

Quantifying bacteria and nutrient sources in Cherry Brook Watershed to develop River Smart solutions for sustainable clean water.



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With funding from the Farmington River Coordinating Committee



**Farmington River
Coordinating Committee**

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Abstract

Cherry Brook watershed as impaired for recreation on two segments. Segment 1 and Segment 2 for *E. coli* bacteria. The bacteria impaired segments are a total of 2.71 miles. The Farmington River Watershed waters are recreational destinations, thus any bacterial impairments convey potential health consequences to recreation users. FRWA staff and interns conducted routine bi-weekly monitoring for *E. coli* bacteria. Sites were sampled six times from June through September 2022. FRWA sampled for nutrients at the same sites in June and August. Three sites were monitored for continuous temperature per CT DEEP VSTeM protocol and four macroinvertebrate surveys were performed in September and October.

Canton experienced severe drought in summer 2022, especially in August. Drought brought low water levels and decreased stream flow, resulting in increased stormwater run-off and higher bacteria levels. Site CB-4140 on Meadow Rd. where the impaired segment starts had the highest *E. coli* values. This indicates agricultural activity is the main location contributor of *E. coli* in Cherry Brook, and is likely the result of high levels downstream. Nutrients indicate pollution at Meadow Rd. Sawmill Brook consistently had high values of phosphorus, likely from the residential area upstream. Other sites with high nitrogen or phosphorus values can be due to drought and stormwater run-off.

Drought brought stress to all waterbodies in the summer of 2022, with only a 1 degree difference in temperature to the average for cold water fish, Cherry Brook fared well in terms of temperature. Macroinvertebrate surveys indicate high water quality at three sites. The one site with insufficient sensitive species can be the result of upstream habitat or drought.

Introduction

Cherry Brook is a tributary of the Farmington River that courses North-South through Canton on its way to the confluence with the Farmington River near Route 44 in Canton, CT, mainly following Cherry Brook Road. The Connecticut Department of Energy and Environmental Protection (CT DEEP) lists Cherry Brook watershed as impaired for recreation on two segments. CT DEEP has a TMDL (Total Maximum Daily Load) for the Cherry Brook Watershed, Segment 1 and Segment 2 for *E.coli* bacteria, and have been placed on the CT List of Waterbodies Not Meeting Water Quality Standards (aka CT 303(d) Impaired Waters List). The bacteria impaired segments are a total of 2.71 miles. Segment 1, CT4309- 00_01, is 2.05 miles long from the confluence with the Farmington River upstream to Barbourtown Road crossing and segment 2, CT4309-00_02, is 0.66 miles long from Barbourtown Road crossing upstream to Meadow Road crossing. The water quality classification for these segments are Class A freshwater rivers. The “designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. As there are no designated beaches in these segments of Cherry Brook, the specific impairment for recreation is for non-designated swimming and other contact water-related activities.” - CT DEEP Cherry Brook Watershed TMDL Summary, September 2012. As noted in the Cherry Brook Watershed TMDL, Cherry Brook flows along Route 179 (Cherry Brook Road) through a large urban-agriculture corridor.

The Farmington River Watershed waters are recreational destinations, thus any bacterial impairments convey potential health consequences to swimmers, waders, boaters and anglers in contact with the waters. Nonpoint source runoff, the primary water quality concern in this watershed, is likely to increase along with increasing heavy precipitation events as predicted by climate change models. It is important to document any increased bacterial load from stormwater influxes to the waterways.

Methods

Bacteria

FRWA staff and interns conducted routine bi-weekly monitoring for *E. coli* bacteria during the summer recreation season. Each site was sampled six times from June through September 2022. The twelve monitoring locations are in the Cherry Brook Watershed (figure 1). Sites were selected due their location relative to bacteria impaired segments, and to evaluate conditions upstream and downstream of agricultural lands and residential areas, as Cherry Brook Road residents have septic systems. Five of the selected sites are located within impaired segments of Cherry Brook, three sites are upstream from the impaired segments, and four of the sites are located on tributaries to Cherry Brook. Site IDs were determined based on stream name and distance in meters from the next downstream confluence (table 1). Barbour Brook, Sawmill

Brook and unnamed tributary discharge into Cherry Brook, and Cherry Brook flows downstream into the Farmington River.

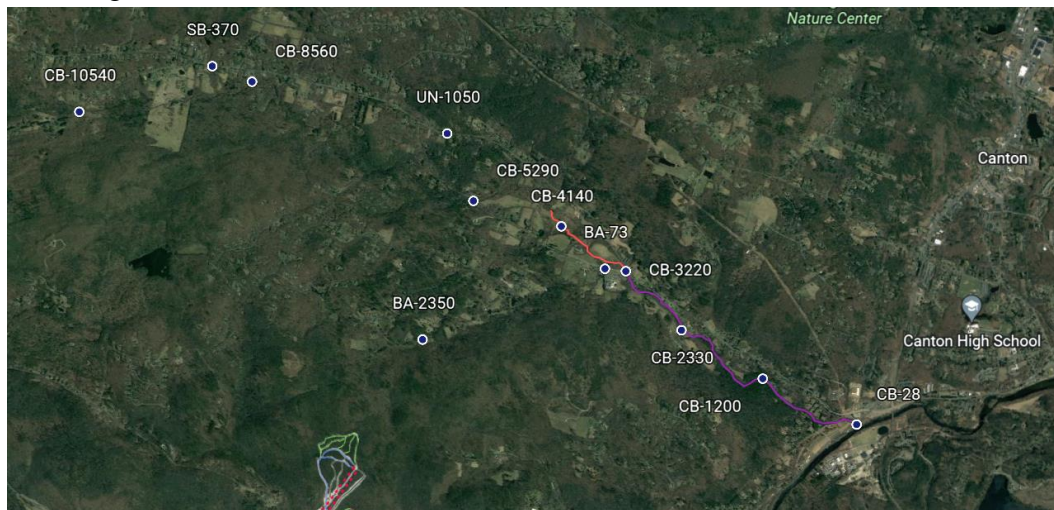


Figure 1: Cherry Brook watershed sites 2022 with impaired segments (red and purple lines)

