Float Fest Water Quality Report

Methods

In order to assess whether the high volume of tubers on the San Marcos River during Float Fest was having measureable impacts on water quality, a water quality monitoring plan was established, and water samples were taken before, during, and after Float Fest.

Monitoring took place at two locations on the San Marcos River (Fig. 1). The first site was at the Old Bastrop Highway Crossing (Fig. 2). This site was the location where the tubing outfitters dropped off tubers, and was chosen because of the anticipated high traffic during Float Fest. The Old Bastrop Highway Crossing is a single lane bridge over the San Marcos River. The river banks are lined with Cypress Trees, and there is a gravel bed on the south side of the river, downstream of the road. The water quality monitoring took place in flowing water off of the gravel bed.

The second site was located at the Scull Road Crossing of the San Marcos River near Martindale, TX (Fig. 3). This site was approximately 5.8 km downstream of the Old Bastrop Highway site, and was 2.5 km downstream of the tubing outfitters where the tubers takeout. This site was chosen because of its location downstream of where the tubers exit the river, and was therefore assumed to not have the high traffic of the upstream site. The Scull Road Crossing is a single lane bridge over the San Marcos River. The banks on both sides of the river are steep, and lined with cypress trees. There is a small log jam downstream of the bridge. The water quality monitoring took place on the south bank of the river, upstream of the bridge.

Both of these sites were monitored three times for this project. The first monitoring date was Thursday, August 28, 2014. This date was chosen because it was the last weekday before the Labor Day weekend, and was assumed to have less recreational traffic on the river than Friday through Monday. The second date for monitoring was Sunday, August 31, 2014. This was the anticipated day of peak traffic on the river due to the scheduled Float Fest. The third monitoring date was Tuesday, September 2, 2014. This date was chosen to capture the water quality immediately after the high recreation traffic on the river due to Float Fest and Labor Day. Monitoring for both sites was done in the afternoon, between 1400 and 1700, for all three days.

Temperature, pH, conductivity, and dissolved oxygen were measured *in situ* with a HydroLab MS 5 Multi-parameter sonde. A transparency tube was used to measure water clarity. The transparency tube is a 120 cm clear plastic tube with a 5 cm Secchi disk on the bottom. Water is poured into the tube and the observer holds the tube upright and opens a spout on the bottom that releases water. The observer looks down the tube and stops the release of water once the Secchi disk on the bottom becomes visible. The observer then looks at the water level in the tube to determine the water clarity which is recorded in centimeters.

E. coli bacteria counts were measured using Coliscan Easygel™. Coliscan Easygel is a U.S. Environmental Protection Agency approved method of collecting E. coli samples for citizen science

projects. It is the adopted protocol for bacterialogical monitoring of freshwater by Texas Stream Team – a citizen science network that monitors water bodies in Texas[1]. Samples were collected in 100 mL bottles and returned to the lab where they were plated and incubated for 28 hours at 33°C according to protocol. The E. coli numbers were recorded as colony forming units per 100 mL (CFU/100 mL).

Samples were collected at each site, and taken back to the lab for analysis of total suspended solids (TSS) and ammonia. The samples were analyzed by the Edwards Aquifer Research and Data Center (EARDC) at Texas State University – San Marcos. EARDC is an accredited lab under the National Environmental Laboratory Accreditation Program (NELAP). The total dissolved solids samples were analyzed according to method M2540D-2005. The ammonia samples were analyzed according to method E350.1 and the Limit of Quantification LOQ for the ammonia test was 0.45 mg/L.

