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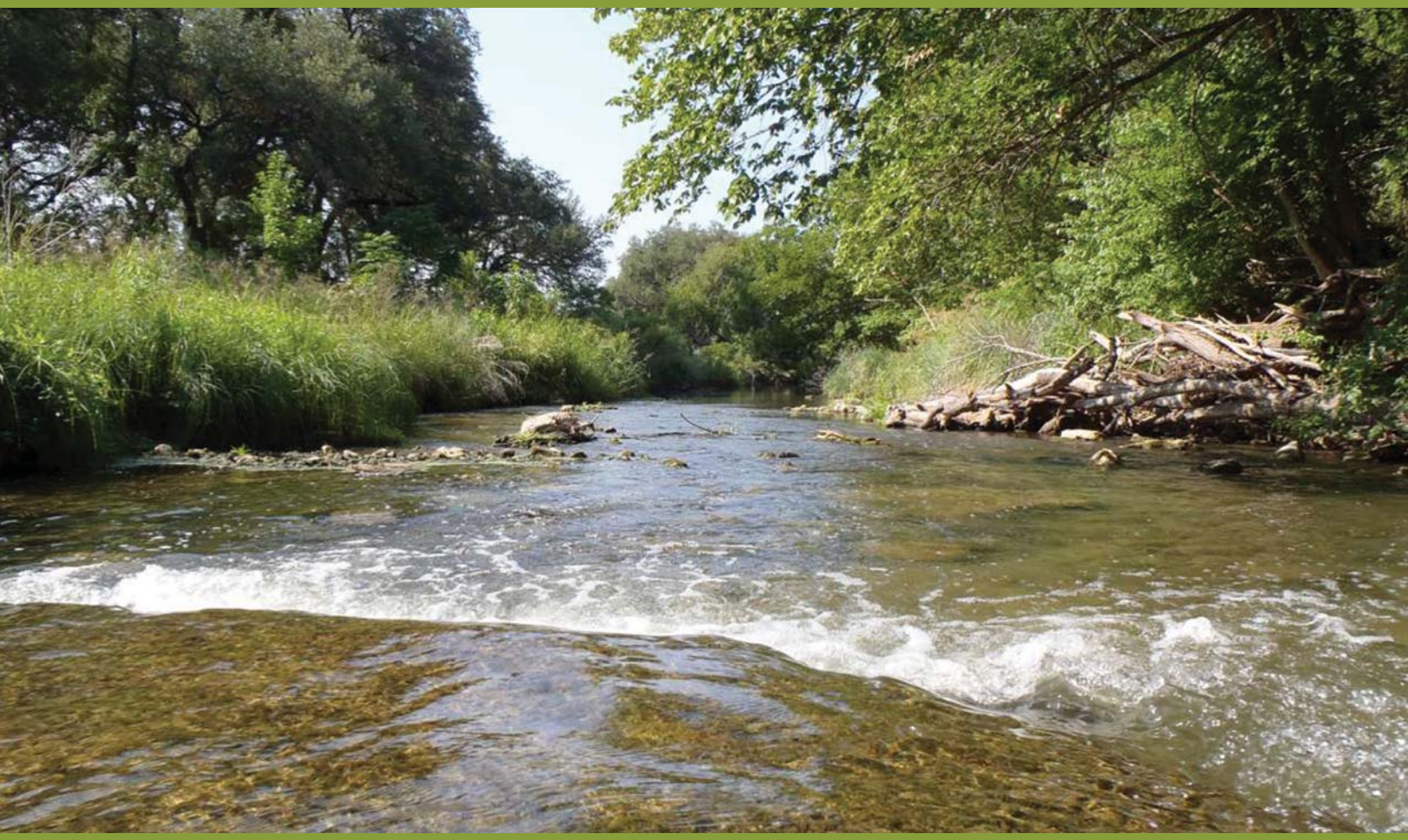

Bacterial Source Tracking to Support the Development and Implementation of Watershed Protection Plans for the Lampasas and Leon Rivers

Lampasas River Watershed Final Report

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Acronyms

ADCM	Acoustic Doppler Current Meter
ARCC	Average Rate of Correct Classification
AgriLife-TP	Blackland Research and Extension Center in Temple
BST	Bacterial Source Tracking
CAFO	Concentrated Animal Feeding Operation
CFS	Cubic Feet per Second
CFU	Colony Forming Units
DNA	Deoxyribonucleic Acid
DO	Dissolved Oxygen
E. coli	*Escherichia coli*
EPA	Environmental Protection Agency
ERIC-PCR	Enterobacterial Repetitive Intergenic Consensus Sequence Polymerase Chain Reaction
ERIC-RP	ERIC-PCR and RiboPrinting Composite DNA Fingerprints
LRW	Lampasas River Watershed
MGD	Million Gallons per Day
n	Number of Samples (or *E. coli* isolates)
NA-MUG	Nutrient Agar with 4-methylumbelliferyl- β-D-glucuronide (MUG)
mTEC	Membrane Thermotolerant *E. coli*
OSSF	Onsite Sewage Facility
QAPP	Quality Assurance Protection Plan
RARCC	Random Average Rate of Correct Classification
RCC	Rate of Correct Classification
RiboPrinting	Automated Ribosomal Ribonucleic Acid Genetic Fingerprinting
TCEQ	Texas Commission on Environmental Quality
TMDL	Total Maximum Daily Load
TNTC	Too Numerous To Count
TSSWCB	Texas State Soil and Water Conservation Board
USDA	United States Department of Agriculture
UTSPH-EP	University of Texas Health Science Center at Houston School of Public Health, El Paso Regional Campus
WPP	Watershed Protection Plan
WWTF	Wastewater Treatment Facility

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Executive Summary

The *Bacterial Source Tracking to Support the Development and Implementation of Watershed Protection Plans for the Lampasas and Leon Rivers* project was developed to provide supplemental information to stakeholders engaged in the development and implementation of watershed protection plans for each watershed. The Leon River is listed as an impaired water body for elevated levels of *E. coli* and does not support its designated contact recreation use. The Lampasas River was also considered impaired for elevated *E. coli* levels until 2010 when it was determined that the data listing the segment no longer met the state's criteria for assessment. Through the watershed protection planning process, stakeholders in each watershed will use adaptive management to refine management strategies that will mitigate bacteria loading from potential sources of pollution within the watershed.

Pairing intensive water quality monitoring and bacterial source tracking (BST), this project was designed to produce useful information that will improve local knowledge of pollutant sources contributing bacteria to the watershed. Typically, water quality data is collected in a watershed on a quarterly basis at a limited number of sampling locations. The intensive water quality monitoring implemented through this project collected monthly samples at 15 monitoring stations over the course of a year. This provided a much clearer look at seasonal and spatial trends in water quality. Additionally, this expansive set of water quality samples was used for BST and allowed estimates of bacteria source contributions to be made at each sampling station. Collectively, these data and associated analysis provided an enhanced look at water quality and pollutant source contributions that will aid watershed stakeholders in their implementation efforts.

Historic drought conditions negatively affected this sampling effort as the Lampasas River and many of its tributaries were diminished to mere pools or were completely dry for a portion of the monitoring period. These unfavorable drought conditions did not appear to adversely impact water quality as *E. coli* levels recorded from samples collected were typically well within the state's water quality standard. The diminished number of samples collected did reduce the effectiveness of the BST by potentially masking some of the temporal variations in *E. coli* that

might have otherwise been observed. Collectively though, the BST results shed light on the sources of *E. coli* in present in the watershed that actually do impact in-stream water quality.

Water quality data collected revealed that *E. coli* levels were periodically elevated across the watershed and were likely a result of nonpoint sources of pollution entering the waterways during or shortly after runoff producing rain events. Collectively, the geometric mean of data from all sites was 51.9 CFU/100 mL, or less than half of the State's current primary contact recreation standard of 126 CFU/100 mL. Of the 15 sampling stations, only 3 exhibited *E. coli* concentration geometric means above this level. These data will be submitted to TCEQ for consideration in the next bi-annual water quality assessment.

BST results from the watershed returned somewhat anticipated results. In looking at all sampling stations combined, wildlife (avian and non-avian) combined to garner 52% of the *E. coli* identified while cattle made up 15%, human sources accounted for 12%, pets and other non-avian livestock both accounted for 6%, and avian livestock was identified 3% of the time. The remaining 12% of the samples analyzed were not able to be identified. Similar results were also produced by conducting BST on each sampling station individually; however, these results should be considered cautiously as the number of samples available for analysis at some stations due to the drought conditions reduces the utility of these findings.

Collectively, the water quality data collected and BST analysis conducted provide useful information to watershed stakeholders and will enable local decision making to be refined as needed.

Introduction

Fecal pollution of water originates from a wide variety of sources, including storm water runoff, wastewater treatment facility discharges, septic tanks, domestic pets, livestock, wildlife and illegal dumping. The majority of microorganisms found in fecal pollution generally do not pose a risk to human health; however, fecal pollution may also contain pathogenic microorganisms capable of causing diseases (pathogens). Testing water for specific pathogens is not feasible due to the high cost, difficulty in performing the tests and the highly variable occurrence of specific pathogens. As a result, the presence of fecal pollution, and consequently the potential presence of pathogens, is typically based upon the detection of fecal indicator bacteria.

Fecal indicator bacteria, such as *Escherichia coli* (*E. coli*), are found in the guts and feces of all mammals and birds. Fecal indicator bacteria typically occur at high levels in fecal pollution sources, are thought to have limited survival in the environment, and are easy and inexpensive to test for. Numerous studies have linked the levels of fecal indicator bacteria (and pathogens by association) in water with levels of gastrointestinal disease (e.g. diarrhea, vomiting, and stomach cramps) observed in swimmers. Water quality standards based on levels of fecal indicator bacteria (e.g. *E. coli*) were subsequently developed to help quantify the risk of illness due to recreational contact with water at varying levels of fecal contamination.

In an effort to accurately identify sources contributing to bacterial loading, specifically *E. coli* in the Lampasas River Watershed (LRW), targeted water quality monitoring paired with bacterial source tracking (BST) was employed. Texas A&M AgriLife Research's - Water Science Laboratory located at the Blackland Research and Extension Center in Temple (AgriLife-TP) cooperated with the University of Texas Health Science Center at Houston School of Public Health, El Paso Regional Campus (UTSPH-EP) to measure LRW stream flow and collect, enumerate, and genetically type *E. coli* from LRW sources. LRW known fecal source *E. coli* were collected and genetically typed to supplement the Texas *E. coli* BST Library for identifying the sources of *E. coli* isolated from LRW water samples. Water samples were filtered and *E. coli* present were selectively cultured and enumerated by AgriLife-TP. Following enumeration, cultures were shipped to El Paso for genetic typing by UTSPH-EP. Using BST, the human and animal sources of *E. coli* isolated from water can be determined (Casarez et al., 2007). Advances

in BST technologies and techniques helped produce high certainty results which may be used to support the implementation of the watershed protection plan (WPP) for the LRW.

Project Goals

The overall field goals for this project included:

- Monitor water quality and quantity at 15 locations within the LRW, monthly, for 1 year
- Collect and analyze LRW water samples for *E. coli* concentration
- Concurrently measure stream water quantity (flow) and quality (physical, chemical)
- Collect known fecal samples for the isolation of *E. coli* and supplementation of the Texas *E. coli* BST Library
- Conduct BST analysis to assess and identify different sources contributing to the bacterial loading of the LRW
- Deliver BST results to stakeholders through the on-going WPP process

Investigative Approach

AgriLife-TP carried out the field monitoring portion of the project which included: 1) cooperating with state agencies and stakeholders to determine monitoring locations, 2) physically scouting and identifying suitable monitoring locations, 3) collecting monthly water samples in conjunction with water quantity (flow) and water quality measurements, 4) enumerating *E. coli* present in collected samples using U. S. Environmental Protection Agency (EPA) method 1603 modified mTEC (USEPA 2006), and 5) collecting at least 50 known source fecal samples for the isolation of *E. coli* and augmentation of the Texas *E. coli* BST Library. Building on previous work conducted in the LRW (TSSWCB project 07-11, Lampasas River Watershed Assessment and Protection Project), this project used portions of the Texas Commission on Environmental Quality (TCEQ) and TSSWCB approved 3-Tier Approach for Developing Bacteria Total Maximum Daily Loads (TMDLs), as recommended by the joint Bacteria TMDL Task Force.

Lampasas River Watershed and Study Area

The Lampasas River watershed is found within the Lampasas Cut Plains, the northern most extension of the Edwards Plateau, west of the Balcones Fault Zone. The Lampasas River (segment 1217 in the Brazos River Basin), rises in western Hamilton county 16 miles west of

Hamilton and flows southeast for 75 miles, passing through Lampasas, Burnet, and Bell counties (Figure 1). In Bell County the river turns northeast and is dammed 5 miles southwest of Belton to form Stillhouse Hollow Lake (segment 1216). Below Stillhouse Hollow Lake, the Lampasas River flows to its confluence with Salado Creek and the Leon River to form the Little River which flows a short distance before emptying into the Brazos River. Monitoring carried out under this project focused on the portion of the Lampasas River above Stillhouse Hollow Lake. Contact recreation use of this segment has been considered impaired in the past due to bacteria exceeding established water quality criteria. The Lampasas River above Stillhouse Hollow Reservoir was listed on the 2008 Texas 303(d) List for elevated bacteria levels but was not included in the 2010 Texas 303(d) List when it was determined that the data listing the segment no longer met the State's criteria for assessment. The Lampasas River is commonly characterized by relatively low water levels and is situated within a predominantly rural and agricultural landscape. Land use within the watershed is dominated by rangeland and grasslands. Major agricultural interests include the production of beef cattle on rangeland and crop production that includes hay, wheat, oats, sorghum, corn, cotton, peanuts, and pecans.

Low flow conditions on the Lampasas River during the 2011 drought.

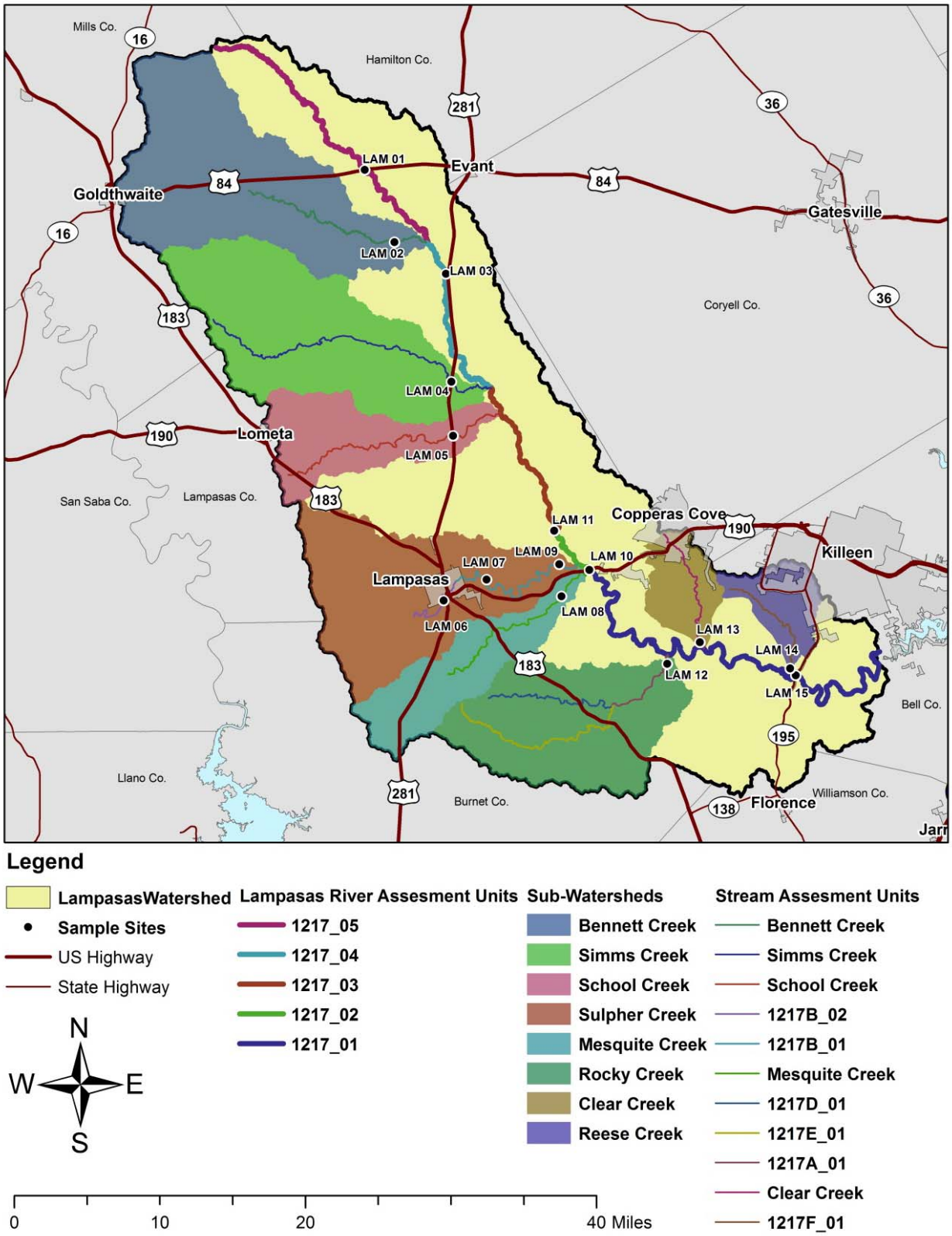


Figure 1. Lampasas River watershed and water quality monitoring sites.

Hydrological Characteristics

Base Flow

The Trinity Aquifer underlies most of the LRW with small, local aquifers also found in the watershed. These aquifers contribute to the base flow of streams in the area. An outcropping of the Marble Falls Aquifer in the City of Lampasas area produces numerous springs of which Hancock and Hanna Springs are the most notable. These springs provide the base flow for Sulphur Creek and a large portion of the Lampasas River downstream of their confluence. The confluence of Sulphur Creek with the Lampasas River is 1.5 miles upstream from the LAM 10 monitoring station near Kempner. Clear Creek (LAM 13) exhibits continuous flow due to discharge from the City of Copperas Cove wastewater treatment facility (WWTF).

Runoff

The LRW is prone to flash flooding due to the topography, soil, and vegetation of the area. Intense rain events often cause rapid runoff. An example of this type event occurred on October 8th and 9th of 2011 producing area wide rains of 2-5 inches with some localized heavier rains. The stream USGS gauge on the Lampasas River at Highway 190 on October 9th increased from 13 cfs to over 4000 cfs in 4 hours creating a 5-6 foot stream rise. During the October 10th and 11th sampling events, the gauge reported a maximum of 174 cfs. This rapid rise and fall of the flow volume clearly illustrate the flashy nature of the streams response to high intensity, high volume rain events. Additionally, the typically clear waters of the river were extremely turbid (muddy) during and following this and other similar events.

Drought

As monitoring commenced in February 2011, Mills, Hamilton, and Lampasas Counties were experiencing moderate to severe drought conditions; Bell, Burnet, Coryell and Williamson Counties were rated as abnormally dry. By August 2011, all counties in the study area exhibited extreme to exceptional drought conditions, as reported by the National Drought Mitigation Center located at the University of Nebraska (web site: http://droughtmonitor.unl.edu). Figure 2 depicts quarterly drought progress during the monitoring period from February 2011 to January 2012. The project documents water quality and quantity conditions observed in the Lampasas River under drought conditions that meteorologists characterized as the worst 1-year dry spell

Texas has seen since records began in 1895. During 2011, 100 percent of the state experienced drought conditions and 86 percent recorded "exceptional drought", the most severe category. As a result, many LRW monitoring locations experienced intermittent flow. Precipitation amounts were obtained from the Comanche, Hamilton, Gatesville, Fort Hood, and Lampasas airport records between January 1, 2011 and January 24, 2012. Normal average annual rainfall for the area is approximately 30 inches. Average precipitation recorded by area airports during the monitoring period was 13.44 inches. The longest period without significant daily rainfall was 125 days (note: "significant daily rainfall" is defined in this report as 0.5 inches, or more, per day). Precipitation between February 1 and September 30, 2011 averaged 4.33 inches. Precipitation between October 1, 2011 and January 24, 2012 averaged 7.34 inches.

No flow condition (ponded) in Reese Creek, Bell County.

