Texas Stream Team Datamap and Site Automation

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Texas State University
Texas Stream Team

Client: The Meadows Center for Water and the Environment
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1. Introduction

1.1 Summary

The Texas Stream Team is a volunteer-based water quality monitoring program housed at The Meadows Center in San Marcos, Texas. They collect water quality data used by resource managers, policymakers, and researchers to assess water health and advise conservation efforts. The Texas Stream Team Datamap is an interactive ArcGIS dashboard that visualizes over 350 sites and their collected monitoring data, serving as a vital tool to bring public awareness to water monitoring.

Currently, the process to update and verify site data is mostly manual, resulting in inefficiencies and potential delays to data accessibility. This project aims to streamline the datamap update process using ArcGIS tools such as Survey123, ArcGIS Online feature layers, and ArcGIS dashboards. Through data automation, validation, and visualization, this project will allow data from the public dashboard to be more reliable and accessible to stakeholders and community scientists.

1.2 Purpose

This project aims to improve site request approval and site monitoring data processes by improving workflow efficiency and reducing manual data entry. To implement this, we will automate geographic attribute population for new site requests using authoritative ArcGIS Online Layers. Additionally, we will use a Hosted Feature Layer View to automatically add newly approved sites to the Water Quality Monitoring Form and Public Datamap. To improve monitoring data accuracy, we will include TCEQ Water Quality Standards in the Water Quality Monitoring form to ensure submitted data is realistic. These improvements will provide the community with more accurate data and faster data updates while also helping the Texas Stream Team by reducing data management workload.

1.3 Scope

This project will focus on sites within the state of Texas and is expected to be completed by April 23, 2025. Refer to Figure 1 for the Area of Interest (AOI) and water monitoring site locations.

