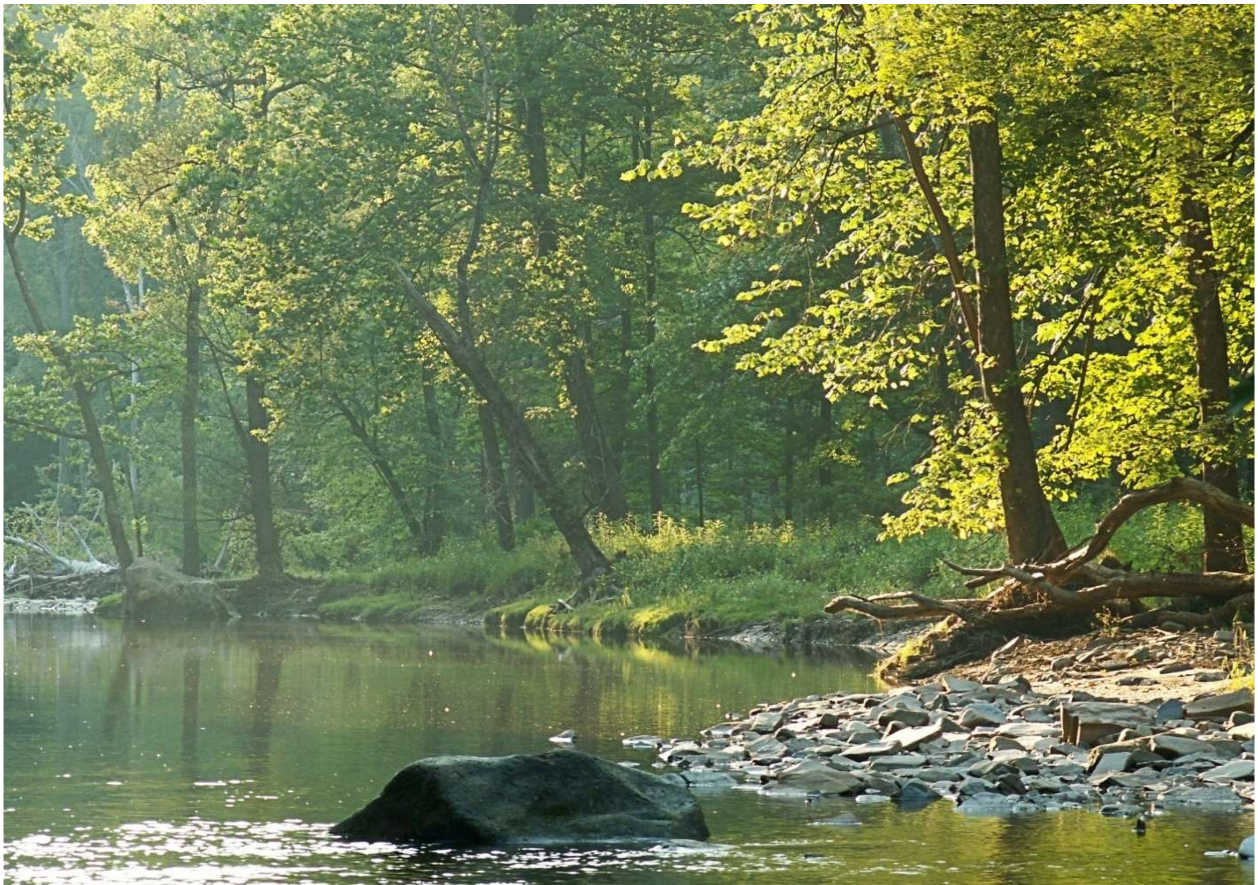

Tinker's Creek and Brandywine Creek Watersheds 2021 Water Quality Report

Acknowledgements

Tinker's Creek
WATERSHED PARTNERS
Rediscover • Respect • Revitalize

Tinker's Creek Watershed Partners (TCWP) would like to acknowledge the following staff and NOWCorps member for their contribution to our water quality monitoring program:

- Kelli Herrick
- Kate Chapel
- Kipp Dietrich

Additionally, TCWP is grateful for the assistance of our watershed volunteers. Without the aid of our volunteers, our monitoring program could not continue to grow from year to year. TCWP would like to acknowledge the following watershed volunteers for their ongoing stewardship:

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- Elise Taylor

TCWP would like to acknowledge its partners for their roles in stream restoration and protection efforts throughout the watershed, including Northeast Ohio Regional Sewer District (NEORSD). Ohio Environmental Protection Agency (OEPA), US EPA, Cuyahoga River Area of Concern (AOC) Advisory Committee, Dominion and Western Reserve Land Conservancy, and the Central Lake Erie Basin (CLEB) collaborative.

The Twinsburg Wastewater Treatment Plant's Lab and staff generous donated their time and provided data analysis for our *E. coli* samples.

Table of Contents

Introduction

About TCWP

Tinker's Creek Watershed Partners (TCWP) is a non-profit, 501(c)(3) watershed organization officially established in 2006. Our mission is to protect and restore water quality and habitats of the Tinker's Creek and Brandywine Creek watersheds through community partnerships. The Tinker's Creek watershed drains 96.4 square miles and is the largest tributary to the Cuyahoga River. The watershed area spans 24 communities in Cuyahoga, Summit, Portage, and Geauga counties. The Brandywine Creek watershed spans approximately 27 square miles in Cuyahoga and Summit counties.

TCWP is governed by 15 dedicated volunteer Board of Directors who bring a variety of expertise in the fields of stormwater management, environmental education, engineering, natural resources, conservation, planning, and economic development. TCWP is guided in their efforts to protect and restore the watershed and educate the public by four Ohio and U.S. EPA endorsed nonpoint source implementation strategic plans (NPS-IS Plans). Each plan encompasses a subset of the Tinker's Creek watershed and Brandywine Creek watershed. They can be found under the Information tab. The group's mission along with the NPS-IS Plans, shaped the goals of TCWP.

The goals of Tinker's Creek Watershed Partners are to:

- Increase the understanding of community officials and the public regarding the natural and monetary value of protecting their water resources
- Promote low-impact and conservation development practices that balance environmental integrity with human development
- Educate watershed communities about their daily activities and habits which negatively impact their environmental surroundings and provide alternative approaches to those practices
- Encourage a no-net-loss wetland mitigation policy where mitigation remains localized within the watershed rather than outsourced to other watersheds
- Lead a watershed -based approach to decision making that advances the concept of connectivity between the different political jurisdictions within the watershed
- Increase recreational opportunities by connecting greenways, corridors, and bike paths between the different jurisdictions within the watershed

Program Overview

In 2018, TCWP was able to begin a pilot water quality monitoring program with the assistance of Earth Echo International as well as Dominion Energy and Western Reserve Land Conservancy. Earth Echo International donated water quality test kits that allowed volunteers to measure temperature, pH, turbidity, and dissolved oxygen. Through Dominion Energy and Western Reserve Land Conservancy's Watershed Mini Grant Program, TCWP was awarded funds to purchase additional supplies for the water quality monitoring program, including HDPE bottles, chest waders, and an Oakton DO 6+ portable dissolved oxygen meter.