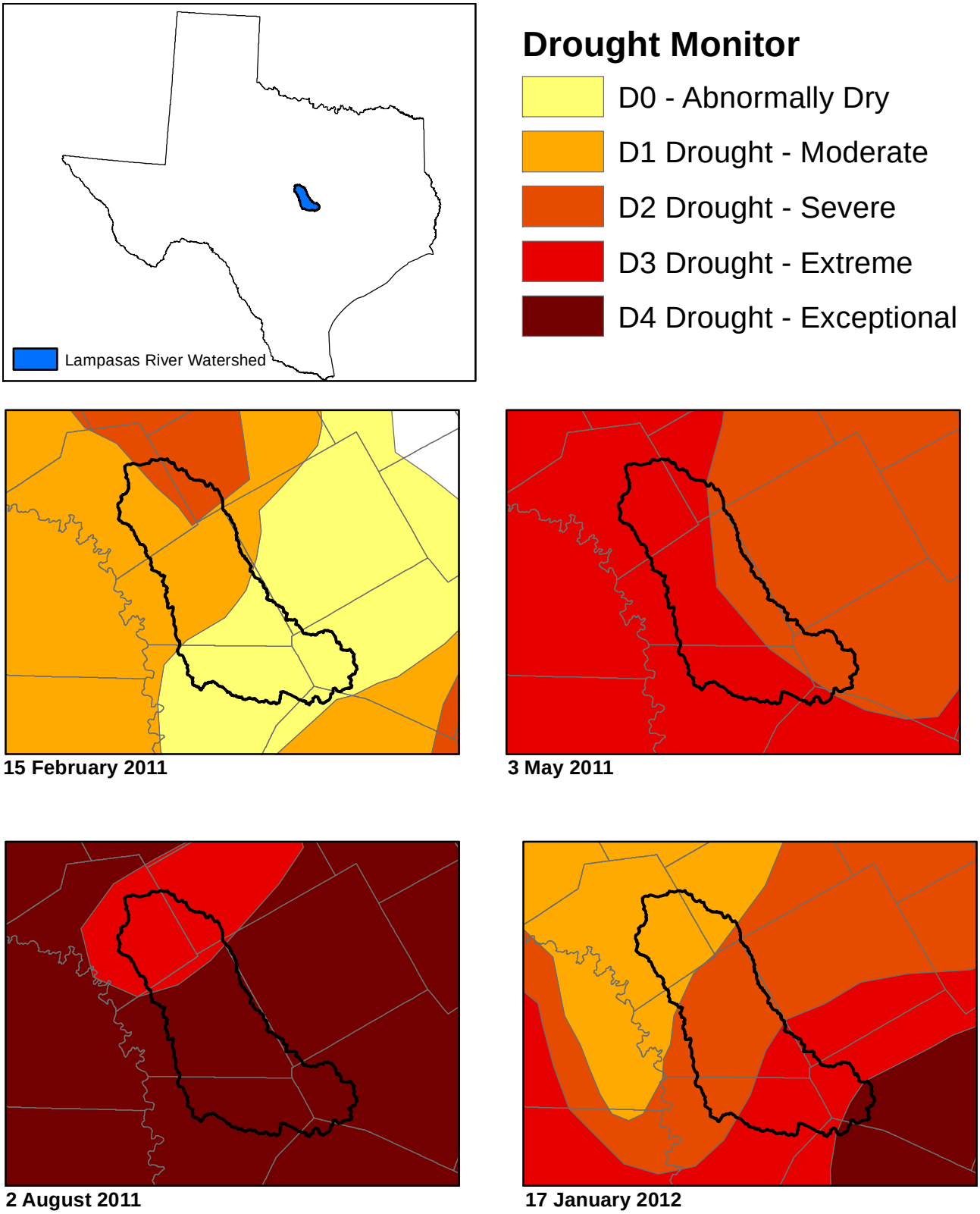


Figure 2. Texas drought monitor maps. Source: http://droughtmonitor.unl.edu

Surface Water Quality and Quantity Monitoring

Monitoring Location Selection

Monitoring stations were selected based on recommended sampling locations described in the draft Lampasas WPP, previous history, location in the watershed, and accessibility. Proposed watershed sampling locations were scouted between September and October of 2010 to determine monitoring suitability. Suitability factors included: representative of specific portion of the watershed, safe accessibility, and streambed characteristics. Fifteen sites were selected (Table 1), 5 on the Lampasas River and 10 on tributaries. Monitoring began in February of 2011. Sampling locations were generally located at the intersection of the stream channel and a public road, mainly for accessibility. Most had either a bridge or low water crossing present. Bridges are inherently focal points for birds, wildlife, cattle, and humans. Birds roost and nest on bridges; wildlife and livestock may cross roadways underneath bridges when accessible or loaf in the shade; people fish, socialize, and dump trash near bridges. The remains of many animals including processed deer, hogs, dogs, cats, and goats were observed dumped near bridges on the banks and in the river. Some reaches of the Lampasas River and its tributaries are suitable for recreational activity and are documented to be used for swimming and fishing. The Lampasas River at Highway 190 in Kempner and Highway 195, at Ding Dong, were the most observed areas for recreational uses. All had either a bridge or low water crossing present.

General Sampling Procedures and Frequency

Fifteen locations in the Lampasas River watershed (See Table 1) were sampled monthly for 1 year during the study (180 scheduled measurement events). Grab samples were taken upstream of the bridge when possible and stream flow was measured within 50 meters of the sampling site depending on channel conditions. The presence of human activity, nesting birds, or other wildlife, was noted in the Field Log. Water samples for *E. coli* enumeration and BST were collected directly from the stream (channel midpoint or deepest accessible portion). Care was taken to avoid the surface and bottom micro-layers which may be enriched with bacteria and not representative of the water column. Immediately after collection the sample was stored on ice for transport and delivered to the lab within 6 hours of collection.

Collecting water sample mid-stream below surface and above stream bottom.

Table 1. Water quality monitoring sites.

Site	TCEQ-ID	Location	County	Latitude	Longitude	USGS Gage
LAM 01	15762	Lampasas River at Hwy 84	Hamilton	31.48027	-98.2735	No
LAM 02	21013	Bennett Creek at CR 2901	Lampasas	31.40775	-98.2395	No
LAM 03	15770	Lampasas River at CR 2925	Lampasas	31.37584	-98.1798	No
LAM 04	15763	Simms Creek at Hwy 281	Lampasas	31.26815	-98.1746	No
LAM 05	21014	School Creek at Hwy 281	Lampasas	31.21433	-98.1731	No
LAM 06	11872	Sulphur Creek at Naruna Road	Lampasas	31.05040	-98.1852	No
LAM 07	15781	Sulphur Creek at CR 3010	Lampasas	31.07091	-98.1353	No
LAM 08	21015	Mesquite Creek at CR 4390	Lampasas	31.05357	-98.0487	No
LAM 09	15250	Sulphur Creek at CR 3050	Lampasas	31.08544	-98.0507	No
LAM 10	11897	Lampasas River at Hwy 190	Lampasas	31.08167	-98.0164	Yes
LAM 11	16404	Lampasas River at FM 2313	Lampasas	31.11900	-98.0565	No
LAM 12	11724	Rocky Creek at FM 963	Burnett	30.98541	-97.9266	No
LAM 13	21016	Clear Creek at Oakalla Road	Bell	31.00634	-97.8887	No
LAM 14	11896	Lampasas River at Hwy 195	Bell	30.97248	-97.7786	No
LAM 15	18759	Reese Creek near FM 2670	Bell	30.97930	-97.7847	No

Water quality and quantity parameters recorded at each sampling location are listed in (Table 2). Water temperature, pH, specific conductivity, and dissolved oxygen were measured with a Quanta multi-probe simultaneously with the collection of grab samples. Water depth was measured at the point where the grab sample was taken. Stream flow volume or discharge was measured using an acoustic digital current meter (OTT Acoustic Doppler Current Meter (ADCM), Hach Hydromet, Loveland CO). Monitoring location, LAM 10, coincided with United States Geological Survey (USGS) stream flow monitoring gauges and stream flow was reported using USGS stream flow volume data.

Monthly routine sampling was conducted between the 5th and 11th days of the month. Some schedule shifting around holidays was required and not all sites could be sampled on the same day. Careful coordination between AgriLife-TP and UTSPH-EP was required to collect, enumerate, ship, and genetically type samples. Field collection and water sample enumeration by AgriLife-TP was done early in the week to allow time for, shipping, and genetic processing by UTSPH-EP, later in the week.

Table 2. Water quality and quantity parameters.

Parameter	Status	Reporting Units
Laboratory		
Escherichia coli	Critical	Colony Forming Units (CFU) per 100 mL
Field		
Dissolved Oxygen	Non-Critical	mg/L
pH	Non-Critical	Dimensionless (standard pH scale)
Specific Conductance	Non-Critical	µS/cm
Temperature	Non-Critical	°C
Flow Volume	Critical	CFS

Special Conditions

Surface water sampling during a drought of record presented several challenges. The flow profile at monitored sites was often very shallow and/or narrow making it difficult to conduct measurements with the Quanta Multi-parameter probe and the ADCM. During the very dry

portion of the study, several locations exhibited surface flow with areas of subsurface flow above and below sampling sites. Flow conditions were noted in the field data sheet (i.e., flow, sub-surface, pooled, dry, etc.). Over the course of the study, 76% of the samples were flowing, 17% ponded and 7% dry.

Physical and chemical water parameters

Dissolved oxygen, temperature, pH, and specific conductance were measured and recorded in situ using a hand-held multiparameter sonde (HACH, Loveland CO, Model: Quanta). The probe was calibrated in the lab prior to each sampling event.

Table 3. Mean water temperature, pH, specific conductivity, dissolved oxygen, and flow for Lampasas River.

Site	TCEQ Station ID	Water Temp (ºC)	DO (mg/L)	pH	Conductance (µS/cm)	Flow (CFS)
LAM 1	15762	16.14	6.62	7.37	468	0.14
LAM 2	21013	16.96	9.17	7.25	529	1.96
LAM 3	15770	18.69	8.04	7.64	556	4.17
LAM 4	15763	14.92	8.85	7.48	527	3.24
LAM 5	21014	14.35	8.06	7.10	262	2.30
LAM 6	11872	20.63	5.97	7.23	2015	1.27
LAM 7	15781	19.33	7.59	7.84	2406	11.61
LAM 8	21015	18.66	8.60	7.80	416	0.12
LAM 9	15250	18.15	8.30	7.82	2107	12.89
LAM 10	11897	21.34	11.10	8.27	1996	25.53
LAM 11	16404	22.30	9.40	7.91	496	17.82
LAM 12	11724	17.88	8.08	7.74	434	0.99
LAM 13	21016	19.15	8.93	7.90	753	1.50
LAM 14	11896	21.45	10.01	8.08	1437	32.55
LAM 15	18759	17.61	7.61	7.57	500	0.71

Temperature

Water temperatures displayed typical seasonal differences. The lowest temperatures of flowing water occurred in the winter months, ranging from 3.95 – 11.37 °C and the warmest in July and August, ranging between 27.09 – 34.68 °C.

Dissolved Oxygen

Dissolved oxygen (DO) concentrations ranged from 7.93 to 19.32 mg/L in the winter months and 2.51 to 7.86 mg/L during summer months. Sulphur Creek at Naruna Road (LAM 06) exhibited the lowest mean DO at 5.97 mg/L. The highest mean DO (11.10 mg/L) was observed in the Lampasas River at Highway 190 (LAM 10).

pH

The pH ranged from 7.10 to 8.27. The lowest pH recorded was from 6.19 in the Lampasas River at Highway 84 (LAM 1) and the highest of 9.29 in the Lampasas River at Highway 190 (LAM 10).

Specific Conductance

The Lampasas River, above the confluence with Sulphur Creek, and its tributaries had a Specific Conductance range of 188 – 677 µS/cm. The 3 sites on Sulphur Creek (LAM 6, LAM 7, and LAM 09) averaged 2176 µS/cm as a result of high mineral content. The sites on the Lampasas River below the confluence with Sulphur Creek average 1996 µS/cm (LAM 10) and 1437 µS/cm (LAM 14).

Flow Volume

Stream flow volume or discharge was measured using an ADCM. Measurements were conducted in reaches free from obstructions (large rocks, vegetation, etc.) with good laminar flow (i.e., minimal turbulence). The ADCM concurrently measured vertical depth and integrated flow velocity across the channel to calculate the flow volume. Measuring stream flow under drought conditions presented several challenges. Stream flow at monitored sites was often very low. Under these conditions stream cross-section profiles were too shallow or narrow to accommodate a measurement with the ADCM. In some cases, the timed float method was utilized to measure flow volumes.

The upper most Lampasas River sites exhibited intermitted flow during the study while the sites further downstream in the watershed had flowing water throughout the study. Flow was present and measured only 3 times at LAM 1 and 6 times at LAM 3; the lower 3 sites, LAM 10, LAM

11, and LAM 14 had flow during the entire study. Sulphur Creek had continuous flow throughout the study. Sulphur Creek at Naruna Road (LAM 6) is above the major springs and had the lowest flows, ranging between 3.360 cfs on February 8, 2011 and 0.380 cfs on August 9, 2011. Other Sulphur Creek monitoring locations, below the springs, had much higher rates. LAM 7 ranged between 13.560 cfs on February 8, 2011 and 7.621 cfs on August 9, 2011. LAM 09 flows ranged between 16.330 cfs on February 8, 2011 and 7.329 cfs on September 6, 2011. All other tributaries experienced intermitted flow with the exception of Clear Creek as its base flow is maintained by wastewater discharge from a Copperas Cove wastewater treatment facility.

Measuring stream flow with Hach Acoustic Doppler Current (ADC) meter.

Table 4. Summary of sampling events (note: samples collected under flowing conditions only).

Station	TCEQ Station ID	Scheduled Sampling Events	Waterbody Status		
			Flowing	Ponded	Dry
LAM 1	15762	12	3	7	2
LAM 2	21013	12	7	4	1
LAM 3	15770	12	6	4	2
LAM 4	15763	12	7	3	2
LAM 5	21014	12	2	7	3
LAM 6	11872	12	12	0	0
LAM 7	15781	12	12	0	0
LAM 8	21015	12	9	1	2
LAM 9	15250	12	12	0	0
LAM 10	11897	12	12	0	0
LAM 11	16404	12	12	0	0
LAM 12	11724	12	10	2	0
LAM 13	21016	12	12	0	0
LAM 14	11896	12	12	0	0
LAM 15	18759	12	8	4	0

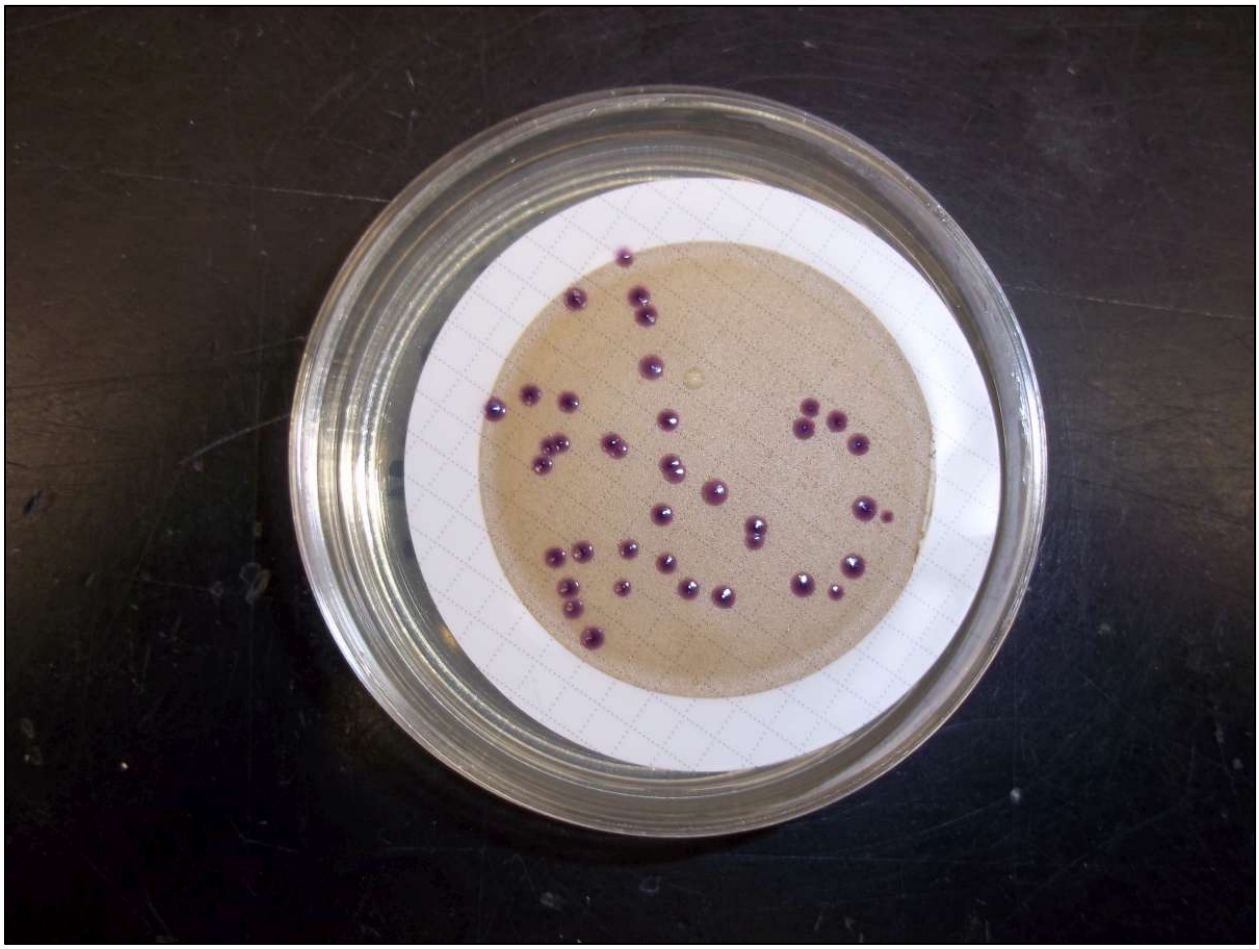
Bacteria Enumeration

Laboratory Procedures

Water samples were collected and enumerated for *E. coli* from all monitoring locations, when flow was present. Samples were collected and processed by AgriLife-TP within 8 hours using the EPA Method 1603 modified mTEC procedure. Aliquots of the collected sample were filtered to yield *E. coli* counts for that sample. Aliquot volumes were determined by visually assessing the sample's turbidity and knowledge of previous *E. coli* counts from that site. Following required processing and incubations periods, *E. coli* colonies were counted.

Samples testing negative for *E. coli* were recorded as 0.5 CFU/100 mL for calculation purposes (NOTE: when calculating geometric mean, a zero value calculation causes a "divide by zero" error. TCEQ guidance requires using 0.5 in place of a zero as this does not increase the

geometric mean average or negatively influence the total CFU). If bacterial growth was too numerous to count (TNTC), the minimum estimated value assumed a count of >200 CFU multiplied by smallest volume filtered. Table 5 summarizes *E. coli* enumeration as the geometric mean of all flowing samples by monitoring location. All data can be found in Appendix B. Following enumeration, plates exhibiting good CFU growth and separation were shipped to the UTSPH-EP. Up to 8 representative colonies were then isolated on Nutrient Agar with MUG (NA-MUG), confirmed as *E. coli*, and archived. Up to 5 isolates per water sample were subjected to BST analysis.



Petri dish with mTEC media and filter positive for *E. coli* (red colonies).

Results

Enumeration yielded a wide range of *E. coli* CFU present in the streams at different times, locations and under varying conditions. The lowest CFU observed was one which occurred at four sites: LAM 02 on February 7, 2011; LAM 11 on July 5, 2011; LAM 14 on February 8 and

September 6, 2011; LAM 15 on February 8, 2011. The highest CFU observed was 9900 which occurred at LAM 14 on October 11, 2011.

Seven of the 15 monitored sites had flowing water during all 12 visits. The geometric mean of *E. coli* enumerations at these sites ranged between 19 and 68 CFU/100 mL. There were 44 scheduled sampling events in which no samples were taken due to lack of stream flow.

Table 5. Summary of *E. coli* enumerations, expressed as colony forming units (CFU) per 100 mL, sampled from flowing water in the Lampasas River watershed.

