was 1.1 mg/L at main stem Station 13096 in April. The **mean concentration** of TP in the **main stem** of Petronila Creek was **0.51 mg/L** and in the **tributaries**, it was **0.17 mg/L**. TP data from the July 12th high flow event was 0.24 mg/L at Station 13094 and 0.35 mg/L at Station 13096.

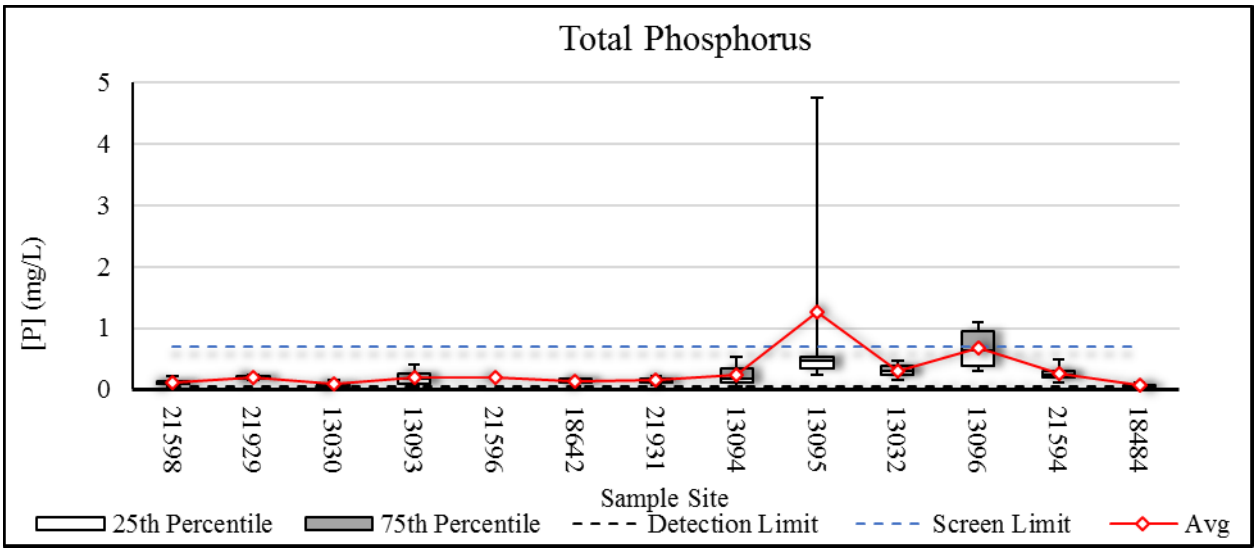

Figure 25. [Total phosphorus] at all stations

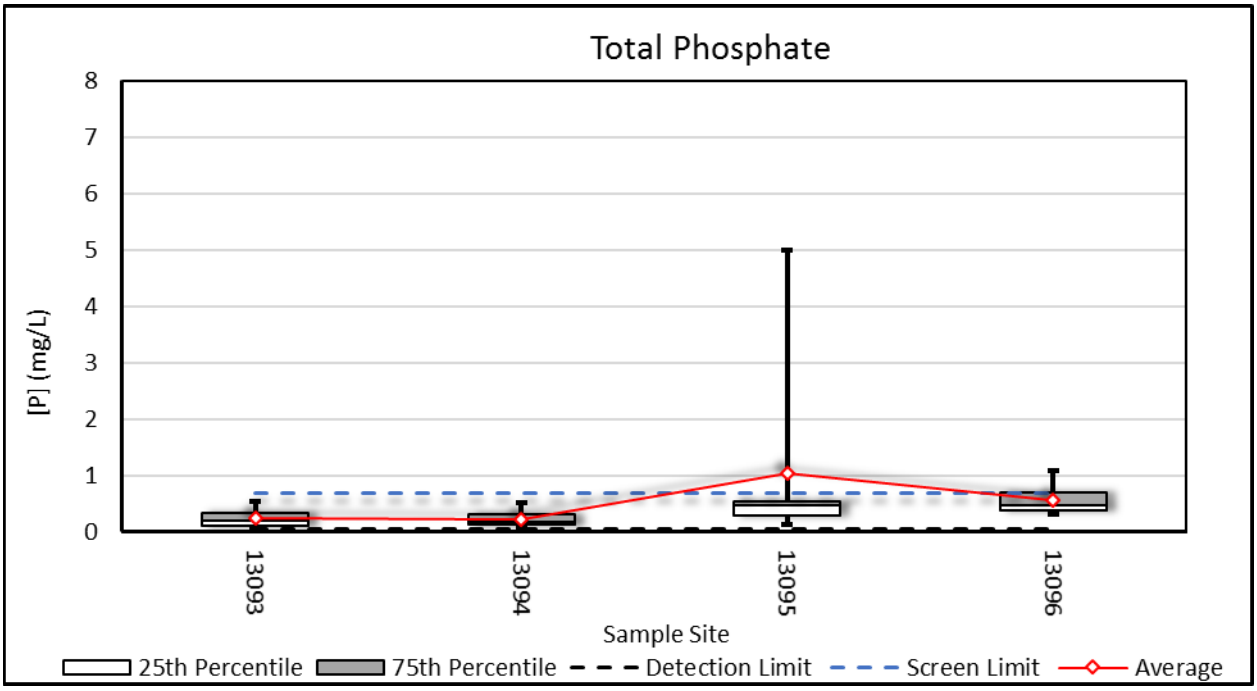

Figure 26. [Total phosphorus] at main stem stations

Chlorophyll-a – [Chl-*a*] ranged from less than 2.0 µg/L to 136.8 µg/L. The LOQ for [Chl-*a*] is 2.0 µg/L and the TCEQ screening level is 14.1 µg/L. Out of 67 total samples submitted for analysis, 18 were at or below the LOQ and 12 were above of the screening level. The **mean concentration** of [Chl-*a*] in the **main stem** of Petronila Creek was **26.8 µg/L** and in the **tributaries**, it was **6.1 µg/L**. For the tributary stations, the lowest mean concentration was < 2.0 µg/L at Station 21929. The highest mean concentration was 11.2 µg/L at Station 21594. For the main stem stations, the highest mean concentrations was 32.4 µg/L recorded at stations 13096.

