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How Akron Affects the Water Quality of the Cuyahoga River

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Abstract:

The purpose of this study was to analyze whether the city of Akron had negative effects on the Cuyahoga river, and determine if the Cuyahoga River was naturally able to remediate these effects downstream. The pollutants measured in this study include hardness, bromine, residual chlorine, iron, copper, lead, nitrate, nitrite, ammonium chloride, total chlorine, fluoride, carbonate, pH, total alkalinity and cyanuric acid. This study was done using water testing strips (JNW Direct) to test the water at four different locations along the Cuyahoga River downstream (North) of Akron. This study found that the city of Akron does have a negative effect on the level of pollutants within the Cuyahoga River. This study found five pollutants measured to either be at or above an acceptable level. The results of this study indicate that the Cuyahoga River is negatively impacted by the contaminants of the urban areas surrounding it, specifically Akron, Ohio. It also indicates that the river does not succeed in remediating these pollutants by itself as it flows towards Lake Erie.

Introduction:

Water quality is taken for granted by many people, but the truth is that many rivers and public waters are struggling to maintain high quality water due to human causes (Stradling and Stradling, 2008). Since 1969 the Cuyahoga river has been known as one of the problem rivers in northeast Ohio, mainly for its low water quality and bad reputation. 1969 is the year that the Cuyahoga river shocked citizens of the United States by catching fire and burning for twenty minutes. (Stradling and Stradling, 2008). The news coverage of this monumental event sparked concern for the river's quality as well as effects on the ecosystems and people it serves (Stradling and Stradling, 2008). Ever since, the river has been undergoing various remediation

practices and projects to try and clean the river's waters and restore its natural beauty and value to the nearby ecosystems (Stradling and Stradling, 2008).

In this research project, I investigate how the city of Akron affects the water quality of the Cuyahoga River in the twenty-first century, and how well the river naturally remediates pollution from the city. To do this I measured water quality at four sites differing in distance downstream from Akron.

Water quality can be affected by many different pollutants. These could be heavy metals, chemicals, or even sound or temperature, and each contaminant has its own effect on the ecosystem and quality of the water in the river (Sutadian et al. 2016). Some pollutants are more prominent in urban areas, and can affect rivers in these areas. In my study, I was particularly looking at the contaminants that would negatively affect humans consuming this water, so I used human water drinking test strips to test the water samples. The Cuyahoga river flows into Lake Erie, north of Ohio, which many communities rely upon for their water supply. The better the water quality is, the healthier the people and the surrounding ecosystems will be.

Water quality "can be classified into three broad categories, namely physical, chemical and biological" (Sutadian et al. 2016), with parameters for each category that are acceptable for different uses, such as drinking or fishing. In this study I am particularly looking into the chemical aspect of water quality. For this reason I wanted to look into the levels of pollutants within the Cuyahoga River. This allowed me to take a closer look at the water quality of the river as it remediates the effects of city pollution.

In this research project, I delve into the water quality of the Cuyahoga River located in northeast Ohio, as it leaves the city of Akron. The question I want to answer in this project is how might the city of Akron be affecting the water quality of the Cuyahoga River, and how long after leaving the premises of the city, in miles, would it take to mitigate these pollutants by natural means.

Overall this study concluded that there were five pollutants that were at an elevated level throughout, and seven that were zero or low ranges. This leads me to believe that the Cuyahoga river does experience negative effects from the city of Akron itself, and due to many sources of pollution, the river struggles to remediate these issues naturally.

Methods:

Image 1: showing a test strip compared to the provided results chart.

To evaluate how water quality varied with the distance downstream from Akron, OH, I took water samples from four different locations, from mile marker twenty four to twenty nine (River miles to from lake Erie), along the Cuyahoga River on November 2, 2022 and November 16, 2022. These specific points were chosen based on their accessibility as well as their position along the Cuyahoga river, as the Cuyahoga river flows north towards Lake Erie. Two dates were used to provide additional data as well as observe any changes to the sites. Some of these commonly changing factors include temperature, due to seasons changing, as well as other measurements that can affect the amount of dissolved solids in water, such as a snow melt or rain. Combined sewer overflows are utilized by many sewer systems in cities. This type of system uses overflow pipes to relieve pressure from the sewer system in times of high influx, leading to raw sewage being dumped into the river. Snowmelt or high rain events could lead to combined sewer overflows (CSO's) being opened

Image 2: Collection points for water samples. Samples were taken on November 2 and November 16th 2022. Flow goes from right to left (towards Cleveland, away from Akron).

along the Cuyahoga river surrounding Akron, affecting the water quality drastically. The CSO's in Akron are approximately eight river miles upstream from the sampling sites in this study.

