Pollution Source Survey and Assessment of the Farm River Watershed in East Haven and Branford, Connecticut. 2012

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All other authors declare no competing interests. All authors declare that there is no conflict of interest with this research report, grant funding and its publication.

The CT Agriculture Viability Grant "Project Scope of Work" Summary:

Part I: Pollution Source Survey and Assessment of the Farm River Watershed in East Haven and Branford, CT

Water quality monitoring was conducted in both the Lower Farm River in Branford and East Haven as well at Cosey Beach in East Haven. Sampling was expanded to a total of 11 sites. Water samples were collected from the sites approximately once a week since April of 2011 through August of 2012, with sampling scheduled at low tide and after rainfall when possible. Collected samples were analyzed for both colony forming units of traditional fecal coliform indicator bacteria as well as genetic analysis of *Bacteroides* to distinguish between human and non-human sources of bacteria. Samples at public bathing beaches were analyzed for *Enterococci* indicator bacteria. Sanitary surveys have been conducted throughout the area to identify potential sources of bacteria entering the Farm River or Long Island Sound. The fecal coliform samples were analyzed for National Shellfish Sanitation Program criteria to reclassify a section of East Haven.

As a result of this analysis, we have found one area of interest which has consistently experienced elevated levels of bacteria, leading to additional sites added to the area, as well as pollution source surveys of the area including sampling of catch basins draining to the Farm River.

A pollution source study was conducted beginning in 2011. Approximately 377 homes were surveyed (80 in Branford and 297 in East Haven) with and GPS locations plotted, and records made for those properties requiring additional follow-up action. There were approximately 301 homes connected to the public sewers, three homes with holding tanks, and 48 with septic systems. There is a total of approximately 80 properties in need of follow-up surveillance or verification of connection to the public sewers. Approximately 201 catch basins were plotted using GPS and visually inspected for flowing water, odors, foam, discoloration and/or sheen with approximately two requiring follow-up investigation. An inventory was completed of all locations surveyed and actual and potential pollution sources were noted. (See attached.) Locations were marked on area maps utilizing ArcMap GIS mapping program.

A total of 207 samples were collected from the Farm River area sites over 34 collection dates. A total of 127 samples were analyzed by PCR for *Bacteroides* and human marker. There were 65 samples found with human specific marker. (See Table page 16.) These samples indicated that sewage is entering the tributaries and LIS where both swimming and shellfishing are occurring.

Water parameters such as temperature and salinity were measured and recorded. Sample results were analyzed for trends using tides and rainfall amount to correlate elevated results.

The PCR analyses method was significantly modified and refined. This methodology will be submitted to the EPA for evaluation as a new "approved method."

Part 1: Pollution Source Survey and Assessment of the Farm River watershed in the towns of East Haven and Branford, CT:

Introduction

Like many shellfish beds along the Connecticut coast, the proposed recreational shellfishing area at Cosey Beach, East Haven and the "Prohibited" area in Short Beach, Branford experience bacteria loading from a variety of sources. Many of the sources of bacteria are non-point sources, originating from a combination of sources rather than a single, identifiable point. These non-point sources of pollution can range from a variety of diffuse sources, including but not limited to urban and agricultural runoff, leaking septic tanks, improper boat waste disposal, pet waste, and wildlife. The nature of non-point sources makes identification, and thus remediation, extremely challenging.

Both Cosey Beach and Short Beach are located near the outflow of the Farm River and are impacted by pollution loading from the river. The Farm River flows approximately 16 miles, primarily through the towns of North Branford, Branford, and East Haven with a watershed area of approximately 26 square miles. The river flows through a variety of land cover types, including forested, agricultural and urban designations (University of Connecticut Center for Land Use Education and Research – UCONN CLEAR). The Farm River also contains a variety of coastal habitats, including a tidal estuary, part of which has been designated as the Farm River State Park.

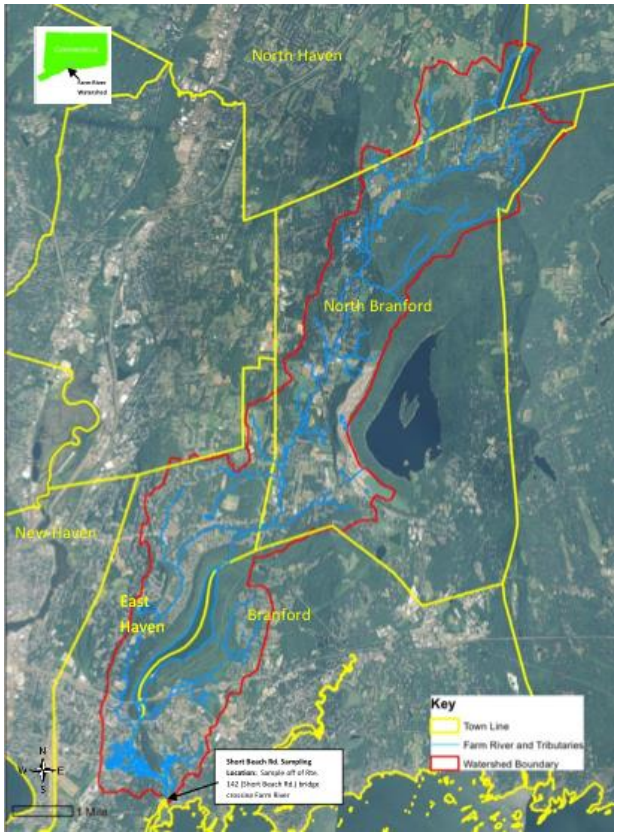


Figure 1 Farm River and the Farm River Watershed

In addition to impacting recreational shellfishing areas, the lower portion of the Farm River has many natural seed beds for both oysters and clams. Also, many privately leased beds are within or impacted by the Farm River. This abundant natural resource is currently classified as "Restricted" or "Prohibited" by the CT Department of Agriculture Bureau of Aquaculture (DA/BA) due to elevated fecal bacteria levels in the river.

This study has been conducted with the following objectives: 1) to identify sources of pollution in the Lower Farm River (below the outlet of Lake Saltonstall) and Cosey Beach, 2) to establish monitoring stations at these locations to determine conditions in which bacteria levels are

elevated 3) collect data that can be used to develop a watershed management plan to address issues uncovered during this project. All of these individual objectives are to be used ultimately to improve the water quality in the Farm River as well as in Cosey Beach. Following improvements in the water quality of these areas, it may be possible to upgrade the areas from their current "Prohibited" or "Restricted" classifications to an "Approved" or "Conditionally Approved" status.

Methods

Site Description

Cosey Beach

The proposed recreational shellfishing area is located at Cosey Beach in East Haven. The area being considered for opening is about half a mile long, and is centered around the East Haven Town Beach, a public beach open to all for recreation activities including swimming. The beach is surrounded by residences including condominium complexes as well as single-family houses and is also in close proximity to several restaurants and a small recreation area including a baseball park.

Figure 2 Map showing highlights of the Farm River Estuary (from Friends of the Farm River Estuary)

Farm River

The Farm River, also known as the East Haven River, runs from Wallingford to Long Island Sound. For the purposes of this study, the Lower Farm River Watershed is considered to be the area south of Lake Saltonstall, a drinking water reservoir managed by the Regional Water Authority (RWA website). The river is a tidal estuary, containing a state park as well as other attractions including the Shoreline Trolley Museum. Historically, the watershed has been home to many farms, however, much of the land has since been converted to residential and commercial properties (Friends of the Farm River Estuary (FFRE) and UCONN CLEAR). The river separates the towns of East Haven and Branford, and drains into Long Island Sound at Kelsey Island, immediately East of Cosey Beach (See Figure 2).

Catch Basin and Sanitary Surveys

To determine potential sources of bacterial loading into the Farm River and Cosey Beach, sanitary surveys were conducted in the Lower Farm River Watershed and Cosey Beach, with a focus on the areas located within a close proximity of the areas of interest, highlighted in green (Figure 3). These preliminary surveys were conducted in addition to water sampling to provide supplemental information regarding all potential sources of bacteria within the watershed. Primarily, the focus of the surveys was to detect any failing septic tanks within the area of interest, although other relevant features were also noted.