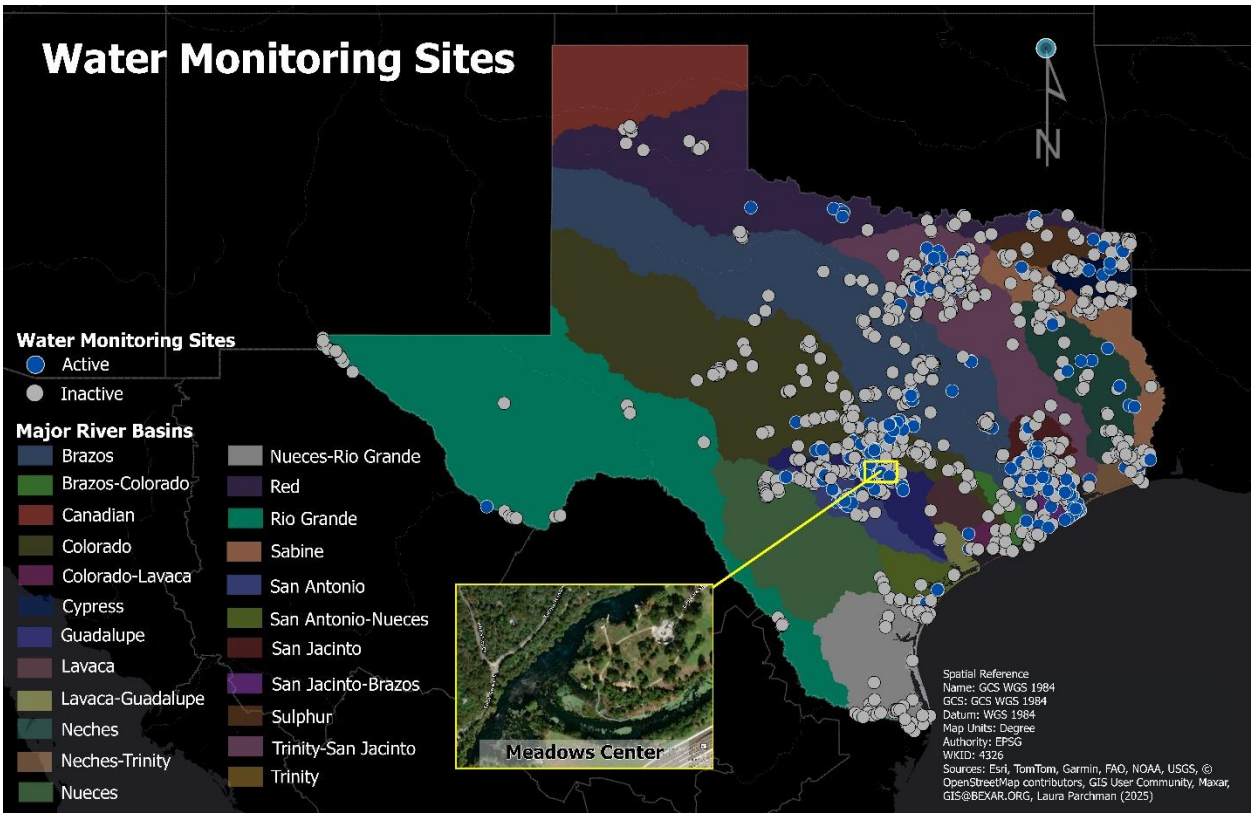

Figure 1. Area of interest

2. Literature Review

The Meadows Center for Water and the Environment utilizes Esri's ArcGIS applications—Survey123, Survey123 Connect, ArcGIS Online, and ArcGIS Dashboards—to refine its water quality monitoring program. For instance, ArcGIS Survey123 is a mobile and web-based data collection tool that allows users to create and submit structured surveys with geospatial data (Esri, n.d. -e), thereby allowing the community scientists to collect and submit water data to the Meadows Center. Survey123 Connect is a desktop application used to modify form structures, apply calculations, set up conditional logic, and format data collection forms using XLSForm for Survey123 (Esri, n.d. -e). This will ensure that the customized forms adhere to the specific water monitoring protocols. Data will then be integrated into ArcGIS Online, a cloud-based mapping and spatial analysis tool (Esri, n.d. -d), which can help manage and share the water data to permitted users. Furthermore, ArcGIS Dashboard is a tool within ArcGIS Online that allows users to create interactive, real-time dashboards for visualizing geospatial and statistical data using maps, charts, indicators, and alerts (Esri, n.d. -c). This will help provide

interactive visualizations by monitoring water conditions, active, inactive, and approved water sites.

Matt Adams, a graduate student at the University of Arizona, conducted a similar project using Survey123 in conjunction with field maps to assess storm damage. Adams utilized Survey123 to design a form that allowed assessors to efficiently input data for specific locations (Adams, 2022). This data was then transferred into a web mapping application for review by officials overseeing disaster response (Adams, 2022). The outcome of Adams' project was a significantly more efficient process for cataloging storm damage, aiming to expedite response times and improve the allocation of funds and resources (Adams, 2022).

This project follows a comparable methodology to ours, with the goal of modernizing data entry and organization for water quality monitoring. It provides a detailed overview of the real-world impacts that automation of data entry using Survery123 can benefit the environment those working to protect it.

3. Data

All the data needed to complete this project was provided to our team by the Texas Stream Team and sourced from authoritative ArcGIS Online layers. Feature layers include Texas counties, river basins, HUC levels 6,8,10, and 12, TCEQ monitoring stations, and Texas stream segments (table 1), which will be used for geographic attribute autopopulation and site verification. Copies of forms, dashboards, and excel spreadsheets used for the current datamap management (table 2) will be used as a reference as we create our own Site Request Form, Water Quality Monitoring Form, Site Feature Layer, Hosted Feature Layer View, Water Quality Monitoring Feature Layer and Internal Site Request Review Dashboard. These data sources will also aid in the implementation of data automation, validation, and visualization.

Table 1. Feature layers used for autopopulation

Entity	Spatial Object	Unit	Source	Status	Year	Attributes
Stream Segments	- Line - Polygon	Stream Segments	- Layer Source: Houston Advanced Research Center - Data Source: Texas Commission of Environmental	Available	2024	Texas Stream Segments
TCEQ Stations	Point	TCEQ Stations	- Layer Source: Houston Advanced Research Center - Data Source: Texas Commission of Environmental	Available	2024	TCEQ Stations
Watershed Boundary Dataset HUC	Polygon	Hydrologic Unit Codes (HUCs) 6, 8, 10, and	- Layer Source: ESRI - Data Source: USGS	Available	2023	United States Watershed Boundaries
River Basins	Polygon	River Basins	- Layer Source: Houston Advanced Research Center - Data Source: Texas Water Development Board (TWDB)	Available	2021	Texas River Basin Boundaries
Counties	Polygon	Texas Counties	Texas Department of Transportation (TxDOT)	Available	2024	Texas County

Table 2. Project data components: forms, feature layers, dashboards, and spreadsheets

Entity	Purpose	Year	Provided/Created
Forms			
Site Request Form	Used by community scientists to request a new site	2024	Both
Internal Review Form	The editable version of the Site Request Form, used by staff to review site details and approve sites	2024	Both
Water Quality Monitoring Form	Used by community scientists to submit site monitoring data	2024	Both
Feature Layers			
Site Feature Layer	Stores all the new site requests and site attributes	2024	Both
Approved/Active/Inactive Sites View Layer	A filtered layer derived from the Sites Feature Layer that only shows approved/active/inactive sites	2025	Created
Water Quality Monitoring Layer	Stores site monitoring data reported by community scientists	2024	Both
Dashboards			
Internal Site Request Review Dashboard	Used by staff to review and approve site requests	2025	Both
Texas Stream Team Water Quality Data Map	Displays approved monitoring sites and site statistics to the public	2025	Provided
Excel Spreadsheets			
Approved sites CSV	Stores approved sites to be selectable in the Water Quality Monitoring Form	2025	Provided
Attribute table	Stores data schema for reference	2025	Provided
TCEQ Basin Water Quality Standards	Stores water quality standard parameters for validation	2025	Both

4. Methodology

The methodology for the project discusses how we will streamline the process from site request to water quality monitoring through data automation, validation, and visualization to create a faster and more accurate data management system. The flow chart in figure 2 shows the progression from site request submission, site review and approval, water quality monitoring data submission, and data visualization on the Public Dashboard. It also shows how each survey, feature layer, and dashboard is involved in this process. These steps are explained further in the following subsections.

