Analysis of Water Quality Trends at CRP Stations

A trend analysis was calculated at the three CRP stations that are monitored monthly and located in Uhland (Figure 18), Lockhart (Figure 19) and Luling (Figure 20) using a running 3-year geometric mean or median calculated for each 6-month period in February and August over the time period. Three years of monitoring data were used to calculate a geometric mean for *E. coli* and a median for nitrate nitrogen and total phosphorus to develop graphs showing water quality trends. These data are influenced by the extreme drought that this area has experienced which has greatly reduced flows at the sites. The red line on the graphs indicates the water quality standard for *E. coli* and the state's screening criteria level for nitrate nitrogen and total phosphorus. To meet water quality standards or screening criteria levels the blue area should be below the red line.

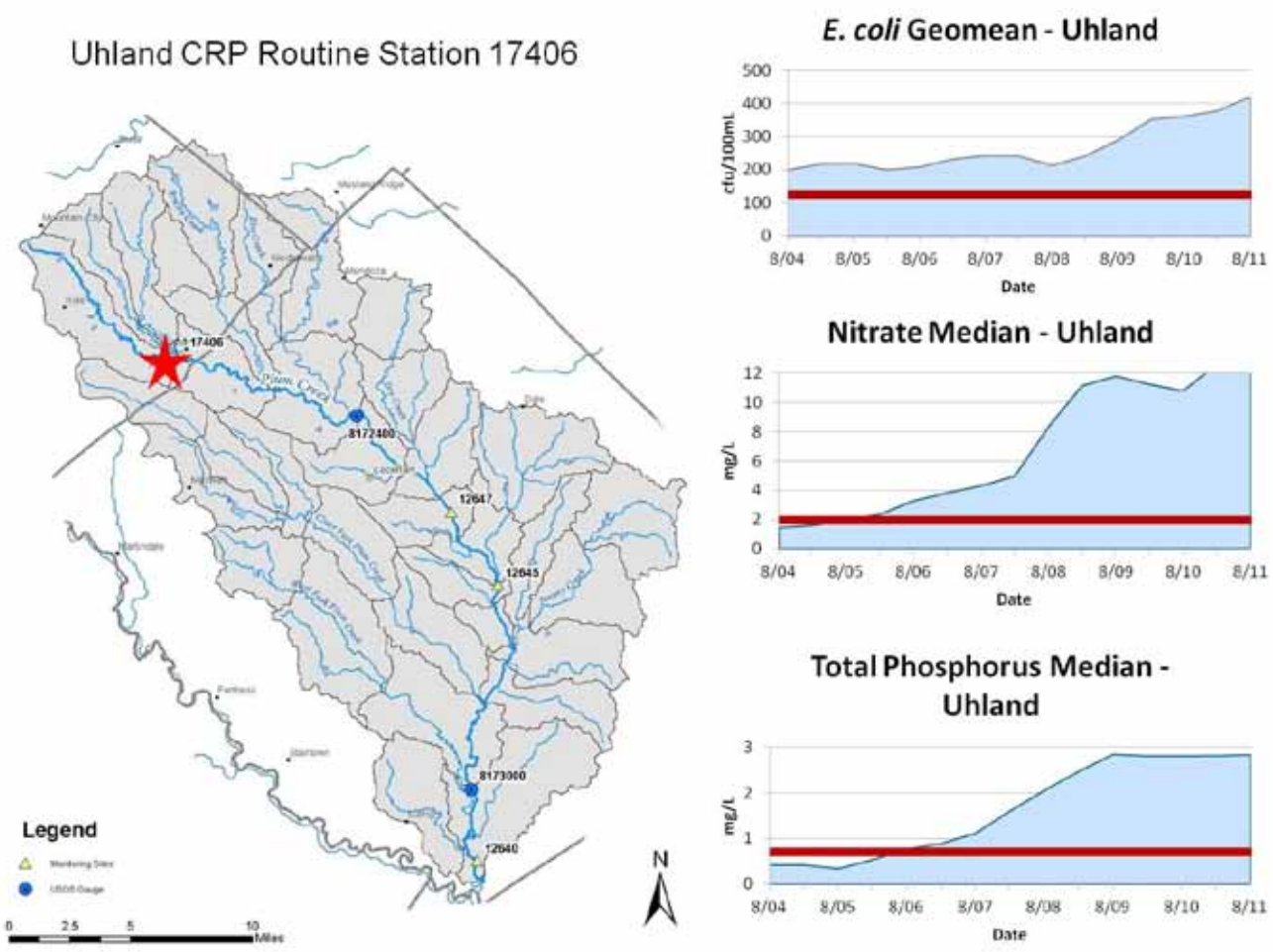

Figure 18. Uhland CRP routine monitoring station and water quality trend analysis for *E. coli*, nitrate nitrogen, and total phosphorus.