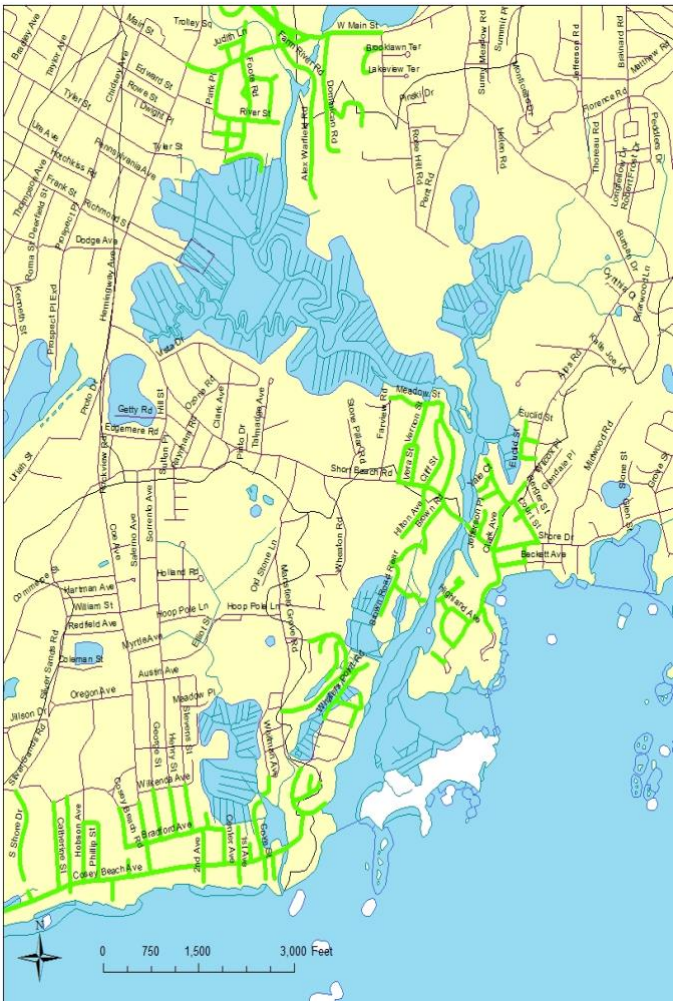


Figure 3 Streets targeted for catch basin mapping and sewer verification and inspection.

The highlighted areas were examined using a mixture of field inspections and record review. Using information available from the East Shore District Health Department (ESDHD), a list of addresses which were not on record as being connected to the sewer was compiled. From this list, houses classified as unverified or not connected were visually inspected for notable signs of septic failure and records were updated as warranted by the inspection.

Using a handheld global positioning system (GPS) unit, all storm drains within the highlighted area have been marked and visually inspected. The marked locations have been used to generate an electronic map showing all catch basins in the area to readily identify potential sources of bacteria loading in the future. Additionally, all identified catch basins have been examined at least once during the study for suspicious activity and unusual odors. Several catch basins have been sampled for fecal coliforms as described below. Two catch basins were sampled repeatedly as part of the general sampling conducted for the DA/BA at the Cosey Beach site.

Water Sampling

East Haven Town Beach

In 2010, sampling stations were established by the DA/BA for monitoring of the proposed recreational shellfishing area at East Haven Town Beach (Figure 4). The area consisted of nine sampling locations along the shore, including two stormwater drains, and one sample site accessible only by boat. Included in this sample area are those sites considered to be part of the proposed recreational area (2.2, 2.3, and 2.8) as well as samples in the surrounding areas.

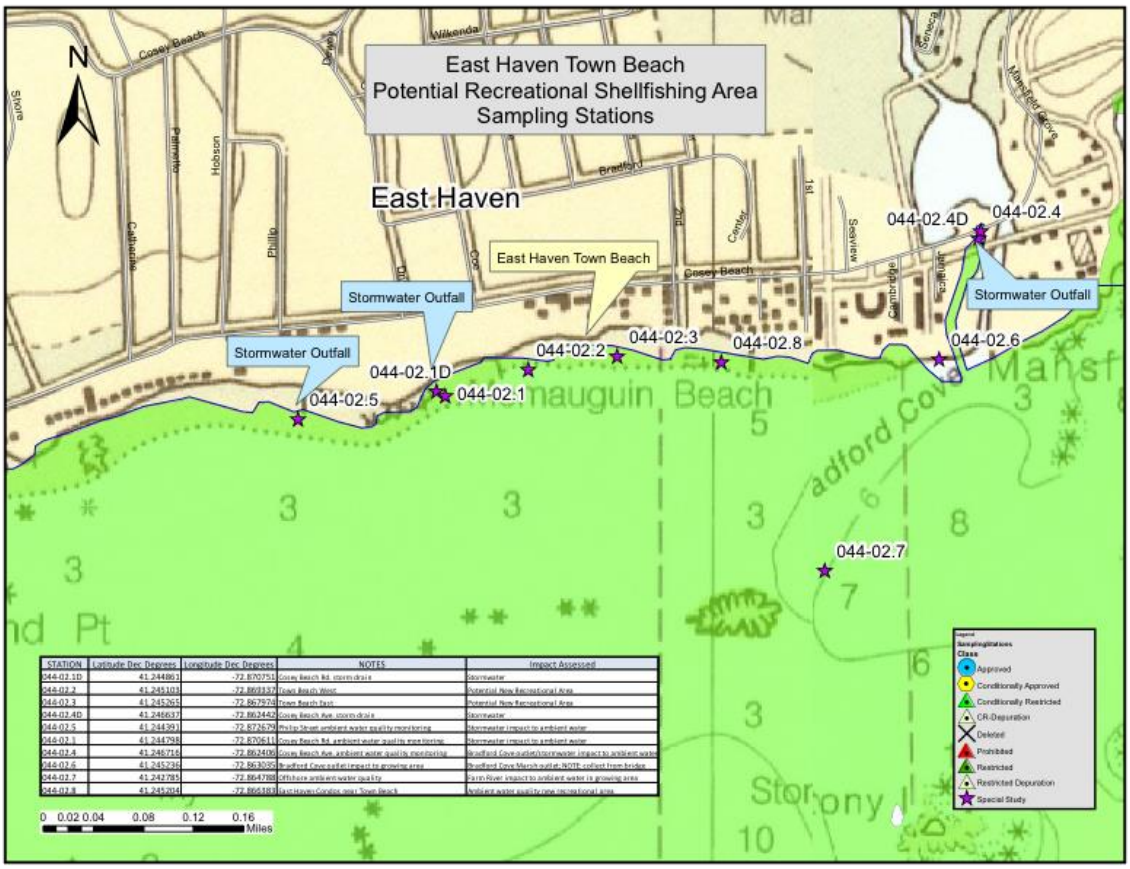
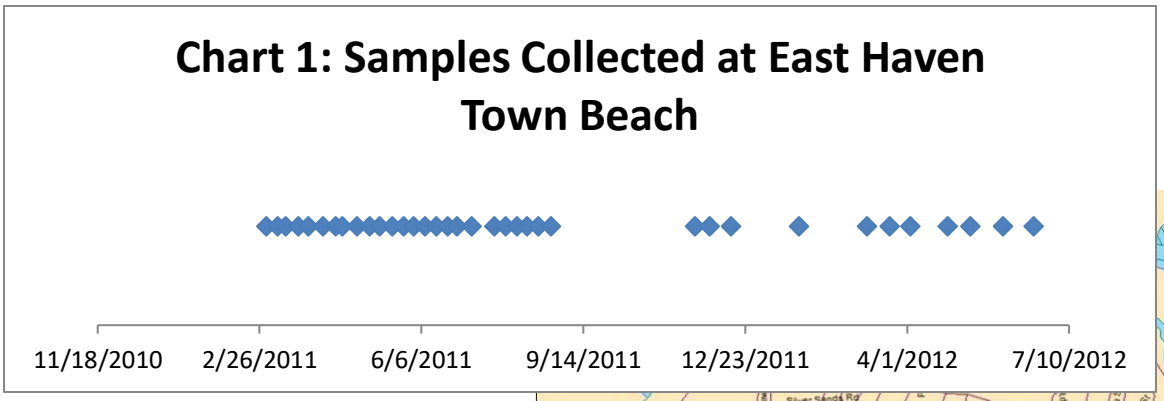


Figure 4 From Bureau of Aquaculture, map of proposed recreational area and sampling locations.

Samples have been collected at ebb and low tides as recommended by the DA/BA, with a focus on collection following rainfall events. Rainfall was recorded at the Branford Wastewater Pollution Control Facility. Samples were collected at depths of approximately 12 inches from the river stations and <12 inches from the storm drains and pipes. In 2012, sampling was limited to only those sites within the proposed area. As seen in Chart 1, samples have been collected for nearly two years at this site, with higher sampling frequency taking place during the summer seasons. An additional gap in sampling collection between September and November 2011 was due to damage caused by Tropical Storm Irene.



