

Measures of Success

ROUTINE WATER QUALITY MONITORING DATA

The Plum Creek WPP was released prior to TCEQ publishing the 2008 Texas Water Quality Inventory and 303(d) List. At that time, only the upper portion of Plum Creek near Umland was considered impaired by *E. coli* bacteria. All three monitoring stations indicated concerns for nitrate, and the central portion near Lockhart exhibited additional concerns for orthophosphorus, ammonia, and total phosphorus. With the release of the 2008 Texas Water Quality Inventory, both the lower portion near Luling and the upper portion were listed as impaired by *E. coli*. All of the monitoring stations indicated concerns for nitrate. Ammonia was removed as a concern for 1810_02, but depressed dissolved oxygen and total phosphorus were added as new concerns for 1810_03. In the Draft 2010 Texas Integrated Report, these concerns remain in addition to the new *E. coli* impairment of 1810_02. Over the period of December 1, 2001 to November 30, 2008 (which is the period of record for the 2010 IR), each of the stations had an *E. coli* geometric mean in excess of the criterion. Table 10 identifies the current impairments and concerns in Plum Creek as described in the 2010 Texas Integrated Report.

Table 10. 2010 Texas Integrated Report impairments and concerns for Plum Creek.

Assessment Unit	Parameter	Status
1810_01: Confluence with San Marcos River to approximately 2.5 miles upstream of the confluence with Clear Fork Plum Creek	<i>E. coli</i> geometric mean	Nonsupport (4b)
	Nitrate screening level	Concern
1810_02: From approximately 2.5 miles upstream of confluence with Clear Fork Plum Creek to approximately 0.5 miles upstream of SH 21	<i>E. coli</i> geometric mean	Nonsupport (4b)
	Nitrate screening level	Concern
	Orthophosphorus screening level	Concern
	Total Phosphorus screening level	Concern
1810_03: From approximately 0.5 miles upstream of SH 21 to upper end of segment	Dissolved Oxygen grab screening level	Concern
	<i>E. coli</i> geometric mean	Nonsupport (4b)
	Nitrate screening level	Concern
	Total Phosphorus screening level	Concern

The PCWP decided that the three stations along Plum Creek could not provide enough data to really see the big picture of this almost 400 square mile watershed that includes such a variation of landuse and potential contributors for pollution depending on locations. To obtain a better understanding of the sources in the watershed, it was determined that additional sampling of tributaries that flow into Plum Creek, the WWTPs, and the springs was necessary. A Clean Water Act 319 program grant was awarded to GBRA to collect water quality data in the

subwatersheds under routine and targeted hydrologic conditions. The monitoring program has increased the number of routine (monthly) monitoring sites from the original three CRP monitored sites to eight. It also included targeted sites that are monitored once under dry weather conditions and once under wet weather conditions each season, collecting field, conventional, flow and bacteria parameter groups. The current monitoring program includes the 8 routine sites, 26 targeted sites spread throughout the watershed, 7 WWTP sites, 3 spring sites and a storm water site (Figure 17 and Table 11). These data will be utilized to track water quality trends and target “hot spots” in the watershed. Only parameters discussed in the WPP are included here. Additional parameters for these locations and results from GBRA targeted monitoring can be found on the website at <http://plumcreek.tamu.edu> and <http://www.gbra.org/plumcreek/data.aspx>

