Supplemental Information: The NC State Environmental Resource Clinic Student Training Program
PI: Angela Allen

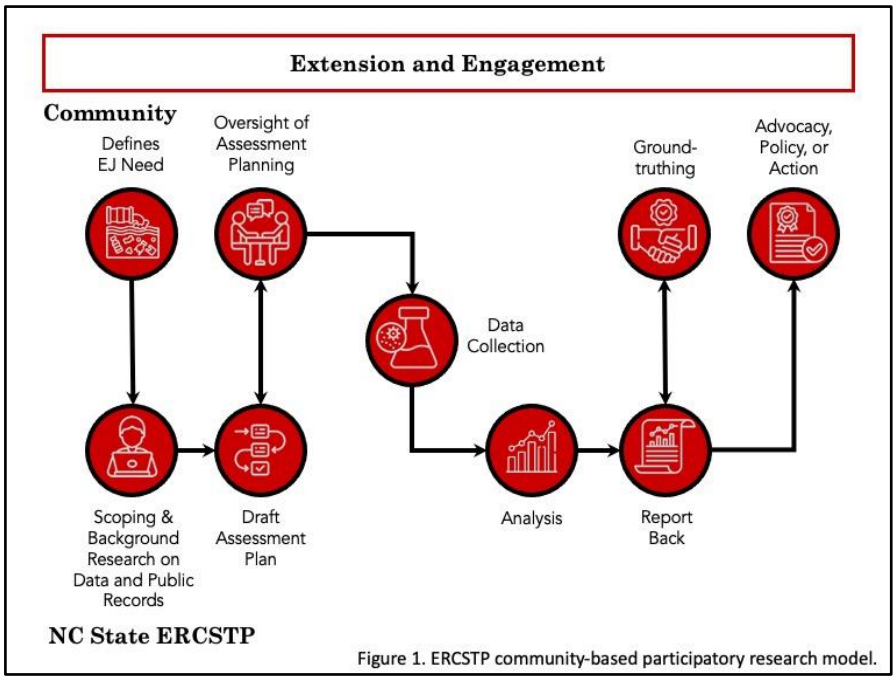


Figure 1. ERCSTP community-based participatory research model.

Project Description

Racial and economic disparities in environmental quality have been well documented in North Carolina (NC) with regard to access to clean water [1-11] and self-governance with regard to environmental decision-making [12, 13]. Several NC-based studies were ground-breaking in their use of community-based participatory research techniques to partner with communities throughout study conception, design, data collection, and interpretation of results [14-16].

Dr. Angela Allen is leading a new effort within the North Carolina (NC) State University ("NC State") Department of Forestry and Environmental Resources (FER) to train our next generation of leaders to identify and address drinking water quality issues in underserved NC communities through the The NC State Environmental Resource Clinic Student Training Program (ERCSTP). Fundamental to the ERCSTP will be hands-on training of undergraduate and graduate students to engage with communities and provide technical support for real-world water quality challenges as part of their education. Students are trained to provide consultation and on-the-ground support to North Carolina communities on water quality: problem scoping, environmental assessment, risk assessment, data interpretation, report-back, and risk communication (Figure 1). Students are taught to center needs voiced by community members to create an equitable support process. Dr. Allen has launched the ERCSTP concept while continuing to grow her partnership with the local organization Partners for Environmental Justice (PEJ). PEJ has sought assistance with assessing ongoing water quality impacts of effluent from the downtown Federal Building into Southeast Raleigh.

