# A Preliminary Analysis Between Select Water Quality Parameters in Two Urban Rivers in Southeastern Michigan.


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**Abstract:**

Evaluating the water quality of a stream is essential for determining potential sources of impairment. The Rouge and Ecorse Rivers are two urban streams impacted by the land they flow through in Dearborn Heights, a suburban community in Southeastern Michigan. This research sought to discover if any correlations exist between conductivity, salinity, and TDS (total dissolved solids). Measurements were taken during a short period of testing extending from mid to late March. During the testing period weather conditions remained consistent with the exception of light rain one day. Vernier conductivity, temperature, turbidity, and salinity probes were used to monitor water at each of the two sites. A water sample from each site was taken back to the school to determine TDS because it requires an analytical balance (measuring to the nearest milligram) and a drying oven. Analysis of our data indicates strong correlations between conductivity, salinity, turbidity, and TDS. The relationship between these variables could potentially make it more efficient to test water quality parameters by using one to find the other two. This means less time and money to obtain the same data. We recommend that future researchers continue to find additional solutions and ways to streamline testing water quality parameters.

**Key words:** conductivity, salinity, temperature, total solids, turbidity.

**Research Questions:**

In what ways do total solids, salinity, and conductivity correlate? How does rainfall affect the amount of total solids? If we had limited testing, how could we find the other measurements? Can conductivity results be used as a way to inferring total solids and salinity? How do water temperature, salinity, and conductivity correlate? Null Hypothesis 1: There is no way to determine salinity or total dissolved solids using conductivity measurements. Null Hypothesis 2: Rainfall does not affect the amount of total dissolved solids. Null Hypothesis 3: There is no way to find any other measurements with limited testing. Null Hypothesis 4: Conductivity, salinity, and water temperature do not correlate.

The management of water quality in Southeastern Michigan is a very important topic. With so many impervious surfaces, there are very few places water can infiltrate into the ground. A great deal of the precipitation we receive (especially from thunderstorms and cold fronts) and quickly melting snow winds up going directly into our rivers as runoff. Because of this, even a little bit of rain can lead to extensive flooding that more often than not damages homes and businesses, closes roads, and even leads to episodes where raw sewage is emptied into rivers because all of the retention basins are filled. The Middle Branch of the Rouge River is especially prone to flooding and the Edward Hines road that parallels the river (and provides a key transportation route to our area) is often closed for many days per year. The Ecorse River (which is really a small stream as it runs through South Dearborn Heights) is also extremely prone to flooding and what used to be 100-year floods are happening almost yearly. This widespread flooding obviously needs to be studied and solutions found. In this research, we tested salinity, water temperature, total solids, turbidity, and conductivity to determine how they might correlate with each other. These parameters, along with others that weren't measured at this time, help to clarify how each river behaves during a storm event. Total solids helps us understand how much dissolved solids, such as inorganic or organic compounds are found inside a body of water. Turbidity is a measure of water's clarity. Because of the clay that makes up the river beds of both the Ecorse and Rouge River, even just a little increase in the river's volume and velocity typically leads to an increase in turbidity. Salinity is the amount of dissolved salt particles that can contribute to harming plants, animals, and even us humans if found in high enough levels. Salinity is closely related to conductivity, which is a measure of how an electrical current can pass through water. Because inorganic compounds and salt conduct electricity, this parameter has a close relationship with salinity. Salinity has been gradually increasing in the Great Lakes for a variety of reasons but one often cited is the abundant halite (rock salt) we add to our roads each winter as a deicer. We tested for each of these parameters to determine which of these tests would be essential to monitor on a tight budget and time schedule.

**Introduction and Review of Literature:**

Two separate watersheds are present in the City of Dearborn Heights, MI. A continuous monitoring of the water quality for each of these rivers is essential in order to identify and understand the effects that an urban area has on the overall health of these bodies of water. A rigorous monitoring of each river is time-consuming, costly, and only some water quality parameters have a major significance to the health of the rivers. This research seeks to study and analyze which parameters are most essential and those that can be inferred by other measurements. If water quality testing can be streamlined and usable information still obtained it is more likely that water quality testing will take place more often, other organizations have found this to be true (Appalachian Citizens Enforcement Project). A close relationship was found between conductivity and TDS (total dissolved solids) because most of the solids in the water dissolve into ions which can pass electricity. Therefore, it increases the conductivity, they have a direct relationship (APERA INSTRUMENTS). Salinity and conductivity were also found to have a strong correlation. Conductivity changes can show where there is an area of increased saline in the water (Dufour).