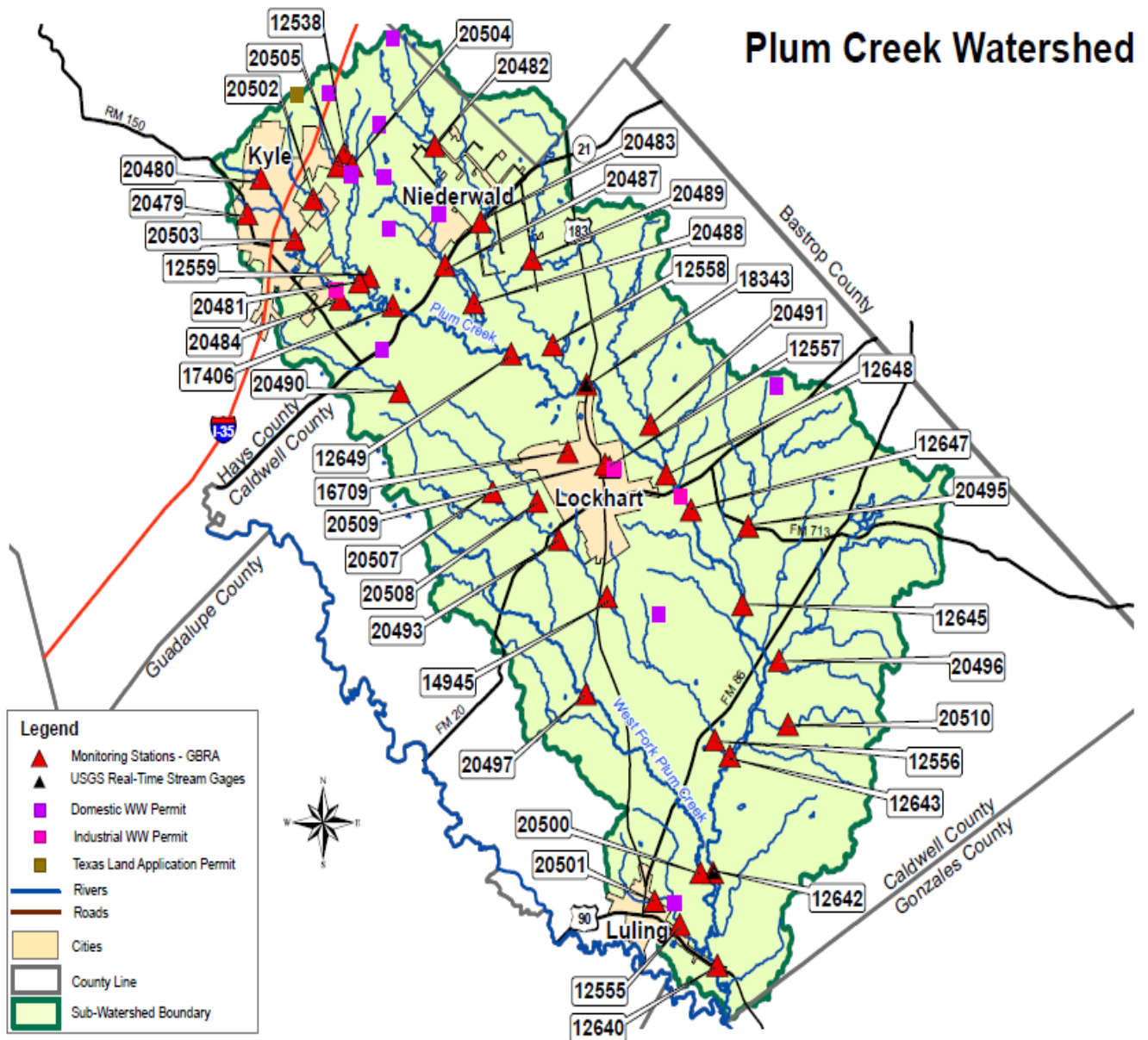


Figure 17. Water quality monitoring in the Plum Creek Watershed.

Table 11. Plum Creek monitoring locations and types of sampling.

