

FAIRFIELD COUNTY

RIVER REPORT



Harbor Watch | 2017

Fairfield County River Report: 2017

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This report includes data on:

Bruce Brook, Byram River, Deep Brook, Farm Creek, Farmill River, Five Mile River, Keelers Brook, Mill River, Muddy Brook, Noroton River, Norwalk River, Pootatuck River, Poplar Plains Brook, Rippowam River, Rooster River, and Saugatuck River

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Key terms and information about this report:

Acronyms:

- CT DEEP: Connecticut Department of Energy and Environmental Protection
- CFU/100 mL: Colony forming units per 100 mL. This is a unit of measurement for bacteria concentrations. A colony is raised from a single bacterium to a visible colony for counting by providing the preferred heat range and media for 24 hours.

Study Site Naming:

- Sites are numbered with the lowest number (1) being closest to the mouth of the river where it meets a larger body of water or Long Island Sound. Sites with the highest numbers are located furthest upstream.
- Site names that include “SD” indicate that the sample location is a storm drain outfall rather than an instream location. These sites are not held to the same pass/fail assessment standards as instream sites and were not included in the figures.

Terms/Symbols in Tables:

- n/a: Indicates that a sample was not taken at that time for reasons including broken or lost sample bag, stagnant water, inaccessibility due to construction, dry river bed, or other factors.
- “>”: More than 100 colonies were on the filtered membrane. Values were obtained by using the formula $(100 \text{ CFU} \times 100\text{mL})/\text{volume filtered (mL)}$.
- “Est.”: Less than 20 colonies were on the filtered membrane, so the colony count is estimated by using the formula $(\text{CFU observed} \times 100\text{mL})/\text{volume filtered (mL)}$.
- Wet: Rainfall is indicated as “Wet” if >0.1 inches of rain fell within 2 days prior to sampling.
- Dry: Rainfall is indicated as “Dry” if <0.1 inches of rain fell within 2 days prior to sampling.

Introduction

Harbor Watch is a water quality research program based out of Earthplace in Westport, CT. Our mission is to provide the people of Connecticut with the data, knowledge, and field expertise necessary to safeguard our waterways, educate our communities about watershed issues, and train volunteers and student interns through hands-on research. In this report, we present a study of water quality in rivers throughout Fairfield County, Connecticut. The goal of this monitoring was to identify sources of sewage pollution entering local waterways using *Escherichia coli* (*E. coli*) as an indicator.

Since 1986, Harbor Watch has been monitoring water quality throughout Fairfield County. The 2017 monitoring season was our largest monitoring effort to date, expanding our geographical range to 18 towns. Partnering with local municipal leaders allowed us to identify and remediate three sources of sewage pollution to the Long Island Sound watershed and improving water quality in 2017. This report contains data summaries for the 16 rivers we monitored from May through September.

This report focuses on the results of three water quality indicators; *E. coli*, dissolved oxygen, and conductivity. *E. coli* was selected for study because it is the indicator bacteria of choice for the Environmental Protection Agency and Connecticut Department of Energy and Environmental Protection (CT DEEP) for sewage pollution in freshwater systems. Its presence in high concentrations suggests that there are likely also more harmful pathogens present. Dissolved oxygen is an important water quality indicator because many aquatic species rely on it for survival, similarly to how land animals rely on oxygen in the air. When dissolved oxygen is not available, species like fish and macroinvertebrates will relocate to higher quality waters, or die due to the lack of oxygen. Conductivity is a measure of how easily the water can carry an electrical current by measuring the ionic strength of the water. It can quantify the intrusion of salt water or other sources of salts and other compounds into a waterway.

Methods

Each river was visited approximately twice per month from May through September for a total of 10 sampling days per river. Sites were selected based on access and representativeness of the river, with effort made to space sites evenly throughout the length of the river. Monitoring was carried out under a Quality Assurance Project Plan approved by the CT DEEP (RFA #17057).

Monitoring teams left Earthplace in Westport, CT in the morning to begin sampling and would return within 2-3 hours. Each team was comprised of fully-trained Harbor Watch employees, sometimes accompanied by volunteers. At each site, a water sample was collected and kept on ice. Water temperature, dissolved oxygen, and conductivity were measured at each site using a YSI Pro2030 meter.

Upon return to the Harbor Watch laboratory, the water samples were analyzed for fecal coliform and *E. coli* using membrane filtration methods set forth in Standard Methods (SM9222D and SM9222G). *E. coli* concentrations were evaluated using the criteria published in the CT DEEP Surface Water Quality Standards on 10/10/13 (Table 1). Because the rivers we tested do not contain designated swim areas, the “all other recreational uses” criteria will apply.

Table 1. CT DEEP criteria for *E. coli* levels as applied to recreational use, effective 10/10/13

Designated Use Recreation	Class	Indicator	Criteria
Designated Swimming	AA, A, B	<i>Escherichia coli</i>	Geomean less than 126 CFU/100 mL; Single Sample Maximum 235 CFU/100 mL
Non-designated Swimming	AA, A, B	<i>Escherichia coli</i>	Geomean less than 126 CFU/100 mL; Single Sample Maximum 410 CFU/100 mL
All Other Recreational Uses	AA, A, B	<i>Escherichia coli</i>	Geomean less than 126 CFU/100 mL; Single Sample Maximum 576 CFU/100 mL

Results and Discussion

A. Fairfield County Summary

From May through September 2017, 16 rivers were monitored, many of these waterways being new to the roster of waterways monitored by Harbor Watch. There were 125 unique sampling locations that were monitored 10 times each. Many of these rivers did not meet state criteria for bacteria concentrations (Table 1) and are acting as a pathway for sewage pollution to enter Long Island Sound. 61% of sites exceeded the CT DEEP geometric mean criterion of <126 CFU/100 mL (Figure A1, left). More than one third of sites were twice the state criterion. Additionally, 36% of sites failed the secondary single sample maximum criterion of <15% of *E. coli* samples at each site >576 CFU/100 mL (Figure A1, right). The Saugatuck River, which flows through Redding, Weston, and Westport, had the fewest exceedances of the CT DEEP criteria. The Bruce Brook, which flows through Stratford and Bridgeport, had the most exceedances of the CT DEEP criteria (Figure A1, left).

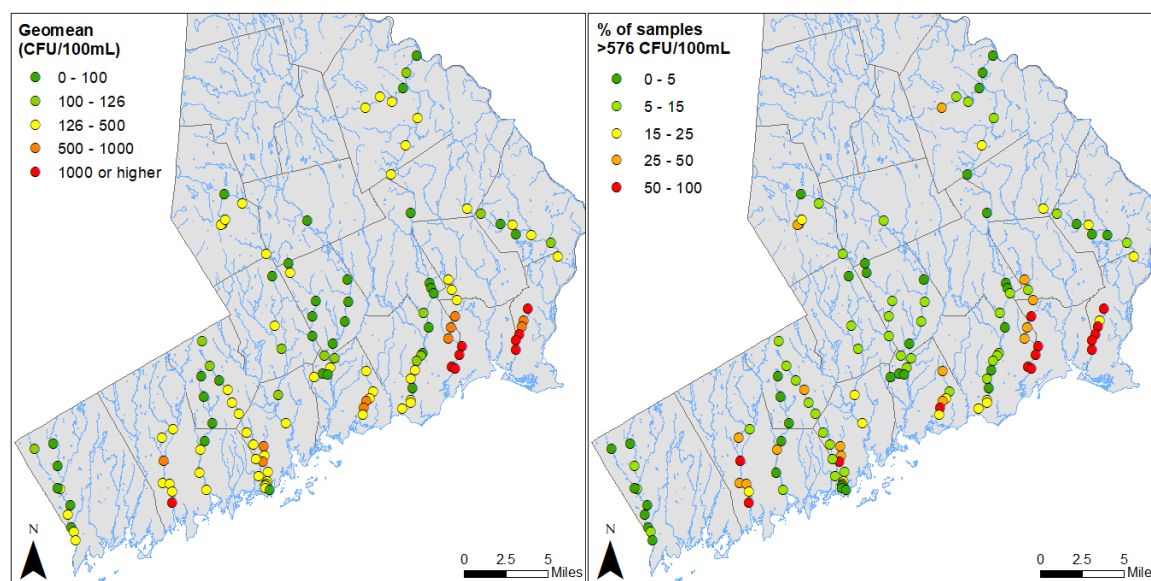


Figure A1. Map of 2017 sampling locations and *E. coli* concentrations. (Left) *E. coli* geomean for each site. The bacteria concentrations for each site were compared to the state criteria for recreational waters. Passing sites have a geomean less than 126 CFU/100 mL. (Right) *E. coli* single sample maximum for each site. The bacteria level for each sample was compared to the state criteria for recreational waters. Passing sites have less than 15% of their samples exceeding 576 CFU/100 mL.

The state criterion for dissolved oxygen levels is a minimum of 5 mg/L. The majority of sampling sites had mean dissolved oxygen values which met this criterion, but a number of sites had mean values which fell below 5 mg/L (Figure A2). Prolonged events of low dissolved oxygen can be harmful to marine and aquatic organisms. Factors observed during the monitoring season such as low flow, decomposition of organic matter, and warm water temperatures have the potential to impact dissolved oxygen values.

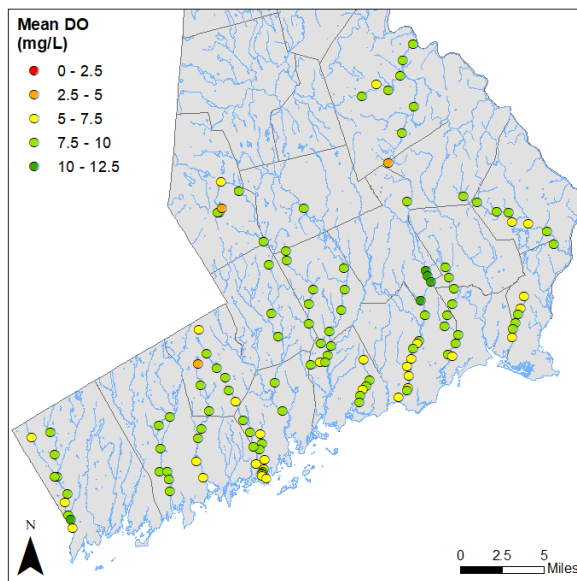


Figure A2. Map of 2017 river sampling locations and mean dissolved oxygen values. The dissolved oxygen level for each sample was compared to the state criterion of a minimum of 5mg/L.

During the 2017 season there was 13.51 inches of rain that fell from May through September. July had the largest precipitation totaling 2.95 inches and June had the least amount totaling 0.84 inches (Figure A3, Weather Underground-KBDR). Precipitation can have both positive and negative impacts on water quality. Rainfall can help improve water quality by pushing a large volume of water through the riverbed. This in turn can alleviate low flow problems which cause decreased dissolved oxygen levels during periods of drought. Alternatively, rainfall can move pollutants from yards, forests, and impervious surfaces into the waterway, impacting bacteria and conductivity values.

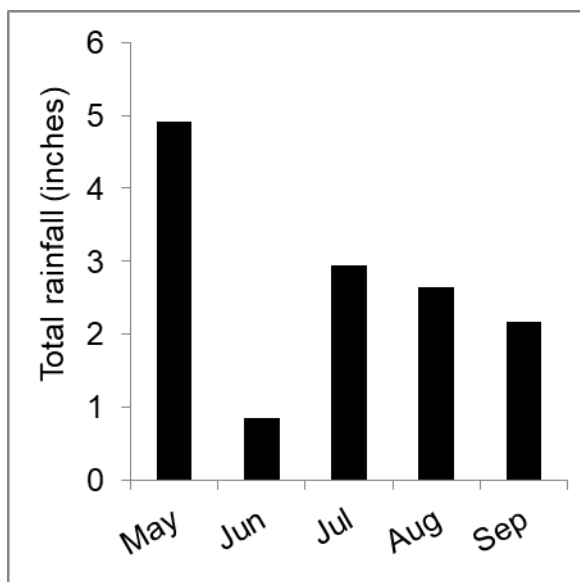


Figure A3. Monthly rainfall totals for 2017 (Weather Underground-KBDR).

Data is collected on Fairfield County waterways for many different reasons. Harbor Watch aims to better understand the ecological health of our watersheds by monitoring dissolved oxygen, conductivity, water temperature, and bacteria levels. A secondary objective is to use the data collected to inform us where sewage pollution sources may be located so that we can perform further investigation. Once sources are identified, Harbor Watch works with municipal partners to fix the problem. During 2017, track-down surveys were conducted on four different projects in Darien, Norwalk, and Wilton. Track-down surveys are ongoing and will continue year-round. Our process of repetitive bacteria testing has been successful in identifying point sources of pollution such as leaking sanitary sewer lines, broken sewer laterals, and pipes illegally hooked into the storm water system. By partnering with municipalities to fix these problems, we have been able to calculate as much as 98% reductions in bacteria concentrations entering our waterways. While summer has brought us trackdown success, the prevalence of failing bacteria concentrations observed over this monitoring season (Figure A1) indicates that there is still more work to be done to improve the overall water quality of the Long Island Sound watershed.

In the chapters to follow, we present a detailed data summary of each of the 16 rivers monitored by Harbor Watch this summer.

B. Bruce Brook

Summary

The Bruce Brook watershed lies in both the Town of Stratford and the City of Bridgeport. It spans approximately 2,199 acres and discharges into Bridgeport Harbor. This land use is divided into 94% urban area, 5% forests, 1% water, and less than 1% agriculture (CT DEEP). The brook itself is channelized with cement through most of its length. Bruce Brook acts as a natural boundary between the two municipalities from the Route 1 corridor south to the coastline.

2017 marked the first year that Harbor Watch monitored Bruce Brook. The river was of interest because it is located in an area where Harbor Watch had not done any sampling previously. All sites exceeded both CT DEEP criteria for *E. coli*. Dissolved oxygen values met the CT DEEP minimum criterion. We have started working with the Conservation Administrator in Stratford to begin track-down surveys in the watershed. Continued monitoring during the 2018 season is suggested to identify potential sources of pollution to the brook.

Table B1. GPS coordinates and site locations for Bruce Brook

Site Name	Latitude	Longitude	Town	Comments
Bruce 1	41.18386	-73.154467	Bridgeport	Connecticut Avenue
Bruce 2	41.191878	-73.154274	Stratford	102 Bowe Avenue
Bruce 3	41.196991	-73.150854	Stratford	380 Canaan Road
Bruce 4	41.20397	-73.14803	Stratford	2340 Broadbridge Avenue
Bruce 5	41.209154	-73.145648	Stratford	Albright Avenue
Bruce 6	41.219491	-73.140906	Stratford	Old Spring Road

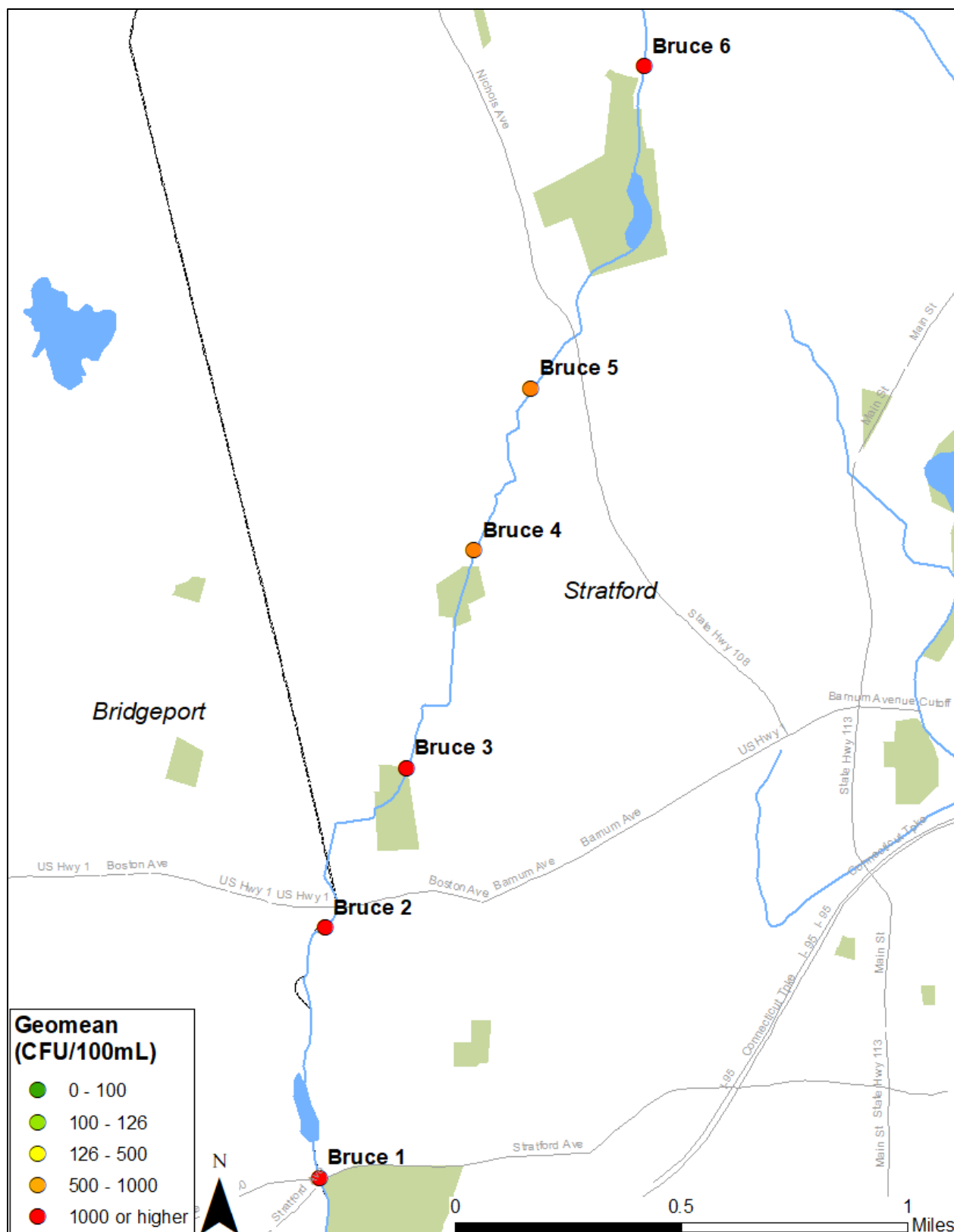


Figure B1. Sampling locations for 6 sites on Bruce Brook.

Bacteria results

All six sites in Bruce Brook exceeded the CT DEEP *E. coli* geomean (<126 CFU/100 mL) and single sample maximum (<15% of *E. coli* samples >576 CFU/100 mL) criteria (Figure B2, Table B2). Bruce 1 consistently had the highest observed bacteria concentrations at all sites monitored by Harbor Watch in 2017. Elevated bacteria concentrations were observed at all sites regardless of weather conditions indicating that a chronic problem may exist.

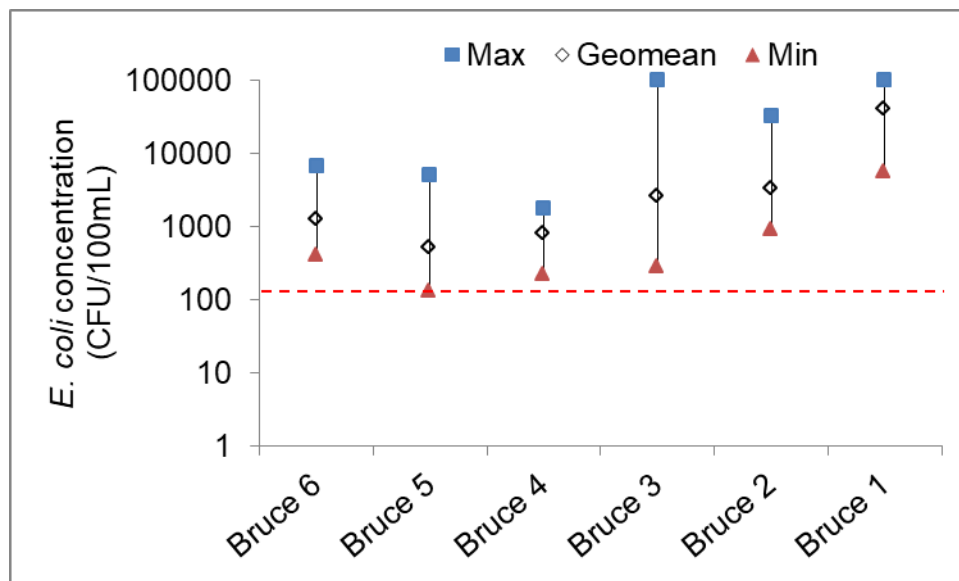


Figure B2. Bruce Brook *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table B2. Bruce Brook *E. coli* concentrations and relation to water quality criteria (rainfall data: Weather Underground – Fairfield Town Hall). Data was not available on the rain gauge for September 17th and 18th.

	5/3/2017	5/24/2017	6/7/2017	6/19/2017	7/12/2017	7/27/2017	8/10/2017	8/24/2017	8/28/2017	9/18/2017	Geomean	% > 576
Bruce 6	480	6700	est. 700	800	1200	1120	1950	2900	1580	400	1241	80%
Bruce 5	460	390	est. 130	860	170	540	n/a	n/a	n/a	> 5000	512	20%
Bruce 4	275	1000	est. 220	940	760	560	1750	1000	1750	1350	794	70%
Bruce 3	285	> 2000	est. 1600	1420	1800	4900	2250	> 100000	3300	1500	2573	90%
Bruce 2	1700	2800	est. 900	1200	> 20000	2200	4200	5000	1000	32000	3298	100%
Bruce 1	5660	7200	39000	67000	98000	57000	> 100000	57000	42000	> 100000	41243	100%
Rainfall	Dry	Wet	Dry	Wet	Wet	Dry	Dry	Wet	Dry	n/a		

Dissolved oxygen results

Mean dissolved oxygen levels met the CT DEEP minimum criterion of 5 mg/L (Figure B3). Individual readings at sites Bruce 6 and Bruce 1 fell below 5mg/L on one and five sampling dates respectively. In August, Bruce 5 dried up and we were unable to collect any data. In September the site had some flow so a bacteria sample could be retrieved, but there was not enough water to take dissolved oxygen and conductivity readings. Bruce 6 and Bruce 2 also had low flow on 8/24 which prevented dissolved oxygen readings from being taken.

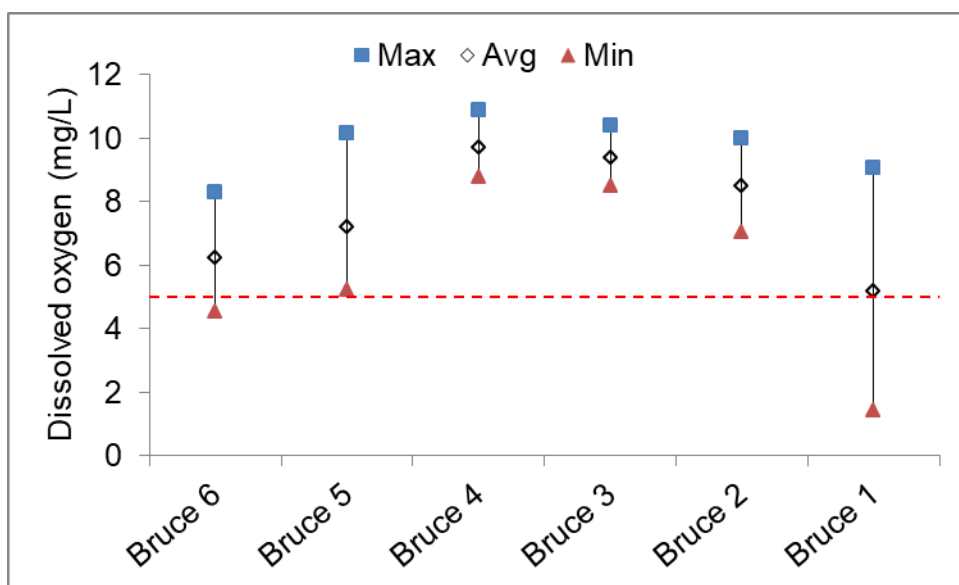


Figure B3. Bruce Brook dissolved oxygen values. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity ranges throughout the brook were wide, but averages in the area above tidal incursion remained steady (Figure B4, left). The wide ranges may be attributed to sampling during different weather conditions where runoff may have impacted the conductivity readings. The wide range at Bruce 1 is due to sampling occurring regardless of the tide cycle (Figure B4, right).

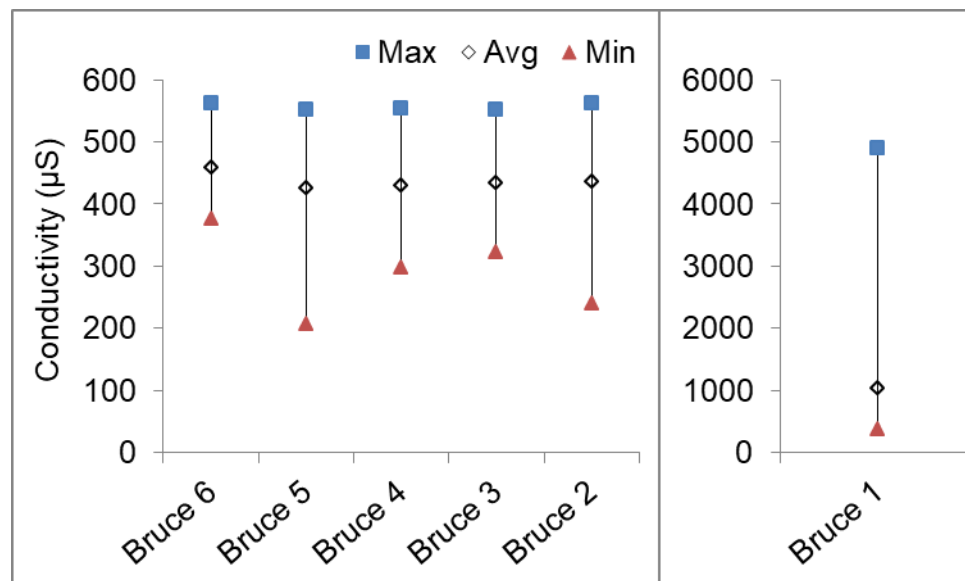


Figure B4. Bruce Brook conductivity values. Maximum, average, and minimum for each site that is (left) above the area of tidal incursion and (right) tidally influenced.

C. Byram River

Summary

The Byram River watershed encompasses portions of four communities whose political boundaries fall within the states of Connecticut and New York. The majority of the river is located in Greenwich, CT. The three towns in New York through which the river runs are New Castle, Purchase, and Port Chester, which fall within Westchester County. The watershed is approximately 12,000 acres or 18.7 square miles and defined by two main drainage basins, the Byram River and the East Branch of the Byram River. The main stem of the Byram River is approximately 14 miles long. The river begins at the Byram River reservoir and flows south, ultimately discharging to Long Island Sound through Port Chester Harbor. The land use in the watershed is predominantly residential.

2017 marked the second year that Harbor Watch collected data on the Byram River. We found that bacteria concentrations were slightly improved over 2016 data, but a number of the sites still exceeded the CT DEEP criteria. The sites that exceeded the state criteria in 2017 were the same sites that exceeded the criteria in 2016. We suggest further investigation of the watershed in the 2018 monitoring season to identify sources that may be contributing to the elevated bacteria levels observed in the river at these sites. We are currently working with the Greenwich Public Works department to design trackdown studies in the Byram River watershed.