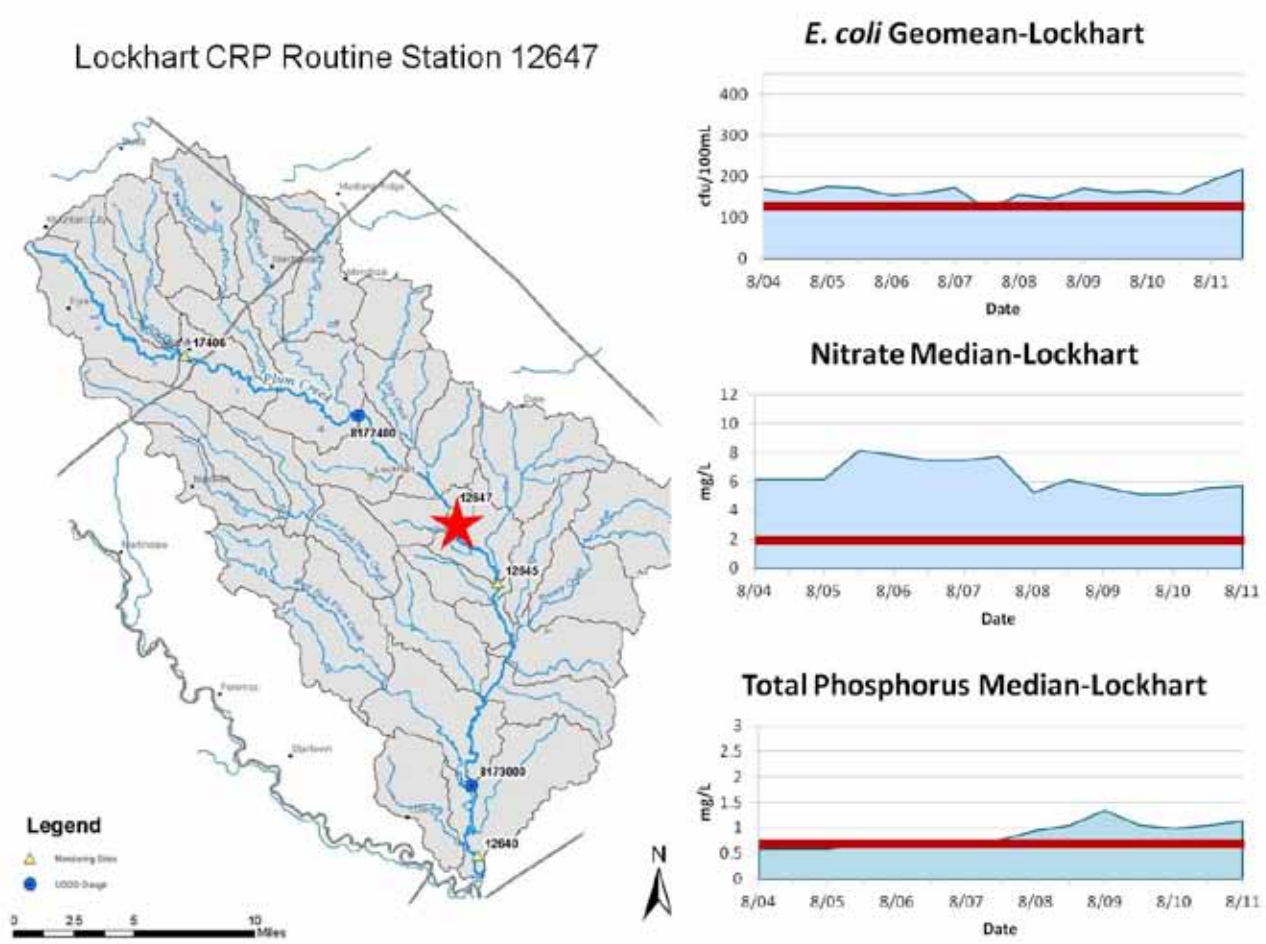

Figure 19. Lockhart CRP routine monitoring station and water quality trend analysis for *E. coli*, nitrate nitrogen, and total phosphorus.