**-Research Importance and Implications:**

Improving water quality research and making monitoring more efficient and meaningful is an ongoing concern for both professional and citizen scientists. Streamlining what parameters need to be tested can make monitoring both more time efficient and targeted to the concerns of each river system. If some water quality parameters differ very little or have less overall significance to the quality of a stream then instead of testing for everything, only the most important tests would be completed. This could potentially save a lot of money and personnel resources and also encourage citizen scientists to participate if they have limited time. This research was only conducted during one week as winter transitioned to spring in Southeastern Michigan. Increased longitudinal water quality testing would be necessary to implement before real recommendations could be made. With increased testing over longer time periods it is hoped that student derived algorithms and mathematical relationships could be developed that would allow for the prediction of what happens when one parameter increases or decreases and what effect that has on other water quality tests. One of the most pressing concerns for both the Ecorse and Rouge Rivers is flooding. Evidence of how this impacts water quality will be essential in helping to motivate both city officials, residents, and other stakeholders take action to solve this pressing issue.

**Research Methods:**

Both research sites, the Rouge River and Ecorse River Creek, were taken in Dearborn Heights, MI. The Rouge River is located near Edwards Hines Drive and Hillcrest Elementary School, while the Ecorse River Creek was located near an abandoned building on the right and a semi-truck parking lot on the left. Salinity, turbidity, conductivity, water temperature, and total solids were all taken at this sites, starting with the Rouge at approximately 6:30 pm and the Ecorse River immediately after (the sights were nearly 15-20 minutes apart). Salinity was tested directly at the sight, using the Vernier Probe connected to a Lab Quest. Conductivity was also tested directly at the site, using the Conductivity Vernier Probe connected to a Lab Quest. Water temperature was tested this way as well. Turbidity was taken at home immediately, using the Vernier Turbidity Sensor. Finally, total solids were taken at the school lab using an analytical balance (measuring to the nearest milligram) and a drying oven. Afterwards, the data was inputted into the GLOBE datasheet and then into a spreadsheet to create the graphs comparing these measurements in the Rouge and the Ecorse River Creek (12 graphs in total). This research is beneficial to those who are looking to make an impact on their local communities, solving pollution problems and revitalizing rivers, lakes, and streams in many areas.

**GLOBE Protocols:**

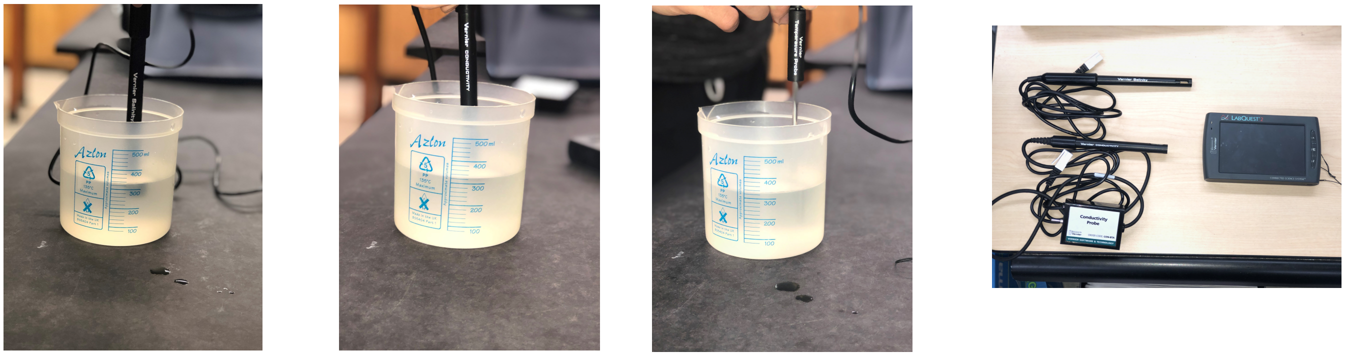



**Figure 1-4 (left to right):** Figures 1,2,3 and 4 show the devices in use of taking the three measurements that were taken on the site. Figure 1 shows the Vernier Salinity Probe. Figure 2 shows the Vernier Conductivity Probe. Figure 3 shows the Vernier Temperature Probe. These devices where all connected to Lab Quest to achieve the data points. Figure 4 shows the Lab Quest (right) next to the Vernier Conductivity Probe (left bottom) and Vernier Salinity Probe (left up).

