

Monitoring Plan for Nolan Creek/South Nolan Creek Watershed Protection Plan (WPP)

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Project Description

The goal of this project is to develop a watershed protection plan (WPP) for Nolan Creek/South Nolan Creek (Segment 1218) building upon a previous characterization project. Segment 1218 is currently listed as impaired due to elevated bacteria concentrations, thus, impacting the recreational use of the creek. Within the WPP, nine key elements outlined by the Environmental Protection Agency (EPA) for watershed-based plans will be addressed. Of these nine elements, monitoring was previously used in the characterization project to identify causes and sources. Within this project, continued water quality monitoring will be used to provide stakeholders with feedback on current conditions as well as track changes in water quality conditions spatially and temporally. Monitoring is to be conducted as routine monthly at 10 stations at a subset of stations monitored in the previous characterization project. Based on stakeholder feedback, some monitoring stations have been selected to further aid in isolating potential sources to allow a better focus on implementation practices in addressing the impairment.

Watershed Description

The Nolan Creek/South Nolan Creek watershed comprises 72,800 acres and is located almost completely within Bell County with only a small portion extending into Coryell County (Figure 1). Municipalities within the watershed include most of Killeen, all of Nolanville and large portions of Harker Heights and Belton. The Fort Hood Military Reservation also covers much of the northern portion of the watershed. Throughout the watershed, there are small lakes and reservoirs, although none directly along the mainstem of the Nolan Creek/South Nolan Creek. Nolan Creek converges with the Leon River after it passes through the City of Belton and is part of the Brazos River Basin.

Descriptions of Segment 1218 and associated assessment units (AUs) as defined by the Texas Commission on Environmental Quality (TCEQ) are as follows:

1218: Nolan Creek/South Nolan Creek - from confluence with the Leon River in Bell County to a point 100 meters upstream to the most upstream crossing of US 190 and Loop 172 in Bell County.

1218_01: Portion of Nolan Creek from the confluence with the Leon River upstream to confluence with North Nolan/South Nolan Creek fork in Bell County.

1218_02: Portion of South Nolan Creek from confluence with North Nolan/Nolan Creek fork upstream to confluence with Liberty Ditch in city of Killeen in Bell County.

1218_03: Portion of South Nolan Creek from confluence with Liberty Ditch in Killeen upstream to a point 100 meters upstream of the most upstream crossing of US 190 near the intersection of US 190 and Loop 172 in Bell County.

1218A: Unnamed Tributary to Little Nolan Creek - from the confluence with Little Nolan Creek upstream to headwaters in the city of Killeen, Bell County.

1218B: South Nolan Creek - from 100 meters upstream of the most upstream crossing of US 190 near the intersection of US 190 and Loop 172 upstream to headwaters in the city of Killeen, Bell County.

1218C: Little Nolan Creek - from the confluence with Nolan Creek/South Nolan Creek upstream to headwaters in the city of Killeen, Bell County.