Table C1. GPS coordinates and site locations for the Byram River

Station Number	Latitude	Longitude	Town	Comments
Byram 1	41.01649	-73.65623	Greenwich	Den Lane, end of road
Byram 2	41.02383	-73.65859	Greenwich	2 Upland Street East
Byram 3	41.02740	-73.66169	Greenwich	Comly Avenue and Pemberwick Road
Byram 4	41.03858	-73.66530	Greenwich	Glenville Street
Byram 5	41.04627	-73.66265	Greenwich	7 Bailiwick Road
Byram 6	41.06092	-73.67760	Greenwich	Sherwood Avenue
Byram 7	41.09460	-73.70437	Greenwich	111 Bedford Road
East Byram 1	41.06051	-73.67454	Greenwich	329 Riversville Road
East Byram 2	41.07998	-73.67743	Greenwich	105 Porchuck Road
East Byram 3	41.09915	-73.68308	Greenwich	88 John Street

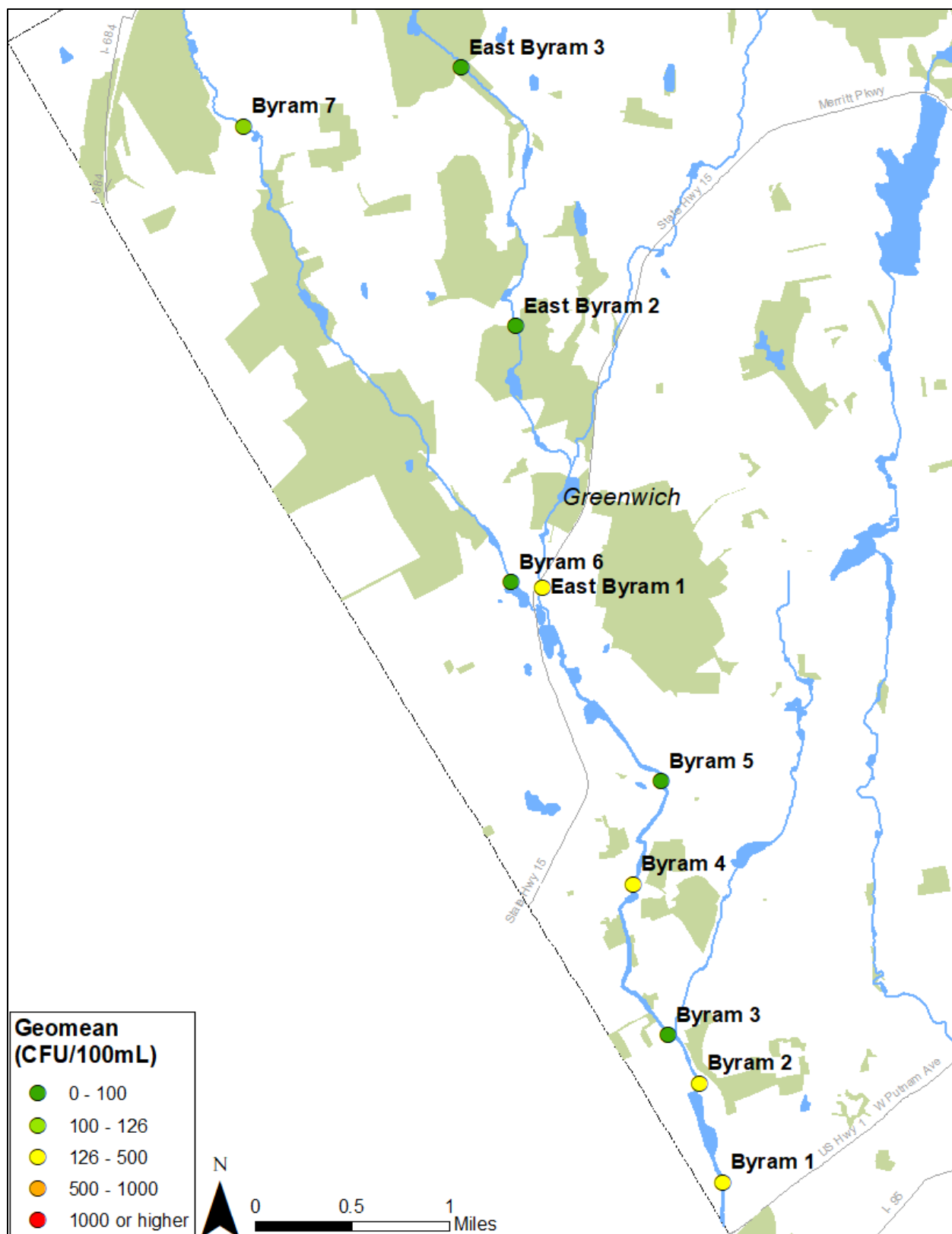


Figure C1. Sample locations for the 10 sites on the Byram River.

Bacteria results

Of the ten sites on the Byram River, six sites, East Byram 3, East Byram 2, Byram 7, Byram 6, Byram 5, and Byram 3, met both CT DEEP criteria for *E. coli* (Figure C2, Table C2). The remaining four sites exceeded the geomean criterion (<126 CFU/100 mL) for *E. coli* (Figure C2, Table C2). None of the Byram River sites exceeded the single sample maximum criterion (<15% of *E. coli* samples at each site >576 CFU/100 mL; Table C2). Elevated bacteria concentrations were observed on sampling days where more than 0.1 inches of rain fell within two days prior to sampling.

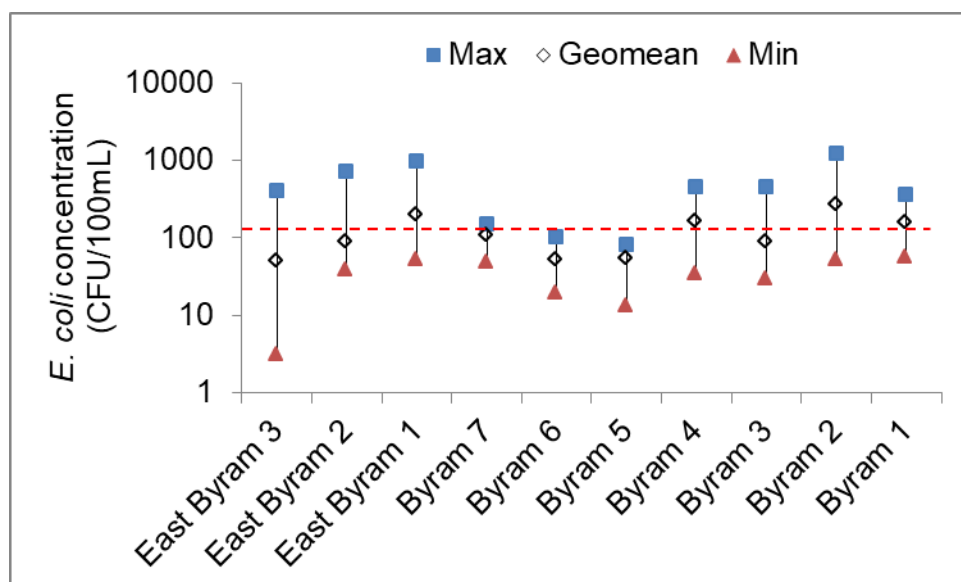


Figure C2. Byram River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table C2. Byram River *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: M. Long, personal communication, October 2, 2017)

	5/4/2017	5/22/2017	5/31/2017	6/15/2017	7/10/2017	7/20/2017	8/2/2017	8/15/2017	8/29/2017	9/11/2017	Geomean	% > 576
East Byram 3	3	29	25	49	100	23	204	est. 32	> 400	124	49	0%
East Byram 2	37	45	62	134	56	80	120	720	est. 64	66	86	10%
East Byram 1	170	176	50	176	280	390	450	est. 100	960	est. 60	194	10%
Byram 7	47	n/a	124	148	140	140	112	120	56	120	105	0%
Byram 6	19	52	41	42	50	100	76	98	36	54	51	0%
Byram 5	13	64	48	72	n/a	64	64	82	44	74	53	0%
Byram 4	34	62	120	est. 200	92	136	420	340	265	440	159	0%
Byram 3	49	240	112	124	440	68	est. 30	78	82	29	88	0%
Byram 2	51	220	128	280	190	360	400	530	1200	256	266	10%
Byram 1	54	152	136	270	250	280	96	112	360	80	152	0%
Rainfall	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Wet	Wet	Dry		

Dissolved oxygen results

All average dissolved oxygen values met the CT DEEP minimum criterion of 5 mg/L (Figure C3). Individual values fell below 5 mg/L at Byram 7 on 6/15 and 7/20 and Byram 4 on 8/2. Low values can be attributed to reduced flow and decaying organic matter.

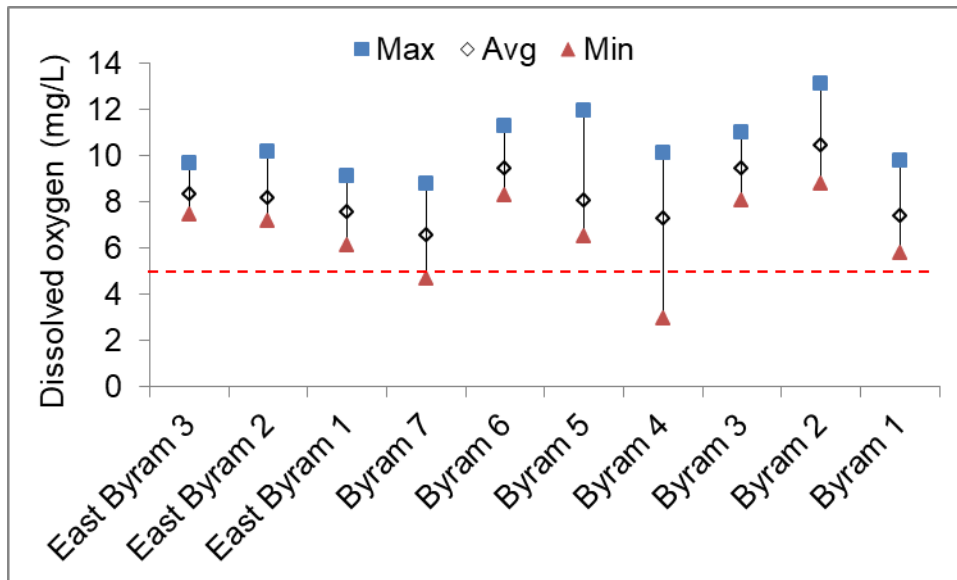


Figure C3. Byram River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity values were stable across the majority of the sites. The widest ranges were observed at sites Byram 7 and Byram 6 (Figure C4). The cause for these ranges is unknown at this time. It is interesting to note that conductivity ranges in the main stem of the river drop and remain stable after the East Branch of the Byram River meets the main stem just below site Byram 6. The mixing of these two branches may be the reason for the stability observed in conductivity values.

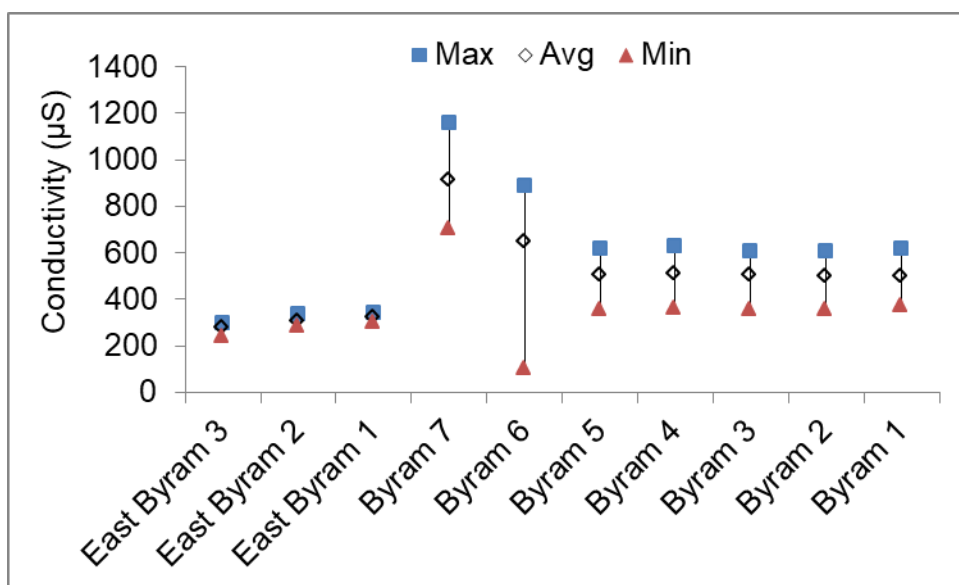


Figure C4. Byram River conductivity values. Maximum, average, and minimum for each site.

D. Deep Brook

Summary

The Deep Brook watershed is entirely within the boundaries of Newtown. Deep Brook starts on Castle Hill Road and flows northeast towards the center of Newtown. It is a tributary of the Pootatuck River (discussed in section M below) and is mostly used for recreation, such as trout fishing (Town of Newtown).

This was the first year that Harbor Watch monitored Deep Brook. Deep Brook was added to the monitoring regime at the request of Town of Newtown due to its impaired status on the CT DEEP impaired waters list. The majority of sites exceeded CT DEEP criteria for bacteria but mean dissolved oxygen levels met the CT DEEP minimum criteria.

Table D1. GPS coordinates and site locations for Deep Brook

Site Name	Latitude	Longitude	Town	Comments
Deep 1	41.409798	-73.285356	Newtown	Old Farm Road
Deep 2	41.397545	-73.298065	Newtown	Elm Drive
Deep 3	41.402423	-73.312272	Newtown	Boggs Hill Road
Deep 4	41.392167	-73.32881	Newtown	Head of Meadow Road

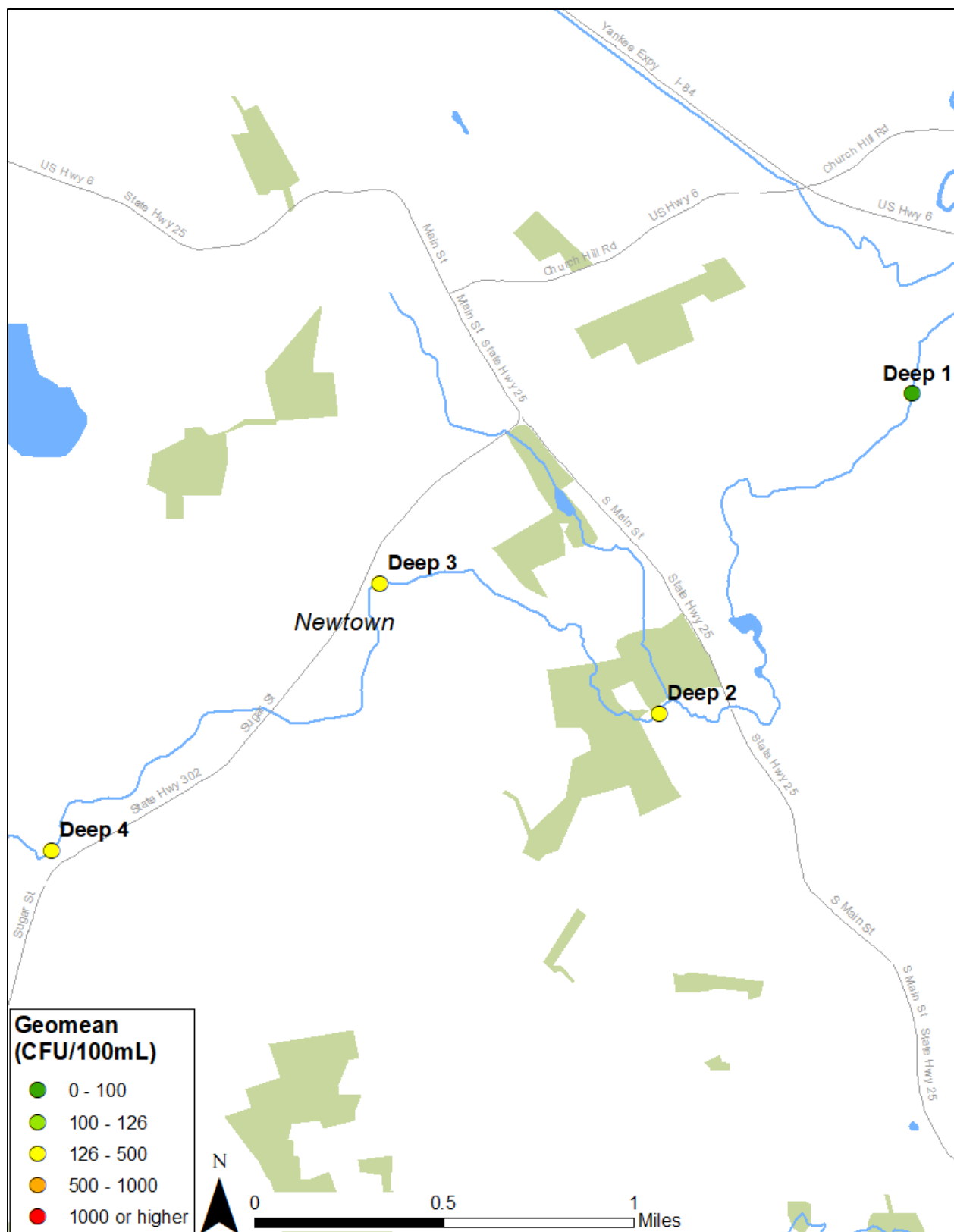


Figure D1. Sample locations for 4 sites on Deep Brook.

Bacteria results

Site Deep 4 was the only site that exceeded both the CT DEEP geomean criterion for *E. coli* of <126 CFU/100 mL as well as the single sample criterion of <15% of *E. coli* samples >576 CFU/100 mL (Figure D2, Table D2). Sites Deep 3 and Deep 2 exceeded only the geomean criterion (Figure D2). Elevated concentrations were observed on days that experienced more than 0.1 inches of rainfall within two days prior to sampling (Table D2). Elevated concentrations were also observed on 8/15 when 0.09 inches of rain fell. While this is below the 0.1 inch “wet” determination, it may have been enough rain to impact the bacteria results.

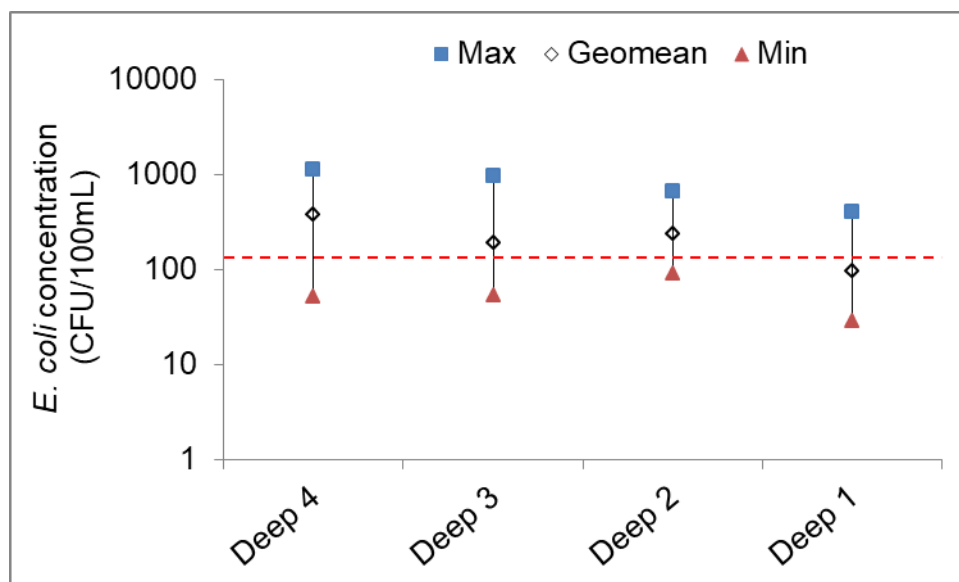


Figure D2. Deep Brook *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table D2. Deep Brook concentrations and relation to CT DEEP water quality criteria (rainfall data: J. Hovious, personal communication, October 10, 2017)

	5/8/2017	5/18/2017	6/8/2017	6/19/2017	6/26/2017	7/26/2017	8/2/2017	8/15/2017	9/6/2017	9/20/2017	Geomean	% > 576
Deep 4	50	196	128	680	350	430	840	1120	est. 350	1120	369	40%
Deep 3	60	52	80	360	188	228	340	140	230	960	182	10%
Deep 2	88	96	112	300	290	290	300	300	320	650	232	10%
Deep 1	68	28	36	98	84	84	100	> 400	210	130	94	0%
Rainfall	Wet	Dry	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet		

Dissolved oxygen results

Mean dissolved oxygen values at all four sites met the CT DEEP minimum criterion of 5 mg/L (Figure D3). Individual readings at site Deep 3 fell below 5 mg/L on four dates, 6/19, 8/15, 9/6, and 9/20, with the lowest reading of 3.83 mg/L on 9/6. This area of the brook often had an abundance of plant life growing which may have attributed to the wide range in dissolved oxygen values with plant growth increasing values and plant decomposition causing low readings.

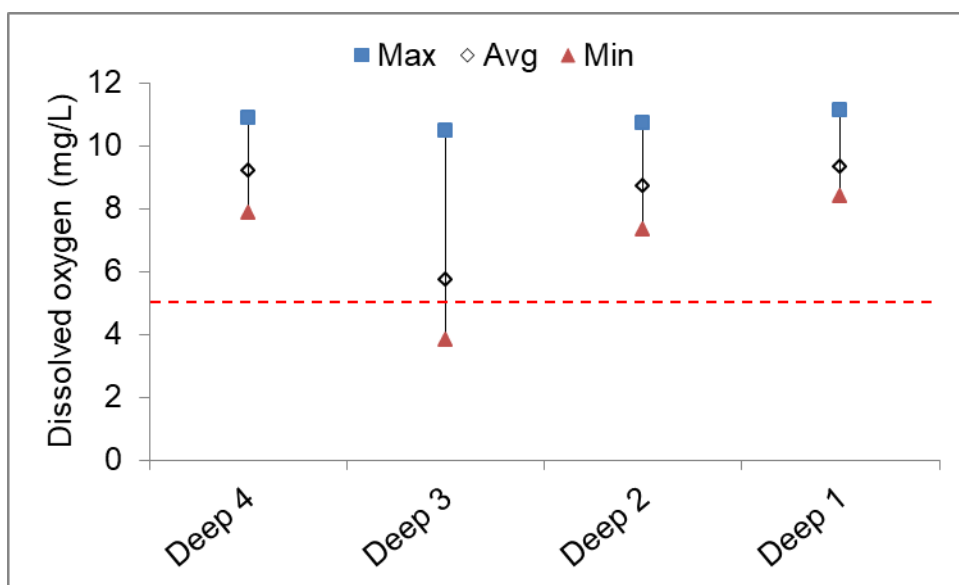


Figure D3. Deep Brook dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity averages in Deep brook varied among sites (Figure D4). The brook flows through many farm fields and sports fields as well as a country club. The changes in conductivity values may be related to runoff from these areas.

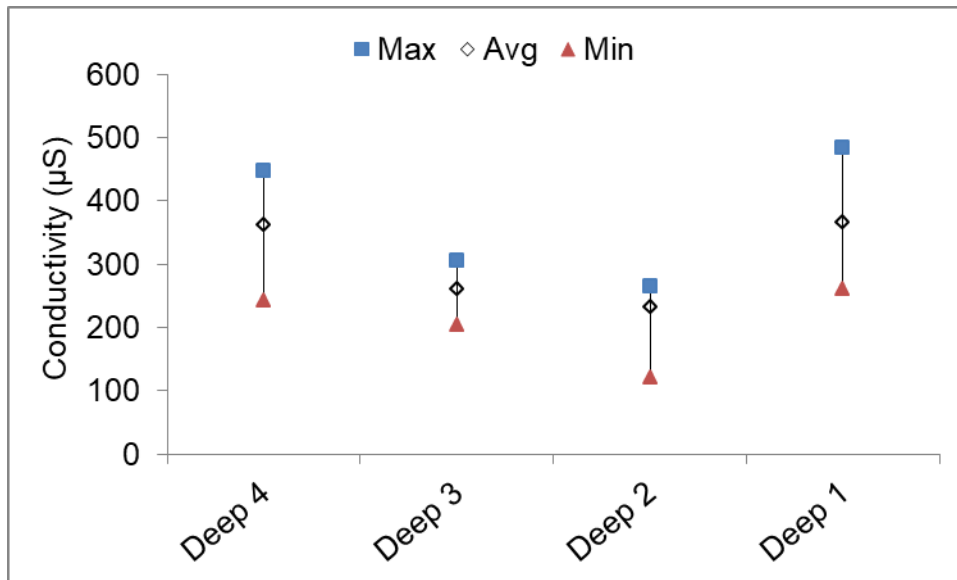


Figure D4. Deep Brook conductivity values. Maximum, average, and minimum for each site.

E. Farm Creek

Summary

Farm Creek is a small tributary to Long Island Sound located entirely in Norwalk, CT. The creek begins north of Roton Middle School, flows south to where the creek opens up to an estuary surrounded by salt marsh, and ultimately discharges to Wilson Cove. Most of the watershed is residential with a few school campuses which include large sports fields.

Harbor Watch has monitored Farm Creek for four years. The majority of sites did not meet the CT DEEP criteria for *E. coli* and many individual readings fell below the minimum criterion levels for dissolved oxygen. The percentage of bacteria concentration exceedances was the same in 2016 and 2017 (Figure E1). The increase in exceedances from 2014 to 2017 can most likely be attributed to temperature differences during the monitoring seasons (winter vs summer). In addition to monitoring the seven sampling locations, a pollution track-down project was conducted during the 2017 monitoring season and is still ongoing. Further investigation of Farm Creek is suggested to identify sources of pollution entering the watershed.

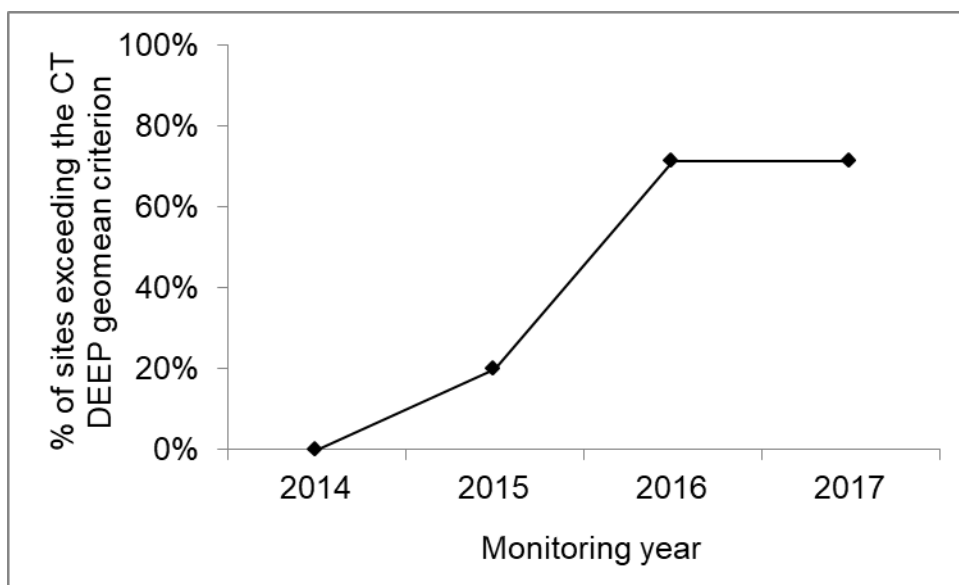


Figure E1. Historic look at Farm Creek CT DEEP geomean criterion exceedances.

Table E1. GPS coordinates and site locations for Farm Creek

Station Number	Latitude	Longitude	Town	Comments
Farm 1	41.06118	-73.43543	Norwalk	86 Bluff Avenue
Farm 2	41.06279	-73.44051	Norwalk	7 Sammis Street
Farm 3	41.06478	-73.44056	Norwalk	25 McKinley Street
Farm 4	41.06506	-73.43994	Norwalk	29 McKinley Street
Farm 5	41.06646	-73.43946	Norwalk	8 Roton Avenue
Farm 6	41.06866	-73.43821	Norwalk	3 Indian Spring Road
Farm 7	41.07687	-73.43706	Norwalk	55 Crooked Trail



Figure E2. Sample location for 7 sites on Farm Creek.

Bacteria results

Five of the seven sites on Farm Creek exceeded one or both of the CT DEEP *E. coli* criteria. Only sites Farm 4 and Farm 1 met both the geometric mean criterion (<126 CFU/100 mL) and single sample maximum criterion (<15% of *E. coli* samples at each site >576 CFU/1100 mL; Figure E3, Table E2). Farm Creek is tidally influenced in the lower region. Because sampling occurred regardless of tides, the low geometric mean at Farm 1 may be attributed to dilution when samples were collected at high tide. Elevated bacteria concentrations in the upper reaches of the watershed in 2016 and 2017 prompted a track-down project which began in May of 2017. Additional sample locations were added above Farm 7 and throughout the stormwater system in the watershed. The results from these sampling dates did not identify any sources of pollution. We will continue to work on identifying potential sources of pollution by adding more sampling locations and working with the Norwalk Conservation and Public Works department to isolate sources of pollution.