**Figure 5-6:** Figures 5 and 6 show the sites that these water parameters were taken at. Figure 5 (left) shows the Rouge River site while Figure 6 (right) shows the Ecorse River Creek site. Exact location of the Rouge River: 42.347138 N, -83.276724 W and Exact location the Ecorse River Creek: 42.269087 N, -83.295737 W.

**Figure 7-8:** Figures 7 and 8 show two student researchers following protocol to obtain the water and measure total solids in the student lab.

**Results:**

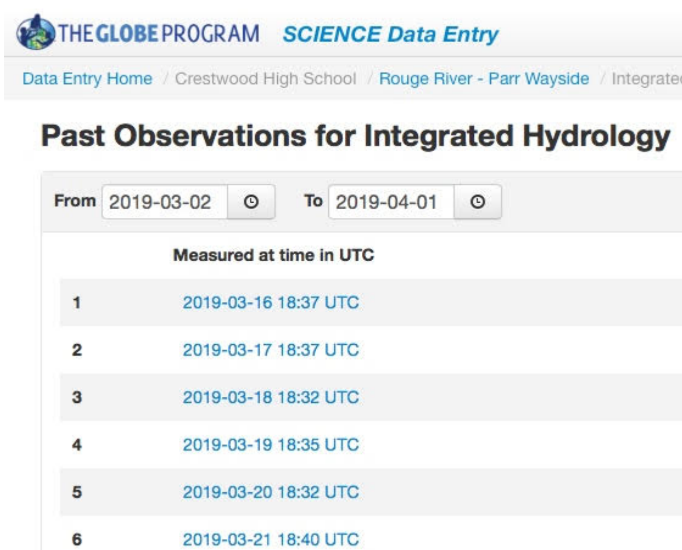



**Figure 9:** Globe Data Entry that has been entered from March 16, 2019 to March 21, 2019.

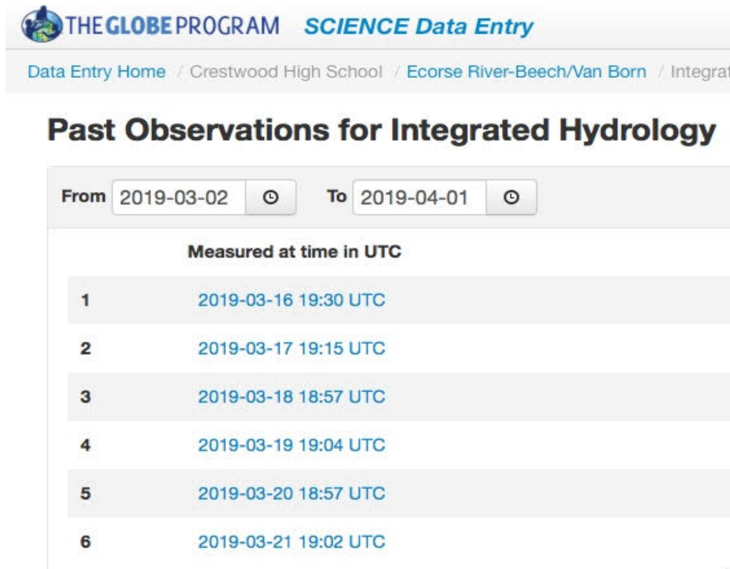
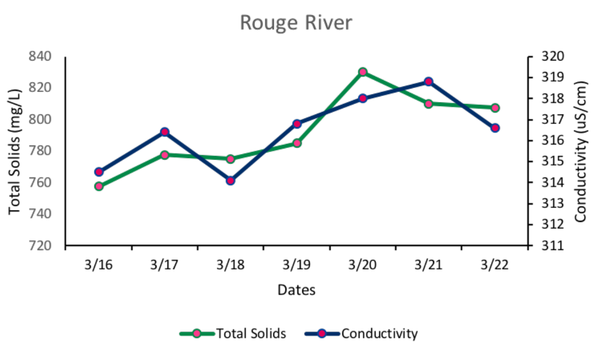



