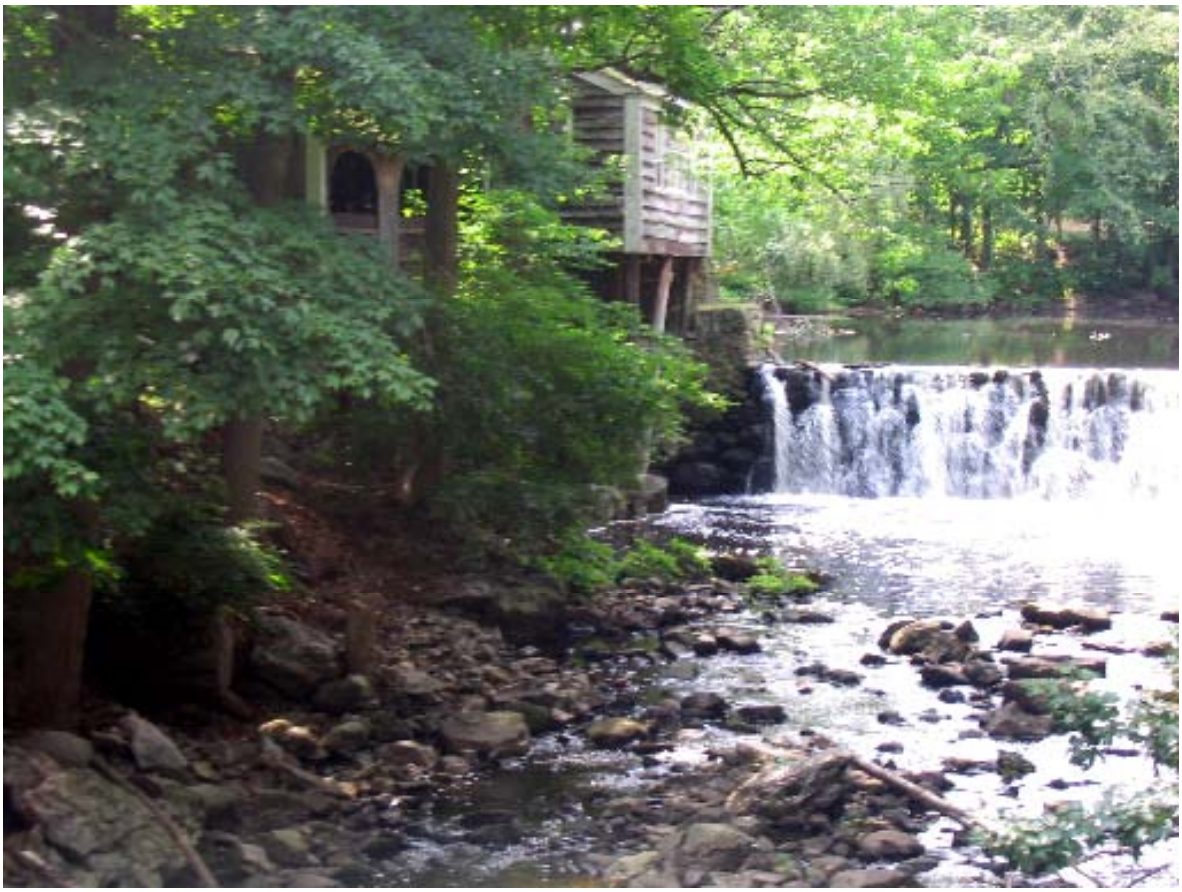
Water Quality Data Report
For
The Silvermine River and Lower Norwalk River
June 2009 through July 2009



Site SM6 at Silvermine Tavern Dam

Submitted by:

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Josh Cooper and Christine Wozniak, Norwalk Mayor's Water Quality Committee summer interns 2009

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Index of Figures and Tables

Figures:

Tables:

Acknowledgements

Harbor Watch/River Watch (HW/RW) wishes to thank the following departments and agencies for their help in the investigation of storm drain networks and rivers for pollution sources. Areas studied during the summer of 2009 included Five Mile River, Silvermine River and the lower end and part of the estuary of the Norwalk River. HW/RW had the use of two interns, Josh Cooper UCONN, 2009 and Christine Wozniak, a junior at Johns Hopkins University. Both students were supported by the Mayor's Water Quality Committee and the Norwalk Health Department

The Norwalk Public Works Department helped with the investigation of Moody's Lane and Keeler Brook's sewage pumping station. Mike Yeosock, Senior Civil Engineer, was particularly helpful in providing maps on drainage systems, background information, and provisions for safety when HW/RW had to work on busy streets. He was also very quick to follow up on possible leads provided by HW/RW. A case in point was the action taken on the pumping station at Keeler Brook where a failing system was discovered and repaired in one day.

The Norwalk Health Department for taking the time to survey areas where HW/RW felt that pollution problems existed after extensive testing turned up elevated bacteria counts. Tom Closter, Director of Environmental Services, was always available to walk the suspected sites and help HW/RW gain access to sites located on private property. The Norwalk Public Health laboratory has also been a great support in helping HW/RW do interlab work in cross checking samples to meet quality assurance requirements

Chris Malik of CT DEP has helped with background information on Five Mile River and Tony D'Andrea of the Harbor Management Commission has helped HW/RW with resources as needed to complete the summer's monitoring work. Support from the Norwalk Mayor's Water Quality Commission under Mike Harden and help from Norman Bloom and Son Oysters and Clams have all helped complete the work in a team effort. This work would not be successful or completed without the people and resources mentioned above.

Richard Harris
Director Harbor Watch/River Watch, a Program of Earthplace.

Water Quality Monitoring of the Silvermine and Norwalk Rivers and Assorted Storm Drain Discharges from June to August 2009.

Abstract:

Harbor Watch/River Watch (HW/RW), the volunteer water quality program of Earthplace, the Nature Discovery Center, has the overall mission of maintaining and improving the biological integrity of rivers and estuaries within Fairfield County. HW/RW works with the Norwalk Mayor's Water Quality Committee each summer to monitor the lower Silvermine and Norwalk rivers in an effort to 1) locate sources of indicator bacteria impairment from numerous storm drain discharges to both rivers; 2) protect the rivers from ill-advised management practices along the river banks; and 3) assess the bacteria concentrations entering the Norwalk, and Silvermine rivers from pollution sources upstream, and 4) assess nutrient concentrations as appropriate.

Dissolved oxygen (DO) levels, conductivity, temperatures, and water samples are taken weekly. Membrane filtration is performed for fecal coliform and *Escherichia coli* (*E. coli*) bacteria at the Earthplace laboratory. *E. coli* input profiles affected by various weather patterns and stream flow are extrapolated from the data to find sources in the waterways of elevated bacteria counts. The results of this survey showed the lower Silvermine and Norwalk rivers and numerous storm drain discharges to be moderately to heavily polluted with *E. coli* bacteria. Nutrient testing for total nitrogen (TN) and total phosphorus (TP) was also done at the major storm drain systems to gain additional insight on the concentrations of sewage infiltration to their networks.

Introduction:

One college level intern, Christine Wozniak, junior at Johns Hopkins University, and a college graduate Josh Cooper, (UCONN, Storrs 2009) were hired by the Norwalk Mayor's water quality committee. Both began monitoring water quality in late May and completed their work during August 2009. These interns worked with trained volunteers under the direction and oversight of the HW/RW program to investigate the health of the lower watershed of the Silvermine, Norwalk, and File Mile River[1]. The objective of the water monitoring research was to discover sources of the bacterial (*E. coli*) pollution from point and non-point sources.

Three Research Zones:

During the summer of 2009, the Norwalk/Silvermine workload was focused on three zones indicated as A, B, and C (Figure 1, Figure 2, Figure 3). The first of these zones, running from Borglum Road to the Silvermine Tavern at Perry Avenue, is referred to as Zone A. This section of the Silvermine River and Belden Hill Brook has been studied over 5 years to monitor the effect of a large hobby farm on water quality. The farm property is poorly located for housing farm animals on a property that is situated between the two water bodies. The Silvermine River and Belden Hill Brook form a confluence at the southern end of the property (Figure 4). Over the years, water quality has slowly improved as farm animals (including two llamas) have been relocated by the owner to other locations. Nevertheless, Belden Hill Brook water still does not meet CT DEP water quality criteria for *E. coli* bacteria. In fairness to the farm's owner, Belden Hill Brook water above the farm is now exceeding the CT DEP bacteria criterion for a Class B river. This new development is masking the actual input from the farm, and now points to additional bacteria sources upstream.

[1] A review of the Five Mile River is included in a separate HW/RW quality report. Preliminary report issued.

Figure 1 Map of Zone A Silvermine River from Borglum Road south to Perry Avenue Bridge showing monitoring sites on Belden Hill Brook and the Silvermine River

Figure 2 Map of Zone B Silvermine River from the Silvermine School to James Street showing monitoring sites on the Silvermine Brook and the Silvermine River

Figure 3 Map of Zone C with sampling site locations

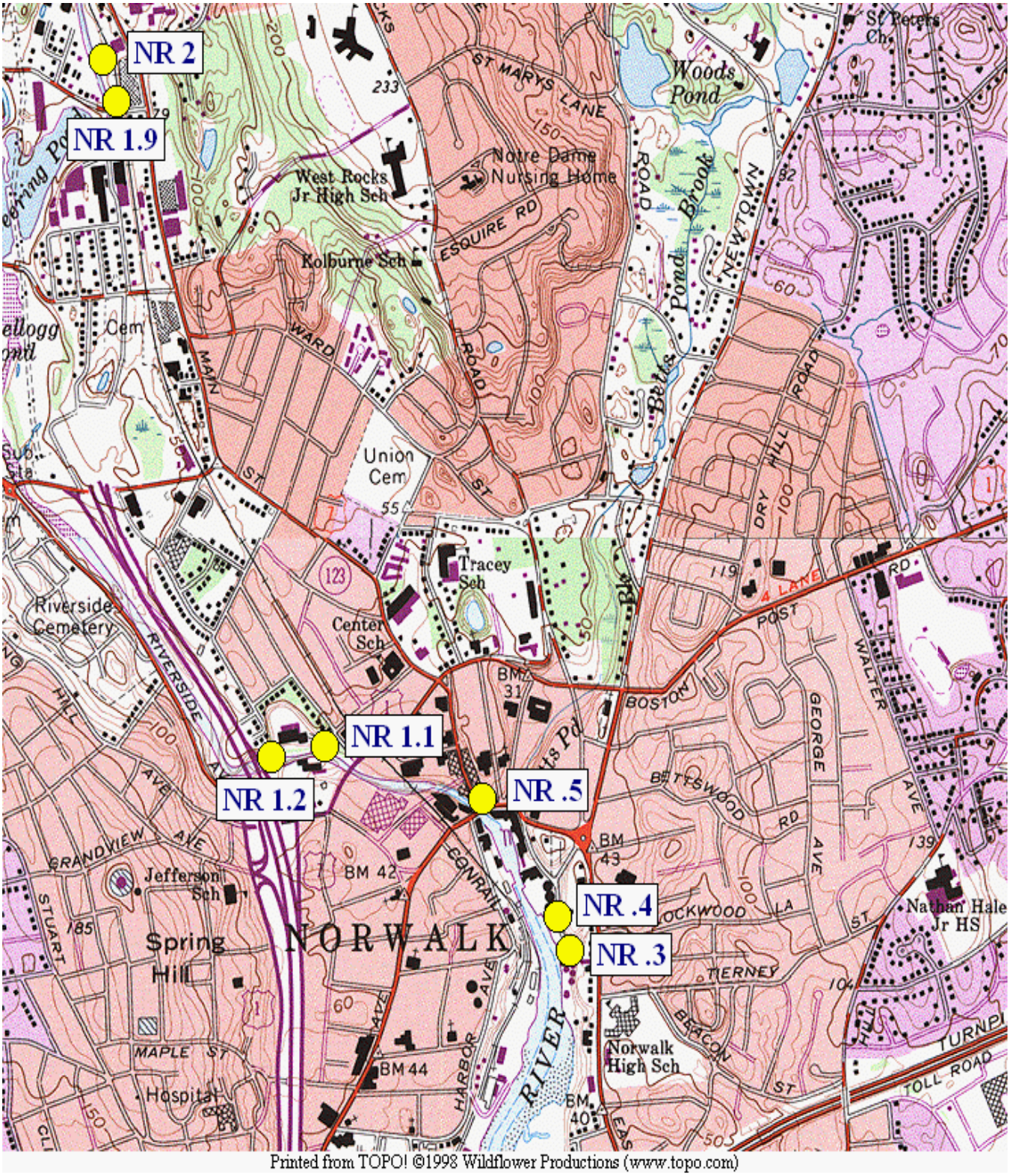
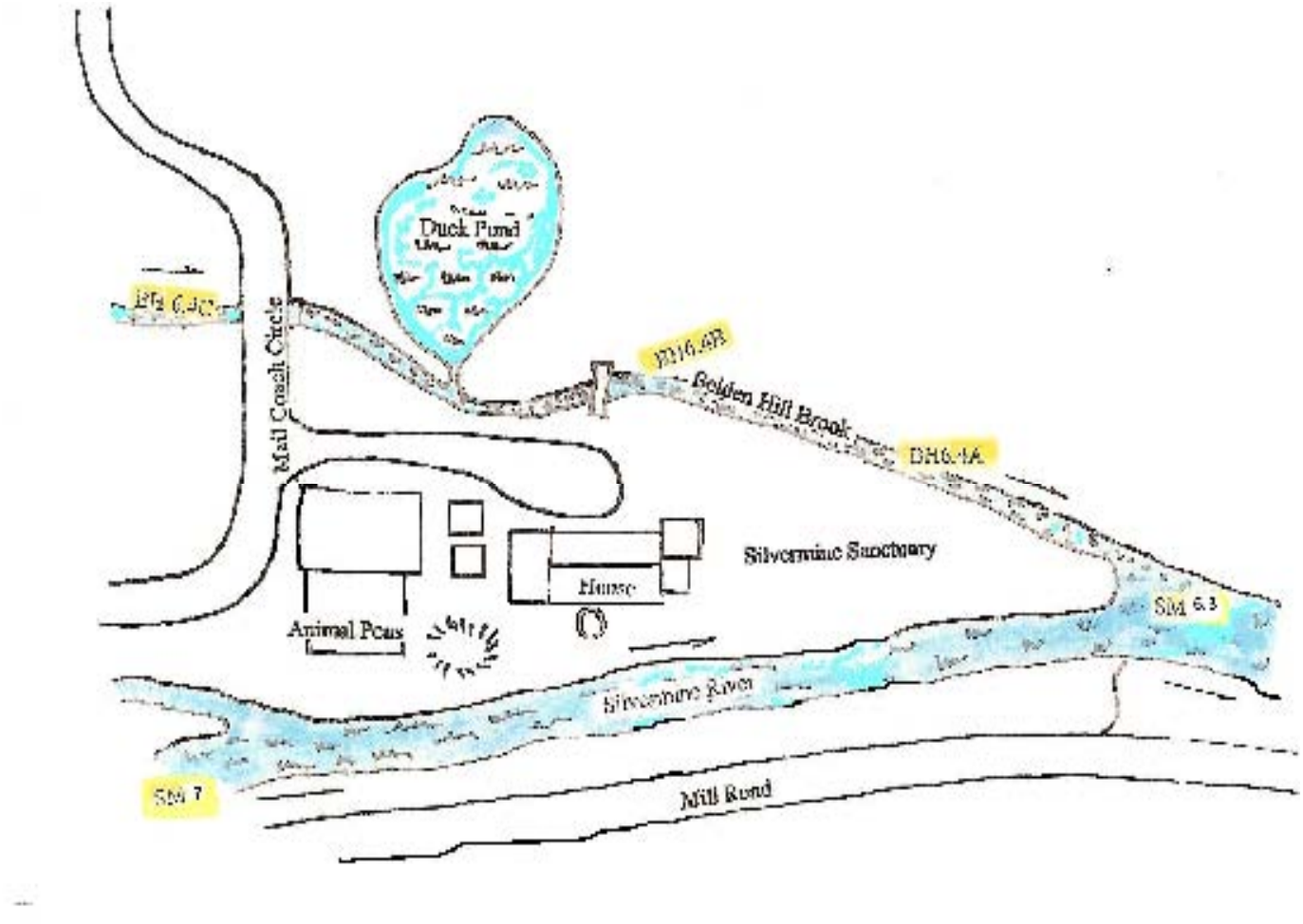


Figure 4 Map of Site locations on the Silvermine River and Belden Hill Brook around the Silvermine Sanctuary



Note: Monitoring Site BH6.4C has been relocated upstream to the Musket Ridge Road Bridge. The new Site is BH6.4D as seen on Figure 1.