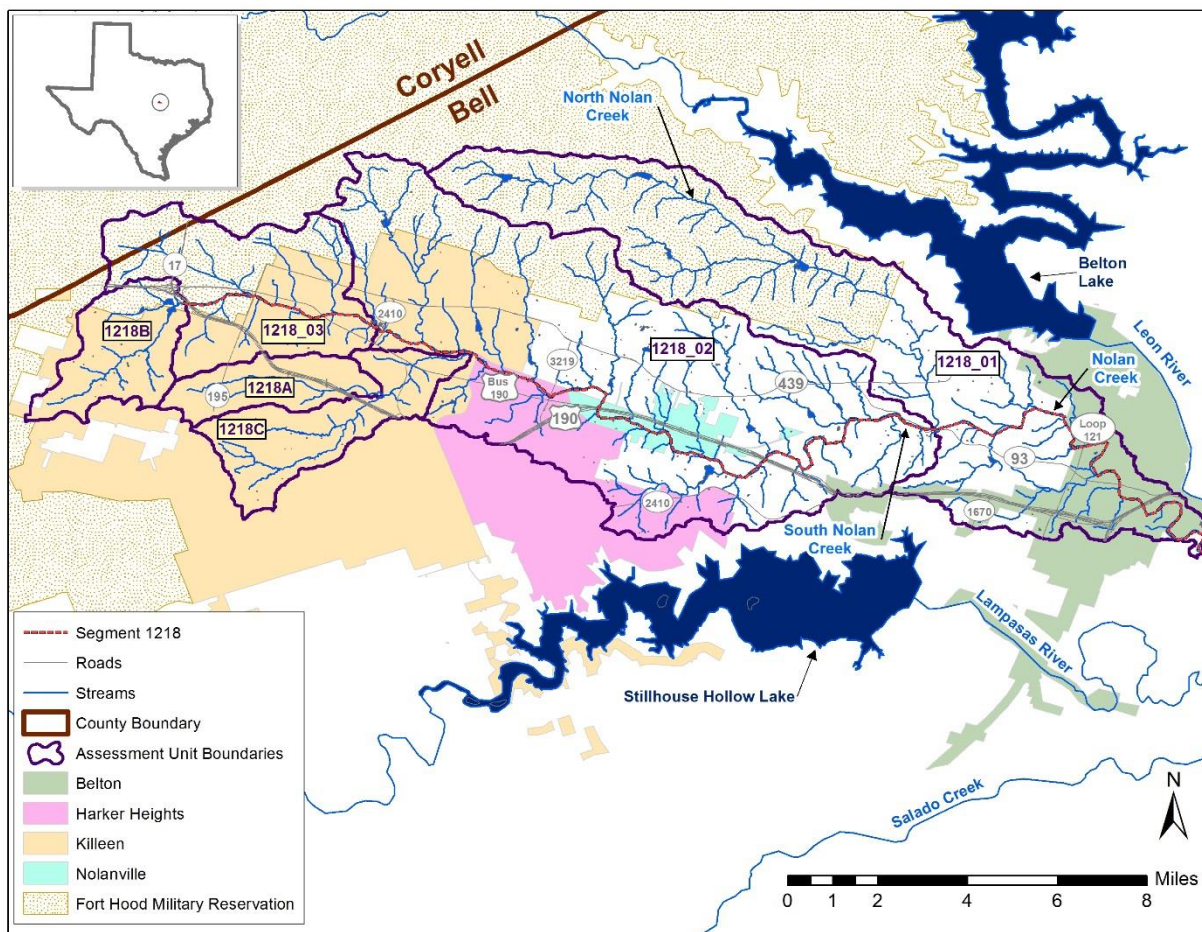


Figure 1 Overall watershed of Segment 1218, Nolan Creek/South Nolan Creek, and associated subwatersheds of assessment units

Water Quality Concerns and Impairments

Segment 1218 is listed as impaired for bacteria in the 2014 *Texas Integrated Report of Surface Water Quality*, specifically for AUs 1218_02 first listed in 1996 and 1218C first listed in 2010. These AUs have been assigned to Category 5b with regard to bacteria indicating that a review of the water quality standards for this water body will be conducted before a Total Maximum Daily Load (TMDL) is scheduled.

As part of the review of the water quality standard, a Recreational Use Attainability Analysis (RUAA) was conducted for Segment 1218 (Nolan Creek/South Nolan Creek) in the summer of 2009 and findings from this RUAA are available on TCEQ's RUAA website (<http://www.tceq.texas.gov/waterquality/standards/ruaas/ruaasbrazos>). The RUAA documented

use of the creek by individuals for primary contact recreation (PCR), thus, the TCEQ has recommended that the recreational use categorization of Segment 1218 remain PCR.

In addition to the bacteria impairment, concerns for nitrate and total phosphorus are noted for AU 1281_02 and for bacteria in AU 1218A in the 2014 *Texas Integrated Report of Surface Water Quality*. Of note, the 2014 *Texas Integrated Report of Surface Water Quality* assesses a seven year period of data covering December 1, 2005 through November 30, 2012. The bacteria data used to note this concern for AU 1218A was collected between October 2006 and February 2008 in association with a Clean Water Act 319 project conducted by the City of Killeen (City of Killeen and Jacobs, 2008).

Monitoring Design and Rationale

As part of continued monitoring in the watershed, routine monthly samples will be collected at 10 stations. Monthly monitoring parameters will include dissolved oxygen (DO), specific conductance (conductivity), pH and water temperature measured in situ. Laboratory parameters will include *Escherichia coli*, chlorophyll-a (CHLA), nitrite-nitrate-nitrogen (NO₂-N+NO₃-N), orthophosphate-phosphorus (PO₄-P), total phosphorus (TP), total Kjeldahl nitrogen (TKN) and total suspended solids (TSS). Instantaneous flow will also be measured the same day as water quality samples are collected, assuming safe wading conditions allow. Of note, if routine monitoring occurs during a period of elevated flows, safety and access issues may preclude the measurement of flow at some locations.