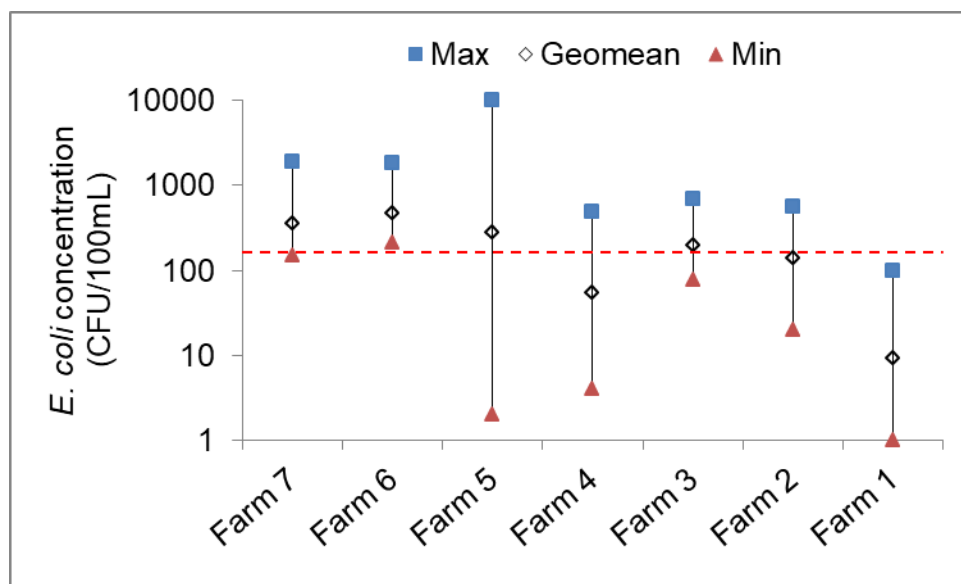


Figure E3. Farm Creek *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table E2. Farm Creek *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: P. DiPietro, personal communication, October 11, 2017)

	5/10/2017	5/15/2017	6/6/2017	6/15/2017	7/11/2017	7/26/2017	8/3/2017	8/14/2017	9/5/2017	9/21/2017	Geomean	% > 576
Farm 7	400	340	300	176	1900	est. 150	n/a	n/a	340	n/a	354	14%
Farm 6	212	440	220	520	1800	540	400	960	400	370	475	20%
Farm 5	204	520	200	450	3600	400	> 10000	780	est. 16	est. 2	284	30%
Farm 4	204	490	est. 40	est. 16	114	74	est. 26	120	est. 36	est. 4	55	0%
Farm 3	136	500	220	700	460	est. 140	84	84	76	240	197	10%
Farm 2	100	440	310	560	520	est. 180	est. 48	124	est. 28	est. 20	137	0%
Farm 1	est. 2	4	> 100	18	76	est. 2	1	68	est. 4	est. 8	9	0%
Rainfall	Dry	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet	Wet		

Dissolved oxygen results

Mean dissolved oxygen values met the CT DEEP minimum criterion of 5 mg/L at all site on Farm Creek with the exception of Farm 4. A number of individual readings fell below 5 mg/L at sites Farm 7, Farm 4, Farm 3, and Farm 2 (Figure E4). Farm Creek is very shallow in the upper watershed and given the low levels of precipitation during the monitoring season, Farm 7 had observed low dissolved oxygen values in June and dried up during August and September. The creek also flows through a number of small ponds that are often choked with algae which may have contributed to low dissolved oxygen values. Farm 4 is located at the mouth of one of these ponds. The wide range in dissolved oxygen observed here may be due to the growth and decomposition of plant life in the pond throughout the monitoring season.

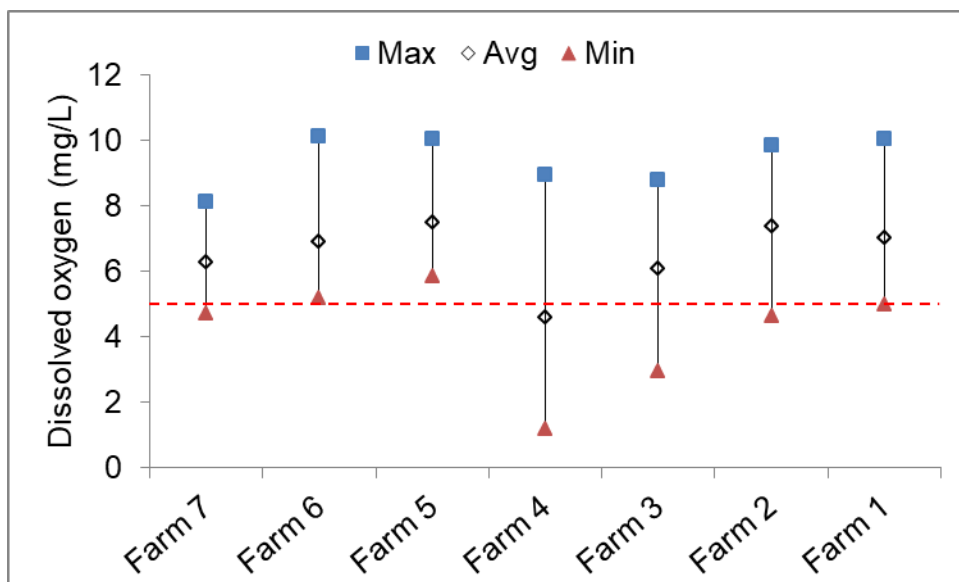


Figure E4. Farm Creek dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity averages above the area of tidal incursion were approximately the same, but the ranges in values throughout the season varied along the length of the creek with Farm 5 having the greatest range (Figure E5, left). The site is located downstream of a parking lot which may have acted as a conduit for runoff into the creek. The conductivity ranges observed at the tidally influenced sites had wide ranges due to sampling at different points within the tidal cycle (Figure E5, right).

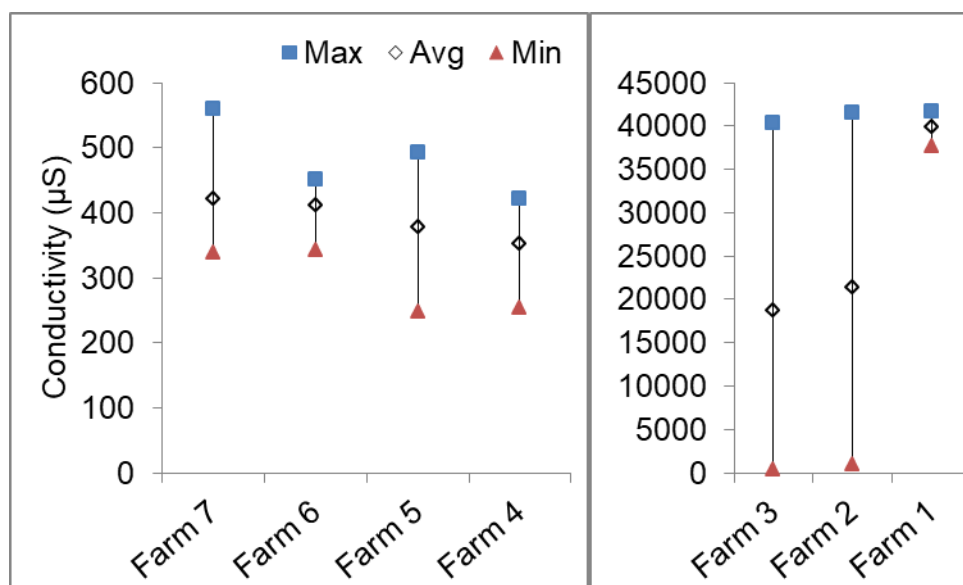


Figure E5. Farm Creek conductivity values. Maximum, average, and minimum for each site that is (left) above the area of tidal incursion and (right) tidally influenced.

F. Farmill River

Summary

The Farmill watershed is located in four municipalities, including Monroe, Shelton, Stratford, and Trumbull. The watershed is 9,657 acres and discharges into Housatonic River. The land is used as follows, 52% urban area, 43% forest, 3% water, and 2% agriculture (CT DEEP).

This is the first year that Harbor Watch collected data on the Farmill River. Half of the sites did not meet the CT DEEP criteria for bacteria. All sites met the CT DEEP minimum for dissolved oxygen of 5 mg/L. While the water quality in 2017 did not appear to be vastly exceeding any criteria, additional monitoring is suggested to identify any pollution sources which may be cause for these few exceedances.

Table F1. GPS coordinates and site locations for the Farmill River

Site Name	Latitude	Longitude	Town	Comments
Farmill 1	41.264572	-73.107256	Shelton	115 Yutaka Trail
Farmill 2	41.276331	-73.115018	Shelton	Under Route 8 Bridge off Beard Sawmill Road
Farmill 3	41.282739	-73.137207	Shelton	Buddington Road
Farmill 4	41.283835	-73.15551	Shelton	Nichols Avenue
Farmill 5	41.291907	-73.159113	Shelton	Walnut Tree Hill Road
Farmill 6	41.292882	-73.173302	Shelton	6 Corn Hill Road.
Farmill 7	41.300952	-73.195789	Shelton	Booth Hill Road and Mohegan Road intersection.
Farmill 8	41.305748	-73.211577	Monroe	Jays Road

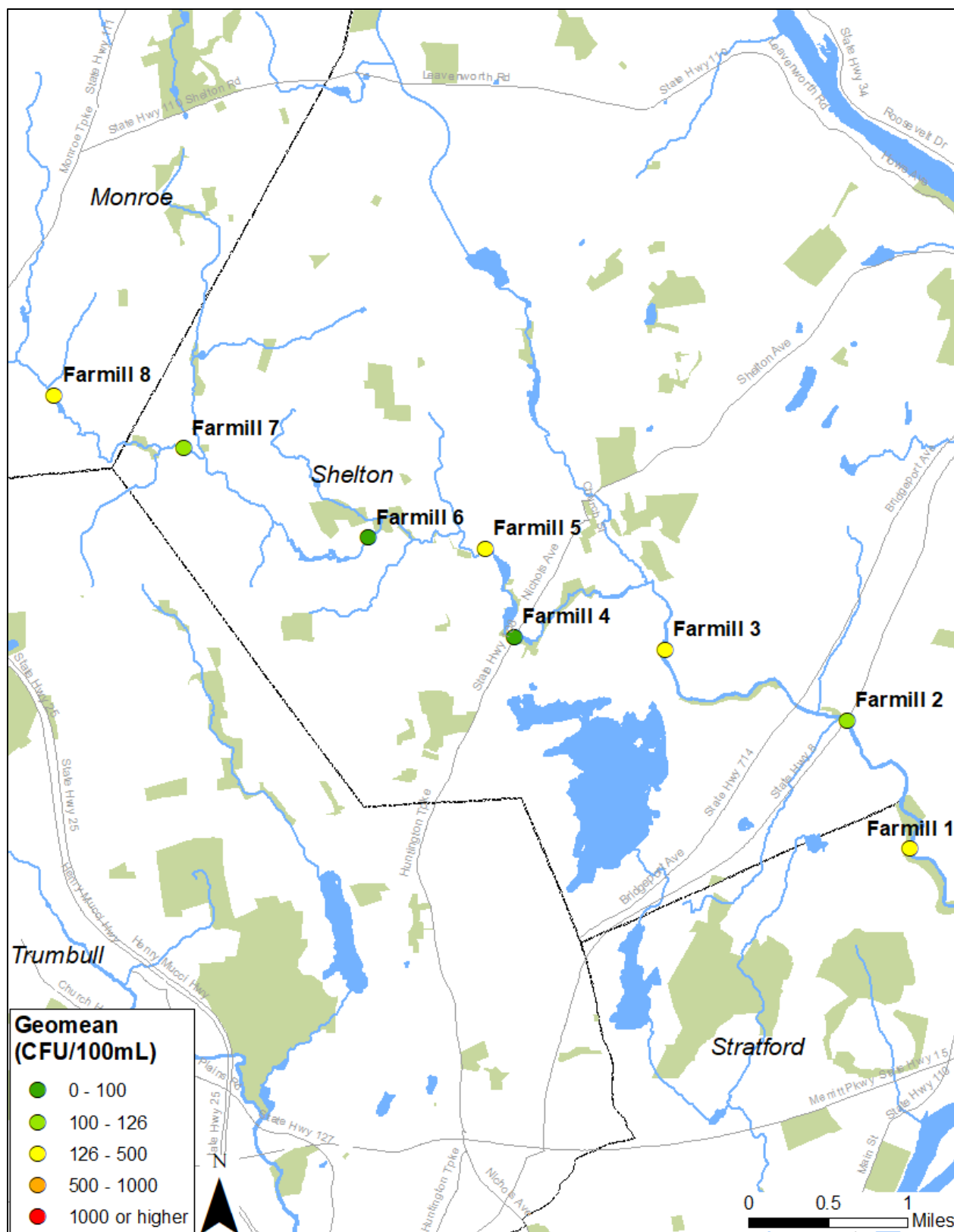


Figure F1. Sample locations for 8 sites on the Farmill River.

Bacteria results

Three sites, Farmill 8, Farmill 5, and Farmill 1 exceeded both CT DEEP geomean (<126 CFU/100 mL) and single sample maximum (<15% of samples >576 CFU/100 mL) criteria for *E. coli* (Figure F2, Table F2). Farmill 3 exceeded only the geomean criterion (Figure F2, Table F2). Elevated bacteria concentrations occurred on sampling dates when more than 0.1 inches of rain fell during collection or within two days prior to sampling (Table F2).

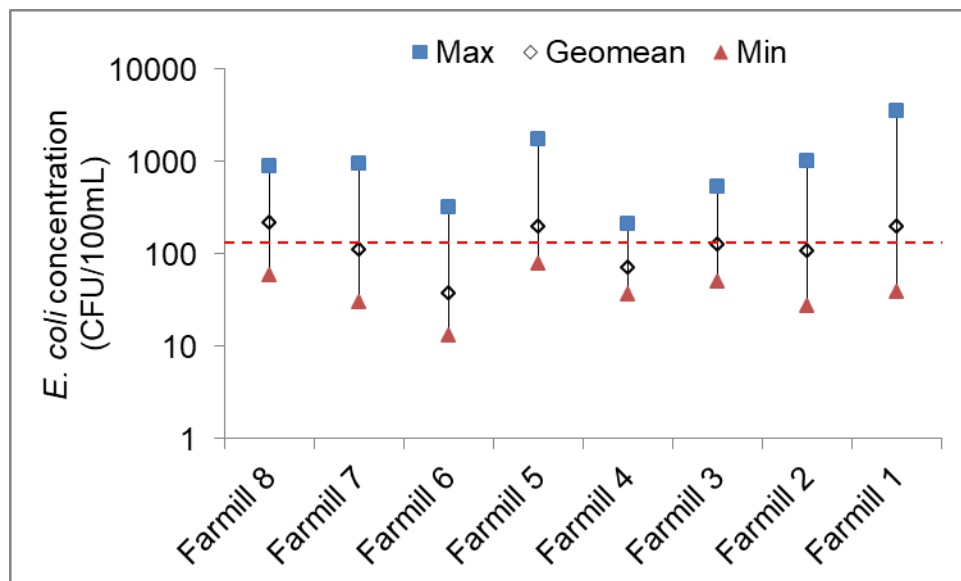


Figure F2. Farmill River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table F2. Farmill River *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: J. Hovious, personal communication, October 10, 2017)

	5/10/2017	5/17/2017	6/8/2017	6/22/2017	7/11/2017	7/19/2017	8/1/2017	8/22/2017	9/7/2017	9/13/2017	Geomean	% > 576
Farmill 8	76	240	380	230	900	128	164	208	660	58	218	20%
Farmill 7	56	70	est. 60	104	960	228	88	46	460	30	112	10%
Farmill 6	20	16	13	14	76	50	24	54	320	58	37	0%
Farmill 5	215	112	80	86	>1000	78	196	116	1720	200	200	20%
Farmill 4	43	62	60	164	210	160	50	36	52	44	72	0%
Farmill 3	50	100	62	112	540	140	n/a	92	440	88	128	0%
Farmill 2	39	27	36	116	1000	136	94	140	380	66	107	10%
Farmill 1	44	39	39	80	>2000	168	204	400	3500	200	200	20%
Rainfall	Dry	Dry	Wet	Dry	Wet	Dry	Dry	Dry	Wet	Dry		

Dissolved oxygen results

Mean dissolved oxygen concentrations met the CT DEEP minimum of 5 mg/L at all eight sites (Figure F3). Individual dissolved oxygen readings were observed to be below 5 mg/L at four sites (Table F3). The lower half the river is wide and flows through a number of small ponds. Low flow through the pond and riverbed as well as decomposing organic matter could have attributed to these low values. It should be noted that on 6/22, site Farmill 2 was observed to have lots of trash dumped on the river bank below the Route 8 overpass. In addition to trash, large dead fish were also dumped on the riverbed and in the river. The decomposition of this material may have added to the low oxygen levels observed later in the sampling season (Table F3).

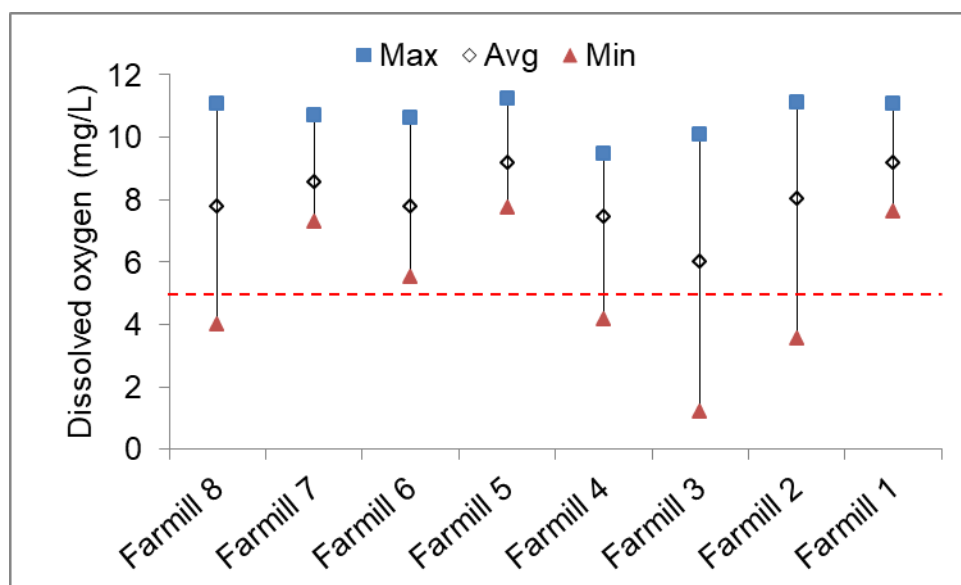


Figure F3. Farmill River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Table F3. Days during which dissolved oxygen levels fell below 5 mg/L. Values are reported in mg/L

	Farmill 2	Farmill 3	Farmill 4	Farmill 8
6/22/2017		4.45		
7/19/2017		4.23		
8/1/2017	3.55	1.21	4.18	
9/13/2017				3.98

Conductivity results

Conductivity ranges were narrow through most of the river (Figure F4). Ranges at Farmill 3, Farmill 2, and Farmill 1 were wider. The cause of this increase is unknown.

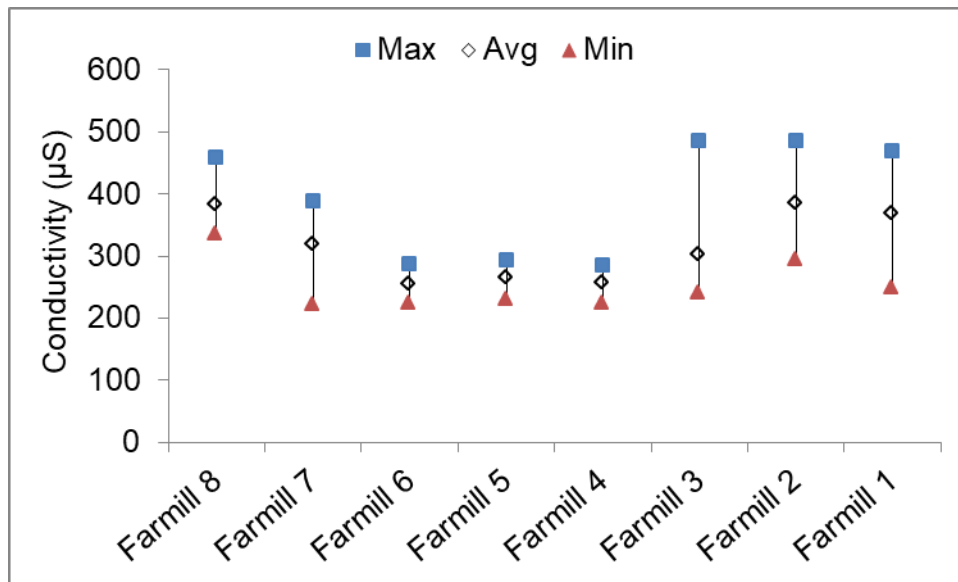


Figure F4. Farmill River conductivity values. Maximum, average, and minimum for each site.

G. Five Mile River

Summary

The Five Mile River Watershed includes approximately 7,995 acres of land and extends from Pound Ridge in New York and through New Canaan, Norwalk, and Darien Connecticut before ending at the Five Mile River Harbor. Keelers Brook is the main tributary to the Five Mile River (results discussed in section H below). Land use in the watershed consists of 70% urban, 26% forest, 3% water, and 1% agriculture (CT DEEP).

Harbor Watch has monitored the Five Mile River in years prior, but it has been two years since it was last monitored in its entirety. In 2017, the river exceeded the CT DEEP geomean criterion more than in 2015 (Figure G1). The majority of sites in 2017 exceeded CT DEEP *E. coli* criteria. Additional monitoring to identify the sources of pollution is suggested for the 2018.

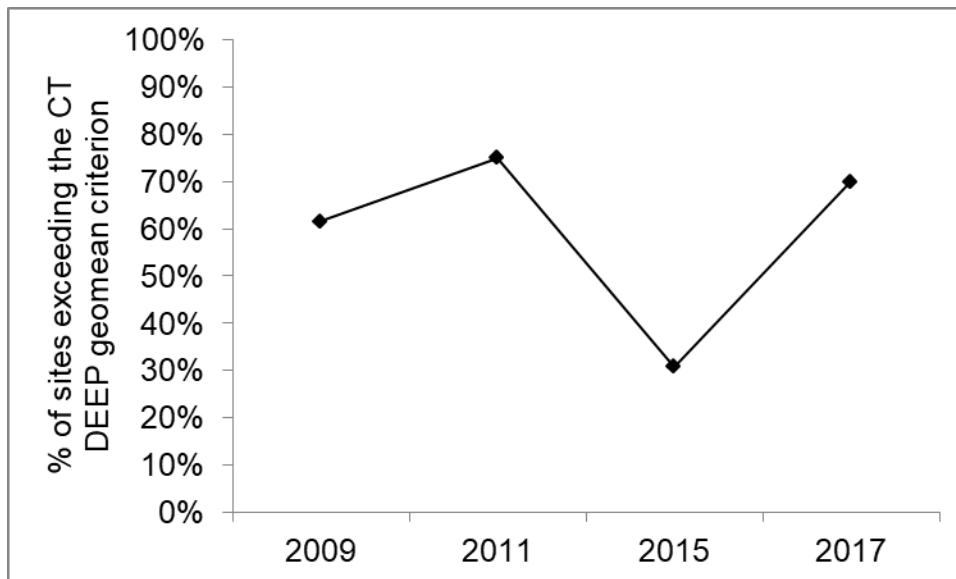


Figure G1. Historic look at Fivemile River CT DEEP geomean criterion exceedances.

Table G1. GPS coordinates and sample locations for the Fivemile River

Site Name	Latitude	Longitude	Town	Comments
Fivemile 1	41.073023	-73.44762	Norwalk	Cudlipp Street
Fivemile 2	41.088194	-73.450708	Norwalk	Flax Hill Road
Fivemile 3	41.100584	-73.454406	Norwalk	W. Cedar Street
Fivemile 4	41.110687	-73.461955	Norwalk	Fillow Street
Fivemile 5	41.126902	-73.471024	New Canaan	Nursery Road
Fivemile 6	41.136623	-73.479169	New Canaan	Old Norwalk Road
Fivemile 7	41.147827	-73.483529	New Canaan	East Avenue
Fivemile 8	41.15558	-73.493453	New Canaan	Route 123 (Smith Ridge Road)
Fivemile 9	41.16811	-73.504929	New Canaan	Country Club Road
Fivemile 10	41.189323	-73.514135	New Canaan	Michigan Road

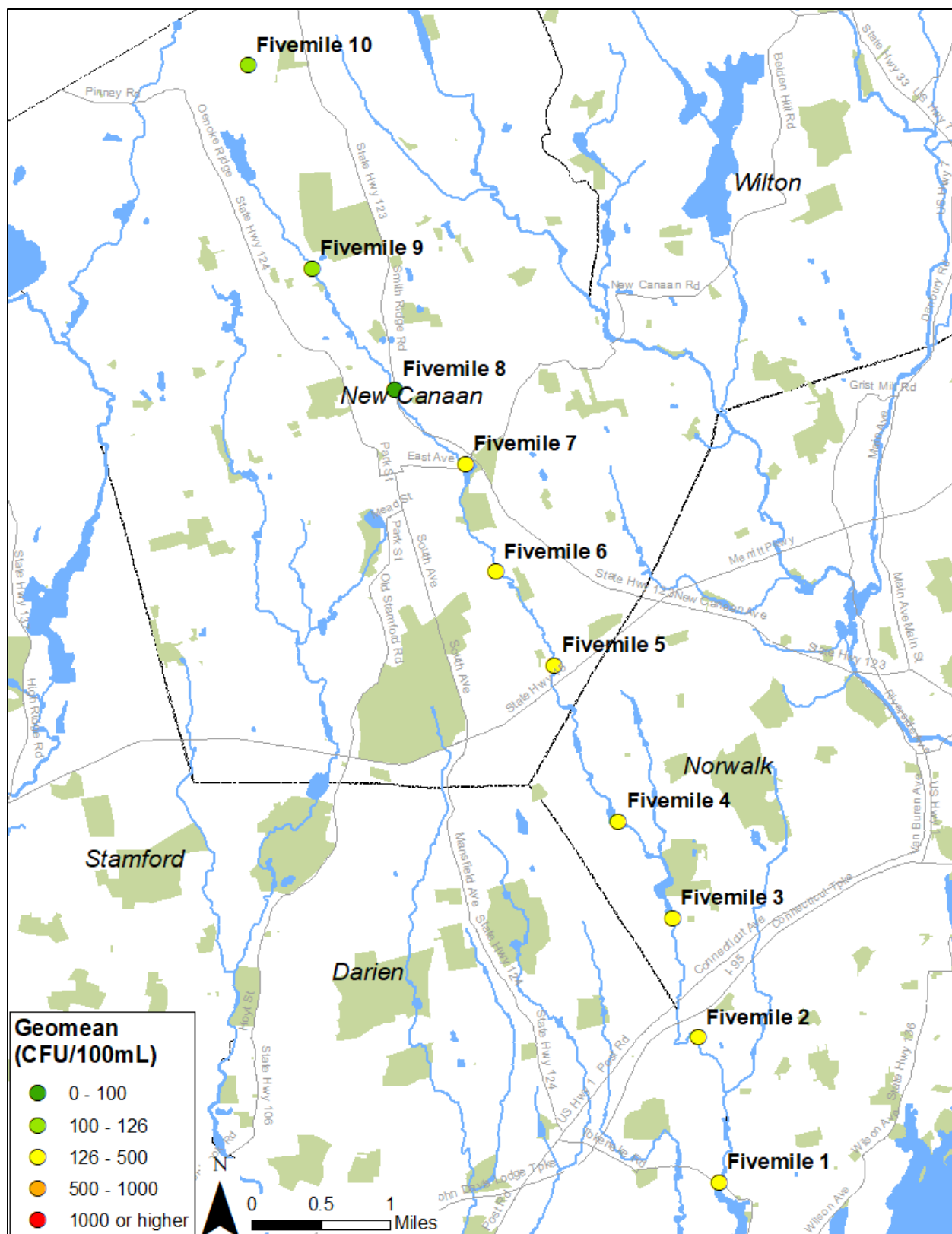


Figure G2. Sample locations at 10 sites on the Five Mile River.

Bacteria results

Seven sites in the lower portion of the watershed exceeded the CT DEEP geomean criterion (<126 CFU/100 mL; Figure G3, Table G2). Of these sites, only site Fivemile 7 also exceeded the CT DEEP single sample maximum of <15% of *E. coli* samples >576 CFU/100 mL (Table G2). Elevated concentrations were observed on days that experienced more than 0.1 inches of rainfall within two days prior to sampling (Table G2). The largest concentrations were observed on 6/1 where 0.42 inches of rain fell within two days prior to sampling.