An additional site (SM6.1) was established on a small tributary to the Silvermine River, which enters the main stream at the Silvermine Tavern (Figure 1). This stream has been found to carry elevated levels of *E. coli* during the summer of 2009.

Zone B is located in the lower portion of the Silvermine River from Perry Street south to Deering Pond (Figure 2). Zone B was first explored in detail by the 2008 Norwalk Mayors Water Quality Committee interns because of elevated *E. coli* bacteria counts found at Site SM3. The 2008 interns were aggressive in exploring this section of the river and new areas were opened up for monitoring including Silvermine Brook (Figure2). In addition, new sites were established in the slower moving ponds that characterize the Silvermine River in that section south of the Merritt Parkway Bridge downstream (south) to James Street (Figure 2). The owner of the house at 38 Silvermine Avenue allowed the 2008 interns to keep a canoe on his property, and the offer for site access was renewed in 2009. This is the only practical method for reaching the lower Silvermine River monitoring sites. As in 2008, both the lower Silvermine River and Silvermine Brook were found to be moderately polluted with *E. coli* bacteria. A major source of bacteria and nutrient input was confirmed at Site SM3.1 (Figure 2). Septic infiltration is suspected here and the source should be found and corrected.

Zone C is comprised of a series of large storm drains many of which carry continuously running streams (Figure 3). Continual elevated bacteria counts coming from these major discharges over the last few years make a study of this zone essential to determine the health of the river and upper estuary. Six major storm drains (2 to six feet in diameter) and a main river Site NR0.5 (the Wall Street Bridge)[2] were evaluated for this part of the study. The storm drain discharges and the main river Site NR0.5 were found to be moderately to heavily polluted. Monitoring was expanded to these sites to include nutrient analysis (TN, TP) to ascertain concentrations and volumes of nutrients entering the Norwalk River and estuary.

Methods and Procedures (Test Zones A, B, and C)

Protocol established in the HW/RW EPA approved Quality Assurance Project Plan (QAPP) for the Norwalk River explains the methods used for water quality monitoring. The interns leave Earthplace, located in Westport, CT, before 10AM and generally return in the early afternoon when testing the Silvermine River or storm drain discharges, on a daily basis. The testing of the Silvermine River centers on monitoring levels of *E.coli* and fecal coliform bacteria because of swimming and fishing safety issues (Table1).

Conductivity (QAPP Appendix 3.5) and Dissolved Oxygen (QAPP Appendix 3.1) were run *in situ* with meters. General observations, time, water temperature, and air temperature were recorded at each Site, with the information entered on a HW/RW Data Sheet (QAPP Appendix 5). Water samples were also taken at each site by inserting a sterilized bottle upside down and turning it underwater to prevent obtaining surface water or disturbing the river bottom (QAPP Appendix 1.1).

Membrane filtration tests for fecal coliform and *E.coli* bacteria are performed after returning to the state-certified lab located at Earthplace (QAPP Appendix 3.5). These tests are analyzed following Standard Methods, 21st edition (9222D, 9222G) and recorded in the HW/RW bacteria log (QAPP Appendix 5).

Both the Silvermine River and the storm drain systems were examined based on fecal coliform and *E.coli* CT DEP water quality bacteria criteria. Silvermine River, a CT DEP designated class B river, is supposed to fulfill certain coliform bacteria criteria: “as an indicator of general sanitary quality, fecal coliform bacteria shall not exceed a geometric mean of 200 colony forming units CFU/100 mLs in any group of samples, nor shall 10% of these samples exceed 400 CFU/100 mLs” (CT Surface Water Quality

[2] Site NR0.5 at the Wall Street Bridge is maintained to determine the seasonal bacteria concentrations entering the estuary under a variety of temperature and weather conditions.

Standards effective 4/8/98). More recently, the Silvermine River is expected to meet the "all other recreational use" *E. coli* criterion of the CT DEP for a Class B river (Table 1).

Table 1 CT DEP criteria for *E. coli* bacteria levels as applied to recreational use, effective 12/17/02

Designated Use	Class	Indicator	Criteria
Recreation Designated Swimming	AA, A, B	Escherichia coli	Geometric Mean less than 126/100 Single Sample Maximum 235/100
Non-designated Swimming	AA, A, B	Escherichia coli	Geometric Mean less than 126/100 Single Sample Maximum 410/100
All Other Recreational Uses	AA, A, B	Escherichia coli	Geometric Mean less than 126/100 Single Sample Maximum 576/100

The Silvermine River and Norwalk Rivers water quality are evaluated against the "all other recreational uses" bacteria geomean of <126 CFUs/100 mLs, and a single sample maximum (SSM) of 576 CFUs/100 mLs. All data in this report will be focused on *E.coli* bacteria. Fecal coliform units are listed in Tables B1, B2, and B3 if the reader has need for these data.

Nutrient analysis for TN and TP was accomplished on six major storm drain systems. HW/RW took the samples and York Analytical Laboratories, Inc., Stratford, CT, ran the tests. Total nitrogen analysis was performed under Standard Methods 4500N with a minimum detection limit (MDL) of 0.50 mg/L. Total phosphorus analysis was performed under EPA Method 365.3 with a MDL of 0.020 mg/L.

Section I

Introduction, Zone A:

Zone A extends from Borglum Road to the Perry Avenue Bridge (Figure 1). The area is fully developed along the river with mostly older homes. A new development of very large houses is on the west bank of the river just north of the Silvermine Tavern (Perry Avenue Bridge). While the river banks around the Borglum Road Site SM9 show adequate riparian buffer, evidence of poor property management exists along the river with yards mowed to the water's edge and a few homes located too close to the water (Photo Section A). All this has taken a toll on riparian buffers (Photo Section A). Some of the homeowners also have been overly aggressive with tree and riparian vegetation removal and the degraded river banks are showing signs of increased erosion. A major impact on the waterway has been a small farm built between the Silvermine River and Belden Hill Brook (Figure 4). Recent action by the owner to reduce the number of animals on the property (llamas, goats, etc.) under urging from the Town of Wilton has improved water quality for 2009 (Discussion, Zone A).

Site BH6.4C, Belden Hill Brook just above the farm on Mailcoach Road had to be abandoned because the owner of the farm (Silvermine Sanctuary) claimed the road was a private drive and HW/RW could no longer test there. The site was relocated upstream to a bridge on Musket Ridge Road and is identified as Site BH6.4D (Figure 1).

In fairness to the owners of Silvermine Sanctuary, recent tests of Belden Hill Brook now show increased impairment of the brook above (to the Northeast) of the property. It would appear that other sources of *E. coli* bacteria have developed, which mask bacterial input from the farm (Table 2). Another area of concern is the elevated bacteria counts observed at Site SM6 (Silvermine Tavern). First tested in 2008, it is now a routine monitoring site for Zone A (Table 2).

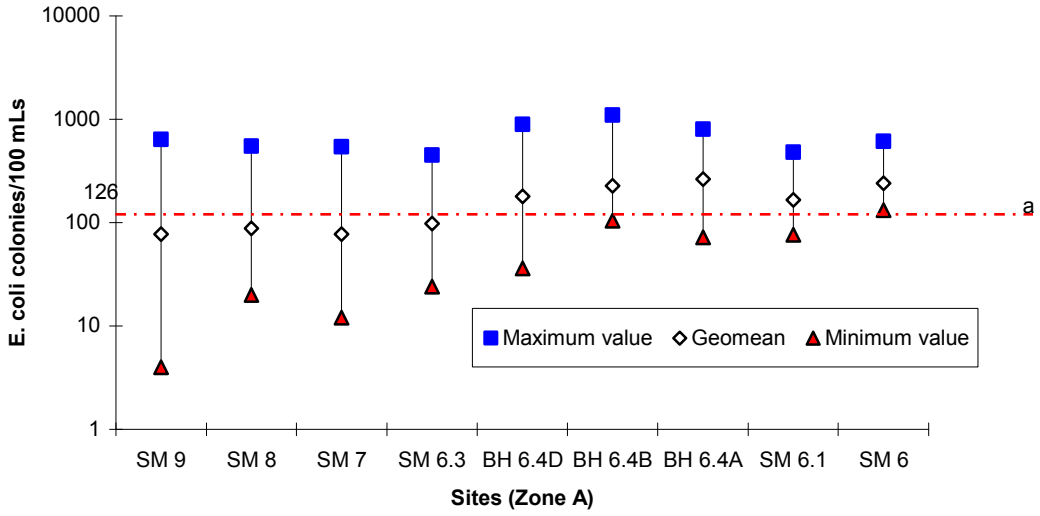
Table 2: *E. coli* bacteria concentrations, geometric means and % frequency exceeding 576 CFU/100 mLs at nine sampling sites in the Silvermine River, (Zone A) Watershed main branch (SM), Belden Hill Brook (BHB) from May through July 2009

Sites	5/27/09	6/3/09	6/15/09	7/1/09	7/22/09	**Geomean**	% Frequency Exceeding 576 CFU/100 mLs
SM9	24	4	530	84	640	**77**	20%
SM8	20	36	550	88	152	**88**	0%
SM7	12	44	540	96	100	**77**	0%
SM6.3	24	56	450	88	168	**98**	0%
SM6.1	76	104	480	216	248	**166**	0%
SM6	164	320	610	132	192	**241**	20%
BH6.4D	N/A	36	890	144	224	**179**	20%
BH6.4B	120	104	1100	160	272	**227**	20%
BH6.4A	128	72	800	380	480	**264**	20%
Rain (inches)	0.02	0.07	0.69	0.57	0.61		
Days Prior	1	0	0	0	1		

Results, Zone A:

Observed bacteria counts at Sites SM9, SM8, SM7, and SM6.3 on the Silvermine River meet the CT DEP geometric mean criterion for a Class B river, vis. "all other recreational uses" (Table 1) of <126 CFU/100mLs. Only Site SM9 fails to meet the CT DEP secondary, single sample maximum (SSM) criterion of having <10% of all samples taken exceed 576 CFUs/100 (Figure 1, Table 2, Figure 5). All the other monitoring sites, SM6 and the three Belden Hill Brook sites, BH6.4D, BH6.4B and BH6.4A exceed both the CT DEP geometric mean and the SSM criterion for a Class B river (Figure 1, Table 2, and Figure 5).

Figure 5 Maximum, geometric means, and minimum values of *E. coli* bacteria concentrations observed at monitoring sites in Zone A of the Silvermine River Watershed from May through July 2009



[a] CT DEP geometric mean maximum for a Class B river

Observed dissolved oxygen (DO) mean values and all individual DO concentrations meet the CT DEP criterion of 5 mg/L or greater for a Class B river (Figure 6).

Observed conductivity means on most of the Silvermine River and the small tributary at the Silvermine Tavern fall into a range of 247.4 to 251 µS (Table 3, Figure 7, and Table B1). The one exception noted is the small tributary at Site SM6.1 with a mean of 313.3 µS (Table 3, Figure 7). The conductivity means on Belden Hill Brook range from 229.7 to 231.4 µS. The key indicators of each site are shown in Table 3.

Table 3 Observed conductivity (µS) maximum, means, minimum and site ranges at nine sites on the Silvermine River and Belden Hill Brook, Zone A

	SM9	SM8	SM7	SM6.3	SM6.1[a]	SM6	BH6.4C	BH6.4B	BH6.4A
Max. value	267.1	268.7	269.0	265.7	331.0	261.9	246.0	246.2	245.9
Min. value	231.6	231.1	232.2	232.1	263.4	219.4	191.1	185.8	186.0
Site Range	35.5	37.4	36.8	33.6	67.6	42.5	55.0	60.4	68.9
Mean	251.3	250.5	250.6	248.2	313.3	247.4	231.4	229.8	229.7

a Site SM6.1 is a small tributary entering the Silvermine River near the Silvermine Tavern

Discussion, Zone A:

Rainfall on Zone A was heavy on 6/15, 7/1 and 7/22, with rainfall occurring on or near the monitoring day (Table 2). On 7/1, the impact from the rain was heaviest on Belden Hill Brook and Site SM6.1 and SM6.0 of the Silvermine River. Rainfall appears to be more uniform on 6/15 and 7/22, because the bacteria counts increased at all monitoring sites (Table 2). Although the Silvermine Sanctuary farm shows an increase in *E. coli* bacteria counts at Sites BH6.4B and BH6.4A, brook water arriving at the upstream (western) boundary of the farm already exceeds the CT DEP *E. coli* criterion for a Class B river (Table 2). It is therefore difficult to assess the impact of the farm independently. Nevertheless, the total *E. coli* counts at Sites BH6.4B and BH6.4A are considerably lower than what has been observed in previous years (Table 2). Domestic and wild aquatic birds presently using the duck pond (Figure 4) are a probable cause of the elevated *E. coli* counts at Sites BH6.4B and BHC.4A. Site SM6.3 on the Silvermine River presently meets the CT DEP *E. coli* criterion and indicates that pollution from the farm into the Silvermine River is being reduced (Figure 4 and Table 2).