Site ID	Name	Location
CB-28	Cherry Brook	Rt. 44 upstream confluence with Farmington River
CB-1200	Cherry Brook	84 Cherry Brook Rd. CLCT Pratt Place
CB-2330	Cherry Brook	Downstream Humphrey Rd bridge
CB-3220	Cherry Brook	Upstream Barbourtown Rd bridge
CB-4140	Cherry Brook	Downstream Meadow Rd bridge
CB-5290	Cherry Brook	Downstream West Rd bridge
CB-8560	Cherry Brook	North Canton Volunteer Fire Department (NCVFD)
CB-10540	Cherry Brook	Downstream Rt. 179 culvert
BA-73	Barbour Brook	Upstream Barbourtown Rd culvert
BA-2350	Barbour Brook	Downstream 172 Barbourtown Rd culvert
SB-370	Sawmill Brook	Upstream North Canton Community United Church culvert
UN-1050	Unnamed trib to Cherry Brook	Upstream 388 Cherry Brook Rd culvert

Table 1: Site IDs, waterbody name and locations.

Our project in Cherry Brook is informed by our processes for bacteria monitoring in Connecticut that have been in practice and shared with CT DEEP for 16 years. FRWA monitors a total of 39 locations for bacteria in the Farmington River Watershed in Connecticut and 17 sites in the headwaters in Massachusetts. All analysis is done using IDEXX Colilert and Quanti-Tray. Our IDEXX laboratory is located in space allotted to us in the Simsbury Water Pollution Control Facility, Simsbury, CT. All of our data is shared with CT DEEP. We use CT DEEP protocols for VSTeM and RBV, and CT DEEP has copies of our sampling and laboratory protocols for bacteria. Our data helps by increasing the availability of credible external bacteria data that can be utilized to support CT DEEP's Clean Water Act Programs. FRWA's Quality Assurance Project Plan is on file at Massachusetts Department of Environmental Protection – *Farmington River Watershed Association's Bacteria Monitoring Program: Massachusetts section* – dated January 10, 2020 – January 9, 2023, signed by MassDEP QA Officer Suzanne Flint, Environmental Analysis.

Nutrients

FRWA sampled for nutrients at the same 12 sites on June 20th and August 22nd. Samples were collected and transported to the University of Connecticut Center for Environmental Sciences and Engineering (UCONN CESE) laboratory for analysis. Total Kjeldahl nitrogen was calculated by FRWA.

Temperature

Three sites were monitored for continuous temperature per CT DEEP VSTeM protocol. Three Onset ProV2 HOBO temperature data loggers were placed in Cherry Brook on May 10th and retrieved on September 8th to determine summer conditions. Temperature loggers were programmed to start logging on May 11th at 12:00 AM, and to log every hour until downloaded. Sites included CB-1200 at the Canton Land Trust Pratt Place, CB-5290 downstream West Rd. Bridge, and CB-8560 behind the North Canton Volunteer Fire Department (NCVFD). Site CB-1200 is located in the impaired segment, and both CB-5290 and CB-8560 are located upstream the impaired segment. All three sites had loggers redeployed on September 8th to monitor temperature from September 2022 to May 2023. All data is uploaded to the Spatial Hydro-Ecological Decision System (SHEDS) Stream Temperature Database. FRWA follows the CT DEEP Bureau of Water Protection & Land Reuse Monitoring & Assessment Program Volunteer Stream Temperature Monitoring (VSTeM) Network, Version 1.2 Last Revised April 2017.

Macroinvertebrates

Four macroinvertebrate surveys were performed during September and October FRWA follows the CT DEEP QAPP "Riffle Bioassessment by Volunteers (RBV): A Community-Science Water Quality Monitoring Program" EPA RFA#: 21045 Prepared by Meghan Lally, Water Planning & Management Division CT DEEP, March 31, 2021. All surveys were performed by CT DEEP RBV certified trainers. Sites included CB-1200 at the Canton Land Conservation Trust (CLCT) Pratt Place, upstream the bridge on West Rd. at CLCT Goedecke-Humprey, behind the North

Canton Volunteer Fire Department (NCVFD), and downstream Barbourtown Rd bridge, next to the Cherry Brook Primary School.

Results

Drought

Canton experienced severe drought in summer 2022, especially in August. At the start of sampling season in June, 21% of Hartford County was in no drought and 79% was abnormally dry. By the end of August, 100% of Hartford County was in severe drought until the beginning of September when 27% was moderate drought and 73% was severe drought (figure 2). Cherry Brook Watershed in June had average to low water level. Mid-July water levels decreased to very low until September after rain events increased to high and average (figure 3). Drought brought low water levels and decreased stream flow, resulting in increased stormwater run-off and higher bacteria levels.