Lower Farm River

Sampling stations in the Lower Farm River Watershed were created in March 2011 and have been sampled repeatedly as indicated by Figure 6. Samples are collected usually at ebb tide, at least one hour past high tide, and sampling events have been focused on capturing information inclusive of all times and weather conditions, although sampling was more intense in the summer season when higher counts were anticipated.

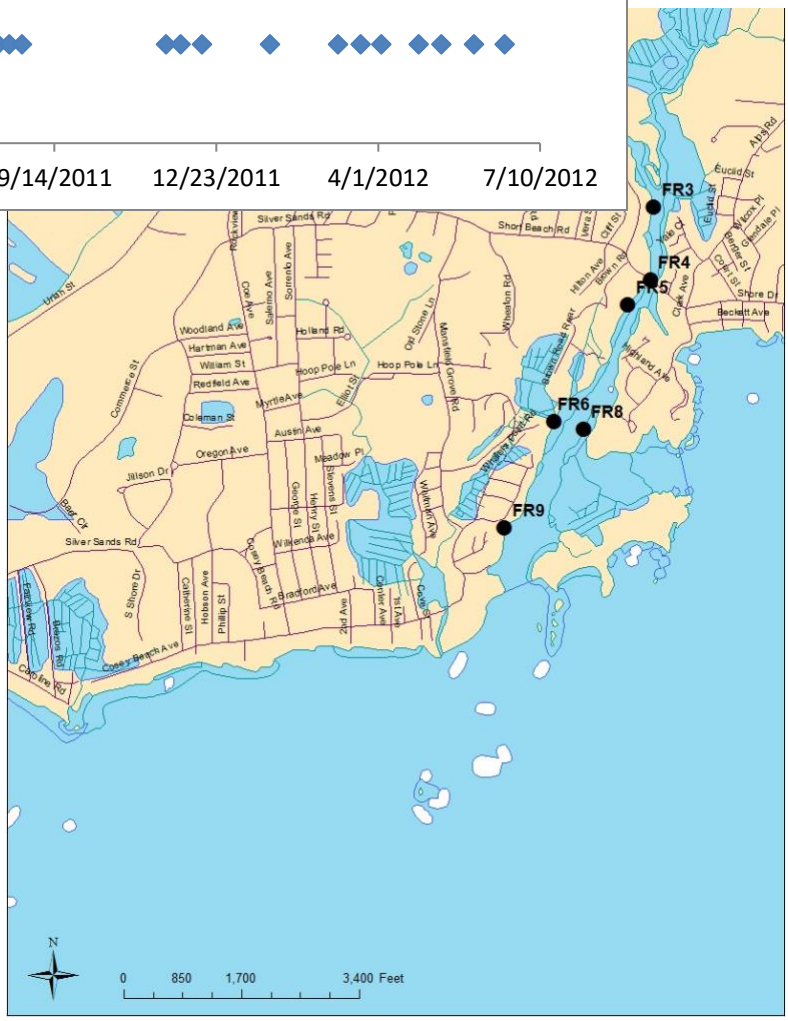
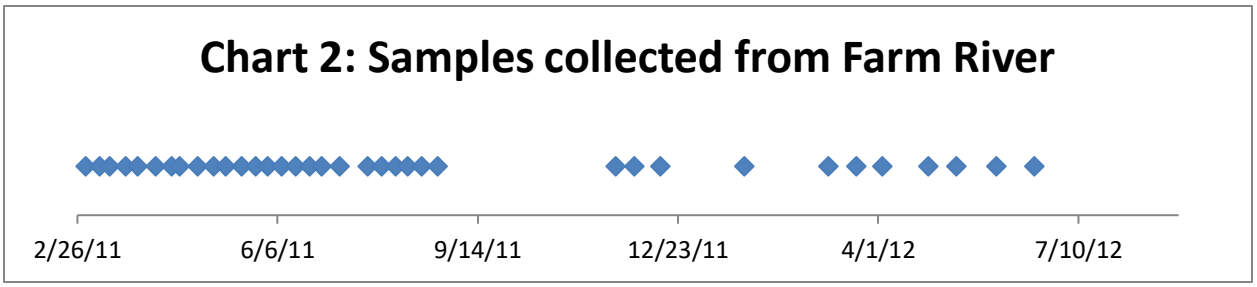


Figure 5 Farm River Sampling locations

Original sampling stations were chosen to represent locations spread throughout the lower river, without introducing redundancies. The original six sampling stations (FR1-FR6, Figure 5) were expanded to include a seventh station immediately below Lake Saltonstall (FR0), in order to capture the water quality levels as they leave Lake Saltonstall. At the end of the summer sampling season, sampling stations were modified to include two new sample sites (FR8 and FR9), while also discontinuing samples at three of the original sites as the sites were spaced close to one another (FR3, FR5 and FR6) and results from these locations did not differ significantly.



Fecal Coliform Monitoring

Water samples collected for the purpose of fecal coliform testing were collected in sterilized bottles provided by the DA/BA. Following Bureau of Aquaculture protocols, water samples were collected and transported on ice to the DA/BA laboratory in Milford, Connecticut. At the time of collection, a temperature control was also collected to verify the appropriate handling of the samples. Samples were brought to the DA/BA lab and processed within 24 hours of collection following DA/BA protocols for the membrane filtration method reporting results in colony forming units (CFUs).

Bacteroides Sampling

In addition to monitoring for fecal coliform levels, water samples were also collected from the Farm River to be analyzed for host specific *Bacteroides* markers. These are markers which have been shown to be present only in *Bacteroides* from human sources, and are therefore able to indicate whether or not human sources of bacteria are loading into the sample site. These samples were collected at the same time as the fecal coliform samples, and at least one sample per month was collected for host specific analysis. Samples were collected in sterile one-liter bottles and stored on ice until brought to the DNA Analysis Facility at Yale University. Samples were stored at 4°C for no more than 6 hours prior to filtration. Subsamples of 250 milliliters were filtered through 20µm pore sized cellulose filters to collect the bacteria. DNA was extracted directly from the filters using the MoBio Power Water DNA Isolation Kit. Extracted DNA was diluted 1:5 to reduce inhibitors and analyzed for the presence of a human specific host marker using the HF183 (5'ATCATGAGTTCACATGTCCG3')/265R (5'TACCCCGCCTACTATCTAATG3') primer pair in 25 µl reactions following SYBR Green Chemistry recommendations. Thermal cycling program consisted of 2 minutes at 94°C, followed by 40 cycles of 15 seconds at 94°C, 32 seconds at 60°C and all analyses were conducted on an ABI 7500 Fast Real-Time Polymerase Chain Reaction (PCR) Machine. All samples were run in triplicate on the machine, and a sample was considered "positive" for the human specific marker if all three replicates amplified. Specificity of the amplicon was evaluated by comparing the melting temperature to that of a known positive control. Additionally, a general (not

specific to human hosts) *Bacteroides* marker was tested for in a similar way with the exception that TaqMan chemistry was used for the detection of the general *Bacteroides* marker.

YSI Probe

In addition to the bacteria monitoring, a Yellow Springs Instruments (YSI) Quatro Professional Plus probe capable of measuring temperature, pH, salinity, and dissolved oxygen (DO) was used to monitor the water quality in the Farm River. The probe was received in the fall, after the summer sampling season and was only used in 2012. The probe was calibrated on a regular basis, for pH and DO following the manufacturer's instructions.

Regression Modeling

Multiple Linear Regression models were developed using the R statistical package. All sample sites were analyzed to determine factors that are most correlated with elevated bacteria counts and models were constructed. Factors considered included: rainfall (on Days 0-3 before sampling as well as total), month collected, time of collection, time before low tide, and high and low air temperatures for the day of sampling. These additional analyses can show interactions between potential factors that are missed using single factor comparisons.

Results and Discussion

Sanitary Survey and Catch Basins

Using the information at the ESDHD regarding connections to the public sewer lines, houses that were not listed as "connected" were visually inspected and if possible, connection was verified. All houses that were not listed as connected were then visually inspected for any obvious signs of septic failure or discharge. All locations were mapped by address producing the map shown below (figure 6). The houses highlighted in Figure 6 were either not connected to the sewers or were located in positions that are likely to impact the water quality if the current systems were to fail. While there were no failures at this time, these sites could cause future concerns if appropriate maintenance fails.

Figure 6. Houses not connected to sewers

All catch basins with potential to impact the study areas were marked using the GPS unit to generate the map pictured in Figure 7. This map was previously unavailable in electronic form and will be helpful in the future if any problems arise. However, during this study, no abnormal discharges or high counts were observed, with one exception described below.