The results of the water quality monitoring for each day were compared to the historical medians of the parameters for each site. The source for the historical data at the Old Bastrop Highway Crossing was the Guadalupe Blanco River Authority which has monitored this location on a quarterly basis since 2003 as part of The Clean Rivers Program. The results of GBRA's monitoring are reported in the 2013 Clean Rivers Program Basin Summary Report for the Guadalupe River and Lavaca-Guadalupe Coastal Basins. The source for the historical data at the Scull Road Crossing was a dataset of water quality collected by citizen scientists with Texas Stream Team. Trained citizen scientists have been collecting water quality data at this location, under an EPA approved protocol, on a monthly basis since 1995. The citizen scientists who monitor the Scull Road Crossing were not trained to collect E. coli samples, and Texas Stream Team does not have an approved method for measuring TSS, so the historical medians of these two parameters were from the data collected by GBRA at the Old Bastrop Highway Crossing site.

Results

Old Bastrop Highway Crossing

The results for the water quality monitoring at the Old Bastrop Highway are summarized in Table 1. The conductivity measurements at this site were slightly above the historical mean of 596 µS/cm. There was little variation in the conductivity measurements. The minimum measurement was recorded on 8/28/2014 and was 613 µS/cm. The maximum measurement was recorded on the day after Float Fest, 9/2/2014, and was 644 µS/cm. The dissolved oxygen measurements at this site did not vary far from the historical median. The median of the 3 days of sampling exactly matched the historical median of 9.2 mg/L for this site. The minimum DO measurement of 8.8 mg/L was recorded on the day of Float Fest and a maximum measurement of 9.9 mg/L was recorded on 8/28/2014. Likewise, the median pH for the 3 days of sampling was exactly the same as the historical median of 7.9. The minimum pH was taken post- Float Fest, on 9/2/2014, and was 7.7. The maximum pH was 8.0 and was recorded pre-Float Fest, on 8/28/2014. A geometric mean of E. coli from historical record was used to compare the E. coli measurements taken during the 3 days of the project. The E. coli geomean for the site at the Old Bastrop Highway was 107 CFU/100 mL. The pre-Float Fest sample had the highest concentration of E. coli at 231 CFU/100 mL. The sample taken on the day of Float Fest had

the lowest E. coli concentration at 33 CFU/100 mL. The E. coli concentration on the day after Float Fest was 198 CFU/100 mL at the Old Bastrop Highway Crossing. The water clarity at this site, measured via a transparency tube, was 90 cm before Float Fest. On the day of Float Fest, the water clarity dropped to 79 cm. The water clarity on the day following Float Fest increased to 97 cm. There was no historical data of water clarity available for comparison, because the GBRA did not measure water clarity as part of the monitoring plan for this location. The total suspended solids concentration pre-Float Fest was 5.1 mg/L. The TSS concentration increased to 28.0 mg/L on the day of Float Fest, and then decreased to 7.0 mg/L post- Float Fest, which was the same as the historical median for TSS at this location. The ammonia concentrations for all 3 monitoring events at this site were below the Limit of Quantification of 0.45 mg/L.

Scull Road Crossing

The results for water quality monitoring at the Scull Road Crossing are summarized in Table 1. The conductivity measurements at this site were slightly above the historical median of 590 µS/cm. The minimum conductivity was taken post- Float Fest and was 612 µS/cm. The maximum conductivity was taken during Float Fest, and was 615 µS/cm. The dissolved oxygen concentrations that were recorded at this site were all higher than the historical median of 8.0 mg/L. The maximum DO concentration was recorded post – Float Fest, and was 11.6 mg/L. The minimum DO concentration was recorded pre-Float Fest, and was 9.8 mg/L. The historical median pH at this site was 7.7. This was very similar to the 3 pH measurements taken for this project. The pH varied between a minimum of 7.9 on both 8/31/2014 and 9/2/2014, and a maximum of 8.0 taken on 8/28/2014. A geometric mean of E. coli from historical record was used to compare the E. coli measurements taken during the 3 days of the project. The citizen scientists who collected water quality data at the Scull Road Crossing were not trained in E. coli sampling, so the geometric mean used for comparison came from GBRA's data from the Old Bastrop Highway site, which was 107 CFU/100 mL. The E. coli concentration on 8/28/2014 was 182 CFU/100 mL. The E. coli concentration dropped to 17 CFU/100 mL on the day of Float Fest, and the E. coli concentration was 33 CFU/100 mL post-Float Fest. The water clarity at the Scull Road Crossing was 115 cm before Float Fest. The clarity dropped slightly to 110 cm on the day of Float Fest, and then it increased back up to 115 cm post-Float Fest. There was no historical median for total suspended solids for this site, because Texas Stream Team citizen scientists do not have a protocol for measuring TSS. The historical median for TSS came from GBRA's monitoring at the Old Bastrop Highway location and it was 7.0 mg/L. The TSS concentration pre-Float Fest was 2.5 mg/L. The TSS concentration increased to 5.0 mg/L on the day of Float Fest, and then it decreased back to 2.5 mg/L post-Float Fest. The ammonia concentrations for all 3 monitoring events at this site were below the Limit of Quantification of 0.45 mg/L.