Water samples were taken from the river, using access points from the Cuyahoga River Water Trail. At each site a vial of water, approximately one ounce of fluid, was taken from the side of the river closest to the access site from a well mixed flowing area. These vials were then tested using water test strips (JNW Direct) for the levels of hardness, bromine, residual chlorine, iron, copper, lead, nitrate, nitrite, ammonium chloride, total chlorine, fluoride, carbonate, pH, total alkalinity and cyanuric acid. The results of each strip were photographed and then compared to the chart provided on the test strip package to determine the level of contaminants, shown in image 2. These contaminants are substances that, if present within a water source, can be damaging to an organism ingesting or coming into contact with the water. Image 2 above shows the four collection sites used on the Cuyahoga river water trail and the addresses of each.

Results and Discussion:

Data from 11/2/22												
Site	Distance from Akron	Hardness (ppm)	Bromine (ppm)	Residual Chlorine (ppm)	Nitrate (ppm)	Total alkalinity	Ammonium Choride (ppm)	Total Chlorine (ppm)	Flouride (ppm)	Carbonate (ppm)	pH	Cyanuric Acid (ppm)
Oxbow Area	3.6 miles	50	10	0	0	0	100	1	10	0	6	0
Lock 29	16 miles	120	6	0.5	10	120	100	1	0	0	6.8	10
Boston Store	17.9 miles	120	6	0	0	180	100	0.5	10	0	7.6	10
Red Lock	20.4 miles	120	2	0	0	80	100	0.5	0	0	6.8	10
Data from 11/16/22												
Site	Distance from Akron	Hardness (ppm)	Bromine (ppm)	Residual Chlorine (ppm)	Nitrate (ppm)	Total alkalinity	Ammonium Choride (ppm)	Total Chlorine (ppm)	Flouride (ppm)	Carbonate (ppm)	pH	Cyanuric Acid (ppm)
Oxbow Area	3.6 miles	50	1	0	0	80	100	0	10	40	6.8	0
Lock 29	16 miles	50	1	0	0	120	100	0	0	40	6.4	0
Boston Store	17.9 miles	50	1	0	0	80	0	0	0	40	6.8	0
Red Lock	20.4 miles	50	0	0	10	80	100	0	0	40	6.8	0

Table 1: Data results of the study, measures of pollutants, iron, copper, lead, and nitrite removed. Orange indicates at maximum acceptable level, red indicates over acceptable maximum level.

The contaminants of iron, copper, lead, and nitrite all showed net zero values within the water, and have been removed from table 1. This is a beneficial quality of the water as iron, copper, lead, and nitrite are all contaminants that can be harmful if present in even small amounts. The test strips used did show if the reading were zero, so I could see the difference between a zero reading and a 5ppm reading based on the strips.

Other values to note were the ammonium chloride, cyanuric acid, and fluoride values. On both dates of collection, there were ammonium chloride values of 100 ppm at three out of four sites. To be considered healthy, the ranges of acceptable levels are zero for ammonium chloride and fluoride. Cyanuric acid however can range up to 50ppm and still be acceptable, according to the water test strip chart provided by the manufacturer. Cyanuric acid and fluoride were both present on both dates, but in small amounts of 10 ppm. There were slightly elevated levels of fluoride and ammonium chloride outside of the acceptable range, but not far enough to cause much concern. These chemical pollutants are most likely the result of water treatment center runoff.

Acceptable levels (ppm)	Maximum level found	Maximum acceptable level	Amount of maximum level
Bromine	10	0	10 times max level
Hardness	120	120	at max level
pH	7.6	7.2	1.05 times max level
Ammonium Chloride	100	0	100 times max level
Fluoride	10	0	10 times max level

Table 2: Indicates the maximum acceptable amount of each contaminant (as indicated by test strip manufacturer), and the amount of this maximum acceptable level reached.