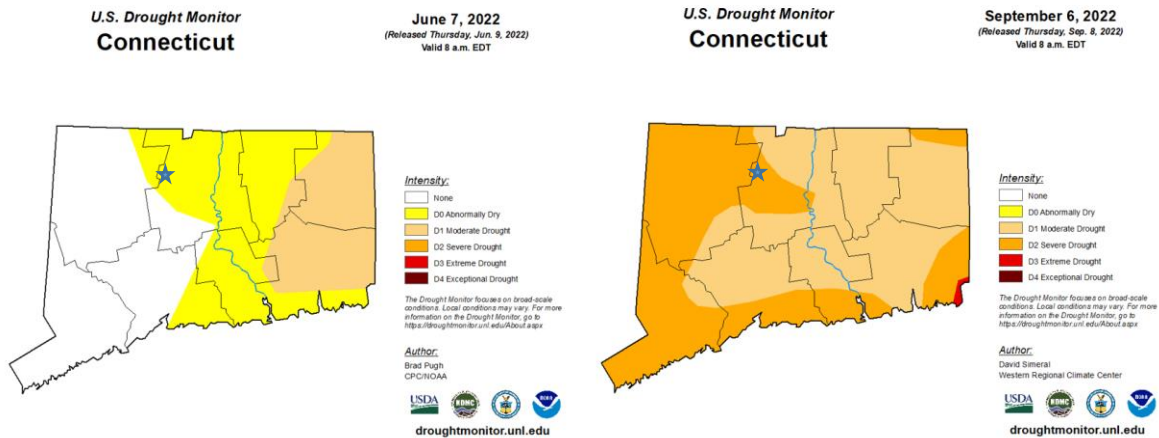


Figure 2: Drought comparison of Connecticut on June 7th and September 6th. Star on maps represents Canton

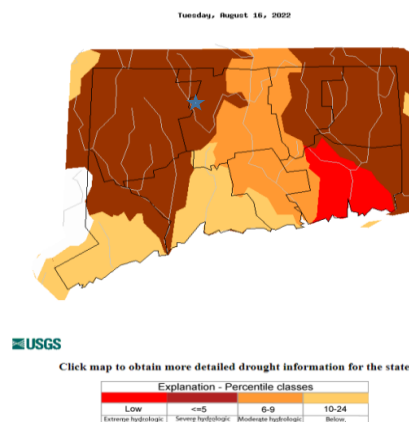


Figure 3: Below normal 7 day average streamflow compared to historical streamflow on August 16th. Star on map represents Canton

Bacteria *E. coli*

Cherry Brook *E. coli* colonies per 100 mL of water were determined using IDEXX Colilert and Quanti-Tray. Water criteria limits for *E. coli* used for this investigation are 410 colonies/100 mL for non-designated swimming, and a geometric mean of 126 colonies/100 mL. Geometric mean is a type of average used for water quality as it allows the values to show a true form when an outlier is present. Having a high value from a rain event will not increase the geometric mean like it would in an average. For water quality 126 colonies/100 mL geometric mean is the criteria for implementation of a TMDL.

Cherry Brook's TMDL was initiated from CT DEEP's monitoring from 2006 to 2009. CT DEEP monitored Cherry Brook for *E. coli* at Meadow Rd from 2006 to 2009. Another site was added in 2008 near the confluence with the Farmington River at the bridge on Rt. 44. Geometric means determined by CT DEEP are listed below, all results are higher than 126 colonies/100 mL (table 2). Wet versus dry sampling was compared, and on wet sampling events, the geometric mean and single sampling values were always higher (table 3).

Location	Year	Geometric Mean
Meadow Rd	2006	501
Meadow Rd	2007	315
Meadow Rd	2008	613
Meadow Rd	2009	237
Rt. 44 bridge	2008	192
Rt. 44 bridge	2009	202
Shaded cells indicate an exceedance of water quality criteria		

Table 2: CT DEEP Cherry Brook Sampling Geometric Mean 2006-2009

Location	Years	Number of Samples		Geometric Mean		
		Wet	Dry	All	Wet	Dry
Meadow Rd	2006-2009	15	32	402	712	292
Rt. 44 bridge	2008-2009	7	10	196	497	102
Shaded cells indicate an exceedance of water quality criteria						

Table 3: CT DEEP geometric mean by weather

Site CB-28 at the Rt. 44 Bridge is a long-term bacteria monitoring site for FRWA. It has been monitored every year since 2008 with the exception of 2020. All years, except 2013 and 2014 have had *E. coli* geometric mean values higher than 126 colonies/100 mL (figure 4). The highest geometric mean value for CB-28 in the last fourteen years was 1454 colonies/100 mL in 2018.

