AN INTERACTIVE MAP FOR THE LONGHORN STREAM TEAM CITIZEN'S SCIENCE INITIATIVE

December 7, 2018

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GIS in Water Resources Term Project Report | The University of Texas at Austin

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Background and Objectives

The Longhorn Stream Team is an organization on the University of Texas at Austin campus and a partner of the Texas Stream Team. This program is overseen by the Meadows Center for Water and the Environment, which is in turn supported by the Texas Commission for Environmental Quality and the Environmental Protection Agency. The stream team collects water quality monitoring data at designated points on rivers around Texas including the Colorado, Pedernales, Guadalupe, Frio and the Rio Grande in Big Bend. The mission of the stream team is to promote understanding and protection of Texas waterways and to train fellow Texas citizens to engage in water quality monitoring through citizen science initiatives. This citizen scientist initiative is important for having a long-term data set of the water quality of Texas rivers. However, citizen science initiatives require organization and engagement in order to remain effective and for the data to be useful.

Figure 1:Members of the Longhorn Stream Team collecting water quality samples on the Guadalupe River

Unfortunately, the Texas Stream Team has dealt with these issues over the past few years. One issue the team faces is the lack of organization of their data. All data points are recorded on paper out in the field. Once the team has returned from a trip they must coordinate a time to enter data sheets into the Texas Stream Team online system for data quality assurance and control. The Texas Stream Team then reviews every entry before it is available on their data viewer website. The quality assurance plan is important for insuring all samples and data collected are of high quality to meet the needs of researchers, resource managers, students and all citizen wanting to utilize the data. However, the process is unfortunately very slow. About 80% of the data sheets entered by the Longhorn Stream Team over the past four years have not been reviewed or released for public viewing. Members of the Longhorn Stream Team have been unable to see their work and contribution to this citizen scientist effort, which has resulted in a disconnect and

lack of engagement between the student members of the team and the water quality science they are collecting.
In addition, the Longhorn Stream Team has a large turnover rate due to the organization being composed mainly of students. A system for storing their data, both in paper form and in digital form, has not been standardized. This has led to a loss of data and inconsistencies in recording the data.

Figure 2:The current method for organizing the water monitoring forms is paper clips and folders.

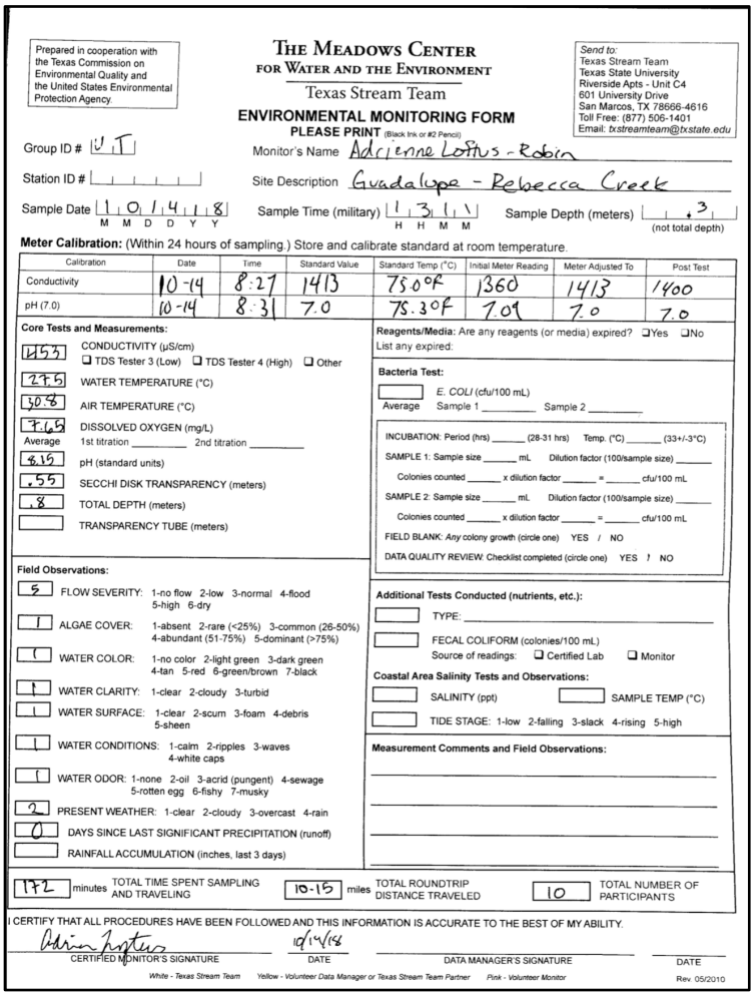
My objective for this term project is to create an interactive map using the four years of data collected by the Longhorn Stream Team. This online map would visually convey to users the status of water quality at the points monitored by the team and give the Stream Team a formal place to update their data and share with the communities they encounter and train as a part of the citizen science component of their mission. In addition, this project will help structure the way the team collects and stores their data. This would help standardize their data management procedures and increase data quality.

Project Objectives:

- Organize existing data into GIS map
- Design a survey on Survey123 for ArcGIS (for more efficient data collection in the field)
- Have survey results auto-populate into online ArcGIS map
- Use the survey to upload data collected this semester

Methods and Materials

The first step in this project was to create a digital survey which contains the same sample information as the water quality monitoring form (Figure 3). This was done using Survey123 for ArcGIS, a software developed by Esri designed to streamline the process of data collection and map making.



Prepared in cooperation with the Texas Commission on Environmental Quality and the United States Environmental Protection Agency.

THE MEADOWS CENTER FOR WATER AND THE ENVIRONMENT
Texas Stream Team

Send to:
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Texas State University
Riverside Apts - Unit C4
601 University Drive
San Marcos, TX 78666-4616
Toll Free: (877) 506-1401
Email: txstreamteam@txstate.edu

ENVIRONMENTAL MONITORING FORM
PLEASE PRINT (Black Ink or #2 Pencil)

Group ID # UT
Monitor's Name Adrienne Loftus - Robin
Station ID #
Site Description Guadalupe - Rebecca Creek
Sample Date 10/14/18 (M M D D Y Y)
Sample Time (military) 1311 (H H M M)
Sample Depth (meters) .3 (not total depth)

Meter Calibration: (Within 24 hours of sampling.) Store and calibrate standard at room temperature.