Discussion

The pH for both sites remained near the historical medians before, during, and after Float Fest. The dissolved oxygen at the Old Bastrop Highway site was also near the historic median for all three monitoring events. The dissolved oxygen at the Sculls Road Crossing was higher than the historical median for all three monitoring events. This may be due to the fact that the DO was sampled in the

afternoon for the purpose of this study, whereas the site is traditionally monitored during the morning hours when DO concentrations are lowest due to diurnal fluctuations.

E. coli bacteria is found in the feces of endothermic organisms. The particular strain of E. coli that is measured for water quality analysis does not make people sick, but it is used as an indicator that fecal matter, which may contain pathogens and parasites is present in the water.[2] The standard for contact recreation set by TCEQ for the San Marcos River is a geometric mean of 126 CFU/100 mL.[3] Sources of E. coli in surface waters are runoff containing feces of pets and wildlife, faulty septic tanks and sewer lines, waste water treatment plants, and waterfowl.[4] The highest E. coli counts during the study for both the Old Bastrop Highway and Scull Road Crossing occurred during the pre-Float Fest monitoring event with 231 CFU/100 mL and 182 CFU/100 mL respectively. The E. coli monitoring for this study was likely confounded by a sewage line that was broken during construction. An estimated 25,000 gallons of raw sewage spilled from the break on the morning of August 28, 2014 – the day of the first monitoring event.[5] An unknown amount of sewage entered the San Marcos River upstream of the monitoring sites. The lowest E. coli counts for both sites occurred during Float Fest when the E. coli was 33 CFU/100 mL at Old Bastrop Highway and 17 CFU/100 mL at Scull Road Crossing. By this time, any remaining sewage in the water may have already been flushed out. The E. coli concentration increased slightly at Scull Road Crossing on the third monitoring event, but it increased sharply to 198 CFU/100 mL at Old Bastrop Highway, this could have been from residual sewage in the area, but it could also have been due to runoff from several short rain events that occurred over Labor Day Weekend.

The ammonia concentration for all three monitoring events at both sites was below the lab's Limit of Quantification of 0.45 mg/L. Therefore, no increase or decrease in ammonia could be ascertained for this study.

Conductivity, or specific conductance, is the ability of water to conduct an electrical current. Conductivity is an indirect measurement of the total dissolved solids (TDS) present in water. Dissolved solids are compounds that break into their ionic components in the presence of a solvent, in this case, water. The positively and negatively charged ions in the water are what allow the electrical current to pass through, and the more dissolved solids in a sample, the higher the conductivity.[6]

The Texas Commission on Environmental Quality (TCEQ) does not set a standard for conductivity, but there are standards set for TDS. The standard TDS concentration on the San Marcos River is 400 mg/L.[7] TDS concentrations can be estimated by multiplying the conductivity in µS/cm by 0.65 to give a TDS value in mg/L.[8] Therefore, a TDS concentration of 400 mg/L would be equivalent to a conductivity value of 615 µS/cm. The historical medians at both sites were slightly below this value. The conductivity for all three monitoring events at Scull Road Crossing were at, or slightly below, this value as well. The conductivity at Old Bastrop Highway was slightly below 615 µS/cm for the pre-Float Fest monitoring event, but the conductivity was slightly above 615 µS/cm on the day of Float Fest and post Float Fest.