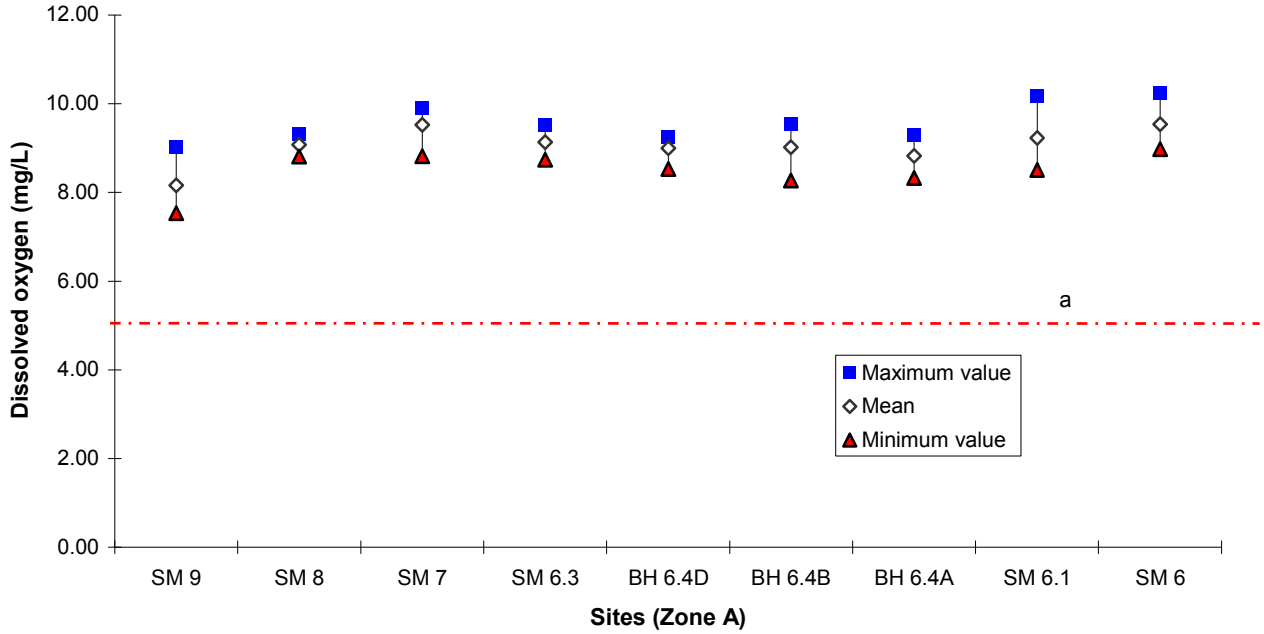
The increased bacteria counts from Belden Hill Brook however, are partially responsible for the increased counts observed at Site SM6 (Figure 2). The elevated *E. coli* counts on the small tributary (Site SM6.1) are also part of the bacteria counts observed at site SM 6, and are still under investigation by HW/RW.

Observed DO means and daily concentrations of DO observed at each monitoring site all meet the CT DEP DO criteria for a Class B river of 5 mg/l or greater (Figure 6 and Table B1).

Observed conductivity means on the Silvermine River and Belden Hill Brook are uniform and show little deviation under a variety of weather conditions (Figure 7). The range in values at individual sites on the Silvermine River is also fairly constant with a span of 33.6 to 42.5 µS (Table 3). The range in Belden Hill Brook is somewhat larger at 55.0 to 68.9 µS (Table 3). Results indicate that the Silvermine River is somewhat more resilient to changes in ionic strength. This may be due to a lesser impact from storm water runoff (Figure 7).

The anomaly in conductivity is found at Site 6.1 (a tributary) with a mean of 313.3 and a range of 67.6 µS (Table 3). Reasons for the high values are unknown at this time.

Figure 6 Maximum, mean and minimum values for dissolved oxygen at monitoring sites in Zone A of the Silvermine River Watershed from May through July 2009



[a]CT DEP minimum DO criterion for a Class B river

Figure 7 Maximum, mean and minimum values for conductivity at monitoring sites in Zone A of the Silvermine River Watershed from May through July 2009

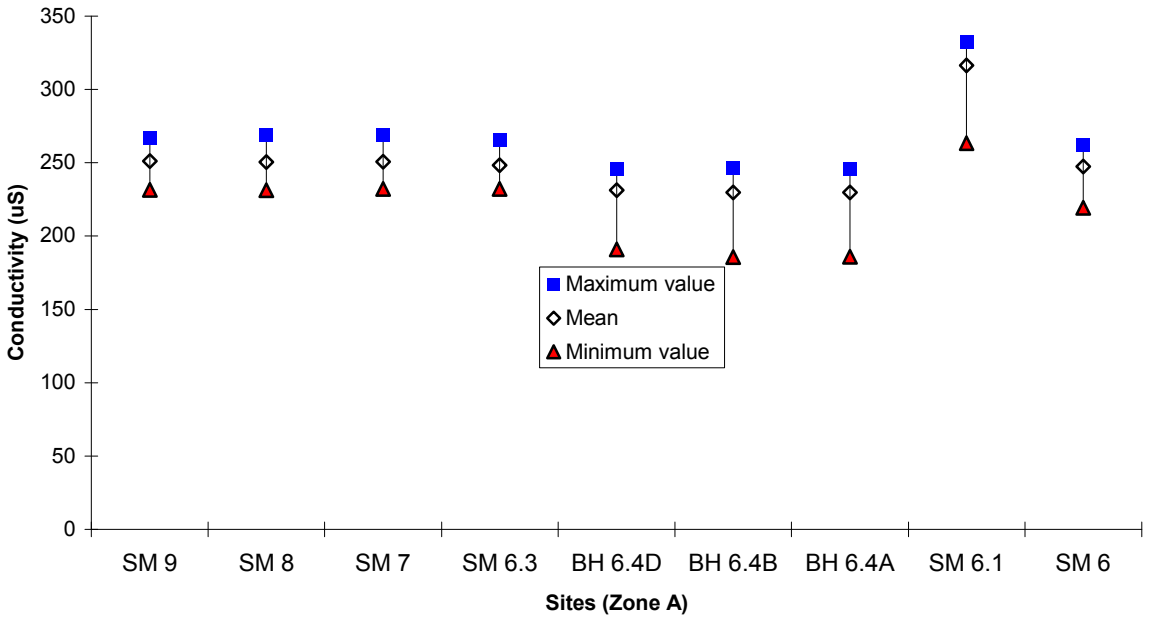


Table B1 Date, time, air & water temperature, dissolved oxygen, conductivity, fecal coliform bacteria, *E. coli* bacteria, rainfall, number of days prior to sampling, and QA/QC activity for monitoring events in the Silvermine River Watershed (Zone A), May through July 2009

Station	Date	Time	Air Temp. deg C	Water Temp. (DO) °C	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFUs/100 mLs	E. coli CFUs/100 mLs	Amount of rain (inches)	Days prior to sampling	QA/QC	Fecal Coliform. CFUs/100 mLs
SM 9	5/27/2009	10:16	14.0	15.6	7.53	267.1	24	24	0.02	1		
SM 8	5/27/2009	10:20	12.5	15.6	8.98	268.7	36	20	0.02	1	Duplicate	4
SM 7	5/27/2009	10:50	13.0	15.5	9.60	269.0	20	12	0.02	1		
SM 6.3	5/27/2009	10:59	14.0	15.3	9.13	265.7	24	24	0.02	1		
BH 6.4D	5/27/2009	11:12	14.5	13.4	9.25	246.0	N/A	N/A	0.02	1		
BH 6.4B	5/27/2009	11:27	14.0	13.4	9.55	246.2	168	120	0.02	1	Field Blank	0
BH 6.4A	5/27/2009	11:31	14.0	13.4	9.00	245.9	136	128	0.02	1		
SM 6.1	5/27/2009	14:44	16.0	15.0	10.18	330.9	140	76	0.02	1		
SM 6	5/27/2009	14:57	15.0	15.3	10.24	261.9	216	164	0.02	1		
SM 9	6/3/2009	10:24	24.0	17.2	7.61	258.4	4	4	0.07	0	Duplicate	24
SM 8	6/3/2009	10:34	26.0	16.9	8.96	256.9	20	36	0.07	0		
SM 7	6/3/2009	10:43	22.5	16.9	9.71	256.8	48	44	0.07	0		
SM 6.3	6/3/2009	10:51	24.0	17.4	8.80	250.9	64	56	0.07	0	Replicate	64
BH 6.4D	6/3/2009	11:11	22.0	16.9	9.01	242.9	20	36	0.07	0		
BH 6.4B	6/3/2009	11:21	23.0	16.2	8.88	241.9	108	104	0.07	0	Field Blank	0
BH 6.4A	6/3/2009	11:26	24.0	16.2	8.80	241.9	124	72	0.07	0		
SM 6.1	6/3/2009	10:58	25.0	16.6	9.45	329.2	104	104	0.07	0		
SM 6	6/3/2009	11:03	23.0	17.2	9.30	261.5	232	320	0.07	0		
SM 9	6/15/2009	1000	19.0	17.7	9.03	235.8	570	530	0.69	0		
SM 8	6/15/2009	1012	17.0	17.7	9.30	233.3	610	550	0.69	0	Field Blank	0
SM 7	6/15/2009	1020	17.0	17.7	9.57	234.0	570	540	0.69	0		
SM 6.3	6/15/2009	1030	17.0	17.7	9.47	234.0	500	450	0.69	0		
BH 6.4D	6/15/2009	1104	19.0	18.3	8.94	191.0	1060	890	0.69	0		
BH 6.4B	6/15/2009	1114	17.5	18.3	9.22	185.8	1600	1100	0.69	0	Duplicate	1070
BH 6.4A	6/15/2009	1120	18.0	18.3	9.29	186.0	1100	800	0.69	0		
SM 6.1	6/15/2009	1037	18.0	16.6	9.63	263.4	640	480	0.69	0		
SM 6	6/15/2009	1043	18.0	17.9	9.64	219.4	750	610	0.69	0		
SM 9	7/1/2009	1017	24.5	20.7	8.44	231.6	88	84	0.57	0		
SM 8	7/1/2009	1037	23.5	20.7	8.81	231.3	100	88	0.57	0		
SM 7	7/1/2009	1048	23.0	20.8	8.82	232.2	100	96	0.57	0	Duplicate	92
SM 6.3	7/1/2009	1104	23.0	20.8	8.74	232.1	96	88	0.57	0	Field Blank	0
BH 6.4D	7/1/2009	1140	23.0	20.3	8.53	237.7	144	144	0.57	0		
BH 6.4B	7/1/2009	1151	23.5	19.9	8.27	234.1	220	160	0.57	0		
BH 6.4A	7/1/2009	1159	23.0	19.8	8.33	234.2	480	380	0.57	0		
SM 6.1	7/1/2009	1112	26.0	19.8	8.51	311.8	248	216	0.57	0		
SM 6	7/1/2009	1125	23.0	21.0	8.98	234.0	140	132	0.57	0	Replicate	160
SM 9	7/22/2009	1229	30.0	19.9	8.19	263.4	600	640	0.61	1		
SM 8	7/22/2009	1237	28.0	20.5	9.32	262.1	144	152	0.61	1		
SM 7	7/22/2009	1243	27.0	20.6	9.91	261.2	96	100	0.61	1	Replicate	108
SM 6.3	7/22/2009	1252	26.0	20.4	9.53	258.5	176	168	0.61	1	Field Blank	0
BH 6.4D	7/22/2009	1314	26.0	20.1	9.26	239.3	236	224	0.61	1	Duplicate	236
BH 6.4B	7/22/2009	1325	26.0	19.8	9.18	241.0	284	272	0.61	1		
BH 6.4A	7/22/2009	1328		19.9	8.72	240.7	380	460	0.61	1		
SM 6.1	7/22/2009	1259	27.0	20.3	9.01	331.0	296	248	0.61	1		
SM 6	7/22/2009	1305	24.0	20.3	9.52	260.0	192	192	0.61	1		

Table C1 Site numbers, descriptions and GPS Coordinates of Silvermine River in Zone A

Site No.	Site Description	GPS Coordinates
SM9	Borglum Road Bridge	Latitude: N 41º 09' 34.7" Longitude: W 073º 27' 09.5"
SM8	Silvermine Ave. Next to Red Barn	Latitude: N 41º 09' 24.2" Longitude: W 073º 26' 59.0"
SM7	Silvermine Ave.	Latitude: N 41º 09' 14.2" Longitude: W 073º 26 ' 55.2"
BH6.4D	Musket Ridge Road Bridge	Latitude: N 41º 09' 28" Longitude: W 073º 26' 55.2"
BH6.4B	11 Mail Coach Drive downstream from Silvermine Sanctuary, upstream of BH6.4A	Latitude: N 41º 09' 12.7" Longitude: W 073º 26' 51.4"
BH6.4A	11 Mail Coach Drive Down stream from Silvermine Sanctuary	Latitude: N 41º 09' 11.9" Longitude: W 073º 26' 52.1"
SM6.3	Confluence of Belden Hill Brook and the Silvermine River	Latitude: N 41º 09' 10.8" Longitude: W 073º 26' 51.6"
SM6.1	Side Stream Next to the Silvermine Tavern	Latitude: N 41º 09' 03.9" Longitude: W 073º 26' 49.1"
SM6	Perry Avenue Bridge	Latitude: N 41º 09' 05.0" Longitude: W 073º 26' 44.4"

Section II

Introduction, Zone B:

The lower end of Silvermine River widens into a series of ponds and backwaters as the waterway approaches its confluence with the Norwalk River in Deering Pond (Figure 2). Stream flow is reduced as the river enters the ponds and the water deepens. This condition results in the deposition of fine silt from land erosion upstream (up to several feet in some of the slow moving areas) and the loss of hard river bottom in many places. This area of the river is best explored by canoe as was done again the summer of 2009. There is little change in pollution input since the summer of 2008.

The lower Silvermine River from the Perry Street Bridge south to Site SM3 at James Street (Figure 2) undergoes much change from Zone A. Poor property management is visible at almost every turn in the river. The most striking form of neglect is the mowing of numerous lawns to the water's edge. This has resulted in massive undercutting and erosion of stream banks (Photo Section B). Many old trees first get their roots exposed and then will topple into the river. Good evidence of this can be seen behind the Silvermine School. In this instance, the Norwalk River Watershed Initiative tried to stabilize the banks with "J hooks" or large stone emplacements to deflect the water away from the west bank. A very large storm on April 15, 2007 accomplished just the opposite, J hooks were overridden, the west bank was severely eroded with the loss of more trees and the river bed has now shifted 20 feet to the west Photo Section B). No effort has been made since to repair the damage short of the removal of fallen trees by the City of Norwalk. Another good example of stream bank erosion is found at HW/RW monitoring site SM4 (Figure 2). Trees continue to fall here as the river undercuts the banks (Photo Section B).

Another issue is the disposal of yard waste. The interns found many instances of leaves, grass clippings, and brush piled on the river bank or thrown carelessly into the water. This was especially true in the previously unexplored shoreline around the ponds comprising the lower river.

Three storm drain systems discharging to the Norwalk River in Zone B were evaluated to determine the volume of indicator bacteria in the input. Two drainage systems SM4.1 and SM3.5 showed moderate pollution levels (Figure 2, Table 4, and Figure 8). Site SM3.1 was monitored more frequently because of elevated levels of *E. coli* bacteria in the discharge to the Silvermine River (Figure 2, Figure 8, and Table 6).