**Figure 10:** Globe Data Entry that has been entered from March 16, 2019 to March 21, 2019.



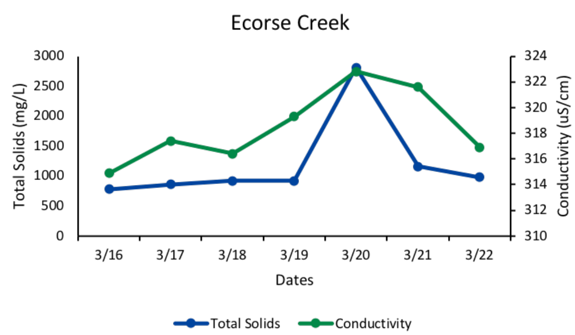




**Figure 11 (left) versus 12 (right): Total Solids versus Conductivity:** The Rouge River had a random relationship between total solids and conductivity. The first two points were directly linear; but as the days went on, as conductivity decreased, total solids increased. The Ecorse River had a totally different relationship. Total solids had a limited variation. That being said, the only day that total solids increased was on the day where it rained approximately 4 mm. This may be because the Ecorse River has a smaller width than the Rouge and has more impermeable surfaces.

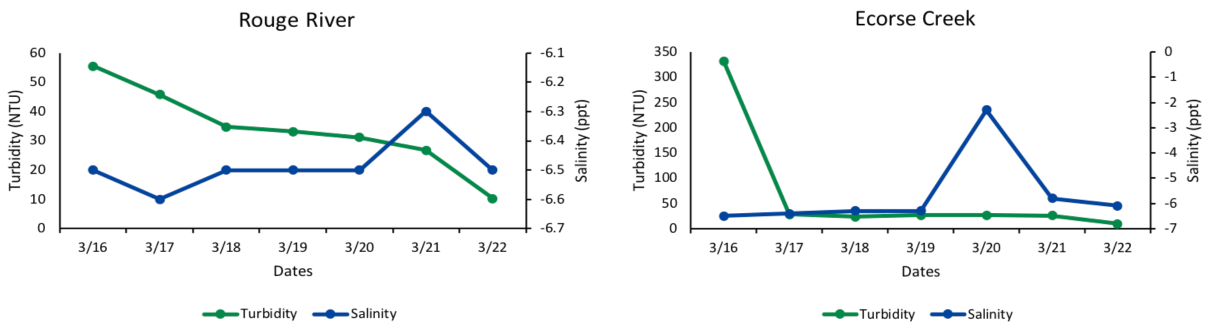



**Figure 13 (left) and Figure 14 (right): Turbidity versus Salinity.** Salinity and Turbidity show a similar pattern in the Rouge River but the Ecorse River shows a much large difference between them. This may be due to the different land types surrounding them. The Ecorse Creek has such a smaller width and is also surrounded by numerous amounts of impermeable surfaces with no or little permeable surfaces. The Rouge River, however, had relatively permeable surfaces surrounding it most places. This contributes to the point that amounts of all measurements will be different.

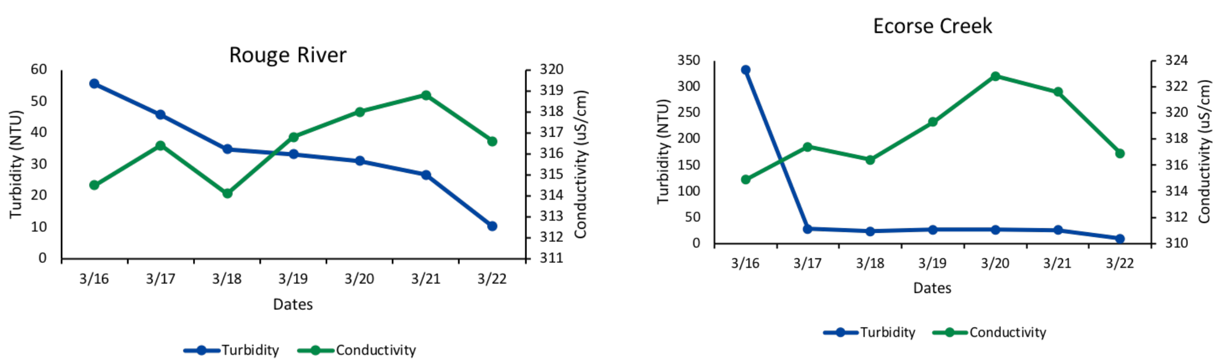
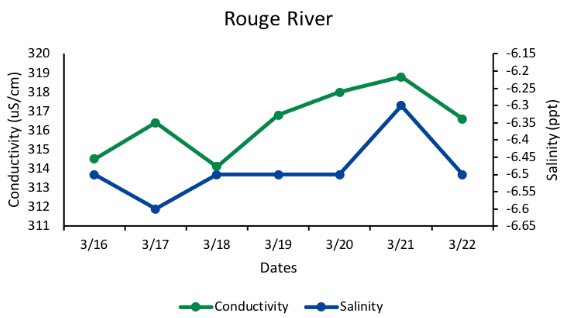