Calibration	Date	Time	Standard Value	Standard Temp (°C)	Initial Meter Reading	Meter Adjusted To	Post Test
Conductivity	10-14	8:27	1413	75.0°F	1360	1413	1400
pH (7.0)	10-14	8:31	7.0	75.3°F	7.09	7.0	7.0

Core Tests and Measurements:
- 1453 CONDUCTIVITY (µS/cm) ❑ TDS Tester 3 (Low) ❑ TDS Tester 4 (High) ❑ Other
- 27.5 WATER TEMPERATURE (°C)
- 30.8 AIR TEMPERATURE (°C)
- 7.65 DISSOLVED OXYGEN (mg/L) Average 1st titration _____ 2nd titration _____
- 8.15 pH (standard units)
- .55 SECCHI DISK TRANSPARENCY (meters)
- .8 TOTAL DEPTH (meters)
- TRANSPARENCY TUBE (meters)

Reagents/Media: Are any reagents (or media) expired? ❑Yes ❑No
List any expired:

Bacteria Test:
E. COLI (cfu/100 mL) Average Sample 1 _____ Sample 2 _____
INCUBATION: Period (hrs) _____ (28-31 hrs) Temp. (°C) _____ (33+/-3°C)
SAMPLE 1: Sample size _____ mL Dilution factor (100/sample size) _____
Colonies counted _____ x dilution factor _____ = _____ cfu/100 mL
SAMPLE 2: Sample size _____ mL Dilution factor (100/sample size) _____
Colonies counted _____ x dilution factor _____ = _____ cfu/100 mL
FIELD BLANK: Any colony growth (circle one) YES / NO
DATA QUALITY REVIEW: Checklist completed (circle one) YES / NO

Field Observations:
- 5 FLOW SEVERITY: 1-no flow 2-low 3-normal 4-flood 5-high 6-dry
- 1 ALGAE COVER: 1-absent 2-rare (<25%) 3-common (26-50%) 4-abundant (51-75%) 5-dominant (>75%)
- 1 WATER COLOR: 1-no color 2-light green 3-dark green 4-tan 5-red 6-green/brown 7-black
- 1 WATER CLARITY: 1-clear 2-cloudy 3-turbid
- 1 WATER SURFACE: 1-clear 2-scum 3-foam 4-debris 5-sheen
- 1 WATER CONDITIONS: 1-calm 2-ripples 3-waves 4-white caps
- 1 WATER ODOR: 1-none 2-oil 3-acrid (pungent) 4-sewage 5-rotten egg 6-fishy 7-musky
- 2 PRESENT WEATHER: 1-clear 2-cloudy 3-overcast 4-rain
- 0 DAYS SINCE LAST SIGNIFICANT PRECIPITATION (runoff)
- RAINFALL ACCUMULATION (inches, last 3 days)

Additional Tests Conducted (nutrients, etc.):
TYPE: _____
FECAL COLIFORM (colonies/100 mL) Source of readings: ❑ Certified Lab ❑ Monitor

Coastal Area Salinity Tests and Observations:
SALINITY (ppt) SAMPLE TEMP (°C)
TIDE STAGE: 1-low 2-falling 3-slack 4-rising 5-high

Measurement Comments and Field Observations:

172 minutes TOTAL TIME SPENT SAMPLING AND TRAVELING
10.15 miles TOTAL ROUNDTRIP DISTANCE TRAVELED
10 TOTAL NUMBER OF PARTICIPANTS

I CERTIFY THAT ALL PROCEDURES HAVE BEEN FOLLOWED AND THIS INFORMATION IS ACCURATE TO THE BEST OF MY ABILITY.

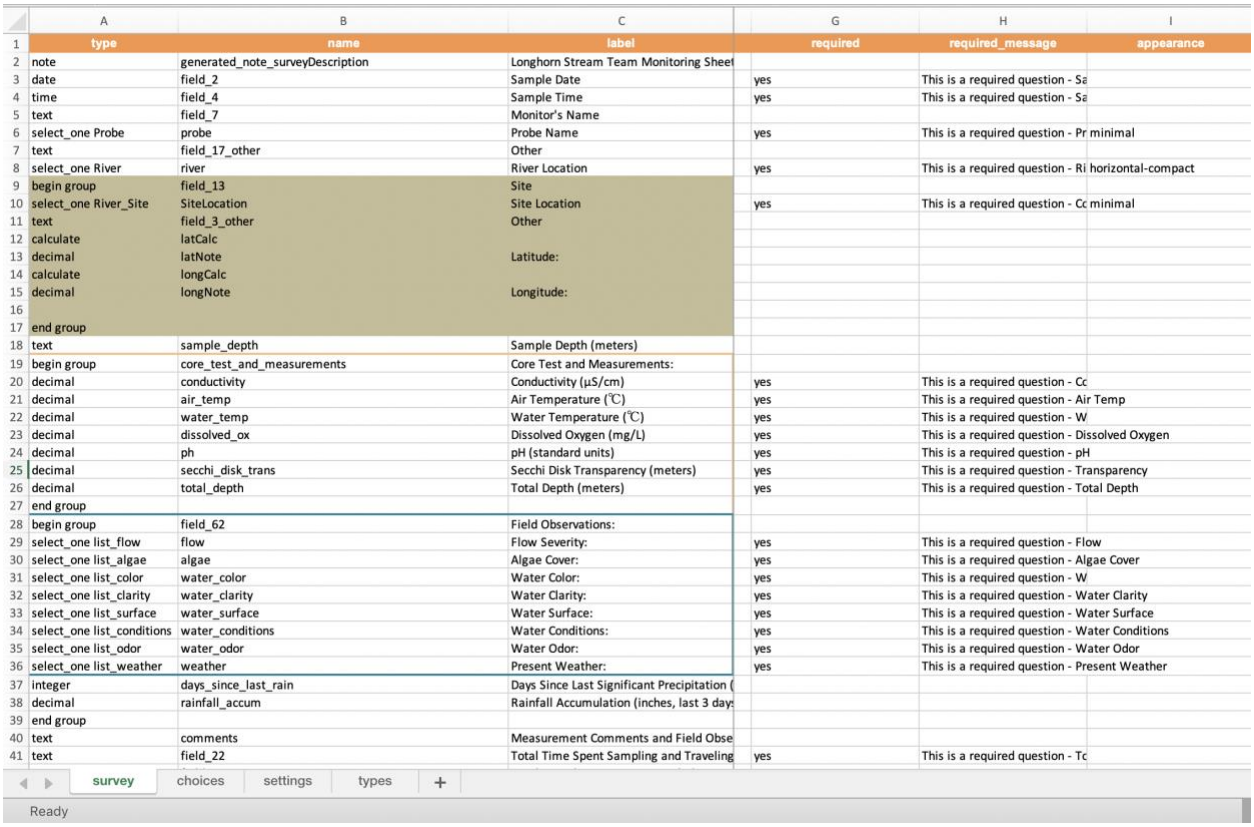
CERTIFIED MONITOR'S SIGNATURE — DATE 10/14/18 — DATA MANAGER'S SIGNATURE — DATE