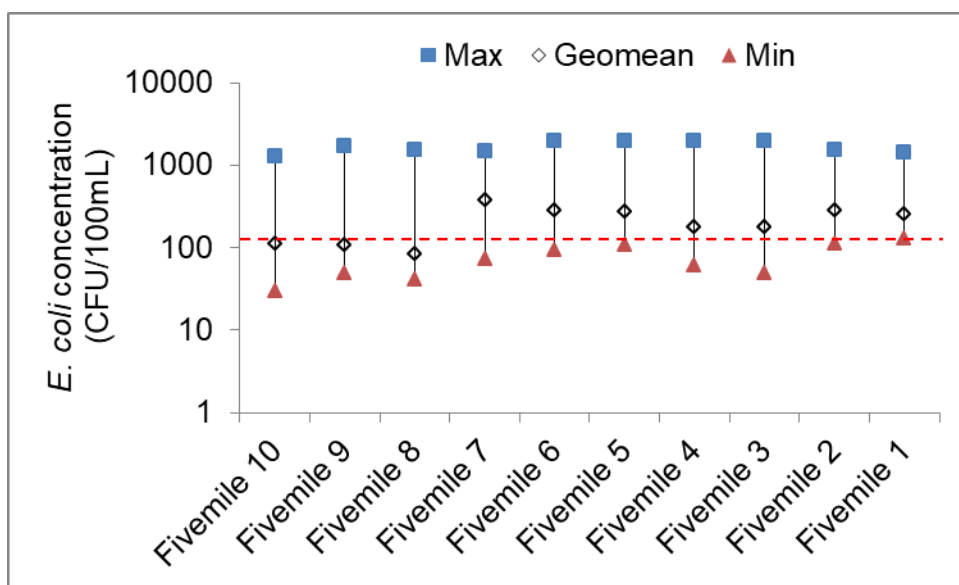


Figure G3. Five Mile River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum 126 CFU/100 mL.

Table G2. Five Mile River *E. coli* concentrations and relation to the CT DEEP water quality criteria (Rainfall data: P. DiPietro, personal communication, October 11, 2017)

	5/9/2017	5/18/2017	6/1/2017	6/12/2017	6/26/2017	7/20/2017	8/1/2017	8/21/2017	9/6/2017	9/18/2017	Geomean	% > 576
Fivemile 10	38	46	1300	29	108	80	78	n/a	168	256	107	11%
Fivemile 9	> 100	48	1720	58	80	54	48	124	est. 64	184	104	10%
Fivemile 8	80	72	1540	42	52	58	42	88	72	40	81	10%
Fivemile 7	70	112	1480	204	208	1120	1060	320	960	230	364	40%
Fivemile 6	92	96	> 2000	120	112	340	470	530	280	500	279	10%
Fivemile 5	160	200	> 2000	344	208	184	164	104	230	550	267	10%
Fivemile 4	130	104	> 2000	132	152	160	76	160	320	58	170	10%
Fivemile 3	124	128	> 2000	116	48	56	104	240	330	280	172	10%
Fivemile 2	150	196	1520	256	152	540	370	320	190	108	273	10%
Fivemile 1	160	124	1440	196	192	196	200	308	350	156	243	10%
Rainfall	Dry	Dry	Wet	Dry	Wet	Dry	Dry	Dry	Wet	Dry		

Dissolved oxygen results

Mean dissolved oxygen levels met the CT DEEP minimum criterion of 5 mg/L at all ten sites (Figure G4). Sites Fivemile 10 and Fivemile 1 had individual readings drop below 5 mg/L. Fivemile 10 is located towards the headwaters and often had low flow and an abundance of plant life which may have attributed to the 1.93 mg/L reading observed on 8/1. At site Fivemile 1 low readings were observed on sampling dates from 6/26 to 9/6; the lowest reading observed was 1.71 mg/L. Fivemile 1 is tidal and poor flushing may have contributed to the low readings.

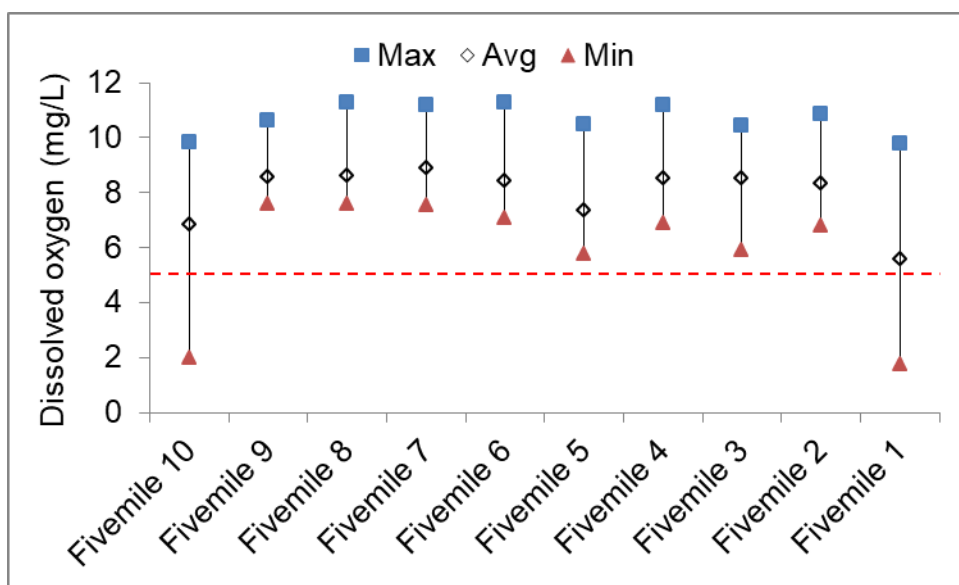


Figure G4. Five Mile River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity means fluctuated along the length of the river (Figure G5). Ranges at Fivemile 9 and Fivemile 8 were much narrower than the rest of the sites. The river flows through residential and commercial areas including a golf course and college campus. It is possible that the lack of riparian buffer and a prevalence of impervious surfaces allowed runoff to enter the river and impact the conductivity. The conductivity range observed at site Fivemile 1 can be attributed to sampling regardless of the tidal cycle (Figure G5, right).

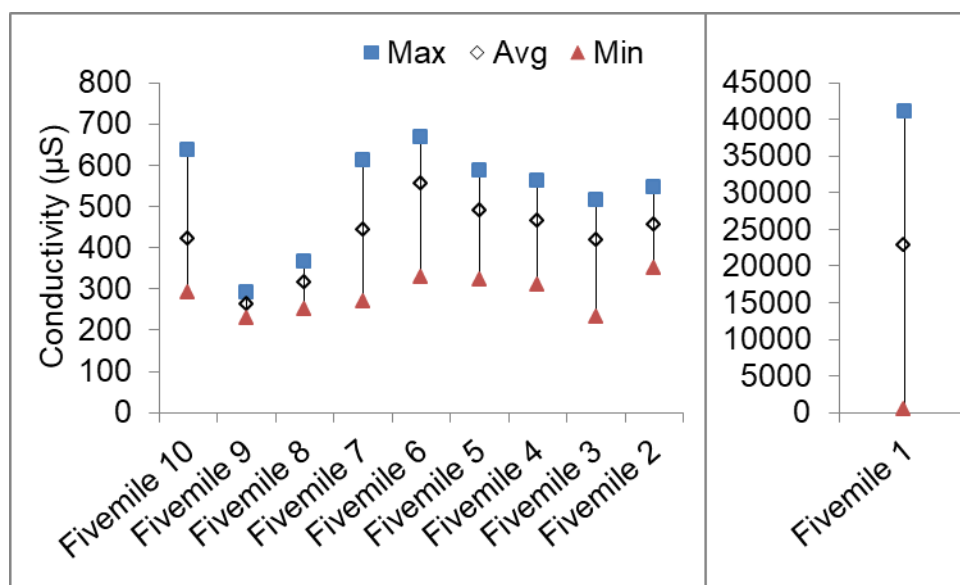


Figure G5. Five Mile River conductivity values. Maximum, average, and minimum for each site.

H. Keelers Brook

Summary

Keelers Brook is a small tributary to the Fivemile River. The confluence is located behind Rowayton Court in Norwalk. The Brook is located entirely in the City of Norwalk and is comprised of many small branches and a series of small ponds near its headwaters.

Harbor Watch monitored Keelers Brook in the past, but has not collected data on the waterway since 2015. With new construction projects ongoing on Route 1 adjacent to the brook, we felt that it was important to revisit the watershed to see how the water quality may have changed. It was anticipated that the water quality would improve due to the removal of an outdated septic system and enforced hookup to the sewer system. All sites on Keelers Brook exceeded the CT DEEP *E. coli* criteria, but met the minimum criterion for dissolved oxygen. Continued monitoring is suggested to identify pollution sources that are impacting the water quality of Keelers Brook.

Table H1. GPS coordinates and sample locations for Keelers Brook

Site Name	Latitude	Longitude	Town	Comments
Keelers 1	41.085621	-73.443046	Norwalk	Rowayton Avenue
Keelers 2	41.090811	-73.441053	Norwalk	Primrose Court
Keelers 3	41.098947	-73.442345	Norwalk	Norwalk Pump Station; Route 1

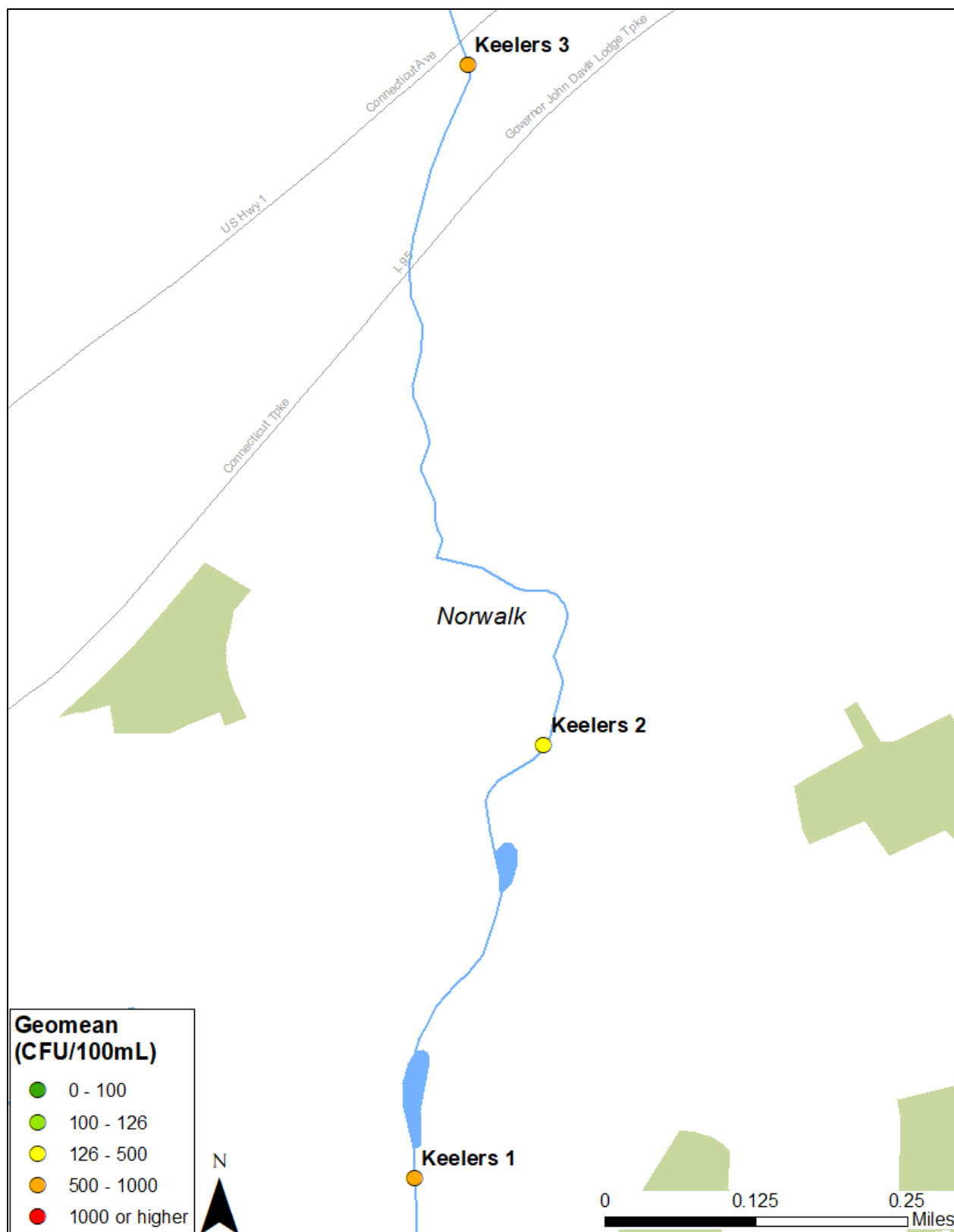


Figure H1. Sampling locations for 3 sites on Keelers Brook.

Bacteria results

All three sites exceeded both the CT DEEP *E. coli* geomean criterion (<126 CFU/100 mL) and the single sample maximum criterion (<15% of *E. coli* samples >576 CFU/100 mL; Figure H2, Table H2). Elevated bacteria concentrations were observed regardless of rainfall conditions indicating that the source may be a chronic issue and not solely connected to runoff impacts.

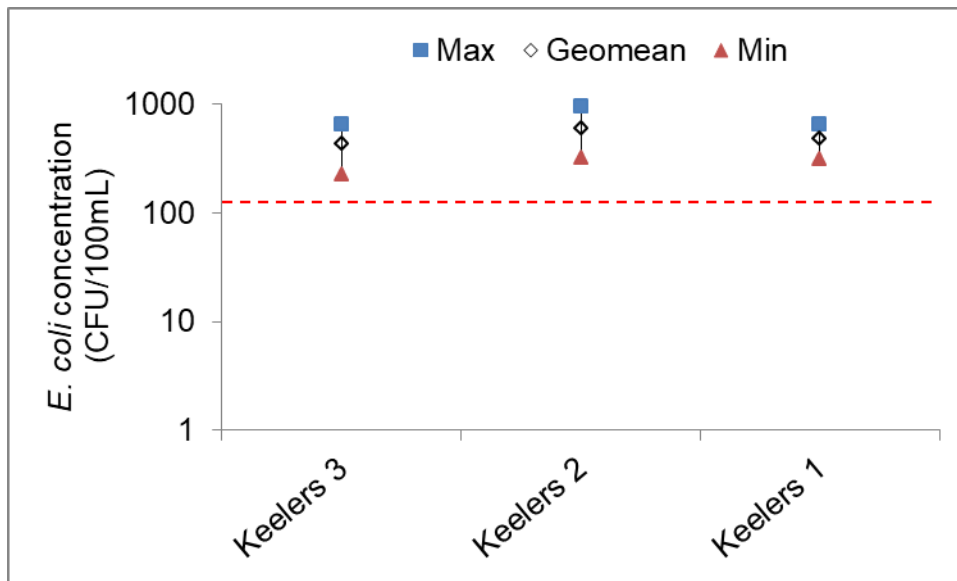


Figure H2. Keelers Brook *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table H2. Keelers Brook *E. coli* concentrations and relation to water quality criteria (rainfall data: P. DiPietro, personal communication, October 11, 2017)

	5/9/2017	5/18/2017	6/1/2017	6/12/2017	6/29/2017	7/20/2017	8/1/2017	8/21/2017	9/6/2017	9/18/2017	Geomean	% > 576
Keelers 3	440	360	1720	220	190	160	360	4500	1200	580	539	40%
Keelers 2	170	108	980	420	720	380	380	320	1200	360	401	30%
Keelers 1	200	520	960	820	780	700	900	860	1150	210	620	70%
Rainfall	Dry	Dry	Wet	Dry	Wet	Dry	Dry	Dry	Wet	Dry		

Dissolved oxygen results

Mean dissolved oxygen concentrations met the CT DEEP minimum criterion of 5mg/L (Figure H3). Individual readings dropped below 5 mg/L at site Keelers 3 multiple times throughout the monitoring season. The lowest observed reading was 3.96 mg/L on 8/1. The water levels at this site were often shallow with low flow. The area also had decaying organic matter and algae present. The combination of these factors most likely had an impact on the dissolved oxygen observed values.

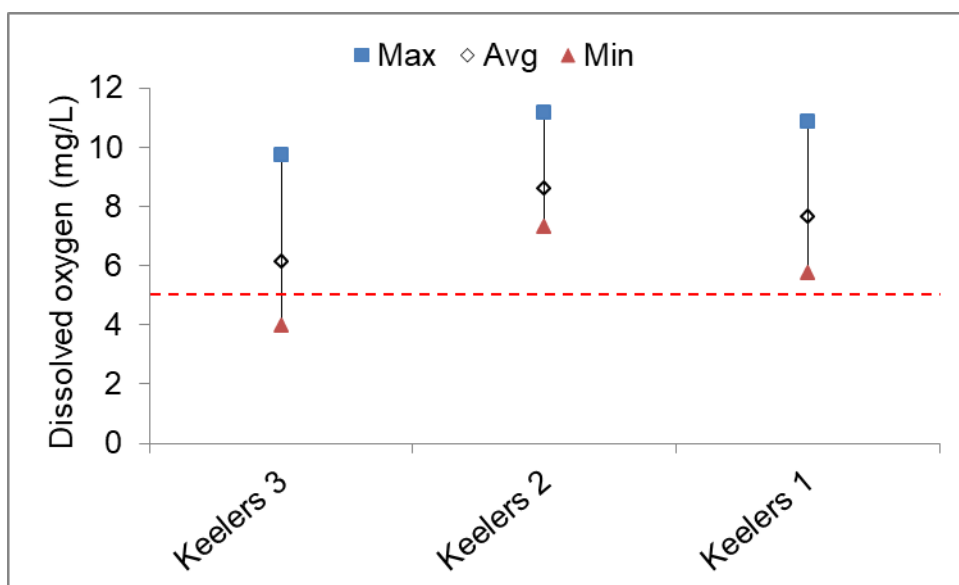


Figure H3. Keelers Brook dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity ranges were wide at all three sites (Figure H4). Keelers 2 had the highest average at 644 μS . The cause for the elevated readings and wide ranges may have been impacted by runoff from the Route 1 corridor which cuts across Keelers Brook at Keelers 3.

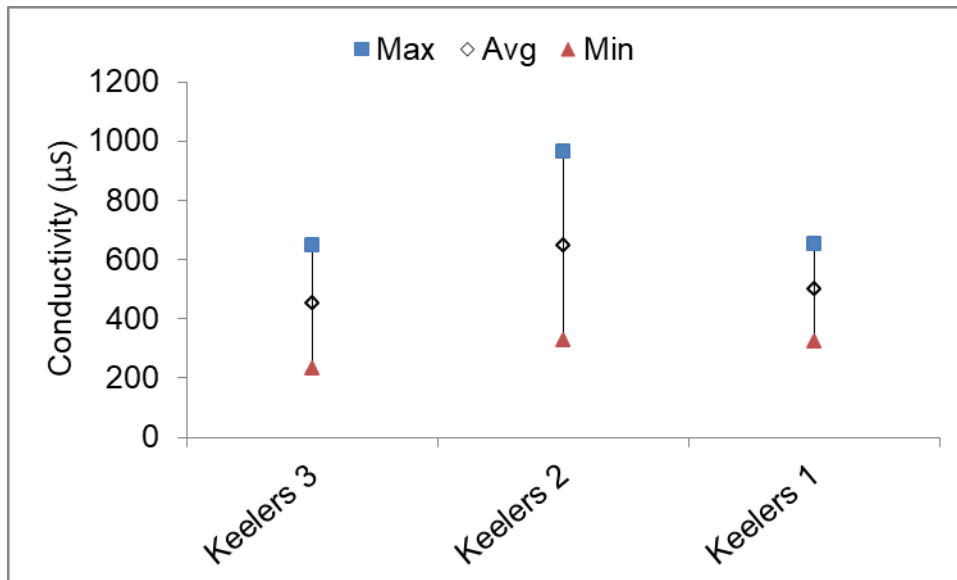


Figure H4. Keelers Brook conductivity values. Maximum, average, and minimum for each site.

I. Mill River

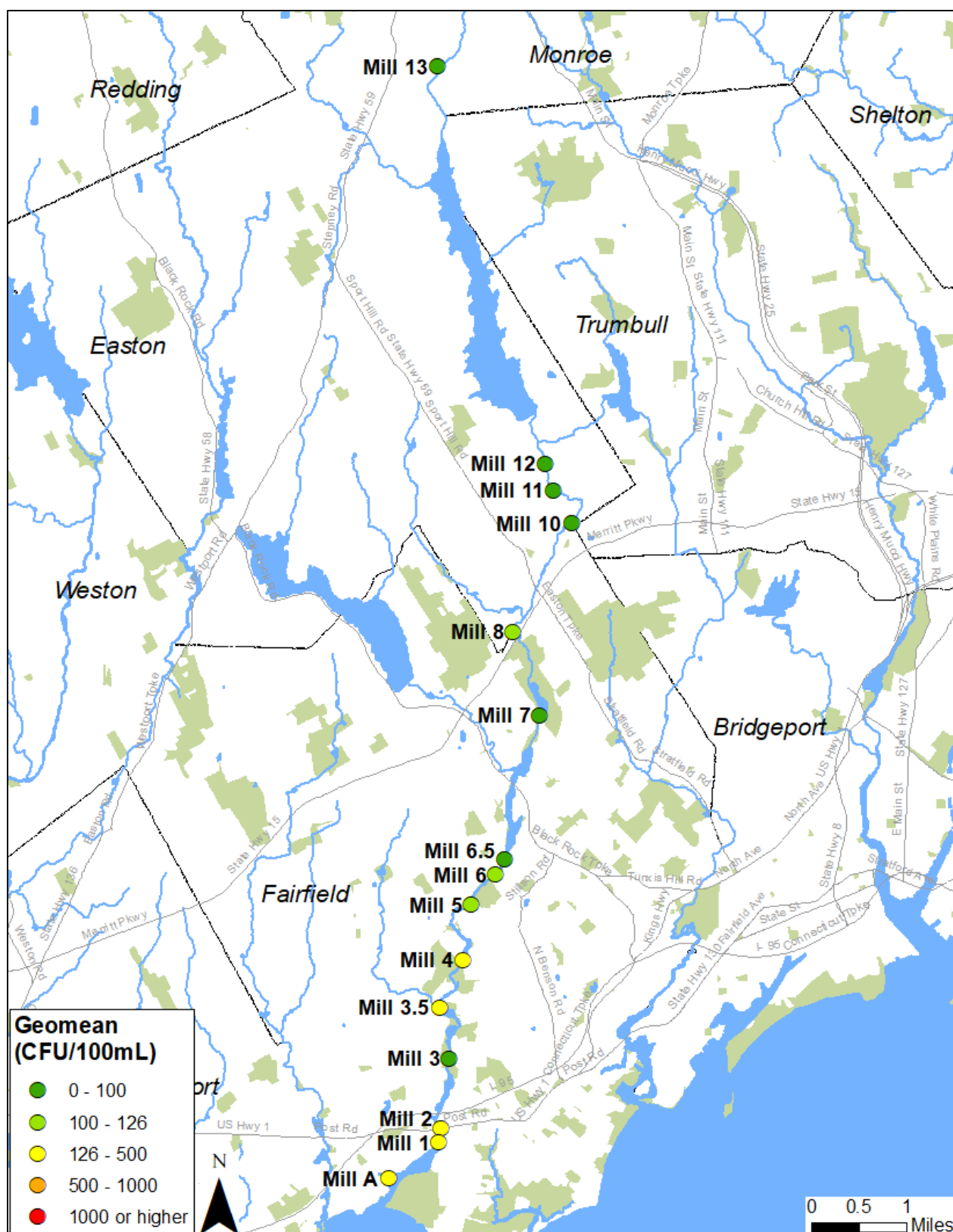
Summary

The Mill River watershed encompasses portions of six communities whose political boundaries fall within the state of Connecticut. The six towns, all located in Fairfield County, are Redding, Easton, Monroe, Trumbull, Fairfield, and Bridgeport. The watershed is approximately 16,000 acres or 25.8 square miles. There are two large dams on the river which create reservoirs (Easton Reservoir and Samp Mortar Reservoir) for drinking water and downriver flow control. The Mill River begins in the north-east corner of Easton and travels south into Southport Harbor in Fairfield.

This was the second year that Harbor Watch monitored the Mill River. Two thirds of sites did not meet at least one of the CT DEEP criteria for *E. coli*. Mean dissolved oxygen values met the CT DEEP criterion at all sites. Site Mill A, the confluence of a tributary and Southport Harbor, was added to the sampling regime in July at the request of Brian Carey, Fairfield Conservation Director, in order to identify potential pollution sources entering Southport Harbor from the commercial corridor along Route 1. Continued monitoring is suggested to identify the cause of elevated bacteria concentrations, especially in the lower half of the watershed.

Table I1. GPS coordinates and site locations for the Mill River

Station Number	Latitude	Longitude	Town	Comments
Mill A	41.132099	-73.284652	Fairfield	789 Harbor Road
Mill 1	41.137579	-73.274603	Fairfield	70 Harbor Road
Mill 2	41.139772	-73.274176	Fairfield	Near Martel Bistro and Bar
Mill 3	41.150400	-73.272600	Fairfield	Big stone bridge on Sturges Road
Mill 3.5	41.158205	-73.274665	Fairfield	Twin Brooks Lane at bend in road
Mill 4	41.165412	-73.270046	Fairfield	165 Duck Farm Road
Mill 5	41.173800	-73.268400	Fairfield	Bridge on Mill Plain Road (where changes to Burr Street)
Mill 5.5	41.180788	-73.261608	Fairfield	Intersection of Samp Mortar Drive and Brookside Drive
Mill 6	41.178466	-73.263413	Fairfield	61 Mountain Laurel Road
Mill 7	41.202727	-73.254708	Fairfield	Bridge on Morehouse Highway (near Canterbury Lane)
Mill 8	41.215454	-73.260199	Fairfield	427 Congress Street
Mill 10	41.231978	-73.248555	Easton	South Park Avenue
Mill 11	41.237067	-73.252174	Easton	South Park Avenue near Riverside Drive
Mill 12	41.241082	-73.253928	Easton	South Park Avenue between Buck Hill Road and Marich Drive
Mill 13	41.301489	-73.276127	Monroe	Judd Road and Velvet Street



Bacteria results

Three sites, Mill 2, Mill 1, and Mill A, exceeded both the CT DEEP geomean criterion (<126 CFU/100 mL) and the single sample maximum criterion (<15% of *E. coli* samples at each site >576 CFU/100 mL; Figure I2, Table I2). Mill 4 and Mill 3.5 exceeded only the geomean criterion (Figure I2, Table I2). The highest geometric means were observed at Mill 2, Mill 1, and Mill A (Figure I2). This is concerning because these sites are tidal and often tidal areas have lower bacteria concentrations due to dilution and the increased mortality of *E. coli* in salt water.

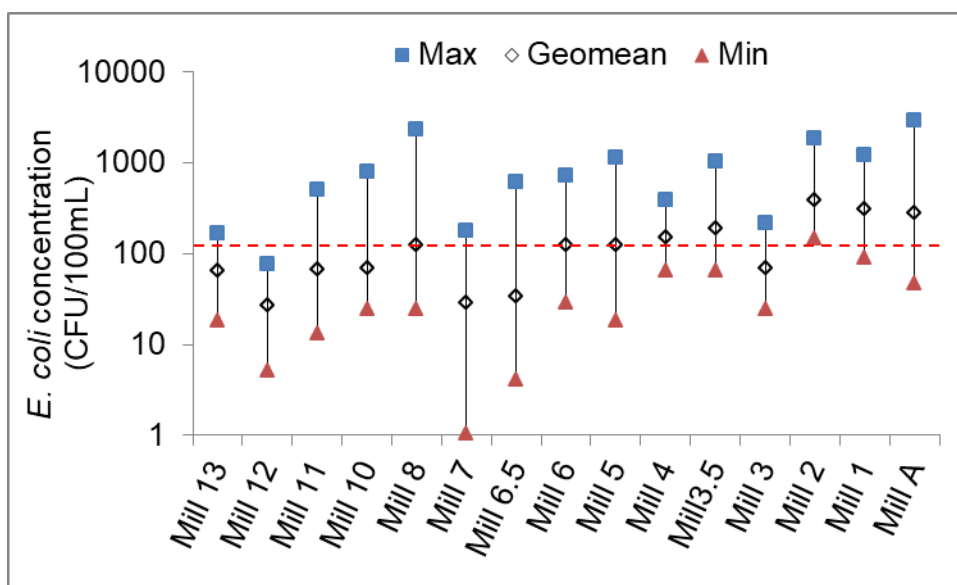


Figure I2. Mill River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table 12. Mill River *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: Weather Underground – Fairfield Town Hall). Data was not available from the rain gauge on August 7th.