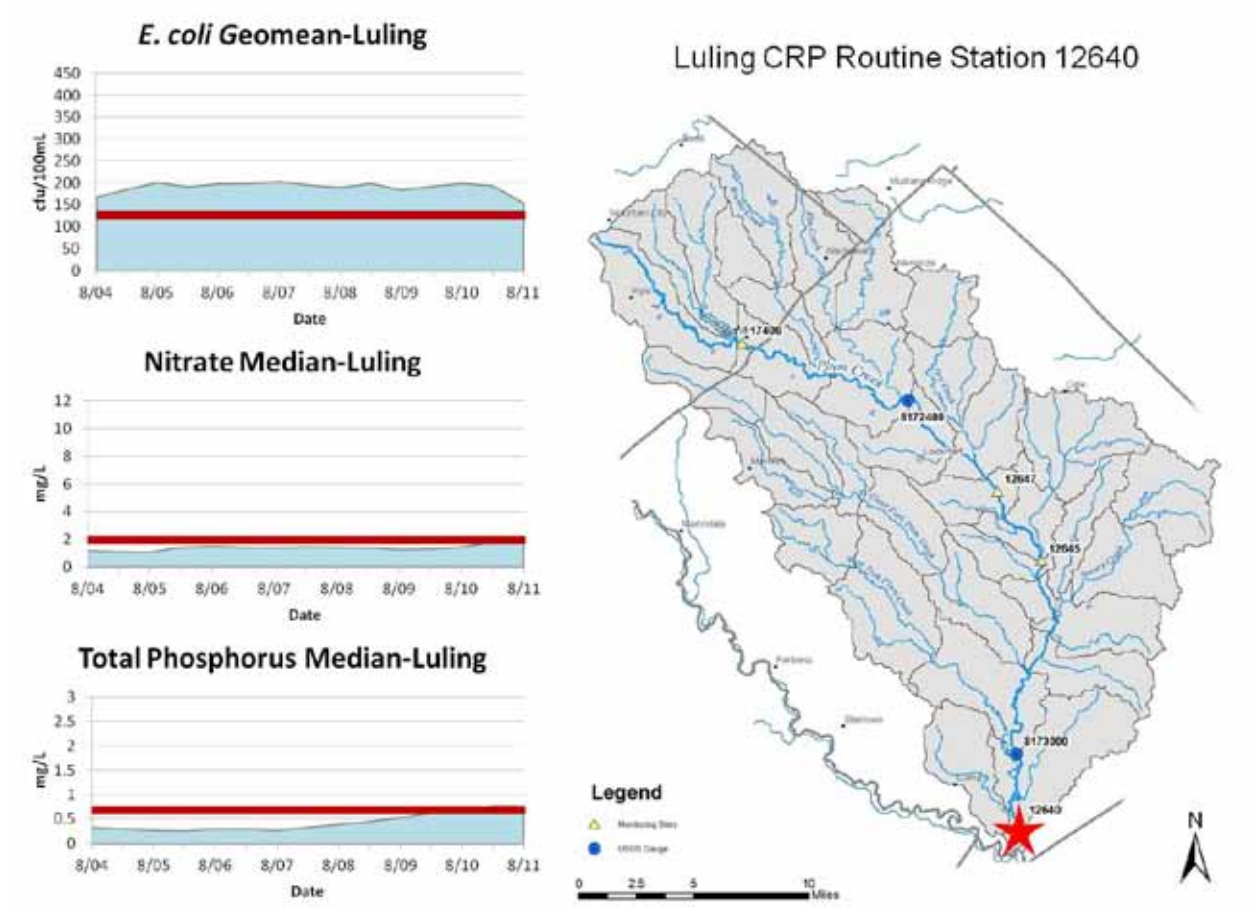

Figure 20. Luling CRP routine monitoring station and water quality trend analysis for *E. coli,* nitrate nitrogen, and total phosphorus.

GBRA Targeted Monitoring Results

TSSWCB provided CWA §319(h) funding for the GBRA to conduct an intensive targeted monitoring project to supplement data collected for TCEQ assessment purposes. In addition to expanding the number of routine monthly monitoring stations from three to eight sites monthly (as discussed in the previous section), 35 sites are now sampled twice per season during both dry and wet weather conditions; six WWTFs are sampled once per season, three springs are sampled seasonally; and automated stormflow sampling of selected rainfall events was conducted at an urban site in the City of Kyle (Table 18). After the initial period of funding (May 2007 through March 2010), TSSWCB utilized state general revenue to continue the mainstem and tributary portions of this monitoring regime through December 2010. GBRA will continue this comprehensive monitoring regime for three additional years (through October 2013) with another §319(h) grant from TSSWCB. This increased monitoring strategy provides a higher level of understanding of the spatial and temporal trends of pollutant loading, serves to refine the focus of management efforts, and helps track the performance of ongoing implementation activities. Because this is a critical part of adaptive management in the Plum Creek watershed, the targeted monitoring will play a key role in future watershed efforts and should continue. The following table summarizes data collected thus far. There is a considerable variation between and within sites, depending on the water quality parameter.

Table 18. Routine and targeted monitoring data in the Plum Creek Watershed categorized by meteorological conditions during sampling (dry weather or wet weather).