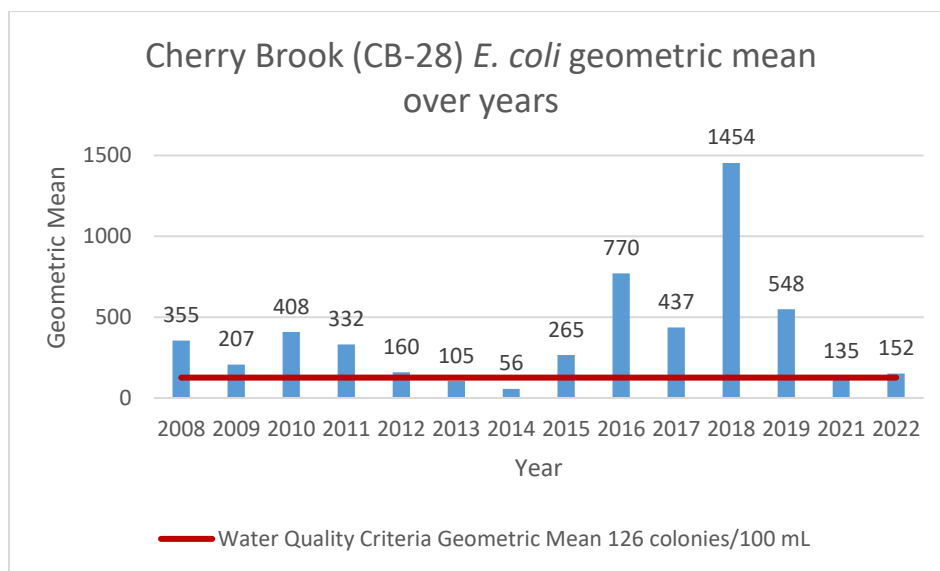


Figure 4: Cherry Brook CB-28 *E. coli* geometric mean 2008-2022

For summer 2022, Cherry Brook Watershed was in severe drought. For sampling events, three days were wet, and three sampling days were dry. Both wet and dry events are characterized on the weather at the time of sampling and the previous two days before the sampling event. Both BA-73 and BA-2350 went dry in late August and had to be sampled after a rain event when the stream was wet. Both sites results from that sampling were greater than 2,419 *E. coli* colonies per 100 mL (the maximum detection limit of IDEXX Colilert procedures). These high values are due to stormwater runoff from previous rain. All sites except CB-4140 at Meadow Rd had higher geometric mean values for wet sampling compared to dry sampling. This is typical due to stormwater runoff, yet CB-4140 higher geometric mean from dry sampling indicates pollution from agricultural activity, as the leading contributor of *E. coli* in Cherry Brook. The severe drought in summer 2022 increased results as water levels were lower and stormwater runoff traveled easier to waterways due to dry soils.

CB-4140, where the impaired segment starts had the highest values. With a geometric mean of 1186 colonies/100 mL it would need a 90% reduction in *E. coli* to meet water quality criteria (table 4). Results from site CB-4140 indicate Meadow Rd is the main contributor of *E. coli* in Cherry Brook, and is most likely the result of high levels downstream. All sites in the impaired segments were higher than 126 colonies/100 mL (figure 5 and 6). As Cherry Brook flows downstream to the confluence with the Farmington River, *E. coli* values decrease. Tributary Barbour Brook had high values, especially near the confluence with Cherry Brook. These high values are most likely the result of the farm upstream site BA-73 or drought and stormwater runoff, or a combination of all those factors. BA-2350, is in the upper reach of Barbour Brook in a residential area. The high values can be from septic leak or drought and stormwater runoff from going dry in August. Barbour Brook is contributing to high values in Cherry Brook, but is not likely the main reason for the TMDL. Cherry Brook sites upstream the impaired segment were high at CB-5290 West Rd. and CB-8560 at NCVFD. These high results can be from

residential septic leak, drought, stormwater runoff and upstream farming. In July CB-8560 had a new beaver dam; this can potentially increase bacteria levels at this location. The most upstream Cherry Brook site, CB-10540, and tributaries Sawmill Brook and Unnamed tributary had low results, and are not contributing to high *E. coli* values in Cherry Brook. Percent reduction was calculated to show how much *E. coli* would need to decrease to meet water quality criteria at 125 colonies/100 mL geometric mean.

Site ID	Location	All Geometric Mean ¹	Wet Geometric Mean ²	Dry Geometric Mean ³	% Reduction ⁴
CB-28	Rt. 44 bridge	152	383	61	18%
CB-1200	CLCT Pratt Place	199	524	76	37%
CB-2330	Humphrey Rd	241	642	90	48%
CB-3220	Barbourtown bridge	265	623	113	53%
CB-4140	Meadow Rd	1186	891	1577	90%
CB-5290	West Rd	174	191	158	28%
CB-8560	NCVFD	240	681	85	48%
CB-10540	Rt. 179	112	135	92	None
BA-73	Barbourtown Rd	500	594	355	75%
BA-2350	Upper Barbourtown Rd	160	380	29	22%
SB-370	Rt. 179	38	101	14	None
UN-1050	Rt. 179	86	326	23	None
Shaded cells indicate an exceedance of water quality criteria					

Table 4: Cherry Brook watershed sites geometric mean, wet geometric mean, dry geometric mean, and % reduction

1 - All indicates all data values collected for the geometric mean calculation.

2 - Wet indicates a geometric mean calculated of data only collected on a rain event, or had a rain event within the last three days.

3 - Dry indicates a geometric mean calculated of data only collected when no rain had occurred at the time of the sampling event and for the past three days.

4 – Percent reduction needed to bring *E. coli* value below the 126 colonies/100 mL water quality criteria (at 125 colonies/100 mL).