	5/8/2017	5/24/2017	6/7/2017	6/13/2017	7/12/2017	7/24/2017	8/7/2017	8/22/2017	8/30/2017	9/14/2017	Geomean	% > 576
Mill 13	56	52	56	45	104	136	168	est. 32	est. 18	94	63	0%
Mill 12	39	13	5	76	est. 30	70	56	19	27	15	27	0%
Mill 11	35	23	13	48	102	500	est. 130	165	88	31	66	0%
Mill 10	55	30	31	24	104	800	est. 200	est. 56	est. 60	24	66	10%
Mill 8	172	72	24	31	240	2300	est. 150	90	100	96	121	10%
Mill 7	180	est. 40	est. 20	13	70	100	152	est. 22	est. 6	1	28	0%
Mill 6.5	290	est. 28	est. 14	21	40	est. 36	est. 8	22	620	est. 4	33	10%
Mill 6	176	32	est. 28	44	170	720	550	290	est. 100	46	120	10%
Mill 5	> 200	144	est. 18	45	112	1160	est. 160	205	est. 80	92	122	10%
Mill 4	390	176	80	102	250	est. 70	240	145	210	64	147	0%
Mill 3.5	94	n/a	n/a	n/a	208	1020	est. 150	188	192	64	183	14%
Mill 3	220	152	est. 28	28	152	220	est. 60	est. 32	est. 24	52	68	0%
Mill 2	212	560	520	144	310	1880	est. 200	260	290	840	382	20%
Mill 1	288	370	340	156	200	1200	230	192	1060	88	298	20%
Mill A	n/a	n/a	n/a	n/a	300	2900	160	n/a	45	260	277	20%
Rainfall	Wet	Wet	Dry	Dry	Wet	Wet	n/a	Dry	Wet	Dry		

Dissolved oxygen results

Mean dissolved oxygen levels met the CT DEEP minimum criterion of 5 mg/L. Individual readings at sites Mill 6, Mill 4, Mill 3.5, Mill 3, Mill 2, Mill 1, and Mill A were observed to be below 5 mg/L once or twice over the course of the monitoring season (Figure I3). The cause for these low readings is unknown and were not observed to be prolonged instances reducing the need for concern at this time.

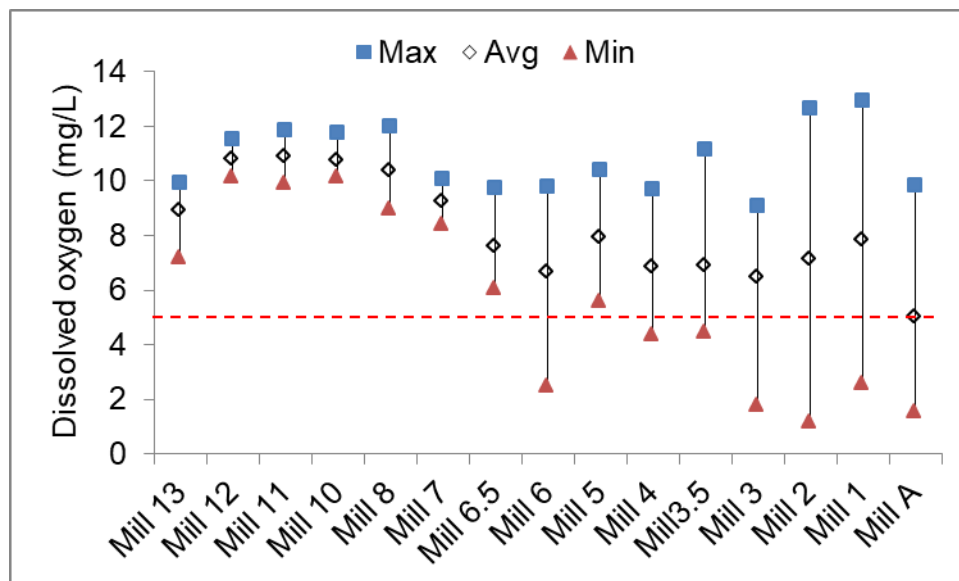


Figure I3. Mill River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity values at sites above the area of tidal incursion were narrow (Figure I4, left). Sites Mill 12, Mill 11, and Mill 10 had the lowest averages. These sites are located in a less densely populated area below the Easton Reservoir with a large riparian buffer which may have reduced runoff from entering the river. The tidally influenced sites had wide ranges which may have been attributed to sampling these sites regardless of the tide cycle (Figure I4, right). It should be noted that although site Mill 3 is displayed on the right side of Figure I4, it is not a true tidally influenced site. On 7/24 conductivity readings were reported to be 23371 μS . The cause of these elevated readings is unknown and values returned to the expected range during the following sampling days. Without the outlier on 7/24, the average conductivity would have been 259 μS .

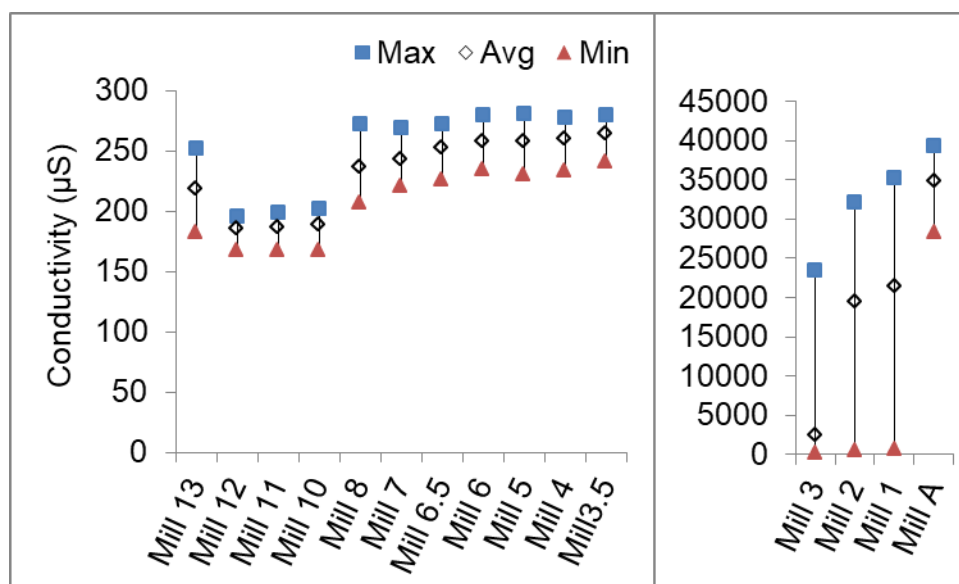


Figure I4. Mill River conductivity values. Maximum, average, and minimum for each site that is (left) above the area of tidal incursion and (right) tidally influenced.

J. Muddy Brook

Summary

Muddy Brook is part of the CT DEEP designated “Southwest Shoreline sub-regional basin” which is 2.8 square miles and discharges into Sherwood Millpond. Muddy Brook is located entirely in Westport. The land use for the Southwest Shoreline sub-regional basin consists of 45% developed areas, 27% turf and grasses, and 24% forests (CT DEEP).

Harbor Watch has monitored Muddy Brook in the past, but often sampling occurred from September through April where colder temperatures and reduced bacteria concentrations were observed. 2017 marked the first year that Harbor Watch conducted a study of Muddy Brook during the May through September monitoring season. The brook is of interest to the Town of Westport because its discharge point is the Sherwood Island Millpond, a historic area known for its swimming and shellfishing activities in decades prior. All sites exceeded at least one of the CT DEEP *E. coli* criteria. Continued monitoring is suggested in order to identify potential sources of pollution.

Table J1. GPS coordinates and sample locations for Muddy Brook

Site Name	Latitude	Longitude	Town	Comments
Muddy 1	41.12735	-73.32958	Westport	Greens Farm Road
Muddy 2	41.132926	-73.328586	Westport	Center Street
Muddy 3	41.138573	-73.32546	Westport	Morningside Drive South
Muddy 4	41.141068	-73.321722	Westport	Turkey Hill Road North
Muddy 5	41.146855	-73.318087	Westport	Long Lots Road
Muddy 6	41.16444	-73.325214	Westport	Bayberry Lane

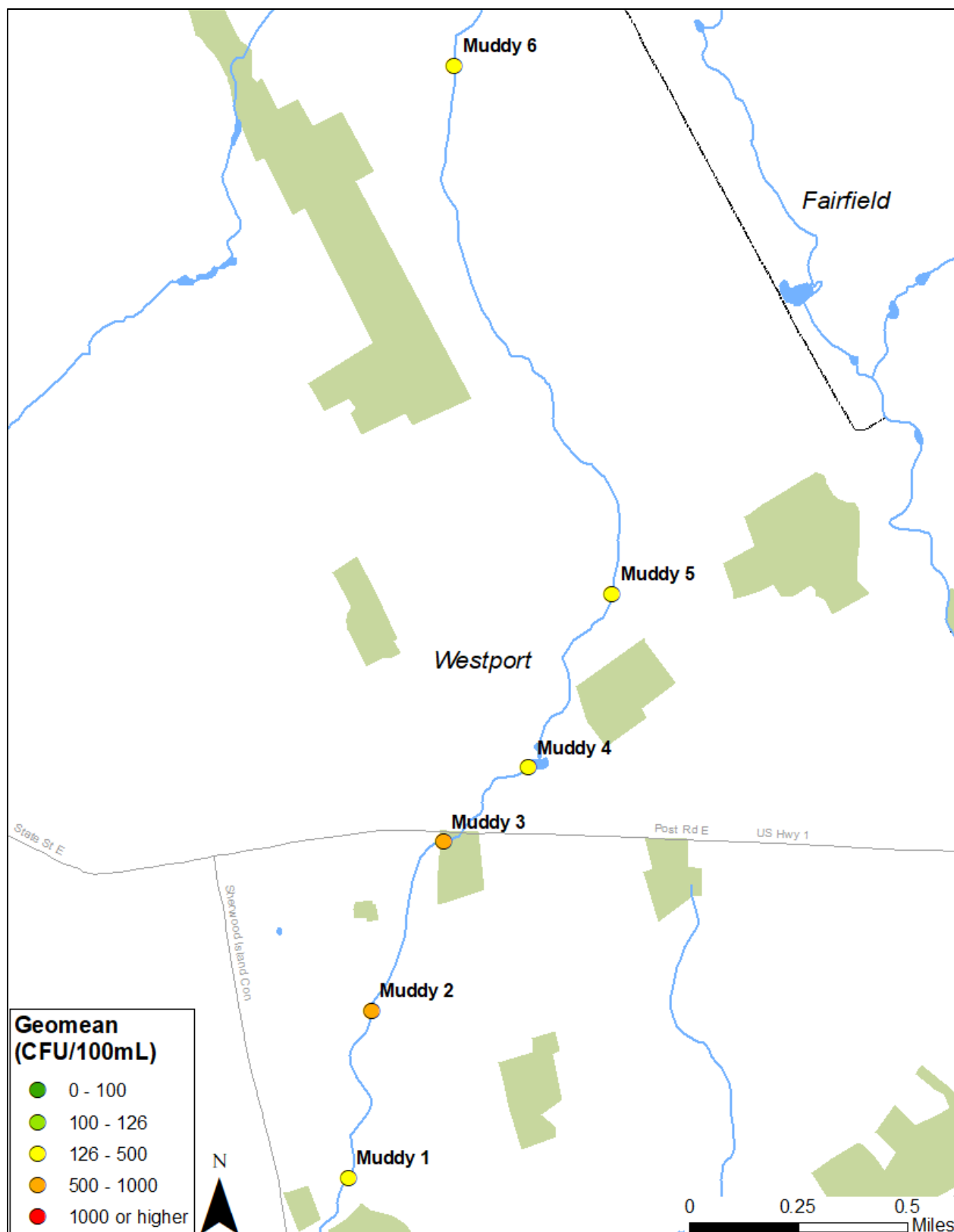


Figure J1. Sample locations for 6 sites on Muddy Brook.

Bacteria results

All six sites exceeded the CT DEEP geomean maximum of 126 CFU/100 mL (Figure J2, Table J2). Only site Muddy 5 did not exceed the single sample maximum criterion of <15% of *E. coli* samples >576 CFU/100 mL (Table J2). Elevated bacteria concentrations were observed on days where more than 0.1 inches of rain fell within 2 days prior to sampling (Table J2).

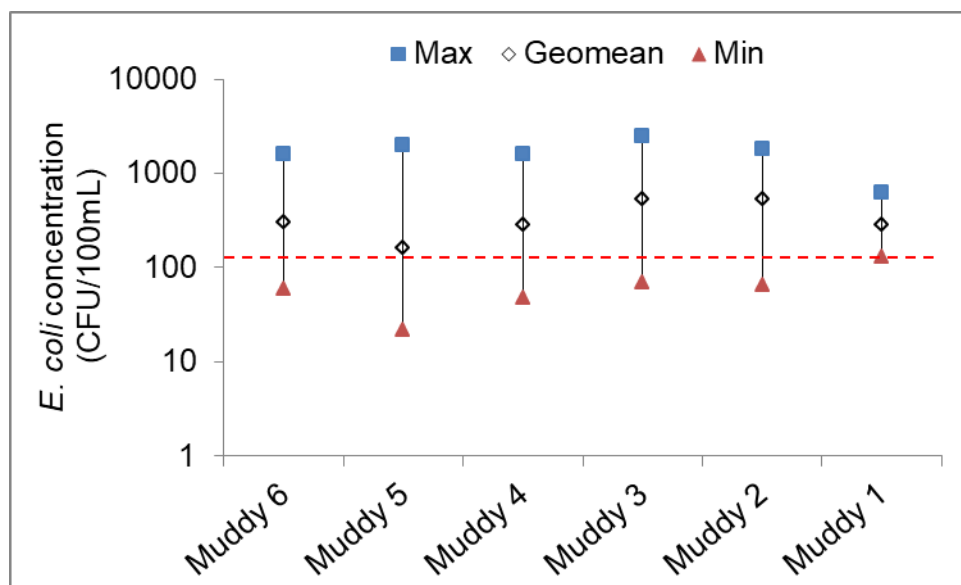


Figure J2. Muddy Brook *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP maximum of 126 CFU/100 mL.

Table J2. Muddy Brook *E. coli* concentrations and relation to water quality criteria (rainfall data: P. DiPietro, personal communication, October 11, 2017)

	5/4/2017	5/16/2017	5/31/2017	6/21/2017	6/26/2017	7/24/2017	8/10/2017	8/24/2017	9/5/2017	9/20/2017	Geomean	% > 576
Muddy 6	57	64	810	300	400	1600	325	370	140	est. 600	299	30%
Muddy 5	21	52	360	320	100	2000	136	190	84	196	160	10%
Muddy 4	166	47	> 400	480	est. 1600	165	est. 200	760	215	205	277	20%
Muddy 3	> 100	68	> 1000	940	1600	1400	est. 260	2500	305	460	515	50%
Muddy 2	192	64	760	940	720	1800	700	440	600	760	525	70%
Muddy 1	128	256	620	600	470	360	170	230	145	195	273	20%
Rainfall	Dry	Dry	Wet	Wet	Wet	Wet	Dry	Wet	Wet	Wet		

Dissolved oxygen results

Mean dissolved oxygen levels met the CT DEEP minimum of 5 mg/L at all six sites (Figure J3). Individual readings at site Muddy 3 dropped to 4.78 mg/L and 4.83 mg/L on 8/10 and 8/24 respectively. Low dissolved oxygen values observed on these dates can be attributed to decaying organic matter and thick beds of debris and trash that impeded flow of the brook under the Morningside Drive South bridge.

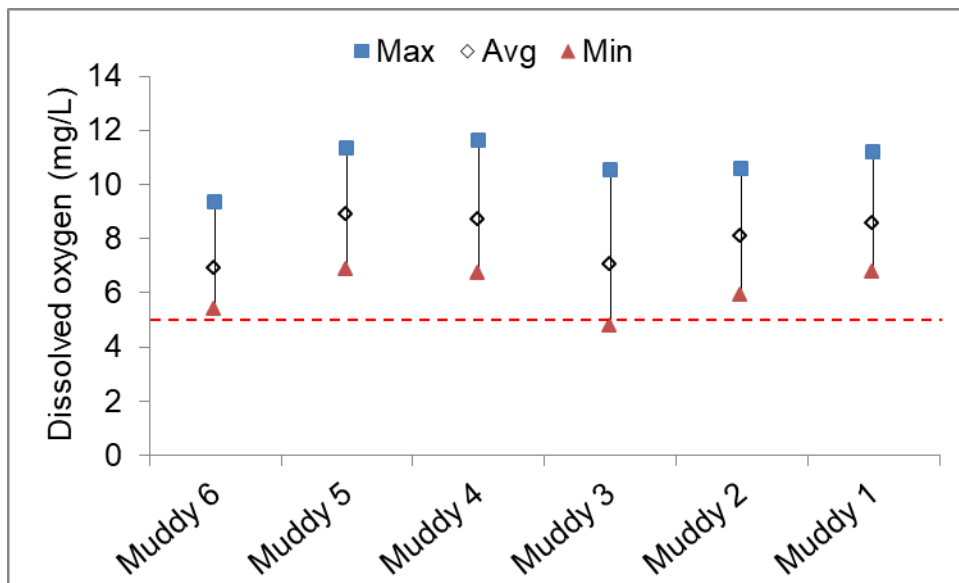


Figure J3. Muddy Brook dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity ranges were stable at all sites except Muddy 1 (Figure J4). Average conductivity values increased downstream. This increase may be attributed to land use changes as the brook flows closer to Long Island Sound. At the headwaters, the land use is large acre residential lots but as the brook flows south, the residential lots are zoned smaller and flows under Route 1, a heavily commercialized corridor with lots of impervious surface which allows runoff to enter the waterway.

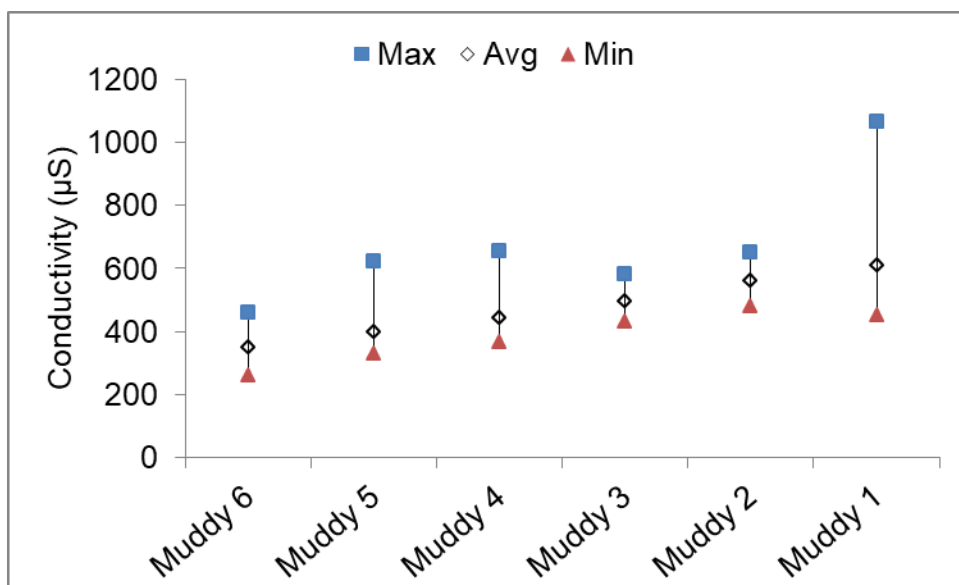


Figure J4. Muddy Brook conductivity values. Maximum, average, and minimum for each site.

K. Noroton River

Summary

The Noroton River watershed encompasses portions of three communities whose political boundaries fall within the state of Connecticut. The three towns are Stamford, Darien, and New Canaan, which fall within Fairfield County. The watershed is approximately 7,000 acres or 11 square miles. The river begins in New Canaan and flows south between the border of Stamford and Darien. The river discharges into Long Island Sound through Holly Pond on the border of Stamford and Darien. The land use along the river is a mixture of residential and light commercial.

This is the second year that Harbor Watch has monitored the Noroton River. For this monitoring season, site Noroton 6 was removed from the testing schedule due to access issues and concerns that the location was not representative of the river as a whole. Construction issues surrounding Noroton 5 prevented access for sampling from the end of August through September. Bacteria concentrations in the upper watershed met CT DEEP criteria, while sites in the lower half of the watershed failed one or both of the criteria. The majority of sites met the CT DEEP criterion for dissolved oxygen. Continued monitoring next season is suggested to identify potential sources of pollution to the lower half of the watershed.

Table K1. GPS coordinates and sample locations for the Noroton River

Station Number	Latitude	Longitude	Town	Comments
Noroton 1	41.06093	-73.50735	Stamford	1308 East Main Street
Noroton 2	41.07530	-73.51550	Stamford	668 Connecticut 106
Noroton 3	41.09540	-73.51430	Stamford	Springdale Athletic Club
Noroton 4	41.10290	-73.50982	Stamford	137 Woodway Road
Noroton 5	41.11868	-73.50130	New Canaan	47 Jellif Mill Road
Noroton 7	41.14108	-73.51167	New Canaan	209 Frogtown Road
Noroton 8	41.15925	-73.51421	New Canaan	West Road and Greenley Road intersection

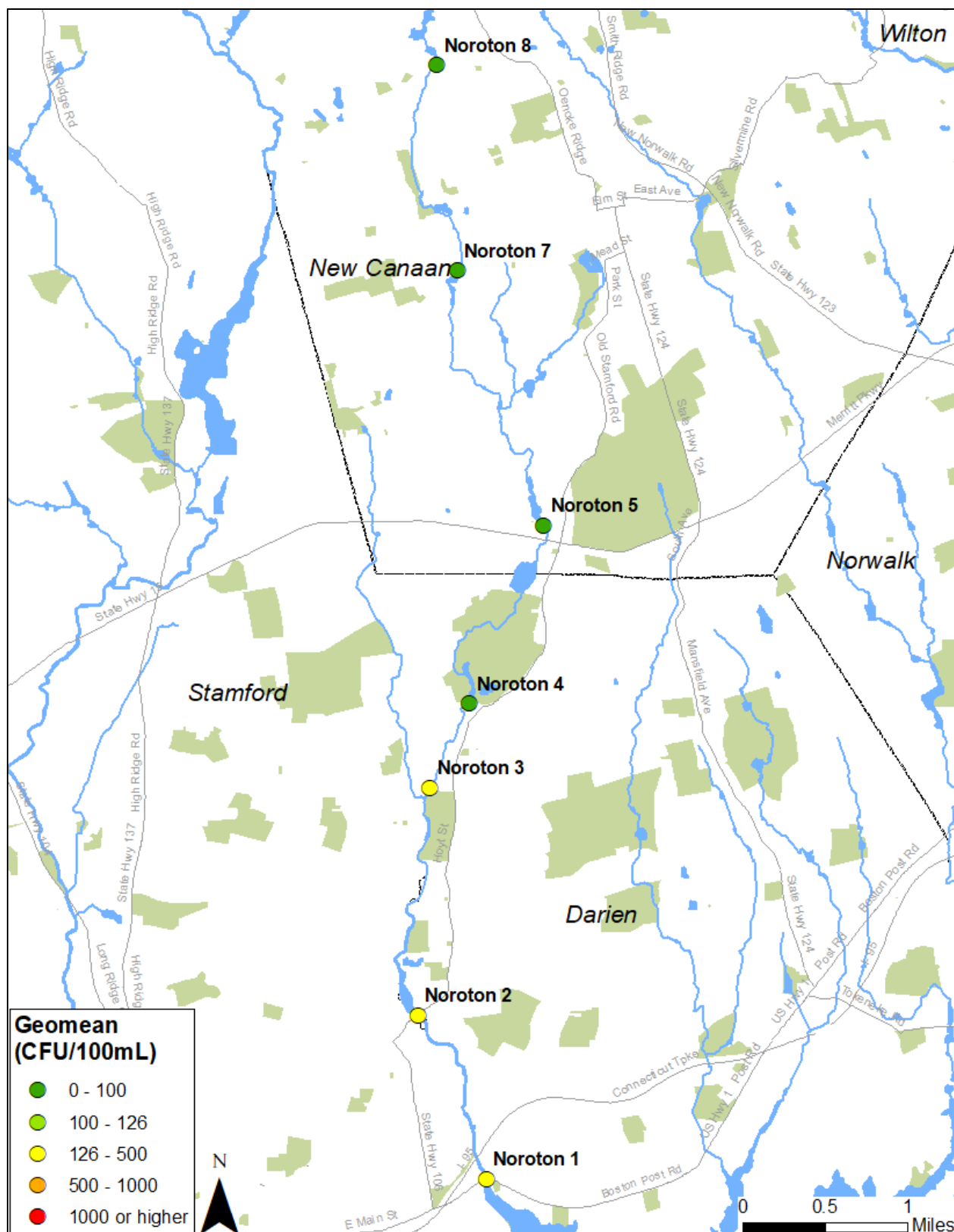


Figure K1. Sample location for 7 sites on the Noroton River.

Bacteria results

Four sites in the upper watershed, Noroton 8, Noroton 7, Noroton 5, and Noroton 4, met both CT DEEP criteria. Noroton 3 exceed both the state geomean criterion of >126 CFU/100 mL and the single sample maximum criterion of <15% of *E. coli* samples at each site > 576 CFU/100 mL (Figure K2, Table K2). Noroton 1 and Noroton 2 only exceeded the geomean criterion (Figure K2).

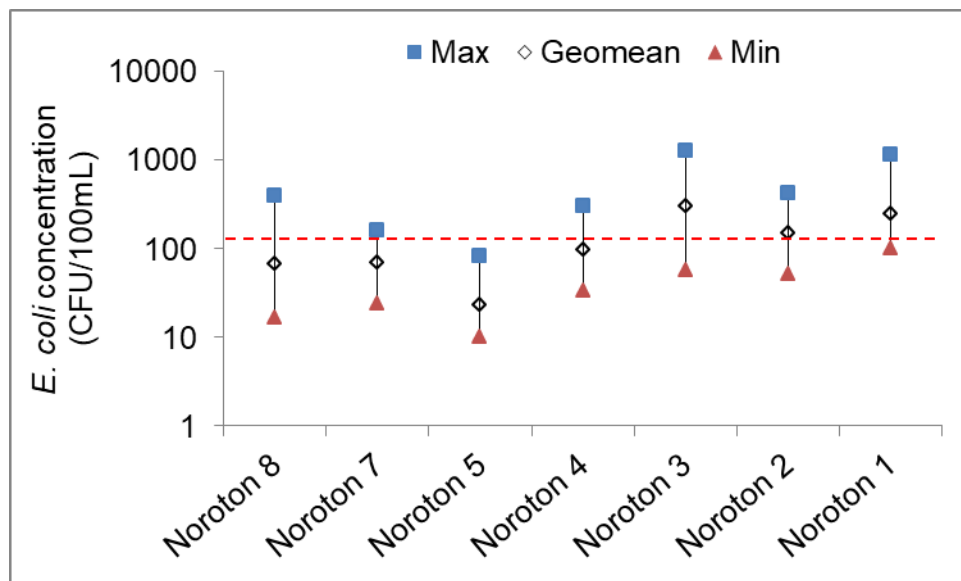


Figure K2. Noroton River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table I2. Noroton River *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: M. Long, October 2, 2017)

	5/2/2017	5/17/2017	5/30/2017	6/13/2017	6/27/2017	7/17/2017	7/31/2017	8/22/2017	8/29/2017	9/12/2017	Geomean	% > 576
Noroton 8	17	50	43	54	>400	144	est. 60	60	25	188	67	0%
Noroton 7	52	72	104	72	112	46	164	68	n/a	est. 24	70	0%
Noroton 5	15	23	82	42	est. 14	n/a	est. 10	n/a	n/a	n/a	23	0%
Noroton 4	34	34	43	132	196	122	310	228	est. 44	188	99	0%
Noroton 3	58	64	88	490	1300	400	800	780	570	230	304	30%
Noroton 2	169	176	132	430	280	204	124	72	160	52	153	0%
Noroton 1	110	102	248	430	1140	220	310	160	265	270	253	10%
Rainfall	Dry	Dry	Wet	Dry	Wet	Dry	Dry	Dry	Wet	Dry		

Dissolved oxygen results

Mean dissolved oxygen levels met the CT DEEP minimum criterion of 5 mg/L at all sites except for Noroton 8 (Figure K3). Noroton 8 is located downstream of a series of small ponds which reduced flow through the river which could have attributed to the low dissolved oxygen values observed. Noroton 1 and Noroton 2 also had a number of individual readings which dropped below 5 mg/L (Table K3). Low values may be attributed to reduced flow at low tide and the decaying organic matter in the riverbed.