Because water quality assessments conducted by TCEQ focus on routine monitoring data, a goal of this project is to include these data in the TCEQ Surface Water Quality Monitoring Information System (SWQMIS) for use in future assessments of Segment 1218. Nolan Creek/South Nolan Creek generally has perennial flow throughout, in part due to discharge contributions from municipal wastewater treatment facilities (WWTFs) associated with the cities of Killeen, Harker Heights, Nolanville and Belton. More intermittent flow is expected at the tributary locations noted in the site selection section below. Of note, discharge from the WWTF associated with the City of Belton is located near the confluence of Nolan Creek with the Leon River, thus, has no impact on water quality along the reach of Nolan Creek/South Nolan Creek that will be monitored.

Site Selection

Site selection was largely based on findings associated with two reports noted below from the previous characterization project.

- Data Inventory for the Nolan Creek/South Nolan Creek Watershed Segment 1218 (available at [http://t-nn.tarleton.edu/docs/nolan_creek/publications/Nolan_Data_Inventory_Report\(revDec2015\)FINAL.pdf](http://t-nn.tarleton.edu/docs/nolan_creek/publications/Nolan_Data_Inventory_Report(revDec2015)FINAL.pdf)) and
- Monitoring Report - Characterizing Water Quality within Nolan Creek/South Nolan Creek (available at [http://t-nn.tarleton.edu/docs/nolan_creek/publications/Nolan_Monitoring_Report\(revDec2015\)FINAL.pdf](http://t-nn.tarleton.edu/docs/nolan_creek/publications/Nolan_Monitoring_Report(revDec2015)FINAL.pdf))

The Data Inventory Report provided detailed information about land use and potential sources as well as a review of previously collected water quality monitoring data at stations throughout the watershed. The Monitoring Report focused on data collected between May 2013 and June 2015, which included routine monthly monitoring at 11 stations and quarterly storm monitoring at 4 stations (Figure 2 and Table 1).