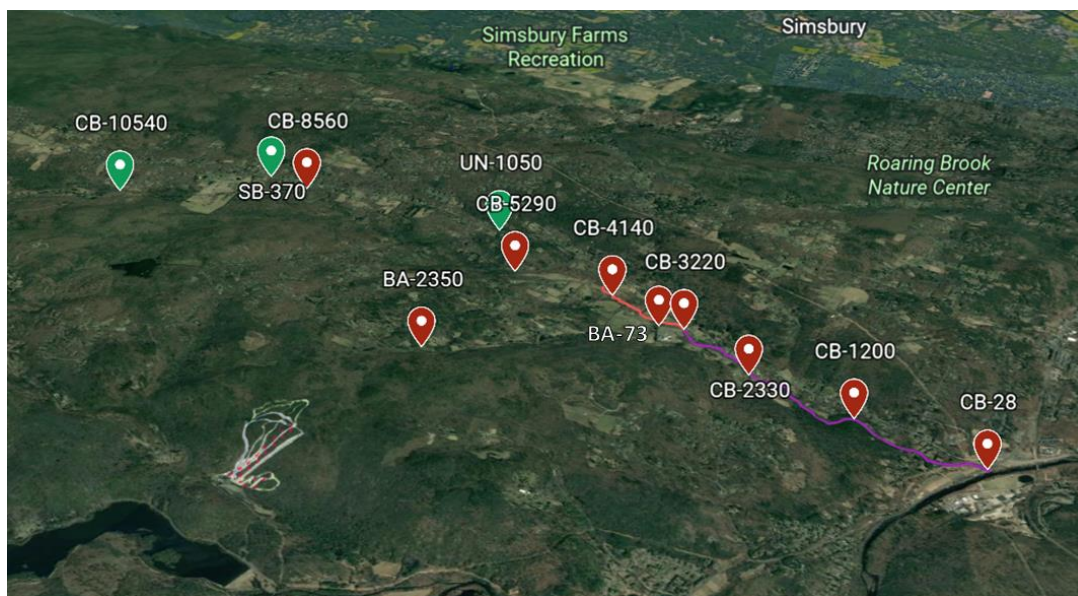


Figure 5: Pins in red represent sites above the geometric mean, pins in green represent sites below geometric mean for 2022

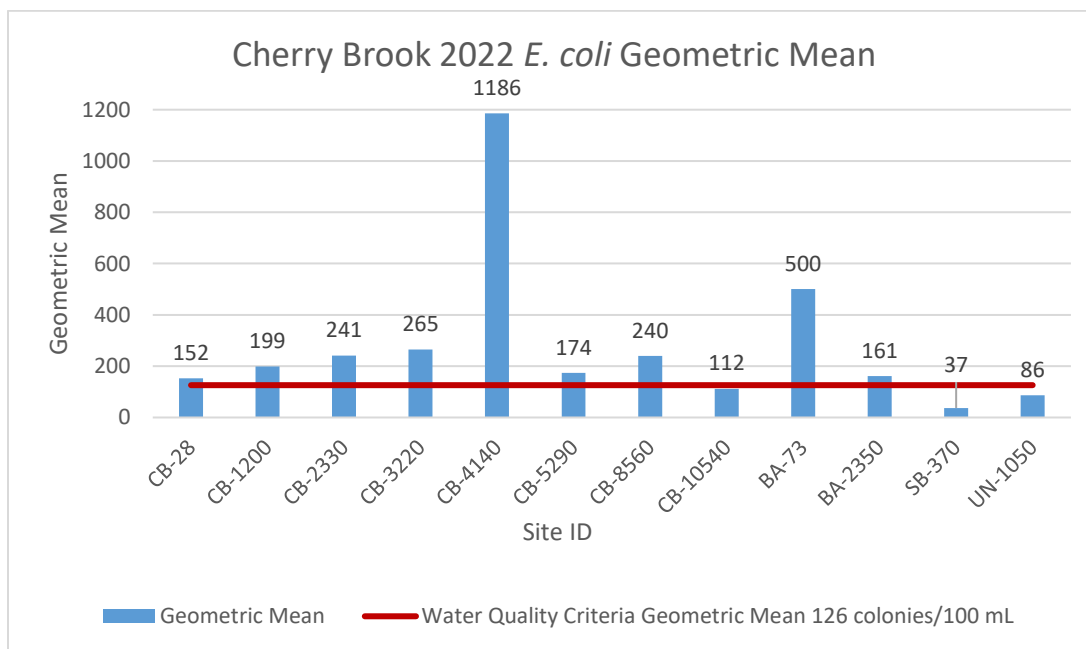


Figure 6: Cherry Brook Watershed *E. coli* geometric mean by site 2022

Nutrients

All nutrient samples were analyzed by University of Connecticut Center for Environmental Sciences and Engineering (UConn CESE). Analysis included total nitrogen, total dissolved nitrogen, total phosphorus, total dissolved phosphorus, nitrogen oxides, and ammonia. Total Kjeldahl nitrogen was calculated by FRWA. Nutrient samples were taken on June 20th and August 22nd. Nutrients were assessed at all sites within Cherry Brook Watershed in order to determine tributaries and stream reaches that may provide favorable conditions for *E. coli*. The availability of nutrients such as nitrogen and phosphorus is an important factor influencing *E. coli* survival and growth in the environment. There is no official numeric water quality criteria for nutrients in rivers and streams, but a suggested criteria. Total nitrogen has a target of 0.5 mg/L, but since most will be unavailable in the environment, a limit of 1.0 mg/L is acceptable. Total phosphorus has a target of 0.01 mg/L with a limit of 0.02 mg/L.

Site ID	Location	Date	Total N	Total P	Date	Total N	Total P
CB-28	Rt. 44 bridge	6/20/22	0.446	0.018	8/22/22	0.562	0.016
CB-1200	CLCT Pratt Place		0.425	0.017		0.519	0.016
CB-2330	Humphrey Rd		0.444	0.02		0.707	0.015
CB-3220	Barbourtown bridge		0.418	0.02		1.030	0.016
CB-4140	Meadow Rd		0.39	0.012		1.080	0.064
CB-5290	West Rd		0.301	0.013		0.259	0.013
CB-8560	NCVFD		0.317	0.017		0.287	0.029
CB-10540	Rt. 179		0.463	0.019		1.910	0.014
BA-73	Barbourtown Rd		0.215	0.014		Dry	Dry
BA-2350	Upper Barbourtown Rd		0.153	0.02		Dry	Dry
SB-370	Rt. 179		0.288	0.022		0.600	0.035
UN-1050	Rt. 179		0.486	0.012		0.498	0.015
Shaded cells indicate an exceedance of suggested water quality criteria							