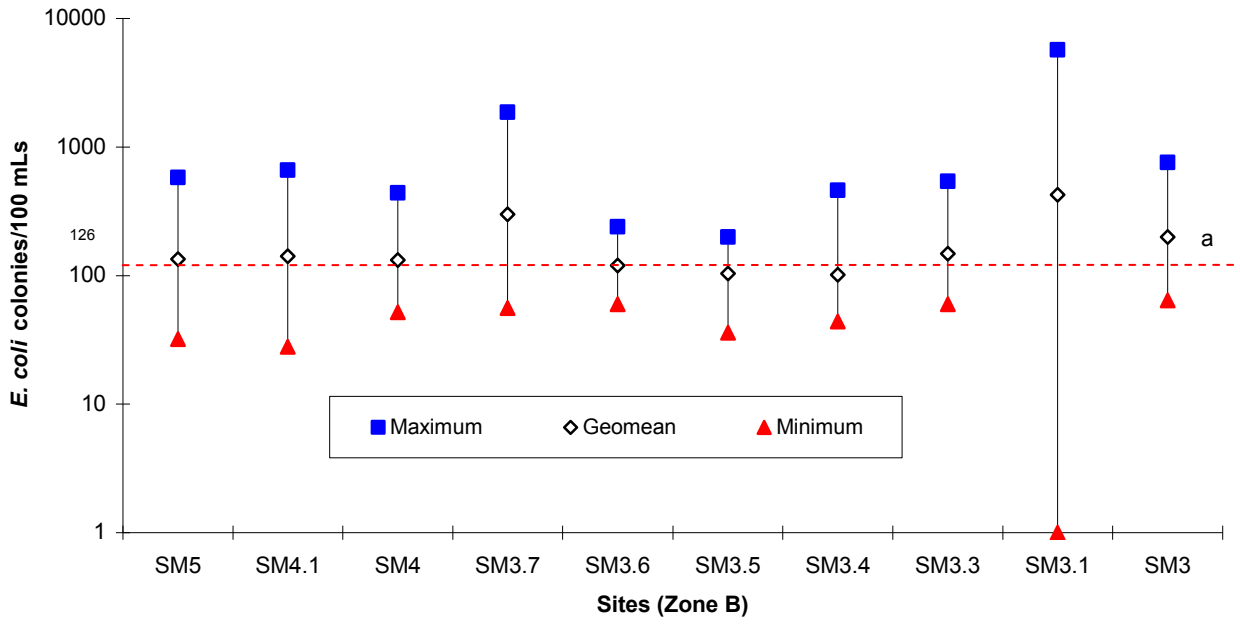
Exploration stopped at James Street, Site SM3 for the summer of 2009. During summer 2010 HW/RW will continue to investigate the Silvermine River south to Deering Pond and the river's confluence with the Norwalk River.

Results, Zone B (Lower Silvermine River):

Monitoring Sites SM3.6, SM3.5 and SM3.4 of Zone B in the lower Silvermine River (Figure 2, Figure 8, and Table 4) meet the CT DEP criterion for the *E. coli* geometric mean of <126 CFU/100 mLs (Table 4). Of these monitoring sites only Site SM3.6 meets the single sample maximum criterion (SSM) of <576 CFUs/100 mLs (Table 4).

The other seven sites exceed the geometric mean and five of these also exceed the SSM value of <10% of all samples taken at Sites SM5, SM3.5, SM3.4, SM3.3, SM3.1, and SM3 (Table 1, Table 4, and Figure 8).

Figure 8 Maximum, geometric means, and minimum values of *E. coli* bacteria concentrations at monitoring sites in Zone B of the Silvermine River Watershed from June through July 2009



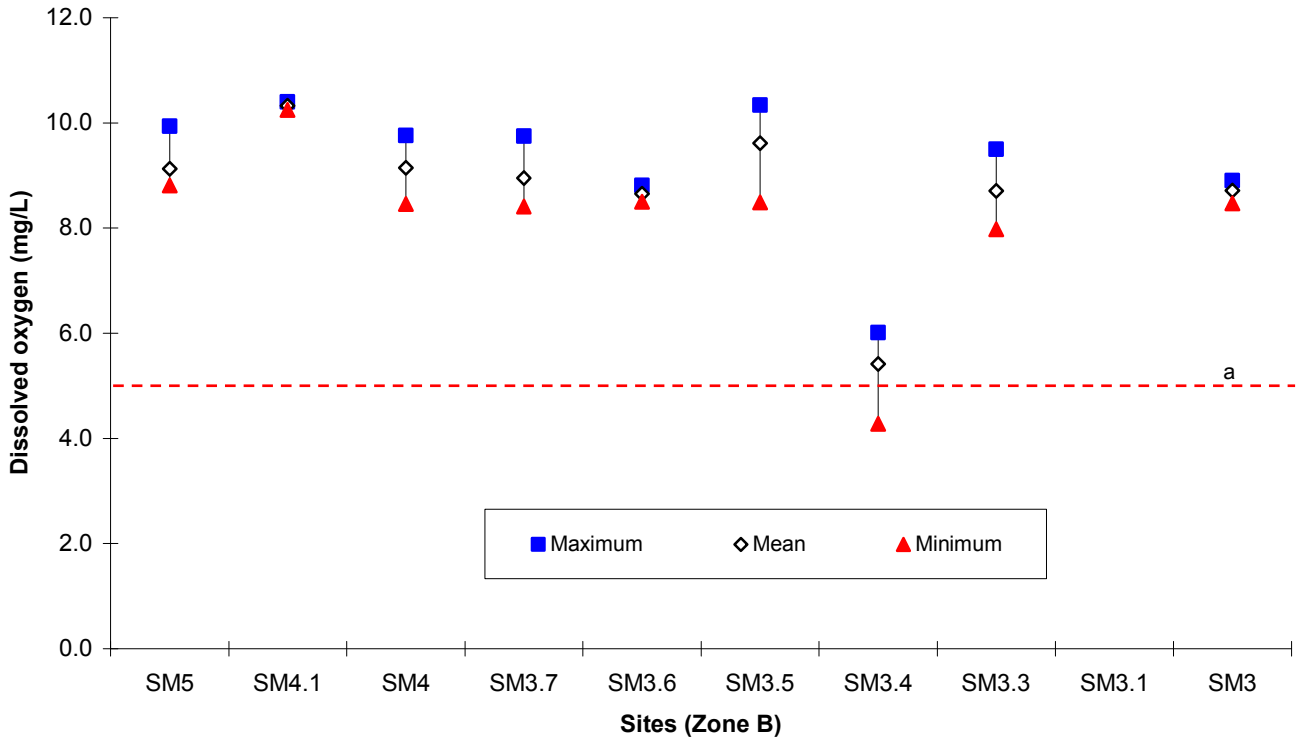
[a] CT DEP geometric mean maximum for a Class B river

Table 4 *E. coli* bacteria concentrations geometric means and % frequency exceeding 576 CFU/100 mLs at nine sampling sites in the lower Silvermine River watershed from June through July 2009

Sites	6/12/09	6/23/09	7/7/09	7/24/09	**Geomean**	% Freq. exceeding 576CFU/100mLs
SM5	580	84	32	208	**134**	20%
SM4.1	660	152	28	-	**141**	-0-%
SM4	440	56	52	240	**132**	-0-%
SM3.7	1860	-	56	260	**300**	-0-%
SM3.6	-	-	60	240	**120**	-0-%
SM3.5	156	-	36	200	**104**	20%
SM3.4	460	-	41	52	**102**	20%
SM3.3	560	-	100	60	**148**	20%
SM3.1	-	560	2000	5700	**1855**	50%
SM3	-	64	164	760	**200**	20%
Rain (inches)	0.18	0.59	0.69	1.21		
Days prior	2	0	0	0		

All ten dissolved oxygen (DO) means meet the CT DEP criterion for DO of 5mg/L or greater for a Class B river (Figure 9). A single DO value of 4.3 mg/L was observed at Site SM3.4 on 6/12 (Figure 9).

Figure 9 Maximum, mean and minimum values for dissolved oxygen at monitoring sites in Zone B of the Silvermine River Watershed from June through July 2009



[a]CT DEP minimum DO criterion for a Class B river

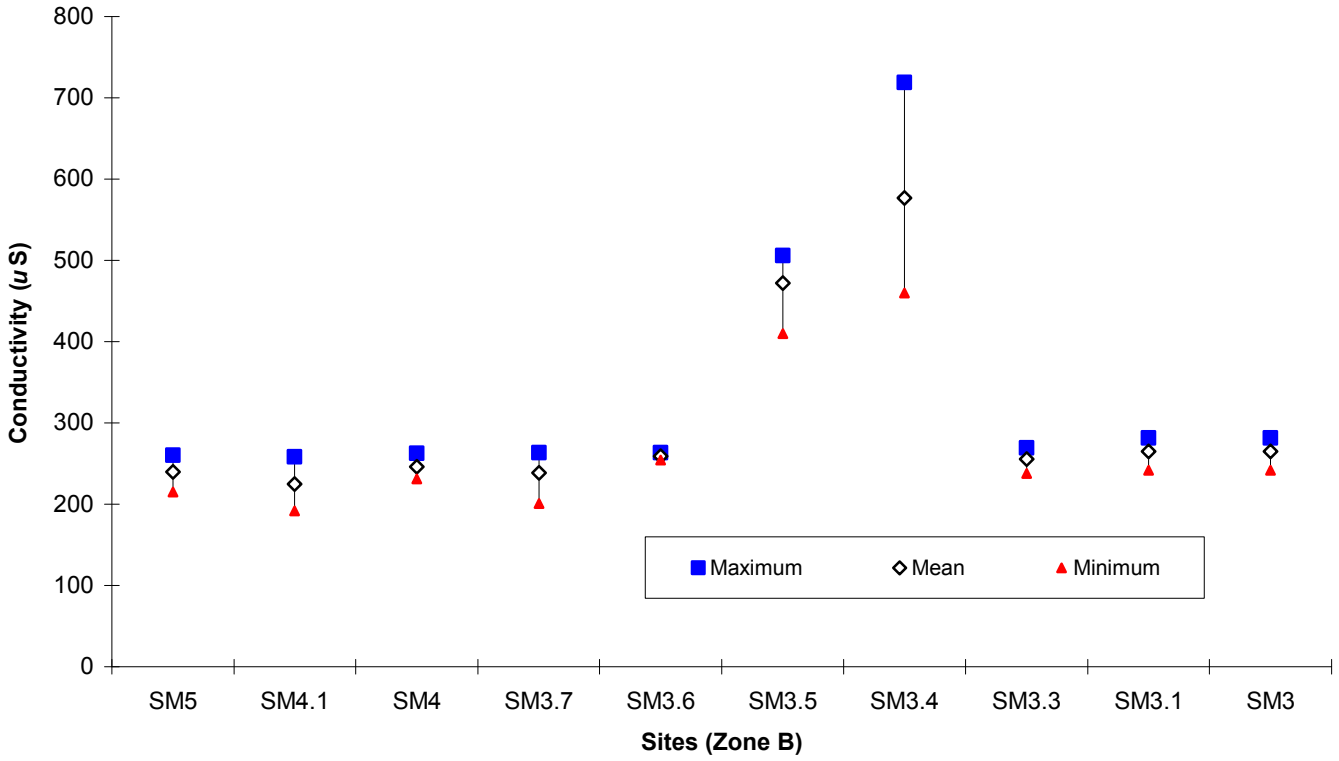
Observed conductivity means range from 225 µS at Site SM4.1 to 577 µS at Site SM3.4 (Figure 10, Table 5, and Table B2). Site SM3.5 and SM3.4 show elevated conductivity means at 472 µS and 577 µS respectively (Figure 10, Table 5, Table B2).

Table 5 Observed Conductivity (µS) maximum, mean, minimum values, and ranges for ten sampling sites in Zone B of the lower Silvermine River

	SM5	SM4	SM4.1[a]	SM3.7	SM3.6	SM3.5[a]	SM3.4[b]	SM3.3	SM3.1[a]
Maximum value	260	263	258	263	264	506	719	269	342
Minimum value	215	231	192	242	255	410	460	238	271
Range	45	77	66	87	9	96	259	31	71
Mean	**239**	**246**	**225**	**252**	**259**	**472**	**577**	**255**	**298**

[a]storm drain discharge pipe
[b]outlet for pond next to DSS building

Figure 10 Maximum, geomean and minimum value for conductivity at monitoring sites in Zone B of the Silvermine River Watershed from June through July 2009



Of special interest is a continuously running storm drain designated as site SM3.1. The discharge is located 50 feet north of site SM3 on the west bank of the Silvermine River. This discharge pipe is very old and no records of its direction and length are available at the Norwalk Public Works Department.

Table 6 *E. coli* bacteria concentrations, geometric means, and SSM % frequency exceeding 576 colonies/100 mLs at site SM3.1 from May through July 2009

	5/27/09	6/4/09	6/18/09	6/23/09	6/25/09	7/7/09	7/24/09	7/30/09	**Geomean**	%frequeny exceeding 576 CFUs/100 mLs
CFUs/100 mLs	1000	800	1200	560	160	2000	5700	2200	**426**[a]	67
Rain (inches)	0	0.92	4.25	0.59	0.78	0.69	1.21	0.29		
Days prior to sampling	7	0	0	0	0	0	0	4		

[a]Geomean is less than the 1855 CFUs/100 mLs shown in Table 4 because eight data points are used in this geomean calculation.

Results, Zone B (Silvermine Brook):

Silvermine Brook was monitored twice during the summer months of 2009; once at the end of a wet period (6/22) and once at the end of a dry period (8/19) (Table 7, and Table B2).

Table 7 *E. coli* bacteria counts (CFU/100mLs) observed at Silvermine Brook during a wet and dry period

Date	SMB3	SMB4	SMB5	SMB7	SMB8	Rain (inches)	Days prior
6/22/09	170	170	170	180	60	4.55	1
8/19/09	88	96	28	56	56	-0-	7

All observed DO values on all sites met the CT DEP criterion of 5 mg/L or greater (Table B2-Silvermine Brook).

All observed conductivity values were elevated in relation to those found in the Silvermine River (Table 8).

Table 8 Conductivity values (µS) observed in Silvermine Brook on 6/22 and 8/19

Date	Unit	SMB3	SMB4	SMB5	SMB7	SMB8	Rain inches	Days prior
6/22/09	µS	333	334	314	336	336	4.55	1
8/19/09	µS	403	404	331	409	406	-0-	7

Discussion, Zone B:

Rainfall for the monitoring period of June, July and August totaled 15.8 inches. June was a very wet (record) month at 8.71 inches followed by July at 3.08 inches and August at 4.01 inches. Greater than half the available rainfall for the test period occurred in June, which led to a drier period in July and August (Table 9). Although the rain through August stands at 28.32 YTD, the first quarter was extremely dry, and it took the month of June to partially catch up with a normal year, *i.e*. 4.5 inches per month (Table 9)[3].

Table 9 Rainfall for the months of January through August 2009

Month	January	February	March	April	May	June	July	August
Rainfall (Inches)	2.23	0.75	2.06	3.47	3.95	8.71	3.08	4.01

Three of the monitored sites in zone B (SM4.1, SM3.5, and SM3.1), exceeding the CT DEP criterion for *E. coli* bacteria, are storm drain discharge pipes (Table 4 and Figure 8). These three sites were chosen because of elevated bacteria counts observed during the summer of 2008. Two of these sites, SM4.1 and SM3.5 show a moderate degree of pollution (Table 4, Figure 8). The third Site, SM3.1, has observed periods of elevated bacteria counts and has been turned over to Norwalk's Health Department for follow-up (Table 4, Table 6). No site plans or drawings exist for this outlet. The pipe appears to be very old.