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
Andrews Branch at CR 131	8	0.85	146	38-490	7	1.2	720	41-10460	0.28	0.18-0.34	0.24	0.16-0.44	12.89	2.49-2.26	7.73	1.14-20.6	0.17	0.1-0.35	0.16	0.05-0.33
Brushy Creek at FM2001	1	0	4	NA	4	0.3	547	110-6800	0.10	NA	0.21	0.05-0.46	<0.05	<0.05	1.47	<0.05-5.7	0.42	NA	0.25	0.05-0.47
Brushy Creek at SH21	5	0	20	1-79	6	0.8	626	120-7270	0.10	0.05-0.16	0.17	0.06-0.33	0.07	<0.05-0.17	0.85	<0.05-2.83	0.23	0.05-0.46	0.16	0.05-0.45
Bunton Branch at Dacy Lane (CR205)	5	0.01	36	16-150	5	0.65	653	50-3550	0.05	<0.05-0.07	0.1	0.05-0.22	0.1	<0.05-0.19	0.57	0.19-1.03	0.14	0.1-0.17	0.14	0.05-0.36
Bunton Branch at Heidenreich Lane (CR152)	1	dry	140	NA	4	1.2	1335	630-2360	0.06	NA	0.09	<0.05-0.22	0.09	NA	0.08	0.2-1.82	0.17	NA	0.11	0.05-0.2
Clear Fork Plum Creek at Old Luling Road (CR213)	8	0.54	88	35-270	8	0.79	372	20-2000	0.06	<0.05-0.12	0.15	<0.05-0.34	1.15	0.05-3.12	1.64	0.18-5.4	0.2	<0.1-0.6	0.2	0.1-0.59
Clear Fork Plum Creek at CR 228	3	dry	59	10-750	3	0	210	10-3080	0.14	0.13-0.15	0.14	0.06-0.24	0.03	<0.05	0.48	0.15-1.04	0.17	<0.1-0.29	0.14	<0.1-0.35
Clear Fork Plum Creek at PR 10	8	0.69	48	19-130	8	0.9	351	160-1700	0.04	<0.05-0.06	0.11	<0.05-0.39	2.55	0.12-5.3	2.44	0.96-5.44	0.13	<0.1-0.3	0.11	<0.1-0.16
Copperas Creek at Tenney Creek Rd (CR141)	1	0	180	NA	4	0.04	642	10-17000	0.12	NA	0.54	0.14-0.93	0.22	0.22	0.49	0.05-1.2	0.46	NA	0.23	0.02-0.37
Cowpen Creek at Schuelke Rd (CR222)	0	dry	NA	NA	3	<0.01	1258	160-46100	NA	NA	0.24	0.06-0.39	dry	NA	0.5	<0.05-1.02	dry	NA	0.2	<0.1-0.5
Dry Creek at FM713	2	0	66	10-440	4	0.14	713	420-1610	0.22	0.17-0.27	0.22	0.15-0.27	1.47	0.14-2.79	0.47	0.1-1.24	0.16	0.14-0.17	0.19	<0.1-0.32
Elm Creek at SH 21	0	dry	NA	NA	2	<0.1	226	160-320	NA	NA	0.14	0.09-0.19	dry	NA	0.71	<0.05-1.4	NA	NA	0.2	<0.1-0.34
Hines Branch at Tenney Creek Rd (CR141)	1	0	70	NA	4	0	606	60-4000	0.16	NA	0.18	0.06-0.37	0.03	<0.05	0.78	<0.05-1.55	0.27	NA	0.22	0.13-0.4
Plum Creek at Biggs Rd (CR131)	8	5.8	188	86-460	8	20.5	1206	170-11200	0.80	0.44-1.34	1.03	0.34-1.69	1.81	0.09-4.26	1.72	0.22-3.75	0.17	<0.1-0.33	0.15	0.12-0.24
Plum Creek at CR 186	8	3.1	217	70-540	8	8.3	864	150-24200	1.13	0.67-2.07	1.05	0.31-2.04	8.09	1.08-12.7	2.87	0.97-9.06	0.11	<0.1-0.23	0.13	<0.1-0.19
Plum Creek at CR 233	8	1.4	96	45-210	7	6.1	711	120-10460	2.64	0.86-4.08	1.42	0.26-3.96	12.17	3.33-19.7	4.39	0.38-18.6	0.16	<0.1-0.33	0.2	<0.1-0.4
Plum Creek at FM 1322	8	2.6	145	53-400	8	12.5	915	150-3650	0.91	0.46-1.53	1.25	0.38-2.14	3.57	0.07-8.74	3.28	0.91-7.08	0.16	<0.1-0.26	0.13	0.1-0.17

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

Stations highlighted 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.

Stations highlighted have a base flow mean concentration greater than the screening level of 0.33 mg NH_3-N/L under dry conditions.

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
Plum Creek at Heidenreich Lane (CR152)	8	1.85	1793	770-4840	7	3.1	5269	1100->24200	3.83	2.71-4.96	2.05	0.33-3.92	18.42	7.05-26.5	11.35	0.65-27	0.94	0.15-5.3	0.45	<0.1-1.63
Plum Creek at Lehman Rd	8	0.01	79	5-260	8	0.7	1283	97-19860	0.04	<0.05-0.08	0.08	<0.05-0.17	0.2	<0.05-0.7	0.49	<0.05-1.07	0.13	<0.1-0.24	0.13	<0.1-0.34
Plum Creek at Youngs Lane (CR197)	8	275	149	76-380	7	10.1	1942	660-17330	1.33	0.47-2.14	1.16	0.33-2.8	4.28	0.17-10.7	4.45	1.16-10.7	0.16	<0.1-0.3	0.14	<0.1-0.17
Plum Creek downstrm of NRCS 1	8	0	39	5-1120	8	0	133	20-1190	0.37	0.18-0.8	0.34	0.06-0.87	1.29	<0.05-7.84	0.99	<0.05-6.52	0.76	0.1-2.81	0.15	<0.1-0.46
Plum Creek upstrm of Hwy 183	8	0.14	62	12-220	7	18	528	50->24200	2.05	0.82-3.42	1.28	0.3-3.18	4.95	0.13-10.3	2.28	0.63-8.48	0.16	0.11-0.3	0.12	<0.1-0.18
Porter Creek at Dairy Rd (CR151)	5	dry	98	8-480	5	1.1	2058	600-24200	0.08	<0.05-0.16	0.1	0.05-0.2	0.14	<0.05-0.55	0.46	<0.05-0.8	0.24	<0.1-0.7	0.17	<0.1-0.38
Porter Creek Trib at Quail Cove Rd	0	dry	NA	NA	2	0.1	382	40-3650	NA	NA	0.17	0.12-0.22	NA	NA	0.43	0.15-0.7	NA	NA	0.25	0.12-0.37
Richmond Branch at Dacy Lane (CR205)	6	0	209	53-690	6	0.58	1408	170-18600	0.06	<0.05-0.14	0.16	0.05-0.43	0.1	<0.05-0.18	1.31	0.07-3.89	0.14	<0.1-0.21	0.22	<0.1-0.75
Salt Branch at CR128	5	0	498	70-4840	9	0.04	2775	350->24200	1.27	0.34-4.13	0.39	0.28-0.7	0.23	<0.05-0.57	0.38	0.07-1.33	5.41	0.23-0.32	0.21	0.14-0.32
Salt Branch at FM 1322	8	<0.01	154	17-2150	8	1.88	2321	100-13000	3.20	1.93-4.02	1.53	0.24-3.69	6.22	0.08-14.6	1.63	0.23-4.59	0.59	0.17-2.59	0.36	0.17-0.64
Tenney Creek at Tenney Creek Rd (CR141)	0	dry	NA	NA	3	0	136	5-960	NA	NA	0.44	0.32-0.65	NA	NA	0.28	0.16-0.47	NA	NA	0.12	<0.1-0.18
Town Creek at E. Market St	8	0.72	253	140-460	8	1.3	665	70-16000	0.05	<0.05-0.07	0.09	0.05-0.18	9.02	0.69-12.4	7.7	3.9-10.3	0.15	<0.1-0.24	0.09	<0.1-0.14
Town Creek W of Lockhart (Stueve Lane)	0	dry	NA	NA	4	0	172	5->24200	NA	NA	0.6	0.15-0.93	NA	NA	0.96	<0.05-3.14	NA	NA	0.21	<0.1-0.51
West Fork Plum Creek at FM671	0	dry	NA	NA	5	0.08	310	10-1200	NA	NA	0.11	<0.05-0.2	NA	NA	0.25	<0.05-0.75	NA	NA	0.16	<0.1-0.41