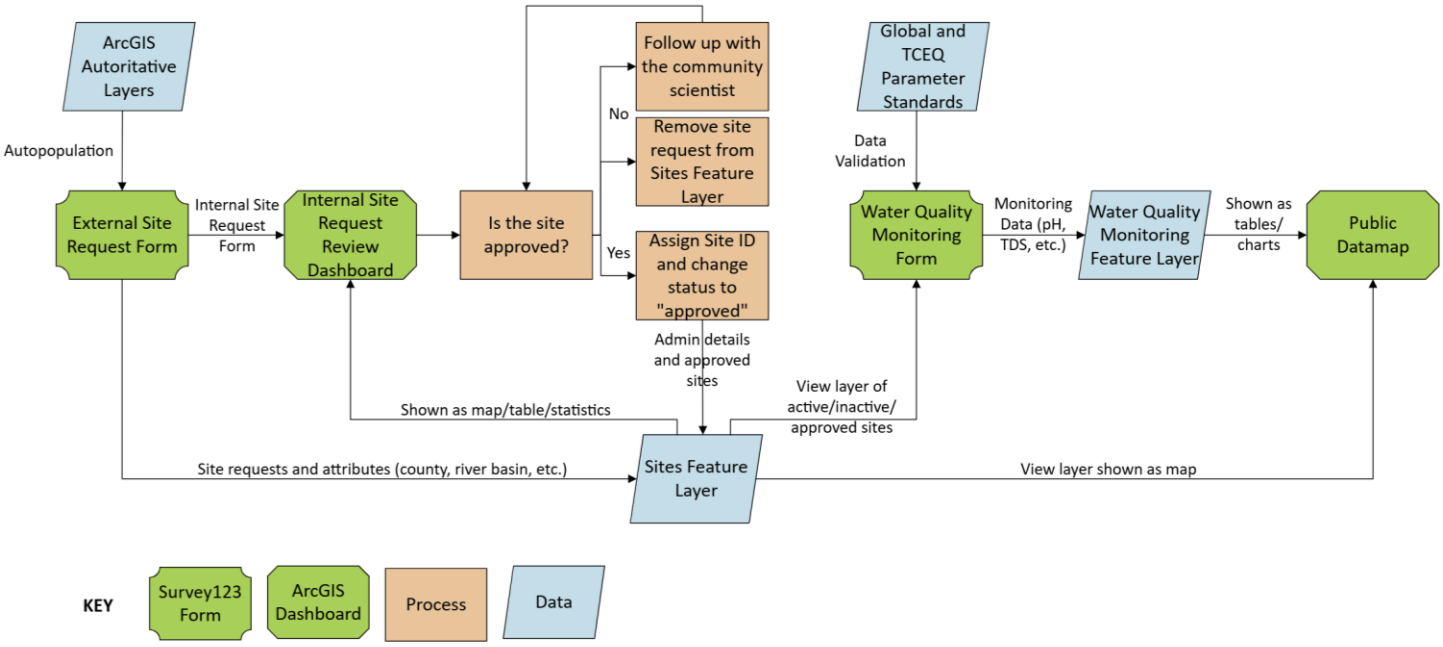

Figure 2. Data flow chart

4.1 Data Processing and Automation

To improve accuracy and decrease processing time, this project will automate and simplify aspects of the datamap update process. Currently, data is manually updated and verified across multiple sources, which can lead to data inconsistences and processing delays. To address these challenges, we will consolidate all 41 required attributes into a Sites Feature Layer and Water Quality Monitoring Feature Layer, automate geographic attribute population, dynamically update approved sites for selection, and implement data validation in the Water Quality Monitoring Form. These improvements will streamline the flow of data from site request to site monitoring, minimizing administrative workload.

4.1.1 Creating the Sites and Water Quality Monitoring Feature Layers

A key objective in this project is the consolidation of site attributes and monitoring data attributes (figure 3) into a related tables system. This approach will require two feature layers—one that records all sites and attributes and another for water quality monitoring data—linked through a one-to-many relationship using the site ID as the key identifier. This structure will allow multiple monitoring records to be associated with a single site, preserving historical monitoring data and simplifying data retrieval.

When a community scientist submits a new site request, a new record will be created in the Sites Feature Layer with all the relevant site attributes and site request attributes. Before the site is approved, the request will be reviewed and verified using the internal version of the Site Request Form, which is the same form submitted by the community scientist but set in "edit" mode. This internal form is embedded within the Internal Site Request Review Dashboard, where staff will check site selection criteria, validate geographic attributes, and update administrative details. Once the site is approved, the site will be manually assigned a site ID and its status will be changed. These changes will be reflected in the Sites Feature Layer, making it available for monitoring.