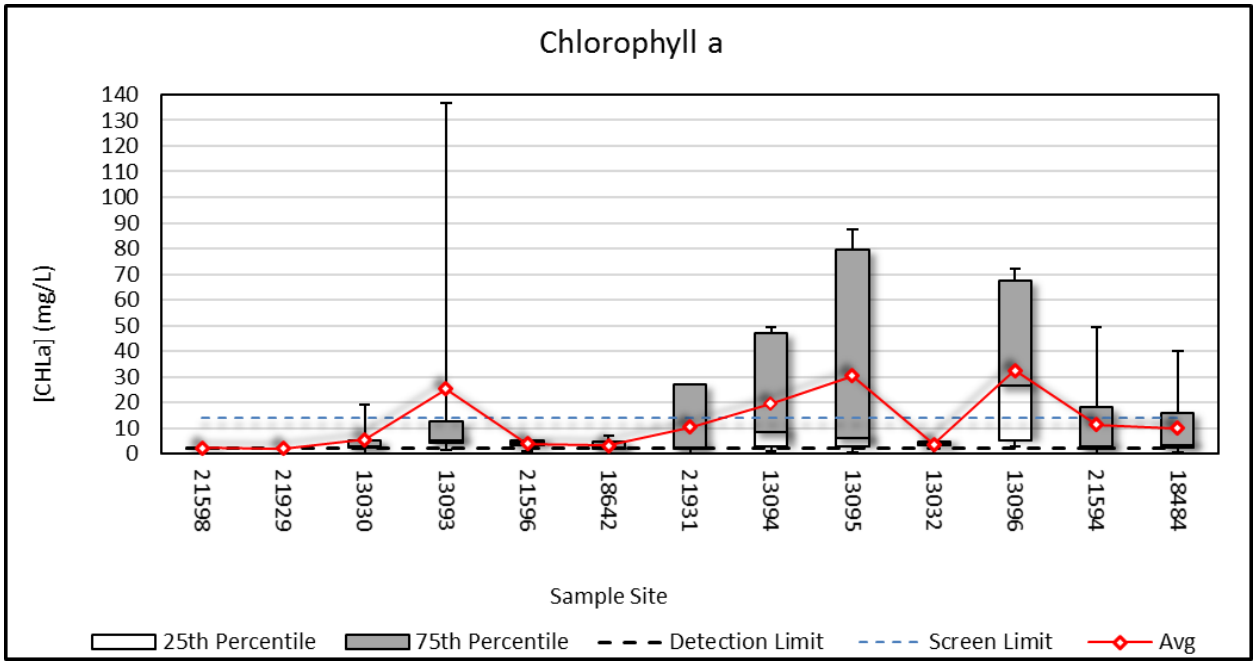

Figure 27. [Chlorophyll-*a*] at all stations

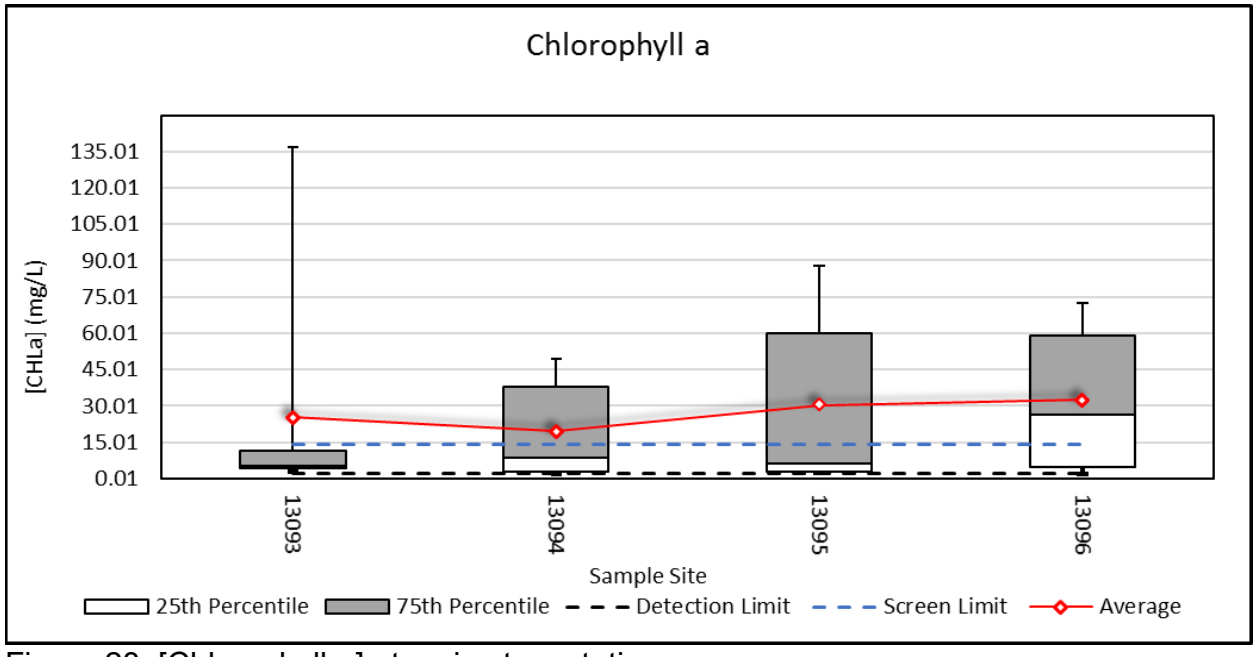

Figure 28. [Chlorophyll-*a*] at main stem stations

Conclusions

Nutrient inputs to Petronila Creek Above Tidal (TCEQ Segment 2204) come from a variety of permitted and non-permitted sources including wastewater treatment plants (WWTPs), non-point source (NPS) runoff from cropland, groundwater interactions, wildlife and other natural sources.

Permitted sources include eight WWTPs that contribute treated domestic wastewater to Petronila Creek Above Tidal or its tributaries, one of which contributes measurable flow to the study area. The City of Driscoll is permitted to release up to 100,000 gpd of treated effluent upstream of station 13096. A ninth source, US Ecology, is permitted for stormwater effluent only (Appendix B).

Data collected for the project from February through April coincided with drought conditions where streamflow rates in the main stem stations were lower than normal (1.0 to 4.0 ft^3/s). The USGS streamflow gage on FM 665 near Driscoll recorded streamflow values below 1.0 ft^3/s during much of this time. Streamflow in the main stem of the creek was dominated by effluent from the WWTPs and extremely high conductivity groundwater seeps (>30,000 µmhos/cm). Many of the tributaries sampled for the study were either not flowing or dry. In February and March, six out nine tributaries sites had flowing water. By late April, only 4 tributary stations had flow. Those flowing stations include: 13030, 18642, 18484, and 21594. Streamflow at stations 13030 and 18642 were attributed to groundwater seeps. Station 18484 and 21594 are sourced by a combination of WWTP effluent and groundwater.