White - Texas Stream Team Yellow - Volunteer Data Manager or Texas Stream Team Partner Pink - Volunteer Monitor Rev. 05/2010

Figure 3:Example of a completed monitoring sheet. Once these are completed the team reports the data in an online database controlled by the Texas Stream Team. However, the information is not able to be seen by anyone until after it has been approved by Texas Stream Team. Unfortunately, data approval can take years.

Survey123, while very intuitive to use once a survey is complete, has a slight learning curve for creating surveys. Because the software is relatively new (launched in 2016) there was a lot of trial and error for learning how to make the software create a complex survey. Survey questions and answer types are created using an excel sheet (Figure 4). It was important to choose question types based on the type of response needed and ease of entry for the user. For example, quantitative measurements – water temperature in Celsius, dissolved oxygen content in

milligrams per liter – required a decimal entry type of question. This means that whenever a user clicks on the box to answer the question, they will automatically be prompted to enter in a numerical value. However, for the more qualitative field observations in the blue box, a numerical code is used to denote a specific observation - a flower severity value of 5 corresponds to high flow, or a water clarity of 2 means it's cloudy. Since there is a limited range of choices, these questions work best as a "select one" type question because the user simply chooses from a list of pre-entered questions rather than having to type in the answer manually every time. The "select one" type question was also used for questions such as river location, river site location, and the sample probe used.