Site No.	Site Name	Latitude	Longitude	Sample Type
12538	Andrews Branch at CR 131	30.03	97.827	Targeted
12555	Salt Branch at FM 1322	29.676	97.625	Targeted
12556	Clear Fork Plum Creek at Salt Flat Rd. (CR 128)	29.76	97.602	Routine/Diurnal
12557	Town Branch at E. Market St. (upstream of Lockhart WWTP #1)	29.885	97.665	Targeted
12558	Elm Creek at CR 233	29.96	97.798	Routine/Diurnal
12559	Porter Creek at Dairy Road	29.974	97.812	Targeted
12640	Plum Creek at CR 135	29.657	97.602	Routine/Diurnal
12642	Plum Creek at Biggs Road (CR131)	29.7	97.604	Targeted
12643	Plum Creek at FM 1322	29.753	97.593	Targeted
12645	Plum Creek at Youngs Lane (CR 197)	29.822	97.584	Targeted
12647	Plum Creek at Old McMahan Rd (CR202)	29.865	97.615	Routine/Diurnal
12648	Plum Creek at Old Kelly Road (CR 186)	29.882	97.63	Targeted
12649	Plum Creek at CR 233	29.938	97.725	Targeted
14945	Clear Fork Plum Creek at Old Luling Rd (CR 213)	29.826	97.668	Targeted
16709	Town Branch west of Lockhart	29.826	97.668	Targeted
17406	Plum Creek at Plum Creek Road	29.96	97.798	Routine/Diurnal
18343	Plum Creek upstream of US 183	29.923	97.679	Targeted
20479	Unnamed Tributary at FM 150 near Hawthorn Dr.	30.003	97.887	stormwater
20480	Plum Creek downstream of NRCS 1 spillway	30.019	97.879	Targeted
20481	Bunton Branch at Heidenreich Lane	29.971	97.819	Targeted
20482	Brushy Creek at FM 2001 (downstream of NRCS 12)	30.033	97.771	Targeted
20483	Elm Creek at SH 21 (downstream of NRCS 16)	29.998	97.743	Targeted
20484	Plum Creek at Heidenreich Lane (downstream of Kyle WWTP)	29.963	97.831	Targeted
20486	11041-002 City of Kyle and Aquasource WWTP	29.97	97.832	WW Effluent
20487	Brushy Creek at SH 21	29.978	97.766	Targeted
20488	Brushy Creek at Rocky Road (Upstream of NRCS 14)	29.961	97.748	Routine/Diurnal
20489	Cowpen Creek at Schuelke Road	29.981	97.712	Targeted
20490	Clear Fork Plum Creek at Farmers Road	29.921	97.794	Targeted
20491	Dry Creek at FM 672	29.904	97.64	Routine/Diurnal
20492	10210-001 City of Lockhart WWTP #1	29.884	97.663	WW Effluent
20493	Clear Fork Plum Creek at PR 10 (State Park)	29.853	97.697	Targeted
20494	10210-002 City of Lockhart WWTP #2	29.872	97.622	WW Effluent
20495	Dry Creek at FM 713	29.858	97.58	Targeted
20496	Tenney Creek at Tenney Creek Road	29.796	97.562	Targeted
20497	West Fork Plum Creek at FM 671	29.782	97.681	Targeted
20498	Copperas Creek at Tenney Creek Road (downstream of Cal-Maine)	29.751	97.557	Targeted
20499	10582-002 City of Luling WWTP	29.685	97.627	WW Effluent
20500	West Fork Plum Creek at Biggs Road (CR131)	29.7	97.612	Routine/Diurnal
20501	Salt Branch at Salt Flat Road (Upstream of Luling WWTP)	29.687	97.64	Targeted

Table 11. (continued).

Site No.	Site Name	Latitude	Longitude	Sample Type
20502	Bunton Branch at Dacy Lane (upstream of NRCS 5)	30.009	97.847	Targeted
20503	Plum Creek at Lehman Road	29.991	97.858	Targeted
20504	Porter Creek at Quail Cove Road	30.024	97.822	Targeted
20505	Richmond Branch at Dacy Lane	30.024	97.831	Targeted
20507	Clear Fork Springs at Borchert Loop (CR 108)	29.869	97.731	Spring
20508	Boggy Creek Springs at Boggy Creek Road (CR 218)	29.865	97.713	Spring
20509	Lockhart Springs	29.887	97.668	Spring
20510	Hines Branch at Tenney Creek (CR 141, downstream of Cal-Maine)	29.767	97.557	Targeted
99923	11060-001 City of Buda and GBRA WWTP	30.057	97.836	WW Effluent
99936	14431-001 GBRA Shadow Creek WWTP	30.043	97.811	WW Effluent
99937	14377-001 GBRA Sunfield WWTP	30.083	97.799	WW Effluent

GBRA ROUTINE MONITORING RESULTS

The water quality data collected at eight routine sites on Plum Creek, including five tributaries, is compiled in the following tables. The data were collected as part of the CWA Section 319 grants, a TSSWCB state grant and the Clean Rivers Program. Only parameters discussed in the WPP are listed. The data have been separated based on the hydrologic conditions of each sampling event. Rainfall data, additional parameters for these locations and results from targeted monitoring can be found on the GBRA website at <http://www.gbra.org/plumcreek/data.aspx> and <http://pcwp.tamu.edu>.