Water quality monitoring data will be stored separately in the Water Quality Monitoring Feature Layer. Every time a community scientist submits monitoring data, a new record will be created in the feature layer. These records will include the water quality standard attributes and the site ID. The site ID will link multiple monitoring records to its corresponding site and its attributes in the Sites Feature Layer, allowing for the preservation of historical monitoring data and simplified database management.

	A	C	E
1	**Site Attributes**	**Water Quality Standard Attributes**	**Site Request Attributes**
2	OBJECTID	Segment Name	Site Request Creation Date
3	Site ID	TDS (mg/L)	Site Request Creator
4	Description	Dissolved Oxygen (mg/L)	Site Request Edit Date
5	Longitude	pH Range (SU)	Site Request Editor
6	Latitude	Indicator Bacteria[1] #/100 mL	Site Request First Name
7	County	Temperature (degrees F)	Site Request Last Name
8	River Basin		Site Request Monitoring Group
9	HUC6 (Basin)		Is the proposed monitoring site on private property?
10	HUC8 (Subbasin)		Site Request Email
11	HUC10 (Watershed)		Site Request Date Last Reviewed
12	HUC12 (Subwatershed)		Site Request Date Added to WWDV
13	TCEQ Station		Site Request Comments (staff use)
14	Latest sampling event		Site Request Reviewed By
15	Status		
16	Testing Type		
17	GlobalID		
18	Creation Date		
19	Creator		
20	EditDate		
21	Editor		
22	Shape		
23	TCEQ Stream Segment No.		

Figure 3. Excel spreadsheet of all 41 fields that will be recorded

4.1.2 Autopopulating Geographic Attributes in the Site Request Form

In the current datamap workflow, community scientists manually select geographic attributes such as county and river basin, while staff manually assign other attributes like TCEQ segment ID (figure 4). This process is time-consuming and error-prone. To improve this process, we will implement automated geographic attribute population using authoritative ArcGIS Online layers. When a user places a pin on the New Site Request Form map, the form will automatically retrieve and populate the following attributes: County, River Basin, HUC6, HUC8, HUC10, HUC12, TCEQ Station, TCEQ Stream Segment Number, and Segment Name.

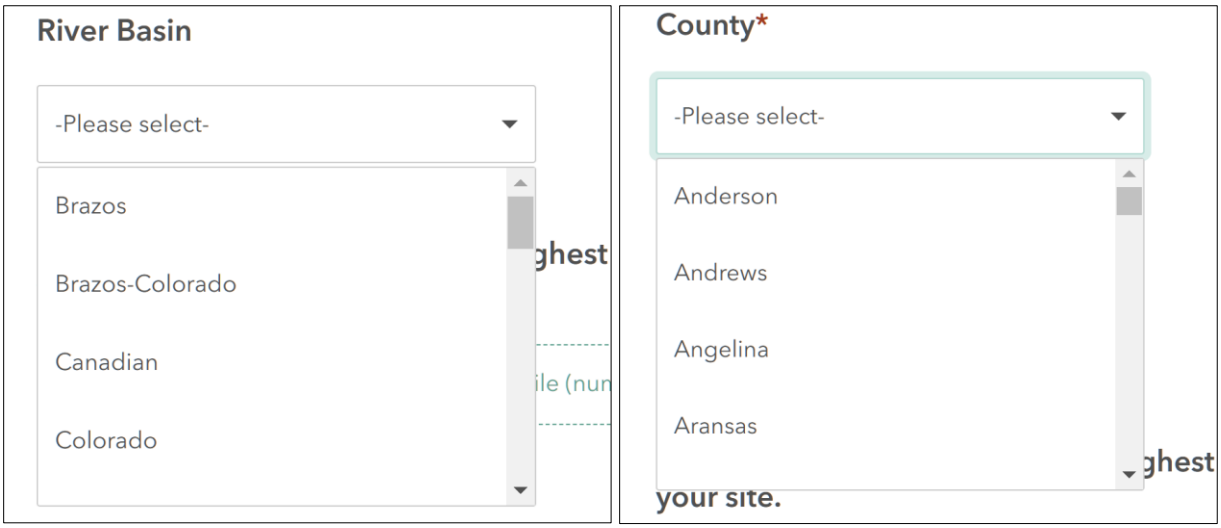

Figure 4. Manual selection of county and river basin in the current Site Request Form

This automation will be achieved by using the pulldata() function in Survey123 Connect, which allows forms to be dynamically linked to ArcGIS Online feature layers (Esri, 2022). This function queries spatial data from these online layers, ensuring that the most recent and accurate data is used. Integrating authoritative online GIS layers will significantly improve the accuracy of the site data while reducing the frequency of manually correcting errors during the review process.