Another site off the main river is Site 3.4, which is the outlet to a pond at the Department of Social Services (DSS) building (Figure 2). This pond, while showing little in the way of bacteria counts, has an observed spike in the conductivity mean; *i.e*. 577 µS (Table 5, Figure 10). The source of the pond's elevated conductivity mean is unknown.

[3] All rainfall data was supplied by Norwalk Health Department

Silvermine Brook, in Zone B (Figure 2), was monitored twice during the summer of 2009; once at the end of a very wet period and again at the end of a dry period to determine water quality during two extremes (Table 7). Although the *E. coli* counts were slightly elevated during the wet period, they met the CT DEP criterion for the *E. coli* during the dry period (Table 7).

All observed DO means and most of the individual DO values met the CT DEP criterion of 5mg/L. The only exception was a value of 4.8 mg/L observed at Site SM 3.4 on the outlet of a pond located on the DSS property (Figure 2, Figure 9, Table B2). This could be due to standing water in the pond.

Conclusion:

The lower end of the Silvermine River (Zone B) is moderately polluted with the hot spots indicated. Site SM3.1 needs to be investigated as to its origin and connections are unknown (Table 6).

The largest problem in Zone B is abuse of land in its watershed and especially at the water front properties. This is always the most difficult aspect to deal with because the owners, for the most part are oblivious or unwilling to change their behavior. Mowing land to the water's edge, discarding leaves and yard waste into the river, the overuse of fertilizers, feeding geese, and lack of septic system maintenance all contribute to impaired water quality.

Weather conditions were favorable to the Silvermine River during the summer of 2009 and water quality slightly improved in comparison to 2008.

Table B2 Date, time, air & water temperatures, dissolved oxygen, conductivity, fecal coliform bacteria, *E. coli* bacteria, rainfall, number of days prior to sampling, and QA/QC activity for monitoring events in the Silvermine River Watershed (Zone B), May through July 2009 and Silvermine Brook on 6/22 and 8/19/09

Station	Date	Time	Air Temp. deg C	Water Temp. (DO) ºC	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFUs/100 mLs	E. coli CFUs/100 mLs	Amount of rain (inches)	Days prior to sampling	QA/QC	Fecal Coliform. CFUs/100 mLs
SM5	6/12/2009	1049	19.0	17.2	9.9	236	680	580	1.04	3		
SM4.1	6/12/2009	1104	20.0	14.6	10.4	258	800	660	1.04	3		
SM4	6/12/2009	1059	19.0	17.1	9.8	237	580	440	1.04	3	Field Blank	0
SM3.7	6/12/2009	1201	23.0	17.0	9.8	201	2120	1860	1.04	3		
SM3.5	6/12/2009	1147	22.0	14.2	10.3	410	180	156	1.04	3		
SM3.4	6/12/2009	1132	21.0	19.9	4.3	719	520	460	1.04	3		
SM3.3	6/12/2009	1123	23.0	17.0	9.5	238	640	540	1.04	3		
SMB3	6/12/2009	1118	23.0	17.5	10.0	343	660	600	1.04	3		
SM5	6/23/2009	1443	25.0	19.2	8.9	215	84	84	0.19	2	Duplicate	72
SM4	6/23/2009	1506	25.0	19.1	9.3	231	56	56	0.19	2		
SM4.1	6/23/2009	1459	25.0	15.1	10.3	192	152	152	0.19	2	Replicate	132
SM3	6/23/2009	1521	26.0	19.0	8.9	242	64	64	0.19	2		
SM3.1	6/23/2009	1522	26.0	SAMPLE ONLY			560	560	0.19	2	Field Blank	0
SM 5	7/7/2009	1031	26.0	19.8	8.9	247	64	32	0.51	6		
SM 4	7/7/2009	1043	25.0	19.7	9.1	253	64	52	0.51	6		
SM 4.1	7/7/2009	1040	SAMPLE ONLY				28	28	0.51	6		
SM 3.7	7/7/2009	1208	26.0	20.0	8.7	252	56	56	0.51	6	Replicate	60
SM 3.6	7/7/2009	1222	26.0	19.7	8.8	255	68	60	0.51	6	Field Blank	0
SM 3.5	7/7/2009	1139	27.0	14.4	10.0	506	40	36	0.51	6		
SM 3.4	7/7/2009	1109	16.0	23.5	6.0	460	56	44	0.51	6	Duplicate	92
SM 3.3	7/7/2009	1127	28.0	19.3	8.6	260	112	100	0.51	6		
SM 3.1	7/7/2009	1053					TNTC		0.51	6		
SM 3	7/7/2009	1057	25.0	19.1	8.8	271	204	164	0.51	6		
Little Stream	7/7/2009	1204	SAMPLE ONLY				224	224	0.51	6		
SM 5	7/24/2009	1019	21.0	19.7	8.8	260	244	208	0.94	1	Replicate	
SM 4	7/24/2009	1035	24.0	19.6	8.5	263	300	240	0.94	1	Field Blank	0
SM 4.1	7/24/2009	Sample Only					640	n/a	0.94	1		
SM 3.7	7/24/2009	1134	27.0	19.6	8.4	263	280	260	0.94	1	Duplicate	
SM 3.6	7/24/2009	1124	28.0	19.4	8.5	264	260	240	0.94	1		
SM 3.5	7/24/2009	1117	27.0	15.9	8.5	500	44	200	0.94	1		
SM 3.4	7/24/2009	1106	26.0	24.2	6.0	552	52	52	0.94	1		
SM 3.3	7/24/2009	1056	26.0	19.3	8.0	269	260	60	0.94	1		
SM 3.1	7/24/2009	Sample Only					6200	5700	0.94	1		
SM 3	7/24/2009	1047	23.0	19.3	8.5	281	800	760	0.94	1		

Silvermine Brook

Station	Date	Time	Air Temp. deg C	Water Temp. (DO) ºC	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFUs/100 mLs	E. coli CFUs/100 mLs	Amount of rain (inches)	Days prior to sampling	QA/QC	Fecal Coliform. CFUs/100 mLs
SMB3	6/12/2009	1118	23.0	17.5	10.03	342.5	660	600	**2.37**	**3**		
SMB8	6/22/2009	1623	22	18.7	9.80	335.5	60	50	4.55	1		
SMB7	6/22/2009	1538	19	18.3	9.01	336.4	180	120	4.55	1		
SMB5	6/22/2009	1542	18	16.5	9.31	314.1	170	170	4.55	1	Replicate	140
SMB4	6/22/2009	1522	22	18.1	9.55	333.6	170	120	4.55	1	Field Blank	0
SMB3	6/22/2009	1554	22	18.0	9.44	333.7	170	120	4.55	1		
SMB8	8/19/2009	1140	31	26.7	7.97	406.4	56	52	0	7	Replicate	28
SMB7	8/19/2009	1120	31	24.2	7.19	409.2	56	44	0	7		
SMB5	8/19/2009	1121	31	21.9	6.42	330.8	28	24	0	7	Field Blank	0
SMB4	8/19/2009	1111	31	23.4	8.89	403.6	96	92	0	7	Duplicate	40
SMB3	8/19/2009	1039	33	23.7	8.62	403.2	88	88	0	7		
SM3.2	8/19/2009	1056	32	23.1	4.27	294.6	228	224	0	7		
SMB4 pipe	8/19/2009	1114	31	SAMPLE ONLY			12	12	0	7		

Table C2 Site numbers, descriptions, and GPS Coordinates of Silvermine River and Silvermine Brook sites in Zone B

Site No.	Site Description	GPS Coordinates
SM3	James Street	Latitude: N 41º 08' 09.8" Longitude: W 073º 26' 6.1"
SM3.1	James Street pipe	Latitude: N 41º 08' 10.3" Longitude: W 073º 26' 04.4"
SM3.3	DMR Bridge	Latitude: N 41º 08' 12.5" Longitude: W 073º 26' 20.4"
SM3.4	DMR Parking lot	Latitude: N 41º 08' 15" Longitude: W 073º 26' 21.4"
SM3.5	Silvermine Ave South of the Merritt Parkway	Latitude: N 41º 8' 17.3" Longitude: W 073º 26' 25.9"
SM3.6	North of the Merritt Parkway	Latitude: N 41º 08' 18.4" Longitude: W 073º 26' 23.8"
SM3.7	North of the Merritt Parkway	Latitude: N 41º 8' 21.4" Longitude: W 073º 26' 27.2"
SM4	Singing Woods Drive	Latitude: N 41º 8' 43.5" Longitude: W 073º 26' 31.6"
SM4 Pipe	Singing Woods Drive Pipe	Latitude: N 41º 8' 45.3" Longitude: W 073º 26' 28.2"
SM5	Silvermine Elementary School	Latitude: N 41º 8' 50.7" Longitude: W 073º 26' 35.2"

Silvermine Brook Sites

SMB3	144 Silvermine Ave	Latitude: N 41º 8' 10.1" Longitude: W 073º 26' 22.6"
SMB4/5	Comstock Hill Lane	Latitude: N 41º 08' 08.6" Longitude: W 073º 26' 26.5"
SMB7	Kreiner Lane	Latitude: N 41º 07' 59.1" Longitude: W 073º 26' 34.9"
SMB8	Ham's Pond in Condominium Complex off of New Cannan Ave	Latitude: N 41º 07' 58.6" Longitude: W 073º 26' 47.7"

Section III

Introduction, Zone C:

Zone C extends from the Linden Street storm drain discharge to the Norwalk River south to the upper end of the Norwalk estuary at Moody's Lane (Figure 11, Figure 12, Figure 13). The lower end of the Norwalk River is characterized as the receiving waters from over one hundred storm drain discharges. Several of these are quite large (up to 6 feet in diameter) with continually running discharges the result of piping away small streams so that the overlying land could be utilized for structures. The subject of this section is the continued monitoring of six storm drain discharges which have been problematical over the past 10 years in terms of elevated *E. coli* bacteria. As part of this study, a Site NR 0.5 was established off the Wall Street Bridge to ascertain the concentration of *E. coli* bacteria entering the estuary. This brings the total number of monitoring sites to seven for Zone C (Figure 11, Figure 12, and Figure 13).

The Norwalk River banks in Zone C are characterized by an almost total loss of wetlands and most riparian buffers. An exception to this characterization is the remaining tree line between Route 7 and Route 1 (Figure 12). Going downstream the river banks are lined by light industry (Figure 10), a large medical unit (Figure 12), asphalt plants and marinas (Figure 13). The river has been dramatically reshaped (Figure 11) to mitigate flooding. Open space has been converted to parking lots all along the banks of Zone C. Zone C is a prime example of where protection of the river's ecology was given little thought during all the development that has occurred over the last 200 years. The unintentional cumulative effect of all this is the creation of a man-made waterway which has lost most of its natural amenities, is unhealthy, has poor tidal flushing, and is visually unappealing. The cost of remedial efforts at this point is unimaginable and not contemplated. Nevertheless, repair of the large storm drain networks (the largest polluters) is possible and should be undertaken as funds become available[4].

Results, Zone C:

Although not enough data were accumulated on the six storm drain discharges to make an adequate assessment against the CT DEP criteria for *E. coli* bacteria levels, the monitoring bacteria data collected during this summer indicates problematic storm drain systems (Table 10). Sites NR1.2 (40 Cross Highway), NR1.1 (School Street), NR0.4 (Daskam Lane), and NR0.3 (Moody's Lane) are being contaminated by sources, which could be compromised septic systems, sewage infiltration from leaking pipe joints and in some instances, an over supply of aquatic birds.

Table 10 *E. coli* bacteria counts (CFUs/100 mLs) for six storm drain discharges and the Norwalk River at the Wall Street Bridge from June through July 2009

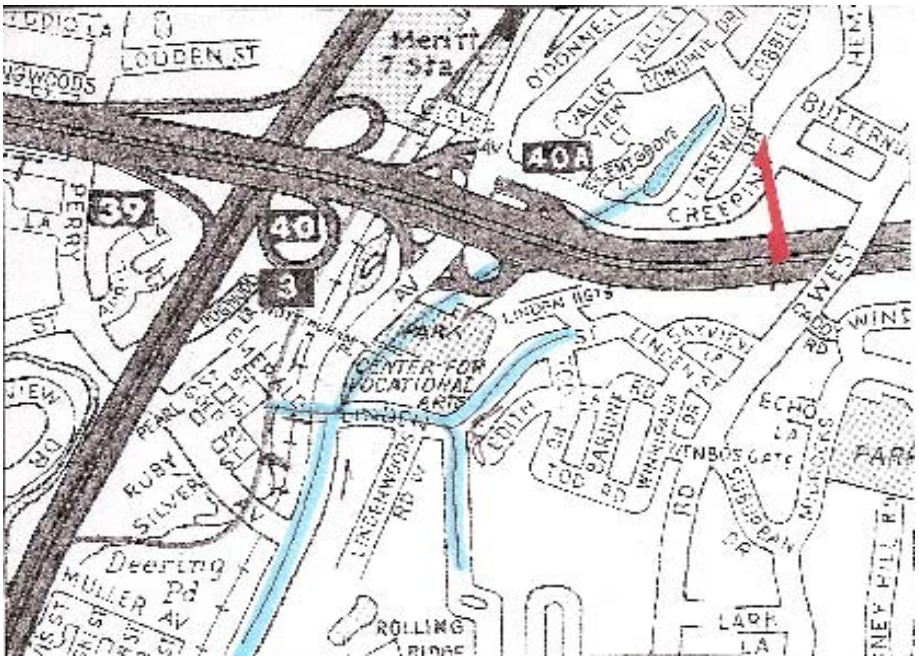
Date/Sites	NR2	NR1.9	NR1.2	NR1.1	NR0.5[1]	NR0.4	NR0.3	Rainfall (inches)	Days prior to sampling
6/2	40	-	1100	400	80	10	200	0.47	4
6/11	390	400	4900	0	310	3500	15000	2.46	2
7/20	400	0	-	-	-	400	8300	0.00	7
7/21	-	-	15000	42000	8000	-	-	0.61	0

[1]Site NR0.5 is the entry point of the Norwalk River to the Norwalk estuary at the Wall Street Bridge

[4] The large storm drain network at Moody's Lane has been investigated by HW/RW, the Norwalk Health and Public Works Department. The degree of cooperation has already led to finding a broken water main (2008), and a "hot spot" between Buckingham Place and Lockwood Lane (2009).