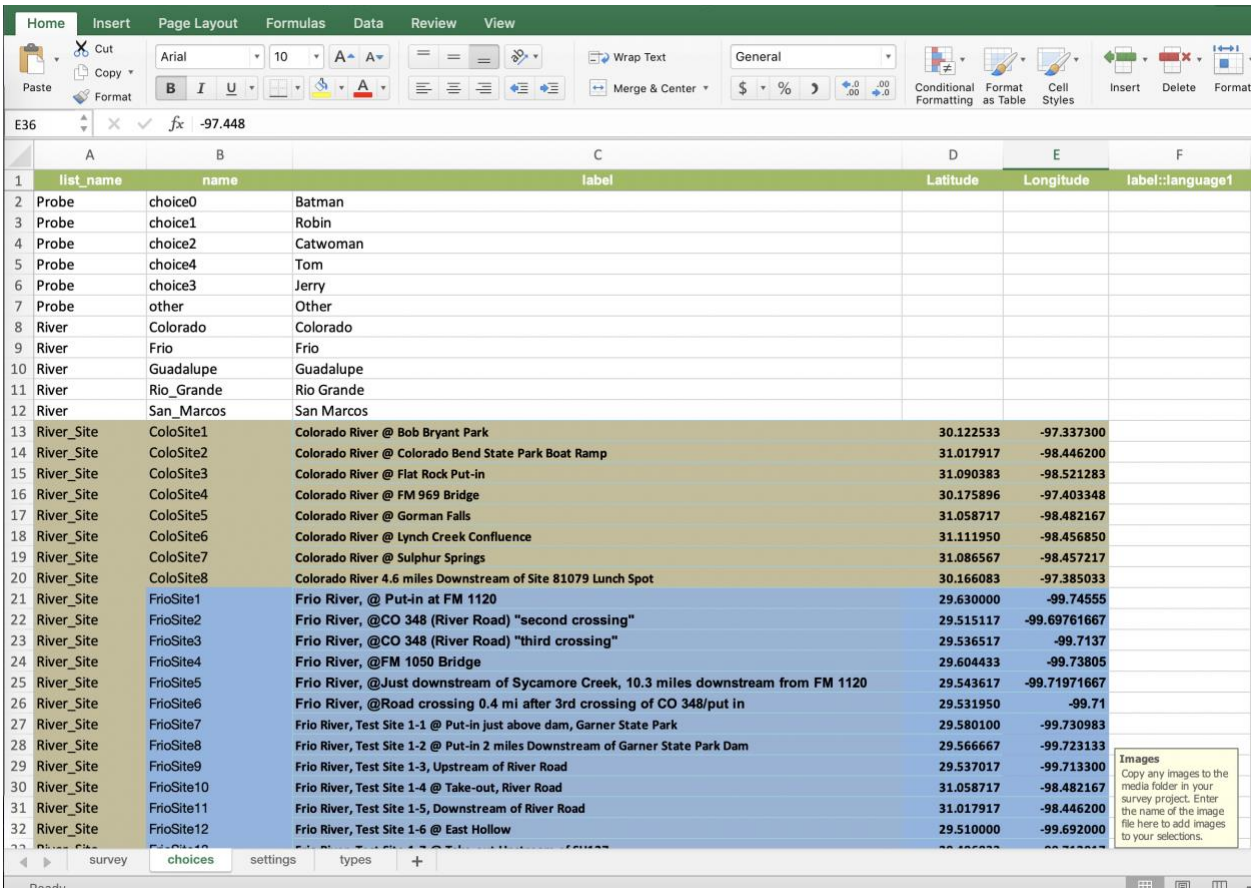
	A	B	C	G	H	I
1	type	name	label	required	required_message	appearance
2	note	generated_note_surveyDescription	Longhorn Stream Team Monitoring Sheet			
3	date	field_2	Sample Date	yes	This is a required question - Sa	
4	time	field_4	Sample Time	yes	This is a required question - Sa	
5	text	field_7	Monitor's Name			
6	select_one Probe	probe	Probe Name	yes	This is a required question - Pr	minimal
7	text	field_17_other	Other			
8	select_one River	river	River Location	yes	This is a required question - Ri	horizontal-compact
9	begin group	field_13	Site			
10	select_one River_Site	SiteLocation	Site Location	yes	This is a required question - Cc	minimal
11	text	field_3_other	Other			
12	calculate	latCalc				
13	decimal	latNote	Latitude:			
14	calculate	longCalc				
15	decimal	longNote	Longitude:			
16						
17	end group					
18	text	sample_depth	Sample Depth (meters)			
19	begin group	core_test_and_measurements	Core Test and Measurements:			
20	decimal	conductivity	Conductivity (µS/cm)	yes	This is a required question - Cc	
21	decimal	air_temp	Air Temperature (℃)	yes	This is a required question - Air Temp	
22	decimal	water_temp	Water Temperature (℃)	yes	This is a required question - W	
23	decimal	dissolved_ox	Dissolved Oxygen (mg/L)	yes	This is a required question - Dissolved Oxygen	
24	decimal	ph	pH (standard units)	yes	This is a required question - pH	
25	decimal	secchi_disk_trans	Secchi Disk Transparency (meters)	yes	This is a required question - Transparency	
26	decimal	total_depth	Total Depth (meters)	yes	This is a required question - Total Depth	
27	end group					
28	begin group	field_62	Field Observations:			
29	select_one list_flow	flow	Flow Severity:	yes	This is a required question - Flow	
30	select_one list_algae	algae	Algae Cover:	yes	This is a required question - Algae Cover	
31	select_one list_color	water_color	Water Color:	yes	This is a required question - W	
32	select_one list_clarity	water_clarity	Water Clarity:	yes	This is a required question - Water Clarity	
33	select_one list_surface	water_surface	Water Surface:	yes	This is a required question - Water Surface	
34	select_one list_conditions	water_conditions	Water Conditions:	yes	This is a required question - Water Conditions	
35	select_one list_odor	water_odor	Water Odor:	yes	This is a required question - Water Odor	
36	select_one list_weather	weather	Present Weather:	yes	This is a required question - Present Weather	
37	integer	days_since_last_rain	Days Since Last Significant Precipitation (			
38	decimal	rainfall_accum	Rainfall Accumulation (inches, last 3 days			
39	end group					
40	text	comments	Measurement Comments and Field Obse			
41	text	field_22	Total Time Spent Sampling and Traveling	yes	This is a required question - Tc	

survey | choices | settings | types | +

Ready

Figure 4:Excel sheet used for creating the survey. Every component of the survey must have its own row with information such as name, type of field, appearance etc.

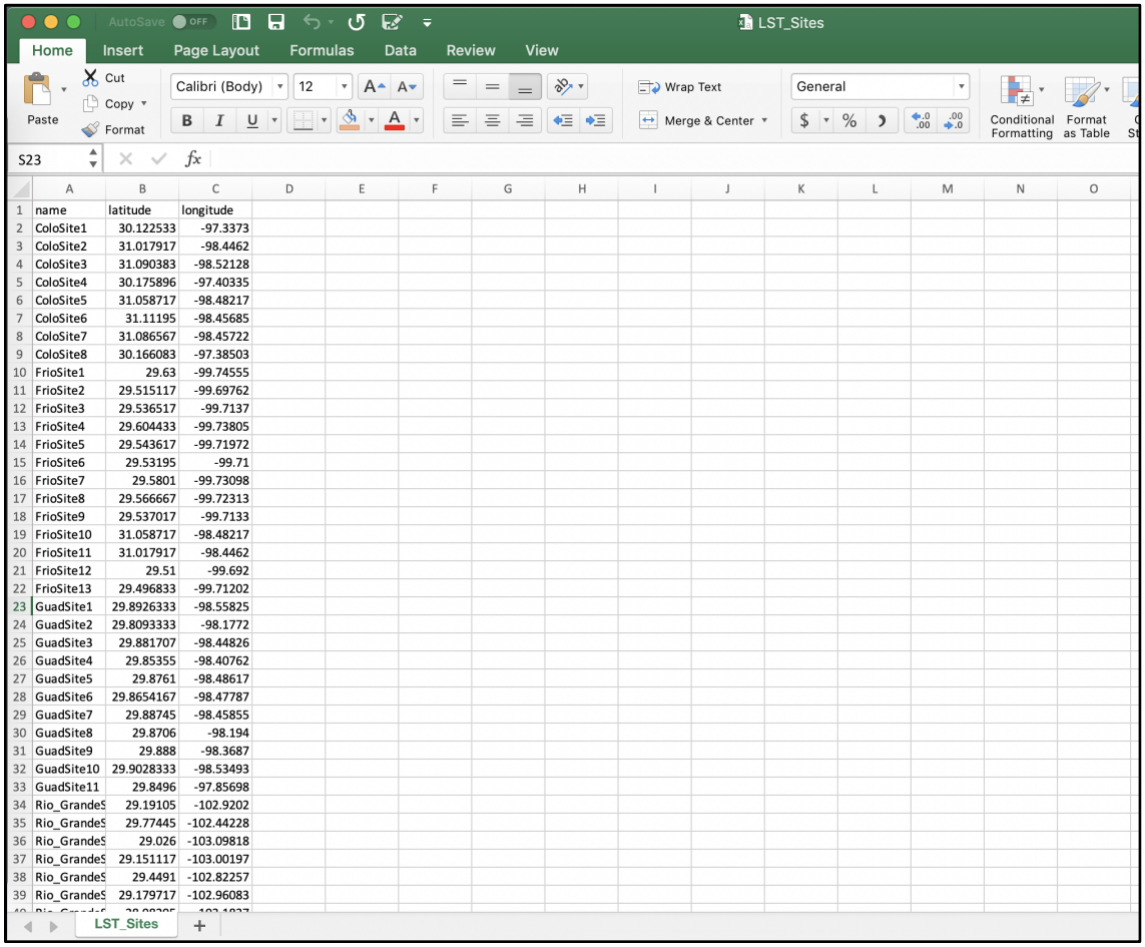
For each "select one" question there must be a separate tab within the excel sheet that list all of the possible questions and links them to the appropriate question (Figure 5). It is important to be consistent in labeling so that the program knows exactly which questions and answer choices go together. For example, on the main excel sheet the label for the question asking for the probe name is "select_one Probe". On the choices excel sheet, all answers with the list_name of "Probe" will appear as options on the survey under the "Probe Name" question.