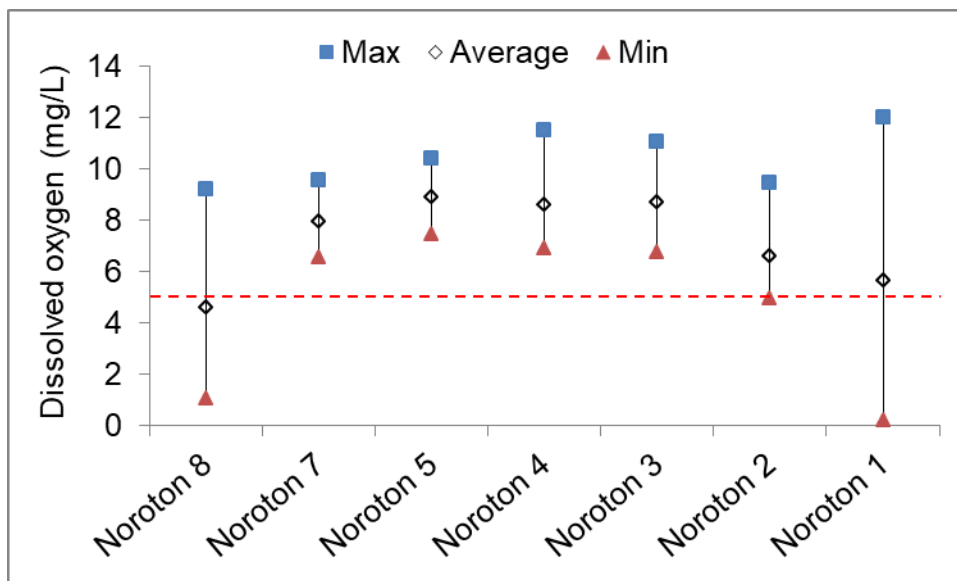


Figure K3. Noroton River dissolved oxygen concentrations. Maximum, average, and minimum values for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Table K3. Days during which dissolved oxygen levels fell below 5 mg/L. Values are reported in mg/L

	Noroton 1	Noroton 2	Noroton 8
6/13/2017	2.71		2.4
6/27/2017	2.94		3.8
7/17/2017			3.74
7/31/2017	0.93		1.7
8/22/2017			1.07
8/29/2017	0.21	4.96	2.38
9/12/2017	2.14		

Conductivity results

Conductivity values at the sites above the area of tidal incursion had narrow ranges with the exception of site Noroton 4 (Figure K4, left). The low reading of 102 μS observed on 8/22 cannot be explained at this time. Conductivity ranges at the tidally influenced site Noroton 1 was wide due to sampling regardless of the tide cycle (Figure K4, right).

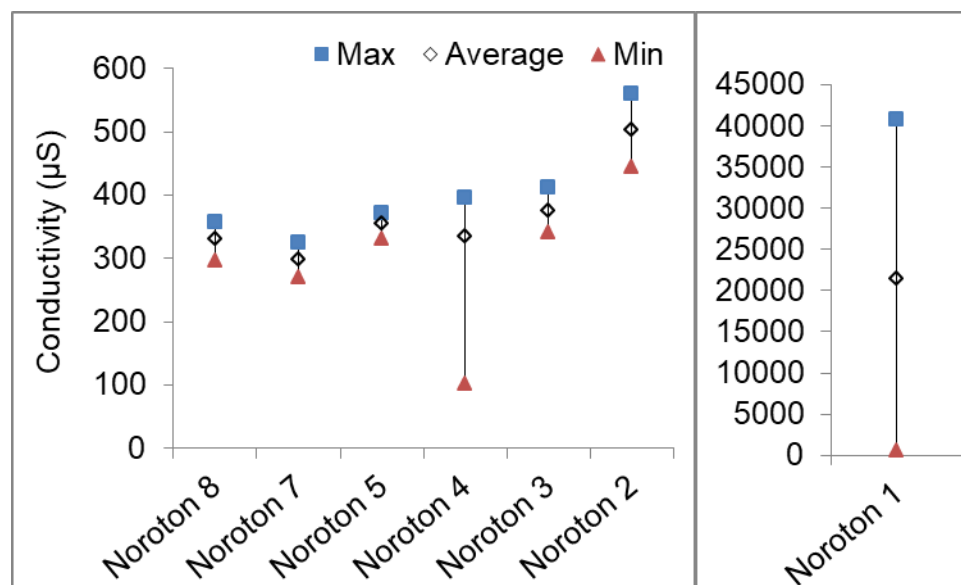


Figure K4. Noroton River conductivity values. Maximum, average, and minimum for each site that is (left) above the area of tidal incursion and (right) tidally influenced.

L. Norwalk River

Summary

The Norwalk River watershed encompasses portions of municipalities in Connecticut and New York. The six Connecticut towns are New Canaan, Norwalk, Redding, Ridgefield, Weston and Wilton. The seventh town is Lewisboro, New York (NRWI, 1998). The watershed is roughly 40,000 acres or 64.1 square miles. Approximately 64% of the watershed land use is developed by commercial/light industry uses, residential neighborhoods, and roads (NRWI, 1998). The main stem of the Norwalk River is approximately 20 miles in length, beginning in the Great Swamp in Ridgefield. From there the river runs north approximately a mile, before turning south discharging in Norwalk Harbor where the last three miles are a tidal estuary (NRWI, 1998).

Harbor Watch has monitored the Norwalk River year-round for 19 years. Water quality conditions in the river in 2017 were improved over 2016 results and had the second fewest exceedances in the last 5 years. More than half the sites exceeded one or both of the CT DEEP criteria for *E. coli*, but the majority of sites met the CT DEEP dissolved oxygen criterion. In addition to instream monitoring, we conducted multiple pollution track down projects and successfully identified three sources of pollution entering the river and estuary downstream of Norwalk 4. All sources were remediated in 2017.

Table L1. GPS coordinates and site locations for the Norwalk River

Station Number	Latitude	Longitude	Town	Comments
Norwalk 1	41.11938	-73.41724	Norwalk	40 Cross Street
Norwalk 4	41.14349	-73.42669	Norwalk	10 Glover Avenue
Norwalk 6	41.18341	-73.42276	Wilton	187 Danbury Road
Norwalk 9	41.20354	-73.43094	Wilton	School Road, trail head across from Cider Mill School
Norwalk 9.5	41.24590	-73.43409	Wilton	Old Mill Road park
Norwalk 13	41.26550	-73.44079	Ridgefield	787 Branchville Road
Norwalk 15	41.30909	-73.46931	Ridgefield	30 Stonehenge Road
Norwalk 19	41.316722	-73.490014	Ridgefield	Limestone Road
Norwalk 21	41.29444	-73.48843	Ridgefield	68 Farmingville Road
Ridgefield SD1	41.29077	-73.49155	Ridgefield	Ligi's Way. Wastewater Treatment Plant effluent discharge
Norwalk 23	41.29055	-73.49337	Ridgefield	22 South Street

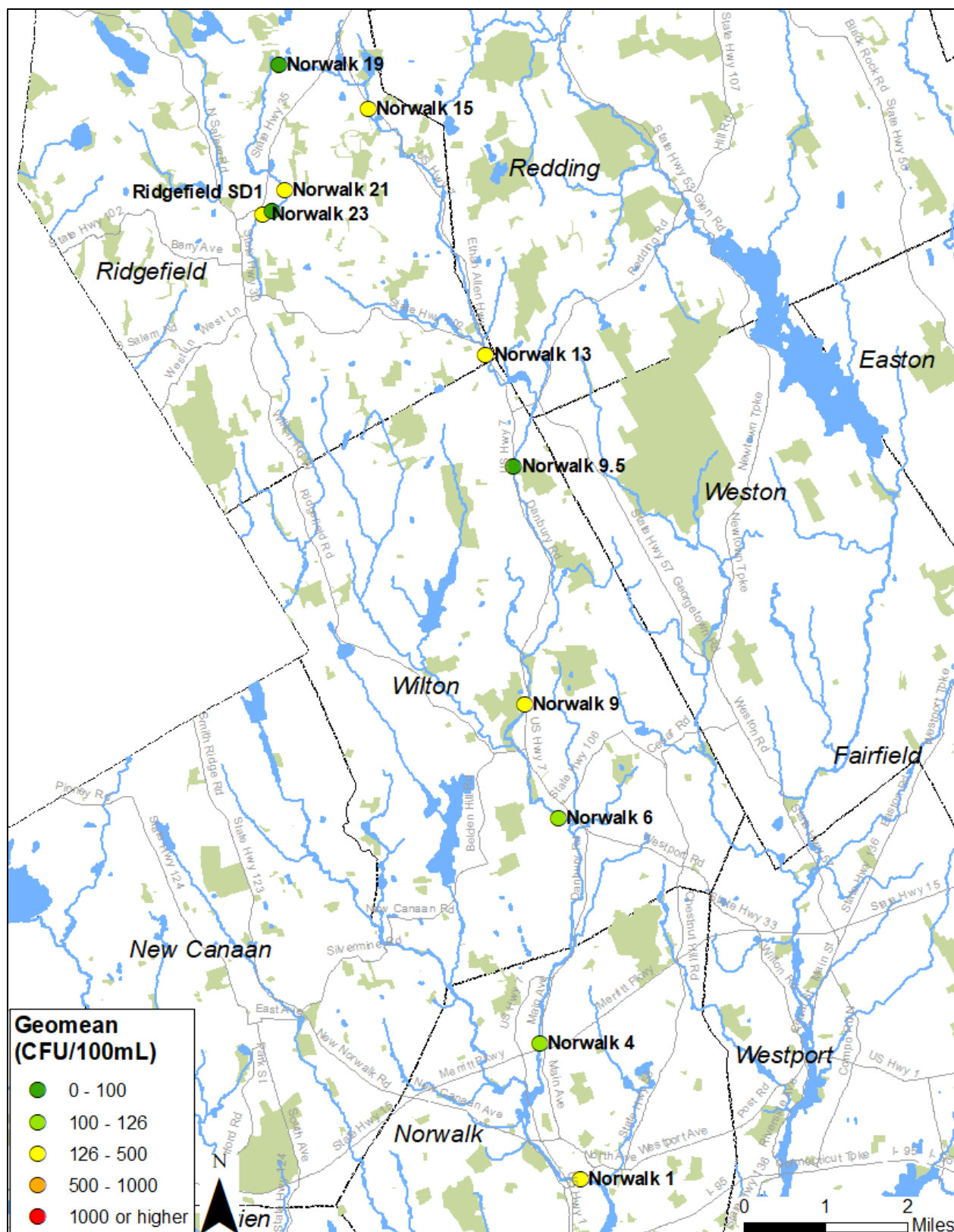


Figure L1. Sample locations for 11 sites on the Norwalk River.

Bacteria results

In 2017, six of the ten instream sites, Norwalk 23, Norwalk 21, Norwalk 15, Norwalk 13, Norwalk 9, and Norwalk 1, exceeded the CT DEEP geomean maximum criterion of 126 CFU/100 mL (Figure L2, Table L2). Only four sites, Norwalk 23, Norwalk 21, Norwalk 4 and Norwalk 1, exceeded the CT DEEP single sample maximum criterion (<15% of *E. coli* samples >576 CFU/100mL; Table L2). Elevated bacteria concentrations were observed on days where samples were collected during rainfall events. Site Ridgefield SD1 is the Ridgefield Wastewater Treatment Plant effluent discharge point to the Norwalk River. From April through October, the plant utilizes ultra-violet lights to sanitize treated effluent. As the treated effluent flows past the lights, the bacteria are eliminated. As can be seen in Table L2, the bacteria concentrations observed in the effluent discharge were frequently 0 CFU/100 mL. The highest count of 32 CFU/100 mL was observed where 1.43 inches of rain fell within three days of sampling. This data indicates that the plant was not discharging untreated water into the Norwalk River during the study period.

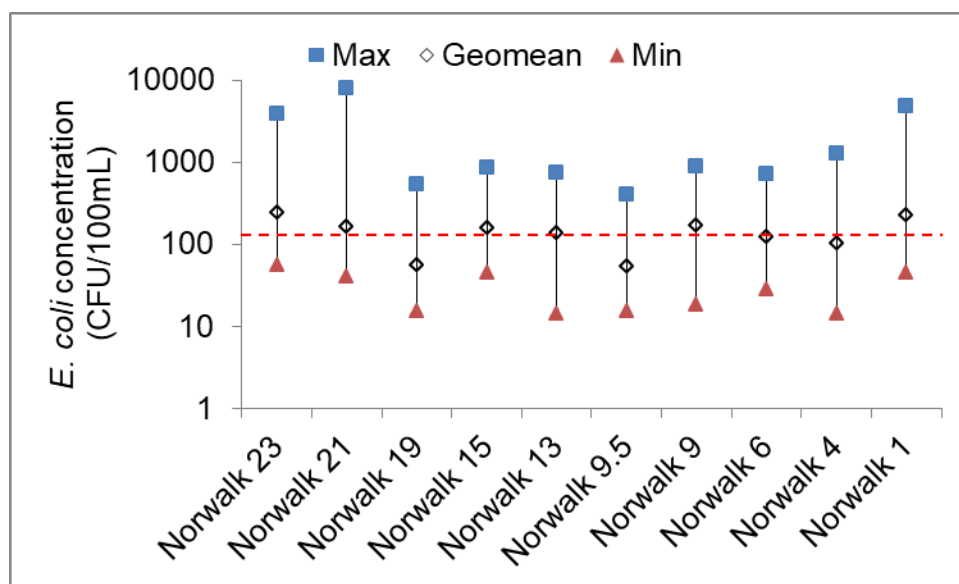


Figure L2. Norwalk River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table L2. Norwalk River *E. coli* concentrations and relations to CT DEEP water quality criteria (rainfall data: P. DiPietro, personal communication, October 11, 2017)

	5/1/2017	5/23/2017	6/1/2017	6/22/2017	7/13/2017	7/24/2017	8/3/2017	8/16/2017	8/31/2017	9/13/2017	Geomean	% > 576
Norwalk 23	252	88	> 1000	est. 70	128	3800	600	140	220	55	245	30%
Ridgefield SD1	0	0	0	32	0	0	0	0	0	1	1	0%
Norwalk 21	45	64	> 1000	est. 120	116	8000	400	50	40	58	165	20%
Norwalk 19	15	74	540	est. 30	est. 32	260	est. 24	30	60	38	55	0%
Norwalk 15	44	74	390	est. 160	104	860	est. 90	260	150	152	158	10%
Norwalk 13	14	56	480	est. 110	168	740	est. 120	156	188	112	135	10%
Norwalk 9.5	16	16	> 400	est. 15	64	280	est. 20	92	68	52	53	0%
Norwalk 9	18	86	540	est. 110	880	480	est. 110	96	310	164	171	10%
Norwalk 6	31	132	720	est. 40	116	540	210	250	28	84	125	10%
Norwalk 4	86	152	1260	est. 200	44	1140	est. 30	28	14	62	102	20%
Norwalk 1	69	> 400	3000	est. 100	380	4800	est. 120	48	44	82	224	20%
Rainfall	Dry	Wet	Wet	Wet	Wet	Wet	Dry	Dry	Wet	Dry		

Dissolved oxygen results

Mean dissolved oxygen met the CT DEEP minimum criterion of 5 mg/L at all sites except for Norwalk 21 (Figure L3). Site Norwalk 21 is located downstream of the Great Swamp in Ridgefield, CT. Low dissolved oxygen values at this site may be contributed to low flow through the Great Swamp combined with decaying organic matter. Dissolved oxygen values below 5 mg/L were first observed on 6/1 and continued throughout the season except for a brief increase on 8/31 but dropped again by 9/13.

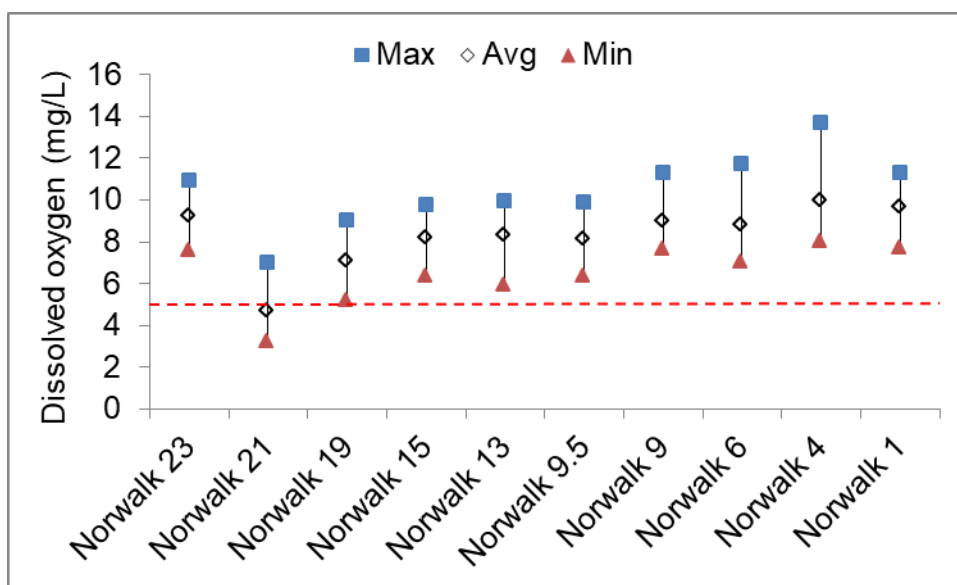


Figure L3. Norwalk River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Mean conductivity values in the Norwalk River decreased as flow traveled downstream (Figure L4). Wider ranges in the upper watershed, specifically site Norwalk 23 and Norwalk 21 may be attributed to the geology of Ridgefield and the presence of limestone beds that increase conductivity from runoff and erosion. Two large tributaries, Comstock Brook and Cooper Brook, converge with the Norwalk River in near Norwalk 9 and Norwalk 13 respectively and aid in the stabilization in conductivity ranges and reduced mean values. These tributaries add an influx of lower conductivity freshwater to the system (Harbor Watch historic data).

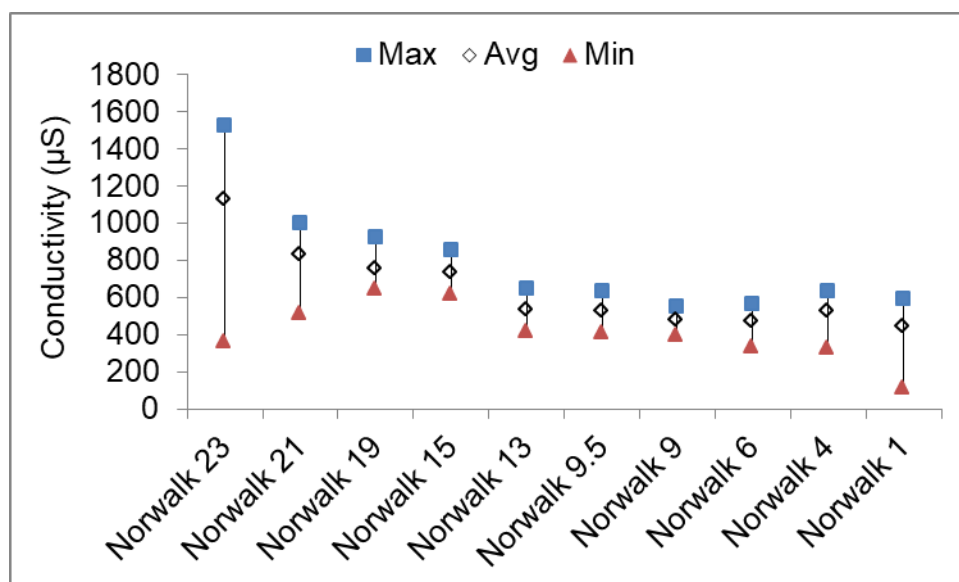


Figure L4. Norwalk River conductivity values. Maximum, average, and minimum for each site.

M. Pootatuck River

Summary

The Pootatuck River begins in Easton flows east into Monroe and discharges into the Housatonic River in Newtown. Deep Brook is one of the larger tributaries which drains to the Pootatuck River (discussed in section D of this report). The watershed spans a total of 26.1 square miles (Carlson et. al.). Much of the watershed land use is defined by residential plots and Rocky Glen State Park.

This was the first year that Harbor Watch monitored the Pootatuck River. Sites were picked with consultation from the Town of Newtown and the Pootatuck Watershed Association to supplement their own data collection. Many sites exceeded the CT DEEP *E. coli* criteria during the 2017 monitoring season. The majority of sites met the CT DEEP minimum criterion for dissolved oxygen.

Table M1. GPS coordinates and sample locations for the Pootatuck River

Site Name	Latitude	Longitude	Town	Comments
Pootatuck 1	41.437449	-73.270169	Newtown	Walnut Tree Hill
Pootatuck 2	41.42292	-73.281898	Newtown	Rocky Glen State Park
Pootatuck 3	41.383545	-73.269192	Newtown	Turkey Hill Road
Pootatuck 4	41.360087	-73.282106	Newtown	Meadow Brook Road
Pootatuck 6	41.334691	-73.298261	Newtown	Mountainside Drive

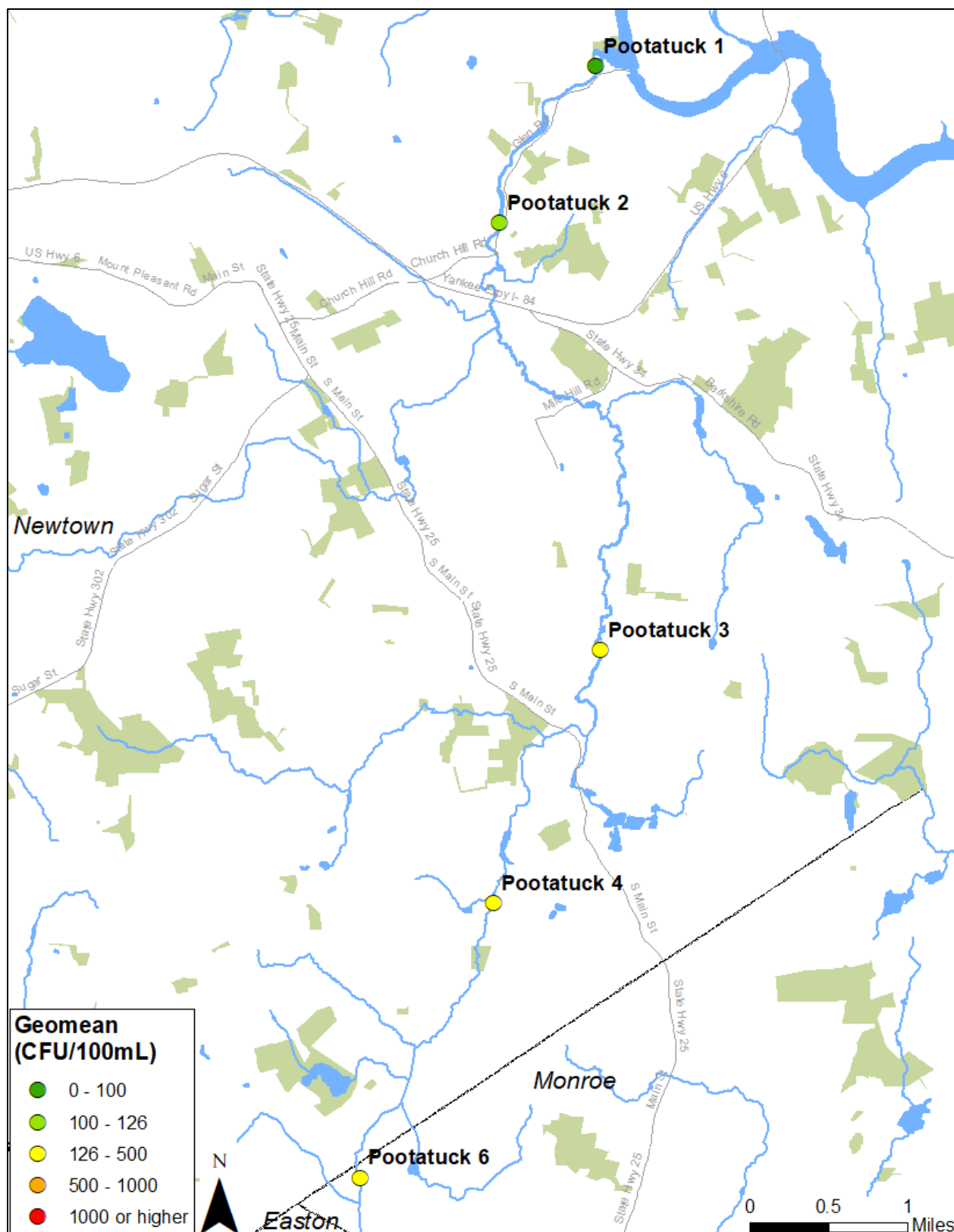


Figure M1. Sample locations for 5 sites on the Pootatuck River.

Bacteria results

Four of the five sites, Pootatuck 6, Pootatuck 4, Pootatuck 3, and Pootatuck 2 exceeded the CT DEEP geomean maximum criterion for *E. coli* of 126 CFU/100 mL (Figure M2, Table M2). Site Pootatuck 4 also exceeded the CT DEEP single sample maximum criterion which states <15% of *E. coli* samples are >576 CFU/100 mL (Table M2).

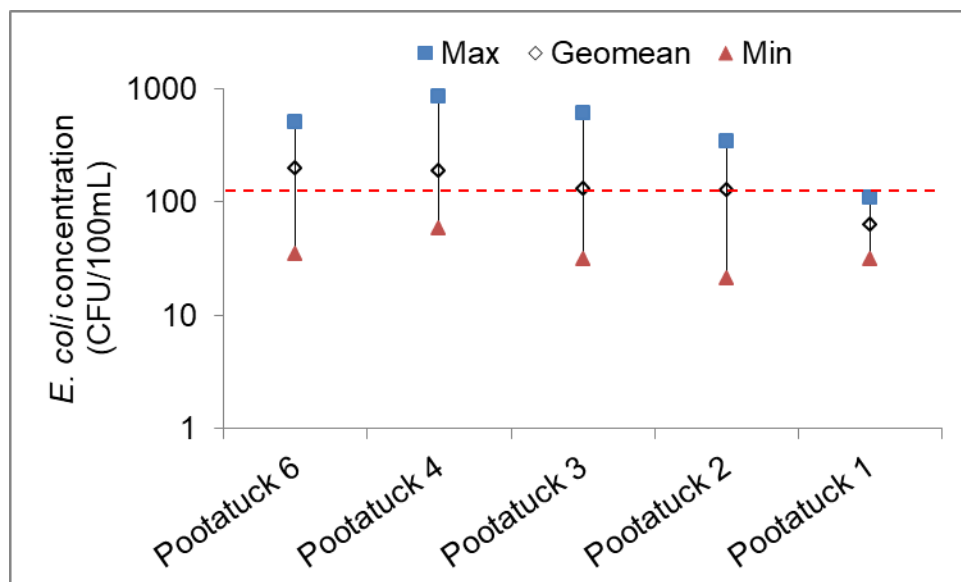


Figure M2. Pootatuck River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table M2. Pootatuck River *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: J. Hovious, personal communication, October 10, 2017)

	5/8/2017	5/18/2017	6/8/2017	6/19/2017	6/26/2017	7/26/2017	8/2/2017	8/15/2017	9/6/2017	9/20/2017	Geomean	% > 576
Pootatuck 6	35	200	168	260	172	128	170	460	est. 340	500	197	0%
Pootatuck 4	80	59	92	132	160	300	820	860	est. 250	est. 130	191	20%
Pootatuck 3	76	62	31	86	80	148	600	104	480	290	129	10%
Pootatuck 2	84	21	62	180	90	188	270	180	340	est. 180	126	0%
Pootatuck 1	110	40	48	78	60	78	46	31	96	84	62	0%
Rainfall	Wet	Dry	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet		

Dissolved oxygen results

Mean dissolved oxygen levels met the CT DEEP minimum at all sites except Pootatuck 6 (Figure M3). Individual readings fell below 5 mg/L on six sampling days with the lowest reading of 1.97 mg/L observed on 8/2. Low dissolved oxygen concentrations at Pootatuck 6 may be attributed to the large pond located upstream of the site which had low flow and lots of decaying organic matter.