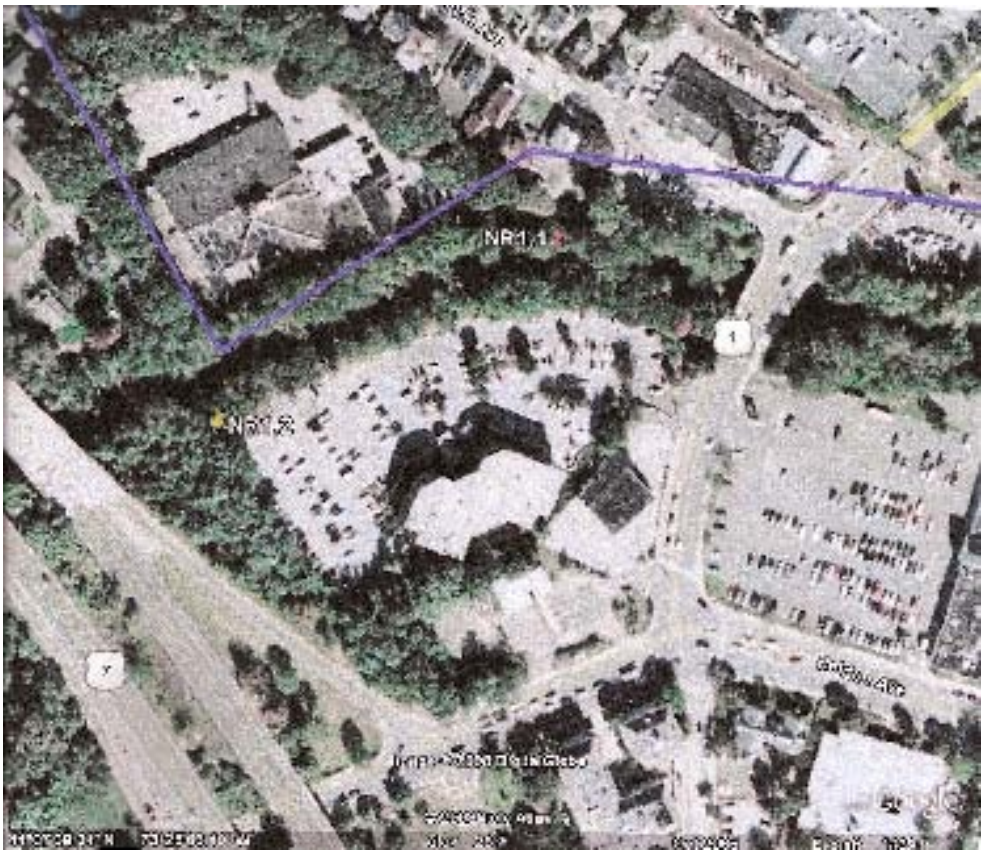
Figure 11 Aerial map (a) and street map (b) of the Linden Street storm drain system, Site NR2 and NR1.9

(a)

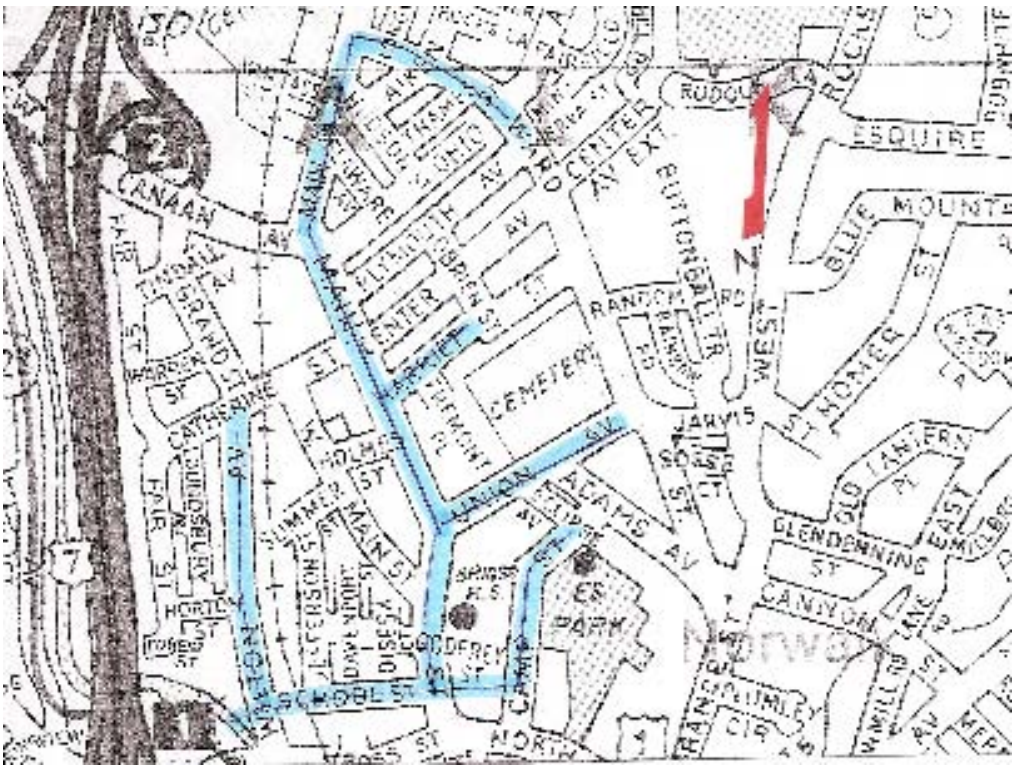


(b)

Figure 12 Aerial map (a) and Street map (b) of the School Street storm drain system, Site NR1.1 and NR1.2



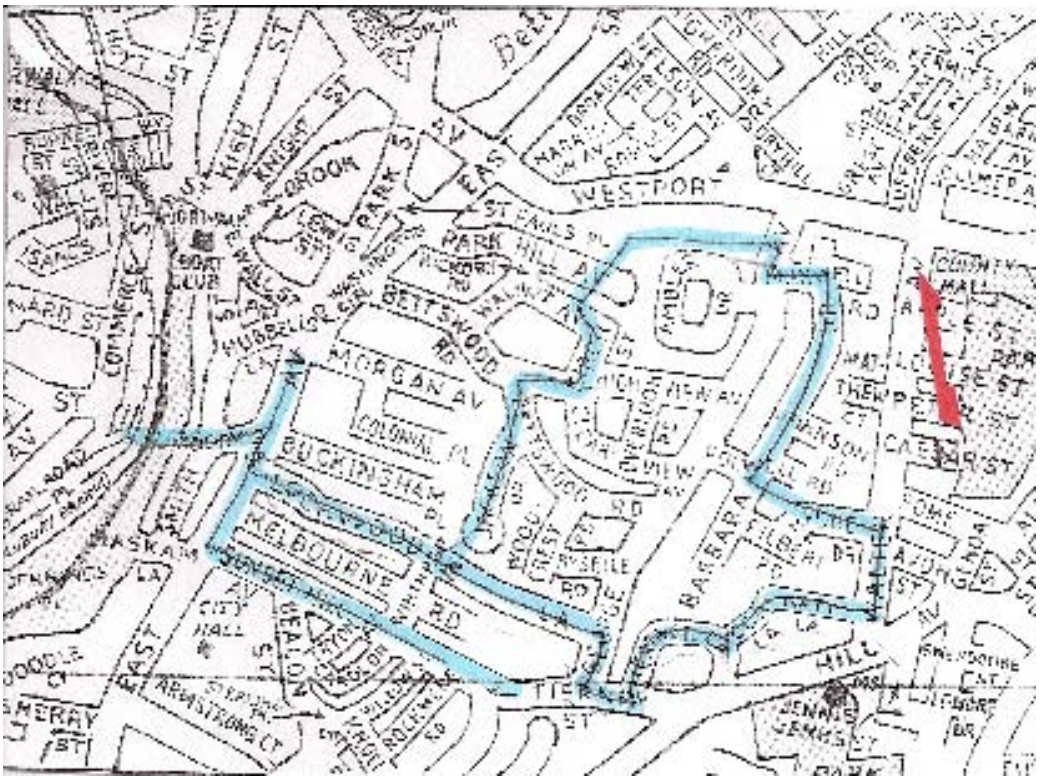
(a)



(b)

Figure13 Aerial map (a) and street map (b) of the Moody's Lane storm drain system, sites NR0.5, NR0.4, and NR0.3

(a)



(b)

All observed pipeline discharges and the harbor entry point (Site NR0.5) meet the CT DEP criterion for DO at 5 mg/L or greater for a Class B river. A single exception of 4.24 mg/L was observed at Site NR0.4 (Daskam Lane) on 7/20/09 (Table B3).

Conductivity levels at these sites were erratic and in some cases were affected by salt water intrusion from the Norwalk estuary (Table 11 and Table B3).

Table 11 Observed conductivity values (*u*S) observed at six storm drain discharges and the landward end of the Norwalk estuary at Wall Street

Date/Sites	NR2	NR1.9	NR1.2	NR1.1	NR0.5	NR0.4[1]	NR0.3
6/2	418	-	930	540	430	19,900	528
6/11	368	342	936	493	400	-	-
7/20	398	546	-	-	-	21,720	541
7/21	-	-	52	66	6720[1]		

[1]saltwater infiltration

Discussion, Zone C:

All six storm drains have conductivity values in excess of 300 *u*S. Extreme examples are seen at Sites NR1.2 (40 Cross Street), and NR1.1 (School Street). Sites NR0.5, NR0.4 and NRO.3 are affected by salt water intrusion (Table 11).

In order to obtain a different aspect of storm drain discharges to the receiving waters (Norwalk River and estuary), it was decided to analyze nutrients, *i.e*. total nitrogen (TN) and total phosphorous (TP). Accordingly five of the storm drains and the main river Site NR0.5 were tested for TN and TP on 6/2/09. Results from these tests showed elevated TN above background levels of 0.2 mg/L (CT DEP 2002)[5]. Total phosphorous levels were all non-detectable (ND) except at Site NR1.1 (Table12). In this instance elevated nitrogen levels were in accord with elevated bacteria levels at the same sites (Table 11 and Table 12).

Table 12 Total nitrogen (TN) and total phosphorous (TP) in six storm drain samples and one main river sample taken on 6/2/09[1]

Sites	NR2	NR1.9	NR1.2	NR1.1	NR0.5	NR0.4	NR0.3	MDL (mg/L)[2]
Total Nitrogen (TN) mg/L	0.85	NA	3.57	4.90	1.10	1.32	2.81	0.1
Total Phosphorous (TP) mg/L	ND	NA	ND	0.35	ND	ND	ND	0.020

[1]All nutrient tests were performed by York Analytical Laboratories, Inc. in Stratford, CT. Total nitrogen (TN) was performed using Standard Methods Method SM4500N and total phosphorous (TP) was analyzed using Method EPA 3653.

[2]MDL is minimum detection limit

[5] The CT DEP has no published background value for nitrogen in moving water, therefore, HW/RW used the published value for an impoundment.

To further the investigation, nutrient levels were assessed again in 7/20/09 and on 7/21/2009 along with flow measurements (cubic ft/sec) to determine the pounds of TN and TP entering the Norwalk River and estuary (Table 13). The discharge volume was measured with a four gallon bucket which was only practical at four storm drains[6].

Table 13 TP and TN loading in lbs/day at four storm drain discharge pipes on 7/20 and 7/21/09

Monitoring Sites	NR2[a]	NR1.9[a]	NR1.1[b]	NR0.4[a]
Flow gal/sec	0.43	0.85	16.0	2.0
TN mg/L	1.93	5.03	2.27	2.97
TN lbs/day	0.59	0.30	26.2	4.2
TP mg/L	N/A	N/A	0.35	N/A
TP lbs/day	N/A	N/A	4.0	N/A

[a]Sites monitored on 7/20/09; rainfall at 0 inches for seven days prior to sampling
[b]Sites monitored on 7/21/09; rainfall at 0.61 inches on the day of sampling

TN and TP loading were calculated as follows:

Flow (F) for each of the four discharge pipes was calculated using a four gallon bucket to calculate this parameter in million gallons per day (MGD). Nutrient concentrations C), taken at the same time from samples collected by HW/RW and analyzed by York Analytical Laboratories (Stratford, CT), are expressed as mg/L. The formula to determine lbs/day is the following: (F x C) x 8.34 (factor) = lbs loading/day.

For example, flow (F) at Site NR1.1 is 16 gallons/sec. x 60 sec/minute x 60 minutes/hour x24 hours/day or 1.382400 MGD x the TN concentration (C) of 2.27 mg/L= 3.138048 x 8.34 factor =26.2 lbs TN/day.

The TN and TP loadings shown in Table 133 are a one time snapshot heavily dependent on the rainfall and weather conditions. Several difficulties were encountered in the first attempt at assessing nutrient loading into the lower Norwalk River.

- Sites NR2, NR1.9, and NR0.3 were all monitored during a dry period on 7/20/09 (Table 13), whereas Site NR1.1 was monitored on a wet sampling day, 7/21/09 (Table 13). The observed discharge from Site NR1.1 was very robust and well above the normal flow for that storm drain system. The corresponding *E. coli* bacteria levels in the discharge were also elevated (42,000 CFUs/100 mLs, Table 10).

- The fact that weather extremes were encountered on both 7/20/09 and 7/21/09 precludes making any valid comparisons of nitrogen loading of Sites NR2, NR1.9, NR0.3 to NR1.1.

What the results do show is that even on a dry day Moody's Lane Site NR0.3 is capable of adding 4.2 lbs of TN/day to the receiving waters of Norwalk Harbor and Site NR1.1 can add as much as 26.2 lbs of TN/day in the middle of a storm. The other two discharges at Site NR2 and NR1.9 add relatively little TN to the Norwalk River as calculated on a dry day.

[6] The only sites where a bucket could be held under the discharge pipe were Sites NR2, NR1.9, NR1.1 and NR0.3. Sites NR2, NR1.9 and NR0.3 were done on 7/20 (a dry period), and Site NR1.1 was monitored and sampled for nutrients on 7/21/09 (a wet period).

More research needs to be done in this area to get any semblance of pounds of TN or TP per year from these discharge sources. Preliminary research shows that the combined flow from just these few discharge points can increase the nitrogen concentrations to the Norwalk estuary and ultimately Long Island Sound. The most likely source of TN and TP to the storm drain systems is storm water runoff carrying fertilizers or pet wastes and/or illegal septic hookups and leaking sewer main connections. Finding these sources of contamination in storm drain systems, which can stretch for miles, is a daunting task.