Figure 29. Dry streambed at Tributary Station 21931

Data collected from May through July coincided with much wetter conditions. Monthly precipitation totals for May were close to nine inches. In June, they were just over five inches. Three high flow events were recorded on the USGS streamgage at FM 665 near Driscoll that were approximately 1,800 to 1,990 ft^3/s. No project sampling occurred during these high flow events due to accessibility issues which included closed and or muddy roads that lead to the sampling sites. Clean Rivers Program (CRP) sampling at Stations 13094 and 13096 were conducted during the peak flow on July 12th.

Ammonia – [Ammonia] were low and largely consistent with results from the 2020 study. Mean [Ammonia] in the main stem decreased slightly from 0.14 mg/L in 2020 to **0.11 mg/L in 2021**. Mean [ammonia] in the tributaries increased slightly from 0.12 mg/L in 2020 to **0.13 mg/L in 2021**. The only exceedance to the screening level occurred at tributary station 21929 in May with a value of 0.41 mg/L under low flow conditions. **Mean concentrations** in the main stem and the tributaries suggest **attainment** of TCEQs 0.33 mg/L **screening level** would **be likely.**

Total Kjeldahl Nitrogen (TKN) – [TKN] were largely consistent with results from the 2020 study. Mean [TKN] in the main stem decreased slightly from 1.53 mg/L in 2020 to **1.47 mg/L in 2021**. Mean [TKN] in the tributaries decreased from 1.44 mg/L in 2020 to **1.12 mg/L in 2021**. Mirroring the 2020 study, the highest [TKN] occurred at stations 13032 at 4.6 mg/L and 13906 at 3.7 mg/L in April. However, Station 13032 only had flowing water from May through July. The highest concentrations occurred in April and May under low flow conditions suggesting a seasonal bias might be a driving factor. **No TCEQ screening level exists for TKN.**

Dissolved Total Kjeldahl Nitrogen (Dissolved TKN) – [Dissolved TKN] were largely consistent with results from the 2020 study. Mean [dissolved TKN] in the main stem decreased from 0.99 mg/L in 2020 to **0.90 mg/L in 2021**. Mean [dissolved TKN] in the tributaries increased from 0.81 mg/L in 2020 to **0.93 mg/L in 2021**. Higher concentrations (>1.4 mg/L) occurred in April through July suggesting a seasonal bias. **No TCEQ screening level exists for Dissolved TKN**.

Nitrate-Nitrogen – Mean [nitrate-nitrogen] in the **main stem** increased from 1.23 mg/L in 2020 to **2.74 mg/L in 2021**. Mean [nitrate-nitrogen] in the **tributaries** increased slightly from 1.66 mg/L in 2020 to **1.72 mg/L in 2021**. TCEQs screening level for [nitrate-nitrogen] is 1.95 mg/L The increased mean [nitrite-nitrogen] on the main stem stations can be attributed to extremely high values in April under low flow conditions. [nitrate-nitrogen] at main stem stations 13093, 13094, 13095, and 13096 were 23.0 mg/L, 16.0 mg/L , 14.0 mg/L, 13.0 mg/L respectively. It is important to note that in the previous full year Petronila Creek Tributary Study (#2003), data suggested attainment of the standard was likely. However, the shortened study period (6-month sampling period) and seasonality bias of the nitrate-nitrogen inputs for higher concentrations in spring contributed to higher mean concentrations in 2021. [nitrate-nitrogen] indicate meeting **TCEQs screening level of 1.95 mg/L would be attainable** if averaged with the main stem data from the 2020 study.

Nitrite-Nitrogen – [Nitrite-nitrogen] rose significantly from 2020 to 2021. Mean [nitrite-nitrogen] in the main stem rose from 0.05 mg/L in 2020 to **1.02 mg/L in 2021**. Mean [nitrite-nitrogen] in the tributaries increased from 0.02 mg/L in 2020 to **0.41 mg/L in 2021**. Much of the increase can be attributed to extremely high [nitrite-nitrogen] in April at four main stem stations and one tributary station that were two orders of magnitude higher than other data results (71% of results were below 0.10 mg/L). Tributary Station 13030 had the highest reading at 13.8 mg/L. Main stem stations 13093, 13094, 13095, and 13096 were 8.64 mg/L, 6.06 mg/L , 5.30 mg/L, 5.12 mg/L respectively. Mirroring the nitrate-nitrogen results, the five highest concentrations were obtained during April under very low flow conditions. **No TCEQ nutrient screening level exists for nitrite-nitrogen.**

Total Phosphorus – In the second year of the nutrient study [total phosphorus] were higher in the main stem stations but lower in the tributary stations. Mean [total phosphorus] in the main stem rose from 0.38 mg/L in 2020 to **0.51 mg/L in 2021**. Mean [total phosphorus] in the tributaries dropped from 0.29 mg/L in 2020 to 0.17 mg/L in 2021. Although fewer exceedances of TCEQs screening level occurred for 2021, fewer results below the LOQ also occurred. **[total phosphorus]** indicate meeting **TCEQs screening level of 0.69 mg/L would be attainable**.