During the pilot year of the program, TCWP utilized volunteer and staff assistance to collect 10 samples at 10 different sites between June 3 and August 19. This pilot year allowed us to work through access, feasibility, and technical issues. TCWP also forged its partnership with Twinsburg Wastewater Treatment Plant (WWTP) for sample analysis in 2018.

2019 served as the first official year of water quality monitoring throughout Tinker's Creek watershed. TCWP expanded the program to sample 12 sites each month from May through September. TCWP relied heavily on volunteer help to meet these monitoring demands at nine of these sites.

We continued to study our watershed in 2020 with 12 sites each month from May to September. Our volunteer force expanded during this year, and we are so grateful to the folks that spend time with us each month and each season to help us better understand our watershed. With multiple years of data, we will be able to start seeing trends and making comparisons.

2021 was a big year for our water quality monitoring program. We removed one sampling site in Tinker's Creek. We included an additional five sites to create a larger sampling area and to better determine health of our watersheds. The new sites are located in the Brandywine Creek Watershed. Two sites were located on Indian Creek (a major tributary) and the final three sites were located on Brandywine Creek for a total of 16 sites. 2021 was also the year for new equipment as TCWP purchased a YSI Quatro Multiparameter probe and a Hatch pH monitor. The new equipment will increase the accuracy and quality of our data set and thus, better help us monitor the watershed. As in previous years we would not be able to collect this data without the help of our wonderful volunteers. We hope that the data we all collected together will continue to allow us to monitor and understand changes within the watersheds we serve.

Program Goals

TCWP's water quality monitoring program serves multiple purposes. By utilizing volunteer assistance, TCWP is able to provide stewardship opportunities for citizen scientists throughout the watershed. Volunteers who adopt particular sites also serve as a type of early warning system. These volunteers visit the same sites each month during the program, so they gain a sense of what is "normal behavior" for that site. If any water quality parameters come back as unusual, any atypical discharge enters the stream, or the surface of the creek looks oily or otherwise polluted, volunteers can take action and report these potential issues to TCWP and surrounding municipalities.

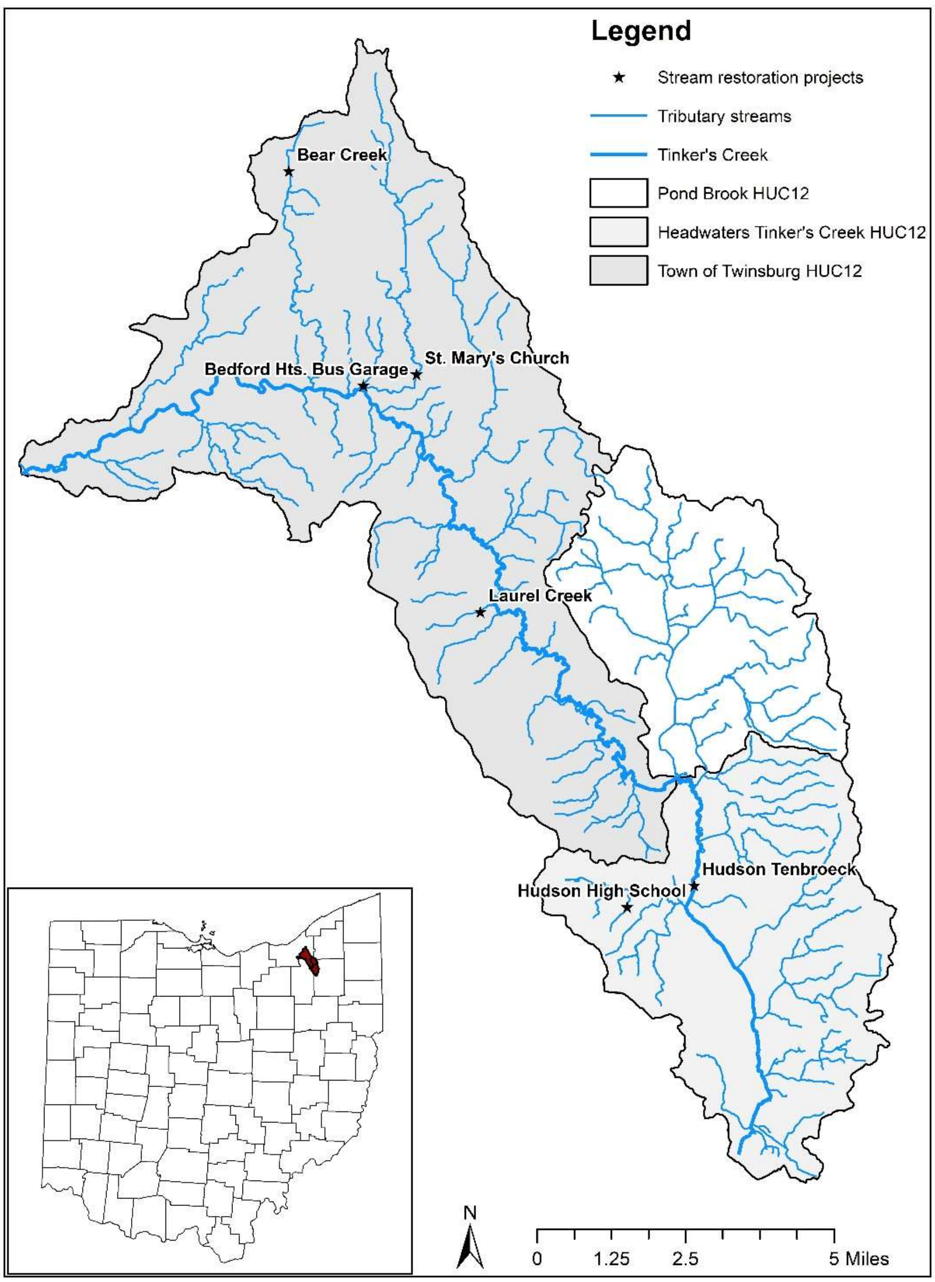
Additionally, the water quality monitoring program provides data to determine baseline water quality conditions in the creek. Prior to the beginning of TCWP's water quality monitoring program, Tinker's Creek was only monitored every few years. By sampling these same 16 sites every month, TCWP can provide insight into baseline conditions in the creek. This allows TCWP, municipalities, and other agencies to identify potential pollution issues in a more time sensitive manner.

TCWP has completed multiple restoration projects throughout the watershed (see page 7) with the goal of improving water quality. In the years immediately following completion, these restoration projects are monitored by contractors and the Ohio EPA to ensure proper function. TCWP's water quality monitoring program is designed for long-term monitoring at each site beyond the usual post-restoration monitoring. After several years of monitoring these sites, TCWP will be able to observe trends in water quality that can be attributed to successful restoration and mitigation efforts or long-term pollution issues. This program will allow TCWP to measure ongoing success of restoration projects and determine the larger impact of these projects on a watershed scale.