Table 5: Nutrient values in Cherry Brook Watershed for June 20th 2022 and August 22nd 2022

All sites were below the limits for total nitrogen on June 20th, with ranges between 0.15 mg/L and 0.48 mg/L (figure 7). On August 22nd, sites CB-3220, CB-4140, and CB-10540 were above the suggested limit for total nitrogen. Phosphorus on June 20th had ranges between 0.01 mg/L and 0.019 mg/L, with CB-2330, CB-3220, BA-2350 and SB-370 above the suggested limits (figure 8). For August, total phosphorus was above the suggested limit at sites CB-4140, CB-8560 and SB-370. Barbour Brook sites were dry during nutrient sampling in August. Site CB-4140 on August 22nd was far above the suggested limit for total phosphorus of 0.02 mg/L with a value of 0.064 mg/L (table 5). The high values at CB-4140 on August 22nd indicate pollution from Meadow Rd. SB-370 on both June 20th and August 22nd had high values of phosphorus. Sawmill Brook runs through a residential area and CLCT property. High values in tributaries can be an indication of stormwater runoff from residential areas. High nutrient values can also

indicate septic system leaks during drought conditions when the streams are primarily originating from groundwater. This could explain the upstream sites CB-8560 and CB-10540 high nutrient values, and it can explain the higher frequency of above-limit readings in August.