Station	TCEQ Station ID	# of Samples	Geometric Mean (CFU/100mL)
LAM 1	15762	3	**162**
LAM 2	21013	7	66
LAM 3	15770	6	**158**
LAM 4	15763	7	33
LAM 5	21014	2	**3257**
LAM 6	11872	12	64
LAM 7	15781	12	43
LAM 8	21015	9	52
LAM 9	15250	12	68
LAM 10	11897	12	37
LAM 11	16404	12	45
LAM 12	11724	10	48
LAM 13	21016	12	63
LAM 14	11896	12	19
LAM 15	18759	8	30

* Geometric means reported in this column were calculated using data collected from flowing water at each respective sampling site.
*** BOLD** geometric means exceed the state's contact recreation standard of 126 CFU/100 mL

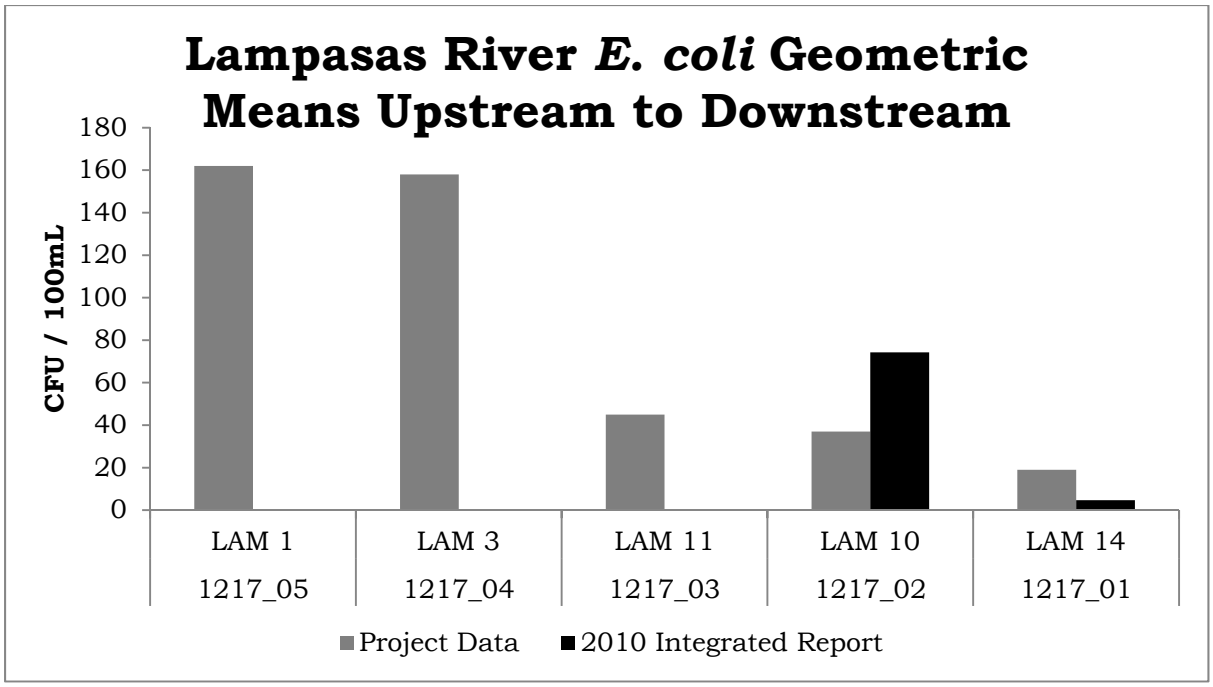


Figure 3. *E. Coli* geometric means of project data along Lampasas River segments

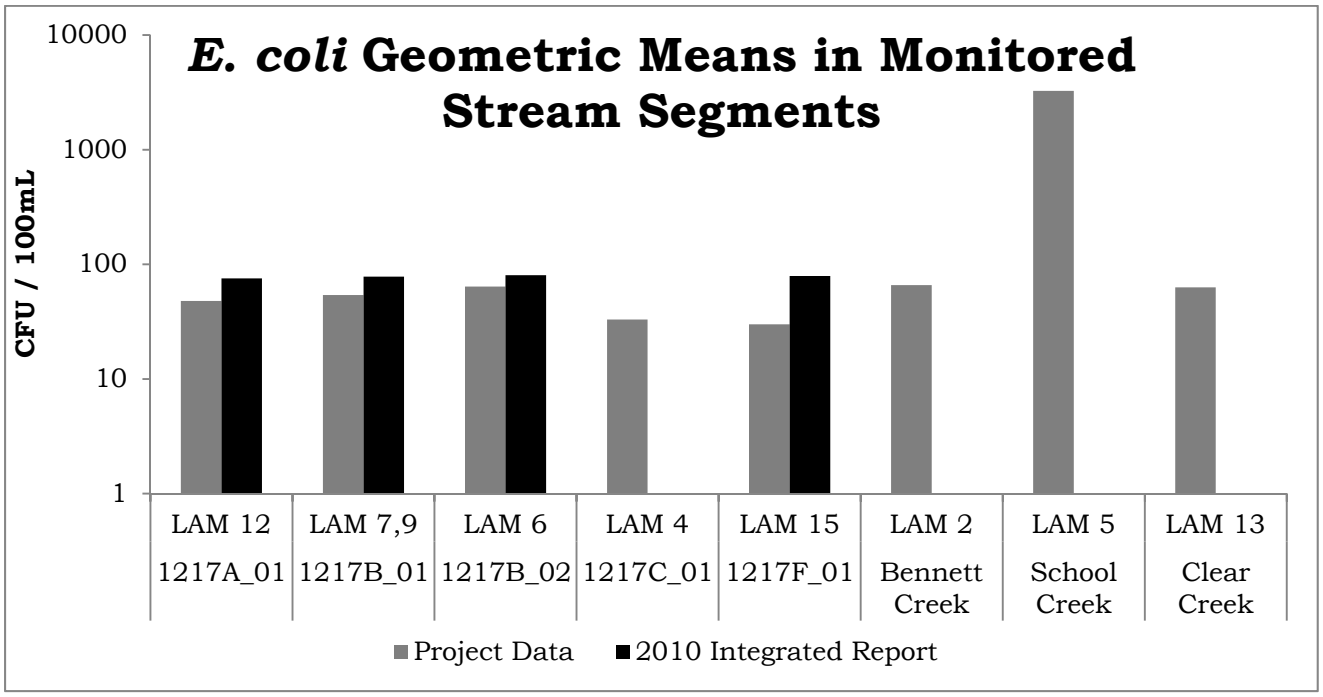


Figure 4. *E. Coli* geometric means of project data along other monitored segments in the LRW.

Known Source Fecal Sampling

Findings from BST work conducted across Texas suggest that incorporating self-validated local watershed isolates, or known source samples, into the statewide library may have a beneficial effect on identification rates and accuracy. Therefore, a total of 118 known source fecal samples were collected from the LRW for the isolation of *E. coli*.

General Procedures

Known source sampling took place between January 19, 2011 and February 29, 2012. Samples were collected during known source collection trips and scheduled monitoring trips with help from cooperating landowners, wastewater treatment facility operators, septic pumping service operators, USDA Wildlife Services Wildlife Damage Management Technicians, and Fort Hood Directorate of Public Works-Environmental Hog Trapping Program. Host sources were selected based on stakeholder concern and supplementation of the Texas *E. coli* BST library. A total of 118 fresh, known source fecal samples were collected in the watershed including: human and 12 source subclasses of domestic and wild animals (Table 6).

Table 6. Known source fecal samples collected in the Lampasas River Watershed.

Known Source	Quantity	Quantity by County				
		Hamilton	Lampasas	Burnet	Bell	Coryell
Wastewater	11		8			3
Septic Tank	5		2		3	
Beef Cow	24	3	9	3	9	
Sheep	3		3			
Horse	5	2	3			
Feral Hog	11		11			
Deer	5	2	2		1	
Raccoon	3		2		1	
Fox	2		3			
Coyote	14		14			
Goose	3		3			
Swallow	28		2	1	25	
Buzzard	2			2		
Squirrel	1				1	
Total	118	7	62	6	40	3

Human Sources

Domestic Sewage

Municipal wastewater samples were collected at the City of Lampasas and City of Copperas Cove wastewater treatment facilities. Multiple samples were taken at each facility. Two permitted facilities are present in the study area (Table 7). Individual samples were analyzed and positive plates where shipped to UTSPH-EP for genetic typing and inclusion in the Texas *E. coli* BST Library.

Collecting known source human sample at wastewater treatment plant.

Table 7. City, volume, and discharge location for permitted Lampasas River point source discharges.

Location	Permit Volume (MGD)	Discharge to:
City of Lampasas	1.55	Sulphur Creek
City of Copperas Cove	2.45	Clear Creek

Septic Systems

The LRW is predominantly rural with Lampasas being the largest city found entirely within the watershed boundaries. On-site sewage facilities (OSSFs) are the dominant type of wastewater disposal system used in the watershed. Five OSSF samples were collected from commercial pump trucks and were thus a composite of several OSSFs. Samples were collected and processed in the same manner as wastewater samples.

Grazing Livestock Sources

Ranching

Free ranging livestock in the watershed include cattle, horses, goats, sheep, and exotics. In total, 32 known source livestock samples were collected and submitted from the LRW. These included horse, sheep, and beef-cow samples.

Collecting known source sample from fresh feces deposit.

Concentrated Animal Feeding Operations

Within the LRW, there are 3 permitted concentrated animal feeding operations (CAFO); a dairy and a feedlot in Hamilton County and a dairy in Mills County. Also, there are several deer breeding operations in the watershed which are permitted by the Texas Parks and Wildlife Department (TPWD). A number of exotic animal breeding operations are also located in the watershed. No known source fecal samples were collected from any of the CAFOs.

Wildlife Sources

The LRW has a variety of habitats supporting numerous wildlife species. The watershed contains areas of cropland, improved pastures, rangeland, cedar/oak covered hills with steep canyons and bluffs, and riparian corridors that provide cover and forage for rabbits, whitetail deer, coyotes, grey fox, squirrel, bobcats, skunks, opossums, raccoons, songbirds, waterfowl, game birds, and raptors. Collectively, 71 known source fecal samples were collected from wildlife species.

Mammalian

Most known source mammalian samples were collected from droppings on the ground and identified by the close proximity of animals as well as fresh road-kill specimens.

Avian

Avian sampling focused on species actively nesting on bridges at monitoring sites. Cliff Swallow samples were collected by placing plastic sheeting under bridge-nesting birds and checking the surface after birds had returned to normal activities. A total of 28 known source avian samples (i.e., Cliff Swallow) were submitted from the LRW.

Cliff Swallow nests under bridge.

Feral Hogs

A special effort to collect feral hog samples was aided by local trappers and the Fort Hood trapping program. In total, 11 known source feral hog samples from LRW were submitted for processing.

Feral hogs from the Fort Hood military reservation in holding pen.

Bacterial Source Tracking

In water bodies that exceed fecal indicator bacteria standards, a common approach to reducing monitored bacteria levels is to study the watershed and identify sources of fecal pollution and develop watershed protection plans. Laboratory tests are used by researchers to identify sources of fecal pollution, a process referred to as bacterial source tracking (BST). This process can identify different strains of *E. coli* that have adapted to conditions in the guts of their specific animal hosts, resulting in strains that are specifically associated with that species or class of

animals (e.g. avian and non-avian wildlife, cattle, humans, etc.). As a result, BST laboratory tests allow the identification of likely human and animal sources of *E. coli* fecal pollution impacting a waterbody.

Two BST tests commonly used on *E. coli* are automated ribosomal ribonucleic acid genetic fingerprinting (RiboPrinting) and enterobacterial repetitive intergenic consensus sequence polymerase chain reaction (ERIC-PCR). These tests generate DNA fingerprints that resemble bar codes. The RiboPrinting and ERIC-PCR techniques are known as 'library-dependent' methods that require reference libraries of DNA fingerprints for *E. coli* isolated from known human, livestock, and wildlife fecal samples. The fingerprints of *E. coli* isolated from water samples are matched with the fingerprints in the identification library to identify the likely sources of fecal pollution.

Technical Approach

To identify the human and animal sources of fecal pollution impacting the Lampasas River, ERIC-PCR and RiboPrinting composite DNA fingerprints (ERIC-RP) were generated for *E. coli* isolated from river water samples. These were compared to the Texas *E. coli* BST Library, which was also supplemented with known source fecal *E. coli* isolates from the local Leon River watershed.

Water Sample Processing

Water samples were processed by AgriLife-TP for *E. coli* enumeration using USEPA Method 1603 with modified mTEC medium (USEPA 2006). After *E. coli* enumeration, plates were shipped to UTSPH-EP. Up to 8 representative colonies were then isolated on Nutrient Agar with MUG (NA-MUG), confirmed as *E. coli*, and archived. Up to 5 isolates per water sample were then subjected to BST analysis for identification.

Known Source Fecal Samples

Between January 2011 and February 2012, a total of 118 known source fecal samples were collected from the Lampasas River watershed by AgriLife-TP for the isolation of *E. coli*. Collected samples were shipped to UTSPH-EP where samples were streaked onto modified mTEC medium. Up to 5 positive colonies were then reconfirmed to be *E. coli* by streaking onto NA-MUG medium. *E. coli* were successfully isolated from 83 fecal samples, and 374 isolates

(up to 5 confirmed *E. coli* isolates per sample) were archived. Up to 3 isolates per sample were then screened for clones (identical isolates) using ERIC-PCR fingerprinting and non-clonal isolates for each sample were selected for RiboPrinting and inclusion into the local watershed library.

ERIC-PCR and RiboPrinting of *E. coli*

E. coli isolates from water samples and known source fecal samples were DNA fingerprinted using a repetitive sequence polymerase chain reaction (rep-PCR) method known as enterobacterial repetitive intergenic consensus sequence PCR (ERIC-PCR) (Versalovic, Schneider et al. 1994). Following ERIC-PCR analysis, *E. coli* water isolates and selected source isolates were RiboPrinted using the automated DuPont Qualicon RiboPrinter and the restriction enzyme *Hin*dIII. For RiboPrinting, all bacterial isolate sample processing was automated using standardized reagents and a robotic workstation, providing a high level of reproducibility. ERIC-PCR and RiboPrinting was performed as previously described (Casarez, Pillai et al. 2007).

Analysis of composite ERIC-RP DNA fingerprints was performed using Applied Maths BioNumerics software. Genetic fingerprints of *E. coli* from ambient water samples were compared to fingerprints of known source *E. coli* isolates in the Texas *E. coli* BST library (ver. 10-12) and the likely human and animal sources were identified. ERIC-RP composite patterns of water isolates were compared to the library using a best match approach and an 80% similarity cutoff (Casarez, Pillai et al. 2007). If a water isolate was not at least 80% similar to a library isolate it was considered unidentified. Although fingerprint profiles were considered a match to a single entry, identification was to the source class, and not to the individual animal species represented by the best match. When analyzing data for the entire watershed, source classes were divided into 7 groups, 1) human; 2) pets; 3) cattle; 4) avian livestock; 5) other non-avian livestock; 6) avian wildlife; and 7) non-avian wildlife, including feral hogs. When analyzing subset data (e.g. individual stations), source classes were divided into 4 groups: 1) human; 2) cattle (which was of special concern for this watershed); 3) other domestic animals (including avian and other non-avian livestock and pets); and 4) wildlife (avian and non-avian). It should be noted that the wildlife source class in this study included feral hogs. The DNA fingerprints from *E. coli* isolated from known feral hog samples are shared more with wildlife than other domesticated livestock.

Library Description

The process for selecting known source isolates for inclusion into the state BST library has recently been refined and was applied to this project. All de-cloned isolates from individual source samples (up to 3) were included in the local watershed library, independent of their similarity to other library isolates. Jackknife analysis of the local watershed library ERIC-RP fingerprints was used to identify the isolates that were correctly classified using a 7-way split of source classes (i.e. human, pets, cattle, other non-avian livestock, avian livestock, avian wildlife, and non-avian wildlife). Isolates with unique fingerprints (left unidentified using an 80% similarity cutoff) were also included to create the local self-validated library.

The local self-validated source isolates were then added to the current Texas *E. coli* BST Library (along with similarly selected isolates from the Leon River) (ver. 10-12 PRE). Jackknife analysis on the Texas *E. coli* BST library was then used to screen out any previously "unidentified" source isolates (those with unique fingerprints) that were incorrectly matching using a 3-way split of source classes (human, domestic animals, wildlife). Isolates that were still unique (left unidentified using an 80% similarity cutoff) were left in the library in order to reflect the diversity of patterns potentially seen in unknown water samples.

Of the 118 known fecal samples collected from the Lampasas River watershed, *E. coli* were successfully isolated from 83 samples, and 374 isolates (up to 5 confirmed *E. coli* isolates per sample) were archived. Of these, 236 isolates from the 83 positive source samples (up to 3 per sample) were screened using ERIC-PCR, with 143 isolates from those samples RiboPrinted and included in the local watershed library. After self-validation screening, 97 isolates from 67 samples were included in the initial (ver. 10-12 PRE) Texas *E. coli* BST Library. After Jackknife analysis, 89 isolates from 64 Lampasas source samples (77% of the local library samples) were left in the Texas *E. coli* BST Library (ver. 10-12). This version of the statewide library was used to identify the source classes for water isolates from the Lampasas River watershed.

The Texas *E. coli* BST Library (ver. 10-12) contains 1632 isolates from 1423 samples and represents 12 watershed projects across Texas and thousands of archived and screened samples.

The results of Jackknife analysis using a 7-way split of source classes is included in Table 8 and the results using a 4-way split is included in Table 9.

Table 8. Texas *E. coli* BST Library (ver. 10-12) composition and rates of correct classification (RCCs) by Jackknife analysis of ERIC-RP composite data sets using an 80% similarity cutoff and 7-way split.

Source Class	Number of Isolates	Number of Samples	Library Composition and Expected Random Rate of Correct Classification	Calculated Rate of Correct Classification (RCC)	RCC to Random Ratio***	Left Unidentified (unique patterns)
Human	413	353	25%	90%	3.6	19%
Pets	103	92	6%	67%	11.2	33%
Cattle	251	207	15%	83%	5.5	11%
Avian Livestock	102	86	6%	76%	12.7	23%
Other Non-Avian Livestock	120	114	7%	76%	10.9	13%
Avian Wildlife	246	227	15%	82%	5.5	20%
Non-Avian Wildlife	397	344	24%	82%	3.4	16%
Total	**1632**	**1423**	**RARCC* = 14%**	**ARCC** = 83%**		**18%**

*RARCC, expected random average rate of correct classification

**ARCC = average rate of correct classification: the proportion of all identification attempts which were correctly identified to source class for the entire library, which is similar to the mean of the RCCs for all source classes when the number of isolates in each source class is similar

***An RCC/Random Ratio greater than 1.0 indicates that the rate of correct classification is better than random. For example, the rate of correct classification for human is 3.6-fold greater than random chance.

Table 9. Texas *E. coli* BST Library (ver. 10-12) composition and rates of correct classification (RCCs) by Jackknife analysis of ERIC-RP composite data sets using an 80% similarity cutoff and 4-way split.

Source Class	Number of Isolates	Number of Samples	Library Composition and Expected Random Rate of Correct Classification	Calculated Rate of Correct Classification (RCC)	RCC to Random Ratio***	Left Unidentified (unique patterns)
Human	413	353	25%	90%	3.6	19%
Cattle	251	207	15%	83%	5.5	11%
Other Domestic Animals	325	292	20%	79%	4.0	22%
Wildlife	643	571	39%	92%	2.4	18%
Total	**1632**	**1423**	**RARCC* = 25%**	**ARCC** = 89%**		**18%**

*RARCC, expected random average rate of correct classification

**ARCC = average rate of correct classification: the proportion of all identification attempts which were correctly identified to source class for the entire library, which is similar to the mean of the RCCs for all source classes when the number of isolates in each source class is similar

***An RCC/Random Ratio greater than 1.0 indicates that the rate of correct classification is better than random. For example, the rate of correct classification for human is 3.6-fold greater than random chance.

BST Results

AgriLife-TP collected 136 water samples from flowing water from the 15 sampling stations between February 2011 and January 2012. Of the 136 samples collected, UTSPH-EP received 133 water samples for BST analysis. UTSPH-EP successfully isolated *E. coli* from 131 samples and a total of 971 isolates (up to 8 per sample) were archived. Up to 5 isolates per sample, for a total of 628 isolates from the 131 water samples, were analyzed with ERIC-PCR and RiboPrint composite (ERIC-RP) fingerprinting and identified using the Texas *E. coli* BST Library (ver. 10-12).

BST results for all 628 watershed isolates are presented in Figure 5. Note that 88% of the water isolates were identifiable using the Texas *E. coli* BST Library (ver. 10-12). Given the rural nature of the watershed it was not surprising that wildlife (both non-avian and avian) was the

leading contributor of *E. coli* in the Lampasas River. Approximately 12% of the isolates were identified as human and another 15% identified as cattle.

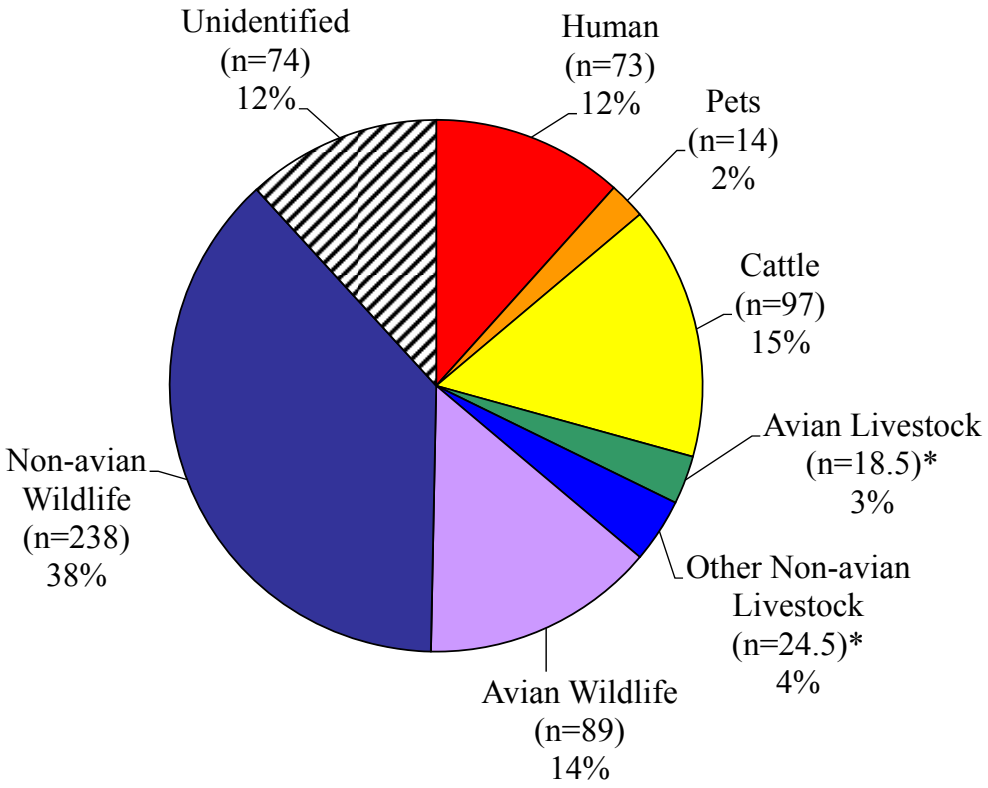


Figure 5. Identification of *E. coli* water isolates from the Lampasas River watershed using a 7-way split of source classes and an 80% similarity cutoff (n = 628 isolates from 131 samples). *One water isolate was equally similar to an "avian livestock" and an "other non-avian livestock" DNA fingerprint and so was considered a tie and split between the two source classes.

A breakdown of the watershed by sampling station is given in Appendix A using a 4-way split of source classes, but generally all follow a similar pattern. Figure 6 presents BST results for each site scaled to their *E. coli* geometric means. Wildlife was the leading contributor at all sites. Twelve of the fifteen sites were below the regulatory *E. coli* geometric mean standard of 126 CFU/100 mL for the 12 months of the study, and therefore were in compliance with recreation standards.