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

Stations highlighted 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.

Stations highlighted have a base flow mean concentration greater than the screening level of 0.33 mg NH_3-N/L under dry conditions.

Rainfall Patterns from January 2008 – November 2011

This region of Texas has seen historic drought levels that have led to crop failures, livestock sell off, and wildfires. Dry conditions in the Plum Creek watershed in 2007-2009 dramatically affected the landscape. Rainfall returned in fall and winter of 2009; however, dry conditions returned by the end of 2010 and continued with unprecedented intensity throughout 2011. The average monthly rainfall is plotted along with the historic average monthly amounts for the period of 1943-2011 (Figure 21). These recent weather patterns have substantially affected pollutant loading characteristics throughout the watershed. Decreased plant cover likely resulted in greater loss of soil and associated nutrients in many areas as rains returned.

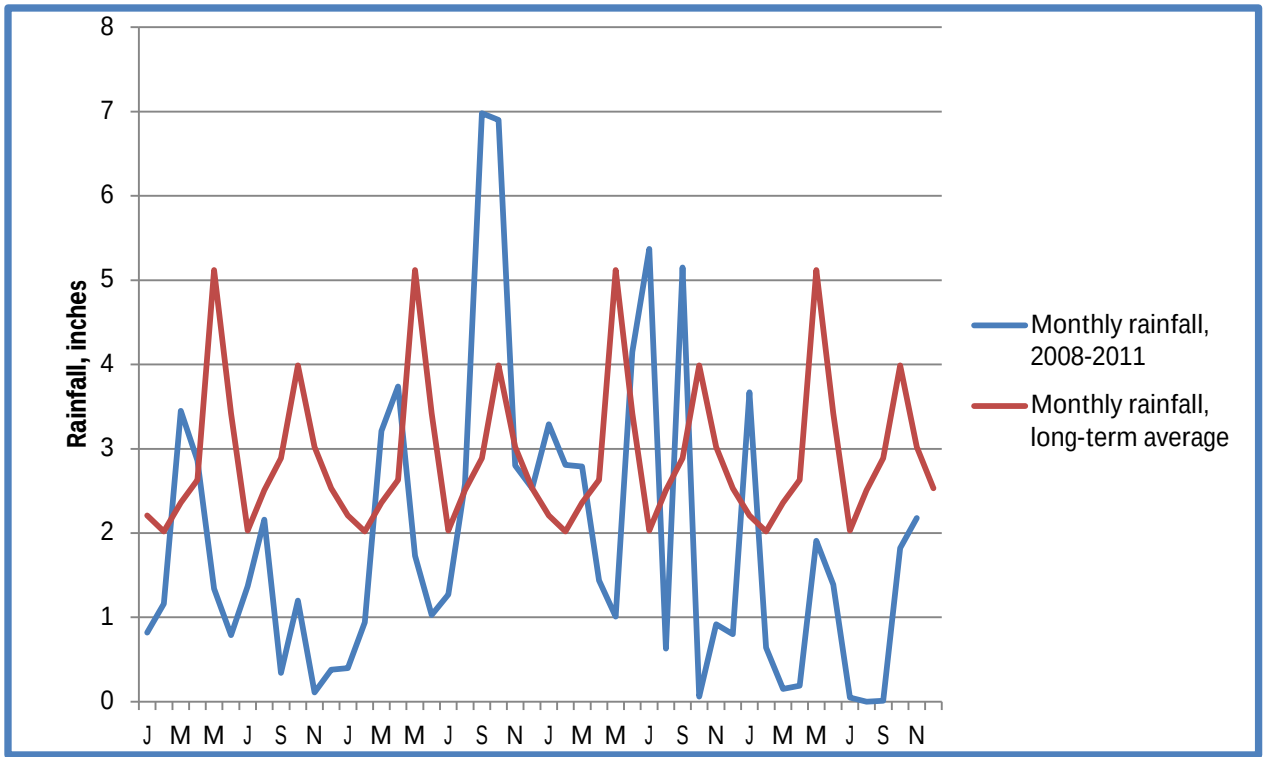

Figure 21. Rainfall data from 2008-2011 compared to the long-term average.