The region experienced severe drought in 2008-09 and again in 2011. These severe conditions impacted the sampling events designed to characterize water quality under different hydrologic conditions. The dry conditions were drier than normal over the period of record. The events conducted under wet hydrologic conditions were few and far between. For example, the routine site on the Dry Creek was only collected four times under dry conditions and five times under wet conditions, as compared to the sampling events conducted at the Plum Creek sites that averaged 30 and 18 events, respectively. The drought has made evaluation of implementation projects difficult, but recognizing the limitations of the small data set, some general observations can be made.

Plum Creek was listed on the 303d list because of *E. coli* concentrations. The *E. coli* results of the monitoring at the routine stations are in Table 12. The upper main stem sites continue to exceed the water quality contact recreation standard of 126 organisms per 100 mL. Rainfall events contribute significant *E. coli* loads but it is important to note that the bacterial contamination is still present and highly variable under baseflow conditions.

Table 12. Water quality monitoring results for *E. coli* at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow-Dry	E. coli Geometric Mean - Dry	Range-Dry	No. of Samples	Median Flow-Wet	E. coli Geometric Mean - Wet	Range-Wet	% Change btwn Dry and Wet *
Plum Creek at Plum Creek Road	30	1.5	320	36-2420	17	4.45	797	73-24000	149.06
Plum Creek at CR 202	27	3.2	155	46-550	19	13	389	16->24200	150.97
Plum Creek at CR 135	31	5	112	9-1200	17	27.5	418	56-9800	273.21
Clear Fork Plum Creek at Salt Flat Road	25	0.13	54	3-3150	14	5.25	534	41-12030	888.89
West Fork Plum Creek at Biggs Road	24	dry w pools	24	1-240	14	0.01	276	10-2500	1050.00
Elm Creek at CR 233	12	0	26	4-300	8	0.6	423	10-17330	1526.92
Dry Creek at CR 672	4	0	231	48-700	5	0.2	1142	330-4160	394.37
Brushy Creek at Rocky Road	15	<0.01	44	5-260	8	3.6	732	43-5480	1563.64

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration.

Stations highlighted have a base flow geometric mean greater than the water quality standard of 126 organisms/100 mL under dry conditions.

Total phosphorus concentrations are assessed for concerns using a screening concentration of 0.69 mg/L. The data collected under dry conditions at the main stem sites exceed this screening concentration consistently due to the high contributions of wastewater effluents to the baseflow. The total phosphorus results of the monitoring at the routine stations are in Table 13. Comparing the phosphorus concentrations measured under dry conditions to the concentrations measured under wet conditions, the majority of the routine sites show a reduction in the phosphorus load as a result of dilution from runoff. Conversely, the Clear Fork Plum Creek at Salt Flat Road site showed a significant percent increase in phosphorus loading as a result of runoff, but still remained below the screening concentration. Because of the rarity of runoff events over the period of record, it is best to hold judgment on consistency and extent of the phosphorus loading until a larger data set can be compiled.

Table 13. Water quality monitoring results for phosphorus at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow	Total P Mean - Dry	Range- Dry	No. of Samples	Median Flow	Total P Mean - Wet	Range- Wet	% Change btwn Dry and Wet *
Plum Creek at Plum Creek Road	30	1.5	3.45	0.76-5	17	4.45	1.22	0.29-2.83	-64.64
Plum Creek at CR 202	27	3.2	1.51	0.65-2.09	19	13	1.18	0.46-7.06	-21.85
Plum Creek at CR 135	31	5	1.02	0.22-2.69	17	27.5	0.7	0.23-1.48	-31.37
Clear Fork Plum Creek at Salt Flat Road	25	0.13	0.08	<0.05-0.31	15	5.25	0.19	<0.05-0.9	137.50
West Fork Plum Creek at Biggs Road	23	dry w pools	0.54	0.06-2.14	15	0.01	0.35	0.08-0.84	-35.19
Elm Creek at CR 233	12	0	0.14	0.09-0.19	8	0.6	0.17	0.06-0.45	21.43
Dry Creek at CR 672	4	0	0.36	0.23-0.47	5	0.2	0.3	0.11-0.41	-16.67
Brushy Creek at Rocky Road	24	<0.01	0.12	<0.05-0.21	14	3.6	0.14	<0.05-0.27	16.67

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration.

Stations highlighted have a base flow mean concentration greater than the screening concentration of 0.69 mg/L Total Phosphorus, under dry conditions.