4.1.3 Automating the Addition of Approved Sites to the Water Quality Monitoring Form

Once a site is approved, it must be added to the Water Quality Monitoring Form to allow community scientists to select it for data submission. Currently, this requires manually updating

and reuploading a CSV file in the Survey123 mymedia folder—another process that is time-consuming and inefficient.

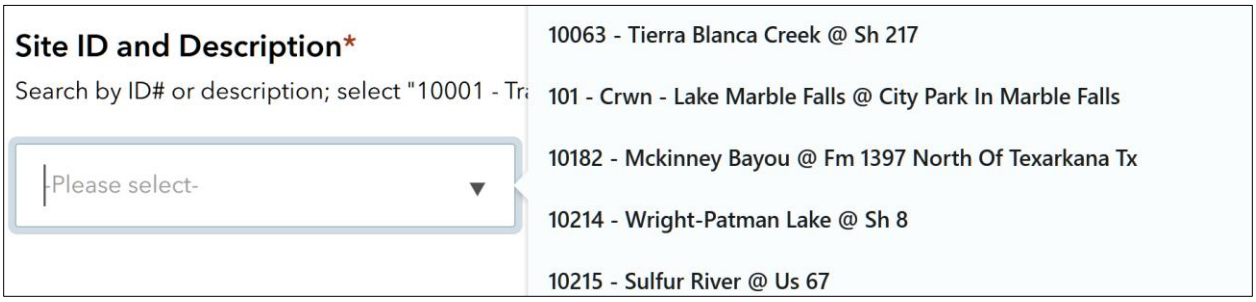

Figure 5. Selection of sites in the Water Quality Monitoring Form

To streamline this process, we will replace the static CSV file with a hosted feature layer view, also known as a "view layer" (Esri, n.d. -b). This View Layer will be a dynamic subset of Sites Feature Layer, displaying only sites with the statuses "active," "inactive," and "approved" (figure 5). By using the pulldata() function in Survey123, the Water Quality Monitoring Form will retrieve site IDs directly from View Layer, eliminating the need for manually updating static site lists. Allowing approved sites to be instantly selectable in the Water Quality Monitoring Form will reduce administrative workload and improve data accuracy.

4.1.4 Implementing Data Validation In the Water Quality Monitoring Form

To prevent errors and ensure data accuracy, the Water Quality Monitoring Form will include an automated validation process. This process will check for values that are outside the expected range for specific parameters seen in figure 2. If a measurement falls outside of a specific range—such as a pH of 15 or a water temperature of 40°C—a warning message will prompt users of the correct range and to verify their entry (figure 6).

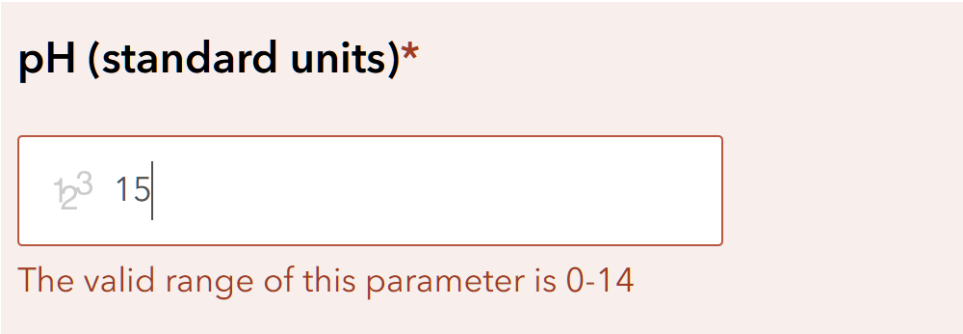

Figure 6. Error message in the Water Quality Monitoring Form

This data validation will be based on two criteria. The first criterion includes global constraints, which will set predefined upper and lower limits for all monitoring sites. The second criterion will use segment-specific constraints, where the form will dynamically retrieve the appropriate TCEQ standard based on the Stream Segment Number. Not all sites will have an associated Stream Segment Number, meaning that the segment-specific parameters will not always be applied. In these cases, only global constraints will be used to prevent unrealistic values. Currently, the Water Quality Monitoring Form includes global constraints on certain parameters, but there are no segment-specific constraints.

To implement this system, the form will dynamically query a TCEQ Water Quality Standards excel spreadsheet that includes the global and segment-specific parameter ranges. While users will receive notifications for potential errors, submissions won't be blocked. This will allow reporting of valid but unusual measurements. Implementing this validation system will reduce errors, improve data quality, and ensure that data aligns with monitoring standards.

4.2 Data Visualization

Another key objective in this project is the visualization of site data through two ArcGIS dashboards: the Texas Stream Team Water Quality Datamap and the Site Request Review Dashboard. Each dashboard will use different sources for their map element to display site data based on its intended purpose.

The Texas Stream Team Water Quality Datamap (figure 7) is used by community scientists and the general public to view site data that is either actively being recorded or has been recorded in the past. Using the View Layer, only sites with the status "active," "inactive," or "approved" will be visible in the map element for simplicity and clarity.