The overarching goals of TCWP's water quality monitoring program are as follows:

- Train citizen scientists to monitor water quality
- Encourage greater watershed stewardship
- Detect potential water quality issues early, like oil and grease or illicit discharges
- Generate a comprehensive understanding of water quality and major impairments throughout the watersheds
- Measure the long-term success of completed stream restoration and stormwater mitigation projects in Tinker's Creek and Brandywine creek watersheds

Restoration Projects in Tinker's Creek



Completed Projects:

Hudson Tenbroeck Stream Restoration

St. Mary's Stream Restoration

Laurel Creek Restoration Project in Twinsburg

Bear Creek Restoration Project in Warrensville Heights

Hudson High School Stream Restoration and Land Lab

Bedford Heights Bus Garage Project

Figure 1. Map showing recent restoration projects in Tinker's Creek Watershed.

Major stream restoration projects aren't the only thing that can improve water quality and watershed health. TCWP also works with local communities, nonprofits, schools, and property owners to install stormwater management practices. These include rain barrels, planting native species, rain gardens, and more. These practices are also important in improving local water quality by reducing inputs of sediment, nutrients, and other pollutants to Tinker's Creek and Brandywine Creek.

Methodology

At each site, TCWP staff and/or volunteer(s) measured water temperature, air temperature and pH using a Hach Pocket Pro + pH meter. Dissolved Oxygen, O_2 Pressure, Conductivity, Nitrate, and Chloride were collected using a YSI ProQuatro Multi parameter meter. Each site is also scanned for any unusual discharges or surface oils. Staff and/or volunteers take note of weather conditions, wildlife, and any other items of interest.

A water sample is collected and placed in a cooler and transported to Twinsburg WWTP. These samples are analyzed at Twinsburg WWTP to measure the *E. coli* concentrations.

Table 1. Field parameters collected by TCWP.

Parameter	Units
Water Temperature	degrees Celsius (C)
pH	S.U.
Dissolved Oxygen	mg/L and percent saturation (%)
O_2 Pressure	mmHg
Conductivity	C-mS/cm
Nitrate Range	mg/L
Chloride Range	mg/L

Table 2. Water quality parameters analyzed by Twinsburg WWTP.

Compound Name	Units
E. coli	cfu/100mL

2021 Water Quality Monitoring Sites

Using volunteer and staff assistance, TCWP sampled 16 sites between May and September, 2021 (Table 3). These sites are located throughout the Tinker's Creek watershed from the headwaters to the confluence of Tinker's Creek and the Cuyahoga River. Additional sites were added this year within the Brandywine Creek watershed. A map of these sites is provided on page 10.

Table 3. Water quality sites sampled during 2021.

Site ID	Site Name	Stream Name	Coordinates
UnHw001	Darrow Road Park	Unnamed headwaters	41.263752, -81.431937
PB001	Liberty Park Pond Brook Conservation Area	Pond Brook	41.305938, -81.399144
TC001	Hudson-Tenbroeck Project	Tinker's Mainstem	41.262003, -81.394144
TC002	Trumbull Woods Park	Tinker's Mainstem	41.269070, -81.392790
TC006	Tinker's Creek at Bissell	Tinker's Mainstem	41.287499, -81.401056
TC003	East Idlewood Park	Tinker's Mainstem	41.336324, -81.457075
TC004	Broadway Trailhead near Bridal Veil Falls	Tinker's Mainstem	41.385043, -81.525098
TC005	Tinker's Creek Aqueduct	Tinker's Mainstem	41.365475, -81.608117
HmC001	Bedford Reservation Hemlock Creek Picnic Area	Hemlock Creek	41.375314, -81.574836
Un001	Highland Woods Apartments	Unnamed tributary	41.432241, -81.490515
Mk001	Bedford Heights Bus Garage	Malicki Creek	41.432241, -81.490515
BC-EH	Brandywine Creek East Hines Hill	Brandywine Creek	41.260278, -81.489167
BC-ET	Brandywine Creek East	Brandywine Creek	41.283056,

	Twinsburg		-81.504444
BC-SS	Brandywine Creek Service Station	Brandywine Creek	41.293889, -81,522778
IN-AN 1	Indian Creek Achieve Nutrition	Indian Creek	41.313333, -81.508611
IN-SR 1	Indian Creek Schoeffler Residence	Indian Creek	41.338056, -81.506389