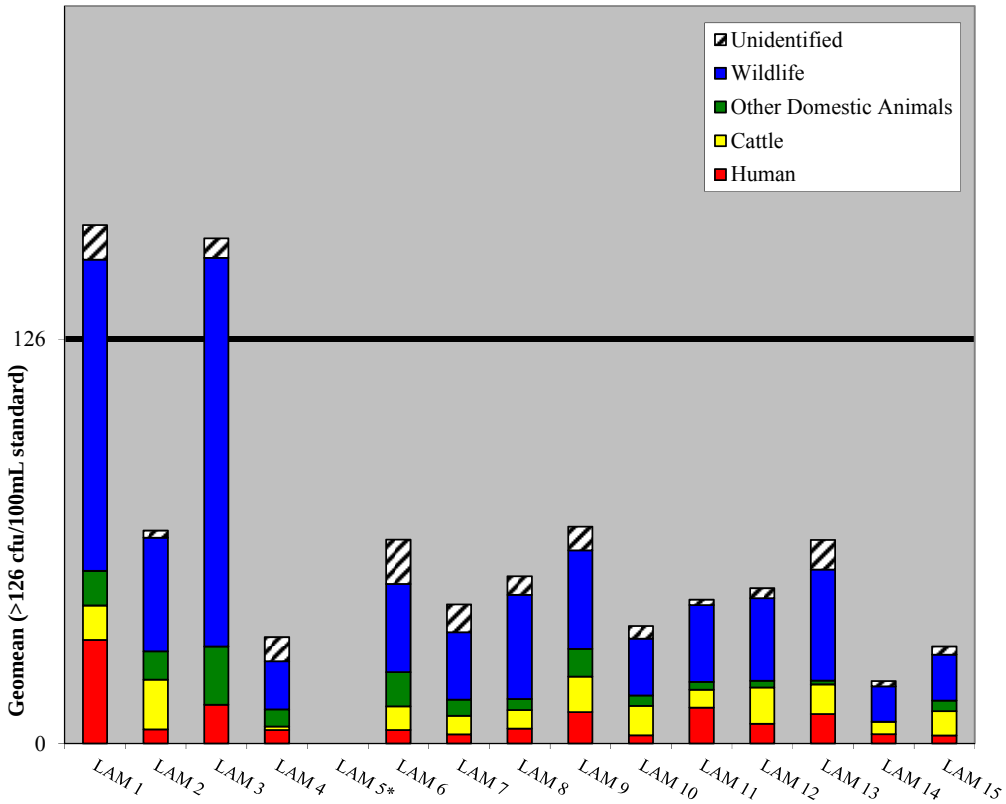


Figure 6. Four-way split BST results for each site scaled to the *E. coli* 12-month geometric means. * Note that LAM 5 was represented by only 2 flowing water samples, and therefore is not shown due to its limited data (see text).

It should be noted that the study period included drought conditions which left two sites dry or with only ponded water for most of the year, and so these sites are represented by only 2 to 3 water samples out of the 12 possible. Interpretation of results must be carefully considered since percentages of source identification can easily be skewed by such small numbers. LAM 5 had only two samples from flowing water, both of which were collected shortly after heavy rainfall and runoff events. These two samples gave LAM 5 a geometric mean of 3257 CFU/100 mL. Wildlife was found to be the leading contributor at LAM 5 although results were drawn from only 10 isolates from 2 water samples and are not statistically robust (therefore these data were not included in breakdowns by site).

Site LAM 1 (represented by 15 isolates from 3 samples) also exceeded the standard with an *E. coli* geometric mean of 162 CFU/100 mL. Wildlife was also identified as the major contributor, with 60% of the isolates identified to this source class. It is interesting to note that a penned deer

operation is located approximately 2.5 miles upstream from site LAM 1. Preliminary analyses of six *E. coli* isolates from two penned deer fecal samples indicated their ERIC fingerprints appeared unique or were identified as wildlife using the Texas *E. coli* BST Library (ver. 10-12). Therefore, targeted *E. coli* monitoring may be used to determine if this is a controllable wildlife source contributing to LAM 1.

LAM 3 was the other site that exceeded the standard, with an *E. coli* geometric mean of 158 CFU/100 mL. Represented by 26 isolates from 6 samples, LAM 3 seems especially impacted by wildlife, with 77% of the isolates identified to that source. Cattle seem to have very little impact on LAM 3, since no isolates were identified to that source class.

Over the course of the study, there were 23 single sampling events throughout the watershed that exceeded the individual sample limit of 394 CFU/100 mL (all sites except LAM 6). Source identifications for the isolates collected from samples in compliance were compared to those from exceedance samples (Figures 7 and 8, respectively). While there was a slight increase in the percentage of isolates identified as cattle-derived during exceedances, there were no significant differences in the source contribution profiles and wildlife was the leading contributor for both exceedance and compliance samples.

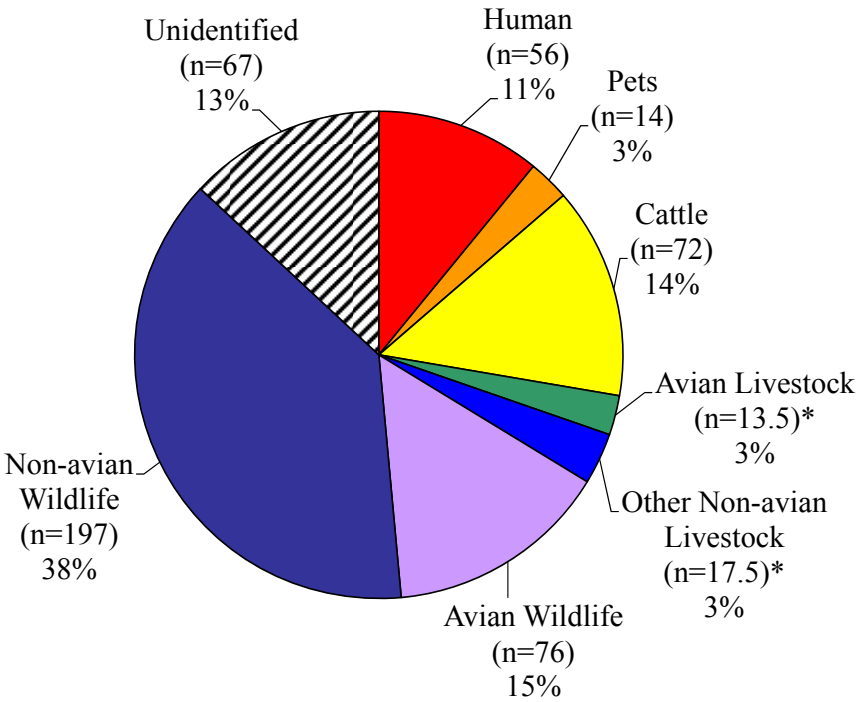


Figure 7. Identification of *E. coli* isolates from samples which were in compliance with the single sample maximum of <394 CFU/100 mL (513 isolates from 108 sampling events--all eligible sampling sites and dates included). *One water isolate was equally similar to an "avian livestock" and an "other non-avian livestock" DNA fingerprint and so was considered a tie and split between the two source classes.

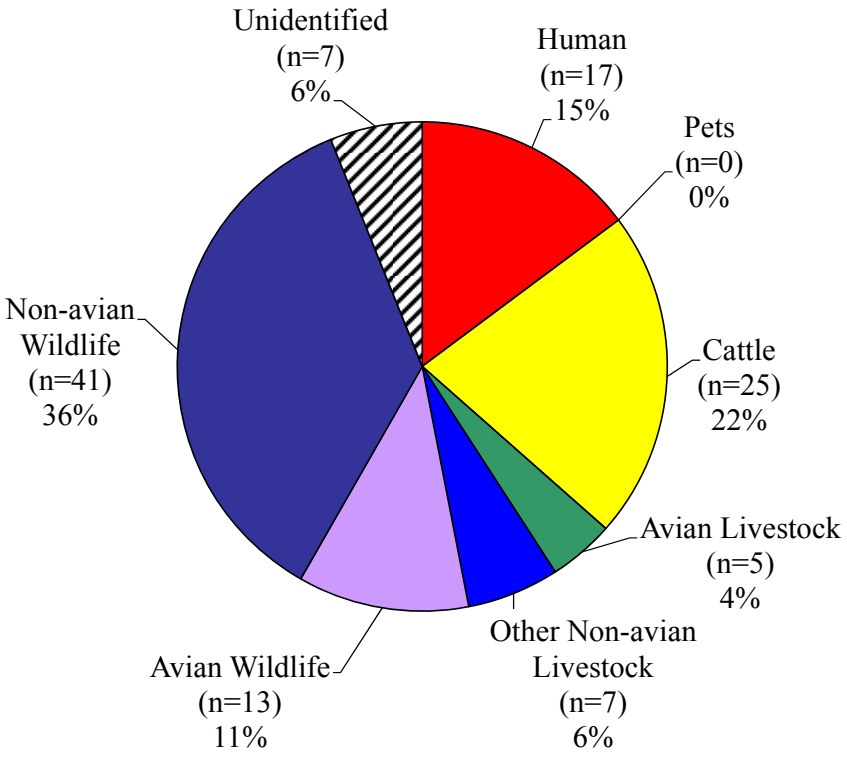


Figure 8. Identification of *E. coli* isolates from samples which were in exceedance of the single sample maximum of <394 CFU/100 mL (115 isolates from 23 sampling events—all eligible sampling sites and dates included).

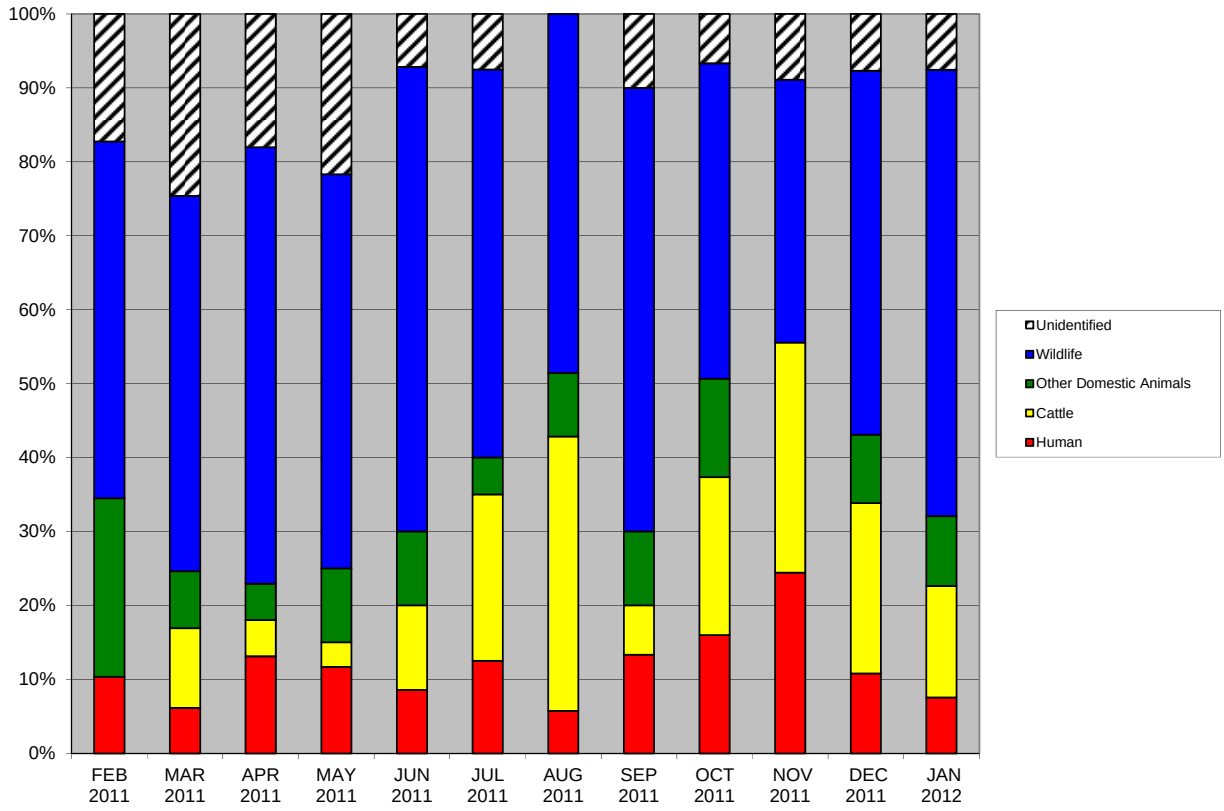


Figure 9. Four-way split of source classes by month for all sites combined.

UTSPH-EP also evaluated how source distributions changed over the study (Figure 9), although it should be noted that with only one year of data, strong conclusions cannot be drawn. October and December had heavy rainfall shortly before their water sampling dates and were therefore likely influenced by runoff. Not surprisingly, these samples had the highest *E. coli* counts, accounting for 20 of the 23 single samples in exceedance. As discussed above, there were no significant changes in the source distribution profiles, with wildlife as the leading contributor followed by cattle. Wildlife was also the leading contributor during the drier months. November did have a more even split between wildlife, cattle, and human contributions, and did have two samples (from LAM 11 and LAM 12) that were in exceedance with similar source contribution profiles.

SUMMARY AND DISCUSSION:

Most sites were in compliance with the *E. coli* geometric mean standard of 126 CFU/100 mL. The BST results indicated that wildlife was the leading pollution source impacting the Lampasas River watershed when there were significant impacts (high geometric means) as well as under compliance conditions. Potential wildlife sources include coyotes, deer, wild birds, and feral hogs (as defined in this study), and other small animals.

Sites LAM 1 and LAM 3 did exceed the *E. coli* regulatory standard of a geometric mean greater than 126 CFU/100 mL. Again, wildlife appeared to be the leading contributor of fecal pollution. Further study of site LAM 1 using targeted water sampling may be needed to determine if the nearby penned deer operation may be contributing to the observed wildlife pollution signature. Wildlife is also the major contributor at site LAM 3, and cattle seem to have minimal impact at this site. Further monitoring of site LAM 5 under normal flow conditions is needed to make sound conclusions as to its possible impairment and pollution sources.

There were 23 single sampling events throughout the watershed that exceeded the individual *E. coli* sample limit of 394 CFU/100 mL. While there was a slight increase in the percentage of isolates identified to cattle, there was no significant change in contribution patterns between exceedance events and when the bacterial counts were in compliance, with wildlife continuing to be the leading contributor. Not surprisingly, most of these single-sample exceedances were associated with recent rainfall and runoff.

The individual sampling sites mirror the results for the overall watershed. Most consideration should be given to the sites with consistently higher bacterial counts and management measures should be implemented to address fecal pollution loading at those sites. A WPP for the Lampasas River watershed is already being implemented to maintain water quality. The results of this study can be integrated into the plan through adaptive management.

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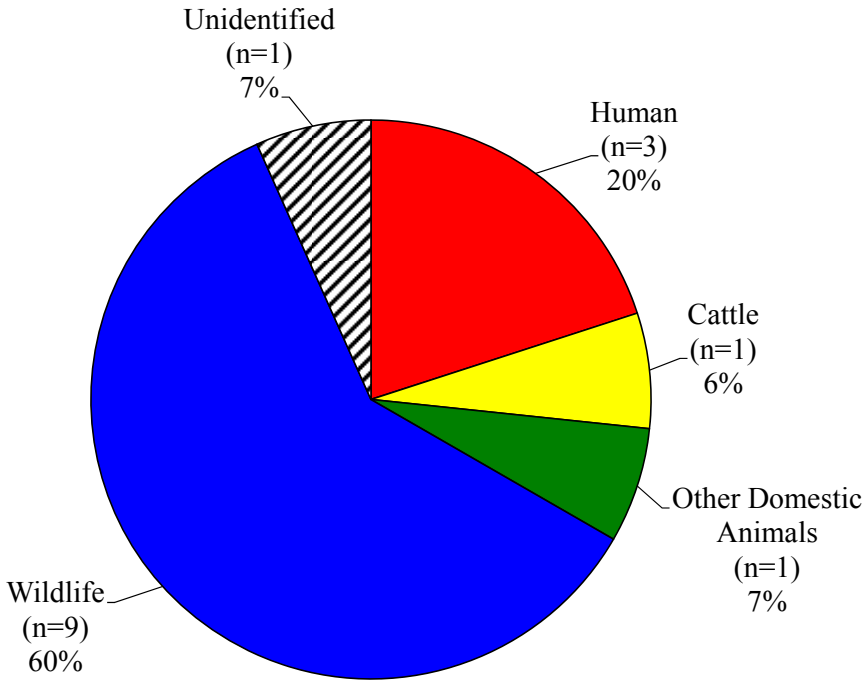
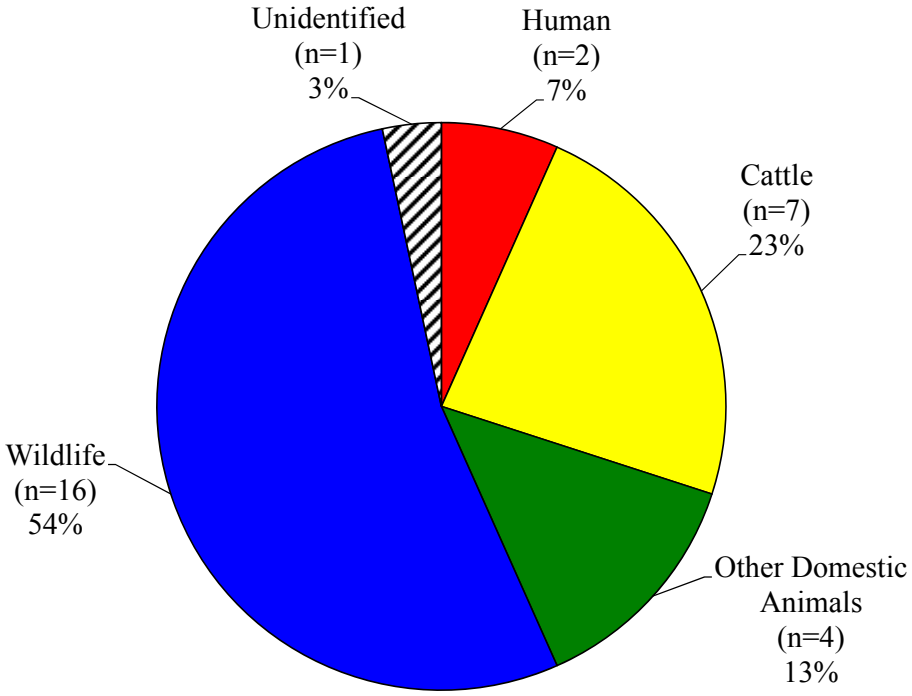
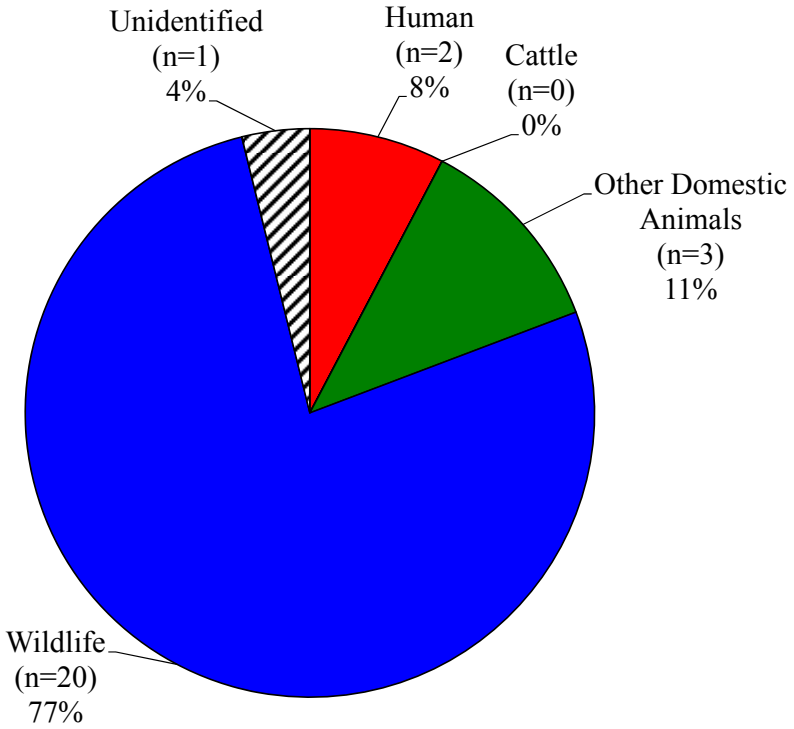
Appendix A: Source Identifications by Sampling Station



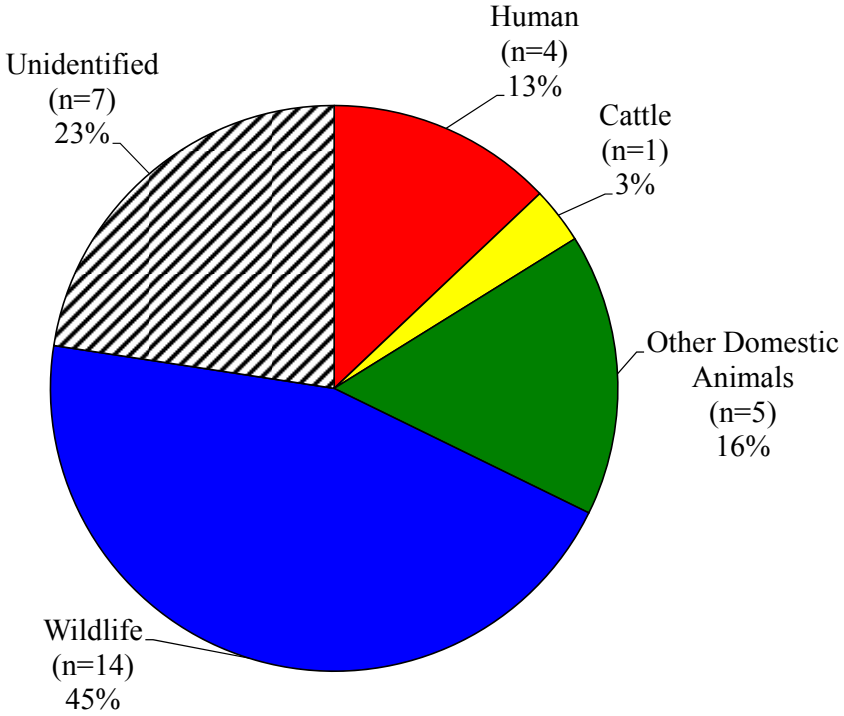
LAM 1 (15762) geometric mean = 162 CFU/100 mL (n=15 isolates; 3 samples)



LAM 2 (21013) geometric mean = 66 CFU/100 mL (n=30 isolates; 6 samples)