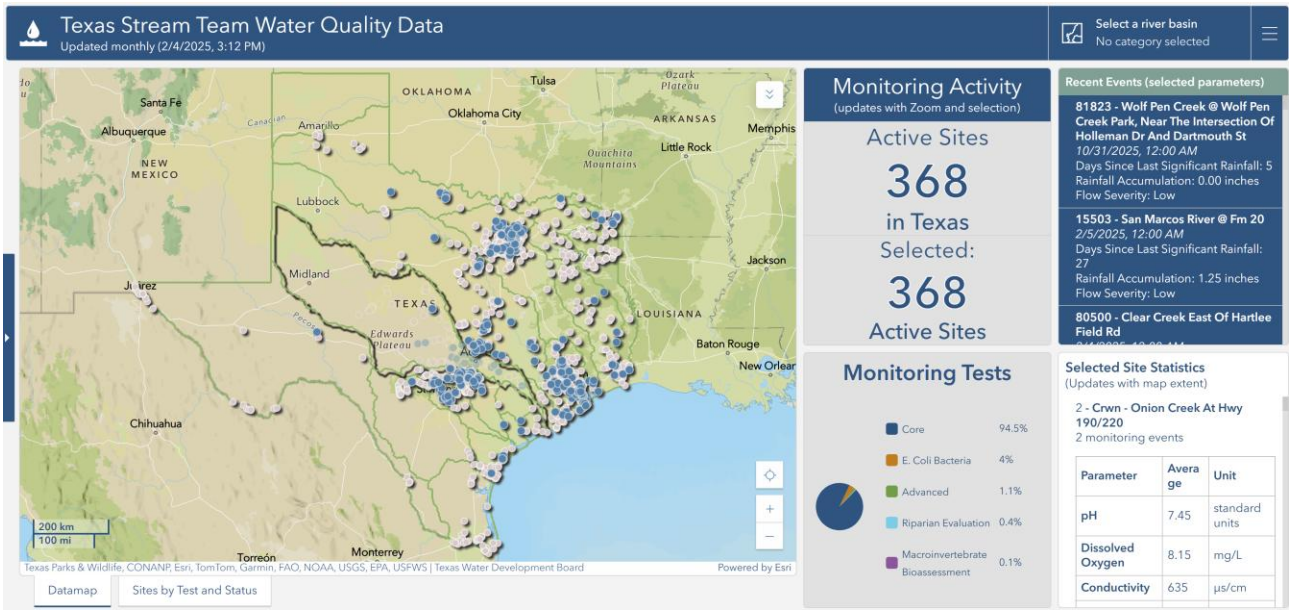

Figure 7. Texas Stream Team Water Quality Datamap

The Site Request Review Dashboard (figure 8) is used by the Texas Stream Team staff to facilitate the site review and verification process. Using the Sites Feature Layer, all site status will be shown: “active,” “inactive,” “approved,” “discontinued,” “new,” “in progress," "staff review,” “needs follow up,” and “remove.” This comprehensive visualization will help staff easily track the site approval process.