2021 Water Quality Sites Map

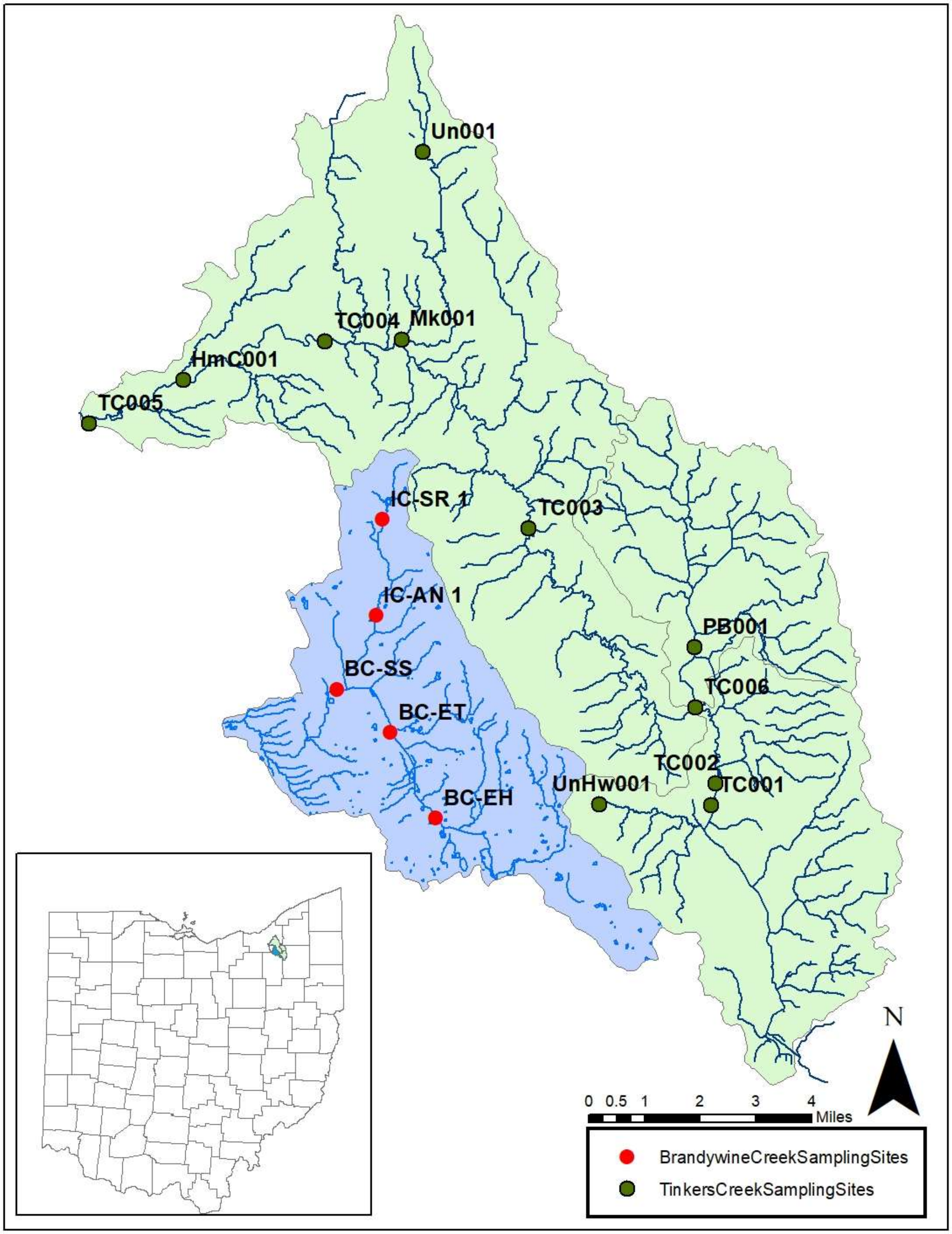


Figure 2. Map featuring the different water quality monitoring sites.

Monitoring Results

pH

pH is an important water quality characteristic that can aid in determining how the health of the system is changing overtime. pH is the measure of how basic or acidic a solution is, and ranges from 0-14. If the pH value is low then the solution is acidic, and if the pH value is high, then the solution is basic. pH with a value of 7 is considered neutral. pH impacts both the solubility and biotic availability of nutrients and pollutants in a stream. The EPA suggests a pH level ranging between 6.0 – 9.0 for freshwater streams. This ensures a safe habit for a variety of aquatic organisms, most of which require pH in the range of 6.5-8.0. All sites sampled were well within the EPA suggested pH level range. The average pH was highest (8.3) for the Hemlock Creek (HmC001), Highland Woods Apartments (Un001), and Indian Creek Schoeffler Residence (IN – SR 1). The lowest average pH (7.5) was at the Brandywine Creek - East Twinsburg (BC - ET) site.

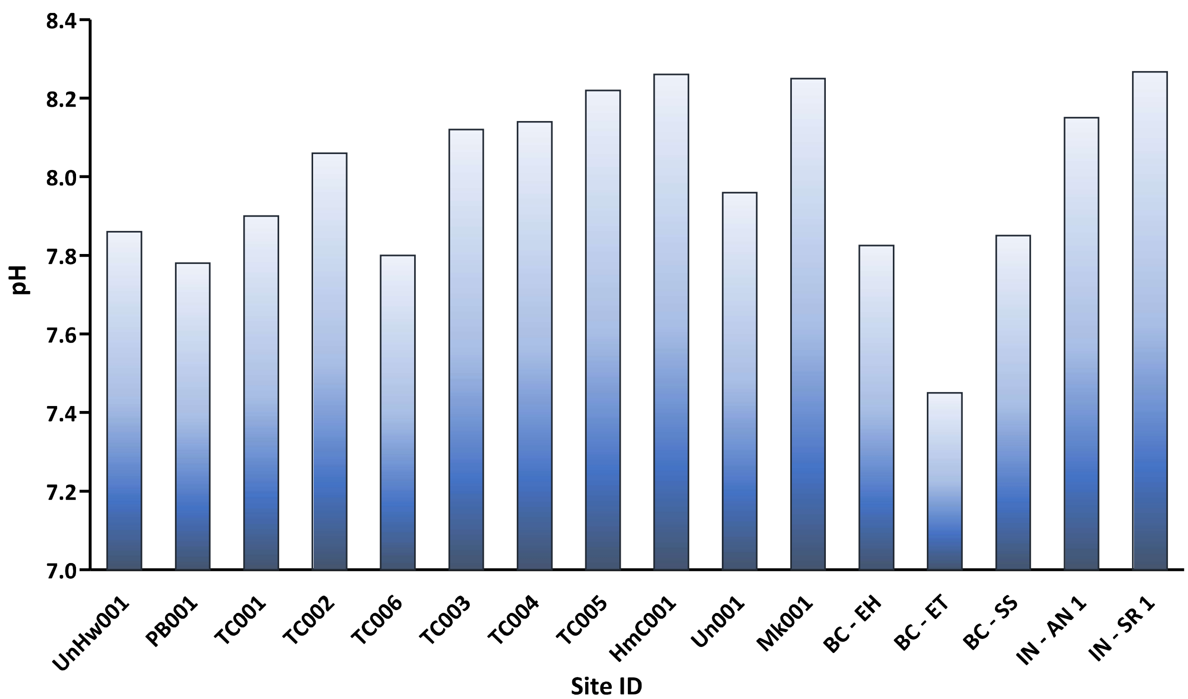


Figure 3. The average pH level of each sampling site.

Dissolved Oxygen

Dissolved oxygen is the concentration of oxygen molecules present in the water. Oxygen enters the water either directly through the atmosphere (aeration) or is added via photosynthetic organisms and ground water. Dissolved oxygen is impacted by increased nutrients, changes to the stream channel, and temperature. Low dissolved oxygen can limit the production of the stream and affect the individual health of the organisms present. Low dissolved oxygen levels may lead to the death of aquatic life, or the replacement of species that have a high sensitivity to fluctuating/reduced dissolved oxygen levels by more generalist species. When dissolved oxygen levels become too high, organisms may develop the gas-bubble disease. This disease causes bubbles to form in the blood vessels of the organism which prevent the flow of blood. This is similar to the bends or decompression sickness that occurs when divers resurface too quickly. A minimum dissolved oxygen concentration of 2 mg/L is required to support fish populations in a stream. For warm water streams the minimum dissolved oxygen concentration is 5 mg/L. Out of the 16 sites sampled, only four were below the minimum dissolved oxygen concentration for warm water streams (5 mg/L). Darrow Road Park (UnHw001), Pond brook (PB001), Brandywine Creek – East Twinsburg (BC – ET), and Trumbull Woods Park (TC002) were all below the 5mg/L minimum threshold. The lowest average dissolved oxygen concentration (3.06 mg/L) was found at Darrow Road Park (UnHw001), while the highest average dissolved oxygen concentration (8.00 mg/L) was found at Hemlock Creek (HmC001).

