For our project, we collaborated with Colten Winters, a Richland County Stormwater Management Division representative, to survey local streams in the Cedar, Crane, and Hollinshead Creek watersheds. Our research aimed to determine the relationship between land use, E. coli contamination, and overall stream health, and identify potential management strategies for alleviating negative effects.

The Richland County Stormwater Management Division works “to promote stormwater drainage and water quality enhancement in order to improve public safety, enhance public health, and increase public awareness.” During the first meeting with our community partner, Colten Winter explained that “Urban stormwater is a leading cause of pollution to fresh and brackish receiving waters, especially fecal bacteria” (NOAA 1998; Smith and Perdek 2004). Many bodies of water across Richland county are facing several health effects caused by runoff from impervious surfaces, faulty infrastructure, and federal neglect. Impervious surfaces are “hard surfaces within a watershed including rooftops, parking lots, streets, sidewalks, driveways, and surfaces that are impermeable to infiltration of rainfall into underlying soils/groundwater” (EPA 2022). Surface runoff carries a variety of chemical pollutants into our streams, such as antifreeze, grease, and oil from cars. There are also home-use fertilizers, pesticides, and other chemicals from gardens, homes, and businesses. Additionally, bacteria from pet waste and failing septic systems as well as sediment from poor construction site management also contribute to stormwater pollution. These pollutants ultimately end up in bodies of water that many people use for swimming, fishing, boating, and as a source of drinking water. Impervious surfaces reduce the land’s ability to absorb water, increasing the volume and speed of surface runoff. This further results in more frequent and intense localized flooding and erosion, which can damage infrastructure. According to the 2021 Report Card for America's Infrastructure, "the impervious surfaces in cities and suburbs are also expanding, exacerbating urban flooding, which results in $9 billion in damages annually… Federal funding, though up in recent years, averages about $250 million annually, which leaves a growing annual funding gap of $8 billion just to comply with current regulations. With few dedicated funding sources, complicated governance and ownership structures, expansive networks of aging assets, increasingly stringent water quality regulations, and concerning climate change projections, the expected performance of stormwater systems is declining". As urbanization expands into rural areas over time, the stream health in these areas gradually decreases. We researched this in hopes to understand more about stormwater issues and management practices by exploring the correlation between urban expansion and sample site contamination.

Colten Winters, the Watershed Program Coordinator for the Richland County Stormwater Management Division, provided us with 29 locations of interest within Richland County. All of the sample sites are located in the North to the Northwestern part of the county within the city limits of Columbia, Irmo, and Blythewood, South Carolina. Our focus areas included Hollinshead, Crane, and Cedar Creeks, which all flow into the Broad River. We divided our group into 3 subgroups to investigate the sample sites at all 3 creeks simultaneously. Each subgroup was responsible for identifying the stream gradient and properly completing the stream assessment forms provided by the Richland County Utilities department for every sample site visit. During the first meeting with our community partner, Mr. Winter briefed us on the concepts detailed in the Richland County Stormwater Management Stream Assessment Manual, and he instructed us on how to properly log our observations using the monitoring packet included in the manual. Additionally, we met with Mr. Winters at sample location TMP 7-0 where he walked us through completing a visual stream assessment. Visitation of the sample sites began in September and wrapped up in October. During this time we visited each site at least twice, once during a dry spell and once after a heavy rain event. We paid close attention to the surrounding area on each visit and documented traffic patterns, residences, utilities, and wildlife diversity. We notated water conditions such as stream flow, odor, and turbidity, as well as a variety of stream characteristics including predominant aquatic vegetation, woody debris, litter concentration, and in-stream structures. We also identified the land use characteristics within a quarter-mile radius of each of our sampling locations. We made detailed observations about the biological and habitual characteristics of the streams and named our greatest concerns regarding the stream's overall health in the future. After we notated our observations, we filled out the scored habitat monitoring sheet according to the guidelines detailed in the Richland County Stream Assessment Manual. This monitoring sheet was used to give our qualitative observations a numerical representation. Additionally, we decided to take pictures of each location so that we could compare photos to reduce subjective bias in our observations. After completing the visual assessment forms, we input our data into an Excel spreadsheet. Since we visited each location twice, we calculated the average score each site received on the scored habitat assessment over both visits. Based on these values, each site was classified as optimal (160 – 200), sub-optimal (110 – 159), marginal (60 – 109), or poor (<60). Of the 29 sampling sites, 9 were classified as marginal, 17 fell into the sub-optimal category, and 3 received optimal scores.