The historical medians for conductivity at both of these sites suggest that the TDS concentration on this stretch of the San Marcos River is at or approaching the standard for TDS set by TCEQ. The Lower

San Marcos River is currently not listed on the state's 303(d) list of impairments for TDS, although the Upper San Marcos, from Spring Lake to the confluence with the Blanco River, is.[9] Sources of TDS can be effluent from waste water treatment plants, nutrients from fertilizers, and dissolved solids in sediments that runoff land into the river.[10] An important source of TDS in the San Marcos River is the naturally occurring dissolved mineral load as the water comes out of the Edwards Aquifer[11]. This spring water is already high in dissolved solids, and the introduction of a small amount from anthropogenic sources could cause the water to exceed the TDS standard. Bank erosion, both naturally occurring and enhanced by high densities of people entering and exiting the river, can also increase loading of TDS, although the main impact of erosion is increased TSS loading.[12]

There was very little deviation in conductivity before, during, and after Float Fest at the downstream site, but there was a small increase of 4.4% in conductivity on the day of Float Fest at the upstream site where people were entering the river. This increase in conductivity translates into an estimated increase of 17.6 mg/L of TDS. This may be attributed to large numbers of people entering the water and causing bank erosion, which could increase the TDS loading. Although the TDS increase was small, a small amount of TDS loading from terrestrial runoff or erosion can cause the river to exceed the TDS standard, because the water of the San Marcos is already near the standard of 400 mg/L.

The conductivity at the Old Bastrop Highway Crossing increased during Float Fest, and stayed elevated for the Post-Float Fest monitoring event, whereas other parameters that seemed to be impacted by large numbers of people in the river returned to pre-Float Fest conditions by the third monitoring event. Water clarity at Old Bastrop Highway Crossing decreased from 90 cm pre-Float Fest to 79 cm during Float Fest, and then increased to 97 cm post-Float Fest. The decrease in water clarity for the Scull Road Crossing was less pronounced. Water clarity went from 115 cm pre-Float Fest to 110 cm during Float Fest, and then returned to 115 cm post-Float Fest. The concentration of Total Suspended Solids (TSS) at the Old Bastrop Highway Crossing increased 449%; from 5.1 mg/L pre-Float Fest to 28.0 mg/L during Float Fest. The TSS concentration at this site then decreased to 7.0 mg/L post-Float Fest which is the same as the historical median. The TSS concentration at the Scull Road Crossing increased 100% from 2.5 mg/L to 5.0 mg/L on Float Fest, and then decreased to 2.5 mg/L post-Float Fest.

Total suspended solids is the measurement of particles suspended in the water column. The sources of TSS can include sediment runoff, erosion, and re-suspension of sediment in the river.[13] The results of the monitoring in this project provide strong evidence that the large number of people using the river during Float Fest led to measureable impacts in TSS concentrations in the San Marcos River. The increase in TSS concentrations could be due to loading of sediments from bank erosion, or the disturbing of the river bottom from a high number of people in the water, but most likely a combination of both. This corresponded with a decrease in water clarity during Float Fest. Increased suspended solids in the water column due to disturbing the river bottom or sedimentation can clog gills of fish, crustaceans, and aquatic insects and can also suffocate eggs and aquatic insect larvae.[14] Sedimentation or disturbing the river bottom can also release pollutants into the water column that were attached to the sediments, or re-suspended after settling to the river bottom.[15] While there is evidence that the large number of people in the river led to changes in water quality with regard to water clarity and suspended solids, the impact was apparently temporary. TSS and water clarity

returned to normal by the third monitoring event as the suspended particles settled to the bottom, or were flushed out, after the recreational use of the river decreased.