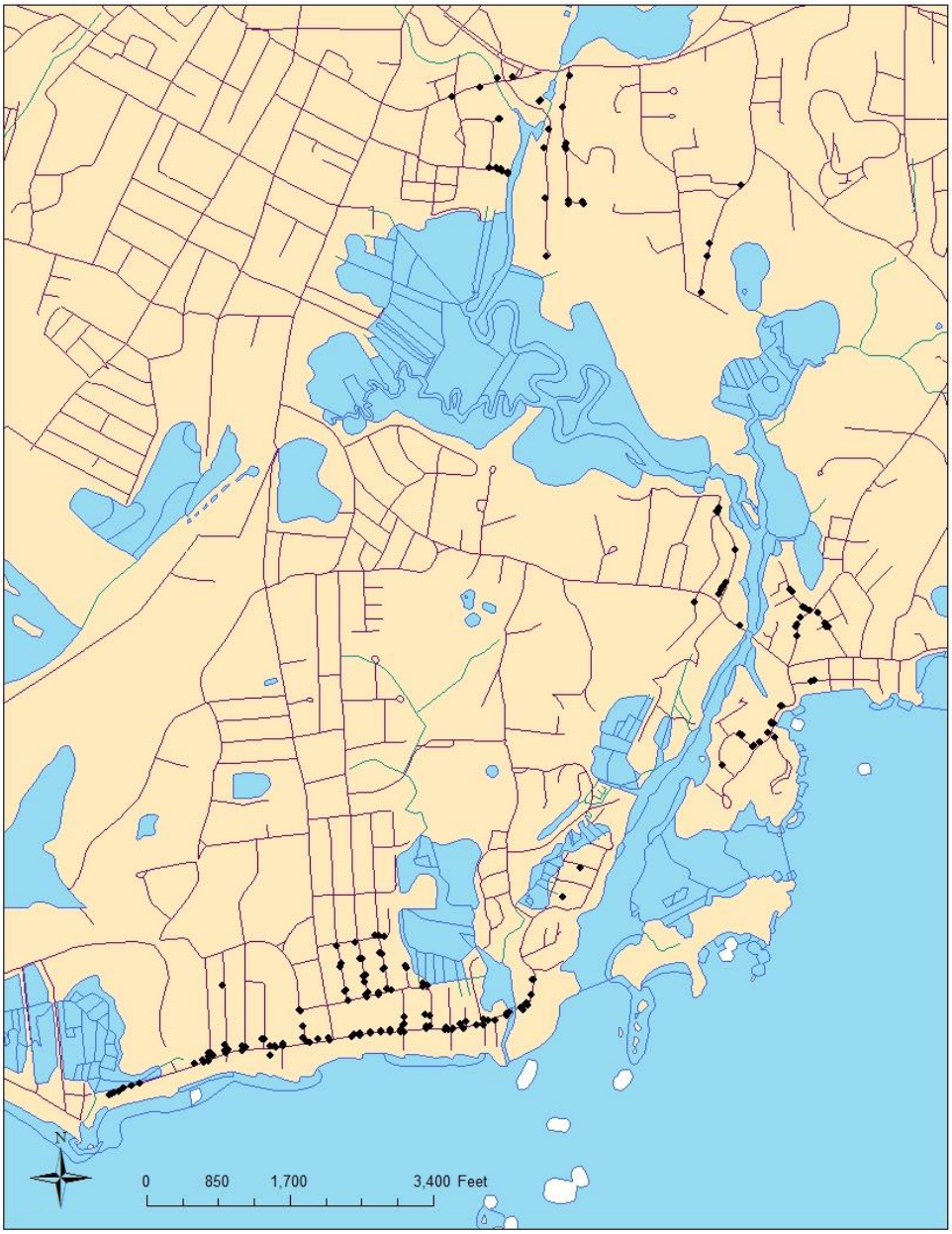
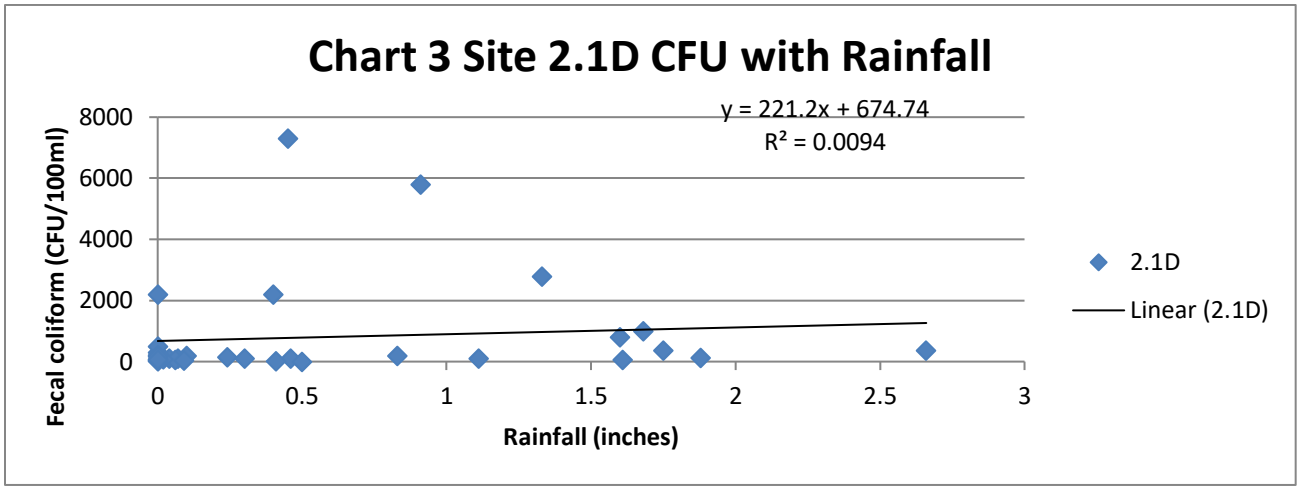


Figure 7 Catch Basins within the study area.

Site 2.1D at Cosey Beach Avenue

2.1D is a catch basin on Cosey Beach Avenue that drains directly to Long Island Sound just east of the proposed recreational shellfish area. This site was monitored by the Bureau of Aquaculture as site 2.1D for nearly two years. During this monitoring period, elevated levels of bacteria occurred on multiple events. Additionally, neighbor complaints were reported on both the color and smell of the water in the catch basin; however, upon inspection no problems were observed. All source tracking investigations in this area were unsuccessful at locating a source, as the elevated bacteria levels appeared to be intermittent and not correlated with common factor such as rainfall (Chart 3). This lack of correlation suggests other sporadic sources, in addition to usual nonpoint runoff.



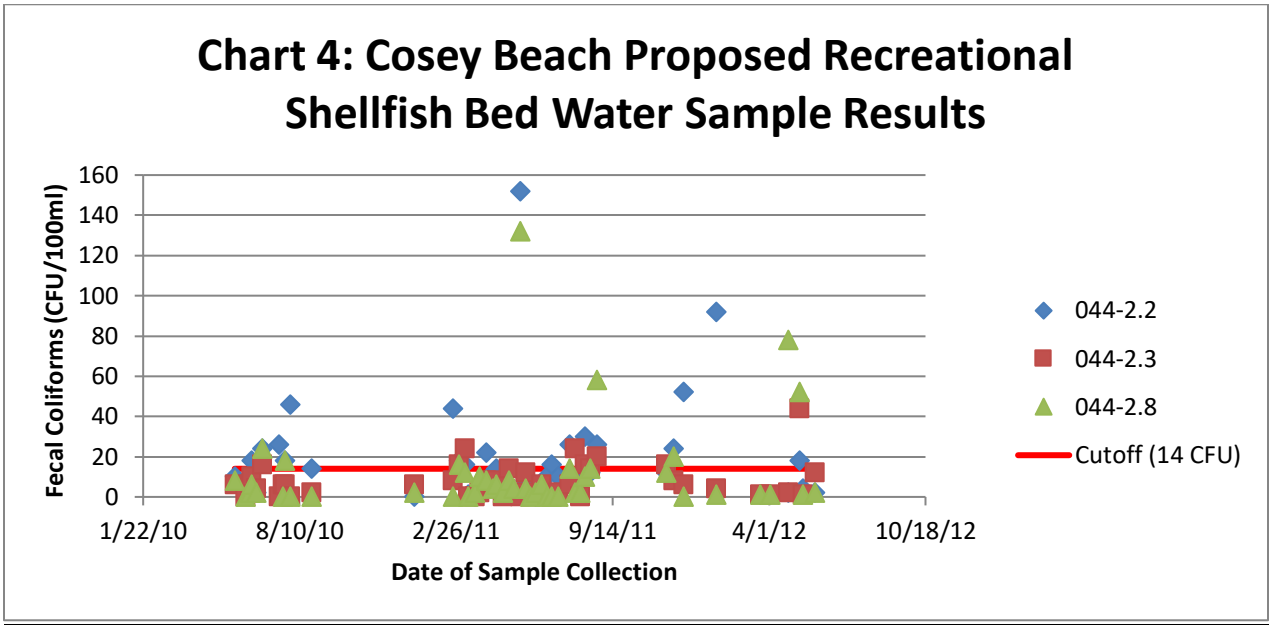
In spite of these high levels and the close proximity to the proposed recreational area, these high counts did not seem to impact the bacterial levels at the proposed bed as there was no correlation between high levels of bacteria within the drain and elevated counts at the proposed bed. However, if counts are consistently elevated, this location should be remembered as a potential source.