Chlorophyll-a – [Chlorophyll-*a*] were significantly lower in the second year of the nutrient study. Mean [chlorophyll-*a*] in the main stem dropped from 70.0 µg/L in 2020 to **26.8 µg/L in 2021**. Mean [chlorophyll-*a*] in the tributaries dropped from 62.1 µg/L in 2020 to 6.1 µg/L in 2021. Although a decrease in **[chlorophyll-*a*]** from the previous year, **attainment** of TCEQs screening level of 14.1 µg/L **would not be attainable**.

City of Driscoll WWTP – It should be noted that Nueces River Authority took over operation of the City of Driscoll WWTP (WQ0011541-001 – City of Driscoll: <100,000 gpd treated domestic wastewater via Petronila Creek) on April 5th, 2021. Maintenance to the facility to date include repairs to an aeration rotor that will provide higher dissolved oxygen levels, better clarification, and lowered suspended solids going forward.

Recommendations

To adequately quantify the spacial and temporal contribution of nutrient inputs to Petronila Creek Above Tidal (TCEQ Segment 2204), nutrient data collection in the watershed is recommended to continue to further assess hydrologic and climactic variability effects on water quality.

Appendix A

Photographs of Monitoring Stations

Station 21929 – Unnamed Tributary @ FM 70

Downstream view at Station 21929

Station 21958 – Unnamed Tributary @ FM 70

Upstream view at Station 21958

Widgeon grass (*Ruppia maritima)* at Station 21598

Station 13030 – Unnamed Tributary @ FM 70

Upstream view at Station 13030

Downstream view at Station 13030

Station 13093 – Petronila Creek @ FM 70

Upstream view at Station 13093

Downstream view at Station 13093

Station 21596 – Unnamed Tributary @ FM 892

Upstream view at Station 21596

Downstream view at Station 21596

Station 18642 – Unnamed Tributary @ FM 892

Upstream view at Station 18642

Downstream view at Station 18642

Station 13094 – Petronila Creek @ FM 892

Upstream view at Station 13094

Downstream view at Station 13094

Station 21931 – Unnamed Tributary @ FM 3354

Upstream view at Station 21931

Downstream view at Station 21931

Station 13095 - Petronila Creek @ CR 232

Upstream view at Station 13095

Downstream view at Station 13095

Station 13032 – Unnamed Tributary @ CR 18 & CR 75

Under the bridge view at Station 13032

Downstream view at Station 13032

Station 13096 – Petronila Creek @ FM 665

Downstream view at Station 13096

Station 18484 – Petronila Creek @ CR 24

Upstream view at Station 18484

Downstream view at Station 18484

Station 21594 – Petronila Creek @ CR 233

Upstream view at Station 21594

Downstream view at Station 21594

Appendix B

Wastewater Discharge Permit Information

2204 Petronila Creek Above Tidal

#1. WQ0010592-001 – City of Orange Grove: <200,000 gpd treated domestic wastewater via Agua Dulce Creek

#2 WQ0010140-001 – City of Agua Dulce: <160,000 gpd treated domestic wastewater via Agua Dulce Creek

#3 WQ0011583-002 – Nueces County WCID #5: <100,000 gpd treated domestic wastewater via Banquete Creek

#4 WQ0014802-001 – Geo Group: <150,000 gpd treated domestic wastewater via drainage ditch

#5 WQ0014981-001 – International Education Services: <9,000 gpd treated domestic wastewater via drainage ditch

#6 WQ0011541-001 – City of Driscoll: <100,000 gpd treated domestic wastewater via Petronila Creek

#7 WQ0002888-000 – US Ecology Texas: storm water via Nueces County drainage ditch

#8 WQ0011689-001 – Coastal Bend Youth City: <15,000 gpd treated domestic wastewater via unnamed ditch

#9 WQ0011754-001 – Bishop Consolidated ISD: <8,000 gpd treated domestic wastewater via drainage ditch