According to the TCEQ assessment protocol, a stream will have a concern for nitrate nitrogen if the mean concentration exceeds 1.95 mg/L. Table 14 shows that the upper two main stem sites on Plum Creek exceed the screening concentration under dry flow conditions due to the contribution of wastewater effluents. As the water flows down the Plum Creek, the mean nitrate nitrogen concentration drops to below the screening concentration. This reduction could be due to the long residence time between the CR 202 and the CR 135 sites at low flows, which allows biological uptake of nitrate by macrophytes and algae. It is important to reiterate that drought impacts the stream by reducing baseflow which increases the percent of wastewater effluent under baseflow conditions and by reducing the contributions of tributaries which have been dry for a significant amount of time during the monitoring period.

Table 14. Water quality monitoring results for nitrate nitrogen at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow	NO3-N Mean - Dry	Range- Dry	No. of Samples	Median Flow	NO3-N Mean - Wet	Range- Wet	% Change btwn Dry and Wet *
Plum Creek at Plum Creek Road	30	1.5	17.44	4.45-27.3	17	4.45	7.68	0.46-20.8	-55.96
Plum Creek at CR 202	27	3.2	7.51	2.8-16.3	19	13	4.39	1.07-11.5	-41.54
Plum Creek at CR 135	31	5	1.59	<0.05-5.88	17	27.5	2.52	0.18-6.76	58.49
Clear Fork Plum Creek at Salt Flat Road	25	0.13	0.72	<0.05-3.02	14	5.25	0.82	<0.05-2.05	13.89
West Fork Plum Creek at Biggs Road	22	dry w pools	0.3	<0.05-1.06	14	0.01	0.23	<0.05-0.88	-23.33
Elm Creek at CR 233	12	0	0.1	<0.05-0.35	8	0.6	0.4	<0.05-1.39	300.00
Dry Creek at CR 672	4	0	0.24	<0.05-0.8	5	0.2	0.95	<0.05-3.78	295.83
Brushy Creek at Rocky Road	24	<0.01	0.13	<0.05-0.69	14	3.6	0.55	<0.05-1.44	323.08

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration.

Stations highlighted have a base flow mean concentration greater than the screening concentration of 1.95 mg/L Nitrate Nitrogen, under dry conditions.

Sources of ammonia nitrogen include decomposition of organic material present in the stream, agricultural contributions and wastewater discharges (Table 15). Comparing water quality conditions under dry and wet conditions, at the majority of the sites, the mean concentration of ammonia nitrogen was reduced to or remained below the screening concentration of 0.33 mg/L after runoff events.

Table 15. Water quality monitoring results for ammonia-nitrogen at routine stations in Plum Creek categorized by meteorological conditions during sampling (dry weather or wet weather).

Site	No. of Samples	Median Flow	NH ₃ -N Mean - Dry	Range-Dry	No. of Samples	Median Flow	NH ₃ -N Mean - Wet	Range-Wet	% Change btwn Dry and Wet *
Plum Creek at Plum Creek Road	29	1.5	0.53	<0.1-5.62	16	4.45	0.32	<0.1-3.16	-39.62
Plum Creek at CR 202	27	3.2	0.13	<0.1-0.22	18	13	0.1	<0.1-0.18	-23.08
Plum Creek at CR 135	31	5	0.15	<0.1-0.25	16	27.5	0.2	<0.1-0.42	33.33
Clear Fork Plum Creek at Salt Flat Road	25	0.13	0.18	<0.1-0.45	14	5.25	0.15	<0.1-0.35	-16.67
West Fork Plum Creek at Biggs Road	23	dry w pools	0.2	<0.1-0.98	14	0.01	0.1	<0.1-0.4	-50.00
Elm Creek at CR 233	12	0	0.33	<0.1-1.24	8	0.6	0.25	<0.1-1.04	-24.24
Dry Creek at CR 672	4	0	0.22	0.12-0.39	5	0.2	0.25	<0.1-0.066	13.64
Brushy Creek at Rocky Road	24	<0.01	0.17	<0.1-0.63	14	3.6	0.14	<0.1-0.32	-17.65

* Positive change indicates an increase in pollutant load with rainfall. Negative change indicates that rainfall is diluting the base flow pollutant concentration.

Stations highlighted have a base flow mean concentration greater than the screening concentration of 0.33 mg/L Ammonia-Nitrogen, under dry conditions.