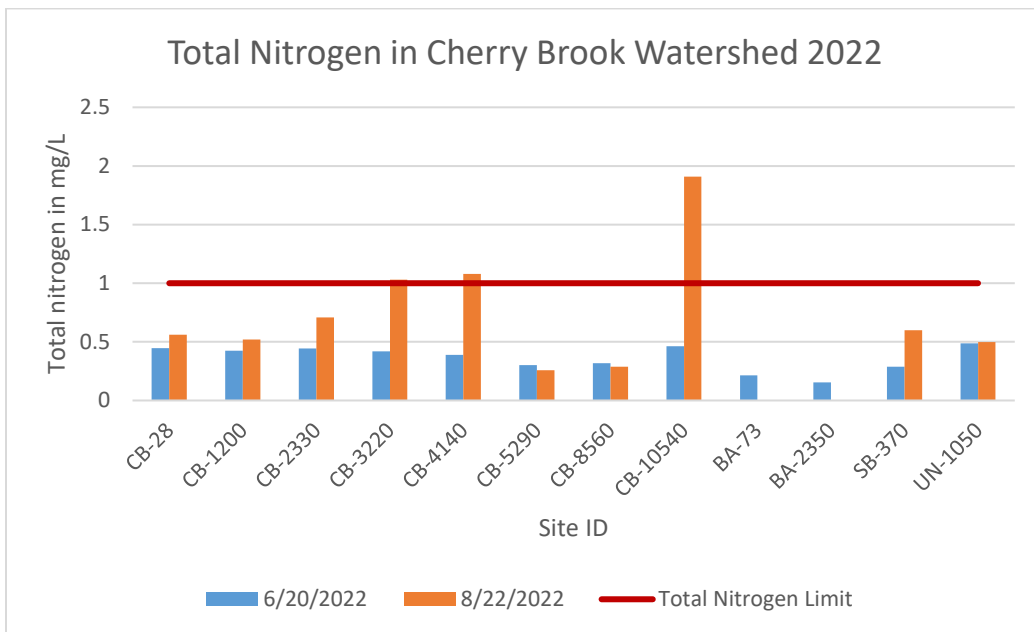


Figure 7: Total nitrogen on June 20th and August 22nd with suggested limit

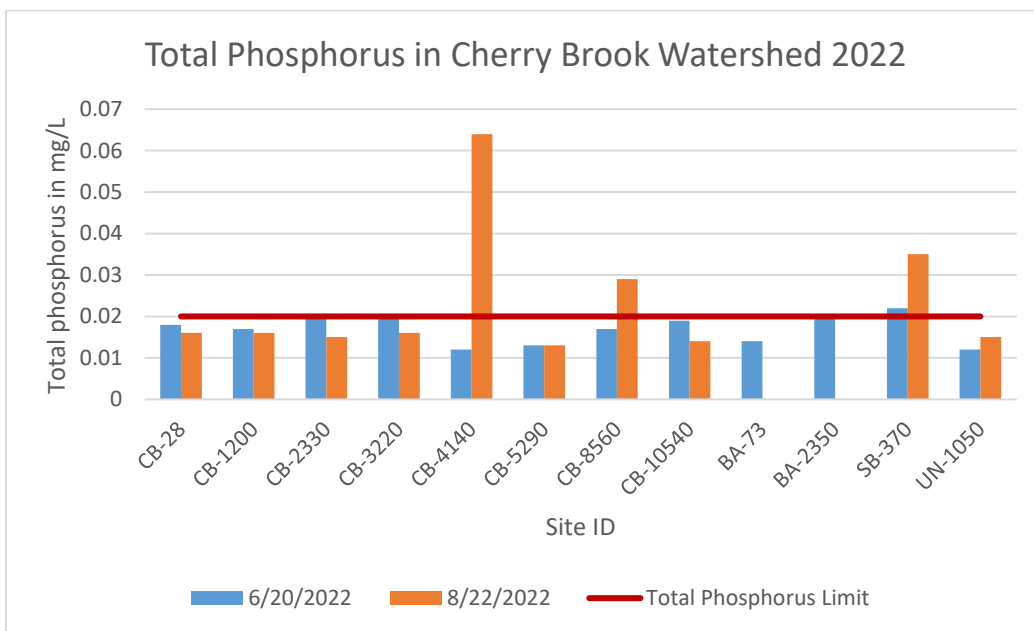


Figure 8: Total phosphorus on June 20th and August 22nd with suggested limit

Temperature

The average water temperature in which cold water fish can survive June through August is 18.3 °C or less. All three temperature sites had cold water from May to mid-July. Mid-July brought drought, and with lower water levels, temperatures increased. All three sites had minimum temperatures of 9-10 °C, maximum temperatures of 25-27 °C, and averages of 19 °C. Minimum temperatures occurred in May, and maximum temperatures were in August. All three sites on average were one degree higher than the habitat temperature average (figure 9, 10, 11). Drought brought stress to all waterbodies in the summer of 2022, with only a 1 degree difference in temperature to the average, Cherry Brook fared well in terms of temperature. CB-8560 in July had a new beaver dam, this can increase temperatures as dams slow water flow.