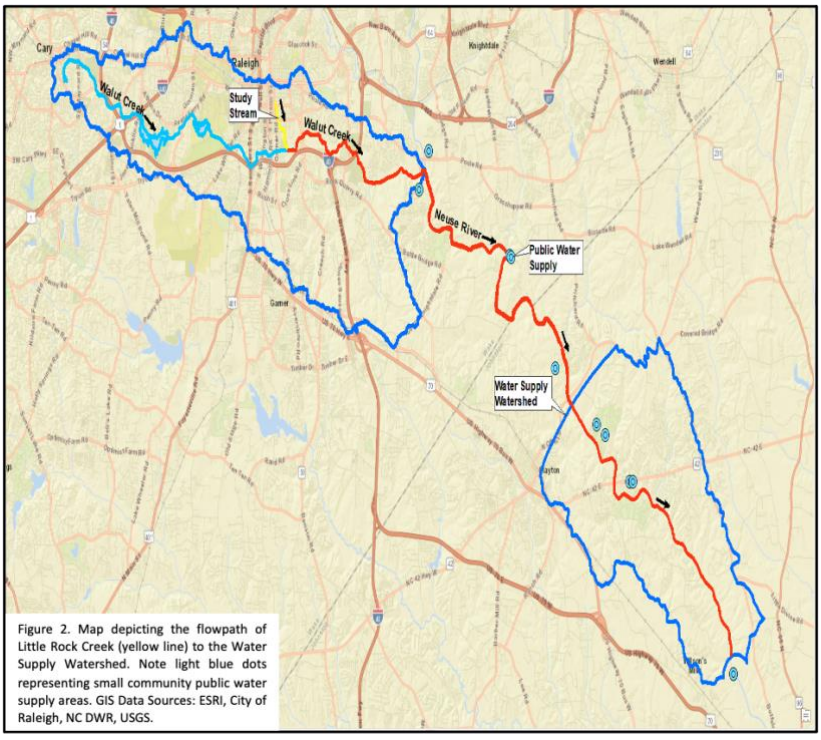


Figure 2. Map depicting the flowpath of Little Rock Creek (yellow line) to the Water Supply Watershed. Note light blue dots representing small community public water supply areas. GIS Data Sources: ESRI, City of Raleigh, NC DWR, USGS.

Walnut Creek feeds into the Neuse River, impacting downstream drinking water systems in Johnston County, including the City of Smithfield. The Walnut Creek Wetland Park, located within the city of Raleigh, has transitioned from marshland to dump land and back. The Rochester Heights subdivision, predominantly composed of African American families, lies adjacent to the Walnut Creek/Little Rock Creek confluence. Over the years, the community-led organization PEJ encouraged cleanup in the region. Eventually initiatives to invest in nearby areas reached beyond the

community and connected to individuals within North Carolina State University (NCSU). Presently, the area houses Walnut Creek Wetland Center, providing nature-based education to the community. Despite efforts to clean up the area, bacterial contamination continues to impact Little Rock Creek, as demonstrated by our preliminary water monitoring efforts (Figure 2). PEJ has posed two questions:

- Does waste from the Sanford Federal Building flow into Little Rock Creek and impact water quality throughout the creek and into the Walnut Creek Watershed?
- Does the recent replacement of the sewer pipes after the Raleigh assessments of poor infrastructure and drainage conditions improve the water quality issues in the area?

This project is designed to train students to collect and interpret drinking water data for community partners and to inform potentially impacted and underserved communities about their water quality through following specific goals:

- Goal 1: Educate, train, and mentor NC State students and community members on assessment of water quality.
- Goal 2: Assess the current water quality along Little Rock Creek by evaluating possible sources of water pollution caused by the Bloodworth Street sewer replacement project.
- Goal 3: Report preliminary findings of water quality issues, local waterway conditions, and solutions to the public.

Figure 3. Research team members from the community and NC State learning sample collection and analysis methods.

Impacts

Goal 1: Educate, train, and mentor NCSU students and community members on assessment of water quality.

Twenty-five (25) student- and community-researchers ("research team members") have been recruited to measure and assess the water quality in Southeast Raleigh since Spring, 2023. The research team members first participate in training about Southeast Raleigh's history, the purpose of the study, and the project details. Recruited students and community members participate in group meetings in which Dr. Allen ensures they understand the principles of water quality. They have journal article discussions as well as Q & A to discuss issues with the basic physical, chemical, and biological parameters.

Dr. Allen trains students in the lab and field to collect and transport water samples. Students are trained to analyze the samples for physical and chemical parameters (dissolved oxygen, conductivity, pH) and for presence of E. coli. All students receive laboratory safety training before graduating to learn calibration, use, and storage of analytical equipment. Each student must demonstrate confidence in each step before Dr. Allen allows them to use the equipment independently. Students develop their own standard operating procedures to ensure they use proper collection, transportation, and temperature requirements, which are approved by Dr. Allen before the research team members graduate to sample collection (Figure 3).

Table 1. E.Coli counts for 2022 and 2023, before and during pipe replacement. Samples were obtained in September-December of each year.

	2022	2023
Sep sample #1	1,119.90	307.60
Sep sample #2	172.5	248.9
Oct sample #1	198.9	579.4
Oct sample #2	478.9	196.8
Nov sample #1	387.3	68.3
Nov sample #2	285.1	116.9
Dec sample #1	272.3	298.7