DO mg/L

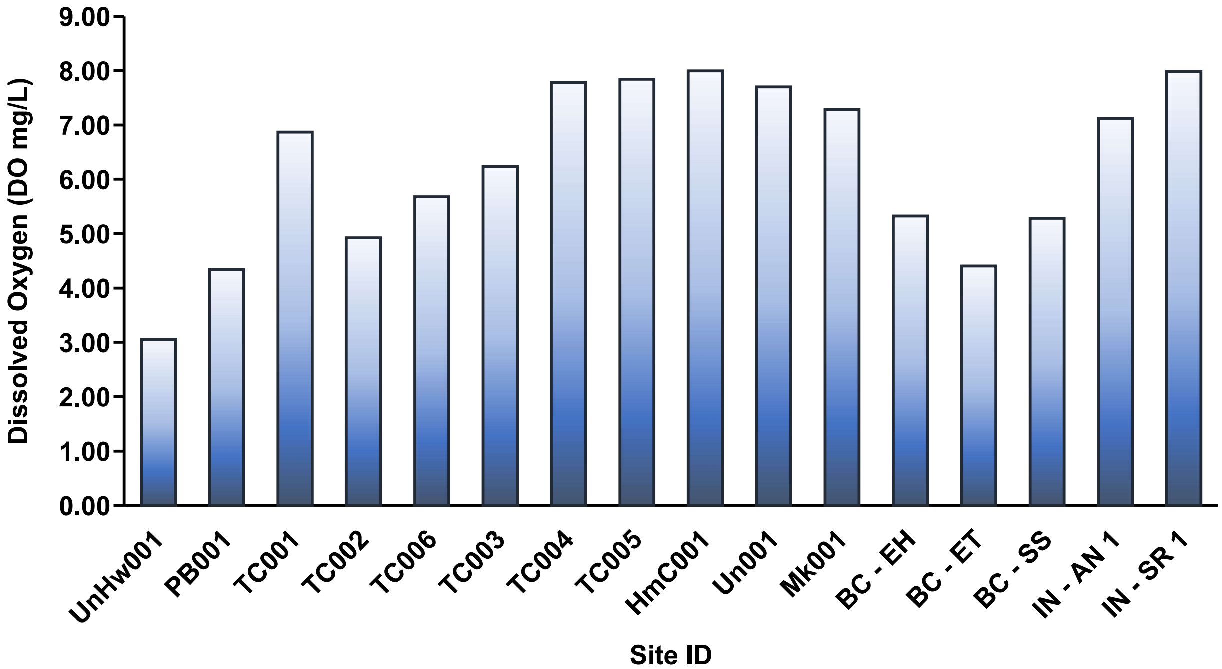


Figure 4. The concentration of dissolved oxygen in the water at each sample site.

DO %

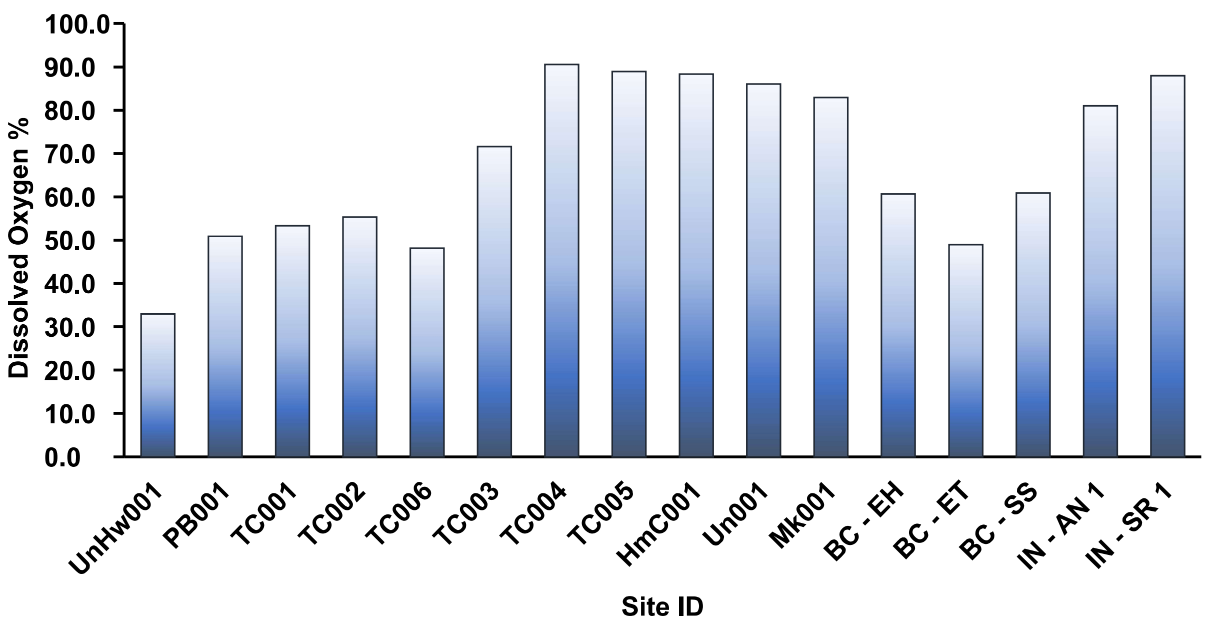


Figure 5. The average dissolved oxygen percentage, or percent air saturation, for each sample site.

O_2 Pressure

Oxygen Pressure is measured in mmHg. It is not a standard measurement that we use in reporting; however, it is helpful when looking at the Dissolved Oxygen of freshwater. Generally, an increase is O_2 pressure is correlated with an increase in dissolved oxygen.

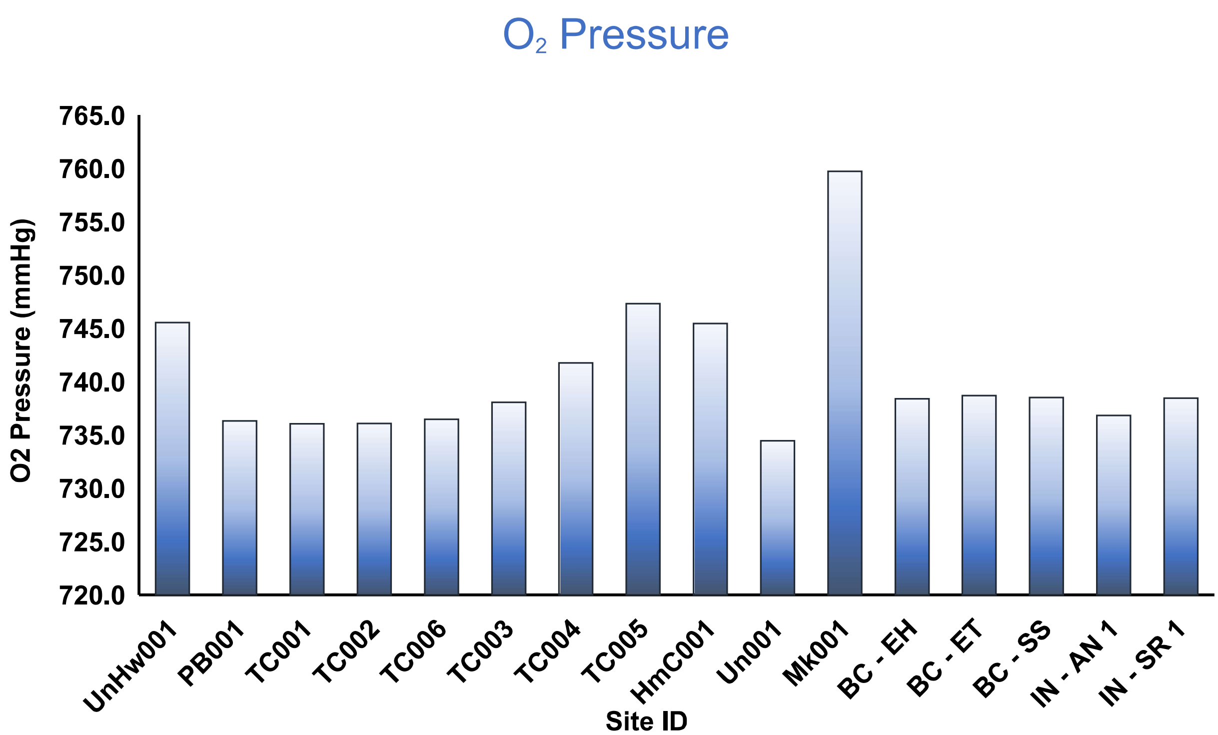


Figure 6. The average partial pressure of oxygen in the water at each sample site.