This was the inaugural year of Float Fest, and it is expected that this event will continue annually, during the Labor Day Weekend. If this is the case, then a standard monitoring plan for collecting data on water quality in the San Marcos should be established to inform stakeholders of any impacts to the water that occur. This initial study should be used as the model for any future data collection that occurs during Float Fest. A few changes can also be made to improve upon this monitoring plan.

Monitoring before, during, and after Float Fest provided a good model for identifying any immediate changes to water quality that occurred during the time when a large volume of tubers enter the water. Future monitoring events should also include an upstream and downstream site. The Old Bastrop Highway Crossing should be considered as a monitoring location because this is where a large percentage of the tubers enter the river. The long term monitoring dataset from this location also provides useful baseline data for a comparison analysis. The Scull Road Crossing is also a prime location to monitor. This site receives less traffic as the Old Bastrop Highway Crossing because it is downstream of the exit for many of the tubers, which makes this location useful for comparing to a site with heavier traffic. The long-term monitoring by citizen scientists at this site also provides useful baseline water quality conditions for a comparison.

Additional sites could also be considered for future monitoring. This may be difficult to achieve due to the lack of public access between the two sites that were monitored, but prior permission to access private property may be achieved beforehand. It may also be possible to collect samples at the exit location of the tubing outfitters on the river, but permission would have to be granted by the outfitters. A kayaker may be able to traverse this stretch of river during the event and take samples from multiple locations. Such an intensive survey of the river during Float Fest may not be practical, however, because the congestion on the river could make navigating a kayak difficult.

A 24 hour monitoring project could be established at the Old Bastrop Highway Crossing for future events. A team of monitors could be organized to sample the water on an hourly basis. Alternatively, an autosampler could be used to collect samples at a predetermined time increment. This type of monitoring could capture changes to the water quality on a finer, temporal scale. A count of tubers passing the monitoring location during each hourly sample could be used to correlate the number of tubers with changes in water quality. A project such as this could answer questions regarding how many people it takes to make a noticeable change in water quality, and how long it takes for the water quality to return to normal conditions. Hourly monitoring such as this requires more manpower to collect the data, and the increase in samples would mean the project would be much more expensive to analyze the TSS and ammonia in the laboratory.

The ammonia samples collected during this study were all below the LOQ of 0.45 mg/L. The screening level for ammonia on the San Marcos River is 0.33 mg/L.[16] It is impossible to know whether the ammonia levels during the monitoring exceeded this screening level or not. Future samples of ammonia should be sent to a NELAP certified lab with a LOQ below the 0.33 mg/L screening level.

The Coliscan Easygel method of measuring E. coli was used because the EARDC Lab where the TSS and ammonia samples were analyzed was closed over Labor Day Weekend. The method of measuring E. coli employed by EARDC requires that the samples be analyzed within 8 hours of capture. This method is more rigorous than the Coliscan Easygel Method, but it was not possible for this study. Future studies could make an arrangement for a NELAP certified lab to accept E. coli samples over the Labor Day Weekend.