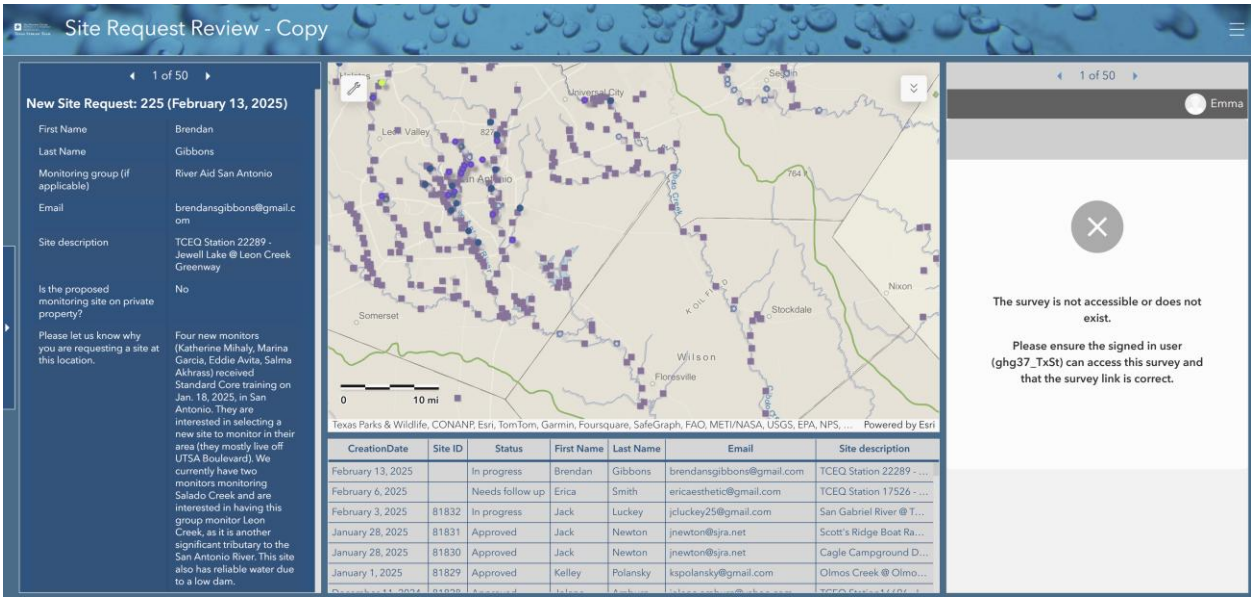

Figure 8. Site Request Review Dashboard

Structuring the map elements for the dashboards in this way will ensure the appropriate site data is shown for its intended users. The public dashboard provides a clean, simplified display for public use while the internal dashboard gives staff full visibility of all site statuses for reviewing and approving sites. These layouts will automatically update as site statuses change, providing faster and more accurate data updates.

4.3 Testing and Validation

To verify that automation, validation, and visualization functions are working properly, we will conduct testing using sample data. The Sites Feature Layer will be populated with test records including all possible site statuses to verify that the map elements used in the dashboards correctly filter and display the correct site status. We will submit test site requests using the Site Request Form to ensure that geographic attributes are correctly autopopulating.

After test sites are submitted, we will manually approve sites within the Internal Site Request Review Dashboard to make sure status updates are correctly reflected in the Sites Feature Layer. We will then verify that approved, active, and inactive sites correctly appear in the View Layer, making them selectable in the Water Quality Monitoring Form.

Data validation rules will be tested by intentionally inputting incorrect values to ensure that warning messages appear for global restraints and segment-specific restraints. Finally, we will submit test monitoring data to confirm that each submission is correctly stored in the Water Quality Monitoring Feature Layer and linked to the correct Site ID in the Sites Feature Layer. Testing all these functions will ensure that we have created an efficient and accurate dataflow from site request to site monitoring.

5. Budget

For a detailed breakdown of the budget, refer to table 3. Salaries are based on current market rates for these positions in Texas, as determined by using two credible sources: ZipRecruiter and Glassdoor (ZipRecruiter, n.d.; Glassdoor, n.d.). Software costs reflect the standard annual rate per user (Esri, n.d. -a; Microsoft, n.d.). The selected laptops are ranked among the top ten for GIS work, with their price representing the average cost of a device that balances portability, processing power, and storage capacity necessary for efficiently running GIS software (Das, n.d.).

Table 3. Budget

WGCC Budget				
Positions	**Weeks**	**Hours**	**Hourly Pay**	**Salary**
Project Manager	5	25	$44.15	$5,518.75
Assistant Project Manager	5	12	$33.60	$2,016.00
GIS Analyst	5	10	$33.60	$1,680.00
GIS Analyst	5	10	$33.60	$1,680.00
Software	**Per Person**		**Annually**	**Yearly Cost**
Esri Dashboard	5		$21,000.00	$105,000.00
Microsoft 365	5		$1,320.00	$6,600.00
Hardware	**Per Person**		**Cost**	**Cost Total**
Razer Blade Pro 17 Laptop	5		$3,790.00	$18,950.00
**Does not included Direct Cost*				
			Total Projection	$141,444.75

6. Timetable

The timetable shown in figure 9 provides an outline of the key tasks that will be completed for this project. This schedule sets clear deadlines to ensure we achieve all project objectives and deliver a functional data workflow within the designated timeframe.