**Figure 15 (left) and Figure 16 (right): Turbidity versus Conductivity.** In the Rouge, conductivity and turbidity are perpendicular to each other, meaning that in the beginning, when turbidity levels were high, conductivity levels were low. As the days gradually went on, the data shifted, making the conductivity levels high but the turbidity levels low. But in the Ecorse, the difference is a little greater. Turbidity stayed almost constant with only the first day very high; while conductivity had a variation. Correlations between conductivity and total solids always linear. The ratio that they create does not only contribute to salinity, but also material counts.



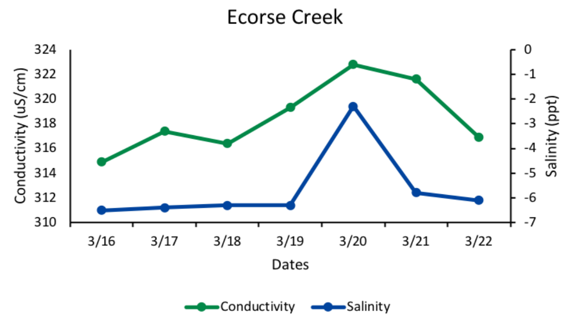
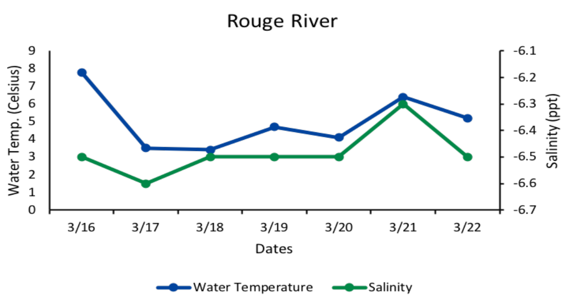




**Figure 17 (left) and Figure 18 (right): Conductivity versus Salinity**. In the Rouge, both parameters increased after the 20th when it rained (we had 4 mm of rain); but in the Ecorse, it increased the day of. This could be due to the fact that both rivers were unable to be measured simultaneously. Every day, we went to the Rouge River around 18:30 (6:30 pm). After that, we would then go to the Ecorse River Creek which was about 10-15 minutes away from the first site.



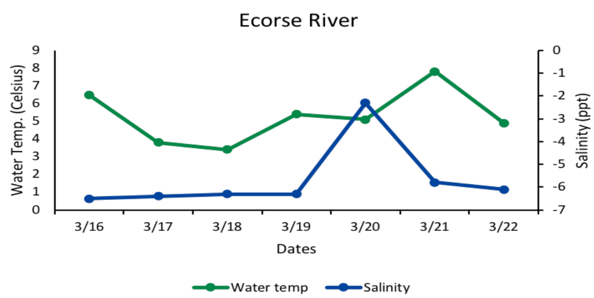




**Figure 19 (left) and Figure 20 (right): Water Temperature versus Salinity**. The Ecorse River had significantly lower amounts of salinity than the Rouge River even though water temperatures at both sites were very similar. Water temperature and salinity have an inverse relationship, meaning that the higher the temperature the lower the salinity in both river systems.

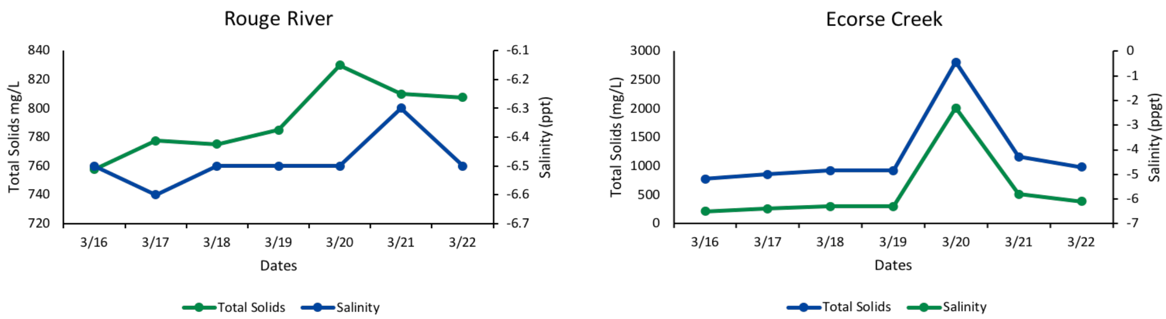



**Figure 21 (left) and Figure 22 (right): Total Solids versus Salinity.** Salt is a particle that contributes to the total solids of a river because it reduces the visibility. The relationship shown above says that in the Ecorse river, it's a direct relationship while in the Rouge, it varies.