	A	B	C	D	E	F
1	list_name	name	label	Latitude	Longitude	label::language1
2	Probe	choice0	Batman			
3	Probe	choice1	Robin			
4	Probe	choice2	Catwoman			
5	Probe	choice4	Tom			
6	Probe	choice3	Jerry			
7	Probe	other	Other			
8	River	Colorado	Colorado			
9	River	Frio	Frio			
10	River	Guadalupe	Guadalupe			
11	River	Rio_Grande	Rio Grande			
12	River	San_Marcos	San Marcos			
13	River_Site	ColoSite1	Colorado River @ Bob Bryant Park	30.122533	-97.337300	
14	River_Site	ColoSite2	Colorado River @ Colorado Bend State Park Boat Ramp	31.017917	-98.446200	
15	River_Site	ColoSite3	Colorado River @ Flat Rock Put-in	31.090383	-98.521283	
16	River_Site	ColoSite4	Colorado River @ FM 969 Bridge	30.175896	-97.403348	
17	River_Site	ColoSite5	Colorado River @ Gorman Falls	31.058717	-98.482167	
18	River_Site	ColoSite6	Colorado River @ Lynch Creek Confluence	31.111950	-98.456850	
19	River_Site	ColoSite7	Colorado River @ Sulphur Springs	31.086567	-98.457217	
20	River_Site	ColoSite8	Colorado River 4.6 miles Downstream of Site 81079 Lunch Spot	30.166083	-97.385033	
21	River_Site	FrioSite1	Frio River, @ Put-in at FM 1120	29.630000	-99.74555	
22	River_Site	FrioSite2	Frio River, @CO 348 (River Road) "second crossing"	29.515117	-99.69761667	
23	River_Site	FrioSite3	Frio River, @CO 348 (River Road) "third crossing"	29.536517	-99.7137	
24	River_Site	FrioSite4	Frio River, @FM 1050 Bridge	29.604433	-99.73805	
25	River_Site	FrioSite5	Frio River, @Just downstream of Sycamore Creek, 10.3 miles downstream from FM 1120	29.543617	-99.71971667	
26	River_Site	FrioSite6	Frio River, @Road crossing 0.4 mi after 3rd crossing of CO 348/put in	29.531950	-99.71	
27	River_Site	FrioSite7	Frio River, Test Site 1-1 @ Put-in just above dam, Garner State Park	29.580100	-99.730983	
28	River_Site	FrioSite8	Frio River, Test Site 1-2 @ Put-in 2 miles Downstream of Garner State Park Dam	29.566667	-99.723133	
29	River_Site	FrioSite9	Frio River, Test Site 1-3, Upstream of River Road	29.537017	-99.713300	
30	River_Site	FrioSite10	Frio River, Test Site 1-4 @ Take-out, River Road	31.058717	-98.482167	
31	River_Site	FrioSite11	Frio River, Test Site 1-5, Downstream of River Road	31.017917	-98.446200	
32	River_Site	FrioSite12	Frio River, Test Site 1-6 @ East Hollow	29.510000	-99.692000	

Figure 5: Answer choices for the "select one" question type

One of the challenges in creating the survey was that the team does not always have service when collecting data. For the survey itself it was not a problem because the survey can be downloaded prior to going out into the field and all recorded survey sheets are uploaded as soon as the device used gets a Wifi signal. However, in order for those surveys to have the appropriate GPS coordinates associated with their data entry, a separate function was needed to automatically add the GPS location for each survey entry without the need for Wifi. These geo-locations were based on previous locations where LST has collected data and were entered into a separate excel sheet (Figure 6). A “pull data” function was added into a data field which the map showing the location would read directly from. The function called upon a certain GPS coordinate depending on which answer was chosen for the “site location” question. Once the user selected the “site location”, the survey would read the information from the external excel sheet and then input the appropriate GPS coordinates into the map for that particular survey responses. Because Survey123 is still fairly new, there were no simple solutions for the GPS coordinate problem. Similarly, none of the examples online had has many selections for answer choices or required as robust of a survey. The solution created specifically for this survey was a novel way to solve the lack of Wifi signal when working out in the field. Another important feature integrated into this survey was the “required question” field. This feature was great for quality control because it will not allow any survey form submissions without first answering all required questions within the survey.