I found two of the contaminant measurements to be particularly informative about changes in water quality as the river flowed away from Akron. I determined whether the values were especially informative by comparing the measured values to the acceptable values listed on the water testing strips. The first measurement that was insightfully important was the bromine values. Shown in the figure are the values that were collected at each test site. On both dates of collection, there were levels of bromine present in almost every sample. On the first collection day, there were relatively low levels of bromine in

the water samples, reaching a maximum level of 1 ppm and there was a minimum value of 0 ppm, and on the second day of collection there was a minimum value of 2 ppm. On the second day of collection, there were significantly higher levels of bromine, starting at 10 ppm at the closest site to the city. However on both days there was a drop off of bromine levels as the river flowed away from Akron. The second value that stood out was the hardness values. As depicted in the figure, on November 2nd, 2022 the hardness levels started at 50 ppm, and increased to 125 ppm as the river flowed farther away from the city. On November 16th, 2022 however, the hardness stayed at 50 ppm at all collection sites. The level of hardness did range from soft to moderately hard, then hard and back down to soft (Sengupta, 2013). This indicates a wide range of amounts of dissolved ions in the water of the river, which can have varying negative health effects (Sengupta, 2013).

The pH ranged from 6-7.6, which is a slightly wide range for water pH. Neutral is 7, which is typical for water. “Normal rainfall has a pH of about 5.6—slightly acidic due to carbon dioxide gas from the atmosphere” (USGS, 2019), which can lower the pH of the river slightly. This measured range is slightly out of the preferred range, and could be due to a number of factors, as discussed earlier. The effects of this range are discussed further below.

Conclusions:

The contaminants found in the study can have many negative effects on the ecosystems and ecology of our rivers as well as on the human population, should they decide to consume this water. Each contaminant has an acceptable level to consume, and above or below this level could have negative effects on

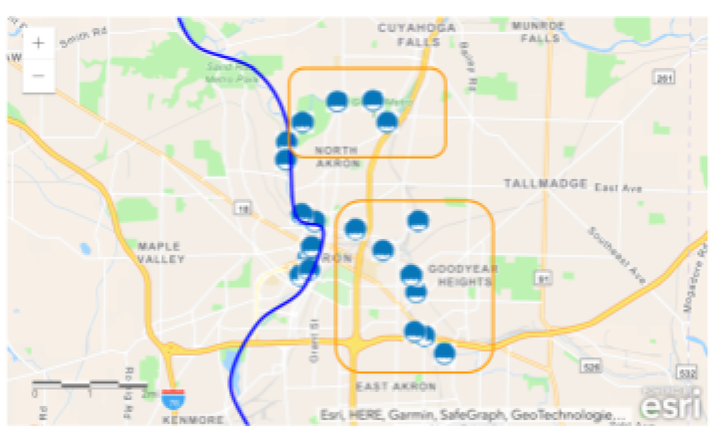

Image 3: A map of the combined sewer overflow sites within Akron along the Cuyahoga River. Cuyahoga river in blue, CSO's on streams feeding to the Cuyahoga river in orange.

the ecosystem. This study is only a snapshot of the water quality of the Cuyahoga river overall, but can provide insight into the overall health of the river.

Overall this study found that the water quality of the Cuyahoga river could use some remediation for a select few pollutants. Other pollutants that were tested showed acceptable levels and are not a cause for concern at this time.

Bromine containing waters can be concerning for both the humans and animals in an ecosystem. Specifically for humans, “During the treatment of bromide-containing waters, disinfection by-products (halo organic compounds) emerge, and some of them are considered to be carcinogens” (Winid, 2015). This is concerning because these bromine containing waters will need to be cleaned, and this will produce carcinogens (Winid, 2015). These carcinogens should not be consumed as they could cause cancer. This means that the treated water would then not be viable for safe consumption. Bromine “is one of the elements, which most often leads to an increased risk to human health, at least 11 different pathologies are associated with the element.” (Perminova, 2020). This is because though bromine is a necessary element, in excess amounts this element has negative effects on all that consume it (Perminova, 2020). These multiple diseases and effects could be prevented or minimized by lessening the bromine additives being put into the environment.