E. coli

Escherichia coli is a coliform bacterium that is present in the digestive track of most warm-blooded animals, including humans and birds. This bacterium, if ingested, can result in sickness depending on the specific *E. coli* species. *E. coli* enters the stream from farm run-off, sewage overflow, and animal waste. This bacterium is naturally occurring in most streams but becomes a major health concern when levels reach a certain threshold. In Ohio, these thresholds were determined by the Ohio Environmental Protection Agency (OEPA). For primary recreation contact (PCR; Any activity that involves full body contact with the water, i.e., swimming, wading, boating, canoeing) and bathing waters (waters used heavily for swimming, have a lifeguard present, or are bath houses), the threshold value is 126 cfu/100ml. The other threshold value, for warm water habitats (WWH), is 1,030 cfu/100ml. All sites were below the WWH threshold value, but only one site was below both the PCR and WWH threshold values. The Bedford Heights Bus Garage (Mk001) had the lowest *E. coli* geometric mean value (77 cfu/100mL) out of every site sampled. The site with the greatest *E. coli* geometric mean was the IN-AN 1 site, with a value of 1,017 cfu/100mL, which is only just below the WWH threshold value. IN-AN 1 had a high *E. coli* reading in June at 1,700 cfu/100 mL which impacted the elevated average observed in 2021. The sample was taken on June 26 and was directly following a heavy rain event. TCWP notified the Northeast Ohio Regional Sewer District who dispatched a team to the site. At the time of the NEORSD sampling the *E. coli* level had returned to level that was characteristic to the site.

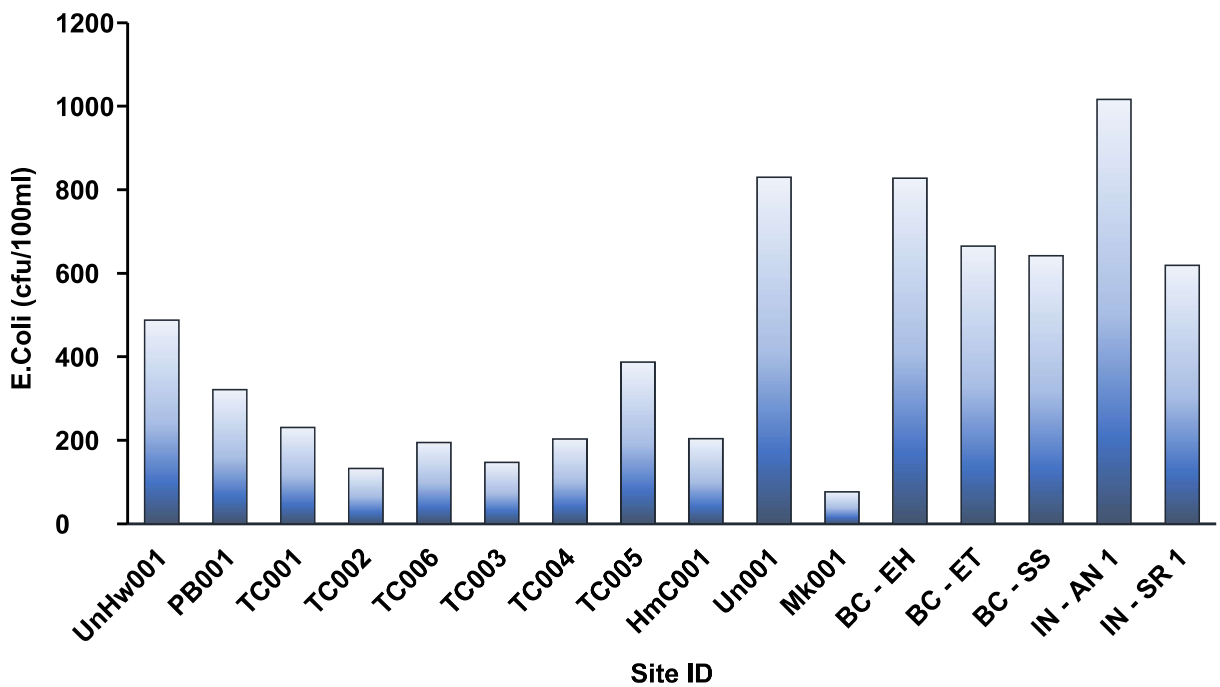


Figure 7. Geometric mean for *E. coli* levels at each sampling site.

Table 4. The comparison of geometric means of *E. coli* levels from each sample site to the PCR and WWH threshold values.

Site ID	*E. Coli* Geometric mean (cfu/100ml)	PCR	WWH

UnHw001	487	✖	✓
PB001	321	✖	✓
TC001	231	✖	✓
TC002	132	✖	✓
TC006	194	✖	✓
TC003	147	✖	✓
TC004	203	✖	✓
TC005	388	✖	✓
HmC001	204	✖	✓
Un001	830	✖	✓
Mk001	77	✓	✓
BC-EH	827	✖	✓
BC - ET	665	✖	✓
BC - SS	642	✖	✓
IN–AN 1	1017	✖	✓
IN–SR 1	619	✖	✓

Nitrate Range

Occurring naturally, Nitrate (and other forms of Nitrogen) loading to streams is important to the overall health of the stream organisms. Nitrogen is often a limiting nutrient in streams; therefore, low levels of nitrogen are to be expected in a stream. When Nitrogen levels become too high, mainly through additions from fertilizer run off, streams may have increased production, leading to algal blooms, low dissolved oxygen levels, and, if conditions are extreme, fish kills. Nitrate levels were lowest (1.15 mg/L) at the Bedford Heights Bus Garage (Mk001). The highest Nitrate levels (11.11 mg/L) were at the Bedford Reservation Hemlock Creek Picnic Area (HmC001).