	name	latitude	longitude
2	ColoSite1	30.122533	-97.3373
3	ColoSite2	31.017917	-98.4462
4	ColoSite3	31.090383	-98.52128
5	ColoSite4	30.175896	-97.40335
6	ColoSite5	31.058717	-98.48217
7	ColoSite6	31.11195	-98.45685
8	ColoSite7	31.086567	-98.45722
9	ColoSite8	30.166083	-97.38503
10	FrioSite1	29.63	-99.74555
11	FrioSite2	29.515117	-99.69762
12	FrioSite3	29.536517	-99.7137
13	FrioSite4	29.604433	-99.73805
14	FrioSite5	29.543617	-99.71972
15	FrioSite6	29.53195	-99.71
16	FrioSite7	29.5801	-99.73098
17	FrioSite8	29.566667	-99.72313
18	FrioSite9	29.537017	-99.7133
19	FrioSite10	31.058717	-98.48217
20	FrioSite11	31.017917	-98.4462
21	FrioSite12	29.51	-99.692
22	FrioSite13	29.496833	-99.71202
23	GuadSite1	29.8926333	-98.55825
24	GuadSite2	29.8093333	-98.1772
25	GuadSite3	29.881707	-98.44826
26	GuadSite4	29.85355	-98.40762
27	GuadSite5	29.8761	-98.48617
28	GuadSite6	29.8654167	-98.47787
29	GuadSite7	29.88745	-98.45855
30	GuadSite8	29.8706	-98.194
31	GuadSite9	29.888	-98.3687
32	GuadSite10	29.9028333	-98.53493
33	GuadSite11	29.8496	-97.85698
34	Rio_Grande$	29.19105	-102.9202
35	Rio_Grande$	29.77445	-102.44228
36	Rio_Grande$	29.026	-103.09818
37	Rio_Grande$	29.151117	-103.00197
38	Rio_Grande$	29.4491	-102.82257
39	Rio_Grande$	29.179717	-102.96083

Figure 6: The external excel sheet used to automatically insert GPS location for every site into the survey. This eliminated the need for internet service while out in the field.

5	text	field_7	Monitor's Name		
6	select_one Probe	probe	Probe Name		
7	text	field_17_other	Other	selected(${probe}, 'other')	
8	select_one River	river	River Location		
9	begin group	field_13	Site		
10	select_one River_Site	SiteLocation	Site Location		
11	text	field_3_other	Other	selected(${SiteLocation}, 'other')	
12	calculate	latCalc			number(pulldata('LST_Sites', 'latitude', 'name', ${SiteLocation}))
13	decimal	latNote	Latitude:		${latCalc}
14	calculate	longCalc			number(pulldata('LST_Sites', 'longitude', 'name', ${SiteLocation}))
15	decimal	longNote	Longitude:		${longCalc}
16	geopoint	location	Location		concat(substr(${latNote}, 0, 10) + " " + substr(${longNote}, -10))
17	end group				
18	text	sample_depth	Sample Depth (meters)		
19	begin group	core_test_and_measurements	Core Test and Measurements:		
20	decimal	conductivity	Conductivity (µS/cm)		
21	decimal	air_temp	Air Temperature (℃)		
22	decimal	water_temp	Water Temperature (℃)		

Figure 7: Example of the use of functions in order to integrate outside excel sheets into the survey. The original solutions to the GPS coordinate problem required the use of many more excel rows and significantly slowed down the survey upload and download time. The solution seen here was far more streamlined and is a simpler solution for those needing to connect GPS coordinates to a survey while offline.

Once the survey was complete, the next step was creating the base map for the map that would appear to users viewing the water quality data. Then existing water quality data was added to the map. After the map was complete, it was published to ArcGIS online. At this point the survey from survey123 and the published map could be combined.

Data	Data Source
River Basins/Major Rivers shapefiles	*Texas Water Development Board (TWBD)*
Shapefiles for state of Texas, Texas NHD River, Streams, and Waterbodies	*Texas Natural Resources Information System (TNRIS*
Existing Water Quality Data Points	*Texas Stream Team and Meadows*

Table 1: Source information for data used.