Table B3 Date, time, air & water temperatures, dissolved oxygen, conductivity, fecal coliform bacteria, *E. coli* bacteria, rainfall number of days prior to sampling, and QA/QC activity for monitoring events in the lower Norwalk River Watershed (Zone C), May through July 2009

Station	Date	Time	Air Temp. deg C	Water Temp. (DO) ºC	D.O. mg/L	COND. umho/cm	Fecal Coliform. CFUs/100 mLs	E. coli CFUs/100 mLs	Amount of rain (inches)	Days prior to sampling	QA/QC	Fecal Coliform. CFUs/100 mLs
NR 2	6/2/2009	1404		14.3			418	50	40	0.47	4		
NR 1.2	6/2/2009	1440					930	1500	1100	0.47	4		
NR .5	6/2/2009	1500		19.7			430	80	80	0.47	4		
NR .3	6/2/2009	1517		13.5			528	4400	200	0.47	4		
NR.4	6/2/2009	1520		16.0			19900	50	10	0.47	4		
NR 1.1	6/2/2009	1544		13.2			540	480	400	0.47	4		
NR 1.1	6/11/2009	1111		14.5	9.50		493	100	0	1.04	2		
NR 0.3	6/11/2009	1043						15000	15000	1.04	2	Replicate	14000
NR 0.4	6/11/2009	1052		16.2	7.60		6	3700	3500	1.04	2		
NR 0.5	6/11/2009	1130		16.3	8.60		400	360	310	1.04	2		
NR 1.2	6/11/2009	1147		14.8	8.16		936	5300	4900	1.04	2		
NR 1.9	6/11/2009	1224		16.8	8.90		342	600	400	1.04	2		
NR 2	6/11/2009	1213		15.3	9.00		368	500	390	1.04	2	Duplicate	
NR 0.3	7/20/2009	1639	29.0	16.9	9.71		541	8500	8300	0.01	2		
NR 0.4	7/20/2009	1649	29.0	21.1	4.24		21720	420	400	0.01	2		
NR 1.9	7/20/2009	1610	28.0	18.9	9.01		546	0	0	0.01	2		
NR 2	7/20/2009	1542	32.0	18.2	8.74		398	450	400	0.01	2	Replicate	350
NR 1.1	7/21/2009	1059	21	20.8	8.95		66.2	48000	42000	0.61	0		
NR 0.5	7/21/2009	1115	21.0	20.8	8.36		6720	9000	8000	0.61	0	Duplicate	
NR 1.2	7/21/2009	1032	22.0	20.4	9.40		52	17000	15000	0.61	0	Replicate	15000
Hobo Pipe	7/21/2009	Sample Only						3000	2000	0.61	0		

Table C3 Site numbers, descriptions and GPS Coordinates of the Norwalk River storm drain in Zone C

Site No	Site Description	GPS Coordinates
NR2	Railroad tracks off of Perry Ave.	Latitude: N 41º 08' 12.3" Longitude: W 073º 25' 34.3"
NR1.9	Lumber yard off of Perry Ave.	Latitude: N 41º 08' 8.1" Longitude: W 073º 25' 32.3"
NR1.2	Medical Center	Latitude: N 41º 07' 09.7" Longitude: W 073º 25' 10.7"
NR1.1	Ash Creek Saloon	Latitude: N 41º 07' 11.2" Longitude: W 073º 25' 4.1"
NR0.5	Wall Street Bridge	Latitude: N 41º 07' 06.2" Longitude: W 073º 24' 43.0"
NR0.4	Norwalk Rowing Association East of Moody's Lane draining into the Norwalk Harbor	Latitude: N 41º 06' 55.1" Longitude: W 073º 24' 33.0"
NR0.3	Moody's Lane draining into the Norwalk Harbor	Latitude: N 41º 06' 54.4" Longitude: W 073º 24' 33.7"

Moody's Lane Storm Drain System

Introduction:

During the 2009 summer season with the help of the Norwalk Health and Public Works Department, HW/RW was able to concentrate its efforts on the Moody's Lane storm drain network. Historically, this large drainage network has been a source of elevated *E. coli* bacteria counts to Norwalk Harbor (Figure 13b). HW/RW has systematically gone catch basin to catch basin with the help of Tom Closter, Director of Environmental Sciences, and Mike Yeosock, Senior Civil Engineer of Public Works to determine the location of pollution sources in the pipeline. The big breakthrough came on 9/29 when Tom Closter and HW/RW employees found a very high bacteria count on Lockwood Lane and followed a feeder line north across private property to Buckingham place (Figure 14). The Public Works department has funding in place and is planning to replace the storm drainpipe line on Lockwood Lane with a larger diameter pipe. Construction will be underway in the immediate area of the elevated bacteria counts found at the Lockwood Lane catch basin Site 3/3a (Table 14). This will allow Public works the opportunity to investigate the source of pollution and eliminate leaks and illegal hookups by residents and replace connecting pipes as necessary.

Finding this hot spot has been difficult and has involved hundreds of bacteria tests at the Earthplace laboratory over the last two years. The pipeline system is complex (Figure 14, Figure 15) and has commercial (Stew Leonard's) and residential properties along its three mile length. The main difficulty in obtaining reliable data relates to difficulties in weather conditions and random use of the storm drain system by houses and businesses, which may be illegally hooked up.

Methods:

Reference methods and procedures in above portion of the report, page 6.

Results:

The recent discoveries of elevated fecal coliform counts at BP2, BP3/BP3a, BP1, and 3/3a all exceed the CT DEP geometric means and SSM for Class B waters (Figure 14, Figure 15, Table 14).

Figure14 Fecal coliform maximum, geometric mean, and minimum values (CFU/ 100mL) for monitoring sites on the Moody's Lane System in Norwalk

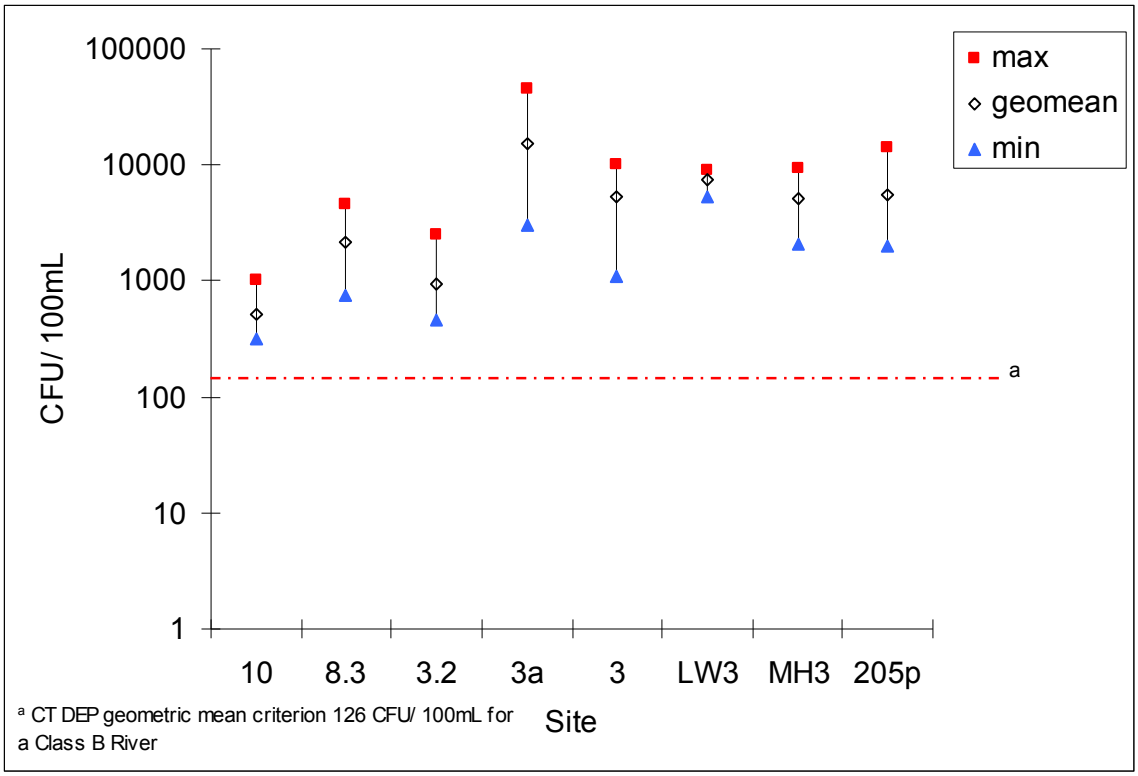


Table14 Bacteria counts (CFU/ 100mL) for Sites BP1, BP2, BP3, and BP3a on Buckingham Place in Norwalk

	9/29/2009	10/6/2009	10/20/2009
BP1	44000	3700	9500
BP2	29000	4500	9700
BP3	27000	3700	9000
BP3a	1700	4400	90

Figure 15 HW/RW monitoring sites on the Moody's Lane storm drain system.

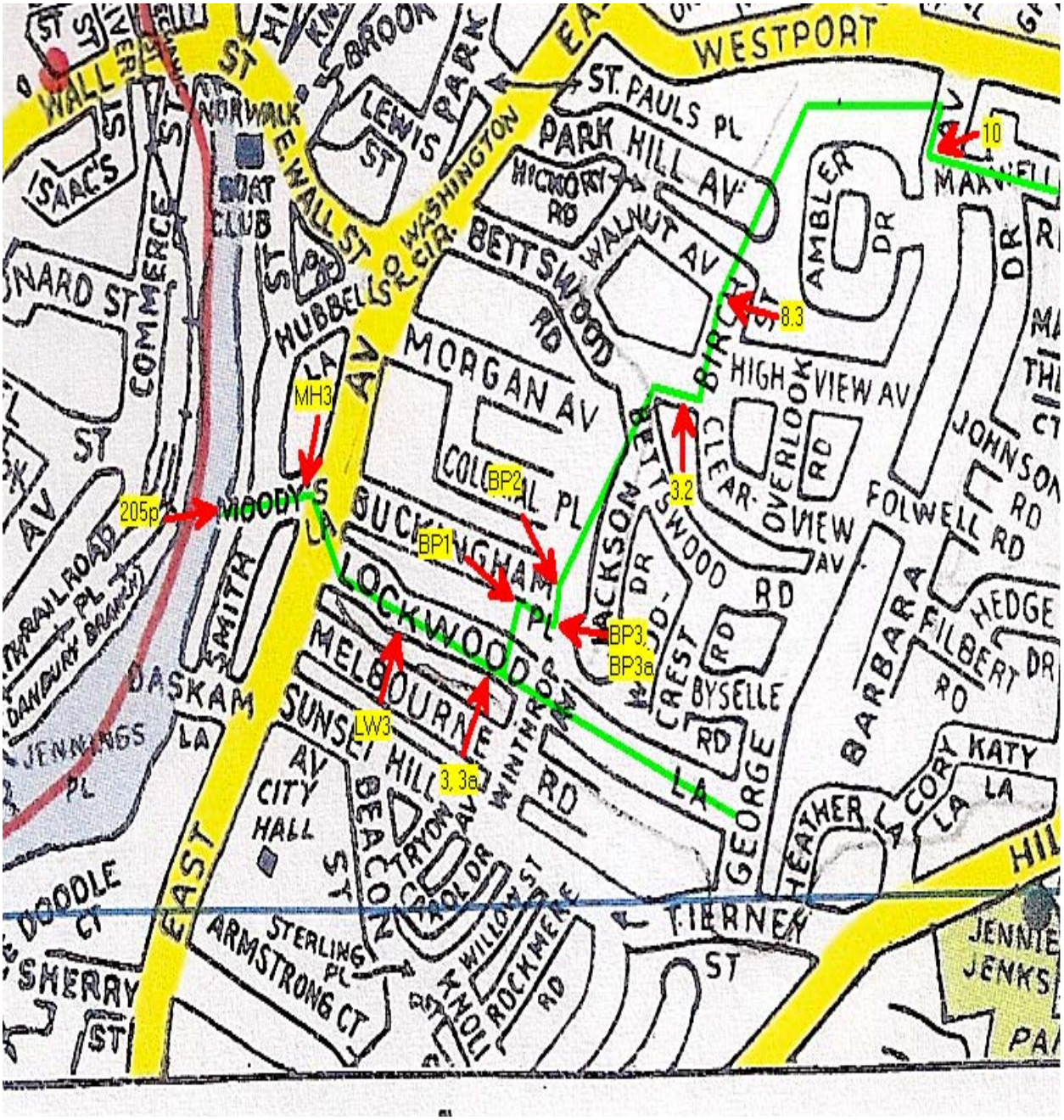


Figure 16 Detail of drainage pipe system between Buckingham Place and Lockwood Lane. The flow of contaminated water goes south past Site BP2 to Site BP3/BP3a. Water flowing to the west at Site BP3a is only mildly polluted (small pipe of unknown origin). The combined stream flows west to Site BP1 and then south to Site3/3a on Lockwood Lane where it joins the Lockwood drainage pipe.

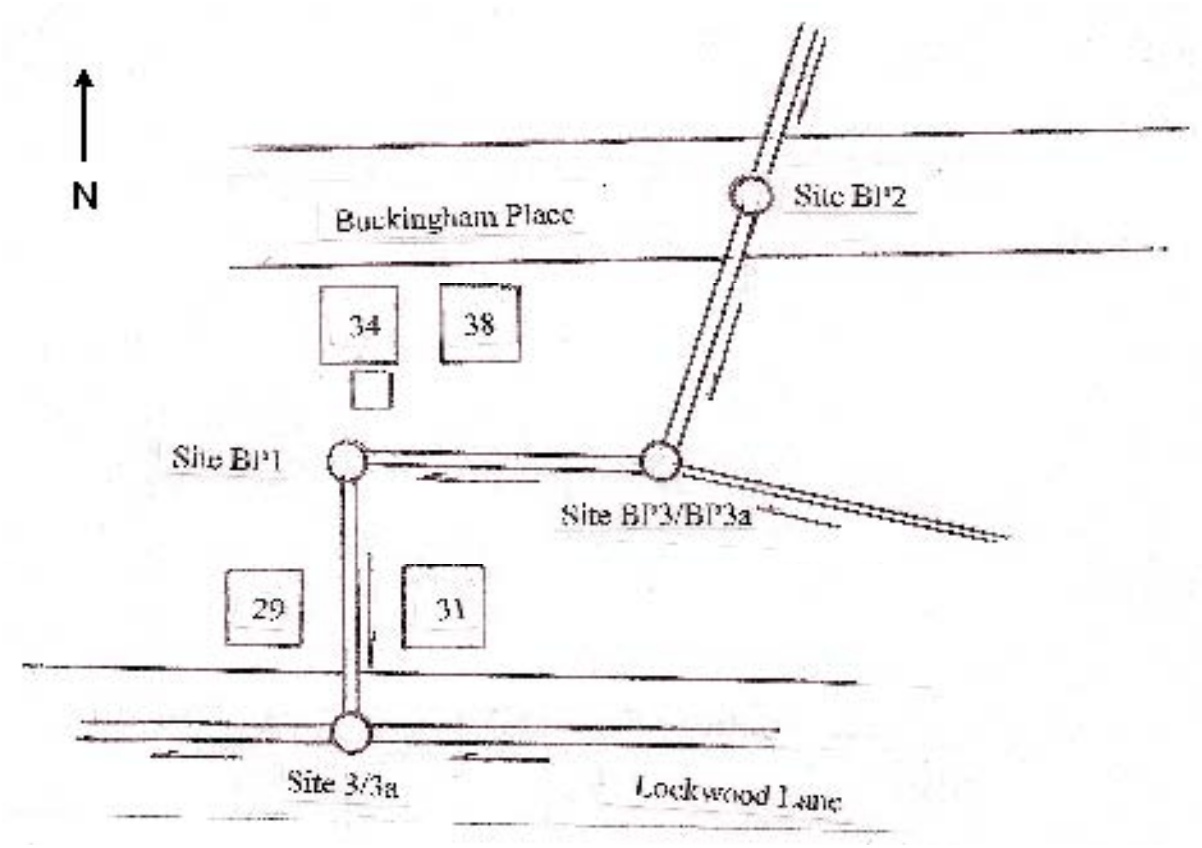
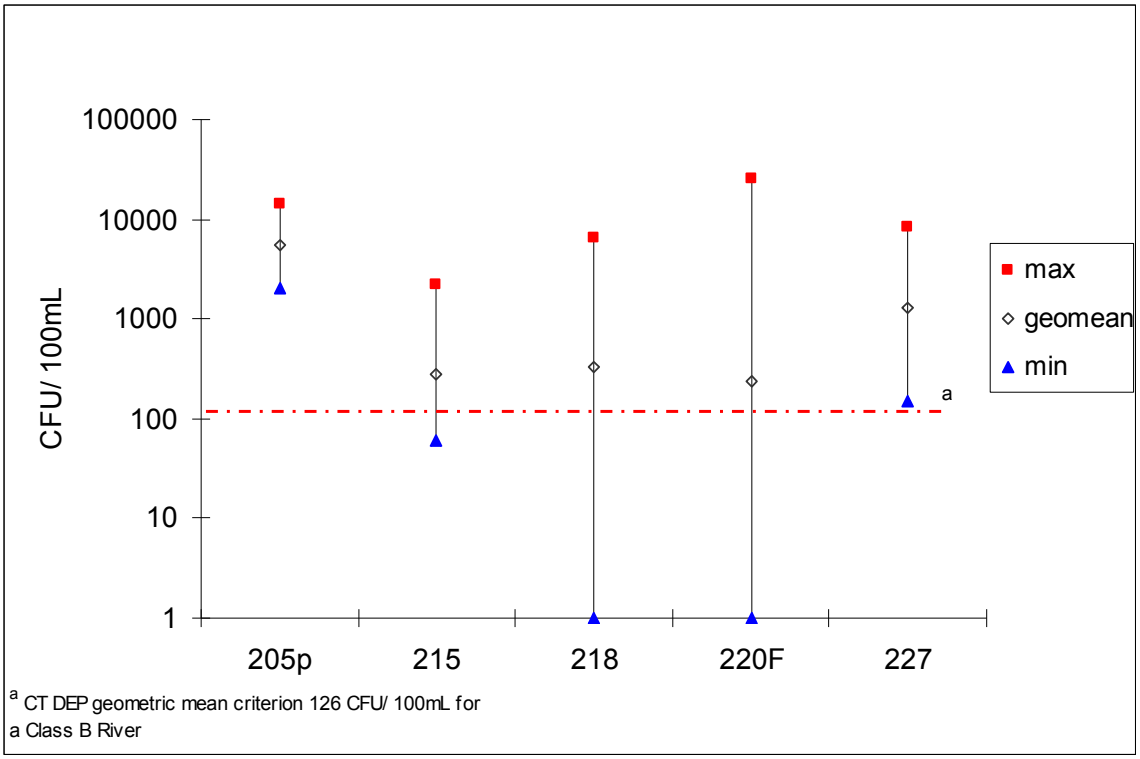