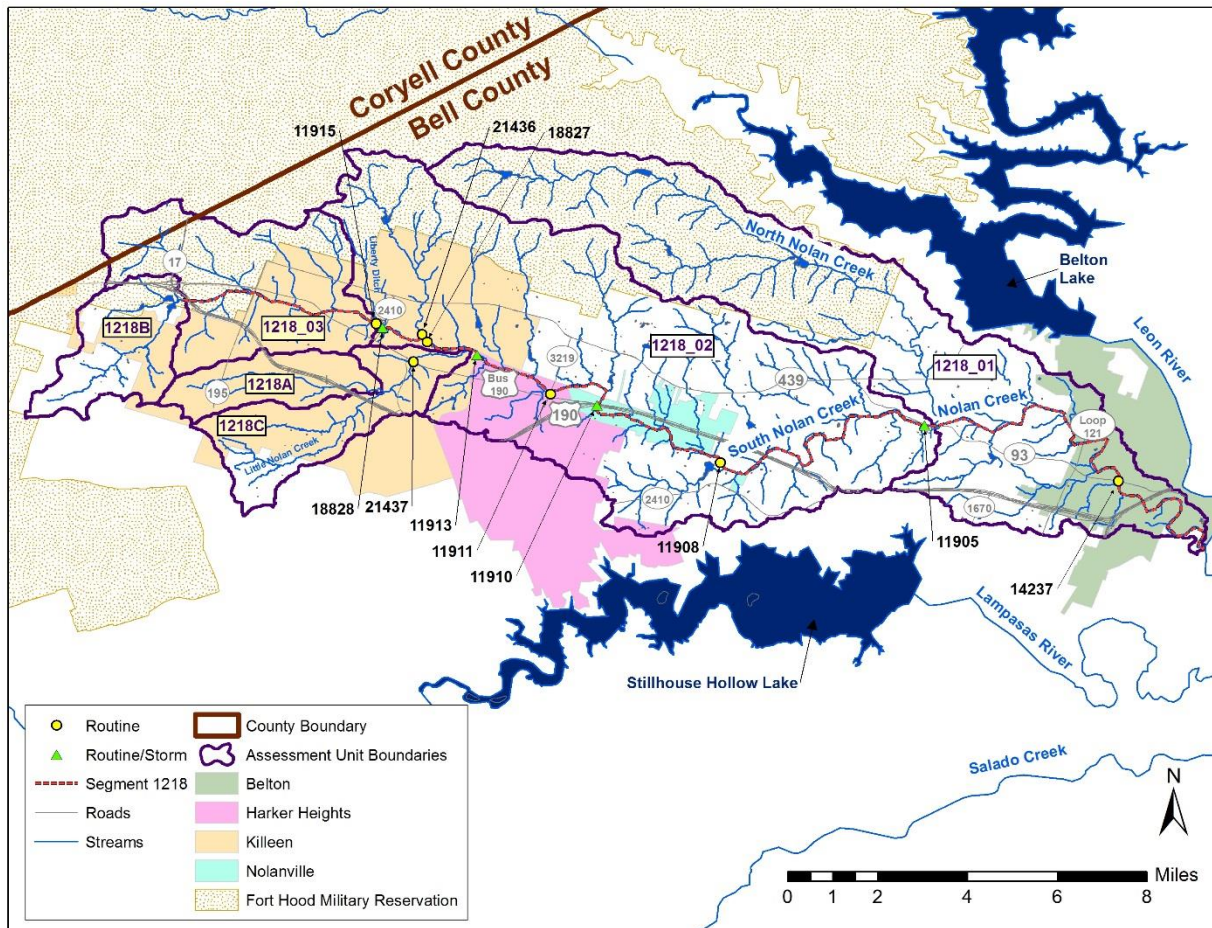


Figure 2 Previous sampling stations for the Nolan Creek/South Nolan Creek characterization project monitored between May 2013 and June 2015.

Table 1 Station descriptions of previously monitored sites for Nolan Creek/South Nolan Creek characterization project. Stations listed in upstream to downstream order and monitored May 2013 through June 2015.

Station ID	Station Description
11915	South Nolan Creek upstream of WWTP outfall
18828	South Nolan Creek at 38th St
21436	Long Branch just upstream of crossing of South Nolan Creek at Twin Creek Dr
18827	South Nolan Creek at Twin Creek Dr
21437	Little Nolan Creek off US 190
11913	South Nolan Creek at Roy Reynolds Road
11911	Nolan Creek at FM 3219
11910	Nolan Creek at US 190
11908	Nolan Creek at Levi Crossing
11905	Nolan Creek at Backstrom Crossing (above confluence of North Nolan Creek)
14237	Nolan Creek at SH 93 in Belton

The geometric mean *E. coli* of monthly data from May 2013 through June 2015 indicated contributing sources along Long Branch and Little Nolan Creek as well as between stations 11913 and 11911 (Figure 3). Based on these findings and interactions with stakeholders during and after the characterization project, it was recommended that future monitoring should focus along Long Branch as well as between 11913 and 11911 to better isolate potential bacteria sources and that the monitoring station on Little Nolan Creek should be maintained. Stations 18827, 11913 and 11911 would be maintained for tracking trends in water quality over time (Figure 4 and Table 2). There was also interest in maintaining station 18828 at 38th Street in Killeen and station 14237 at State Highway 93 in Belton.