Data collected at the wastewater treatment facilities are tabulated in Table 16. The upper site on Plum Creek is dominated by wastewater effluent. During the drought, the site near Umland would have been dry if not for the wastewater effluents discharged upstream. This site experienced a fish kill caused by the discharge of poorly treated wastewater, resulting in the discharge of high levels of ammonia and low dissolved oxygen from the Kyle AquaSource Wastewater Treatment facility in November 2010.

Data collected from Boggy Springs, Lockhart Springs, and Clear Fork Springs can be found in Table 17. The samples were collected quarterly but the hydrologic conditions were noted. The mean *E. coli* concentrations are at or above the water quality standard for contact recreation under both hydrologic conditions. These results could be impacted by the difficulty of collecting a representative sample of the springs, one that would not be impacted by either low flow conditions or after a rainfall event that contributes pollutant loads via surface runoff to the channel at the outlet of the springs.

Table 16. Wastewater treatment plant water quality monitoring results in the Plum Creek Watershed.

Site	Effluent Requirements		Median Flow	E. coli		Total P		NO3-N		NH3-N	
	E.coli/TotP/NH3-N	No. of Samples		Geometric Mean	Range	Mean, mg/L	Range	Mean, mg/L	Range	Mean, mg/L	Range
Kyle and AquaTX	126/NA/3	11	2.6	129	1-4840	4.3	3.5-5.7	23.5	12.4-33.8	0.58	<0.2-4.21
Buda and GBRA	NA/1.2/2	11	1.2	2	<1-25	0.38	0.24-0.49	20.73	16.1-25.7	0.13	<0.2-0.28
Shadow Creek and GBRA	NA/1/2	10	0.1	3	<1-1300	0.4	0.1-1.14	8.86	0.52-15.8	3.98	<0.2-6.01
Sunfield and GBRA	NA/1/2	7	0.1	<1	<1	0.41	0.33-0.45	54.67	50-63.5	<0.2	<0.2
Lockhart #1 and GBRA	126/NA/3	11	0.62	10	1-820	3.02	1.91-5.32	15.95	9.88-26.3	0.8	<0.2-1.91
GBRA Lockhart #2	126/NA/3	11	1.5	30	4-240	2.91	0.73-4.92	6.88	0.15-16	<0.2	<0.2-0.52
Luling	NA/NA/3	11	0.3	<1	<1-3	3.7	1.98-4.89	13.05	0.19-25.2	0.46	<0.2-2.37

Table 17. Water quality monitoring results for three springs sites in the Plum Creek Watershed.

Site	No. of Samples - Dry	Median Flow - Dry	E. coli Geomean - Dry	E. coli Range- Dry	No. of Samples - Wet	Median Flow - Wet	E. coli Geomean - Wet	E. coli Range- Wet	Tot P Mean - Dry	Tot P Range - Dry	Tot P Mean - Wet	Tot P Range- Wet	NO3-N Mean - Dry	NO3-N Range- Dry	NO3-N Mean - Wet	NO3-N Range- Wet	NH3-N Mean - Dry	NH3-N Range- Dry	NH3-N Mean - Wet	NH3-N Range- Wet	
Boggy Springs	4	0.25	124	64-190	3	0.1	1078	200-9800	<0.05	<0.05	0.04	0.02-0.06	6.78	5.58-8.28	5.81	5.4-6.28	0.24	<0.1-0.31	0.16	<0.1-0.19	
Lockhart Springs	5	0.64	359	160-770	2	1.4	384	200-370	0.05	<0.05-0.05	0.05	<0.05-0.05	9.61	7.35-11.4	9.08	8.56-9.6	0.23	<0.1-0.36	0.13	<0.1-0.13	
Clear Fork Springs	5	0.4	287	91-2420	2	2.35	362	460-860	<0.05	<0.05	0.05	0.03-0.07	6.04	5.22-6.6	5.48	5.36-5.6	0.21	<0.1-0.29	0.13	<0.1-0.13	
			Stations highlighted have a base flow geometric mean concentration greater than the water quality standard of 126 organisms/100 mL under dry conditions.							No stations highlighted since none have a base flow mean concentration greater than the screening level of 0.69 mg P/L under dry conditions.				Stations highlighted have a base flow mean concentration greater than the screening level of 1.95 mg NO ₃ -N/L under dry conditions.				No stations highlighted since none have a base flow mean concentration greater than the screening level of 0.33 mg NH ₃ -N/L under dry conditions.			