Stream Biological Assessments

In addition to water quality analyses, GBRA conducts annual biological and habitat assessments at two sites in the Plum Creek watershed under the Clean Rivers Program: Plum Creek at CR 202 near Lockhart (12647) and Plum Creek at Plum Creek Road near Uhland (17406). Surveys of the fish and macroinvertebrate communities in the stream as well as the plant communities and physical characteristics of the environment adjacent to the stream serve as indicators of positive or negative responses to changes in stream conditions. The type and the number of fish and macroinvertebrate species collected are used to calculate the Index of Biotic Integrity (IBI). Table 19 gives the IBI scores and the classifications that are based on those scores for each site since 2006. Bioassessments were not performed at either site in 2007 and at the Plum Creek at Plum Creek Road site in 2009 due to high flow events that scoured the stream.

The TCEQ Clean Rivers Program (CRP) funded the GBRA to perform one biological monitoring event per year at the Plum Creek at Plum Creek Road (TCEQ ID #17406) monitoring station near Uhland. The GBRA began monitoring the fish community, benthic macroinvertebrate community and physical habitat characteristics at station 17406 in 2004. Each monitoring event was conducted under the GBRA CRP quality assurance project plan (QAPP) and followed the sampling protocols defined in either the TCEQ Surface Water Quality Monitoring Procedures Manual: Volume 2, published in June of 2007, or the Receiving Water Assessment Procedures Manual, published in June of 1999. These monitoring events were scheduled at this location in order to "screen" the creek for undiagnosed biological impairments or concerns. During the March 2009 Guadalupe River Basin coordinated monitoring meeting, the CRP stakeholders agreed to remove the biological monitoring event at station 17406 after fiscal year 2010 in order to re-distribute the funding into new monitoring projects elsewhere in the basin. The decision to discontinue the biological assessment at this station was largely due to the results from the last available assessment event in September of 2008 using the newly published SWQM Procedures Manual: Volume 2 aquatic life monitoring (ALM) protocols. This event showed that all three calculated biological monitoring criteria were meeting the designated "High" aquatic life use for the stream segment. The removal of biological monitoring at station 17406 was also possible because aquatic life use monitoring had been added to another station (12647) on the Plum Creek at Old McMahan Road, downstream of the City of Lockhart, which represented a larger portion of the Plum Creek watershed.

Table 19. Stream biological assessments at two sites on Plum Creek.

Stream Biological Assessments - IBI Score (Classification)										
Site	**2006**		**2008**		**2009**		**2010**		**2011**	
	Nekton	**Benthics**	**Nekton**	**Benthics**	**Nekton**	**Benthics**	**Nekton**	**Benthics**	**Nekton**	**Benthics**
Plum Creek at Plum Creek Road (17406)	33 Limited	20 Limited	42 High	42 High	Flooding	Flooding	42 High	24 Intermed	Removed from Monitoring Schedule	
Plum Creek at CR 202 (12647)	24 Intermed	17 Limited	42 High	24 Intermed	33 Limited	24 Intermed	24 Intermed	24 Intermed	42 High	24 Intermed

* Assessment not conducted in 2007.

The IBI classification system for nekton species developed by the Texas Parks and Wildlife Department is specific to each ecoregion. The IBI classification system for the benthic community developed by the TCEQ is applied to all ecoregions across the state. The following are the stream classifications assigned based on IBI scores (Table 20):

Table 20. Stream classifications assigned based on IBI scores.

Classification	Nekton	Benthic
Exceptional	≥49	>36
High	41-48	29-36
Intermediate	35-40	22-28
Limited	<35	<22

GBRA has observed that the majority of macroinvertebrate species collected at both locations are *tolerant species*. Additionally, there are very few nekton species collected per unit effort and those fish species caught included very few benthic invertivores (fish that feed on invertebrates).

The lower species diversity and number of individuals collected have negatively impacted the IBI scores at the Plum Creek sites. There are more tolerant species found at these sites than intolerant species.

The TCEQ assesses the biological integrity of streams by comparing the classification given a site based on the IBI score to the water quality standard for flowing streams. The presumed use for flowing streams is High Aquatic Life Use. Aquatic Life Monitoring (ALM) protocol used by TCEQ requires that two assessments be conducted each year for two years, with one of the annual assessments done in the critical period (July-September) and one done outside the critical period (March-October). The biological assessments conducted by GBRA on the Plum Creek sites were done only in the critical period of each year. ALM performed by GBRA on the Plum Creek sites was to provide baseline data on environmental conditions.

Soil and Water Assessment Tool (SWAT)

The use of the SWAT model was investigated during WPP development to help guide implementation efforts. However, due to a lack of critical data and incomplete understanding of the fate and transport of *E. coli* bacteria in freshwater streams, the approach was inconclusive. While calibration and validation of flows was successful, replication of bacteria loads proved very problematic. In some instances, removal of pollutant sources resulted in a net increase in bacteria loading. The use of LDCs in concert with SELECT analysis was very effective for quantifying and targeting implementation measures. Due in part to the extreme drought, but also because more time is needed for practice implementation and to address issues of lag time, neither LDC nor SELECT analyses was conducted for the purposes of this update. The SWAT approach may again receive attention in the future, but current adaptive management approaches and implementation guidance primarily will rely on pollutant loading trends as indicated by the targeted water quality monitoring.