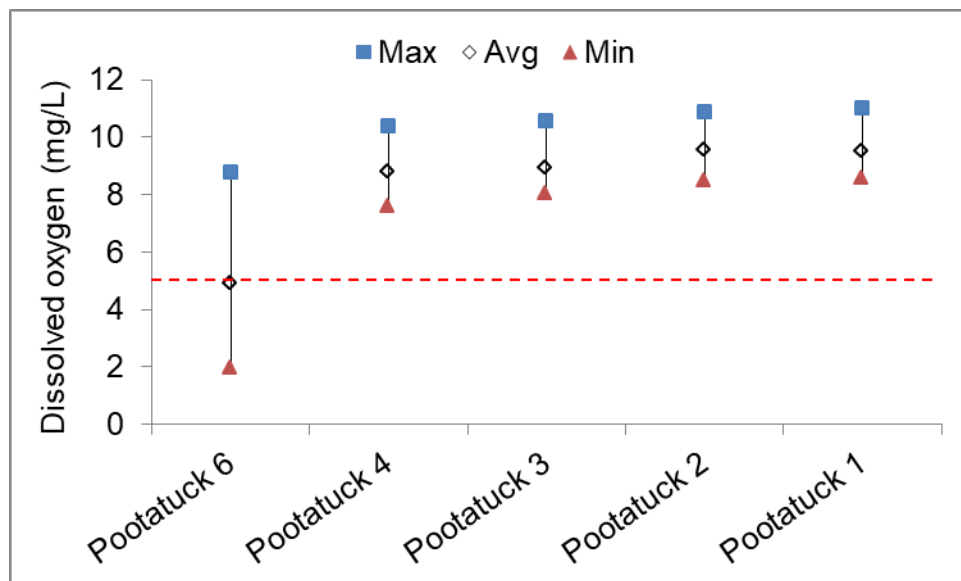


Figure M3. Pootatuck River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity averages increased as sites were located closer to the mouth of the river (Figure M4). Deep Brook meets up with Pootatuck River upstream of Pootatuck 2. The wide range observed in Pootatuck 2 and Pootatuck 1 may be attributed to an influx of higher conductivity water mixing with the main stem of the river.

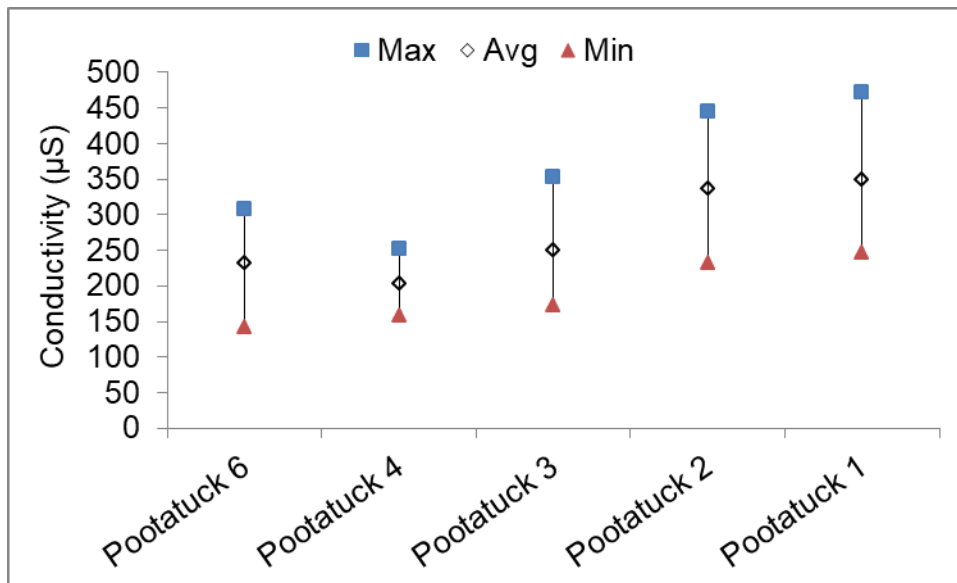


Figure M4. Pootatuck River conductivity values. Maximum, average, and minimum for each site.

N. Poplar Plains Brook

Summary

Poplar Plains Brook is located entirely in Westport, CT. It is a small tributary that flows into the Saugatuck River at the north end of Lee's Pond. Beginning at the Merritt Parkway, the brook flows south into Partrick Wetlands, and turns northeast until it travels under Route 33 where it flows due east and meets the Saugatuck River. The land use along the river is a mixture of residential, preserve (Partrick Wetlands), and light commercial.

2017 marked the second consecutive year for monitoring Poplar Plains Brook during the summer monitoring season. Site Poplar 3 was removed from the testing schedule due to access issues and concerns that the location was not representative of the brook as a whole. Bacteria concentration exceedances in 2017 were fewer than 2016. Continued monitoring of Poplar Plains Brook is suggested given its role as a tributary to the Saugatuck River.

Table N1. GPS coordinates and sample locations for Poplar Plains Brook

Station Number	Latitude	Longitude	Town	Comments
Poplar 1	41.16173	-73.36938	Westport	Bridge on Westport Weston YMCA property
Poplar 2	41.16205	-73.37512	Westport	Route 33 at the old Red Barn restaurant.
Poplar 4	41.15946	-73.38549	Westport	Newtown Turnpike at Twin Oaks Lane

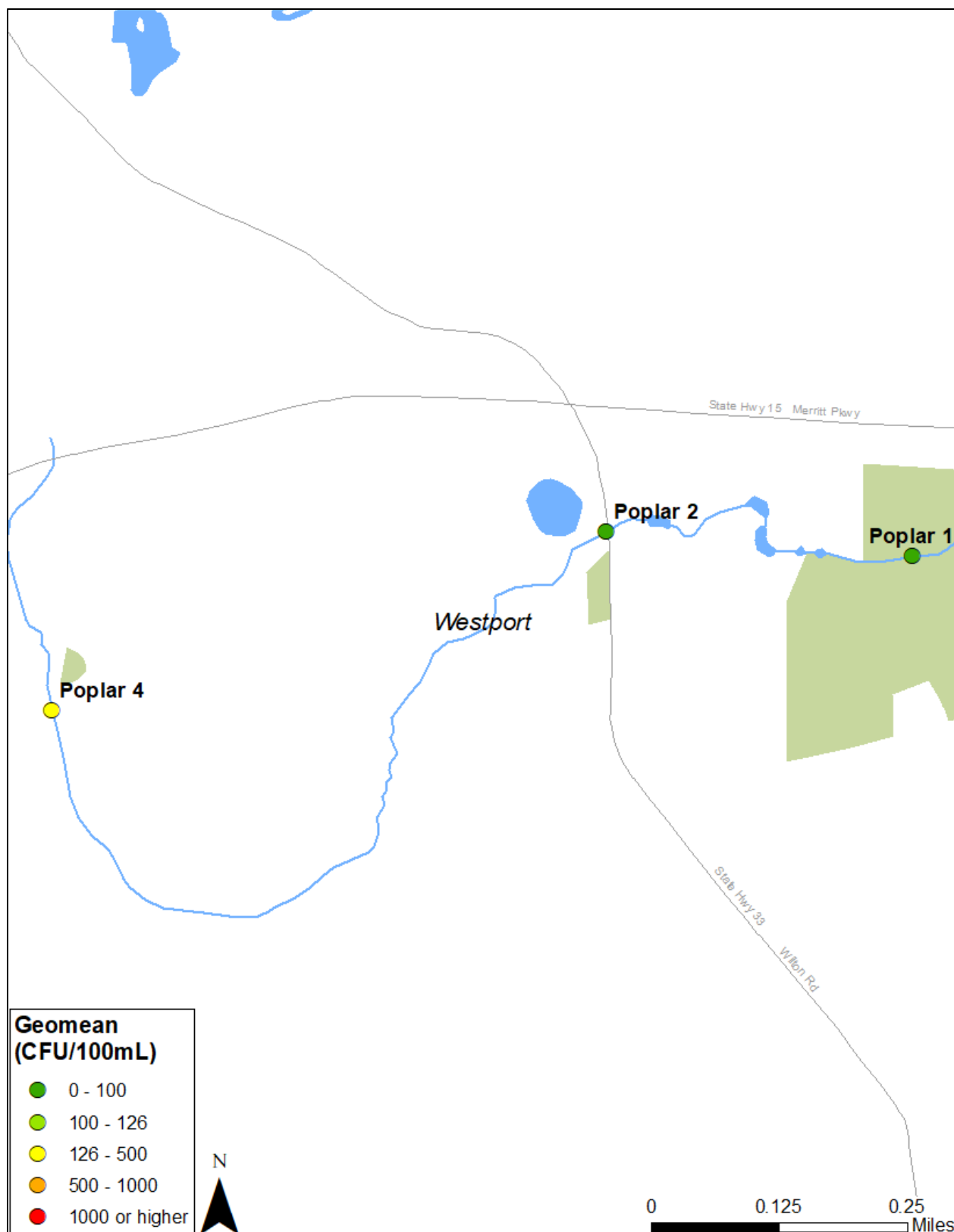


Figure N1. Sample locations for 3 sites on Poplar Plains Brook.

Bacteria results

Site Poplar 4 exceeded the CT DEEP geomean maximum criterion of 126 CFU/100 mL (Figure N2, Table N2). All three samples met the single sample maximum criterion (<15% of *E. coli* samples >576 CFU/100 mL; Table N2).

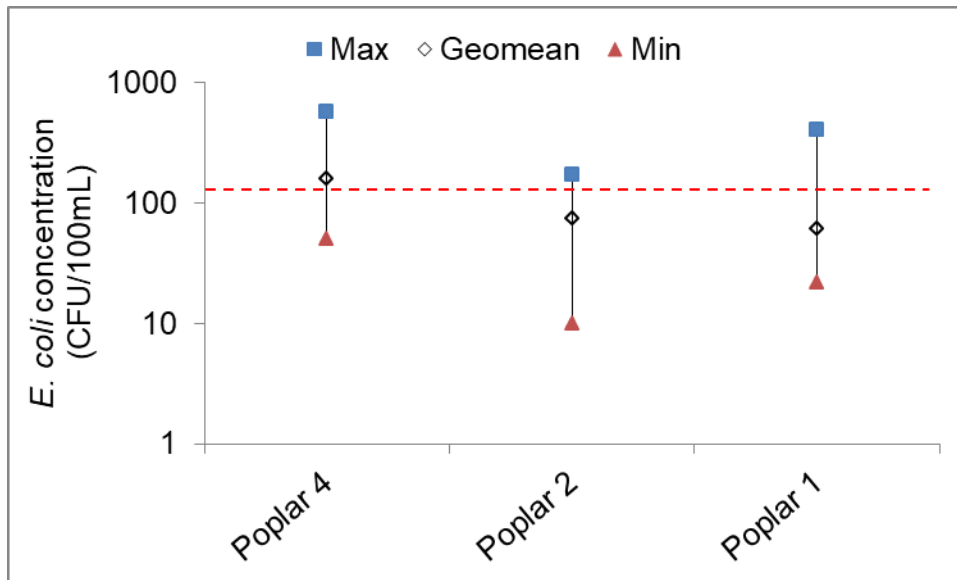


Figure N2. Poplar Plains Brook *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum criterion of 126 CFU/100 mL.

Table N2. Poplar Plains Brook *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: P. DiPietro, personal communication, October 11, 2017)

	5/10/2017	5/15/2017	6/6/2017	6/15/2017	7/11/2017	7/26/2017	8/3/2017	8/14/2017	9/5/2017	9/21/2017	Geomean	% > 576
Poplar 4	138	200	est. 110	est. 56	560	est. 50	240	155	320	164	157	0%
Poplar 2	62	124	84	40	128	est. 10	132	172	64	92	73	0%
Poplar 1	56	124	est. 22	28	400	184	est. 22	70	68	est. 22	61	0%
Rainfall	Dry	Wet	Wet	Dry	Wet	Wet	Dry	Wet	Wet	Wet		

Dissolved oxygen results

Mean dissolved oxygen levels all met the CT DEEP minimum criterion of 5 mg/L (Figure N3). Individual readings at site Poplar 2 were observed to drop below 5 mg/L on 8/3, 8/14, and 9/21. Low flow was observed at this site which could have contributed to the reduced dissolved oxygen levels.

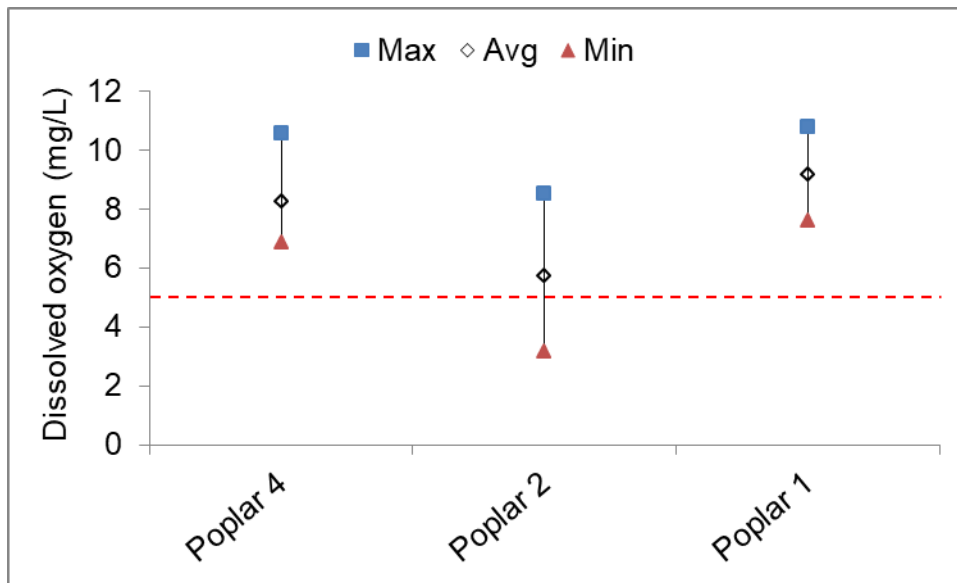


Figure N3. Poplar Plains Brook dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Mean conductivity values in Poplar Plains Brook were very similar, ranging from a maximum of 424 μS at Poplar 1 to a minimum of 382 μS at Poplar 2 (Figure N4).

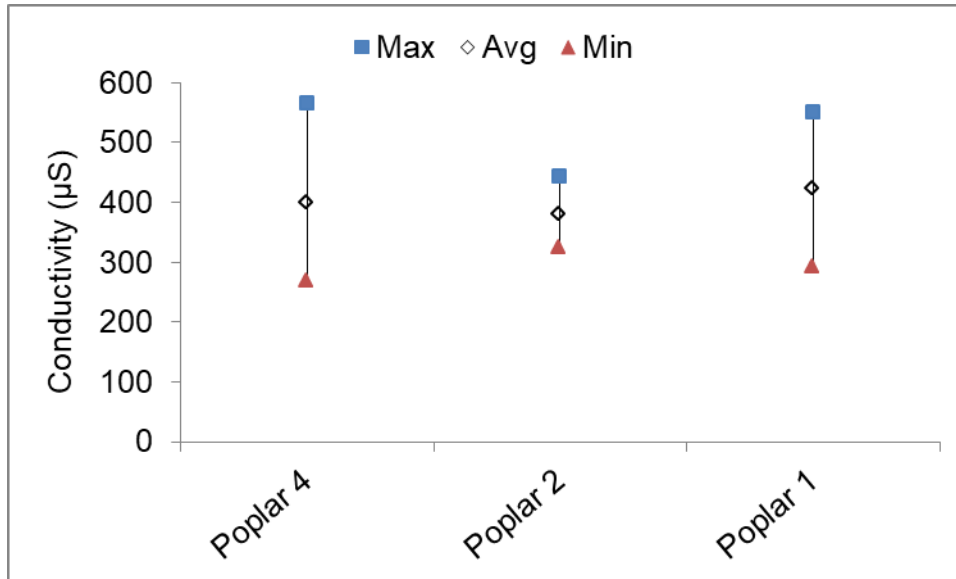


Figure N4. Poplar Plains Brook conductivity values. Maximum, average, and minimum values for each site.

O. Rippowam River

Summary

The Rippowam River, sometimes referred to as the Mill River, watershed covers 37.5 square miles from the New York State border, through parts of New Canaan, Ridgefield, and Stamford to where it discharges in the Stamford Harbor. Approximately 18 square miles of this watershed are within the City of Stamford, where all data for this report was collected. Due to the expansiveness of this watershed the land use is better classified in two portions. The southern portion of the basin is commercial, industrial and residential and the northern portion is largely residential, forested and agricultural (CT DEEP).

2017 was the first year that Harbor Watch monitored the Rippowam River. The water quality in the river did not meet CT DEEP criteria for bacteria. All sites met the CT DEEP minimum criterion for dissolved oxygen. In order to identify sources of bacteria, continued monitoring is suggested for the 2018 monitoring season. We are currently working with the Stormwater Department in the City of Stamford to identify and remediate any pollution sources.

Table O1. GPS coordinates and site locations for the Rippowam River.

Site Name	Latitude	Longitude	Town	Comments
Rippowam 1	41.049399	-73.545877	Stamford	Division Street
Rippowam 2	41.059044	-73.546643	Stamford	W North Street
Rippowam 3	41.065926	-73.549116	Stamford	Bridge Street
Rippowam 4	41.066174	-73.557631	Stamford	Cold Spring Road
Rippowam 5	41.08559	-73.556636	Stamford	Long Ridge Road
Rippowam 7	41.105586	-73.558604	Stamford	Cedar Heights Road
Rippowam 8	41.113024	-73.546191	Stamford	High Ridge Road

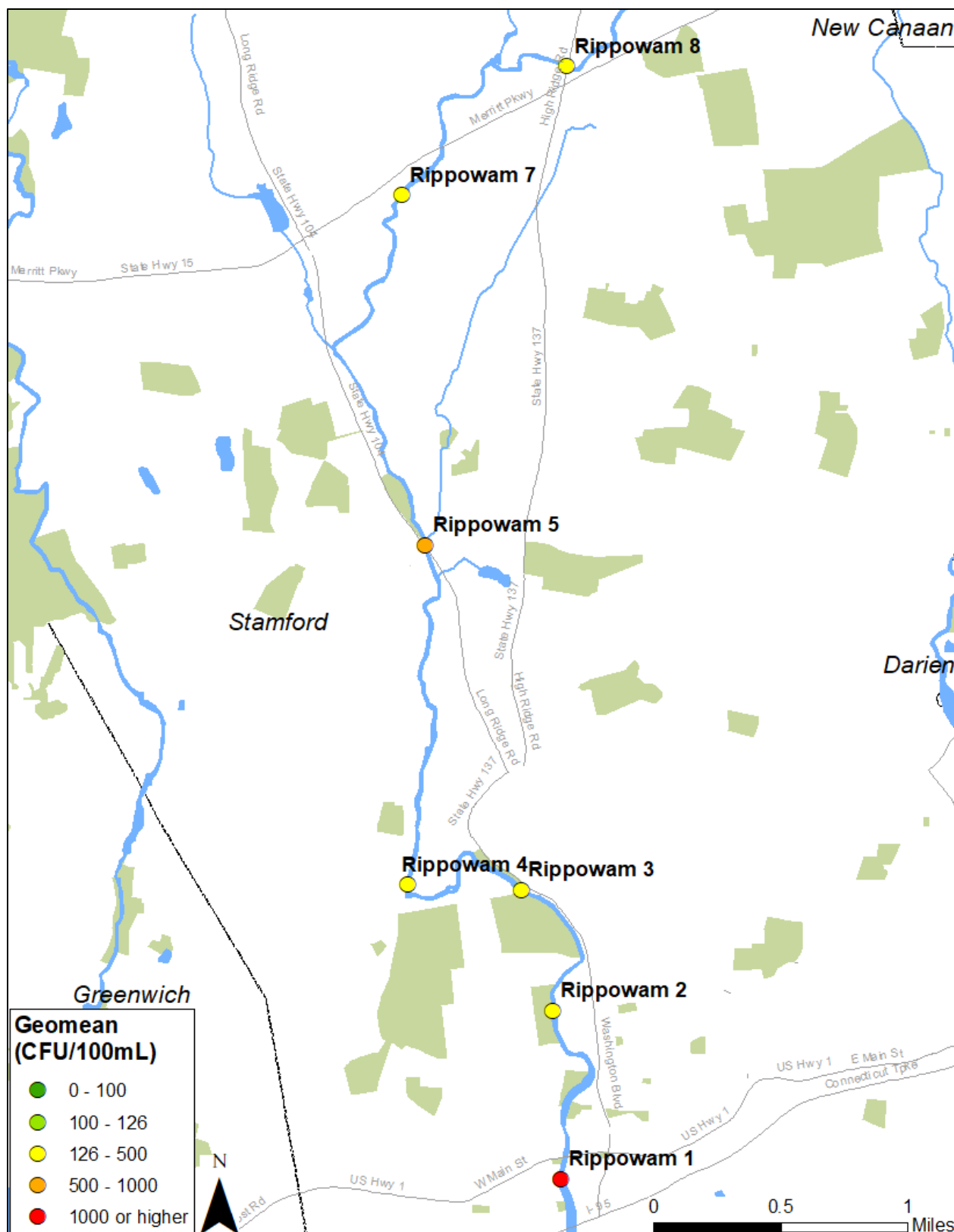


Figure O1. Sample locations for 7 sites on the Rippowam River.

Bacteria results

All seven sites exceeded the CT DEEP *E. coli* geomean maximum of 126 CFU/100 mL (Figure O2, Table O2). Rippowam 8 is the only site that met the CT DEEP single sample maximum of <15% of *E. coli* samples >576 CFU/100 mL (Table O2). The majority of samples were collected within two days of a rain event greater than 0.1 inches but elevated bacteria concentrations were observed regardless of the rainfall conditions (Table O2).

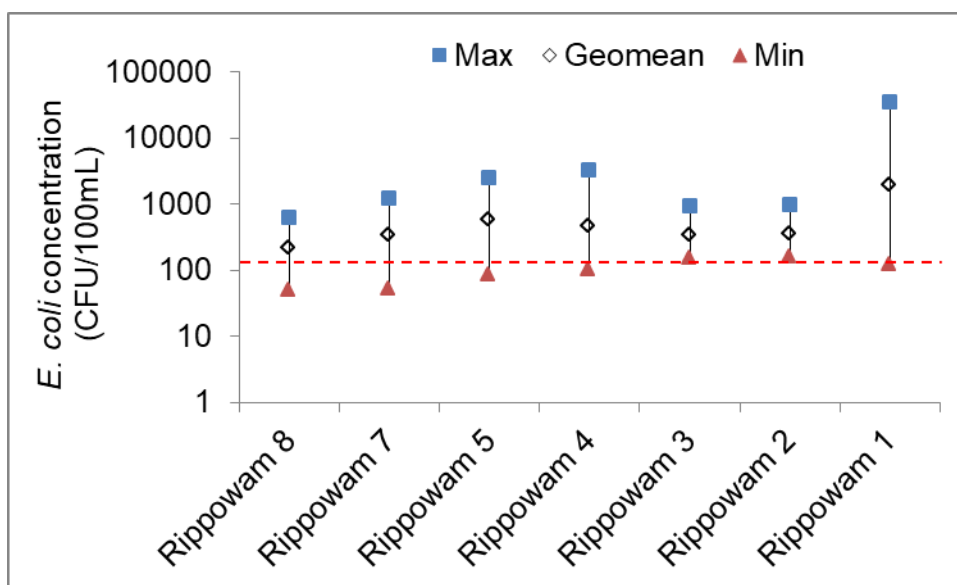


Figure O2. Rippowam River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table O2. Rippowam River *E. coli* concentrations and relation to CT DEEP water quality criteria (Rainfall data: M. Long, personal communication, October 2, 2017)

	5/3/2017	5/15/2017	6/5/2017	6/21/2017	6/27/2017	7/26/2017	8/8/2017	8/17/2017	8/31/2017	9/14/2017	Geomean	% >576
Rippowam 8	82	48	500	620	510	310	280	160	210	88	209	10%
Rippowam 7	51	61	400	580	960	260	700	1200	1050	100	331	50%
Rippowam 5	92	84	380	400	2500	860	820	820	1400	1800	580	60%
Rippowam 4	100	172	680	3200	1400	est. 160	840	310	380	480	457	40%
Rippowam 3	160	160	580	620	780	360	350	920	est. 160	148	338	40%
Rippowam 2	228	152	960	570	760	350	450	200	210	220	341	20%
Rippowam 1	120	260	1560	7700	34000	2700	1140	3200	1300	4600	1939	80%
Rainfall	Dry	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Wet	Dry		

Dissolved oxygen results

The individual and mean dissolved oxygen readings at all seven sites met the CT DEEP minimum of 5 mg/L (Figure O3). The river maintained good flow throughout the summer along the length of the river.

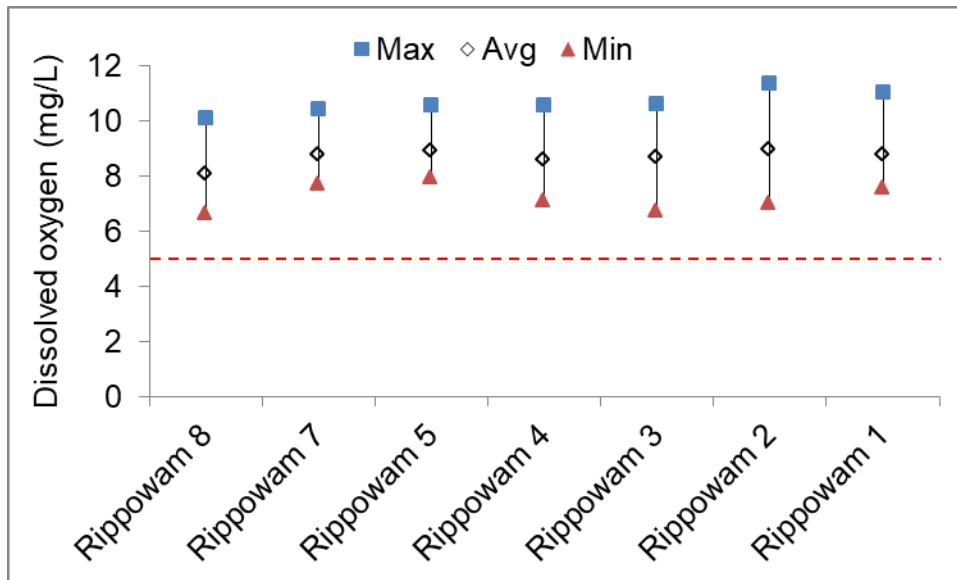


Figure O3. Rippowam River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity Results

Conductivity ranges were wide throughout the watershed (Figure O4). Much of the river traverses through densely populated areas with yards mowed to the river bank with little to no riparian buffer. This land use may be part of the cause for the range in conductivity values. The river also travels through a very urban area, and while the Mill River Parks may act as a riparian buffer reducing runoff, there are numerous storm drains which discharge to the river and can act as conduits for runoff during rainfall events increasing conductivity values. Rippowam 1 is located in a tidally influenced area. The wide range in values observed can be attributed to sampling regardless of the tide cycle (Figure O4).