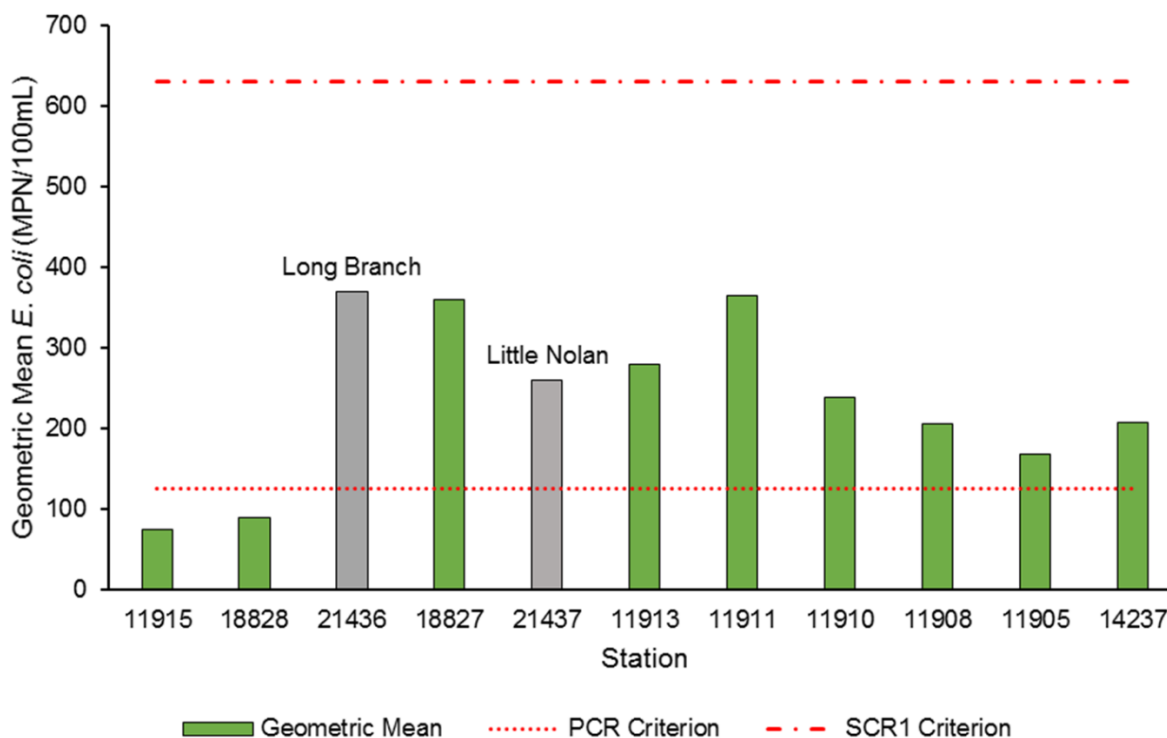


Figure 3 Geometric mean *E. coli* concentrations for routine monthly grab samples collected between May 2013 and June 2015 compared to assessment criteria. Tributaries to South Nolan Creek/Nolan Creek colored in grey. PCR = primary contact recreation and SCR1 = secondary contact recreation 1.

Station 18828 is the most upstream station in impaired AU 1218_02 and has maintained geometric mean concentrations below the criterion for PCR (Figure 3). Also, a dog park was opened to the public in June 2015 just above station 18828. There is interest to see if the dog park might have a localized impact on water quality. There are animal waste disposal bags and trash containers made available at the dog park, but getting people to pick up after their dogs still seems to be a challenge. Linking pet waste to water quality problems should help improve human behavior throughout the watershed with regard to picking up pet waste.

Station 14237 is located near Yettie Polk Park within the City of Belton and represents another station where there is an opportunity to educate people who use the park on the impact of behaviors, such as feeding ducks, on water quality. While ducks probably have a minor impact on water quality overall along Nolan Creek/South Nolan Creek, at this particular location within Yettie Polk Park ducks have been consistently noted when water quality samples have been collected and geometric mean *E. coli* concentrations have occurred above the PCR criterion (Figure 3). People feed the ducks within the park, thus, encouraging the ducks to congregate in this area. Several communities have found that educational campaigns are needed to teach people about some of the negative impacts associated with feeding wildlife. Yettie Polk Park also provides an area of the creek where people may use the water for recreation. This promotion also spikes interest in making the bacteria results from monitoring available, even if only as preliminary data, on the project website and to the City of Belton for indicating water conditions for recreation use.