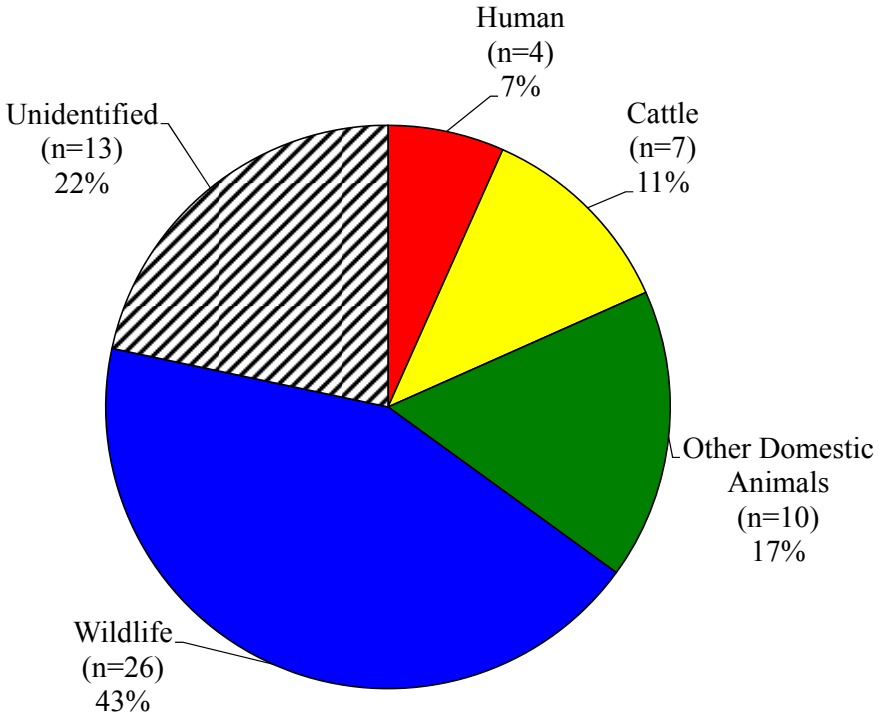


LAM 3 (15770) geometric mean = 158 CFU/100 mL (n=26 isolates; 6 samples)

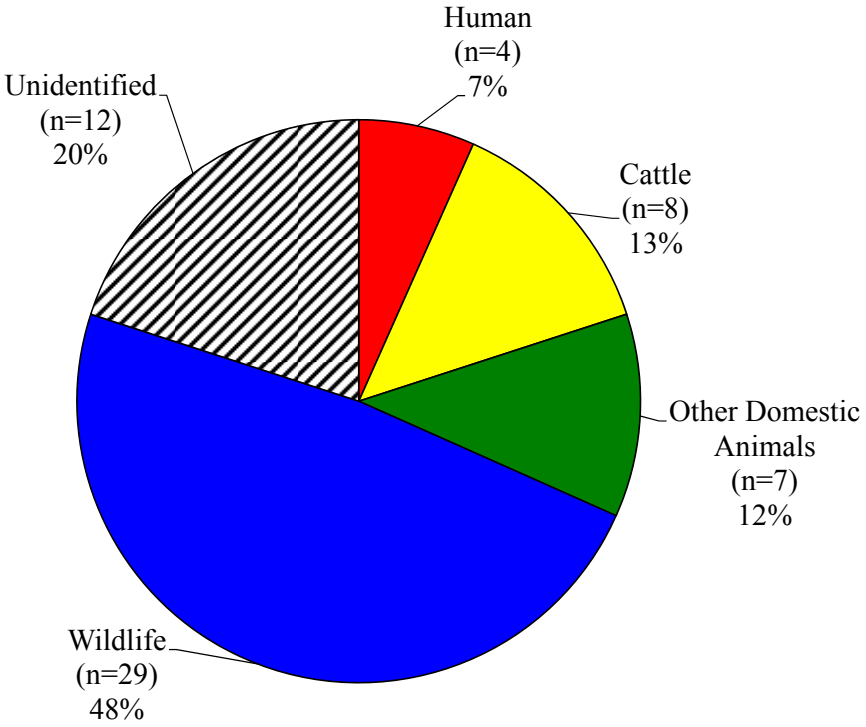


LAM 4 (15763) geometric mean = 33 CFU/100 mL (n=31 isolates; 7 samples)

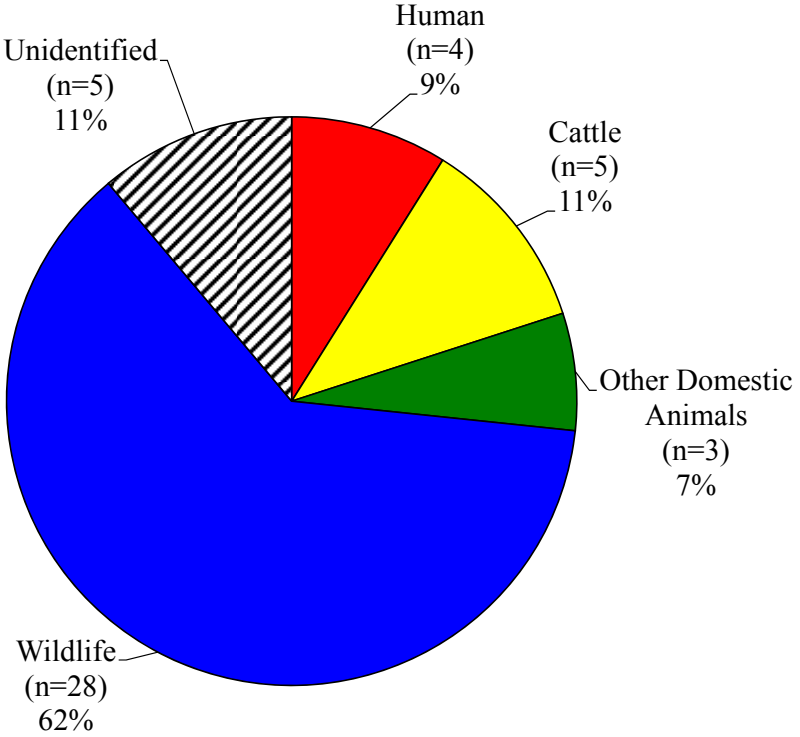
DATA NOT SHOWN FOR LAM 5 (21014) — Only two water samples were collected from this site. Consequently, BST results are not statistically reliable and were not presented.



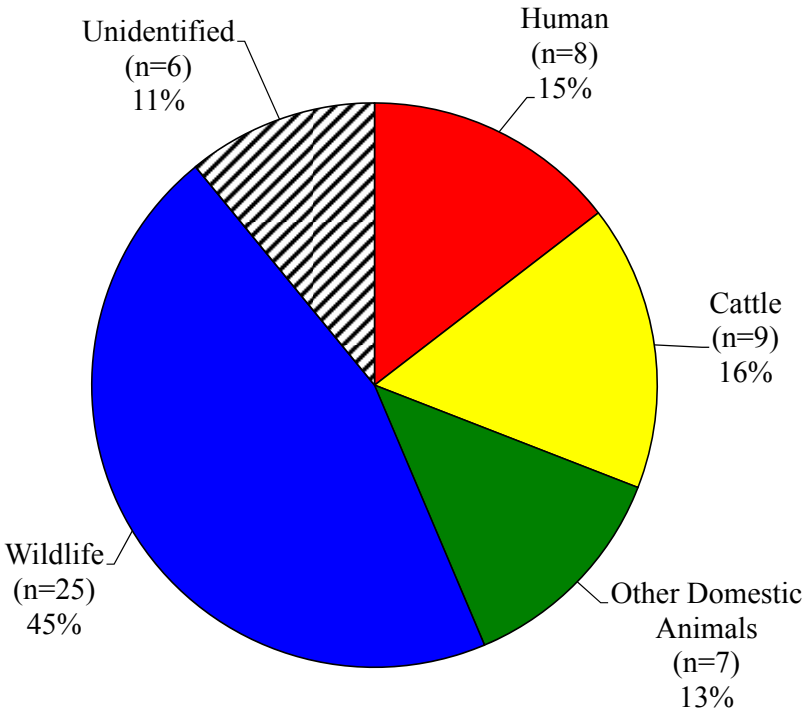
LAM 6 (11872) geometric mean = 64 CFU/100 mL (n=60 isolates; 12 samples)



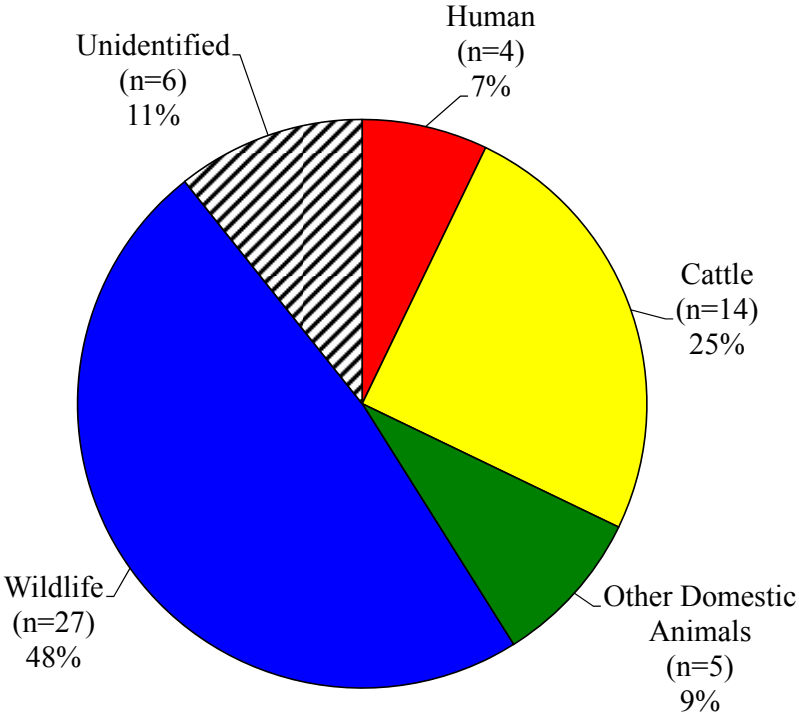
LAM 7 (15871) geometric mean = 43 CFU/100 mL (n=60 isolates; 12 samples)



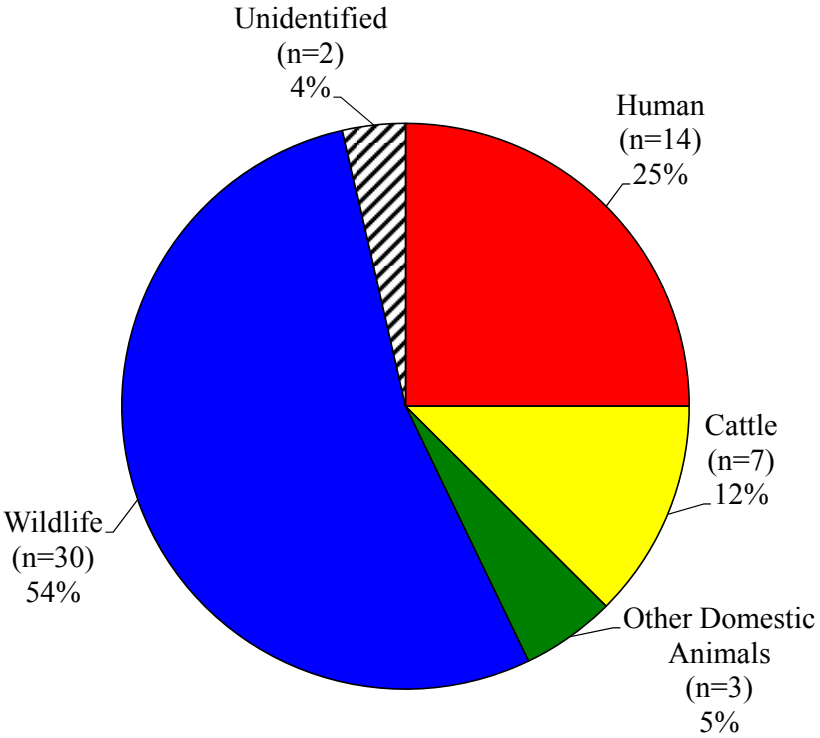
LAM 8 (21015) geometric mean = 52 CFU/100 mL (n=45 isolates; 9 samples)



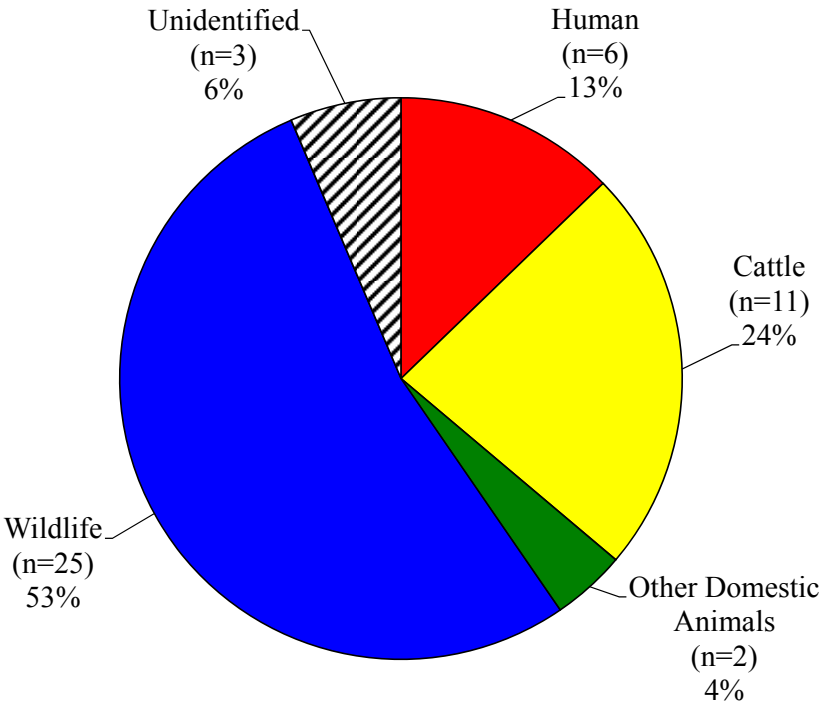
LAM 9 (15250) geometric mean = 68 CFU/100 mL (n=55 isolates; 11 samples)



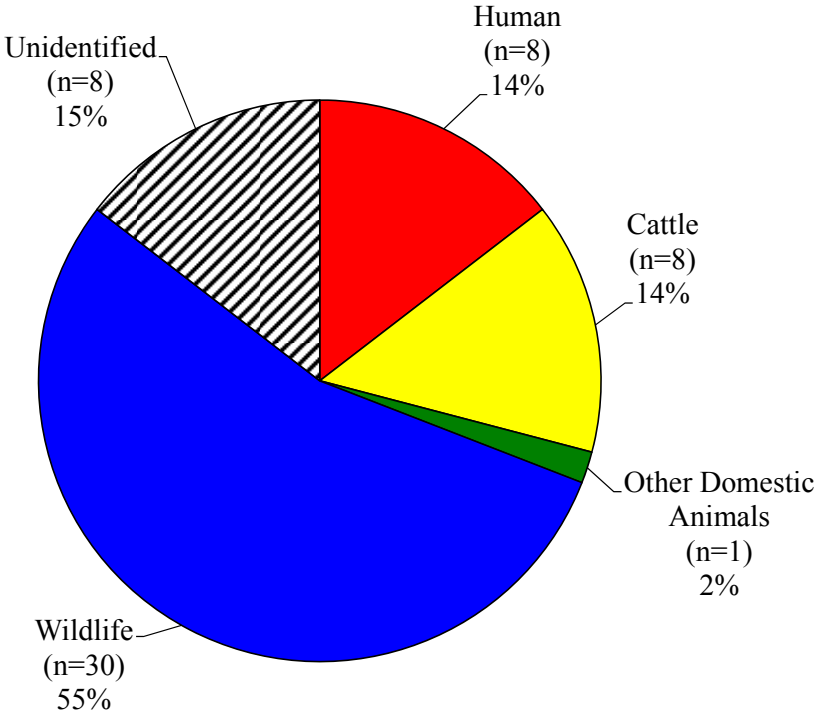
LAM 10 (11897) geometric mean = 37 CFU/100 mL (n=56 isolates; 12 samples)



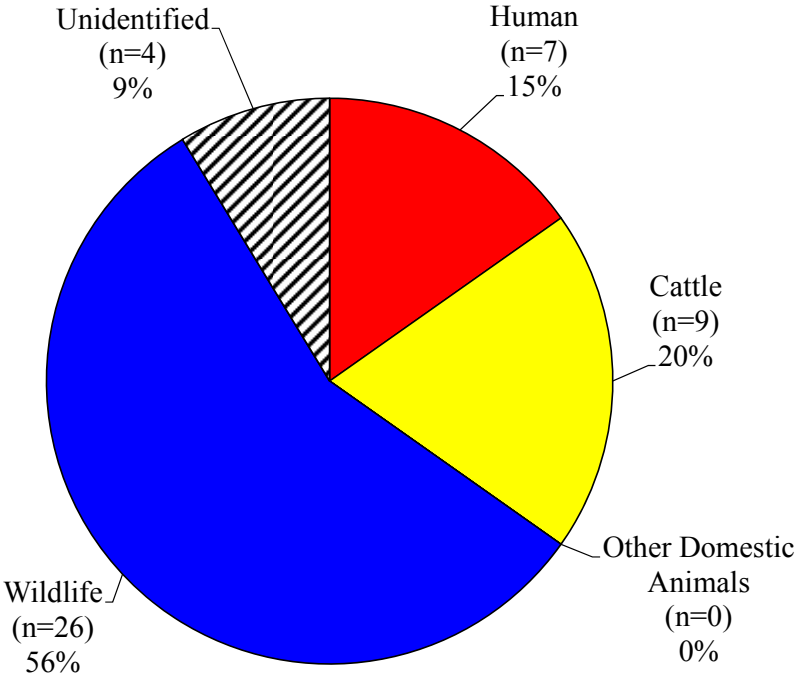
LAM 11 (16404) geometric mean = 45 CFU/100 mL (n=56 isolates; 12 samples)



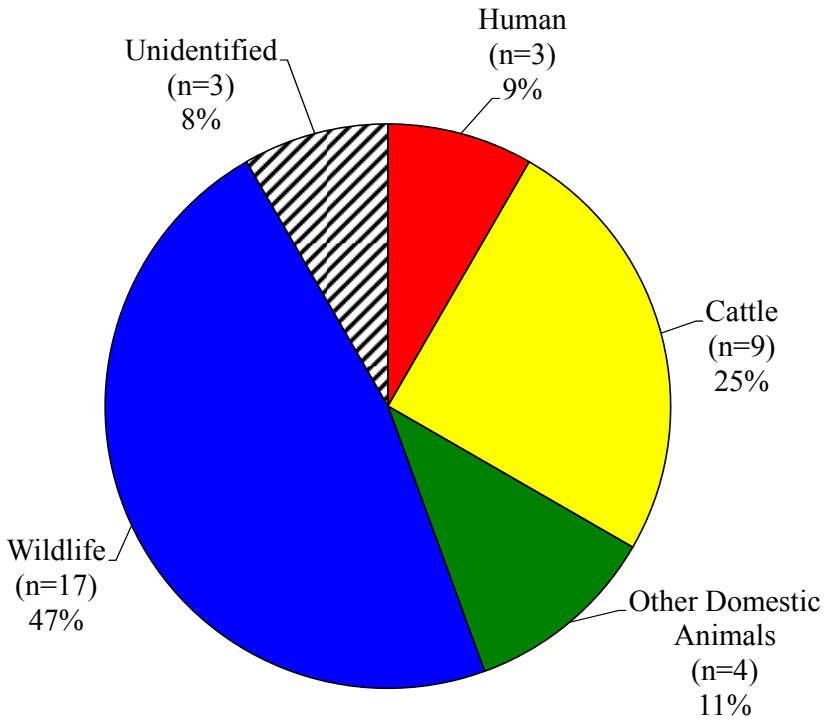
LAM 12 (11724) geometric mean = 48 CFU/100 mL (n=47 isolates; 10 samples)



LAM 13 (21016) geometric mean = 63 CFU/100 mL (n=55 isolates; 11 samples)



LAM 14 (11896) geometric mean = 19 CFU/100 mL (n=46 isolates; 10 samples)



LAM 15 (18759) geometric mean = 30 CFU/100 mL (n=36 isolates; 8 samples)