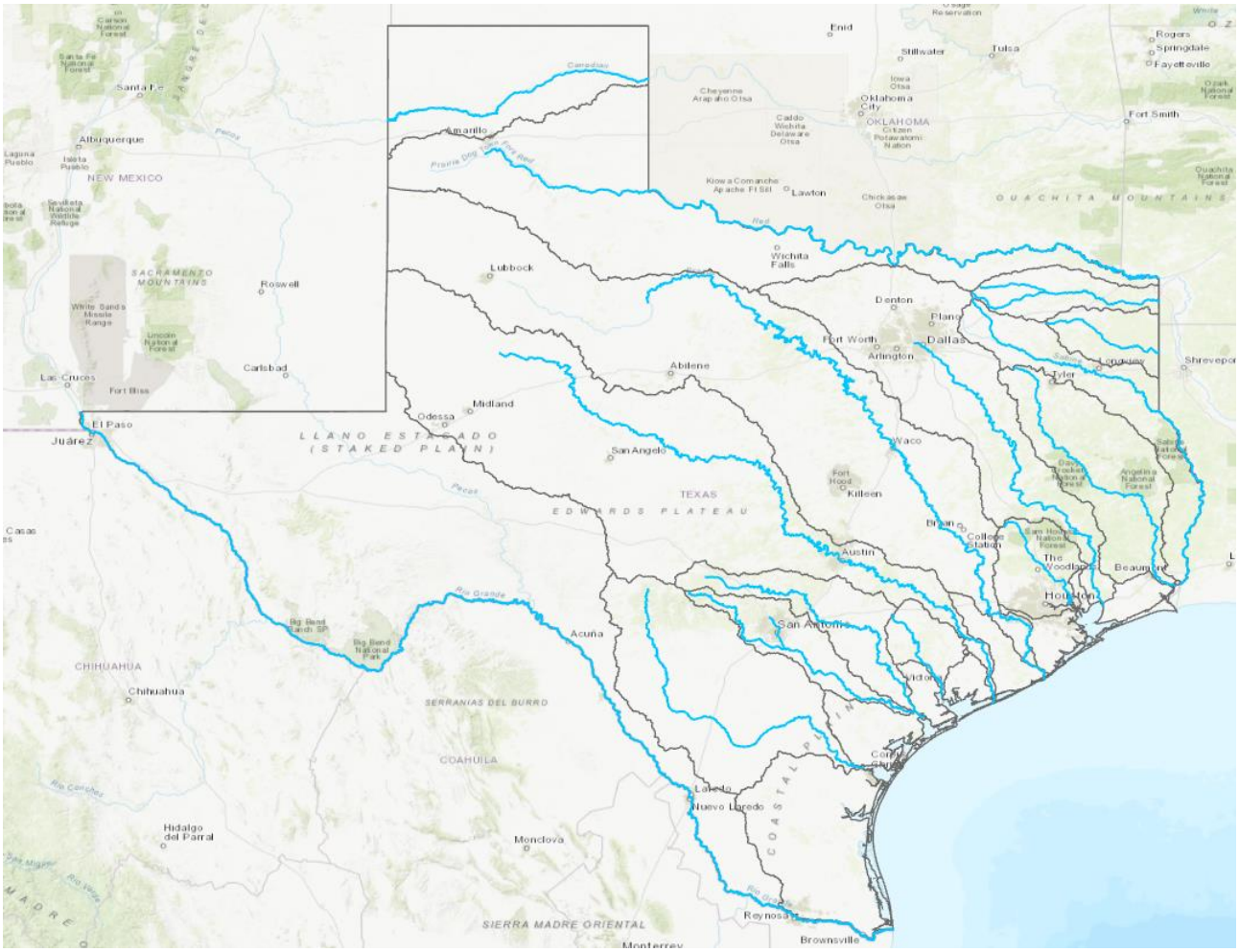


Figure 8:Base map showing the major rivers of Texas as well as the major river basins. Additionally, smaller rivers such as the Frio were added based on historical visitation to those sites by the Longhorn Stream Team

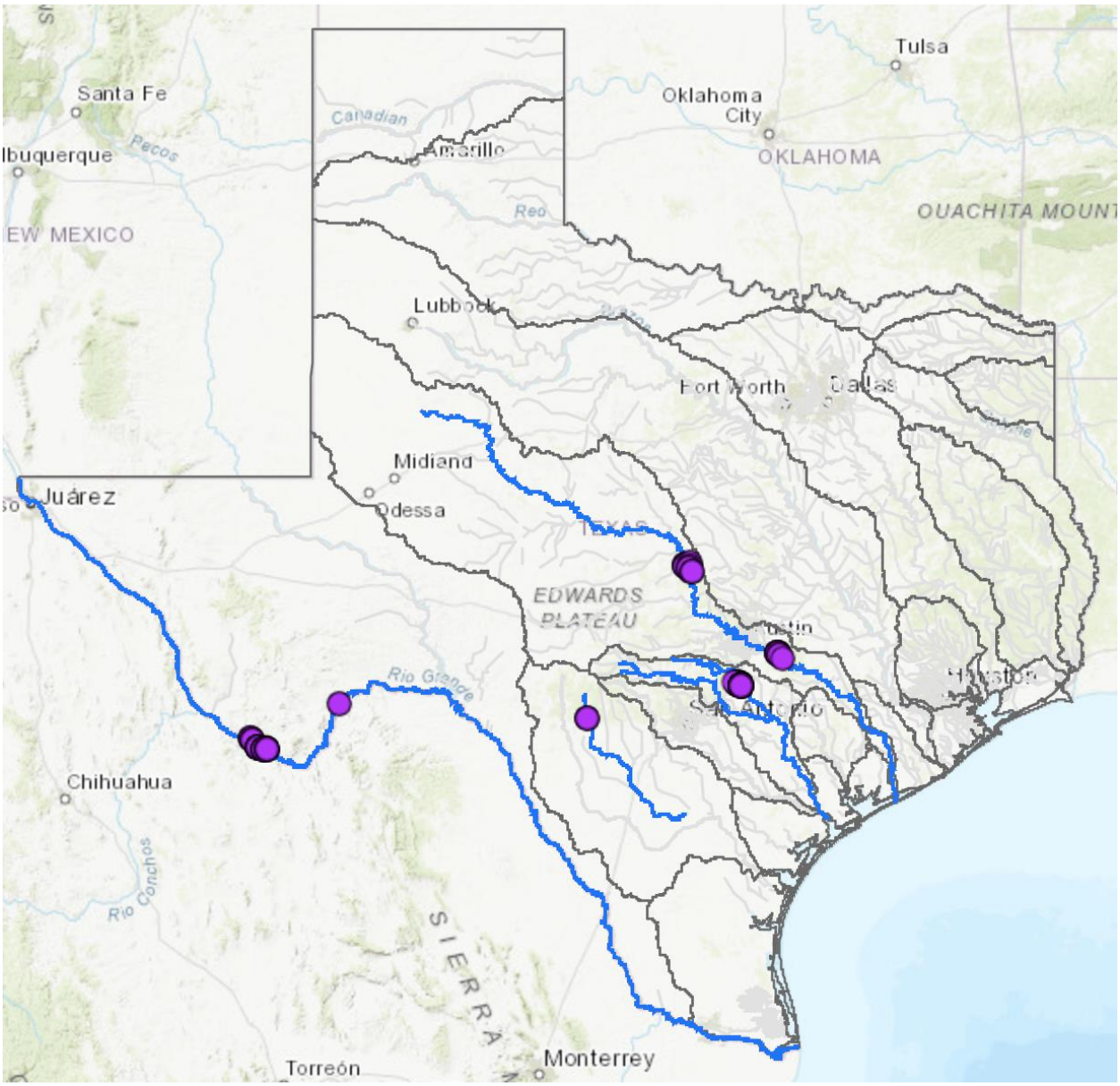


Figure 9: Completed ArcGIS map.

Results and Conclusions

The survey worked well in the field and linked seamlessly to the published ArcGIS map online. Both the survey and map are open for public use. Survey123 is a great tool for having a streamline connection between data collected in the field and real-time plotting of those data points on an online map. The functions used in this project are applicable to many fields and can help in data management and data sharing.