Nitrate Range

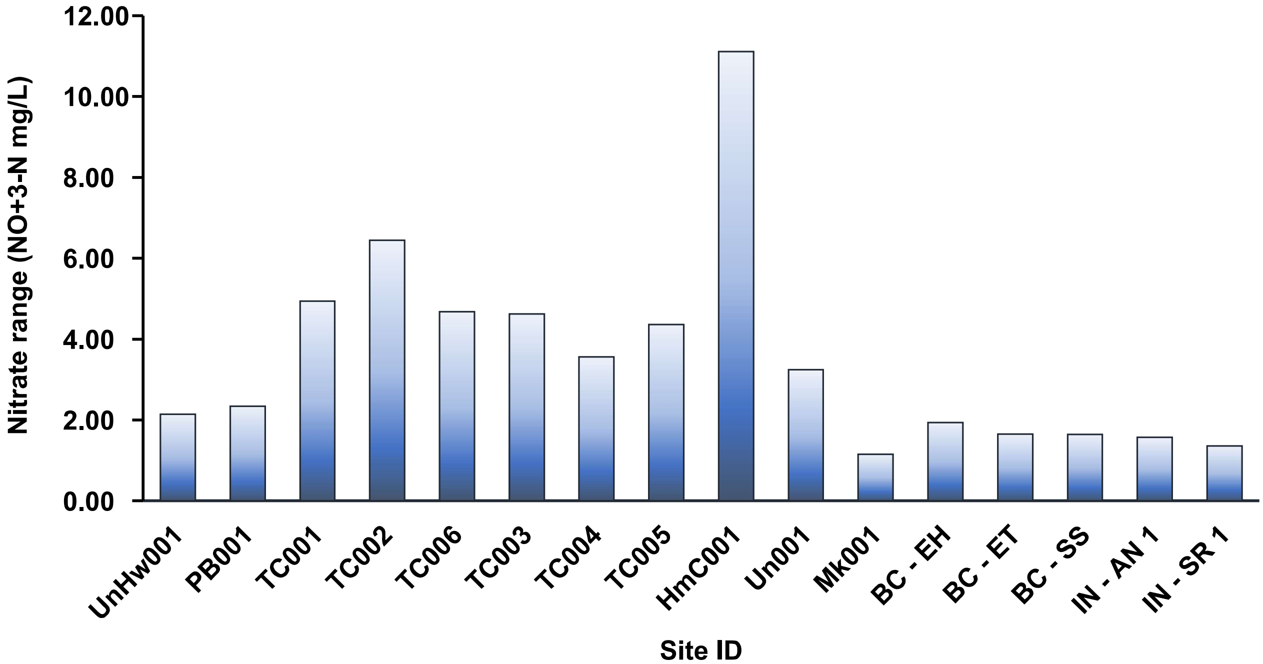


Figure 8. Average nitrate range concentration at each of the sampling sites.

Salinity

Salinity is an important stream characteristic that greatly impacts both the watershed and the organisms that reside there. Salinity is quantified using multiple parameters including chloride levels and conductivity. High levels of chloride and a greater conductivity mean that there are high levels of salt in the water column. Chloride is an anion of chlorine that is present in stream and rivers naturally but can rise to hazardous levels following additions from salt deposits and, primarily, road salts. Conductivity is the measure of how well an electrical current can pass through the water in a stream. The dissolved salts, inorganic chemicals, and other dissolved substances present in the water conduct electricity, so the greater the number of dissolved substances in the water, the greater the conductivity. Conductivity is related to salinity, since both are measured by the number of dissolved salts/substances in the water, therefore higher salinity in the water would increase conductivity as well. The highest average Chloride range was observed at Un001 and was greater than 600 mg/L this is much higher than the EPA recommended limit of 250 mg/L for drinkable water. Un001 is adjacent to several apartment buildings and has a high percentage of impervious surface surrounding the sampling site. It is probable that runoff from the impervious surfaces is a reason for the increased average Chloride reading.

Chloride Range

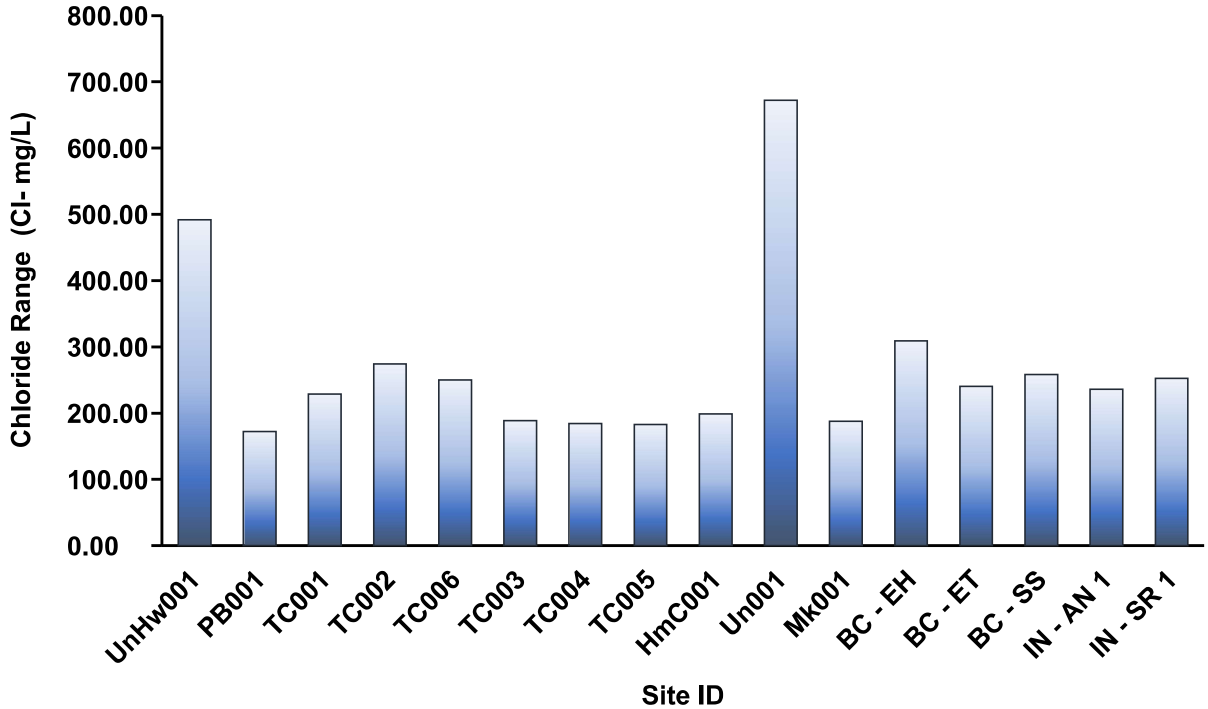


Figure 9. The average chloride range for each sample site.

Conductivity

Conductivity is the measurement of waters ability to pass an electrical current. As dissolved salts such as Chloride conduct electrical current conductivity increases as salinity increases. It is completely expected that site UnOO1 would have the highest average conductivity reading as it also displayed the highest average level of Chloride.