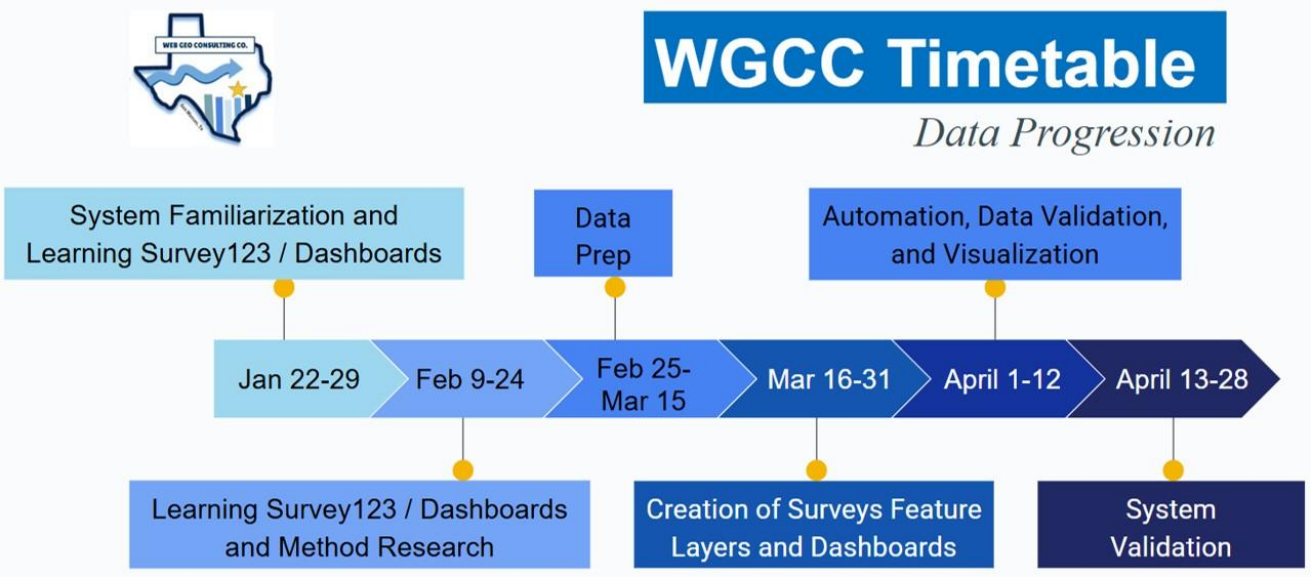

Figure 9. Timetable

Weeks 1-3 (January 22nd to February 8th) will consist of team members learning and further expanding understanding of the current datamap process, and how current surveys, feature layers, data sources and dashboard are involved in this process. Our team will meet with

the client often to confirm workflow understanding and answer all initial questions. During this phase, tasks will be assigned, and a proposal will be drafted outlining our goals, schedule, responsibilities, and project results.

In weeks 4-5 (February 9th- 23rd), we will continue to learn the basic functionalities of Survery123, ArcGIS Online feature layers, and ArcGIS dashboards. As we gain a better understanding of these tools, we will research methods on how these tools can be utilized to achieve our objectives. The proposal will be finalized and presented at the end of this period.

Weeks 6-8 (February 25th to March 15th) are when we focus on preparing the necessary data needed for attribute autopopulation and data verification. We will take note of all authoritative ArcGIS Online feature layer URLs, the appropriate layer indices, and official field names. This information is important to know when writing the syntax for the pulldata() function in Survey123. We will also create the TCEQ Water Quality Standards excel spreadsheet with all relevant information and format it in a way that can be appropriately used for the Water Quality Monitoring Form.

Weeks 9-10 (March 16th-31th) are set aside to begin work on the Site Request Form, Water Quality Monitoring Form, Sites Feature Layer, View Layer, Water Quality Monitoring Feature Layer, and Site Request Review Dashboard. We will first create the two feature layers, which will include all the relevant attributes. We will then create the forms from these existing feature layers. We will model the forms and their questions based on the copies provided to us. We will then create the internal dashboard, also modeled from the copy provided by our client.

Weeks 11-12 (April 1st-12th) will be devoted to data automation, validation, and visualization. We will add pulldata() functions and connect the TCEQ Water Quality Standards excel spreadsheet to the forms. We will also make sure the newly created Sites Feature Layer and Site Request Form are properly embedded into the Internal Dashboard. All components of the project will be made visually attractive, cohesive and readable for both the client and general audience.

Weeks 13-14 (April 13th-27th) are the final weeks of the project where we will be analyzing the data and interoperating results. The project is expected to be almost complete by this time, with only minimal finishing touches remaining. A combination of our process, results, and findings will be amalgamated into the final project and we will prepare for our final presentation.

7. Final Deliverables

A comprehensive report detailing our process, our results, and our findings will be provided April 23rd, 2025. Subsequently, a poster will be created to visually present all survey, feature layer, and dashboard updates to the client. We will outline how the automation and data validation has been completed and walk through the new user process.

A comprehensive table summarizing the deliverables to this project is shown in table 4. Forms will be user-friendly and accurate through data validation and autopopulation, feature layers provide centralized and simplified data management, and the internal dashboard will be simple and intuitive.

Table 4. Final project deliverables

Deliverables	
Forms	Feature Layers
Site Request Form	Site Request Feature Layer
Internal Review Form	Approved/Active/Inactive Sites View Layer
Water Quality Monitoring Form	Water Quality Monitoring Layer
Dashboards	Excel Spreadsheets
Internal Site Request Review Dashboard	Water Quality Standards

8. Conclusion

Through enhanced data automation, validation, and visualization, this proposes a faster and more accurate datamap process for the Texas Stream Team. Achieving our objectives will provide a more accessible and reliable public datamap while also reducing administrative workload. By making these improvements, this project will support the broader impacts of empowering community scientists and contributing to environmental sustainability and water conservation efforts.

9. References

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10. Appendix

- Emma Moffat
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        - Timetable
        - Final Deliverables
        - Conclusion
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    - Introduction
        - Scope
    - Budget
    - References
- Ella Rader
    - Cover Page
        - Logo
    - Introduction
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        - Purpose
    - Data
    - Methodology

    - Timetable
    - Final Deliverables
    - Conclusion
- Noah Lindsay
    - Introduction
        - Summary
    - Literature Review
    - References