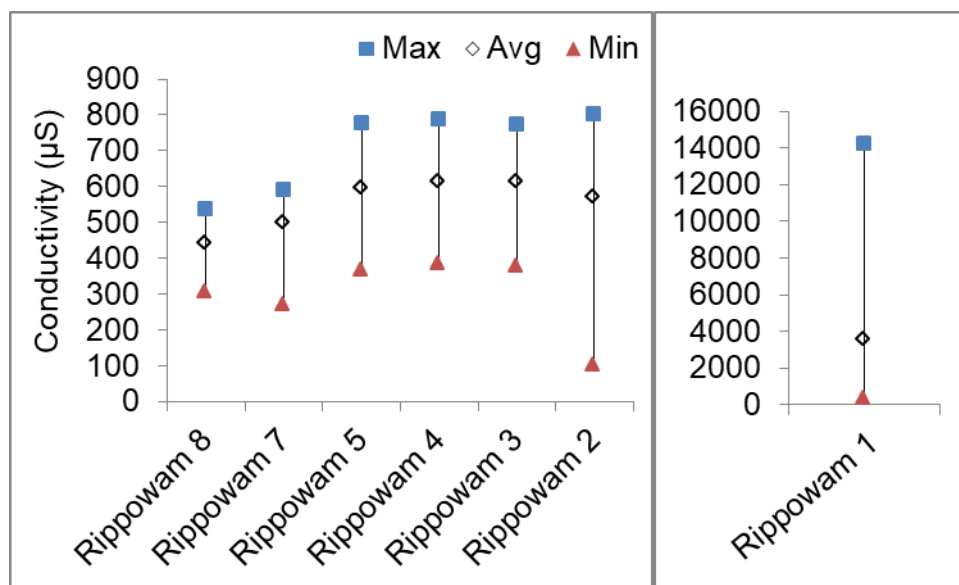


Figure O4. Rippowam River conductivity values. Maximum, average, and minimum for each site that is (left) above the area of tidal incursion and (right) tidally influenced.

P. Rooster River

Summary

The Rooster River watershed encompasses portions of four communities whose political boundaries fall within the state of Connecticut. The four towns, all located in Fairfield County, are Fairfield, Bridgeport, Trumbull, and Easton. The watershed is approximately 9,800 acres or 15.3 square miles. The Rooster River begins on the west side of Trumbull and travels south, traversing the Bridgeport/Fairfield town boundary before discharging to Ash Creek. Rooster River is also known as Ash Creek and Horse Tavern Brook.

2017 was the second year Harbor Watch monitored the Rooster River. For the monitoring season, due to access issues, Rooster 1 was removed and replaced with site Rooster 1A. In addition, two sites in Trumbull were added to get a more comprehensive look at the water quality in the whole watershed. Although the whole river is not meeting CT DEEP criteria for bacteria, the concentrations observed in 2017 were lower than those observed in 2016. In 2017, site Rooster 4.5 was not sampled due to bridge construction at the site.

Table P1. GPS coordinates and site locations for the Rooster River

Station Number	Latitude	Longitude	Town	Comments
Rooster 1A	41.16745	-73.22369	Fairfield	Commerce Drive
Rooster 2	41.16910	-73.22773	Fairfield	Fairchild Avenue
Rooster 3	41.17889	-73.21954	Bridgeport	Cartright Street
Rooster 4	41.18642	-73.21613	Bridgeport	41 Astoria Avenue
Rooster 5	41.19351	-73.23204	Fairfield	131 Westwood Road
Rooster 6	41.20316	-73.22940	Fairfield	263 Wilson Street
Rooster 7	41.21243	-73.22382	Bridgeport	Vinvellette Street
Rooster 8	41.22641	-73.22206	Bridgeport	2825 Old Town Road
Rooster 9	41.23572	-73.22811	Trumbull	Chestnut Hill Road
Rooster 10	41.24438	-73.23205	Trumbull	Revere Lane

Bacteria results

All ten sites exceeded the CT DEEP *E. coli* geomean criterion (<126 CFU/100mL) while nine sites exceeded the CT DEEP single sample maximum criterion (<15% of *E. coli* samples >576 CFU/100 mL; Figure P2, Table P2). Only site Rooster 9 met the CT DEEP single sample maximum criterion. Rooster 4 had the highest observed bacteria concentrations, but during mid-July the site dried up. This also happened during 2016 and is most likely due to river diversion upstream which was constructed to mitigate flooding issues.

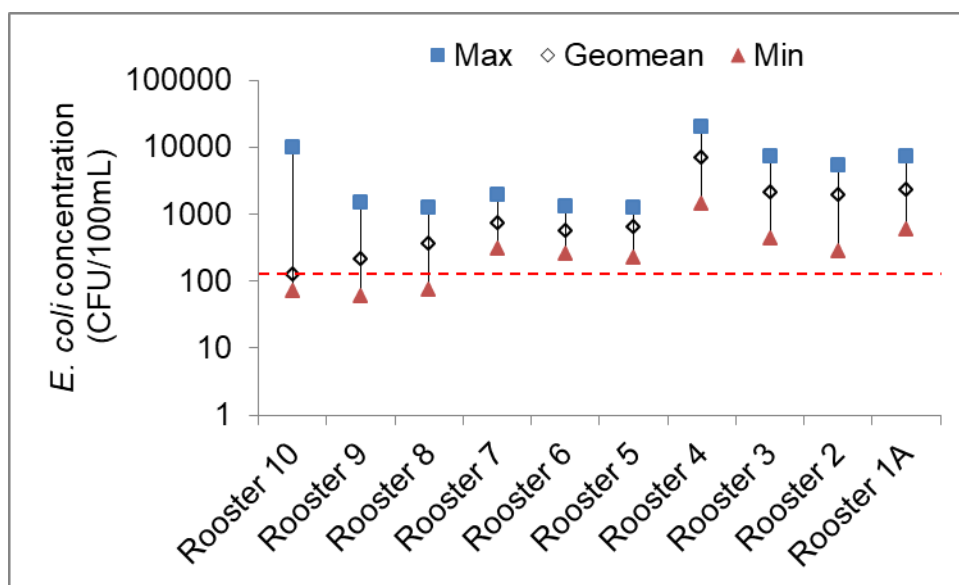


Figure P2. Rooster River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table P2. Rooster River *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: Weather Underground – Fairfield Town Hall)

	5/9/2017	5/23/2017	6/6/2017	6/14/2017	7/5/2017	7/17/2017	7/31/2017	8/16/2017	9/7/2017	9/21/2017	Geomean	% > 576
Rooster 10	est. 80	70	100	100	200	340	520	> 10000	est. 900	> 5000	394	30%
Rooster 9	est. 110	160	104	220	260	290	210	290	1500	est. 60	210	10%
Rooster 8	est. 75	236	176	350	700	280	620	640	1250	380	364	40%
Rooster 7	620	920	580	540	1900	700	1450	600	750	310	738	80%
Rooster 6	260	430	380	550	740	460	480	740	1300	840	561	40%
Rooster 5	220	560	380	530	1160	470	1240	880	1250	800	656	50%
Rooster 4	est. 13000	1400	3400	> 20000	12000	n/a	n/a	n/a	n/a	n/a	6829	100%
Rooster 3	430	900	600	2150	2700	1250	2800	6800	6800	7200	2087	90%
Rooster 2	280	1040	980	est. 1700	4400	1150	4700	2600	5400	3700	1896	90%
Rooster 1A	720	7400	est. 900	est. 600	3600	1650	4000	3600	5800	3600	2350	100%
Rainfall	Dry	Wet	Wet	Dry	Dry	Dry	Dry	Dry	Wet	Wet		

Dissolved oxygen results

Dissolved oxygen values in the Rooster River met the CT DEEP minimum criteria of 5 mg/L (Figure P3). One individual reading fell below 5mg/L at Rooster 1A on 8/16 with a dissolved oxygen concentration of 4.51 mg/L. Data was not collected on 9/21 due to equipment failure.

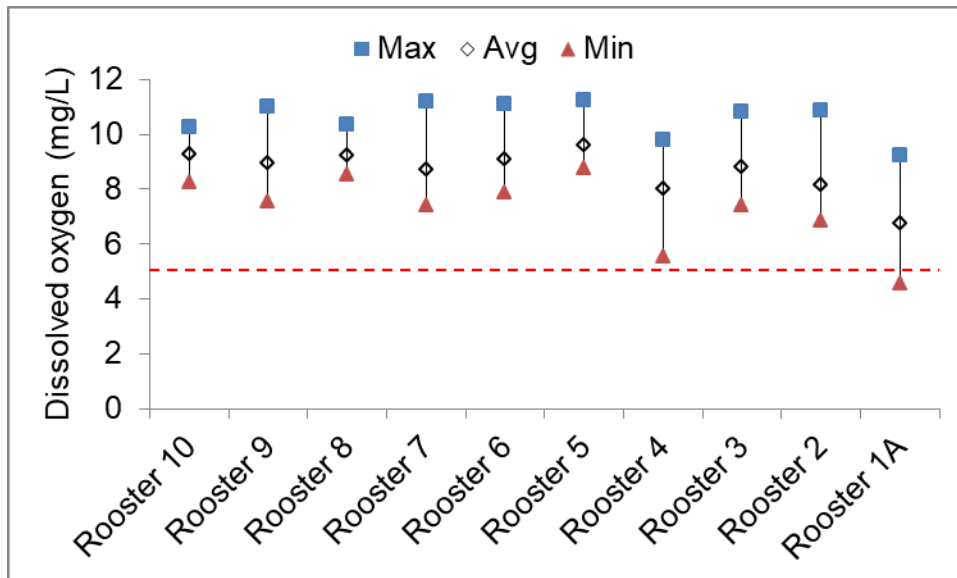


Figure P3. Rooster River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum criteria of 5 mg/L.

Conductivity results

Conductivity values showed some variability within each site (Figure P4). Rooster 4 had the widest range and highest average value of the freshwater sites. The wide range observed at Rooster 1A can be attributed to samples being collected regardless of the tide cycle (Figure P4, right).

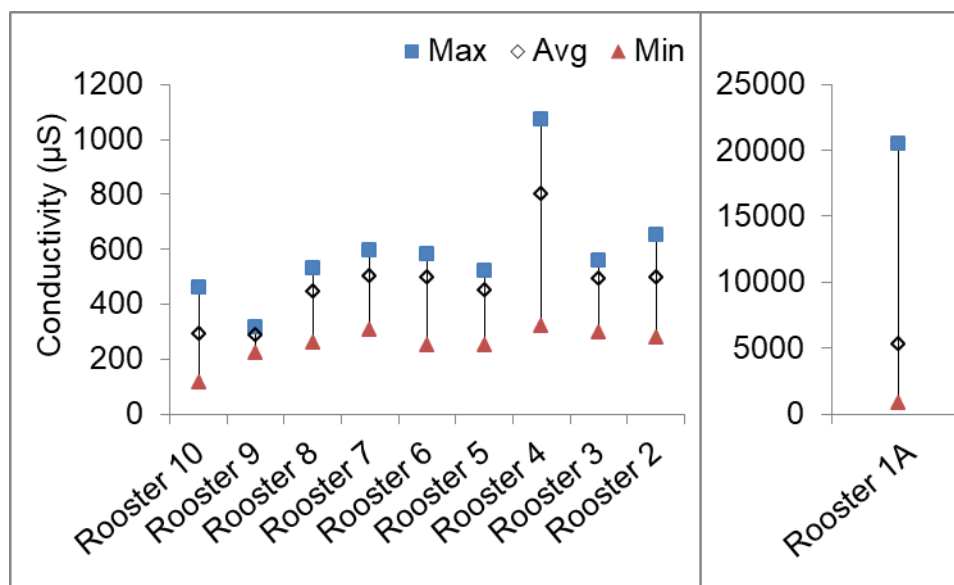


Figure P4. Rooster River conductivity values. Maximum, average, and minimum for each site that is (left) above the area of tidal incursion and (right) tidally influenced.

Q. Saugatuck River

Summary

The Saugatuck River watershed encompasses portions of nine communities whose political boundaries fall within the state of Connecticut. The towns, all located in Fairfield County, are Danbury, Ridgefield, Bethel, Redding, Wilton, Weston, Easton, Westport, and Norwalk. The watershed is approximately 38,704 acres or 60.5 square miles and is defined by two main drainage basins and a tributary: the Saugatuck River, the West Branch of the Saugatuck River, and Poplar Plains Brook (presented in section N of this report). The land use is a combination of protective preserve around the Saugatuck Reservoir, residential, and light commercial. The Saugatuck River begins in Redding and flows southeast into Weston, and then south into Westport discharging to Long Island Sound through the Saugatuck Harbor. The West Branch of the Saugatuck River is located primarily in Weston, with a small portion traveling southwest into Westport.

Harbor Watch has monitored the Saugatuck River on and off for 12 years. Bacteria concentrations from 2017 were slightly improved over 2016 (Figure Q1). Data collected in 2015 occurred from October through November when water temperatures drop and lower bacteria concentrations are often observed. When comparing only summer monitoring seasons, 2017 had the fewest observed geomean criterion exceedances since 2011 (Figure Q1).

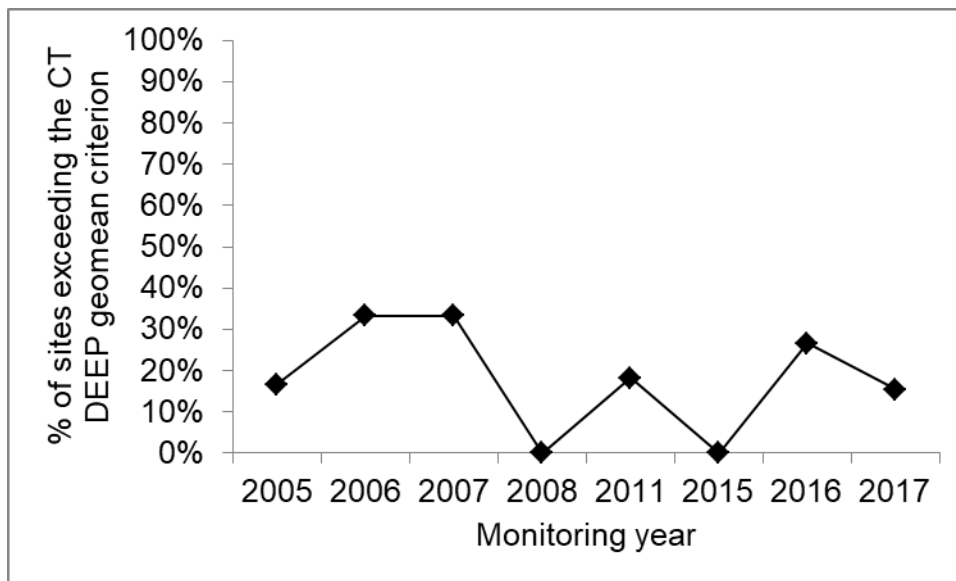


Figure Q1. Historic look at the Saugatuck River CT DEEP geomean criterion exceedances.

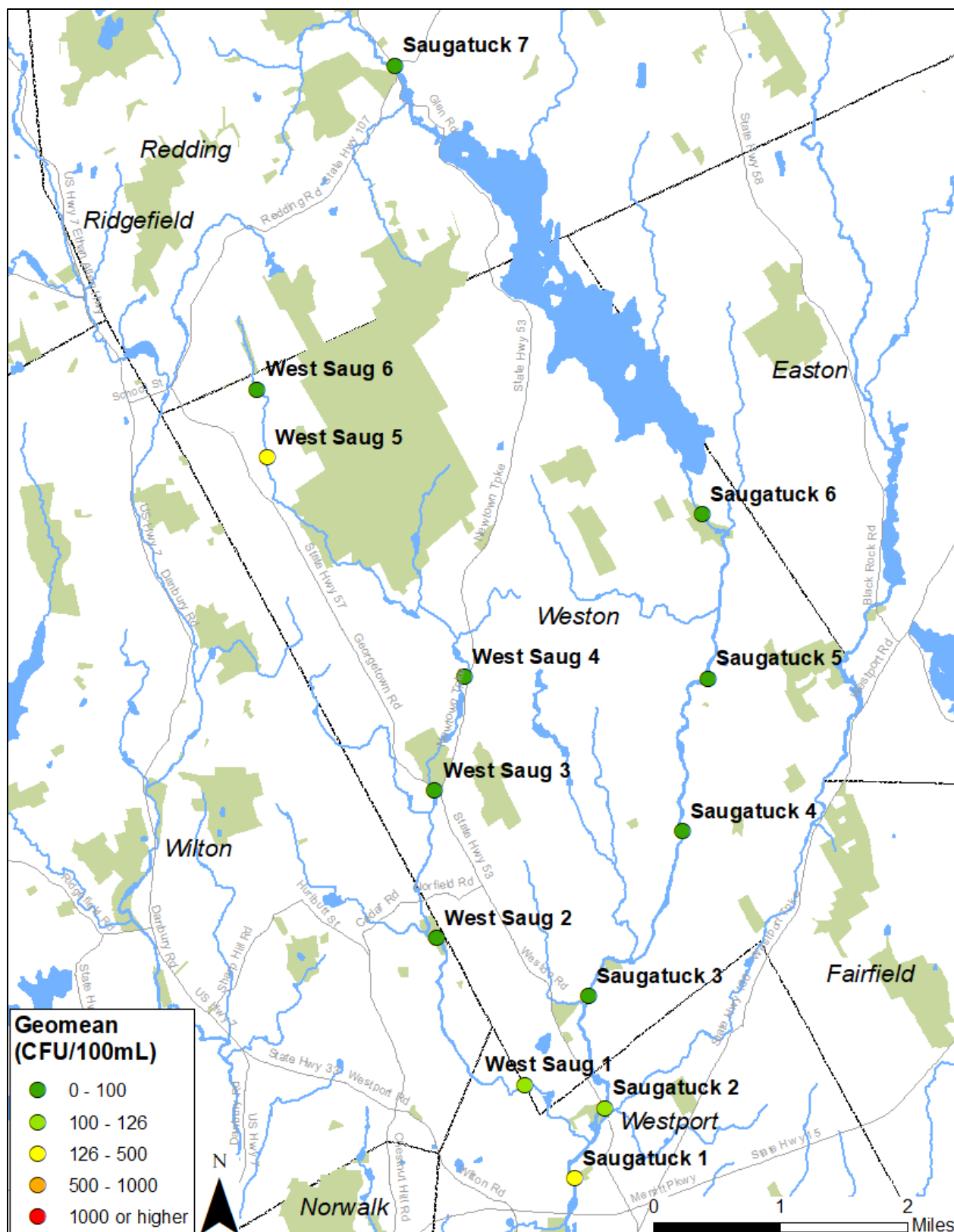


Figure Q2. Sampling locations for 13 sites on the Saugatuck River.

Table Q1. GPS coordinates and site locations for the Saugatuck River

Station Number	Latitude	Longitude	Town	Comments
Saugatuck 1	41.16748	-73.36647	Westport	Michele Lane on Clinton Avenue
Saugatuck 2	41.17553	-73.36193	Westport	Weston Road by Glendinning Place
Saugatuck 3	41.18830	-73.36441	Weston	27 River Road
Saugatuck 4	41.20722	-73.35043	Weston	1 Cartbridge Road
Saugatuck 5	41.22469	-73.34670	Weston	18 Davis Hill Road
Saugatuck 6	41.24343	-73.34785	Weston	153 Valley Forge Road
Saugatuck 7	41.29439	-73.39480	Redding	Route 53 and Route 107 intersection
West Saugatuck 1	41.17809	-73.37404	Weston	21 Cavalry Road
West Saugatuck 2	41.19480	-73.38763	Wilton	23 Stonebridge Road
West Saugatuck 3	41.21162	-73.38800	Weston	Intersection of Georgetown Road and Old Mill Road
West Saugatuck 4	41.22465	-73.38366	Weston	3 Michaels Way
West Saugatuck 5	41.24954	-73.41377	Weston	20 Indian Valley Road
West Saugatuck 6	41.25730	-73.41533	Weston	86 Old Farm Road

Bacteria results

Two sites, West Saug 5, and Saugatuck 1, exceeded the CT DEEP geomean maximum criterion of 126 CFU/100 mL (Figure Q3, Table Q2). All sites met the secondary single sample maximum criterion of <15% of *E. coli* samples >576 CFU/100mL (Table Q2). The most elevated bacteria concentrations were observed on 6/20, one day after a rainfall event which totaled 1.31 inches (Table Q2). The lowest geomean was observed at Saugatuck 6 (Figure Q3). This site is located downstream of the Saugatuck Reservoir which is surrounded by a protected lands which acts as a buffer from human inputs. The water temperature at this site was also observed to drop on multiple occasions throughout the summer (Harbor Watch data not shown). The drop is most likely tied to the release of colder water from the bottom of the reservoir. Bacteria tend to survive better in warmer temperatures so the low temperatures may have slowed or prevented growth of bacteria at site Saugatuck 6.

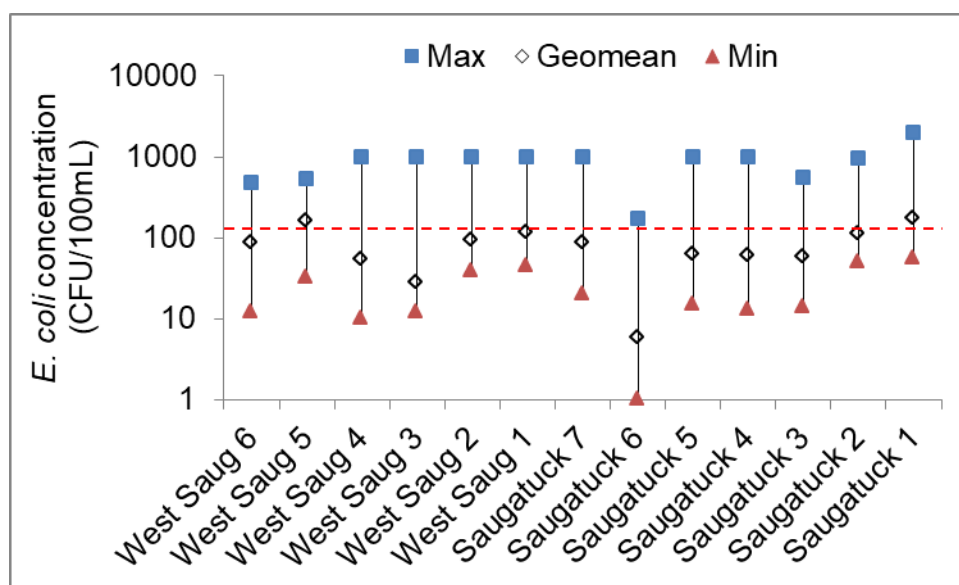


Figure Q3. Saugatuck River *E. coli* concentrations. Maximum, geomean, and minimum for each site. Dotted line represents the CT DEEP geomean maximum of 126 CFU/100 mL.

Table Q2. Saugatuck River *E. coli* concentrations and relation to CT DEEP water quality criteria (rainfall data: P. DiPietro, personal communication, October 11, 2017).

	5/4/2017	5/22/2017	6/5/2017	6/20/2017	6/29/2017	7/19/2017	8/8/2017	8/21/2017	8/30/2017	9/11/2017	Geomean	% > 576
West Saug 6	12	92	480	440	70	est. 12	172	n/a	n/a	n/a	86	0%
West Saug 5	32	66	148	530	280	64	460	270	n/a	n/a	157	0%
West Saug 4	47	49	122	>1000	est. 12	38	38	210	est. 10	est. 18	53	10%
West Saug 3	18	12	18	>1000	est. 24	est. 12	68	est. 14	est. 14	16	27	10%
West Saug 2	38	55	52	>1000	82	54	220	66	84	68	91	10%
West Saug 1	45	92	90	>1000	100	184	132	80	88	60	114	10%
Saugatuck 7	20	51	88	970	est. 60	52	184	104	n/a	39	84	11%
Saugatuck 6	4	1	2	est. 22	0	2	172	2	7	52	6	0%
Saugatuck 5	15	55	37	>1000	est. 24	est. 64	112	52	54	58	62	10%
Saugatuck 4	13	21	41	>1000	72	52	64	78	76	est. 28	58	10%
Saugatuck 3	14	34	35	550	est. 44	62	62	62	62	53	56	0%
Saugatuck 2	50	60	64	960	50	80	128	220	est. 120	96	109	10%
Saugatuck 1	58	144	112	1980	160	164	184	200	216	est. 56	171	10%
Rainfall	Dry	Wet	Wet	Wet	Wet	Dry	Wet	Dry	Wet	Dry		

Dissolved oxygen results

Mean dissolved oxygen levels met the CT DEEP minimum criterion of 5 mg/L at all sites (Figure Q5). Only site West Saug 5 had an individual reading below 5 mg/L. On 8/21 the dissolved oxygen reading was 4.29 mg/L. This low reading may be attributed to the reduction in flow and volume at the site. Towards the end of the monitoring season, West Saug 6 and West Saug 5 dried up.

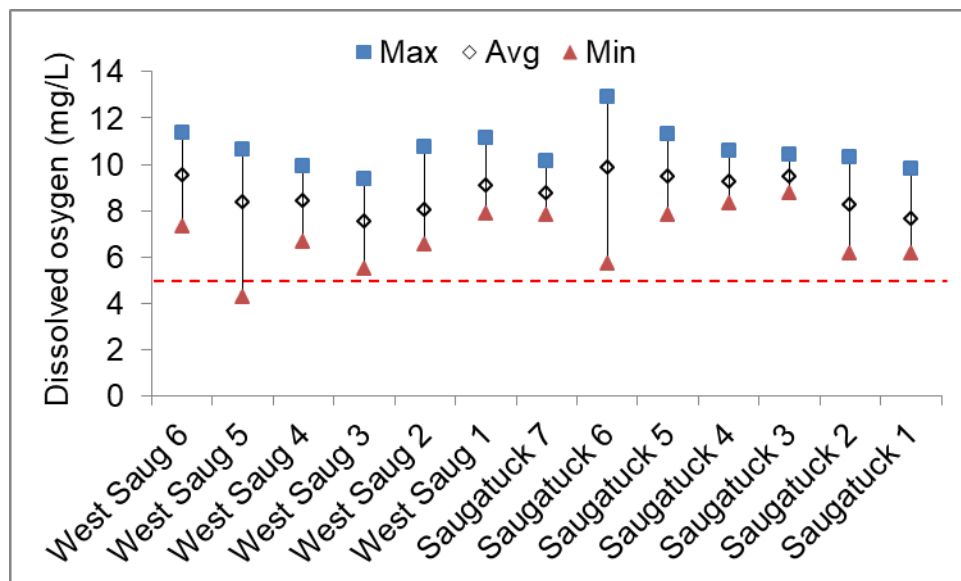


Figure Q4. Saugatuck River dissolved oxygen concentrations. Maximum, average, and minimum for each site. Dotted line represents the CT DEEP minimum of 5 mg/L.

Conductivity results

Conductivity ranges in the Saugatuck River remained narrow throughout the length of the river. A drop in mean conductivity values occurs between site Saugatuck 7 and Saugatuck 6 which may have been attributed to the Saugatuck Reservoir (Figure Q5). Again, the protected lands surrounding the reservoir may have acted as a buffer zone between the roads and the river.

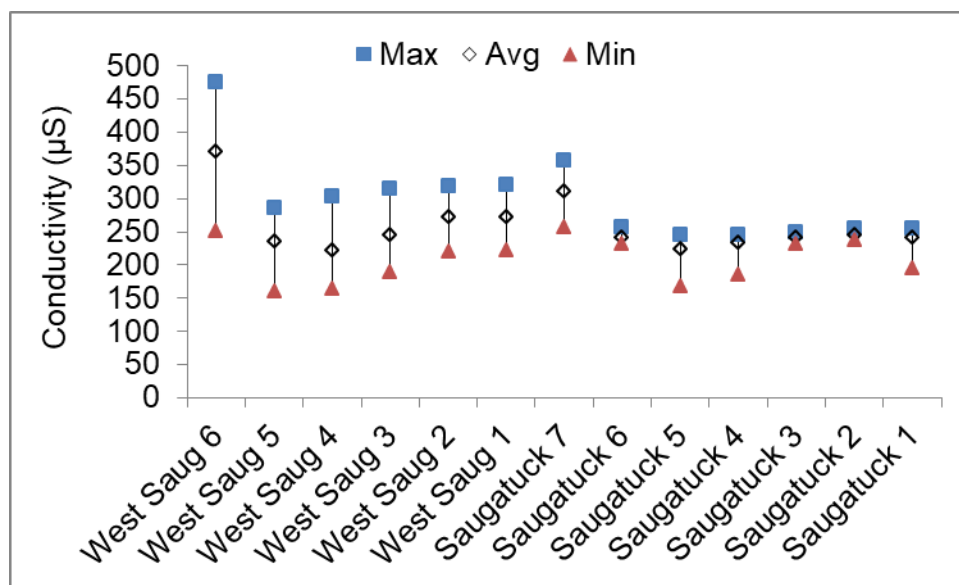


Figure Q5. Saugatuck River conductivity values. Maximum, average, and minimum for each site.

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