Water Sampling

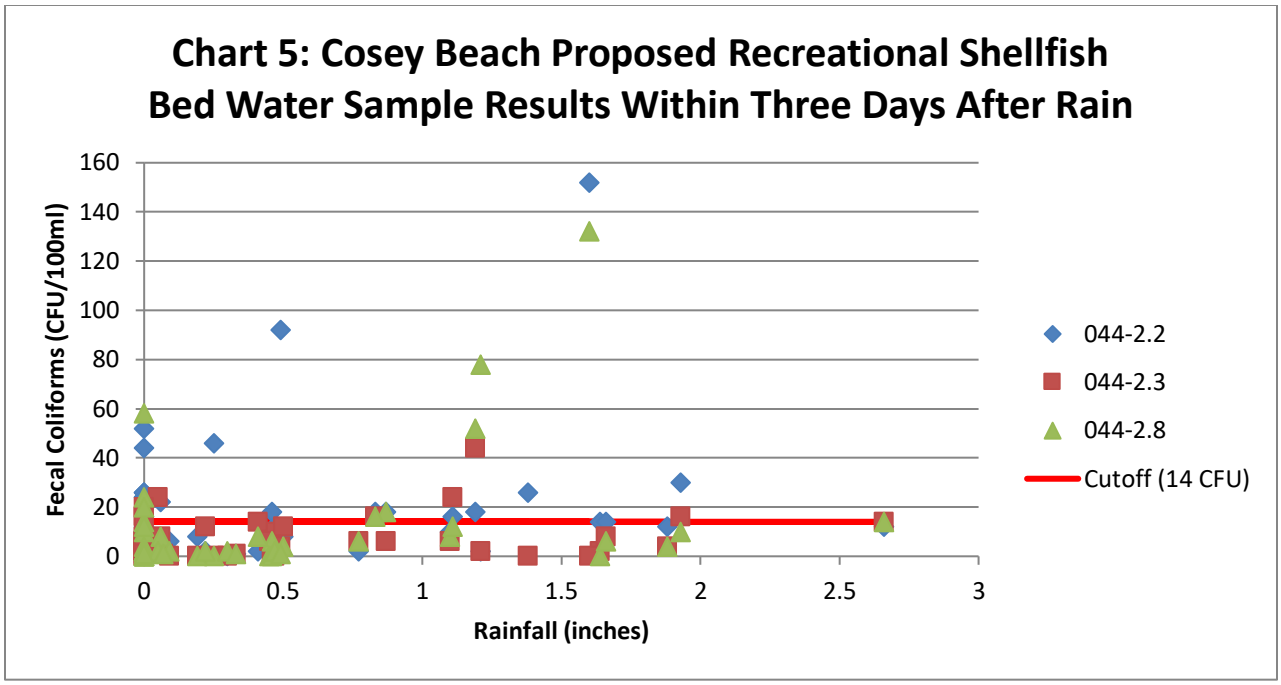
Cosey Beach

After nearly two years of sampling the East Haven Town Beach, the DA/BA decided to limit the sampling sites to those being considered for the potential recreational area. The repeated sampling has consistently shown that the area has potential to be conditionally approved with a 0.5 or 1.0 inch rainfall required to trigger the closing of the area. Monitoring of areas outside of the potential area is to be discontinued and only samples collected at those three sites will be continued.

In depth analysis of the data is ongoing by the DA/BA; however, a brief analysis will be presented here. In general, the data suggest that overall, the area has a general trend of low fecal coliform counts, with the majority of sample results below the cutoff set by the National Shellfish Sanitation Program at 14 CFU/100 ml (shown in red in Chart 4). However, as seen in Chart 4, not all the sample values are below this threshold.



Inspecting the sites based on rainfall shows that bacteria levels at each of these sites is correlated with rainfall. This correlation with rainfall allows the potential for a conditional recreational bed, with a closing trigger to be determined by future water and meat sampling, but likely to be set at either 0.5 inch or 1 inches of rainfall.