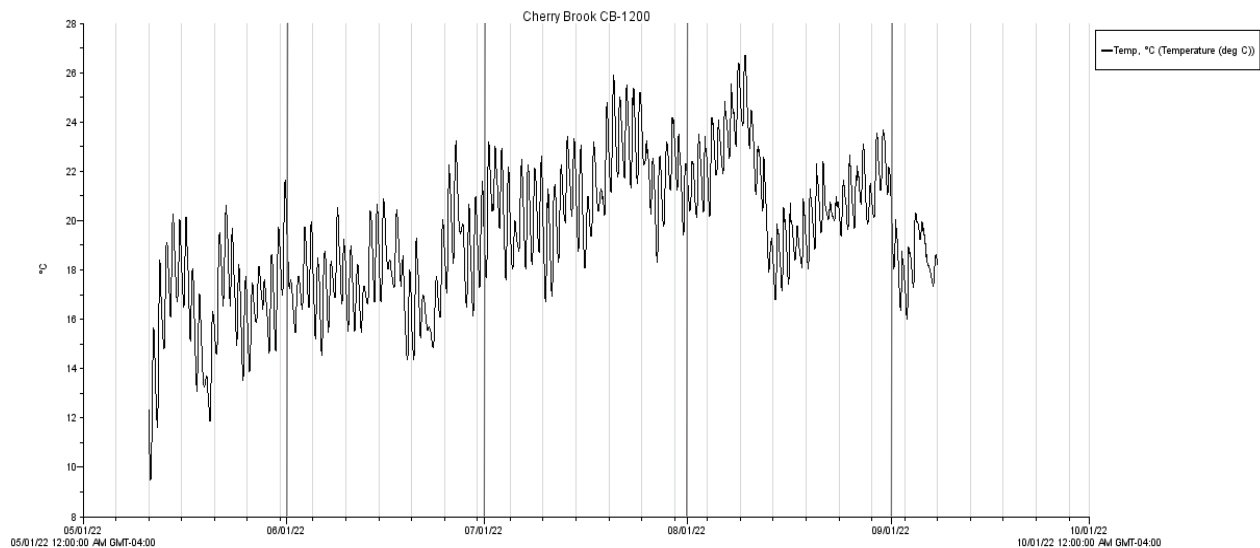


Figure 9: Cherry Brook CB-1200 at CLCT Pratt Place temperature May - September

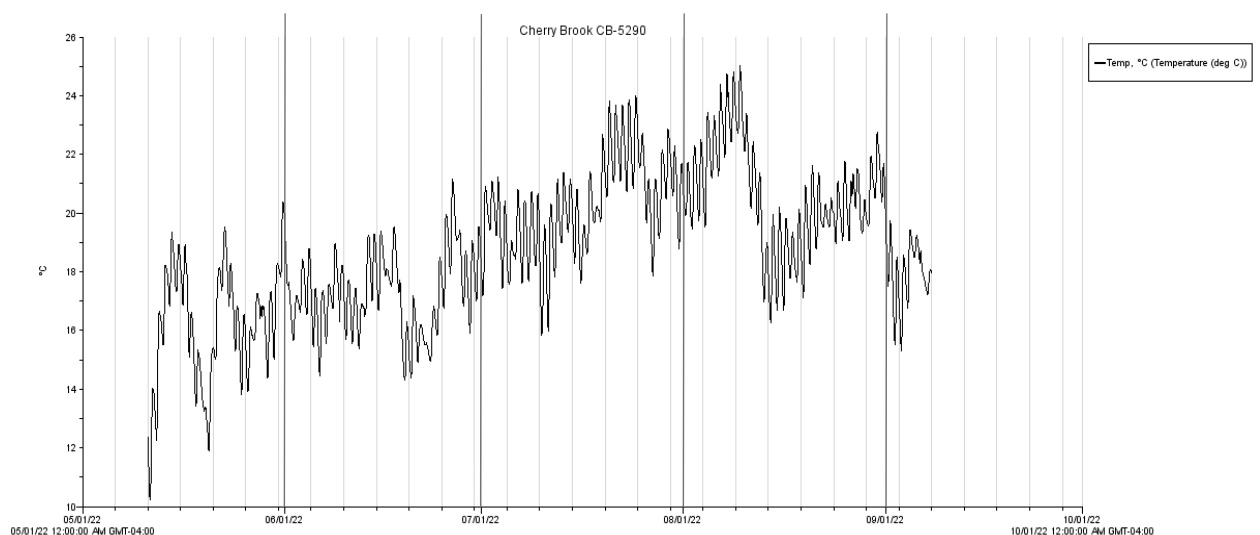


Figure 10: Cherry Brook CB-5290 on West Rd. temperature May - September

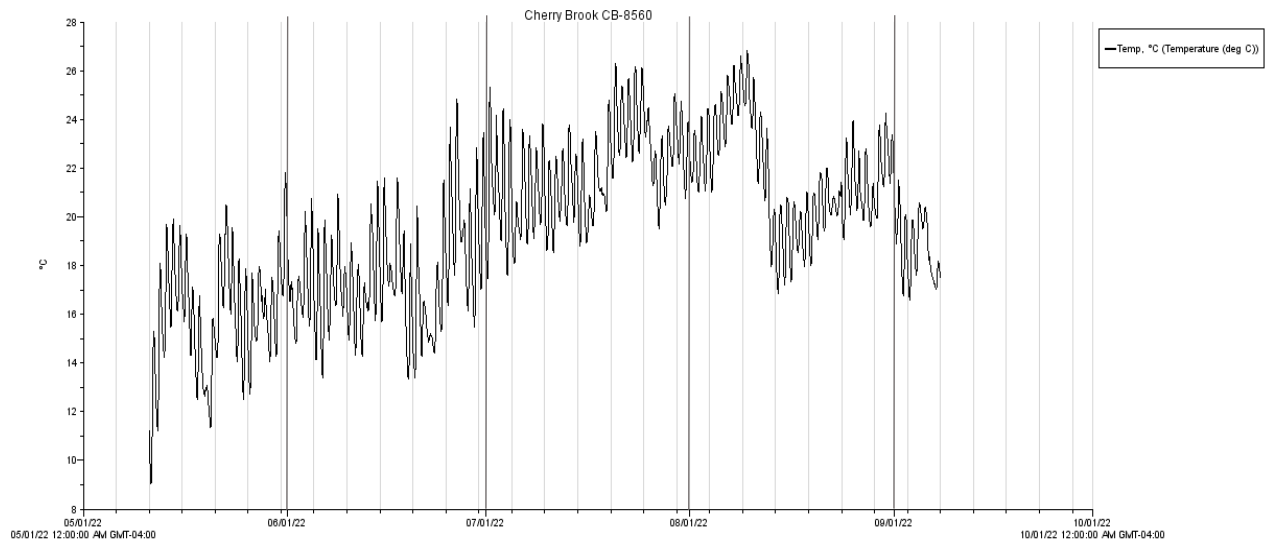


Figure 11: Cherry Brook CB-8560 behind NCVFD temperature May - September

Macroinvertebrates

Four macroinvertebrate surveys were performed in September and October per CT DEEP RBV protocol. Sites included CB-1200 at the Canton Land Trust Pratt Place, downstream CB-3220 Barbourtown Rd. Bridge, upstream site CB-5290 on West Rd. at CLCT Goedecke-Humphrey, and CB-8560 behind NCVFD. Two sites were within the impaired segment, and the other two were upstream the impaired segment. CT DEEP RBV protocol to determine high water quality is based on finding four or more of the most sensitive macroinvertebrate species. All sites sampled except at CLCT Goedecke-Humphrey, had four or more most sensitive species (table 6). High bacteria values at these sites will not affect the macroinvertebrates present. Goedecke-Humphrey had sufficient riffles present for survey. It is likely the lower results at this location are due to the upstream habitat being pool-cascade, which can alter the results downstream. It can also be the result of drought over the summer. This site can be resampled in the future and does not indicate poor quality. With the exception of Goedecke-Humphrey, Cherry Brook is fully-supporting for aquatic life. These samples were examined by Alisa Phillips-Griggs whom has macroinvertebrate taxonomy experience. The samples will be examined by a state certified taxonomist to confirm the macroinvertebrates present. The results will be published in a CT DEEP RBV report in 2023.

Site ID	Location	Most Sensitive Species
CB-1200	CLCT Pratt Place	4
CB-3220	Downstream Barbourtown Rd Bridge	4
CB-5290	Upstream at CLCT Goedecke-Humphrey	2
CB-8560	Behind NCVFD	5

Table 6: Macroinvertebrate results by most sensitive species

Conclusion

Site CB-4140 indicates Meadow Rd. is the main contributor of *E. coli* in Cherry Brook due to a high geometric mean and high nitrogen and phosphorus values on August 22nd. Meadow Rd. is likely the result of high levels downstream Cherry Brook to the confluence with the Farmington River. Tributary Barbour Brook had high *E. coli* values, especially near the confluence with Cherry Brook. Barbour Brook is contributing to high values in Cherry Brook, but is not the main reason for the TMDL. Cherry Brook sites upstream from the impaired segment were high at West Rd. and NCVFD, but likely due to drought conditions. The most upstream Cherry Brook site, CB-10540, Sawmill Brook and Unnamed tributary were low in *E. coli*. Sites with nutrient values above the suggested limits indicate stormwater run-off, septic leaks and for CB-4140, agricultural activity at Meadow Rd. Temperatures were one degree above the average for cold water fish. For severe drought conditions, Cherry Brook fared well for temperature. Macroinvertebrate surveys indicated Cherry Brook had high water quality, with the exception of the site upstream CB-5290 at Goedecke-Humphrey.

This data has allowed us to better determine locations for best management practices, such as rain gardens and buffer projects. With drought in summer 2022, it would benefit to continue monitoring certain sites in Cherry Brook watershed to understand how it fares in different weather patterns and water flows.

References

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