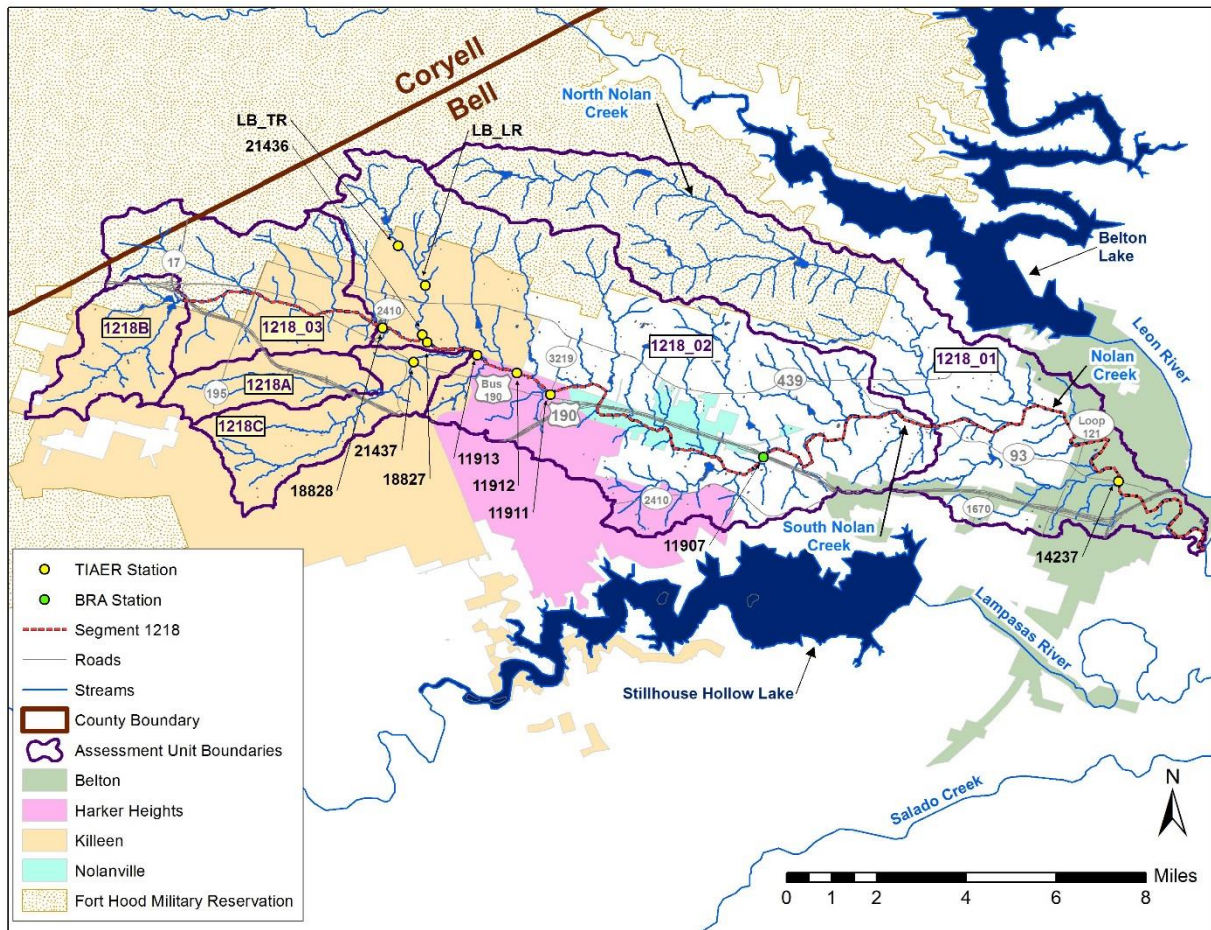


Figure 4 Proposed stations to be monitored by TIAER for the Nolan Creek/South Nolan Creek WPP project. Station 11907 is monitored by the BRA under the Clean Rivers Program.

In focusing monitoring along Long Branch, two new monitoring stations will be added, one at crossing with Tripp Trail (LB_TT) and the other at crossing of Lake Road (LB_LR) in Killeen (see Figure 4). These two stations are given temporary identification labels until a request for TCEQ SWQM location IDs can be fulfilled. The location on Tripp Trail is the second road crossing below the reservoir on Long Branch and is located in a residential area. The first road crossing below the reservoir (Westcliff Road) is fenced off on the upstream side representing a boundary with Fort Hood and on the downstream side access to the creek would be difficult due to dense vegetation and fencing. A monitoring location on this portion of Long Branch was considered desirable to better isolate potential contributions from grazing animals associated with land on Fort Hood. The site on Lake Road was selected as it captures a portion of the Long Branch watershed just below the confluence of a couple small unnamed tributaries. The site on Lake Road is located just above the Long Branch Park in the City of Killeen. Of note, considerations for all monitoring locations include accessibility and safety for monitoring personnel for sample collection and measurement of stream flow.

Table 2 Monitoring sites and selection rationale for Nolan Creek/South Nolan Creek WPP Project. Stations listed in upstream to downstream order.

TCEQ Station or Temp. ID	Site Description	Rationale for Selection	Latitude	Longitude
18828	South Nolan Creek at 38 th St in Killeen	Represents most upstream location of AU 1218_02 with background concentrations generally below PCR criterion for bacteria. Located just below Bell County WCID1 Main Plant WWTF discharge. Of note, the City of Killeen opened Mickey's Dog Park just above this location in June 2015.	31.108091	-97.702156
LB_TR	Long Branch at Tripp Trail in Killeen	Located below reservoir along upper third of Long Branch. Station added to aid in isolating sources on Long Branch.	31.134587	-97.697216
LB_LR	Long Branch at Lake Road in Killeen	Located just above Long Branch Park in Killeen below the confluence with an unnamed tributary on Long Branch. Station added to aid in isolating sources on Long Branch.	31.12176	-97.688445
21436	Long Branch just upstream of crossing of South Nolan Creek at Twin Creek Dr in Killeen	Considered a potential contributing source based on increasing concentrations noted between stations 18828 and 18827.	31.105946	-97.689364
18827	South Nolan Creek at Twin Creek Dr in Killeen	Elevated bacteria concentrations indicated at this location downstream of confluence of Long Branch, a major tributary to South Nolan Creek.	31.103470	-97.687851