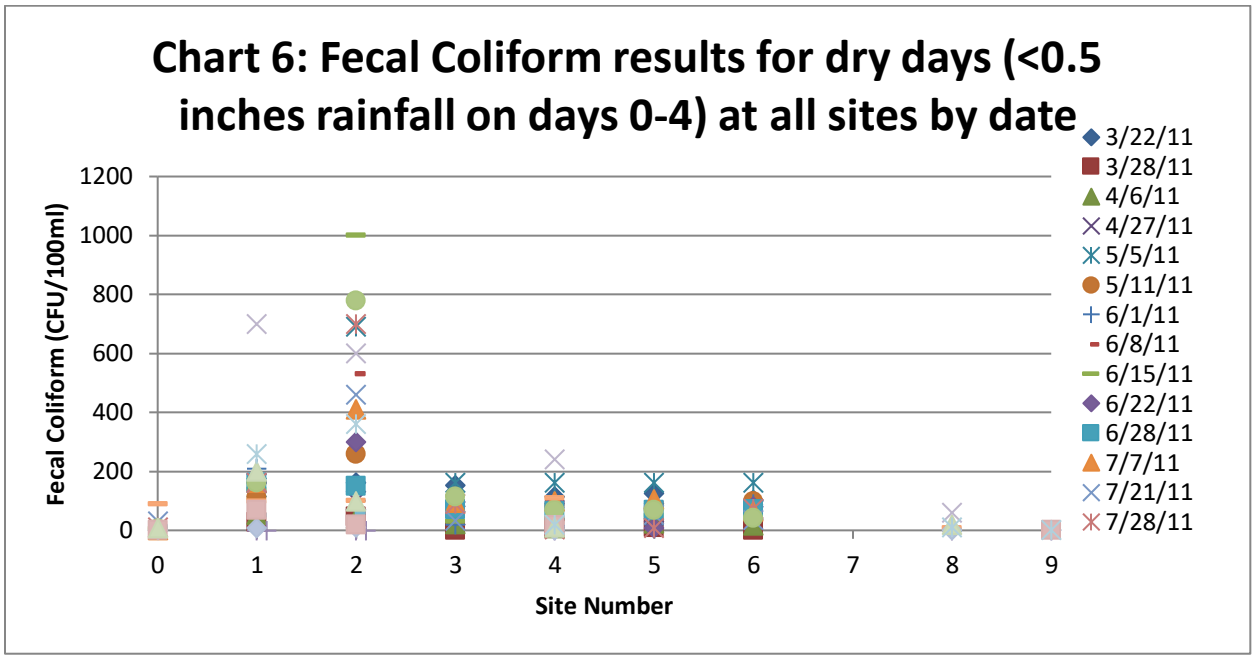
YSI Monitoring

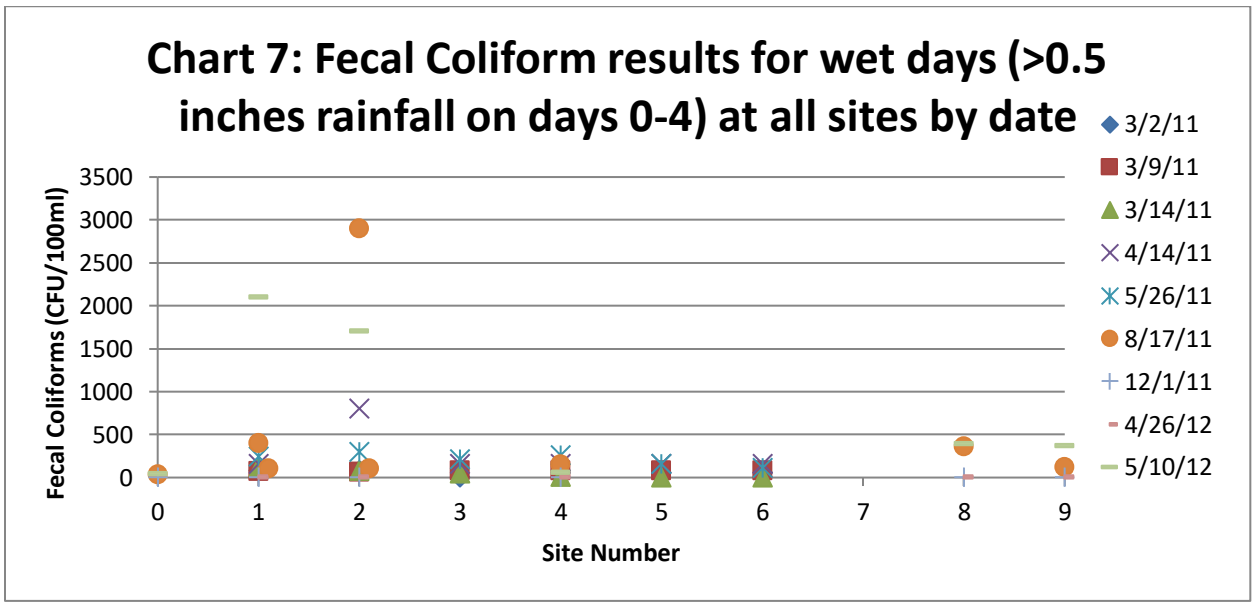
Month	Salinity (ppt)	Temperature (Celsius)	DO (%)
January	25	4.1 (39.4 F)	127
March	25	4.8 (40.6 F)	129
April	24	10.5 (50.9 F)	128
May	25	15.6 (60.1 F)	121
June	26	22.2 (72.0 F)	109

The YSI probe was used to track water quality parameters other than bacteria levels. Water from Cosey Beach was analyzed with the probe once per month in 2012 for the parameters shown on the left. All measurements are within normal and expected bounds for the area. Readings were recorded at depths of <12 inches. The probe will continue to be used for measuring parameters for meat collection at the proposed recreational shellfish area as required by the Bureau of Aquaculture.

Lower Farm River

Fecal coliform monitoring in the Lower Farm River has revealed several trends in the Farm River. Most notable in these results is the consistent spiking in the fecal coliform counts seen at Site #2. Bacteria levels at this site are consistently elevated relative to the other sites under both dry (Chart 6) and wet (Chart 7) conditions. While actual counts may be difficult to interpret from this graph, the general trend of increased fecal coliform counts at Site 2 is clearly shown. * *Additionally, two wet weather dates in which counts exceeded 8,000 CFU at Site 2 were left out of this graphic as it altered the scale past a visible level.*





Traditional survey work provided possible sources, but no definitive cause as catch basins surveyed in the area were not experiencing bacteria levels as high as those seen in the river and regions immediately up or downstream had lower coliform counts. Other potential sources in the region of Site 2 were noted during the survey work, including several houses in the area, the Shoreline Trolley Museum, and a nearby farm (birds), none of which appeared to be potential sources of bacteria due to distance from the water or lack of problems noted.

Using Real-Time PCR to detect host specific markers, the presence of human specific fecal *Bacteroides* was detected at least once at each of the sites (with the exception of site 0 at the outflow of Lake Saltonstall), with Site 2 experiencing the most frequent detection at 91% (Table 1). Both Sites 1 and 2 experienced more frequent presence of human sources of bacteria relative to the downstream sampling locations. Additionally, these sites typically had the highest fecal coliform counts as well, suggesting that this area is negatively impacted by human sources of bacteria loading. However, it cannot be stated that other, non-human, sources are not also contributing to the bacteria loading in this area, and should still be considered in future investigations as well as any remediation attempts. (See Appendix 1.)

PCR Analyses Detection Frequency Results			
Site Number	Bacteroides Detection Frequency (% of samples)	Human Specific Bacteroides Detection Frequency (% of samples)	Number of Samples
0	100	0	4
1	100	82	23
2	100	91	23
3	100	45	11
4	100	27	23
5	100	27	11
6	100	45	11
8	100	36	11
9	100	22	11

Regression Modeling

Multiple linear regression models were constructed for each site within the Farm River as well as the three sampling sites within the proposed shellfishing area. These models provide useful information about other parameters that are correlated with elevated bacteria levels, while they should not be used to predict bacteria counts.

The models constructed for the sites at Cosey Beach showed a general trend of rainfall on Day 1 (one day before samples were collected) being the most significantly correlated with bacteria counts. Rainfall on Day 2 and Day 3 were also significant, as was total rainfall in days 0-4, as

was the month in which the sample was collected. No other parameters had significant correlation with the bacteria levels.

Models for the Farm River sites varied greatly between sample sites, but all had rain on Day 1 as the most significant predictor. However, each site differed with respect to the relative significance of other parameters, but in general all models showed correlation between rainfall and bacteria levels.

Conclusions

As a result of this project, valuable water quality data has been collected in both the Farm River as well as at Cosey Beach. This new information provides a more in-depth examination, adding to the historical data collections to create a holistic picture of water quality in this study area. Additionally, valuable information about other aspects of the region has been gained, including electronic maps showing catch basins as well as houses not connected to the sewers, which will provide valuable resources should future issues arise.

Water samples in the proposed recreational shellfishing area at Cosey Beach continue to be collected on days 0 through 4 after a 0.5 to 1.0 inch rainfall. Additionally, oyster and clam meat samples will be collected in the proposed area for bacterial analysis by the DA/BA. While collecting tissue samples, it will also be necessary to use the YSI probe to monitor water temperature and salinity at the time of collection, as these parameters are required by the Bureau of Aquaculture. With an adequate number of samples indicating the site has acceptable bacteria levels, there is potential to open the area for recreational shellfishing.

Further investigations into the area surrounding Site #2 are also planned, as the location of the town sewer line has not been verified, but may be located nearby. The sewer line is thought to run under the Farm River at a location near Site #2, and could be one more possible source of the bacteria loading. If reasonably close, the sewer line will be tested to attempt to detect any potential leaks. If any leaks are detected, the necessary actions will be taken to ensure the sewer line is functioning properly.

Additionally, the Lower Farm River Watershed was studied extensively for nearly 18 months, providing in depth information regarding the water quality within the estuary. Overall, the water flowing out of the Farm River did not have significantly elevated bacteria counts. While Site #2 did have consistently elevated bacteria counts, it is located above a marsh which acts as a filter. Sites below the marsh consistently had lower counts than those upstream, as well as fewer detections of the human specific marker. As a result of this filtration and possible dilution by other feeder streams, water entering Long Island Sound has significantly lower

bacteria counts than anticipated based on sampling upstream in the Farm River. While the bacteria levels in the river are still high enough to prohibit shellfishing activities in the river, they are likely not impacting the shellfish beds at the adjacent beaches.

The ESDHD will continue to monitor and assess catch basins, pipes and homes with subsurface sewage disposal systems and holding tanks in the coming year(s).

Survey locations summary:

201 catch basins inspected –

2 require follow-up sampling and investigation.

377 homes surveyed -

301 homes were connected to public sewers.

3 homes had holding tanks

48 homes had subsurface sewage disposal systems

80 locations require rechecks or some type of follow-up action.