Table 15 Site numbers, descriptions, and GPS coordinates of the storm drain pipes between Buckingham Place and Lockwood Lane in Norwalk

Site No.	**Site Description**	**GPS coordinates**
BP2	End of Buckingham Place in front of Number 38	Latitude: N 41º 06' 59.6" Longitude: W 073 º 24' 13.9"
BP3/BP3a	Behind 38 Buckingham Place	Latitude: N 41º 06' 58.5" Longitude: W 073 º 24' 13.4"
BP1	Behind 34 Buckingham Place	Latitude: N 41º 06' 57.6" Longitude: W 073 º 24' 13.9"
3/3a	On south side of Lockwood Lane across From number 29	Latitude: N 41º 06' 56.1" Longitude: W 073 º 24' 14.4"

Figure 17 Fecal coliform maximum, geometric mean, and minimum values (CFU/ 100 mL) for five monitoring sites located in Norwalk Harbor



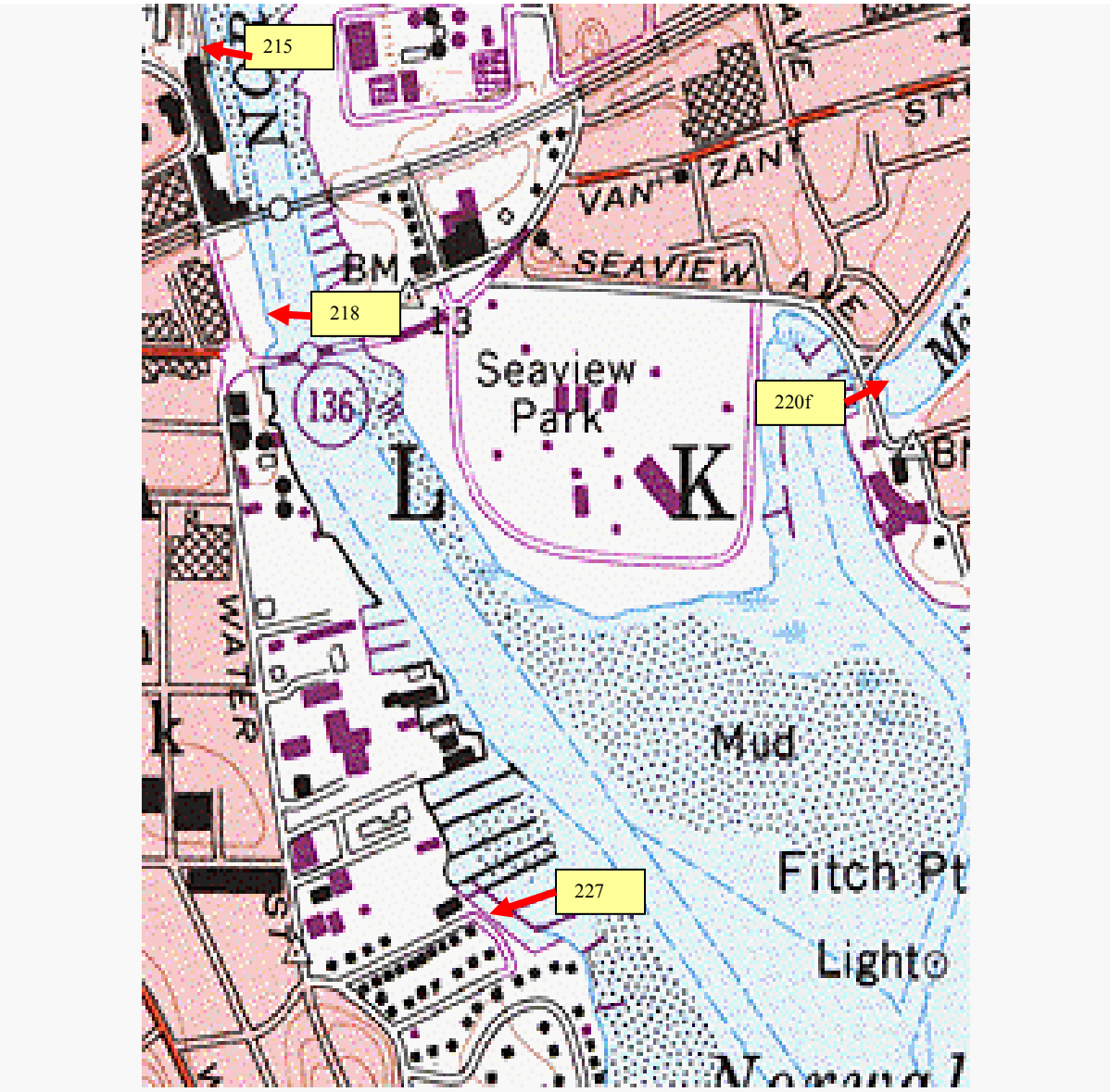
Discussion:

Clearly, the Moody's Lane storm drain system is highly impacted (Figure 14, Table 14). The manhole at Site 3 receives a pipe that runs westward on Lockwood Lane, through Sites LW3, MH3, and downstream to Site 205p which discharges to the harbor (Figure 15). Sites 10, 8.3, 3.2, and 3a represent a pipe from the north that joins the Lockwood pipe at Site 3 (Figure 15). After the addition of Site 3a to the catch basin, the westerly flowing bacteria concentrations are higher. These monitoring stations show heavy infiltration at a number of locales. Working with the Norwalk Health Department, HW/RW was able to augment these findings by adding sites that fall between Sites 3.2 and 3a (Figure 16) on Buckingham place (Table 14). These new sites are highly impacted and create a new direction in which to focus efforts.

Future Work:

The testing performed on other storm drain pipes that discharge into Norwalk Harbor once again showed elevated concentrations of fecal coliform (Figure 17, Figure 18). While not shown on the Figure 18 map, Site 205p (Moody's Lane) is included in this segment as well because it does discharge directly into the harbor (Figure 15). While all of the sites exceed the CT DEP criterion of 126 CFUs/100mL geometric mean, the most egregious offenders are Sites 205p and 227 (Figure 17, Figure 18). These sites represent both the east (Site 205p) and west (Site 227) sides of Norwalk Harbor. This illustrates that infiltration is not sequestered to one area, and that it will take the combined future efforts of local organizations to track down pollution sources within these diverse drainage systems (Figure 17, Figure 18).

Figure 18 Four HW/RW monitoring sites in Norwalk Harbor



Conclusion:

Given the extreme nature of some of the overages, HW/RW would recommend the following:

1. Dye testing of 34 and 38 Buckingham Place, as well as 29 and 31 Lockwood Lane in Norwalk.

In the months to come HW/RW hopes to make inroads on some of the other polluting storm drain networks (Figure 17), which have been found to discharge excessive amounts of bacteria to Norwalk Harbor on a routine basis using some of the Techniques used on Moody's Lane (Figure 16).

Appendix A

References

Harris, R. B. and P. J. Fraboni: Quality Assurance/Quality Control Plan for the Norwalk River Watershed Monitoring Project (QA No. CT00162) (re-approved October 2001).

US Environmental Protection Agency. 1986. Ambient Water Quality Criteria for Bacteria, US EPA 440/5-84-002, Washington, DC.

Harris, R. B. and P. J. Fraboni.2001. Water Quality Data Final Report for the Norwalk River Watershed (May 2008 –September 2008).

CT DEP, Water Quality Standard 12/17/02

Eaton, A.D., Clesceri, L.S., Rice, E.W., and A.E. Greenberg. 2005. Standard Methods for the Examination of Water and Wastewater, 21st Ed. American Public Health Association, American Water Works Association, Water Environment Federation

Appendix B

Glossary

Dissolved oxygen: The oxygen dissolved in water and readily available to aquatic organisms expressed in milligrams per liter (mg/L) or parts per million (ppm). Connecticut's Water Quality Standards requires that the dissolved oxygen of a Class B stream shall not be less than 5 mg/L at any time.

Conductivity: Conductivity is a measure of the ability of water to pass an electrical current. Conductivity of water is positively affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate (ions that carry a negative charge) as well as sodium, magnesium, calcium, iron and aluminum (ions that carry a positive charge). Conductivity is useful as a general measure of stream water quality. Each stream tends to have a relatively constant range of conductivity measurements. Significant changes in conductivity can be used as an indicator of pollution entering a stream. For example, the presence of metal trash in water and/or the use of iron pipes can increase conductivity. An elevated conductivity level can also occur from natural sources such as the presence of limestone in streambeds. Conductivity is measured in micromhos per cm, (μmhos/cm) a measure of conductance equal to one millionth of a mho/cm. While there is no CT DEP criterion for conductivity, the rivers in the United States generally range from 50 to 1500 μmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 μmhos. Conductivity values outside this range could indicate that the water is not suitable for certain species of fish or macro invertebrates.

Fecal coliform bacteria: Fecal coliform bacteria are that portion of the coliform group that originates in the intestinal tract of man and other warm-blooded animals. Fecal bacteria are used as indicator organisms, which are not usually harmful to man. Their presence indicates that pathogens (such as cholera, salmonella, etc.) may be present in surface waters. The higher the count in colonies per 100 milliliters indicates a higher probability that pathogens are being discharged to surface waters. Fecal bacteria are used because they are more universal and survive for longer periods than pathogens in water. The Connecticut Water Quality Standards for a Class B stream are as follows: As an indicator of general sanitary quality Fecal coliform bacteria shall not exceed a geometric mean of 200 organisms/100 mL in any group of samples nor shall 10% of the samples exceed 400 organisms/100 mL.

***E. coli* bacteria:** *Escherichia coli* (*E. coli*) bacteria are one of two organisms that comprise fecal coliform bacteria. Studies have indicated that *E. coli* alone may be a more specific indicator organism of gut level contaminants to fresh surface waters from either man or animal. The other organism comprising coliform bacteria is *Klebsiella*, which sometimes occurs in soil or leaves. The EPA recommends *E. coli* as the best indicator of health risk from water contact in recreational waters.

Quality Assurance/Quality Control (QA/QC): Analytical measures taken to assure that field and laboratory work meets the highest standards of precision and accuracy. QA is an integrated management system designed to ensure that a product or service meets defined standards of quality with a stated level of confidence. QA activities involve planning quality control, quality assessment, data management and quality improvement. QC is the overall system of technical activities designed to measure quality and limit error in a product or service. A QC program
manages quality so that data meets the needs of the user as expressed in a quality assurance project plan. All scientific analysis of the Norwalk River is accomplished in accord with an EPA approved QA/QC which was re-approved on April 25, 2001 and covers the monitoring period from April 2001 through September 2001.

Water temperature: Water temperature is measured in degrees centigrade (^{o}C). Connecticut's Water Quality Standards state that no temperature increase is allowable except when the increase will not exceed the recommended limit on the most sensitive receiving water use. In no case shall the temperature exceed 85 ^{o}F (29.4 ^{o}C), or in any case raise the normal temperature of the receiving water more than 4 ^{o}F (2.2 ^{o}C).

Rainfall: Rainfall measurements used in this report follows criteria used by the CT State Health Services. The day of sampling is referred to as day zero. Days are numbered backwards from the testing date to the first rainfall in inches prior to the testing date. For example, if a test was conducted on Monday 5/25 and the previous rain of 0.2 inches occurred on 5/18, the records would indicate 0.2 inches for the amount of rain occurring seven days before the sampling date. If the rain were continuous over the time period, for example, if 0.3 inches fell on 5/17 and 0.2 more inches fell on 5/18, rainfall would be shown as 0.5 inches occurring seven days before the sampling. Rainfall is recorded at rainfall monitoring station located at the Town Hall in Norwalk.

Storm events: Storm events are classified as rainfall exceeding one inch in 24 hours. This much rain will increase surface runoff (input) and flow through the storm drain networks. Stormwater runoff carries many pollutants to the river, especially during the first hour.

Observations: Observations are noteworthy occurrences in the river ecology such as the appearance of stranding blue-green algae, a flock of geese or fish kills. These observations can be incorporated into the data record sheets. These help provide a seasonal definition for water related problems which are not recorded elsewhere.

Seasonal Disinfection: Seasonal disinfection is action taken by a wastewater treatment plant to eliminate bacteria from the effluent discharge. Connecticut's Water Quality Standards require disinfection for the period of May 1st through September 30th at all Wastewater Treatment Plants discharging effluent into streams north of Route I-95. The process is carried out by chlorination or exposing the effluent to ultra violet light just prior to discharge. The period of this disinfection presently takes place when the public is deemed more likely to be fishing or bathing in the water.

Appendix C

Photos of Zone A

Good riparian areas exist in the upper Silvermine River near Borglum Road

Often development of residential homes occurs too close to the Silvermine River, which frequently eliminates valuable riparian areas.
This practice may lead to a major negative impact to the health and water quality conditions of the river.

Photos of Zone B

Tree roots have been exposed as visible evidence of stream bank erosion near the Silvermine School site

Foot bridge over the Silvermine

Photos of Zone C

Strom Drain Outfall at Moody's Lane

Upstream view of Norwalk Harbor from Moody's Lane outfall pipe

Wastewater from residential properties on Lockwood Lane/Buckingham Place, part of the Moody's Lane Storm Drain System