TCEQ Station or Temp. ID	Site Description	Rationale for Selection	Latitude	Longitude
21437	Little Nolan Creek off US 190 in Killeen	Considered a potential contributing source based to South Nolan Creek between stations 18827 and 11913. Little Nolan indicated to have elevated bacteria concentrations in the 2014 Texas Integrated Report.	31.097143	-97.692268
11913	South Nolan Creek at Roy Reynolds Road in Killeen	Elevated concentrations indicated at this location on South Nolan just after confluence of Little Nolan Creek.	31.099382	-97.671748
11912	South Nolan Creek at Amy Lane in Harker Heights	Located between station 11913 and 11911 where increases in bacteria are occurring.	31.09361	-97.6589
11911	South Nolan Creek at FM 3219 in Harker Heights	Located below WWTF discharge associated with Harker Heights. Elevated bacteria concentrations noted between stations 11913 and 11911.	31.086666	-97.648056
11907	Nolan Creek at US 190 downstream of Nolanville	Monitoring by Brazos River Authority as part of the Clean Rivers Program	31.06656	-97.5795
14237	Nolan Creek at SH 93 in Belton	Within Yettie Polk Park, a recreational area in Belton. Included to complement quarterly monitoring under the Clean Rivers Program that had been occurring at station 14237 in assessing water quality within AU 1218_01.	31.058743	-97.464989

- a. A TCEQ Station identification will be obtained for all sampling stations, if one is not already assigned.

In focusing on water quality between stations 11913 and 11911, station 11912 will be added. Station 11912 aids in isolating flows from a major tributary (unnamed) between stations 11913 and 11911. Data collected at station 11912 is expected to help direct site selection during the second 12 months of monitoring for this project by indicating whether increases in bacteria noted at station 11911 are occurring above or below station 11912.

As part of developing this monitoring plan, the Coordinated Monitoring Schedule (CMS) maintained by the Texas Clean Rivers Program was consulted (<https://cms.lcra.org/>). The CMS for FY17 indicates quarterly monitoring at station 11907 by the Brazos River Authority (BRA) for Segment 1218, which will include conventional parameters, bacteria and field parameters. Station 11907 has been long-term, quarterly, monitoring station within Segment 1218 with bacteria data as fecal coliform dating back to 1980 and *E. coli* samples starting in January 2001. Station 11907 is located between previously monitored stations 11908 and 11905 (see Figures 2 and 4). Quarterly monitoring data collected over a similar timeframe at stations 11908 and 11906 shows comparable *E. coli* concentrations (Table 3), so data from 11907 collected by the BRA should provide a good assessment of water quality for this portion of the creek.

Table 3 Geometric mean *E. coli* concentrations for samples collected between May 2013 and June 2015 for stations 11908, 11907 and 11905.

Station	Monitoring Period	Monitoring Frequency	Geometric Mean <i>E. coli</i> (MPN/100 mL)	Number of Samples
11908	May 2013 – June 2015	Monthly	205	26
11907	June 2013 – June 2015	Quarterly	154	9
11905	May 2013 – June 2015	Monthly	169	26

While it would be ideal to place a large number of monitoring stations throughout the watershed, project funding for monitoring is limited to monthly monitoring at 10 stations for 24 months. At the May 4, 2016 advisory committee meeting, it was suggested that after 12 months some monitoring sites be moved to another location in the watershed. Moving some stations would allow focused monitoring in different areas of the watershed to better aid in targeting sources. This proposal was reviewed by TCEQ and considered feasible if accompanied by an expedited amendment of the Quality Assurance Project Plan (QAPP).