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Appendix 1: Farm River Sites Raw Data

The data below includes the Site Number, Date of sample collection, Rainfall on Days 0 through 3, Total Rainfall, CFU as reported by the Bureau of Aquaculture, and the presence or absence of both the general *Bacteroides* marker, as well as the Human Specific Marker (0 = no detection, 1 = detected, - - = not analyzed)

Site	Date	Rain Day 0	Rain Day 1	Rain Day 2	Rain Day 3	Rain Total inches	Fecal coliform CFU	*Bacteroides*	Human marker
1	3/2/2011	0	0	1.13	0.06	1.19	81	--	--
2	3/2/2011	0	0	1.13	0.06	1.19	81	--	--
3	3/2/2011	0	0	1.13	0.06	1.19	1	--	--
4	3/2/2011	0	0	1.13	0.06	1.19	81	--	--
5	3/2/2011	0	0	1.13	0.06	1.19	56	--	--
6	3/2/2011	0	0	1.13	0.06	1.19	58	--	--
1	3/9/2011	0	0	0.24	1.05	1.29	73	--	--
2	3/9/2011	0	0	0.24	1.05	1.29	68	--	--
3	3/9/2011	0	0	0.24	1.05	1.29	81	--	--
4	3/9/2011	0	0	0.24	1.05	1.29	81	--	--
5	3/9/2011	0	0	0.24	1.05	1.29	81	--	--
6	3/9/2011	0	0	0.24	1.05	1.29	81	--	--
1	3/14/2011	0	0	0	0.61	0.61	120	--	--
2	3/14/2011	0	0	0	0.61	0.61	78	--	--
3	3/14/2011	0	0	0	0.61	0.61	48	--	--
4	3/14/2011	0	0	0	0.61	0.61	8	--	--
5	3/14/2011	0	0	0	0.61	0.61	2	--	--
6	3/14/2011	0	0	0	0.61	0.61	2	--	--
1	3/22/2011	0	0.25	0	0	0.25	161	--	--
2	3/22/2011	0	0.25	0	0	0.25	161	--	--
3	3/22/2011	0	0.25	0	0	0.25	152	--	--
4	3/22/2011	0	0.25	0	0	0.25	114	--	--
5	3/22/2011	0	0.25	0	0	0.25	126	--	--
6	3/22/2011	0	0.25	0	0	0.25	102	--	--
1	3/28/2011	0	0	0	0	0	28	--	--
2	3/28/2011	0	0	0	0	0	46	--	--
3	3/28/2011	0	0	0	0	0	2	--	--
4	3/28/2011	0	0	0	0	0	8	--	--
5	3/28/2011	0	0	0	0	0	10	--	--
6	3/28/2011	0	0	0	0	0	2	--	--
1	4/6/2011	0.01	0.09	0.03	0	0.13	54	--	--
2	4/6/2011	0.01	0.09	0.03	0	0.13	40	--	--
3	4/6/2011	0.01	0.09	0.03	0	0.13	22	--	--
4	4/6/2011	0.01	0.09	0.03	0	0.13	8	--	--
5	4/6/2011	0.01	0.09	0.03	0	0.13	24	--	--

6	4/6/2011	0.01	0.09	0.03	0	0.13	18	--	--
1	4/14/2011	0.01	0.69	0.5	0	1.2	161	--	--
2	4/14/2011	0.01	0.69	0.5	0	1.2	801	--	--
3	4/14/2011	0.01	0.69	0.5	0	1.2	161	--	--
4	4/14/2011	0.01	0.69	0.5	0	1.2	161	--	--
5	4/14/2011	0.01	0.69	0.5	0	1.2	161	--	--
6	4/14/2011	0.01	0.69	0.5	0	1.2	161	--	--
1	4/27/2011	0	0	0	0.11	0.11	160	--	--
2	4/27/2011	0	0	0	0.11	0.11	100	--	--
3	4/27/2011	0	0	0	0.11	0.11	50	--	--
4	4/27/2011	0	0	0	0.11	0.11	70	--	--
5	4/27/2011	0	0	0	0.11	0.11	60	--	--
6	4/27/2011	0	0	0	0.11	0.11	70	--	--
1	5/5/2011	0	0.35	0	0	0.35	146	--	--
2	5/5/2011	0	0.35	0	0	0.35	690	--	--
3	5/5/2011	0	0.35	0	0	0.35	161	--	--
4	5/5/2011	0	0.35	0	0	0.35	161	--	--
5	5/5/2011	0	0.35	0	0	0.35	161	--	--
6	5/5/2011	0	0.35	0	0	0.35	161	--	--
1	5/11/2011	0	0	0	0	0	112	--	--
2	5/11/2011	0	0	0	0	0	260	--	--
3	5/11/2011	0	0	0	0	0	64	--	--
4	5/11/2011	0	0	0	0	0	82	--	--
5	5/11/2011	0	0	0	0	0	74	--	--
6	5/11/2011	0	0	0	0	0	98	--	--
1	5/19/2011	0.14	0.9	0.85	0.14	2.03	801	1	1
2	5/19/2011	0.14	0.9	0.85	0.14	2.03	8001	1	1
3	5/19/2011	0.14	0.9	0.85	0.14	2.03	801	1	1
4	5/19/2011	0.14	0.9	0.85	0.14	2.03	801	1	1
5	5/19/2011	0.14	0.9	0.85	0.14	2.03	801	1	1
6	5/19/2011	0.14	0.9	0.85	0.14	2.03	801	1	1
1	5/26/2011	0	0	0.41	0.24	0.65	240	1	0
2	5/26/2011	0	0	0.41	0.24	0.65	300	1	1
3	5/26/2011	0	0	0.41	0.24	0.65	210	1	1
4	5/26/2011	0	0	0.41	0.24	0.65	260	1	0
5	5/26/2011	0	0	0.41	0.24	0.65	160	1	1
6	5/26/2011	0	0	0.41	0.24	0.65	110	1	1
1	6/1/2011	0	0	0.2	0	0.2	210	1	1
2	6/1/2011	0	0	0.2	0	0.2	100	1	1
3	6/1/2011	0	0	0.2	0	0.2	20	1	1
4	6/1/2011	0	0	0.2	0	0.2	10	1	0
5	6/1/2011	0	0	0.2	0	0.2	20	1	0
6	6/1/2011	0	0	0.2	0	0.2	90	1	1

1	6/8/2011	0	0	0	0	0	161	1	1
2	6/8/2011	0	0	0	0	0	530	1	1
3	6/8/2011	0	0	0	0	0	96	1	0
4	6/8/2011	0	0	0	0	0	86	1	0
5	6/8/2011	0	0	0	0	0	92	1	0
6	6/8/2011	0	0	0	0	0	86	1	0
1	6/15/2011	0.07	0.09	0.11	0.18	0.45	140	1	1
2	6/15/2011	0.07	0.09	0.11	0.18	0.45	1000	1	1
3	6/15/2011	0.07	0.09	0.11	0.18	0.45	30	1	1
4	6/15/2011	0.07	0.09	0.11	0.18	0.45	40	1	1
5	6/15/2011	0.07	0.09	0.11	0.18	0.45	50	1	1
6	6/15/2011	0.07	0.09	0.11	0.18	0.45	70	1	0
1	6/22/2011	0.02	0.02	0.02	0.03	0.09	161	1	1
2	6/22/2011	0.02	0.02	0.02	0.03	0.09	300	1	1
3	6/22/2011	0.02	0.02	0.02	0.03	0.09	96	1	1
4	6/22/2011	0.02	0.02	0.02	0.03	0.09	92	1	0
5	6/22/2011	0.02	0.02	0.02	0.03	0.09	8	1	0
6	6/22/2011	0.02	0.02	0.02	0.03	0.09	80	1	0
1	6/28/2011	0	0.03	0.02	0.03	0.08	161	1	1
2	6/28/2011	0	0.03	0.02	0.03	0.08	150	1	0
3	6/28/2011	0	0.03	0.02	0.03	0.08	72	1	0
4	6/28/2011	0	0.03	0.02	0.03	0.08	64	1	0
5	6/28/2011	0	0.03	0.02	0.03	0.08	70	1	0
6	6/28/2011	0	0.03	0.02	0.03	0.08	72	1	1
1	7/7/2011	0	0	0	0	0	161	1	1
2	7/7/2011	0	0	0	0	0	410	1	1
3	7/7/2011	0	0	0	0	0	94	1	0
4	7/7/2011	0	0	0	0	0	98	1	0
5	7/7/2011	0	0	0	0	0	106	1	0
6	7/7/2011	0	0	0	0	0	64	1	0
0*	7/7/2011	0	0	0	0	0	2	1	0
1	7/21/2011	0	0	0	0	0	161	1	1
2	7/21/2011	0	0	0	0	0	460	1	1
3	7/21/2011	0	0	0	0	0	32	1	0
4	7/21/2011	0	0	0	0	0	46	1	1
5	7/21/2011	0	0	0	0	0	54	1	0
6	7/21/2011	0	0	0	0	0	34	1	0
0*	7/21/2011	0	0	0	0	0	30	1	0
1	7/28/2011	0	0	0	0	0	161	1	1
2	7/28/2011	0	0	0	0	0	700	1	1
3	7/28/2011	0	0	0	0	0	90	1	0
4	7/28/2011	0	0	0	0	0	4	1	0
5	7/28/2011	0	0	0	0	0	8	1	0