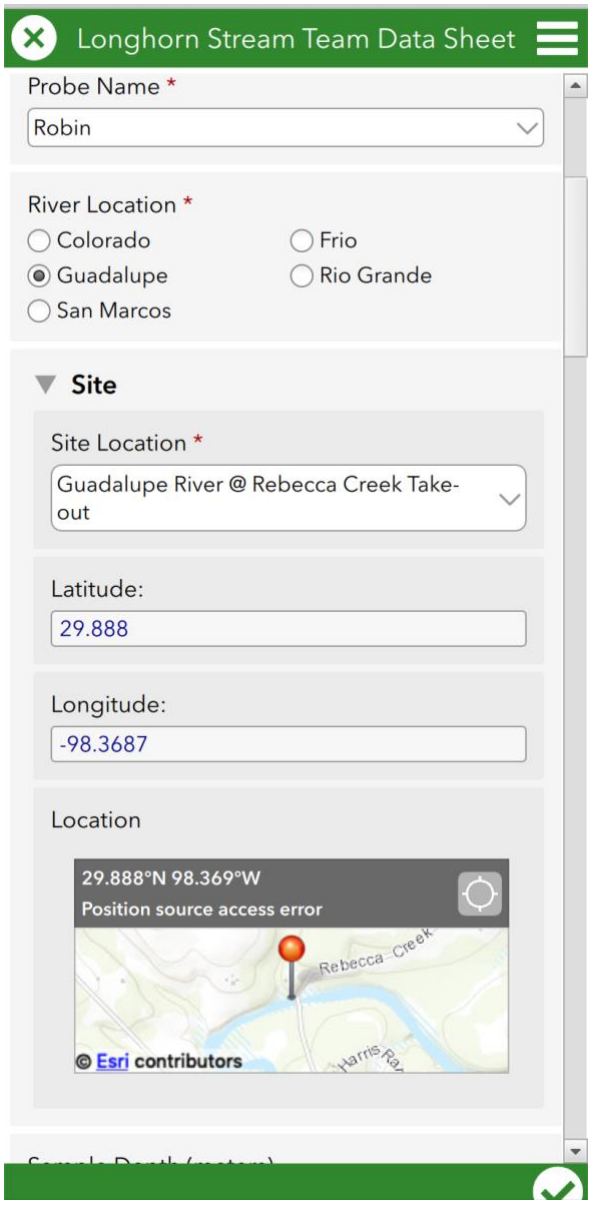


Figure 10: Completed survey for the Longhorn Stream Team. The survey can be found by any Sruvey123 user under the name "Longhorn Stream Monitoring Form" or at this link: [Monitoring Form]

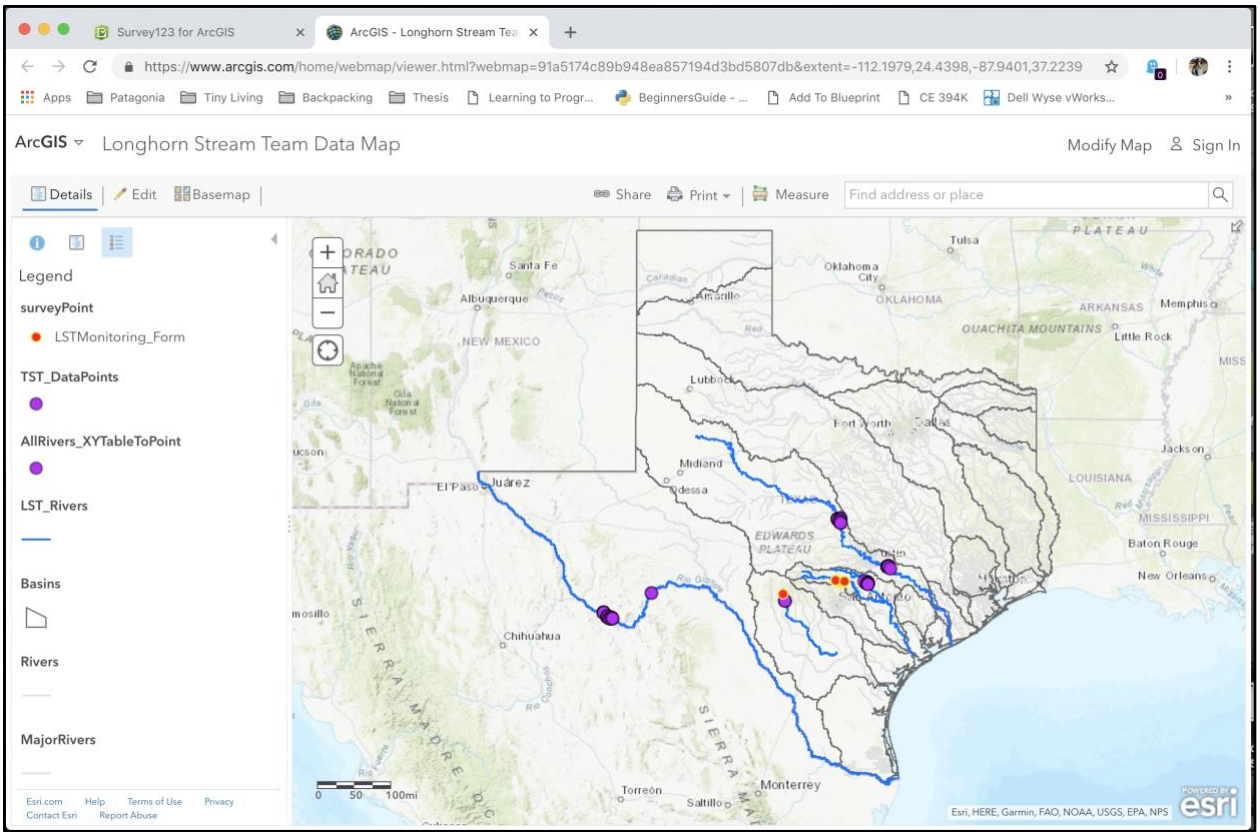


Figure 11: Completed published map with the Survey123 linked to it. As soon as a survey form is submitted the map auto-populates with the data point and survey information. The map can be viewed here.