While the first 12 months of monitoring is being conducted, TIAER will work with the stakeholder advisory committee to determine other monitoring locations of interest. Within the third quarter of monitoring, the data collected will be evaluated by the committee. This evaluation will be done to determine if the current set of sampling stations is providing stakeholders with adequate information. If it is determined that adequate information has been collected at a given station or set of stations, some stations may be removed and new stations added during the second 12 months of monitoring. If stations are removed and new ones added, a revision to the monitoring plan will be developed including the rationale for these changes leading to an expedited amendment of the QAPP. No changes in monitoring will occur until the expedited amendment to the QAPP is approved by TCEQ.

Sampling Procedures

Routine Monitoring

Routine samples will be collected monthly and involve the following at each station:

- Measurement of instantaneous stream flow within the same day as when routine water quality samples are collected and documentation of flow measurement method,
- Instantaneous measurement in situ of DO, specific conductance, water temperature and pH using YSI multiprobes,
- Collection of a water sample for chlorophyll-a, nutrient and TSS analysis in appropriate containers,
- Collection of a sample for *E. coli* analysis in a sterile container,
- Documentation of field conditions including days since last precipitation (DSLPP), flow severity and comments on stream characteristics or sampling conditions.

Field data and samples will be collected following the TCEQ guidance document *Surface Water Quality Monitoring Procedures, Volume 1* (TCEQ, 2012). Table 4 lists the field parameters, methods and parameter codes, and Table 5 lists the parameters for water samples that will be analyzed by the lab. All laboratory analyses will be conducted by the TIAER laboratory, which is accredited for these parameters through TCEQ.

Table 4 Field parameters to be collected with routine grab samples

Parameter	Abbreviation	Units	Method ^a	Parameter Code
pH (standard units), field determined	pH	pH/ units	EPA 150.1 & TCEQ SOP	00400
Oxygen, dissolved, field determined	DO	mg/L	EPA 360.1 & TCEQ SOP	00300
Specific conductance, field determined (µS/cm @ 25°C)	Conductivity	µS/cm	EPA 120.1 & TCEQ SOP	00094
Temperature, water, field determined	Temp.	°C	EPA 170.1 & TCEQ SOP	00010
Flow, stream, instantaneous (cubic feet per second)	Flow	cfs	TCEQ SOP	00061
Flow Method	F-Method	1-gage, 2-electric, 3-mechanical, 4-weir/flume, 5-doppler	TCEQ SOP	89835
Days Since Last Precipitation	DSLPP	days	TCEQ SOP	72053
Flow Severity	Flowsev	1-no flow, 2-low, 3-normal, 4-flood, 5-high, 6-dry	TCEQ SOP	01351

- a. EPA refers to *Methods for Chemical Analysis of Water and Wastewater*, Manual #EPA-600/4-79-020 (March 1983) and TCEQ SOP refers to *Surface Water Quality Monitoring Procedures*, Volume 1 (RG-415, revised August 2012).

Table 5 Laboratory parameters to be analyzed for routine grab and storm samples

Parameter	Abbreviation	Units	Method ^a	Parameter Code
Nitrite plus nitrate, dissolved (mg/L as N)	NO ₂ -N+NO ₃ -N	mg/L	SM 4500-NO ₃ -F	00631
Nitrite plus nitrate, total, one lab determined value (acidified field, lab filtered) ^b	NO ₂ -N+NO ₃ -N	mg/L	SM 4500-NO ₃ -F	00630
Phosphorus, total, wet method (mg/L as P)	TP	mg/L	EPA 365.4	00665
Nitrogen, Kjeldahl, total	TKN	mg/L	SM 4500-NH ₃ G	00625
Residue, total nonfilterable (also referred to as total suspended solids)	TSS	mg/L	SM 2540 D	00530
Orthophosphate phosphorus, dissolved, field filtered < 15 min	PO ₄ -P	mg/L	SM 4500P-E	00671
Orthophosphate phosphorus, dissolved, lab filtered > 15 min ^b	PO ₄ -P	mg/L	SM 4500-P E	70507
<i>E. coli</i> , Colilert, IDEXX method	<i>E. coli</i>	MPN/100 mL	IDEXX Colilert®	31699
Chlorophyll-a spectrophotometric acid. method	CHLA	µg/L	SM 10200-H	32211

- EPA refers to *Methods for Chemical Analysis of Water and Wastewater*, EPA-600/4-79-020 and SM refers to *Standard Methods for the Examination of Water and Wastewater* (latest online edition).
- The total form of NO₂-N+NO₃-N and OPO₄-P (lab filtered) are analyzed only if routine grabs cannot be field filtered due to excessive sediment; otherwise, dissolved forms of these parameters are analyzed for consistency with historical data.

References

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