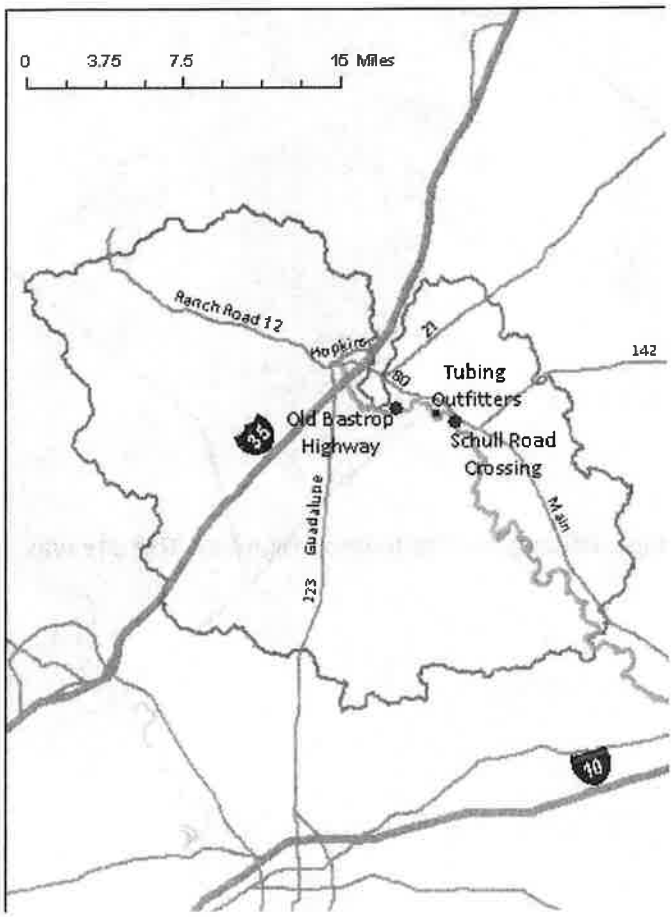

Figure 1: Map of the San Marcos River, the monitoring locations and the location of the tubing outfitters.

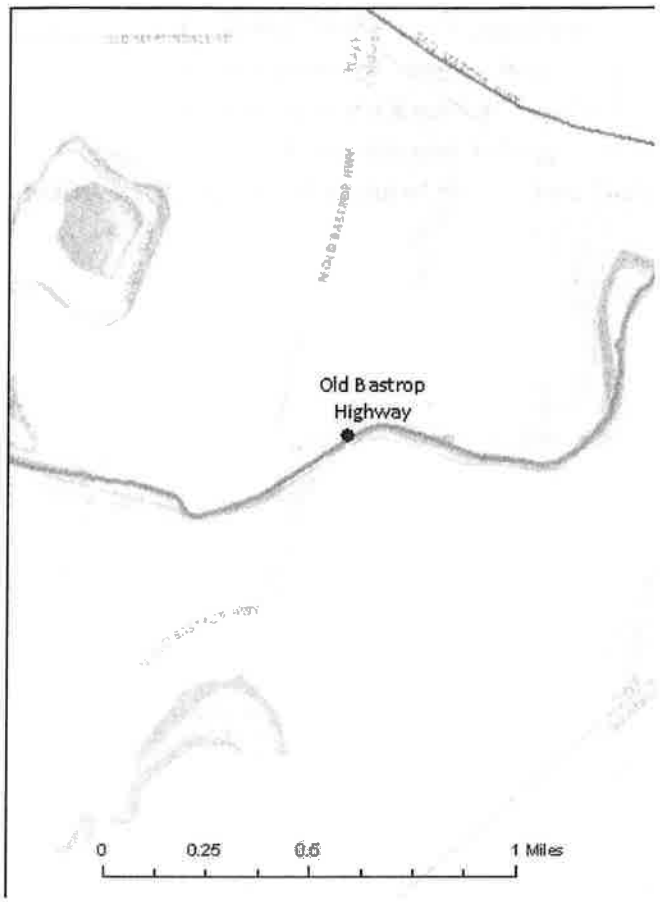

Figure 2: Location of the site upstream of the tubing outfitters, on Old Bastrop Highway. This site was where many of the tubers entered the water.