Bacterial Source Tracking

Bacterial source tracking (BST) is a valuable tool for identifying human and animal sources of fecal pollution. BST has not yet been utilized to determine in-stream source loading in the watershed. The Partnership and technical advisory group determined that the initial approach to determining target sources and geographic areas using SELECT analysis was adequate at that stage of developing the WPP. The Partnership will continue to investigate opportunities to employ BST strategies, and if satisfactory progress toward water quality restoration is not apparent, use of this technique may be reconsidered.

The state of BST science, methodologies, application and confidence has evolved greatly in the past few years since the Plum Creek WPP was published. The Texas *E. coli* BST library was developed based on known source isolates from different domestic sewage, wildlife, livestock and pet fecal samples from selected watersheds across the state. Expansion of the library to include additional known source isolates from other Texas watersheds and different animal hosts is continuing. Investments by the state in building BST analytical laboratory infrastructure and the use of the Texas *E. coli* BST library will provide for significant cost and time savings for the identification of nonpoint source pollution should the Partnership reconsider the use of BST.

NITRATE NITROGEN ISOTOPE STUDY

Plum Creek is 52 miles in length and has a drainage area of 389 mi^2. According to the 2008 Texas Water Quality Inventory and 303(d) List, all three assessment units of Plum Creek that make up the classified stream segment exhibit nutrient enrichment concerns for ammonia, nitrate+nitrite nitrogen and total phosphorus. Data collected from December 2001 through November 2008, reports the mean concentration of nitrate nitrogen for Assessment Unit (AU) 1810_01 as 3.07 milligrams per liter (mg/L) with 25 out of 82 samples exceeding the screening concentration; the mean concentration for AU 1810_02 as 8.89 mg/L with 24 out of 27 samples exceeding the screening concentration; and, the mean concentration for AU 1810_03 as 9.5 mg/L with 50 out of 82 samples exceeding the screening concentration.

Since monitoring of Plum Creek began in the late 1990's it has shown elevated concentrations of nitrate-nitrogen. Currently, because the state stream water quality standards are not numeric for nutrients, exceedences of a screening concentration of 1.95 mg/L nitrate-nitrogen have been used to designate a stream as having a concern for nitrate-nitrogen. The possible sources of the nutrient concern are numerous. Plum Creek is effluent-dominated and is also fed by springs that come from the Leona Aquifer, known to have elevated concentrations of nitrate-nitrogen. Stakeholders in the watershed have long suspected fertilizer use as the source of the nitrates in the Leona, but oddly enough, elevated concentrations of nitrates had been seen in well testing long before commercial inorganic fertilizers came into use. Septic systems, organic fertilizers, nitrifying plants and atmospheric deposition round out the list of possible sources.

The Texas Commission on Environmental Quality (TCEQ) has begun to develop numeric water quality standards for nitrate-nitrogen. At the end of that process, the standards established by TCEQ and the USEPA could move Plum Creek from a designation of "concern for nutrients" to the 303(d) List of Impaired Waterbodies. The Plum Creek Watershed Partnership has not waited for "impaired waterbody" status to start working on best management practices that could reduce sources of nitrates. In order to help direct efforts and funding toward the most likely or most influential source(s) of nitrate, this project will look to isotopic signatures of nitrogen and oxygen in the nitrates. The ratios of the isotopes of nitrogen and oxygen in nitrate often are useful for determining sources of nitrates in groundwater and surface water. Isotopic ratios are expressed as the ratio of the heavier isotope to the lighter isotope relative to a standard in parts per thousand (USGS, 2011). Figure 22 describes graphically the relationship of nitrogen and oxygen isotopes, and the nitrogen cycle.

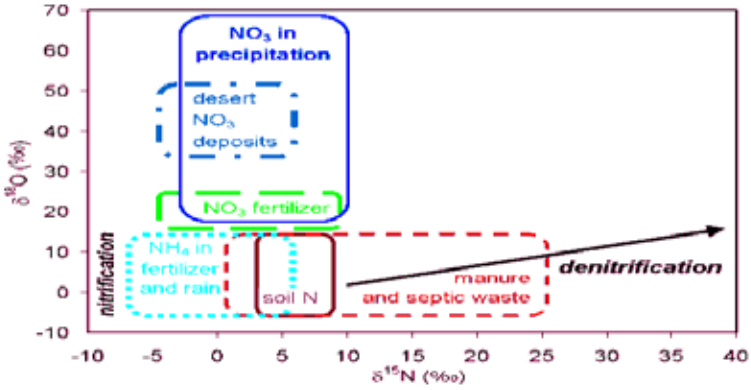

Figure 22. Relationships of nitrogen and oxygen isotopes and the nitrogen cycle.

A total of 10 sites in the Plum Creek and the Geronimo Creek watersheds will be sampled for major ions, selected nutrient species including nitrate-nitrogen, and ($^{15}N/^{14}N$) and oxygen ($^{18}O/^{16}O$) isotopes four times during the first year. A total of 40 environmental samples and six (6) quality-assurance samples will be collected. The quality-assurance samples will consist of 2 field blanks and 4 replicates samples. Sample collection will occur approximately every quarter and if possible, sampling will occur over a range in hydrologic conditions. Field parameters and flow measurements will be collected at the same time as the water-quality samples. In Plum Creek, five routine monitoring locations included in the CRP and the TSSWCB CWA Section 319(h) project 10-07, "*Surface Water Quality Monitoring and Additional Data Collection Activities to Support the Implementation of the Plum Creek Watershed Protection Plan*," will be sampled. In addition one well and one spring identified in the TSSWCB CWA Section 319(h) project 10-07 (Plum Creek), will be sampled for the same constituents at the same time as the surface water samples are collected. Sample collection and analyses for nutrients, major ions, and nitrogen isotopes will be performed by the USGS; measurements of field parameters and flow will be collected by GBRA. Quality-assurance samples including blanks and replicates will be collected to ensure the integrity of the dataset. The USGS will evaluate the data and submit a technical report at the end of the study if funded.