Appendix B: Sample Data

ID	End Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100mL	Split
32	2/7/2011	10:01	LAM 1	15762	Water	5.8	1	28	12.11	7.68	512	3.95	48	2	0.001	22	25
33	2/7/2011	10:56	LAM 2	21013	Water	6.1	1	28	12.39	7.62	621	3.99	6	2	0.163	0	
34	2/7/2011	11:30	LAM 3	15770	Water	6.1	1	28	12.18	7.67	677	5.3	11	2	0.286	53	
35	2/7/2011	12:10	LAM 4	15763	Water	7	1	28	12.13	7.82	609	7.34	15	3	0.99	5	
36	2/7/2011	13:00	LAM 5	21014	Water	7	1	28						1			
37	2/7/2011	14:15	LAM 10	11897	Water	9	1	7	19.32	8.05	1620	11.96	30	2	21	2	
38	2/7/2011	13:45	LAM 11	16404	Water	9	1	7	13.38	7.81	584	12.69	17	2	4.18	4	
39	2/8/2011	9:55	LAM 8	21015	Water	2	1	7	13.32	7.63	475	5.46	24	3	1.06	31	31
40	2/8/2011	10:15	LAM 7	15781	Water	3	1	5	11.44	7.98	2190	10.59	30	3	13.56	15	
41	2/8/2011	11:00	LAM 6	11872	Water	6	1	5	7.81	7.33	1920	14.18	22	3	3.36	25	
42	2/8/2011	11:35	LAM 9	15250	Water	7	1	5	14.51	8.42	2100	6.73	15	3	16.33	45	
43	2/8/2011	12:20	LAM 12	11724	Water	8	1	5	11.3	7.91	460	7.82	18	3	3.24	2	
44	2/8/2011	12:50	LAM 13	21016	Water	10	1	5	13.44	8.06	625	9.89	18	3	5.5	1	
45	2/8/2011	13:30	LAM 15	18759	Water	17	1	5	9.46	7.59	563	10.53	15	3	2.49	1	
46	2/8/2011	13:45	LAM 14	11896	Water	18	1	5	12.57	8.04	1136	9.88	40	3	36.9	1	
70	3/7/2011	9:20	LAM 1	15762	Water	12	2	34						1			
71	3/7/2011	10:05	LAM 2	21013	Water	14	2	34	8.86	7.68	622	13.16	8	2	0.031	23	
72	3/7/2011	10:40	LAM 3	15770	Water	16.5	2	34	7.12	7.65	662	12.3	30	2	0.213	43	
73	3/7/2011	11:10	LAM 4	15763	Water	19	2	34	9.72	7.91	582	13.63	8	2	0.361	9	
74	3/7/2011	11:30	LAM 5	21014	Water	19	2	34						1			
75	3/8/2011	10:45	LAM 6	11872	Water	25.5	1	34	8.65	7.19	1810	19.13	20	3	2.431	84	
76	3/8/2011	10:20	LAM 7	15781	Water	24	1	34	9.98	7.86	2090	17.87	40	3	13.244	82	
77	3/7/2011	12:05	LAM 8	21015	Water	23	1	34	9.99	8.15	445	17.22	24.5	2	0.379	6	
78	3/8/2011	9:45	LAM 9	15250	Water	23	2	35	10.85	7.84	2010	16.16	34	3	15.442	149	156
79	3/7/2011	13:05	LAM 10	11897	Water	24	1	34	11.89	8.54	1710	16.81	30	2	16	18	
80	3/7/2011	12:45	LAM 11	16404	Water	22	2	34	11.46	8.12	547	18.34	18	2	3.183	7	
81	3/8/2011	11:45	LAM 12	11724	Water	28	1	35	10.48	7.78	415	18.31	29	2	1.645	15	
82	3/8/2011	12:35	LAM 13	21016	Water	30	1	35	13.61	8.26	605	17.85	27	2	3.34	26	
83	3/8/2011	13:35	LAM 14	11896	Water	30	2	35	11.88	8.02	1126	19.93	57	2	29.764	13	
84	3/8/2011	13:08	LAM 15	18759	Water	29	1	35	9.93	7.14	519	19.12	15	2	1.418	22	
122	4/4/2011	10:00	LAM 1	15762	Water	19.5	2	62						1			
123	4/4/2011	10:40	LAM 2	21013	Water	16.5	2	62	9.28	7.5	654	19.33	5	2	0.019	225	
124	4/4/2011	11:15	LAM 3	15770	Water	16	2	62	6.95	7.57	647	21.34	12	2	0.23	103	
125	4/4/2011	11:45	LAM 4	15763	Water	17	2	62	8.51	7.81	640	18.35	11	2	0.126	75	
126	4/4/2011	12:05	LAM 5	21014	Water	19.5	2	62						1			
127	4/5/2011	10:45	LAM 6	11872	Water	22	2	63	6.79	7.15	1940	19.56	22	3	2.007	43	
128	4/5/2011	10:20	LAM 7	15781	Water	17	2	63	7.52	7.68	2340	17.92	52	3	12.204	35	

ID	Field Comments
32	Flow less than 1 L/sec - trickle, too small for probe, estimated (visual). Ice one inch thick in shaded areas. Was probably frozen the previous week due to extreme temperatures.
33	Some ice - Was probably frozen the previous week due to extreme temperatures
34	Was probably frozen the previous week due to extreme temperatures.
35	Was probably frozen the previous week due to extreme temperatures
36	No flow - possible sub-surface flow. Long pool above bridge. Ice in shaded area. Sample taken above bridge
37	Discharge from USGS gage
38	Sampled above bridge
39	Sunshine - cool - windy from south.
40	Sunshine - cool - windy from south. Water temp. and Specific Conductance higher than other streams due to warm mineral springs upstream.
41	Sunshine - cool - windy from south. Water temp. and Specific Conductance higher than other streams due to warm mineral springs in area.
42	Sunshine - cool - windy from south. Water temp. and Specific Conductance higher than other streams due to warm mineral springs upstream.
43	Sunshine - cool - windy from south.
44	Sample left on site, re-sampled on 10 Feb
45	Sunshine - cool - windy from south.
46	Sunshine - cool - windy from south.
70	No flow-ponding. Sample taken above bridge. Cattle feces on bank above bridge. Raccoon tracks very abundant under bridge. Cloudy - south wind.
71	Cattle droppings on bridge and banks
72	Sample taken above bridge. Cloudy - partly sunny
73	Sample taken above bridge. Floating and attached algae. Water clear. Partly cloudy - south wind.
74	No flow - ponding. Sample taken above bridge. Mostly sunny - south wind
75	Sample taken above bridge. Partly cloudy south wind
76	Sample taken above bridge. Partly cloudy south wind
77	Low water crossing. Samples taken below bridge. Sunny - few high clouds - south wind
78	Sample taken above bridge. Cliff swallows present. Attached algae. Partly cloudy - south wind.
79	Sample taken above bridge. Floating and attached algae. Sunny - few high clouds.
80	Sample taken above bridge. Sunny - fewer clouds - south wind
81	Sample taken above bridge. Cliff swallows present. Partly cloudy - sunny - south wind
82	Sample taken above bridge. Floating algae. Mostly sunny
83	Sample taken above bridge. Sunny- some clouds
84	Sample taken above bridge.
122	No surface flow. Long pool under bridge. Sample taken above bridge. Few swallows presented. Water clear. Little floating algae. Cricket Frogs present. Scattered showers early morning - norther before dawn - 20 -30 mph wind.
123	Trickle of flow. Floating and attached algae. Partly cloudy - North wind 20 -30 mph
124	Partly cloudy, N. wind 20 - 30 mph. Cricket Frogs. Gambusia and other small fish. Lot of floating algae. Cow feces in water. Sample taken downstream of bridge. No swallows noted. Ravens still in area.
125	Sunny - partly cloudy - N. wind 20 mph. Floating and attached algae. Small fish noted. Some odor. Small fish. No swallows noted.
126	No surface flow. Water clear. Floating algae. Cricket Frogs and small fish. No swallows noted. Sample taken above bridge in long pool.
127	Sunny - Light S. wind. Low water bridge. Sample taken upstream 20 ft. Water clear. Many small fish - Gambusia, Sunfish and others. Cattail, pondweed, watercress, dwarf Rush, Coontail, Broom Sedge. Lots of small mussel shells on bottom.
128	Sunny - Light S. wind. Low water bridge. Little algae. Mayfly hatch. Large sedge lining bank. Swanson Hawk.

ID	Lab Comments
32	
33	No colonies, plate not shipped to El Paso
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36	No colonies, plate not shipped to El Paso
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38	TCEQ audit notes transposition of raw count (strikeout with no comment) - should be reported as non-conformance
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44	Sample beyond holding time, plate not shipped to El Paso
45	No colonies, plate not shipped to El Paso
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ID	End Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100mL	Split
129	4/4/2011	13:45	LAM 8	21015	Water	25	2	62	9.56	8.14	486	20.95	13	2	0.058	6	
130	4/5/2011	9:45	LAM 9	15250	Water	17	2	63	8.71	7.67	2300	15.31	25	3	12.557	38	41
131	4/5/2011	13:25	LAM 14	11896	Water	25	2	63	10.01	7.94	1358	21.03	65	2	18.716	1	
132	4/4/2011	13:00	LAM 11	16404	Water	24	2	62	11.09	8.09	562	22.83	14	2	1.407	41	
133	4/5/2011	11:25	LAM 12	11724	Water	18.5	2	63	7.47	7.55	462	14.38	32	2	0.896	11	
134	4/5/2011	12:15	LAM 13	21016	Water	24	2	63	9.35	7.82	687	19.27	38	2	1.223	14	
135	4/4/2011	13:25	LAM 10	11897	Water	23	2	62	15.58	8.57	1920	23.75	28	2	17	11	
136	4/5/2011	13:00	LAM 15	18759	Water	26	2	63	6.8	7.28	591	20.48	10	2	0.576	09	
183	5/9/2011	10:15	LAM 1	15762	Water	27	1	7						1			
184	5/10/2011	11:05	LAM 2	21013	Water	30	2	7	9.77	7.93	643	29.4	5	2	0.048	41	
185	5/9/2011	11:45	LAM 3	15770	Water	29.5	2	7	6.22	7.85	603	25.19	12	2	0.068	310	
186	5/9/2011	12:05	LAM 4	15763	Water	32	2	7						1			
187	5/9/2011	12:25	LAM 5	21014	Water	31.5	2	7						1			
188	5/10/2011	10:40	LAM 6	11872	Water	28	2	8	4.85	7.39	1950	23.82	20	2	1.426	26	
189	5/10/2011	10:10	LAM 7	15781	Water	27	2	8	6.17	8.02	2370	24.71	42	3	11.073	29	
190	5/9/2011	14:00	LAM 8	21015	Water	38	2	7	6.29	7.83	482	34.68	6	2	0.001	46	
191	5/10/2011	9:35	LAM 9	15250	Water	27	2	8	6.58	7.96	234	24.63	45	3	16.097	37	29
192	5/9/2011	13:40	LAM 10	11897	Water	37.5	2	7	13.97	8.51	2110	29.98	22	2	13	8	
193	5/9/2011	13:15	LAM 11	16404	Water	37	2	7	12.24	8.3	551	29.12	15	2	0.667	44	39
194	5/10/2011	11:20	LAM 12	11724	Water	28	2	8	4.86	7.72	457	25.74	33	2	0.393	29	
195	5/10/2011	12:10	LAM 13	21016	Water	28	2	8	9.01	8.21	644	24.05	41	2	0.461	16	
196	5/10/2011	13:20	LAM 14	11896	Water	29	2	8	9.6	8.36	1550	26.09	65	2	13.047	29	
197	5/10/2011	12:58	LAM 15	18759	Water	28.5	2	8	7.3	7.67	591	24.85	8	2	0.276	17	
236	6/6/2011	10:10	LAM 1	15762	Water	32	2	26	3.84	7.25	504	26.44	50	2	0.063	196	
237	6/6/2011	10:45	LAM 2	21013	Water	34	2	26	7.12	7.11	564	28.05	9	2	0.021	42	
238	6/6/2011	11:10	LAM 3	15770	Water	34.5	2	26	8.44	8.07	532	30.11	4	2	0.02	121	
239	6/6/2011	11:30	LAM 4	15763	Water	38	2	26	7.01	7.61	490	29.29	12	2	0.11	14	
240	6/6/2011	11:50	LAM 5	21014	Water	38	3	26						1			
241	6/7/2011	9:55	LAM 6	11872	Water	33	2	27	4.94	7.21	2070	25.92	22	2	1.7	21	
242	6/7/2011	9:00	LAM 7	15781	Water	29	2	27	4.8	7.67	2350	25.93	40	2	13.357	44	53
243	6/6/2011	13:30	LAM 8	21015	Water	41	2	26	8.4	8.18	428	34.23	10	2	0.001	15	
244	6/7/2011	9:30	LAM 9	15250	Water	29	2	27	4.72	7.74	2490	26.08	43	2	9.642	28	
245	6/6/2011	13:10	LAM 10	11897	Water	42	2	26	11.23	8.42	1990	32.73	1.06	2	2.9	18	
246	6/6/2011	12:45	LAM 11	16404	Water	38	2	26	7.27	7.86	470	31.1	10	2	0.968	43	43
247	6/7/2011	10:30	LAM 12	11724	Water	30.5	2	27	5.49	7.65	434	30.5	31	2	0.205	40	

ID	Field Comments
129	Sunny - Light S. wind. Low water bridge. Some attached algae - little floating algae. Numerous small fish - some Darters. Cricket Frogs.
130	Sunny - Light S. wind. Some attached algae. Sulfur smell. Cricket Frogs. Many Swallows. Samples taken 100 ft. upstream from bridge.
131	Sunny - Light S. wind. Some attached algae. Water clear. Many small fish of various species. Double bridge. Many swallows. Sample taken 300 ft. above bridge.
132	Sunny - N. wind 20 mph. No floating algae - some drying on bank. Water clear. Flow noticeably lower. Many small fish. No livestock noted near river. Some Swallows. Sample taken above bridge.
133	Sunny - Light S. wind. Some floating and attached algae. Soft, thin, brown coating on gravel. Water clear. Many small fish. Many small fish. Sampled above bridge.
134	Sunny - Light S. wind. Some floating -attached algae. Water is clear. Numerous species of fish - Black Bass, several types of Sunfish, small fish. Water snake -species not ID.
135	Sunny - N. wind 20 mph. Few swallows. Floating - attached algae. Algae drying on bank. Small fish, tadpoles, Cricket Frogs. Sampled above bridge.
136	Sunny - Light S. wind. Attached algae. Brown slime on gravel. Numerous fish. Cricket Frogs.
183	Sunny - partly cloudy - south wind. Numerous cow paddies near water. Swallows on nests. Water has barnyard smell. Long pool upstream from bridge. Sample taken above bridge.
184	Sunny - partly cloudy - south wind 20 mph. Water is clear with numerous small fish. Flow is a trickle. Some attached algae. Cow paddies abundant near water.
185	Sunny - partly cloudy - south wind 20 mph. - hazy. Trickle of flow. Numerous small fish. Raven present and noisy. No birds on bridge.
186	Sunny - partly cloudy - south wind 20 mph. No swallows. Clear water. Ribbon Snake. Small fish. Bladder Worts under bridge, few blooms. Switchgrass along bank.
187	Sunny - hazy, few clouds - south wind 20 mph. Clear water. Numerous small fish. No birds. Easter Gama Grass in bloom. Some Switchgrass.
188	Cloudy - windy. Water clear. Numerous small fish. Ducks around. Cattails in bloom.
189	Cloudy - windy. Water clear. A lot of attached algae, some floating algae.
190	Sunny - hazy, few clouds - south wind 20 mph. - 30mph. Water clear. Flow a trickle. Small fish and tadpoles.
191	Cloudy - windy. Water clear. Numerous small fish. Cricket Frogs. Attached algae. H2S odor - mild. Swallows on bridge.
192	Sunny - hazy - few clouds - s. wind 20 -30 mph. Swallows on bridge. Water clear. Numerous small fish. Attached and floating algae.
193	Sunny - hazy - few clouds - s. wind 20 -30 mph. Swallows on bridge. Water clear. Numerous small fish. Little algae.
194	Sunny - hazy -windy. A few Swallows on nest. Water clear. Numerous small fish. Some attached algae. Nesting Bass and Sunfish in large natural pool upstream.
195	Sunny - hazy -wind. Numerous small fish - Sunfish on nest. Water clear with a slight greenish tint. Floating and attached algae. No swallows on bridge.
196	Cloudy - humid. Water clear - some attached algae. Numerous small fish and nesting Sunfish. Birds on bridge. Off road vehicles now have access to river - County or State cut road to river next to bridge.
197	Cloudy - humid -light south wind. Water clear - some attached and floating algae. Scum over gravel. Numerous small fish and nesting Sunfish and Bass in deep pool above bridge. No birds on bridge. Equisetum hyemale abundant upstream from bridge.
236	Sunny - clear - hazy. Swallows on bridge. Trickle. Water turbid. Few small fish. Evidence of river being up a few feet. Long pool from rock ledge downstream of bridge to out of sight above bridge.
237	Sunny - clear - hazy. Trickle. Brown scum on gravel. Cow paddies in creek. Numerous small fish.
238	Sunny - clear - hazy. Birds on bridge - circling 200 ft. upstream of bridge. Sample taken 200 ft. downstream of bridge.
239	Sunny - clear - hazy. Trickle. No birds. Sampled above bridge. Water clear. Small fish. Creek appears to have been up - bent grass on bank.
240	Sunny - mostly clear - hazy - few cumulus clouds. No flow - ponded. Numerous small fish. Water has brownish ting. Nest on bridge, no birds seen.
241	Sunny - clear - hazy. Water clear. Numerous small fish. Texas slider. Numerous emergent plants.
242	Sunny - clear - hazy. Birds on bridge. Water clear. Attached and floating algae. Numerous small fish - school of small Black Bass - sunfish.
243	Sunny - few clouds - hazy. Very low flow - not measurable with flow meter ≤ 0.001 cfs. Water clear. Numerous small fish, Cricket Frogs
244	Sunny - few clouds - hazy. Water clear. Floating & attached algae. Numerous small fish.
245	Sunny - few clouds - hazy. Water clear. Swallows on bridge. Some attached algae. Numerous small fish. Several groups of people and dogs in river.
246	Sunny - few clouds - hazy. Water clear. Swallows on bridge. A little attached algae. Local swimming hole upstream 1/4 mile.
247	Sunny -clear - hazy. Water clear. Swallows on bridge. Some attached and floating algae. Numerous small fish. Minnows feeding on bird droppings as they hit.

ID	Lab Comments
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ID	End Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100mL	Split
248	6/7/2011	11:30	LAM 13	21016	Water	33.5	2	27	7.83	7.9	633	25.83	36	2	0.581	45	
249	6/7/2011	12:30	LAM 14	11896	Water	36	2	27	7.86	7.89	871	30.3	60	2	11.669	13	
250	6/7/2011	12:00	LAM 15	18759	Water	35.5	2	27	7.45	7.44	589	26.47	50	2	0.343	56	
297	7/5/2011	9:15	LAM 1	15762	Water	31	2							1			
298	7/5/2011	10:00	LAM 2	21013	Water	34	2							1			
299	7/5/2011	10:30	LAM 3	15770	Water	33.1	2							1			
300	7/5/2011	10:55	LAM 4	15763	Water	34	2							1			
301	7/5/2011	11:10	LAM 5	21014	Dry		2	55						6	0		
302	7/6/2011	10:33	LAM 6	11872	Water	34.8	2	56	5.12	7.27	2080	27.09	10	2	0.321	75	
303	7/6/2011	9:58	LAM 7	15781	Water	30.3	2	56	4.59	7.81	2670	27.23	12	3	13.357	10	
304	7/5/2011	12:53	LAM 8	21015	Water	43	2	55	6.48	8.91	461	35.49	10	1	0	1	
305	7/6/2011	9:02	LAM 9	15250	Water	30	2	56	5.45	7.56	2490	27.27	15	3	9.785	20	16
306	7/5/2011	12:25	LAM 10	11897	Water	39	2	55	9.24	9.29	2300	31.54	10	2	9.2	10	11
307	7/5/2011	11:50	LAM 11	16404	Water	38	2	55	5.8	8.5	514	30.72	15	2	0.243	2	
308	7/6/2011	11:17	LAM 12	11724	Water	33.4	2	56	5.29	7.72	398	26.6	15	2	0.021	79	
309	7/6/2011	12:04	LAM 13	21016	Water	33.9	2	56	5.88	7.67	625	27.37	20	2	0.422	120	
310	7/6/2011	13:29	LAM 14	11896	Water	39.3	3	56	6.98	8.03	1480	32.07	20	2	4.139	4	
311	7/6/2011	12:54	LAM 15	18759	Water	43.2	3	56						1			
329	8/8/2011	9:25	LAM 1	15762	Dry		2	89						6	0		
330	8/8/2011	9:55	LAM 2	21013	Dry		2	89						1			
331	8/8/2011	10:13	LAM 3	15770	Dry		2	89						6	0		
332	8/8/2011	10:22	LAM 4	15763	Dry		2	89						6	0		
333	8/8/2011	10:28	LAM 5	21014	Dry		2	89						6	0		
334	8/9/2011	10:22	LAM 6	11872	Water	31.6	2	90	3.35	7.03	2170	26.61	10	2	0.038	75	
335	8/9/2011	9:50	LAM 7	15781	Water	31	2	90	4.58	7.68	2640	27.95	12	3	7.621	31	
336	8/8/2011	12:20	LAM 8	21015	Dry		2	89						6	0		
337	8/9/2011	9:05	LAM 9	15250	Water	32	2	90	4.65	7.19	2650	28.34	12	3	8.106	13	14
338	8/8/2011	11:40	LAM 10	11897	Water	36.2	2	89	9.78	8.2	2560	31.16	15	2	6.5	5	3
339	8/8/2011	11:10	LAM 11	16404	Water	35.4	2	89	6.68	7.45	568	29.92	10	2	0.234	2	
340	8/9/2011	10:55	LAM 12	11724	Dry		2	90						1			
341	8/9/2011	11:14	LAM 13	21016	Water	33.6	2	90	5.77	7.66	531	28.09	12	2	0.018	23	
342	8/9/2011	12:29	LAM 14	11896	Water	38.4	2	90	8.38	7.99	1890	32.06	12	2	1.151	6	
343	8/9/2011	12:03	LAM 15	18759	Dry		2	90						1			

369	9/7/2011	9:25	LAM 1	15762	Dry		2	126						6	0	
370	9/7/2011	10:00	LAM 2	21013	Dry		2	126						6	0	
371	9/7/2011	10:17	LAM 3	15770	Dry		2	126						6	0	
372	9/7/2011	10:30	LAM 4	15763	Dry		2	126						6	0	
373	9/7/2011	10:45	LAM 5	21014	Dry		2	126						6	0	
374	9/6/2011	11:25	LAM 6	11872	Water	27.3	2	125	4.82	7.16	2140	23.66	12	2	0.283	29