Conductivity

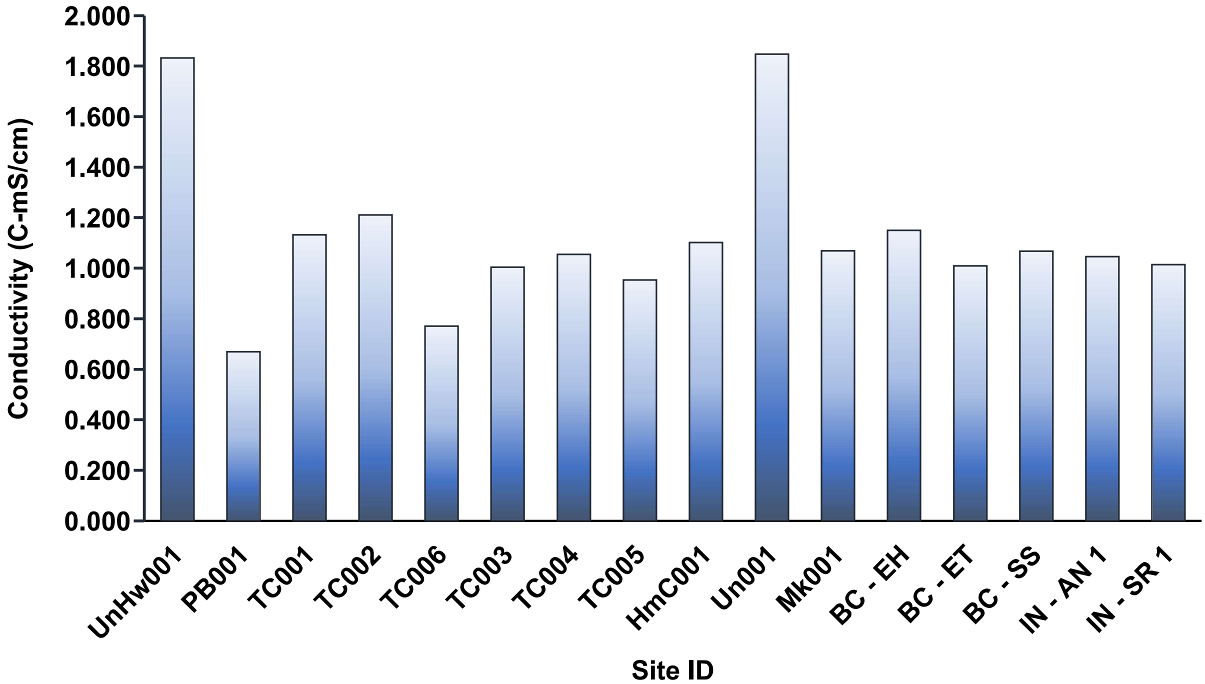


Figure 10. The average conductivity for each sample site.

Conclusions

This year's data will likely act as a new baseline for comparison with future water quality reports. The data collected this year had different parameters than in the previous years. New parameters were added to the water quality report, while some were no longer collected or reported. This was due to a new type of sampling methodology and new equipment. Some categories, however, remained the same, or denote similar characteristics within the watershed to previously collected parameters, allowing for comparison between years. New parameters this year include chloride and conductivity, and parameters that are no longer included are total suspended solids, ammonia, and phosphorus. Additionally, since 5 new sites were added in 2021 and one removed, there will be more data to compare in future monitoring years. Both Brandywine Creek and Indian Creek have the potential to show significant changes in the years to come, and we're excited to observe and monitor those changes alongside our volunteers and communities.

Dissolved oxygen levels were lower this year compared to both 2020 and 2019. Average dissolved oxygen at Darrow Road Park was well below the threshold value of 5.00 mg/L, which occurred in both 2020 and 2019. This year, the average dissolved oxygen levels were also below the threshold value at the Liberty Park Pond Brook Conservation Area, which had not occurred in previous monitoring years. Geometric means for *E. coli* levels this year were similar to those in 2020. Darrow Road Park again had the highest levels of *E. coli* compared to the other sampling sites, this year however, the levels decreased to below the WWH threshold value. This is much lower than in 2020 which was well beyond the WWH threshold value. The Bedford Heights Bus Garage has continued to improve since the restoration project, having the lowest values for *E. coli* out of all sites sampled. Nitrate levels were the same for a majority of sites within the watershed. The Bedford Reservation Hemlock Creek Picnic Area had the highest average Nitrate value out of all sites sampled, and was similar to the value recorded in previous years. Nitrate values increased at three of the sampling sites within Tinker's Creek. Hudson-Tenbroeck Project, Trumbull Woods Park, and East Idlewood Park all had increased average Nitrate levels compared to previous years. Liberty Park Pond Brook Conservation Area, and Highland Woods Apartments also had increased average Nitrate values compared to previous years. Only one site, Tinker's Creek Aqueduct, had a large decrease (nearly 4 mg/L) in average Nitrate levels.

Water quality in Tinker's Creek watershed has been improving since restoration actions began in the Cuyahoga River basin. To continue these improvements, we need your help. To learn more about watershed stewardship and what you can do to protect and restore Tinker's Creek, please contact us at info@tinkerscreekwatershed.org or 330-963-6243.

Thank you to all of our volunteers for a successful monitoring season! We hope to work with you again in 2022. TCWP also wants to thank all of our partners who have contributed to and assisted with the monitoring, restoration, and protection of Tinker's Creek watershed.

Appendix A: Definitions

Watershed: An area of land where all of the water flows into a single larger water body.

Air Temperature: Degrees in Celsius of the air.

Water Temperature: Degrees in Celsius of the water. Impacts life in the stream, as well as other water quality parameters.

pH: Ranging from 0-14, the measure of how acidic or basic a solution is.

Dissolved Oxygen: Concentration of Oxygen molecules present in a solution.

E. coli: A form of coliform bacteria that is present in the digestive tract of most animals, including humans and birds. May lead to illness if ingested. Dangerous to interact with the water if levels are too high.

Nitrate: Naturally occurring form of Nitrogen, that normally is present in small quantities. Pollution and runoff from agriculture leads to increase levels of Nitrate, potentially causing algal blooms and fish kills.

Limiting Nutrient: A nutrient that is present in small quantities, limiting the growth and number of organisms present within an ecosystem (i.e., Nitrogen, Phosphorus)

Nutrient Loading: When a nutrient that is normally limited within an ecosystem is brought into that system in large, unnatural quantities.

Salinity: The measure of salts within a solution.

Chloride: Naturally occurring anion of Chlorine, that is often associated with high levels of salinity within a water body. Forms a bond with Sodium to form Sodium Chloride (table salt).

Conductivity: The measure of how well an electric current can pass through a solution. Pure water has a conductivity of 0, but when salts and other dissolved molecules/particles are present in the water column, the solution will have a higher conductivity value.

Appendix B: Additional Resources

Dominion Energy and Western Reserve Land Conservancy Watershed Mini Grant Program Retrieved from https://www.wrlandconservancy.org/articles/tag/dominion-energy-watershed-mini-grant-program/.

EarthEcho International: Water Challenge. Retrieved from http://www.monitorwater.org/.

Ohio Administrative Code 3475-1-01 through 3475-1-44 and 3475-1-50 through 3475-1-54. Retrieved from https://www.epa.gov/sites/production/files/2015-09/documents/oh_34751_1_to_40.pdf.

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