BACTERIA REDUCTIONS (Revisions to WPP Tables 5.1 and 10.3.)

An error was identified in the calculations which influenced reported values for Table 10.3 in relation to Table 5.1 in the WPP. For Table 5.1 (page 38 in the WPP) the footnote was corrected to state *E. coli* loads (Table 21). For Table 10.3 (page 120 of the WPP), values for the Luling monitoring station have been revised to be consistent with Table 5.1 (Table 22).

Table 21. Table 5.1 from WPP with updated footnotes. Annual load characteristics and *E. coli* reductions for each station (in billions of cfu).

Monitoring Station	Average Annual *E. coli* Load (cfu/year)	Lower 95% CI	Upper 95% CI	Load Reduction (cfu/year)	Target Load (cfu/year)
Uhland (17406)	1.12E+05	8.74E+04	1.36E+05	7.28E+04	3.92E+04
Lockhart (12647)	4.26E+05	2.46E+05	6.06E+05	6.39E+04	3.62E+05
Luling (12640)	3.02E+07	1.04E+07	5.01E+07	1.24E+07	1.78E+07

[1] The 95% confidence interval for minimum and maximum *E. coli* loads.

Table 22. Revised Table 10.3 in WPP. Estimated regional pollutant load reductions expected upon full implementation of the Plum Creek WPP.

Management Measure	Expected Load Reduction								
	Uhland			Lockhart			Luling		
	Ec[1]	N[2]	P[3]	Ec	N	P	Ec	N	P
Urban Stormwater Management Measures									
Pet Waste Collection Stations	7.2E+12	70.6	8.2	7.3E+12	158.5	17.9	**6.0E+14**	1.4	N/A
Comprehensive Urban Stormwater Assessment	4.3E+13	531.7	19.1	1.9E+13	929.6	32.5	**1.8E+15**	7.8	N/A
Retrofit Stormwater Detention Basins									
Initiate Street Sweeping Program									
Manage Urban Waterfowl Populations									
Rehabilitate Stormwater Retention Pond									
Wastewater Management Measures									
Wastewater Upgrade (TSS Reduction)	3.5E+10	N/A	N/A	2.1E+10	N/A	N/A	**3.2E+12**	N/A	N/A
Wastewater Upgrade (Phosphorus Removal)									
Voluntary Monthly *E. coli* Monitoring									
Voluntary Monthly Phosphorus Monitoring									
Sanitary Sewer Pipe Replacement									
Lift Station SCADA Installation									
Initiate Sanitary Sewer Inspection Program									
Septic System Inspection/Enforcement (New Position)	6.1E+12	22.7	13.3	5.0E+12	42.2	24.2	**3.8E+14**	0.4	N/A
Septic System Repair									
Septic System Replacement									
Septic System Connection to Sewer									

Table 22. (continued).

Management Measure	Expected Load Reduction								
	Uhland			Lockhart			Luling		
	Ec[1]	N[2]	P[3]	Ec	N	P	Ec	N	P
Agricultural Management Measures									
WQMP Technician (New Position)	9.6E+12	5,472	827	2.1E+13	30,427	4,772	**5.6E+15**	542	N/A
Livestock Water Quality Management Plans									
Cropland Water Quality Management Plans									
Non-Domestic Animal and Wildlife Management Measures									
Feral Hog Control (New Position)	7.3E+12	1,615	327	1.2E+13	5,902	1,163	**4.0E+15**	105	N/A
Feral Hog Control (Equipment)									

[1] Ec: *E. coli* reduction indicated in cfu/year.
[2] N: Nitrogen reduction in kg/year.
[3] P: Phosphorus reduction in kg/year.

Adaptive Management

Adaptive management is a type of natural resource management in which decisions are made as part of an ongoing science-based process. Adaptive management involves testing, monitoring, and evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings and the needs of society. Results are used to modify management policy, strategies, and practices [65 Fed. Reg. 62566-62572 (October 18, 2000)].

The essence of successful watershed planning and management is a commitment to adaptive management. The Plum Creek Watershed Partnership is committed to adaptive management of the Plum Creek WPP. Over the course of project implementation, instream monitoring data provided by GBRA will be compared with interim milestones and water quality criteria to determine progress in achieving WQS. If water quality improvement is not being demonstrated within the proposed timeframes, efforts will be made to increase adoption of BMPs and/or adjust strategies or focus areas if and when necessary.

The Plum Creek WPP Update report is a document that will be developed and approved to be published approximately every two years. This report will contain updates on tracking the progress of implementation, outreach activities, and water quality monitoring in the watershed. The report will document and provide updates and any issues or adaptive management decisions on all of the measures within the WPP and any modifications to the goals and strategies identified in the WPP. In addition it will include an analysis of up to date water quality data to determine progress in achieving water quality restoration.