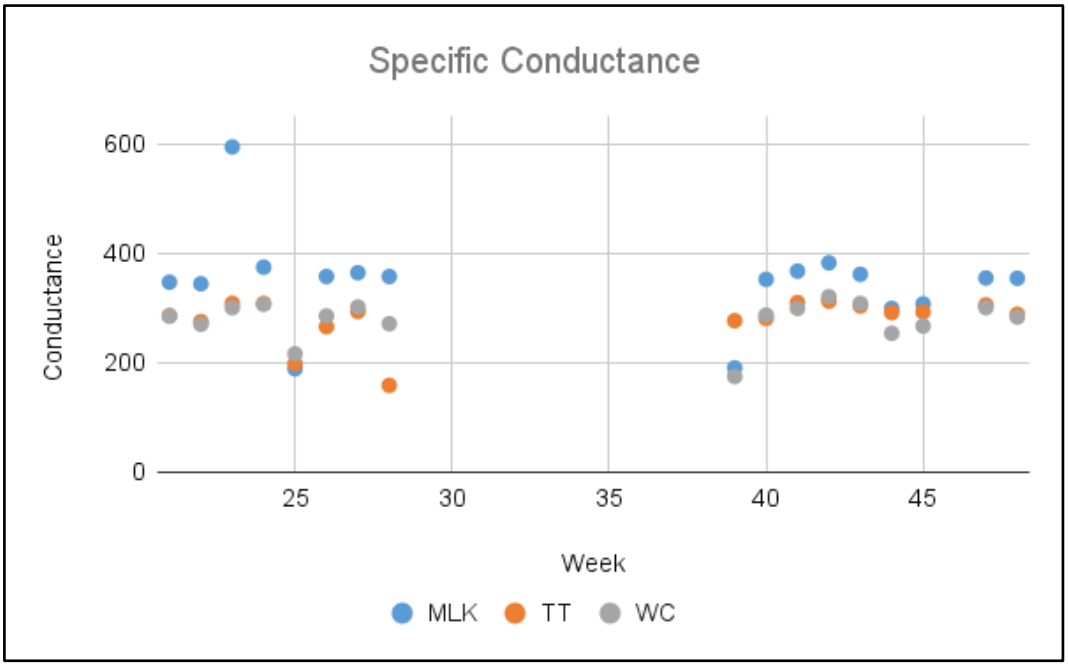
Dr. Allen emphasizes high integrity of data collection, including data security training, good laboratory notebook practices, data management, and incorporation of pictures. Dr. Allen assigns the research team members to groups tasked with statistical analysis and interpretation of collected data and to make recommendations for next steps in the study.

Goal 2: Assess the current water quality along Little Rock Creek by evaluating possible sources of water pollution caused by the Bloodworth Street sewer replacement project.

The research team continues to conduct sampling and analysis for physical and chemical parameters and *E.Coli*. Overall, *E. Coli* decreased by 57% between 2022 and 2023 (Table 1). Ideally for a healthy waterway, a consistent 130 Colony Forming Units (CFU) (1 Most Probable Number (MPN) = 1 CFU).[17] Initial data at the Walnut Creek Wetland Center revealed high levels of *E. coli* contamination, exceeding Environmental Protection Agency (EPA) water quality standards for Class C waters in the downstream samples. *E. Coli* CFUs decreased for four year-over-year sampling periods but increased for three. Continued monitoring of bacterial parameters will indicate if replacing the sewer pipes achieved a reduction in *E. Coli*.

The research team observed specific conductance (SPC) measurements over time at three sites to monitor any viability changes and establish a comparison among the sites (Figure 4). This allows for elucidation of how water quality changes with downstream distance. The MLK site (Chavis Park near Martin Luther King Jr. Blvd) is furthest upstream. We moved downstream to the TT site (bridge near the Trash Trout) then to the WC site (inland area at the Walnut Creek Wetland Center). Our results show that SPC decreases by 19% on average when moving from MLK to TT. When removing the outlier from week 22, SPC decreases by 15.48% from MLK to TT. This indicates a reduction in the presence of ions between Chavis Park/MLK Blvd. and the WC. SPC is nearly constant (<1% decrease) when moving from TT to WC.

Figure 4. Selected specific conductance (SPC) measurements observed between the third week of May (5-3) and the first week of December (12-1) at the Wetland Center (WC), Trash Trout (TT), and Martin Luther King Jr. Blvd. (MLK).



The research team compared Little Rock Creek data with data from a suggested healthy stream located on Centennial Campus (CC) of NC State. Contrary to our anticipated results, higher dissolved oxygen levels have consistently been observed at WC compared with CC. We attribute this finding to greater turbulence and less influence of the built environment at WC.

The research team also participated in several trash collection efforts at the Wetland Center. Inventories suggest possible microplastic pollution along Walnut Creek and Little Rock Creek. This finding has stimulated ideas among the research team members to investigate the extent of microplastics contamination.

Figure 5. Students with the research team presenting findings in scientific fora (top) and to community partners (bottom).

Goal 3: Report preliminary findings of water quality issues, local waterway conditions, and solutions to the public.

The research team members regularly participate in presentations to inform the public of the scientific findings of our work with results, conclusions, and future plans. Public presentations have been given before the City of Raleigh, the National Recreation Foundation, and PEJ. Additionally, the research team members present our findings to the scientific community via symposiums such as the Equity Research Symposium at NC State (Figure 5).

Through the program, the students have learned about the level and type of support that we can provide to under-resourced communities with environmental concerns while helping to improve water quality for the Rochester Heights community. Thus, the students are learning practical skills in real-world research outside of the classroom and laboratory. They are answering community questions through research-based information. Student groups are led by Dr. Allen and community liaisons, who share knowledge of the issues of community concern, lead collaborative study design, provide training on field skills, and guide the Walnut Creek project to completion including sharing of results.

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