**Discussion:**

There were some testing conditions that were beyond our control during this investigation. For example, because we were testing two different rivers, there was a time lag between when each was tested. In addition, although we tried to be consistent with what times we monitored each day, these times varied because of school and family observations. Another limitation was that the test period was only 7 days (1 week). In the future it would be good to have longer test period within each of the four seasons we have in Dearborn Heights, Michigan. We were somewhat inexperienced with the sampling equipment we used and it also took longer to get water samples some days because of the weather. In addition, the GLOBE website does not currently accept data entry from Vernier or Pasco data acquisition devices even though they have been approved by the GLOBE Program for this purpose. To overcome this issue we entered some of the data we recorded under comments in the appropriate spot under general hydrology data entry. With our study, we weren't able to compare our data with any other school or organization due to our limited time. This study led to conclusions that did not support our null hypotheses.

**Conclusion:**

During our one week study period, rainfall appears to increase the amount of total solids measured in a water sample. This is most likely due to the increased addition of both sediments and dissolved minerals as runoff enters the stream and the velocity of the river increases due to an increased volume of water. Increased groundwater entering the stream during these times also adds dissolved minerals. The testing period of this research was too limited to make any definitive conclusions. In order to truly understand how each of the tested parameters affect each of these rivers, a longer longitudinal study must be conducted. Conductivity, water temperature, and salinity all closely correlate with one another. Our monitoring indicates that with increasing water temperature, conductivity increases as well due perhaps to the increased fluidity of water at higher temperatures. Salinity is also changed because the temperature determines how easily dissolved the salt ions are. The salt ions, which are more soluble in warm water, also contribute to conductivity because they break down into cations and anions. Turbidity has a relationship with both salinity and conductivity. Salinity contributes to turbidity because the salt particles in the water reduce visibility. Although other researchers have developed an equation that allows one to way to derive salinity and total dissolved solids using conductivity measurements, we found our results lacking sufficient data points to work with this mathematical relationship. For the present, until a larger sampling effort is mounted at both rivers, we suggest that water quality monitoring efforts continue to report the parameters. One of the goals of this research was to find a close enough correlation between total solids, conductivity, and salinity so that only one parameter could be measured and the others inferred mathematically. We also suggest that additional replicate testing be done for each parameter in case some of the data is an outlier. As we analyzed the data, we determined that conductivity, total solids, and salinity do correlate with each other, therefore we rejected one of our null hypotheses. In fact, all our null hypotheses were rejected showing that conductivity was found to be able to determine the amounts of salinity and total solids in the water without testing for those two parameters and that rainfall does, indeed, affect the amount of total solids in the water.

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**Badges:**

**Be a Data Scientist:** We sampled two separate urban rivers and analyzed our data by importing it into an Excel spreadsheet. This allowed to see which of the water quality parameters we tested were most closely correlated. We found that conductivity, salinity, and turbidity have a strong relationship to each other. In order to decide which parameter(s) are most important to test in the future, more data must be collected.

**Make an Impact:** We observed that the relationships we discovered between our tested water quality parameters are going to be very useful to us as junior watershed commissioners of our city. One of our missions is to work with city officials to implement increased testing during all seasons of the year, not just fall and spring. By choosing only the most significant parameters, we can streamline the process and have time to test more frequently.

**Acknowledgments:**

We would like to thank Mr. David Bydlowski (Wayne RESA and AREN) and Dr. Kevin Czajkowski (Mission Earth-University of Toledo for providing us with some of the equipment used in this research. Several Crestwood High School students also shared their GLOBE expertise with us teaching us how to access the GLOBE website, enter data, visualize data, etc. Sara Komaiha, Ali and Mohamed Eter, and Leanne Alawieh spent countless hours with us teaching us Excel and how to make a poster. Thanks also to Mrs. Johns for helping us and inspiring us to start this project.