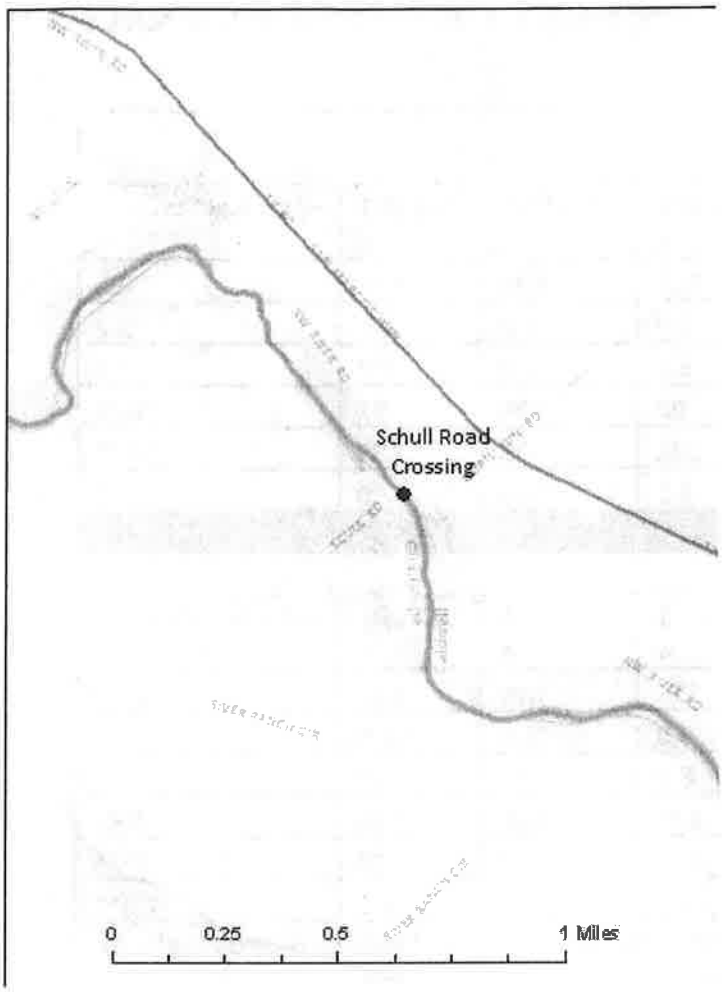

Figure 3: Location of the downstream site at Scull Road Crossing. This site was downstream of the tubing outfitters.

Table 1: Water quality parameters collected before, during, and after Float Fest, and compared to the historical medians for each site.

San Marcos at Old Bastrop Highway				
	8/28/2014	8/31/2014	9/2/2014	Historical Median
Conductivity (µS/cm)	613	640	644	596
Dissolved Oxygen (mg/L)	9.9	8.8	9.2	9.2
pH (su)	8.0	7.9	7.7	7.9
Transparency Tube (cm)	90	79	97	N/A
E. coli (CFU/100 mL)	231	33	198	107*
Total Suspended Solids (mg/L)	5.1	28.0	7.0	7.0
San Marcos at Scull Rd. Crossing				
	8/28/2014	8/31/2014	9/2/2014	Historical Median
Conductivity (µS/cm)	613	615	612	590
Dissolved Oxygen (mg/L)	9.8	11.0	11.6	8.0
pH (su)	8.0	7.9	7.9	7.7
Transparency Tube (cm)	115	110	115	N/A
E. coli (CFU/100 mL)	182	17	33	107*
Total Suspended Solids (mg/L)	2.5	5.0	2.5	7.0**

* E.coli represented as the geometric mean from the GBRA dataset of the Old Bastrop Highway Crossing.

** Total Suspended Solids historical median from the GBRA dataset of the Old Bastrop Highway Crossing.

References

1. Texas Stream Team Water Quality Monitoring Manual. 2010. Texas State University – San Marcos
2. Monitoring and Assessing Water Quality – Volunteer Monitoring: Chapter 5.11 Fecal Bacteria. 2012. United States Environmental Protection Agency.
3. Texas Surface Water Quality Standards – Chapter 307. 2014. Texas Commission on Environmental Quality.
4. Monitoring and Assessing Water Quality – Volunteer Monitoring: Chapter 5.11 Fecal Bacteria. 2012. United States Environmental Protection Agency.
5. "Sewage Spills Into San Marcos River" *San Marcos Daily Record.* August 28, 2014.
6. Monitoring and Assessing Water Quality – Volunteer Monitoring: Chapter 5.9 Conductivity. 2012. United States Environmental Protection Agency.
7. Texas Surface Water Quality Standards – Chapter 307. 2014. Texas Commission on Environmental Quality.
8. 2013 Clean Rivers Program Basin Summary Report. 2014. Guadalupe Blanco River Authority.