ID	Field Comments
248	Sunny - few clouds - hazy. Water clear. No birds. Some attached and floating algae. Numerous small fish - Black Bass - Sunfish.
249	Sunny -clear - hazy. Water clear. Swallows on both bridges. Small fish. Road cut to river eroded in last rain forming large gully. It is being filled in with broken concrete.
250	Sunny -clear - hazy. Water clear. Some attached algae. Scum on bottom gravel. Numerous small fish.
297	Sunny - clear - haze - light wind. No flow. Water clear with brown tint. Sample take above bridge. No bird seen. Long pool under bridge and upstream from bridge - dry down stream.
298	Sunny - clear - haze - light wind. No flow. There may be flow through gravel. Stagnant pool upstream of low water bridge - long, shallow pools downstream. Water is clear. Numerous small fish. Lot of cattle and deer signs.
299	Sunny - clear - haze - light wind. No flow. Water brown and turbid. Pools under bridge and upstream. Dry downstream as far as can be seen. Sample taken downstream under old bridge. Swallows on new bridge.
300	Sunny - clear - haze - light wind. No flow. May be flow through gravel. Water clear. Some algae on gravel. Pools up and down stream. Few nest - no Swallows seen. Sampled upstream. Numerous small fish - some Sunfish.
301	Sunny - clear - haze - light wind. Creek is dry. Two small puddles seen - fish in one. Nest on bridge - no birds seen.
302	Sunny - clear - haze - light wind. Water clear. Cattails and pondweed in water - attached algae. Numerous small fish.
303	Sunny - clear - haze - light wind. No flow. Water clear. Attached algae. Numerous small fish, Sunfish. Crayfish seen.
304	Sunny - clear - haze - light wind. No flow. There is a dam 100 ft upstream with large pond - no flow into pond. There is seepage from dam which creates a pool. Seepage under bridge causes a small flow into lower pool, no flow down- stream from pool.
305	Sunny - clear - haze - light wind. Attached and some floating algae. Water clear. Numerous small fish - Sunfish on nest. Sample above bridge. Few Swallows on nest.
306	Sunny - clear - haze - light wind. Water clear . Some attached green algae. Numerous small fish - Cricket Frogs. Swallows on bridge. Sampled above bridge.
307	Sunny - clear - haze - light wind. Water clear. Algae slime on gravel. Numerous small fish. Few Swallows on bridge. Sampled above bridge.
308	Sunny - clear - haze - light wind. Water clear. Numerous small fish. Attached algae. Rocks are slick.
309	Sunny - clear - haze - light wind. Water clear - brown tint. Numerous small fish. Attached algae. Sunfish and bass in pool above bridge.
310	Sunny - clear - haze - light wind. Water clear - more turbid in deeper water. No small fish noted. Water Snake. Attached algae. Birds on bridge. Sample 200 ft. + above bridge.
311	Sunny - clear - haze - light wind. Water clear. Numerous small fish. Attached algae & green filamentous algae. Pool above bridge then a long dry gravel bed. Flow from gravel under bridge and flows 100 ft. to deep pool - no flow from that pool noted.
329	Clear-sunny. Dry. One pool downstream of bridge - dry upstream as far as can be seen.
330	clear - south wind. Creek dry downstream from low water bridge. Water ponding caused by bridge, 10 cattle in water, more on bridge. Water in pond stagnant - brown, foamy, very turbid, odor of manure.
331	Clear - south wind. Dry above and below bridge - few small puddles.
332	Clear - south wind. Dry - shallow pool 100 feet upstream - none downstream.
333	Clear - south wind. Dry creek.
334	Sunny - clear. Water mostly clear - some turbidity. Attached algae and macrophytes. Numerous small fish.
335	Sunny - clear. Attached algae, sunfish, overhanging trees, duckweed floating in current. Water clear.
336	Sunny and hot. Some ponding caused by low water bridge - dry downstream as far as can be seen.
337	Sunny - clear - south wind. Sunfish on nest, numerous small fish, overhanging trees. Water clear. No Swallows.
338	Sunny - clear -hot. Numerous small fish, Cricket Frogs, some algae. Water clear. No Swallows. Sampled above bridge.
339	Sunny - clear - hot. Numerous small fish, Cricket Frogs, attached algae. Water clear. No swallows. Flow meter velocity 2 ft/sec. Width 4 ft. Average depth 0.146 ft. Calculated flow value. See back of field data form.
340	Sunny - hot. Some ponding, no flow, no sample.
341	Sunny - hot. Sunfish and Black Bass. Attached and floating algae. Overhanging trees. Water somewhat turbid.

342	Sunny - hot. Water clear to slightly turbid. Small fish, Cricket Frogs. Some algae.
343	Sunny - hot. Ponded - no flow between ponds - ponds appear stagnant.
369	Sunny and Clear - Dry, few small shallow pools.
370	Sunny and Clear - Dry downstream, pool above low water bridge. Pool is well used by cattle.
371	Sunny and Clear - Dry up and down stream - few shallow pools below bridge.
372	Sunny and Clear - Dry up and down stream - small shallow pool upstream.
373	Sunny and Clear - Dry no pools or damp areas
374	Sunny and Clear -Water clear. Small fish.

ID	Lab Comments
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301	No sample.
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304	Field comments con't. Numerous small fish - Sunfish and Bass in pool above bridge. Water clear.
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ID	End Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100mL	Split
375	9/6/2011	10:15	LAM 7	15781	Water	25.3	2	125	6.73	7.82	2660	21.37	42	3	9.206	13	
376	9/6/2011	9:30	LAM 8	21015	Dry		2	125						6	0		
377	9/6/2011	9:45	LAM 9	15250	Water	23	2	125	7.24	7.8	2690	19.99	48	3	7.329	18	
378	9/6/2011	9:15	LAM 10	11897	Water	17.9	2	125	7.5	7.72	2660	19.81	22	2	7.5	9	14
379	9/6/2011	10:50	LAM 11	16404	Water	21	2	125	9.08	7.67	535	28.97	8	2	0.002	14	
380	9/6/2011	11:55	LAM 12	11724	Dry		2	125						1	0		
381	9/6/2011	12:25	LAM 13	21016	Water	27.4	2	125	8.95	8.05	478	19.95	10	2		14	
382	9/6/2011	13:25	LAM 14	11896	Water	31.5	2	125	11.59	8.32	2100	27.13	15	2	0.716	0	
383	9/6/2011	13:13	LAM 15	18759	Dry		2	125						1	0		
408	10/10/2011	9:30	LAM 1	15762	Water	17.1	2	1	6.15	6.19	207	18.03	21	2	0.207	>2000	
409	10/10/2011	10:15	LAM 2	21013	Water	19	2	1	6.5	6.53	188	17.53	27	3	13.452	>4000	
410	10/10/2011	10:45	LAM 3	15770	Water	18.2	2	1	7.34	6.84	216	17.92	13	5	24.225	>4000	
411	10/10/2011	11:30	LAM 4	15763	Water	18.6	2	1	6.4	7.06	203	18.74	41	5	20.966	5940	
412	10/10/2011	11:55	LAM 5	21014	Water	19.1	2	1	5.46	7.04	208	19.96	9	3	0.53	3120	
413	10/11/2011	11:05	LAM 6	11872	Water	21.6	2	2	4.26	7	1670	21.63	9	3	0.796	283	
414	10/11/2011	10:40	LAM 7	15781	Water	20.8	2	2	7.08	7.54	2280	19.41	52	3	10.088	290	
415	10/11/2011	10:15	LAM 8	21015	Water	21.1	3	2	6.03	7.56	221	18.26	10	2	0.138	1609	
416	10/11/2011	9:45	LAM 9	15250	Water	18.4	2	2	7.28	7.42	1203	18.57	49	3	12.869	359	346
417	10/10/2011	13:35	LAM 10	11897	Water	20.1	2	1	7.69	7.44	208	18.89	45	5	102	>4000	
418	10/10/2011	12:55	LAM 11	16404	Water	21.9	2	1	6.73	7.49	192	18.64	50	5	174.1	>4000	
419	10/11/2011	11:45	LAM 12	11724	Water	24.8	2	2	7.55	7.68	276	20.06	31	3	2.573	1200	
420	10/11/2011	12:35	LAM 13	21016	Water	28	2	2	4.23	7.64	271	19.89	35	2	0.107	1573	
421	10/11/2011	13:55	LAM 14	11896	Water	25.8	2	2	8.06	7.72	512	20.91	63	5	138.15	9900	
422	10/11/2011	13:30	LAM 15	18759	Water	26.4	2		2.51	7.77	240	20.88	12	2	0.159	226	
450	11/8/2011	10:00	LAM 1	15762	Dry		2	29						1	0		
451	11/8/2011	10:30	LAM 2	21013	Dry		2	30						1	0		
452	11/8/2011	10:45	LAM 3	15770	Dry		2	30						1	0		
453	11/8/2011	11:00	LAM 4	15763	Dry		2	30						1	0		
454	11/8/2011	11:07	LAM 5	21014	Dry		2	30						1	0		
455	11/7/2011	13:00	LAM 6	11872	Water	24.9	2	29	5.79	7.2	2040	20.84	24	3		55	

456	11/7/2011	10:25	LAM 7	15781	Water	22.4	2	29	7.97	8.19	2690	19.05	48	3	10.973	23	
457	11/7/2011	9:55	LAM 8	21015	Water	22.7	2	29	4.88	7.77	384	18.82	11	2	0.027	31	
458	11/7/2011	9:30	LAM 9	15250	Water	22.1	2	29	8.26	8.23	2700	18.03	46	3	11.672	155	
459	11/7/2011	9:00	LAM 10	11897	Water	21.7	2	29	9.23	8.26	2610	18.66	24	2	9.2	104	105
460	11/7/2011	11:00	LAM 11	16404	Water	24.5	2	29	9.78	8.17	504	21.98	11	2	0.368	2470	105
461	11/8/2011	11:50	LAM 12	11724	Water	21.4	2	30	7.23	7.26	418	19	23	2	0.001	1110	1230
462	11/8/2011	12:30	LAM 13	21016	Water	22.2	2	30	5.73	7.28	450	18.39	18	2	0.034	81	
463	11/7/2011	14:15	LAM 14	11896	Water	24.4	2	29	10.21	8.36	1610	20.19	60	2		45	
464	11/7/2011	14:00	LAM 15	18759	Dry		2	29						1	0		

ID	Field Comments
375	Sunny and Clear -Water clear. Small fish.
376	Sunny and Clears light north wind. Shallow pool near bridge.
377	Sunny and Clear -Water clear. Small fish and attached macrphytes.
378	Sunny and Clear -Water clear. Some algae.
379	Sunny and Clear -Water clear. Trickle of flow through gravel and rocks. Numerous small fish and small Cricket Frogs. A lot of attached algae of several different types.
380	Sunny and clear. Few shallow pools.
381	Sunny and clear. Water clear. Trickle of flow - can be seen flowing but not enough volume to measure - flow estimated at less than 1 liter per second. Attached and floating algae> Numerous small fish.
382	Sunny and clear. Water clear. Fishermen upstream.
383	Sunny and clear. No flow - shallow pools.
408	Cloudy-humid-cool. Heavy rain over the weekend. Water brown and turbid. Sample taken downstream of bridge - below the ford (3 ft. waterfall)
409	Cloudy-humid-cool. Heavy rain over the weekend. Water brown and turbid. Water going over low water bridge.
410	Cloudy-humid-cool. Heavy rain over the weekend. Water brown and turbid.
411	Cloudy-humid-cool. Heavy rain over the weekend. Water brown and turbid.
412	Cloudy-humid-cool. Heavy rain over the weekend. Water turbid.
413	Sunny - few clouds. Heavy rain over the weekend. Water clear.
414	Sunny to partly cloudy. Heavy rain over the weekend. Water clear. Some attached algae - a little Duck Weed. Some small fish.
415	Sunny to partly cloudy. Heavy rain over the weekend. Water clear with brown tint. Some small fish' Cricket Frogs and Crayfish.
416	Clear-Sunny. Heavy rain over the weekend. Water clear with brown tint. Some attached algae - Some small fish.
417	Clear-Sunny. Heavy rain over the weekend. Water brown and turbid.
418	Clear-Sunny. Heavy rain over the weekend. Water brown and turbid.
419	Sunny to partly cloudy. Heavy rain over the weekend. Water clear with brown tint.
420	Sunny to partly cloudy. Heavy rain over the weekend. Water turbid and brown. Cricket Frogs.
421	Sunny to partly cloudy. Heavy rain over the weekend. Water brown and turbid.
422	Sunny to partly cloudy. Heavy rain over the weekend. Water clear with a little brown tint. No surface flow under bridge- flow through gravel. Some small fish and Cricket Frogs.
450	Cloudy with some sun. Showers moved through the area earlier - not enough rain for runoff. Pools - no flow.
451	Cloudy with some sun. Showers moved through the area earlier - not enough rain for runoff. Pool above low water bridge no water flowing past bridge - pool downstream of bridge several hundred feet. Rain puddles on rocks.
452	Cloudy with some sun. Showers moved through the area earlier - not enough rain for runoff. Pooled above and below bridge. Rain puddles on rocks.
453	Cloudy with some sun. Showers moved through the area earlier - not enough rain for runoff. Few pools.
454	Cloudy with some sun. Showers moved through the area earlier - not enough rain for runoff. Few pools.
455	Cloudy . Water clear. Numerous small fish.

456	Cloudy . Water clear. Numerous small fish.
457	Cloudy - few sprinkles. Water clear. Some Duckweed. Samll tadepoles.
458	Cloudy - Lighr showers and sprinkles. Water clear. Some Duckweed. Small fish and Cricket Frogs. A little Duckweed.
459	Cloudy - Light showers and sprinkles. Water clear. Small fish and Cricket Frogs.
460	Cloudy - Windy - south wind. Water clear. Numerous small fish and Cricket Frogs.
461	Cloudy -Rain earlier, not enough for runoff. Very low flow - observed flowing but flow is below the detection level of ADCP, less than 0.001. Water clear, some algae.
462	Cloudy. Rain earlier, not enough for runoff. Water clear. Some Duckweed. Small fish.
463	Cloudy - Few showers around. Water clear. Numerous small fish and Cricket Frogs.
464	Cloudy - Few showers around. No surface flow. Pooled

ID	Lab Comments
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408	Enumeration is an a estimate
409	Enumeration is an a estimate
410	Enumeration is an a estimate
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417	Enumeration is an a estimate
418	Enumeration is an a estimate
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ID	End Date	Time	Location	TCEQ Station	Sample Type	Air Temp (C)	Weather	Last Rain (days)	Dissolved Oxygen (mg/L)	pH	Conductivity (µS/cm)	Water Temp (C)	Stream Depth (cm)	Flow Severity	Instaneous Stream Flow (cfs)	Ecoli/100mL	Split
481	12/5/2011	9:40	LAM 1	15762	Dry		2	1						1	0		
482	12/5/2011	10:30	LAM 2	21013	Water	3.5	2	1	10.27	6.36	411	7.27	11	2	0.037	342	
483	12/5/2011	10:50	LAM 3	15770	Dry		2	1						1	0		
484	12/5/2011	11:05	LAM 4	15763	Water	3.8	2	1	9.75	6.86	509	8	12	2	0.058	34	
485	12/6/2011	11:35	LAM 5	21014	Water	3.8	2	1	10.66	7.15	315	8.31	20	5	4.078	2676	
486	12/6/2011	10:25	LAM 6	11872	Water	2.3	2	2	7.32	7.45	1970	11.37	10	3	0.894	198	
487	12/6/2011	9:50	LAM 7	15781	Water	0.7	2	2	10.11	7.82	1354	8.5	45	3	11.448	514	
488	12/5/2011	13:30	LAM 8	21015	Water	3.8	2	1	9.14	7.7	344	8.49	11	2	0.005	1766	
489	12/6/2011	9:20	LAM 9	15250	Water	0.2	2	2	10.53	7.93	1378	7.63	42	3	17.183	802	673
490	12/5/2011	13:15	LAM 10	11897	Water	3.9	2	1	10.86	8.1	1530	10.26	42	5	95	3636	
491	12/5/2011	12:40	LAM 11	16404	Water	5.7	2	1	9.83	7.85	358	10.86	22	3	27.187	1018	1036
492	12/6/2011	11:25	LAM 12	11724	Water	1.7	2	2	11.15	8.13	460	6.81	21	2	0.799	90	
493	12/6/2011	11:50	LAM 13	21016	Water	1.8	3	2	11.03	8.05	2720	8.14	12	5	2.356	5545	
494	12/6/2011	13:25	LAM 14	11896	Water	2.5	2	2	11.65	8.19	1560	7.97	55	5	102.07	613	
495	12/6/2011	12:30	LAM 15	18759	Water	2.9	2	2	9.11	7.98	240	7.4	11	2	0.379	1414	
514	1/9/2012	10:10	LAM 1	15762	Water	6.9	4	0						1			
515	1/9/2012	10:45	LAM 2	21013	Water	5.7	4	0						1			
516	1/9/2012	11:15	LAM 3	15770	Water	6.4	4	0						1			
517	1/10/2012	11:35	LAM 4	15763	Water	6.4	4	0	8.46	7.3	657	9.38	25	2	0.002	3	
518	1/9/2012	12:00	LAM 5	21014	Water	6.7	4	0						1			
519	1/10/2012	10:45	LAM 6	11872	Water	8.8	2	1	7.93	7.38	2480	13.8	16	3	0.699	114	
520	1/10/2012	10:15	LAM 7	15781	Water	6.8	2	1	10.11	8.01	3240	11.48	45	3	13.203	41	
521	1/9/2012	13:50	LAM 8	21015	Water	6.8	4	0	9.82	7.24	478	9.8	14	2	0.014	29	
522	1/10/2012	9:40	LAM 9	15250	Water	7	2	1	10.86	8.09	3040	9.36	50	3	17.416	80	86
523	1/9/2012	13:30	LAM 10	11897	Water	7.3	2	0	11.75	8.11	2730	10.52	28	2	7	237	234

524	1/9/2012	12:55	LAM 11	16404	Water	7.3	2	0	9.49	7.66	567	12.37	18	2	1.306	1609
525	1/10/2012	11:25	LAM 12	11724	Water	9.3	2	1	9.93	8.01	556	9.6	36	2	0.081	26
526	1/10/2012	12:10	LAM 13	21016	Water	10.6	2	1	12.31	8.15	761	10.62	35	3	2.424	2109
527	1/10/2012	13:15	LAM 14	11896	Water	11.2	2	1	11.38	8.13	2050	10.85	59	3	24.959	111
528	1/10/2012	12:50	LAM 15	18759	Water	11.6	2	1	8.31	7.65	669	11.14	21	2	0.069	8

ID	Field Comments
481	Cloudy - drizzle - North wind - temperature in 30's (F). No flow. Pools upstream of bridge and downstrream of waterfall. Numerous swallows under bridge - do not know species. Rain in area the last two days.
482	Cloudy - drizzle - North wind - temperature in 30's (F). Small flow. Water clear with brown tinge. Pool above low-water bridge dark brown. Rain in area the last two days.
483	Cloudy - drizzle - North wind - temperature in 30's (F). No flow. Rain in area the last two days. Rain puddles on rock bottom - pools up and down stream
484	Cloudy - drizzle - North wind - temperature in 30's (F). Small flow. Water clear - attached algae. Flow through gravel bar above bridge - noticeable current coming out of gravel. Rain in area the above blast two days.
485	Cloudy - North wind -Water very turbid and milky brown. Rain in area the last two days.
486	Cloudy - few breaks in clouds. Water clear.
487	Cloudy and cold. Water somewhat turbid.
488	Cloudy - North wind. Water clear - little turbid.
489	Cloudy and cold. Waater a little turbid.
490	Cloudy - North wind. Water brown and turbid. Sampled at peak of storm event. Rain in area the last two days.
491	Cloudy- North wind. Water clear to slightly turbid. Rain in area the last two days.
492	Cloudy with peeks of sunshine. Water clear.
493	Cloudy. Water turbid - milky rown.
494	Cloudy - some sun. Water turbid - brown. School of carp in shallow water of pool above bridge.
495	Cloudy. Water turbid - milky brown.
514	Light rain. There may be a trickle of flow at the waterfall due to rain. Sampled pool by bridge. Water muddy.
515	Light rain and thunder. Water clear. Slight flow, could not be measured - neg. values.
516	Rain. No flow. Sampled pool above bridge - water turbid.
517	Light rain. Low flow. Water clear. Attached and floating algae. Water flowing under gravel above bridge.
518	Drizzle. Flow not measurable. Water clear. Cricket Frog.
519	Cloudy - partly cloudy. Water clear. Rained yesterday.
520	Cloudy with breaks in coverag - North wind. Water clear. Mallars downstream of bridge. Rained yesterday.
521	Mist. Water clear. Some attached algae. Spring next to bridge flowing.
522	Cloudy - north wind. Water clear. Flock of Mallards under bridge. Rained yesterday.
523	Cloudy. Water clear.
524	Cloudy. Water clear. Some attached algae.
525	Cloudy - partly cloudy. Water clear. Rained yesterday.