In addition to our observational data, our community partner also provided us with data on E. Coli levels from each of our sample sites. E. coli is a bacteria found in the digestive systems of warm-blooded organisms. According to the CDC, “Fecal coliforms and E. coli are usually harmless. However, a positive test may mean that feces and harmful germs have found their way into your water system. These harmful germs can cause diarrhea, dysentery, and hepatitis” (CDC, Well testing 2009). Furthermore, since fecal coliform is significantly cheaper to test for than similar harmful pathogens, it is often monitored as a water quality indicator. Fecal coliform contamination is often the by-product of waste from pets, livestock, and wildlife, however, it also serves as an indicator of illicit sewage discharge. For this reason, it is important to pinpoint areas of concern quickly so that the sites can be inspected for malfunctioning septic system connections. E. coli is expressed as the Most Probable Number (MPN) of colony-forming units per 100 mL. The EPA recreational water quality standard requires less than 126 MPN (or CFU) of generic E. coli per 100 ml of water (Recreational Water Quality Criteria - US EPA). SCDHEC water quality standards permit a maximum daily E. coli concentration of 349 MPN/100ml and a monthly average of 126 MPN/100ml. There are 26 sites within Richland County that have been monitored by DHEC or MRC for the presence of E. coli from 2016-2021; 25 sites have had at least one event of over 349 MPN/100 mL, 11 sites have a geometric mean of 129 MPN/100 mL, 13 sites are located in high-impervious surface areas, and all 26 sites are located within a 100-year floodplain. Each location was sampled monthly, however, the samples were not taken concurrently which made cross-comparison of sites difficult. For each site, we took an average of the E. coli measurements from January through October 2022 and graphed the Average E. coli (MPN/100 mL) for each of our sample locations. Our analysis revealed that all 29 of our sample locations had an average E. coli concentration greater than 126 (MPN/100 mL), indicating unsafe swimming conditions, and 24 of these locations had an average E. coli concentration greater than 349 (MPN/100 mL). Furthermore, 13 of our sites had an average E. coli concentration greater than 600 (MPN/100 mL), and 5 of our sites had an average E. coli concentration greater than 1000 (MPN/100 mL). Additionally, we graphed the E. coli concentration (MPN/100 mL) of each site over the course of the year. We noticed that E. coli levels were significantly lower during the winter months compared to the summer months. Overall, all of our sample locations had E. coli concentrations indicative of hazardous water quality conditions.

Due to the proximity of sample sites to impervious surfaces, it is important to monitor the impact of impervious surfaces when urbanizing areas, since impervious surfaces change the volume and concentration of pollutants within runoff. While impervious surfaces do have a significant impact on the runoff in a watershed, there is not enough visual evidence to confirm a positive or negative relationship between E. Coli contamination and land use around our sample locations. Since our study resulted in insufficient data to support a statistical correlation between land use and E. Coli contamination at our sample locations, we would recommend that future researchers expand the land use radius to 1 mile, as this may provide better insight into the cause of peak E. coli contamination levels.

In conclusion, preventative actions may be the best solution to mitigate the number of runoff pollutants contaminating sample sites. We suggest that the county invests in integrating permeable surfaces into residential areas when suitable, redirecting rainwater to gardens or other permeable surfaces, and adding more native vegetation in urban areas to reduce and filter pollutants contaminating stormwater runoff.

Over the course of the semester, I learned a lot about proper research methods. This course definitely helped me improve my writing skills, and my ability to communicate information effectively in a large group. The annotated bibliography assignment helped me refine my research skills by forcing me to comb through hundreds of articles from peer-reviewed journals. Although it was a slow and tedious process, I found that the articles became increasingly detailed on specific niche topics as I ventured further down the database rabbit hole. Another skill this course taught me was how to create a Gant chart to divide the workload between members of our group. I had never heard of a Gant chart before this class and I thought it was kinda cool. Also, this was the first class I've taken that used APA style formatting, so I learned a new citation method from this course. I really enjoyed working with our community partner because it made the research we conducted meaningful. Before starting this project, I had very little knowledge about stormwater management. Personally, my biggest takeaway from this project is that stormwater is not treated before it is dumped into local water sources. In regard to our analysis of the E. coli data, it somewhat grossed me out to learn just how dirty creek water actually is because I used to spend hours prowling the neighborhood creeks when I was a kid. Also, as a dog dad, I took a personal interest in how pet waste ends up in our streams. While I always pick up after my dog personally, I live in an apartment, meaning that my dog is always leashed when we are outside. After deliberating on the topic, I hypothesized that E. coli concentrations would be higher in areas surrounded by residences with enclosed yards vs nonenclosed yards because many of these pet owners are accustomed to letting their pets remain outside in the yard unsupervised.

In this project, we formulated a research plan to collect in-situ observational data at 29 locations of interest provided by the Richland County Stormwater Management Division. Our research aimed to determine the relationship between land use, E. coli contamination, and overall stream health. Additionally, we sought to identify potential management strategies for alleviating negative effects. We conducted a thorough analysis of E. coli measurements from each site and discovered that none of the 29 locations met water quality regulation standards.