6	7/28/2011	0	0	0	0	0	74	1	1
0*	7/28/2011	0	0	0	0	0	10	1	0
1	8/4/2011		0	0	0.47	0.47	161	1	1
2	8/4/2011		0	0	0.47	0.47	780	1	1
3	8/4/2011		0	0	0.47	0.47	114	1	0
4	8/4/2011		0	0	0.47	0.47	70	1	0
5	8/4/2011		0	0	0.47	0.47	68	1	0
6	8/4/2011		0	0	0.47	0.47	42	1	0
0*	8/4/2011		0	0	0.47	0.47	6	1	0
1	8/10/2011		0.82	0.01	1.1	1.93	>800	1	1
2	8/10/2011		0.82	0.01	1.1	1.93	>8000	1	1
3	8/10/2011		0.82	0.01	1.1	1.93	560	--	--
4	8/10/2011		0.82	0.01	1.1	1.93	380	1	1
5	8/10/2011		0.82	0.01	1.1	1.93	320	--	--
6	8/10/2011		0.82	0.01	1.1	1.93	140	--	--
0*	8/10/2011		0.82	0.01	1.1	1.93	<100	--	--
1	8/17/2011		0	0.33	2.33	2.66	400	1	1
1.1	8/17/2011		0	0.33	2.33	2.66	100	1	1
2	8/17/2011		0	0.33	2.33	2.66	2900	1	1
2.1	8/17/2011		0	0.33	2.33	2.66	100	--	--
4	8/17/2011		0	0.33	2.33	2.66	150	1	1
0*	8/17/2011		0	0.33	2.33	2.66	30	--	--
8	8/17/2011		0	0.33	2.33	2.66	360	1	1
9	8/17/2011		0	0.33	2.33	2.66	120	1	1
1	8/25/2011		0	0	0	0	460	1	0
1.1	8/25/2011		0	0	0	0	210	1	1
2	8/25/2011		0	0	0	0	360	1	1
2.1	8/25/2011		0	0	0	0	120	--	--
4	8/25/2011		0	0	0	0	42	1	0
8	8/25/2011		0	0	0	0	6	1	0
9	8/25/2011		0	0	0	0	6	1	0
1	12/1/2011	0	0.05	0.58	0	0.63	1400	1	1
2	12/1/2011	0	0.05	0.58	0	0.63	700	1	1
4	12/1/2011	0	0.05	0.58	0	0.63	640	1	0
0*	12/1/2011	0	0.05	0.58	0	0.63	30	--	--
8	12/1/2011	0	0.05	0.58	0	0.63	540	1	0
9	12/1/2011	0	0.05	0.58	0	0.63	490	1	0
1	12/14/2011	0	0	0	0	0	50	1	1
2	12/14/2011	0	0	0	0	0	60	1	1
4	12/14/2011	0	0	0	0	0	2	1	0
0*	12/14/2011	0	0	0	0	0	12	--	--
8	12/14/2011	0	0	0	0	0	2	1	0
9	12/14/2011	0	0	0	0	0	10	1	0

1	1/25/2012	0	0	0.23	0.02	0.25	99	1	1
2	1/25/2012	0	0	0.23	0.02	0.25	100	1	1
4	1/25/2012	0	0	0.23	0.02	0.25	110	1	0
0*	1/25/2012	0	0	0.23	0.02	0.25	90	--	--
8	1/25/2012	0	0	0.23	0.02	0.25	9	1	0
9	1/25/2012	0	0	0.23	0.02	0.25	20	1	0
1	3/7/2012	0	0	0	0	0	9	1	0
2	3/7/2012	0	0	0	0	0	10	1	0
4	3/7/2012	0	0	0	0	0	1	1	0
0*	3/7/2012	0	0	0	0	0	1	--	--
8	3/7/2012	0	0	0	0	0	1	1	0
9	3/7/2012	0	0	0	0	0	1	1	0
1	3/21/2012	0	0	0	0	0	70	1	0
2	3/21/2012	0	0	0	0	0	20	1	1
4	3/21/2012	0	0	0	0	0	16	1	0
0*	3/21/2012	0	0	0	0	0	1	--	--
9	3/21/2012	0	0	0	0	0	2	1	0
1	4/3/2012	0	0	0.16	0.12	0.28	200	1	1
2	4/3/2012	0	0	0.16	0.12	0.28	99	1	1
4	4/3/2012	0	0	0.16	0.12	0.28	10	1	0
0*	4/3/2012	0	0	0.16	0.12	0.28	9	--	--
8	4/3/2012	0	0	0.16	0.12	0.28	20	1	0
1	4/26/2012	0.05	0.01	0	1.27	1.33	300	1	1
2	4/26/2012	0.05	0.01	0	1.27	1.33	300	1	1
4	4/26/2012	0.05	0.01	0	1.27	1.33	230	1	1
8	4/26/2012	0.05	0.01	0	1.27	1.33	70	1	1
9	4/26/2012	0.05	0.01	0	1.27	1.33	50	1	1
1	5/10/2012	0.5	0.7	0.06	0	1.26	2100	1	1
2	5/10/2012	0.5	0.7	0.06	0	1.26	1700	1	1
4	5/10/2012	0.5	0.7	0.06	0	1.26	60	1	0
0*	5/10/2012	0.5	0.7	0.06	0	1.26	40	--	--
8	5/10/2012	0.5	0.7	0.06	0	1.26	390	1	1
9	5/10/2012	0.5	0.7	0.06	0	1.26	370	--	--
1	5/30/2012	0.01	0.04	0.3	0.02	0.37	700	--	--
2	5/30/2012	0.01	0.04	0.3	0.02	0.37	600	--	--
4	5/30/2012	0.01	0.04	0.3	0.02	0.37	240	--	--
8	5/30/2012	0.01	0.04	0.3	0.02	0.37	60	1	1
1	6/18/2012	0	0	0	0	0	260	1	1
2	6/18/2012	0	0	0	0	0	360	1	1
4	6/18/2012	0	0	0	0	0	20	1	0
8	6/18/2012	0	0	0	0	0	10	1	0
9	6/18/2012	0	0	0	0	0	1	1	0

*Station 0 = site just south of the Lake Saltonstall reservoir entry.

Part II: Local Shellfish Marketing and Promotional Program

Two free family recreational clam digs were held with and additional educational booth set-up at a local festival event. The digs were so popular the Shellfish Commission and ESDHD decided to make them an annual town event.

Areas were stocked with local hard clams and local harvesters also donated clams for "tastings." Recipes and shucking guides were provided.

An informational booth was set-up during the Branford Festival and the Branford Town Clerk was on-site to issue recreational shellfishing permits to festival goers. Local shellfishing information, recipes, shucking guides, tide charts and other various Long Island Sound brochures were handed out to hundreds of residents during this annual town festival.

The first local "Clam Dig" was held in July of 2011 at Limewood Beach with more than 42 clammers of all ages turning out. A local commercial harvester worked with the Shellfish Commission to stock the area prior to the dig and also provided fresh locally harvested CT Clams for a locally licensed caterer to steam and serve to the participants. Prizes were awarded for those finding specially marked clams. Residents were also shown how to open their catch! A table was set-up providing informational brochures on Long Island Sound, water quality, and shellfish. A new awareness pamphlet was created to reduce bacterial loading by educating shoreline residents about the hazards of pet waste and the importance of proper disposal.

The second "Clam Dig" was scheduled in September at the Owenego Club but had to be cancelled the morning of the event due to heavy rain closing the area.

The 2012 Clam Dig was hosted by the Owenego Inn on Sunday September 9, 2012 from 11:00 AM – 1:00 PM during low tide.
The two-hour event was free to all.

The grounds of the Owenego Inn were beautiful with trees providing shade and gorgeous views of Long Island Sound and the nearby Branford islands. The weather was perfect; calm and sunny with warm air and water temperatures! The clamming area was generally soft and sandy and less than waist high at low tide.

The Shellfish Commission restocked the area two days prior with 6,000 locally harvested clams from a local commercial harvester.

The ESDHD had a table with information on Long Island Sound, water quality, shellfishing, seafood safety, and shellfish recipes. The first 50 families received an insulated food bag (promoted by CT Sea Grant, CT Seafood Council and CT Department of Agriculture) with an ice pack promoting food safety! Prizes were awarded for those lucky enough to find a green colored clam! There were between 125 and 150 people at the event with more than 60 people out clamming at any one time.

There were six (6) “loaner” rakes available that were used for the entire event with several new-clammers waiting for a rake! Instructors walked new clammers out and taught them how to rake for the clams.

The Owenego made two special chowders, a clear-broth, and creamy New England chowder along with fresh locally harvested steamed clams which were all donated by a local commercial harvester.

A PowerPoint presentation on “How to Host a Clam Dig” was developed and presented at the Annual CT Shellfish Commission gathering at the New Haven Sound School in January. A clamming video was made by a local student and several different educational brochures on shellfish safety, animal waste, and wastewater were also developed.