526 Partly cloudy to sunny _ north wind. Water clear. Rained yesterday.

527 Partly cloudy - sunny. Water clear - some turbidity. Small fish in shallows. Rained yesterday.

528 Partly cloudy - North wind. Water flowing through gravel bar above bridge.

ID	Lab Comments
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ID	End Date	Time	Sample Type	Field Comments	Lab Comments
1	1/19/2011	12:20	Fecal	Sheep sample, collected - 1 mile from Lampasas River, FM 1690 & FM581, Lat-31.25532, Long--98.11669 Samples on ground in bedding area. Sheep grazing on wheat or oats.	
2	1/19/2011	12:20	Fecal	Sheep sample, collected - 1 mile from Lampasas River, FM 1690 & FM581, Lat-31.25532, Long--98.11669 Samples on ground in bedding area. Sheep grazing on wheat or oats.	
3	1/19/2011	12:20	Fecal	Sheep sample, collected - 1 mile from Lampasas River, FM 1690 & FM581, Lat-31.25532, Long--98.11669 Samples on ground in bedding area. Sheep grazing on wheat or oats.	
4	1/19/2011	13:00	Fecal	Cow sample - Brangus Farm on CR 3712 off FM 1690 Lat. 31.24905 Lon. -98.13125 About 1/3 from Lampasas River. Calf in a pen - fresh sample off pipe fence.	
5	1/19/2011	13:15	Fecal	Cow sample - Brangus Farm on CR 3712 off FM 1690 Lat. 31.24981 Lon. -98.13556 Less than 1/3 from Lampasas River. Cattle feeding on hay. Sample on ground.	
6	1/19/2011	13:15	Fecal	Cow sample - Brangus Farm on CR 3712 off FM 1690 Lat. 31.24906 Lon. -98.13563 Less than 1/3 from Lampasas River. Cattle feeding on hay. Sample on ground.	
12	1/19/2011	14:45	Fecal	Goose samples taken in Brooks Park - Lampasas Lat. 31.05618 Lon. -98.18063 Near Sulphur Creek.	
13	1/19/2011	15:02	Fecal	Goose samples taken in Brooks Park - Lampasas Lat. 31.05618 Lon. -98.18063 Near Sulphur Creek.	
14	1/19/2011	15:02	Fecal	Goose samples taken in Brooks Park - Lampasas Lat. 31.05618 Lon. -98.18063 Near Sulphur Creek.	
64	3/1/2011	14:20	Fecal	Samples are from Whitetail Deer kept in large pens and are fed hay and feed. 77 deer in the pens and will release 50 of them on his hunting land. Rodney Parish Ranch - 8.5 miles west of Evant on CR 530. Lat 31.49343 Lon -98.29443	
65	3/1/2011	14:20	Fecal	Samples are from Whitetail Deer kept in large pens and are fed hay and feed. 77 deer in the pens and will release 50 of them on his hunting land. Rodney Parish Ranch - 8.5 miles west of Evant on CR 530. Lat 31.49343 Lon -98.29443	
66	3/1/2011	14:35	Fecal	Samples are from horse kept in corral - 8.5 miles west of Evant on CR 530. Lat 31.49343 Lon - 98.29443	
67	3/1/2011	14:35	Fecal	Samples are from horse kept in corral - 8.5 miles west of Evant on CR 530. Lat 31.49343 Lon - 98.29443	
68	3/1/2011	14:50	Fecal	Samples are from beef cattle(cow) at a feeding site - 8.5 miles west of Evant on CR 530. Lat 31.49343 Lon -98.29443	

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
69	3/1/2011	14:50	Fecal	Samples are from beef cattle (cow) at a feeding site - 8.5 miles west of Evant on CR. 530. Lat 31.49343 Lon -98.29443	
85	3/8/2011	11:30	Fecal	Beef cow. Samples from feeding area. Less than 1/2 mile from LAM 12 - less than 200 yards from Rocky Creek. Lat 30.983555 Lon.97.930988	
86	3/7/2011	10:15	Fecal	Beef cow. Taken on low water bridge at LAM 2. Free range area.	
87	3/7/2011	10:20	Fecal	Beef cow. Sample at side of CR 2901 about 1 mile south of LAM 2 near barn. Free range area. Lat 31.394862 Lon -98.228141	
91	3/8/2011	11:30	Fecal	Beef cow. Samples from feeding area. Less than 1/2 mile from LAM 12 - less than 200 yards from Rocky Creek. Lat 30.983555 Lon.97.930988	
92	3/8/2011	11:30	Fecal	Beef cow. Samples from feeding area. Less than 1/2 mile from LAM 12 - less than 200 yards from Rocky Creek. Lat 30.983555 Lon.97.930988	
137	4/4/2011	10:00	Fecal	Beef Cow. Under bridge at LAM 01 - less than 1 ft. from water. Hamilton, Co.	
138	4/5/2011	13:30	Fecal	Cliff Swallow samples from under Hwy 190 bridge over Lampasas R. - LAM14. Samples on broadleaf weed.	
139	4/5/2011	13:30	Fecal	Cliff Swallow samples from under Hwy 190 bridge over Lampasas R. - LAM14. Samples on broadleaf weed.	
140	4/5/2011	13:30	Fecal	Cliff Swallow samples from under Hwy 190 bridge over Lampasas R. - LAM14. Samples on broadleaf weed.	
165	4/27/2011	10:50	Fecal	Lam 09 bridge - CR3050. Cliff Swallow - sample on rocks under nest in shade.	
166	4/27/2011	10:50	Fecal	Lam 09 bridge - CR3050. Cliff Swallow - sample on rocks under nest in shade.	
167	4/27/2011	12:10	Fecal	Black Buzzard - feeding on road kill. CR 223 (Burnet Co.) near CR 224E Less than 1/2 mile from Lampasas River. Lat. 31.00817 Lon. -97.98331	
168	4/27/2011	12:10	Fecal	Black Buzzard - feeding on road kill. CR 223 (Burnet Co.) near CR 224E Less than 1/2 mile from Lampasas River. Lat. 31.00817 Lon. -97.98331	

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
178	5/8/2011	9:45	Fecal	Bradley Ware Ranch on the Lampasas River near Maxdale - at the end of Gann Branch Road. Lat. 30.99472 Lon. -97.84799 Squirrel - Was killed prior to my arrival, was still warm. It was cut open and feces was extracted from colon.	
179	5/4/2011	11:40	Fecal	Bradley Ware Ranch on the Lampasas River near Maxdale - at the end of Gann Branch Road. Beef cow Lat. 30.983782 Lon. 97.85486	
180	5/4/2011	11:40	Fecal	Bradley Ware Ranch on the Lampasas River near Maxdale - at the end of Gann Branch Road. Beef cow Lat. 30.983782 Lon. 97.85486	
181	5/4/2011	11:40	Fecal	Bradley Ware Ranch on the Lampasas River near Maxdale - at the end of Gann Branch Road. Beef cow Lat. 30.983782 Lon. 97.85486	
182	5/4/2011	12:25	Fecal	Bradley Ware Ranch on the Lampasas River near Maxdale - at the end of Gann Branch Road. Grey Fox Kit was taken from den - feces near anus collected. The fox was released. Lat. 30.991951 Lon. -97.848069	
198	5/9/2011	10:30	Fecal	Fresh Beef Cow sample near water at Lam 01. Lat.31.4802 Lon. -98.2735	
199	5/10/2011	10:20	Fecal	Raccoon scat on road shoulder 20 feet from Lam 07 bridge. Fresh sample - flies still on it.	
200	5/10/2011	12:33	Fecal	Beef Cow. Fort Hood in Bell County. Intersection of Mayberry Rd. and Ivy Mt. Rd. (Oakalla Rd.) near Reese Creek. Lat. 31.04253 Lon. -97.81866	
201	5/10/2011	12:33	Fecal	Beef Cow. Fort Hood in Bell County. Intersection of Mayberry Rd. and Ivy Mt. Rd. (Oakalla Rd.) near Reese Creek. Lat. 31.04253 Lon. -97.81866	
202	5/10/2011	12:33	Fecal	Beef Cow. Fort Hood in Bell County. Intersection of Mayberry Rd. and Ivy Mt. Rd. (Oakalla Rd.) near Reese Creek. Lat. 31.04253 Lon. -97.81866	
251	6/7/2011	10:40	Fecal	Cliff Swallow - Collected within seconds of dropping. Lam 12 - Rocky Creek Bridge. Burnet County.	
252	6/7/2011	12:40	Fecal	Cliff Swallow Collected from bed of truck parked under bridge, less than 30 minutes old. Lam 14 - Hwy 195 bridge. Bell County.	
253	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
254	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
255	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
256	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
257	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
258	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
259	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
260	6/13/2011	12:00	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
261	6/13/2011	13:50	Fecal	Cliff Swallow Lam 09 - CR 3050 Sulphur Creek Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Lampasas County.	
280	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
281	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
282	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
283	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
284	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
285	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
286	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
287	6/28/2011	10:35	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
288	6/28/2011	11:40	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
289	6/28/2011	11:40	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
290	6/28/2011	11:40	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
291	6/28/2011	11:40	Fecal	Cliff Swallow Lam 14 - Hwy 195 Lampasas River Bridge. Samples collected from plastic sheets under bridge where birds were nesting. The samples are less than 20 min. old when collected. Bell County.	
312	7/6/2011	13:05	Fecal	Wild Deer - Lam 15, Reese Creek bridge on FM 2670. On ground near road - still moist. Bell County.	
359	8/29/2011	9:00	Fecal	Property of Wayne Duncan Tower Hill Rd., Killeen 31.039559 -97.748674 Cow (Beef Master) fecal sample - on ground near hay feeding site.	
360	8/29/2011	9:10	Fecal	Property of Wayne Duncan Tower Hill Rd., Killeen 31.039559 -97.748674 Cow (Beef Master) fecal sample - on ground near water source.	
361	8/29/2011	9:20	Fecal	Property of Wayne Duncan Tower Hill Rd., Killeen 31.039559 -97.748674 Cow (Beef Master) fecal sample - on ground in hay pile.	
362	8/29/2011	11:15	Fecal	Property of Wayne Duncan About a mile upstream from Lam 13 - 50 yds. From Clear Creek. 31.02095 - 97.89053 Raccoon fecal sample - on ground - had been feeding on seeds and fruit.	
363	8/30/2011	11:20	Fecal	Four miles west of the City of Lampasas on FM 580-Ellis Property. 31.07549 -98.25311. Cow fecal sample in shaded area. Cows feeding on dry grass and hay	
364	8/30/2011	11:25	Fecal	Four miles west of the City of Lampasas on FM 580-Ellis Property. 31.07549 -98.25311. Cow fecal sample in shaded area. Cows feeding on dry grass and hay	
365	8/30/2011	11:26	Fecal	Four miles west of the City of Lampasas on FM 580-Ellis Property. 31.07549 -98.25311. Cow fecal sample in sunny area. Cows feeding on dry grass and hay	
366	8/30/2011	11:30	Fecal	Four miles west of the City of Lampasas on FM 580-Ellis Property. 31.07549 -98.25311. Horse fecal sample. Horses feeding on dry grass and hay	

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
367	8/30/2011	11:30	Fecal	Four miles west of the City of Lampasas on FM 580-Ellis Property. 31.07549 -98.25311. Horse fecal sample. Horses feeding on dry grass and hay	
368	8/30/2011	11:35	Fecal	Four miles west of the City of Lampasas on FM 580-Ellis Property. 31.07549 -98.25311. Horse fecal sample. Horses feeding on dry grass and hay	
423	10/10/2011	11:40	Fecal	Deer. Sample on ground at Lam 04 - Simms Creek at HWY 281	
529	1/16/2012	9:00	Fecal	Coyote (male) caught in Trap by USDS Wildlife Service Trapper. Four miles North of Adamsville in Lampasas County in Freeman Branch area. Lat. 31.35665 Lon. -98.15347	
530	1/16/2012	10:00	Fecal	Feral Hog (female) caught in Trap by USDS Wildlife Service Trapper. Four miles North of Adamsville in Lampasas County in Freeman Branch area. Lat. 31.37312 Lon. -98.16522	
531	1/16/2012	10:10	Fecal	Feral Hog (male) caught in Trap by USDS Wildlife Service Trapper. Four miles North of Adamsville in Lampasas County in Freeman Branch area. Lat. 31.37312 Lon. -98.16522	
532	1/16/2012	4:08	Fecal	Coyote caught in Trap by USDS Wildlife Service Trapper. Two mile east of Lampasas in Lampasas County in Sulphur Creek area. Crawford Ranch. Lat. 31.02413 Lon. -98.06939 (Degrees, Minutes, Seconds)	
533	1/17/2012	2:32	Fecal	Feral Hog (male) caught in Trap by USDS Wildlife Service Trapper. Two miles West of Adamsville in Lampasas County in Turkey Creek area. Lat. 31.20725 Lon. -98.14311 (Degrees, Minutes, Seconds)	
534	1/18/2012	8:30	Fecal	Coyote caught in Trap by USDS Wildlife Service Trapper. Four miles Northt of Kempner in Lampasas County in Lampasas River area. 31.09512 -98.01544	
535	1/18/2012	8:45	Fecal	Coyote caught in Trap by USDS Wildlife Service Trapper. Four miles Northt of Kempner in Lampasas County in Lampasas River area. 31.09512 -98.01544	
554	1/22/2012	9:30	Fecal	Coyote caught in Trap by USDS Wildlife Service Trapper. Race Ranch in Lampasas County, 2 miles north of Adamsville on Freeman Branch. Lat. 31.21642 Lon. -98.09490 (Degrees, Minutes, Seconds)	
555	1/23/2012	10:00	Fecal	Gray Fox caught in Trap by USDS Wildlife Service Trapper.(female) Five miles northeast of Lampasas in Lucy Creek area. Lampasas County.	
556	1/23/2012	10:10	Fecal	Gray Fox caught in Trap by USDS Wildlife Service Trapper (male). Five miles northeast of Lampasas in Lucy Creek area. Lampasas County.	
557	1/23/2012	8:30	Fecal	Deer collected by USDS Wildlife Service Trapper. Nine miles west of Adamsville in Sims Creek area. Lampasas County.	

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
558	1/24/2012	7:30	Fecal	Coyote caught in Trap by USDS Wildlife Service Trapper. Garder Ranch. Nine miles north of Kempner. Lampasas County. Lat. 31 09.385 Lon. -98 01.944	
559	1/25/2012	1:25	Fecal	Coyote (male) caught in Trap by USDS Wildlife Service Trapper. Crawford Ranch. Two miles east of Lampasas in Sulphur Creek area. Lampasas County. Lat. 31 03.049 -98 07.360	
560	1/31/2012	6:30	Fecal	Coyote (male) caught in Trap by USDS Wildlife Service Trapper. Two miles east of Lampasas in Sulphur Creek area. Lampasas County. Lat. 31 02.049 -98 06.405	
561	1/31/2012	7:08	Fecal	Coyote (female) caught in Trap by USDS Wildlife Service Trapper. Two miles east of Lampasas in Sulphur Creek area. Lampasas County. Lat. 31 02.651 Lon. -98 06.405	
562	1/31/2012	9:35	Fecal	Feral Hog (male) caught in Trap by USDS Wildlife Service Trapper. . Five miles east of Lometa in School Creek area. Lampasas County. Lat. 31 18.846 -98 34.657	
563	1/31/2012	9:55	Fecal	Feral Hog (female) caught in Trap by USDS Wildlife Service Trapper. Five miles east of Lometa in School Creek area. Lampasas County. Lat. 31 18.773 -98 35.674	
564	2/5/2012	10:30	Fecal	Feral Hog (female) caught in Trap by USDS Wildlife Service Trapper. Nance Ranch 8 miles south of Adamsville in Lampasas County - School Creek area.	
565	2/6/2012	9:50	Fecal	Coyote (male) caught in Trap by USDS Wildlife Service Trapper. Six miles east of Lometa in Lampasas County - School Creek area.	
566	2/7/2012	14:00	Fecal	Feral Hog caught in Trap by USDS Wildlife Service Trapper. Birchfield Ranch 5 miles north of Lometa in Simms Creek area. Lampasas County. Lat. 31 16.292 -98 24.695	
567	2/7/2012	14:00	Fecal	Feral Hog caught in Trap by USDS Wildlife Service Trapper. Birchfield Ranch 5 miles north of Lometa in Simms Creek area. Lampasas County. Lat. 31 16.292 -98 24.695	
568	2/7/2012	14:00	Fecal	Feral Hog caught in Trap by USDS Wildlife Service Trapper. Birchfield Ranch 5 miles north of Lometa in Simms Creek area. Lampasas County. Lat. 31 16.292 -98 24.695	
570	2/14/2012	12:35	Fecal	Coyote (male) caught in Trap by USDS Wildlife Service Trapper. Five miles south of Lampasas in Lampasas County - Donalson Creek area. Lat. 31.08721 Lon. -98.29381	
571	2/15/2012	11:15	Fecal	Raccon (male) caught in Trap by USDS Wildlife Service Trapper. Seven miles south of Lometa in Lampasas County - School Creek area. Lat. 31.24765 Lon. -98.30785	
572	2/22/2012	8:58	Fecal	Feral Hog caught in Trap by USDS Wildlife Service Trapper. Race Ranch in Lampasas County, 5 miles north of Adamsville. Lat. 31.21665 Lon. -98.09866 (Degrees, Minutes, Seconds)	

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
573	2/21/2012	9:15	Fecal	Feral Hog (male) caught in Trap by USDS Wildlife Service Trapper. Five miles north ofLomete in School area. Lat. 31.18931 Lon. -98.35750	
582	2/29/2012	9:12	Fecal	Coyote (male) caught in Trap by USDS Wildlife Service Trapper. Five miles north of Adamsville in Lampasas County - Freeman Branch area. Lat. 31.20146 Lon. -98.09875	
583	2/28/2012	8:00	Fecal	Coyote (female) caught in Trap by USDS Wildlife Service Trapper. Three miles east of Lampasas in Lampasas County - Suphur Creek area. Lat. 31.02054 Lon. -98.07543	
584	2/29/2012	8:35	Fecal	Coyote (male) caught in Trap by USDS Wildlife Service Trapper. Three miles east of Lampasas in Lampasas County - Suphur Creek area. Lat. 31.02054 Lon. -98.07543	
62	3/1/2011	11:20	Sewage Septic Tank	Sample taken from S & M Vacuum & Waste pump truck. Sewage from 1st Baptist Church of Kempner. The sewage was in the truck about two hours before sampling. Lat 31.081755 Lon -97.003765 (Church) Lat 31.08155 Lon -97.57341 (S&M)	
63	3/1/2011	11:20	Sewage Septic Tank	Sample taken from S & M Vacuum & Waste pump truck. Sewage from 1st Baptist Church of Kempner. The sewage was in the truck about two hours before sampling. Lat 31.081755 Lon -97.003765 (Church) Lat 31.08155 Lon -97.57341 (S&M)	
209	5/18/2011	13:00	Sewage Septic Tank	S & M Vacuum & Waste Farm -Nolanville - Pump Truck - Pumped aerobic system in Harker Heights in Comanche Gap area, less than mile from Stillhouse Hollow Reservoir. Lat. 31.043639 Lon. -97.619306	
210	5/18/2011	13:00	Sewage Septic Tank	S & M Vacuum & Waste Farm -Nolanville - Pump Truck - Pumped aerobic system in Harker Heights in Comanche Gap area, less than mile from Stillhouse Hollow Reservoir. Lat. 31.043639 Lon. -97.619306	
211	5/18/2011	13:00	Sewage Septic Tank	S & M Vacuum & Waste Farm -Nolanville - Pump Truck - Pumped aerobic system in Harker Heights in Comanche Gap area, less than mile from Stillhouse Hollow Reservoir. Lat. 31.043639 Lon. -97.619306	
7	1/19/2011	14:45	Sewage Wastewater	Lampasas Wastewater Treatment Plant - Pre U.V. treatment sample Lat. 31.06875 Lon. -98.169597 Discharged into Sulphur Creek.	Plated onto mTec agar prior to shipment to El Paso
8	1/19/2011	14:45	Sewage Wastewater	Lampasas Wastewater Treatment Plant - Pre U.V. treatment sample Lat. 31.06875 Lon. -98.169597 Discharged into Sulphur Creek.	Plated onto mTec agar prior to shipment to El Paso
9	1/19/2011	14:45	Sewage Wastewater	Lampasas Wastewater Treatment Plant - Pre U.V. treatment sample Lat. 31.06875 Lon. -98.169597 Discharged into Sulphur Creek.	Plated onto mTec agar prior to shipment to El Paso
10	1/19/2011	14:45	Sewage Wastewater	Lampasas Wastewater Treatment Plant - Pre U.V. treatment sample Lat. 31.06875 Lon. -98.169597 Discharged into Sulphur Creek.	Plated onto mTec agar prior to shipment to El Paso
11	1/19/2011	14:45	Sewage Wastewater	Lampasas Wastewater Treatment Plant - Pre U.V. treatment sample Lat. 31.06875 Lon. -98.169597 Discharged into Sulphur Creek.	Plated onto mTec agar prior to shipment to El Paso
88	3/7/2011	11:50	Sewage Wastewater	Lampasas Waste Water Plant Lat 31.06875 Lon -98.169597 Samples taken from aerator - first step past screening. Discharges into Sulphur Creek. Discharges 800,000 - 900,000 gal/day. Sample from different dips.	25 microliters plated onto mTec agar for to shipment to El Paso

ID	End Date	Time	Sample Type	Field Comments	Lab Comments
89	3/7/2011	11:50	Sewage Wastewater	Lampasas Waste Water Plant Lat 31.06875 Lon -98.169597 Samples taken from aerator - first step past screening. Discharges into Sulphur Creek. Discharges 800,000 - 900,000 gal/day. Sample from different dips.	25 microliters plated onto mTec agar for to shipment to El Paso
90	3/7/2011	11:50	Sewage Wastewater	Lampasas Waste Water Plant Lat 31.06875 Lon -98.169597 Samples taken from aerator - first step past screening. Discharges into Sulphur Creek. Discharges 800,000 - 900,000 gal/day. Sample from different dips.	25 microliters plated onto mTec agar for to shipment to El Paso
156	4/26/2011	11:00	Sewage Wastewater	Copperas Cove South WWP. 2711 Big Valley Rd. Lat. 31.094077 Lon. -97.908216 Discharge into Clear Creek. Sample taken before treatment. Each sample a separate dip.	25 µl of sample plated on mTec agar.
157	4/26/2011	11:00	Sewage Wastewater	Copperas Cove South WWP. 2711 Big Valley Rd. Lat. 31.094077 Lon. -97.908216 Discharge into Clear Creek. Sample taken before treatment. Each sample a separate dip.	25 µl of sample plated on mTec agar.
158	4/26/2011	11:00	Sewage Wastewater	Copperas Cove South WWP. 2711 Big Valley Rd. Lat. 31.094077 Lon. -97.908216 Discharge into Clear Creek. Sample taken before treatment. Each sample a separate dip.	25 µl of sample plated on mTec agar.