Bromine is a contaminant that is most often introduced into the environment from anthropogenic sources. It has been found that “There are numerous anthropogenic factors responsible for bromine presence in urban and rural areas, including the presence of waste water, leaks in the sewage systems, pesticide and road de-icers” (Winid, 2015). Akron is a city that still uses a combined sewer overflow system. This means that in times of increased influx of water into the wastewater system, like a bad storm, there are outflow pipes that will open and raw sewage will spill into the Cuyahoga river to release strain on the wastewater system (Akron Waterways Renewed, 2023). This in turn will dramatically increase the levels of bromine, as well as many other contaminants, in the waters of the Cuyahoga river. The city of Akron has

determined that these CSO's are detrimental to the water quality of the Cuyahoga River and have begun a project to remediate this. Since this project has been underway, "the conditions of Akron's waterways continue to improve" and there has been a "resurgence of the Great Blue Heron along the Cuyahoga River." (Akron Waterways Renewed, 2023).

The hardness levels found in my study was another important reading to evaluate. The hardness of the water ranged from 50ppm to 120ppm. Recently, "Several epidemiological investigations have demonstrated the relation between risk for cardiovascular disease, growth retardation, reproductive failure, and other health problems and hardness of drinking water." (Sengupta, 2013). The USGS classifies hardness of water as "0 to 60 mg/L (milligrams per liter) as calcium carbonate is classified as soft; 61 to 120 mg/L as moderately hard; 121 to 180 mg/L as hard; and more than 180 mg/L as very hard" (Water Science School, 2018). This means that there was mostly soft water within my study, but there were instances of moderately hard and hard water. This is concerning because consumption of this water can cause many health effects for humans as well as animals that use this water for survival. Reduction in the hardness of water would be beneficial to prevent these diseases from occurring in large numbers.

When analyzing the pH range, (7.6-6) the lower, more acidic, ranges could be due to a number of factors such as acidic rain, runoff from industrial sites or roads, and many other factors (USGS, 2019). This difference in pH could also present a stressor for the fish and organisms that live in the river, as all aquatic organisms have a preferred range of pH and if the water pH ranges out of that, it can cause excessive stress or even death of the fish.

After completing this research project, there are a few things that could have been done differently, or researched more. It would have been helpful to have more data points along the river, possibly spinning a larger length of the river. This would have provided a more in depth view of the pollutants in the Cuyahoga River. In addition to this, future research could be conducted to include soil samples of the river. This information would be helpful in showing the buried contaminants that may be present in the river.

When the Cuyahoga river flows away from the city of Akron, it does not see a drastic increase in overall water quality, but many pollutants did slightly improve or were absent entirely. From my research, it took approximately 17.9 miles for the river to see the most benefits from natural purification of the water. Overall there were five measurements of pollutants that were at an elevated level throughout, and seven that were zero or low ranges. This leads me to believe that the Cuyahoga river does experience negative effects from the city of Akron itself, but it still possesses the ability to slightly clean itself, when presented with enough mileage from the city.

References

"Hardness of Water Completed." *Hardness of Water | U.S. Geological Survey*, U.S. Geological Survey, 11 June 2018, https://www.usgs.gov/special-topics/water-science-school/science/hardness-water.

"Impact & Benefits." *Akron Waterways Renewed!*, Akron Waterways Renewed, 2023, https://www.akronwaterwaysrenewed.com/impact-benefits.

Perminova, Tatiana, et al. "Bromine in the Natural Environments of the Tomsk Region and Its Toxicity Assessment." *Université de Technologie de Troyes; Université polytechnique de Tomsk (Russie)*, 2020.

"Ph and Water." *PH and Water | U.S. Geological Survey*, Water Science School, 2019, https://www.usgs.gov/special-topics/water-science-school/science/ph-and-water.

Sengupta, Pallav. "Potential Health Impacts of Hard Water." *International Journal of Preventive Medicine*, U.S. National Library of Medicine, Aug. 2013, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3775162/.

Stradling, David, and Richard Stradling. "Perceptions of the Burning River: Deindustrialization and Cleveland's Cuyahoga River." *Environmental History*, vol. 13, no. 3, 2008, pp. 515–535., https://doi.org/10.1093/envhis/13.3.515.

Sutadian, Arief Dhany, et al. "Development of River Water Quality Indices—a Review." *Environmental Monitoring and Assessment*, vol. 188, no. 1, 2015, https://doi.org/10.1007/s10661-015-5050-0.

Winid, Bogumiła. “Bromine and Water Quality – Selected Aspects and Future Perspectives.” *Applied Geochemistry*, vol. 63, Dec. 2015, pp. 413–435., https://doi.org/10.1016/j.apgeochem.2015.10.004.