VERMONT
ENVIRONMENTAL CONSERVATION

Direct Smaller Drainages to inner Mallets Bay

Watershed Description

This bacteria TMDL summary applies to the entire stream and tributary length of the direct smaller drainages to Inner Mallets Bay, hereafter referred to as "the direct drainages." The direct drainages are comprised of Smith Hollow Brook and Crooked Creek. The watersheds of these two small streams abut one another and the streams drain into Malletts Bay only a quarter mile apart. The streams begin in a wooded and agricultural area to the east of Interstate 89 near Severance Road and Poor Farm Road in the center of Colchester. Multiple smaller tributaries enter the streams along their north westerly course under Interstate 89 before draining into Malletts Bay near Lakeshore Drive.

Colchester has a population of around 17,000 people and is one of the largest municipalities in Vermont (CCRCP, 2006). Protecting the streams draining into Malletts Bay and their water quality is important to Colchester residents. The town is 37 square miles and it has almost 30 miles of shoreline on Lake Champlain mostly in Malletts Bay (Colchester, 2002). Over the last several decades the inner bay has been plagued by sporadic outbreaks of high bacteria counts forcing beach closures (Colchester, 2007).

The entire length of both Smith Hollow Brook and Crooked Creek are considered bacteria impaired. Including all of the tributaries that makes the total segment length nearly 18 miles long (CCRCP, 2006). The combined watershed for the direct drainages (Figure 1) covers 3.5 square miles, entirely in the town of Colchester. Overall, land use in the watershed is 59% forested, 23% agricultural, 15% developed, and 3% wetland, as shown in Figure 2 (based on 2006 Land Cover Analysis by NOAA-CSC).

Waterbody Facts (VT05-09)

- **Towns:** Colchester
- **Impaired Segment Location:** Entire length of both streams
- **Impaired Segment Length:** 18 miles
- **Classification:** Class B
- **Watershed Area:** 7.5 square miles
- **Planning Basin:** 5 – Northern Lake Champlain

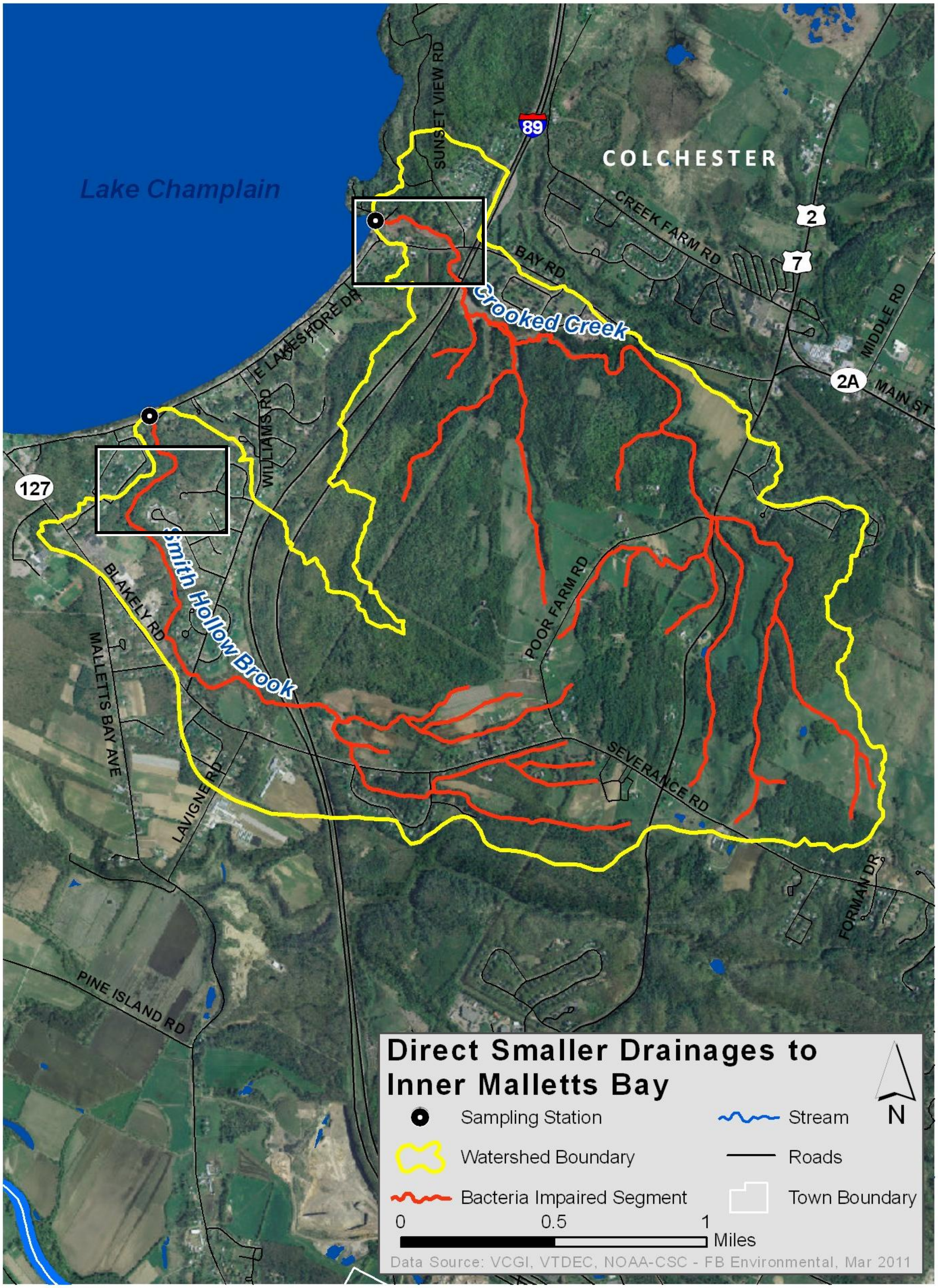

Figure 1: ***Map of The Direct Drainages to Malletts Bay watershed with impaired segment and sampling stations indicated. Insert areas correspond to figures 3 and 4 below.***

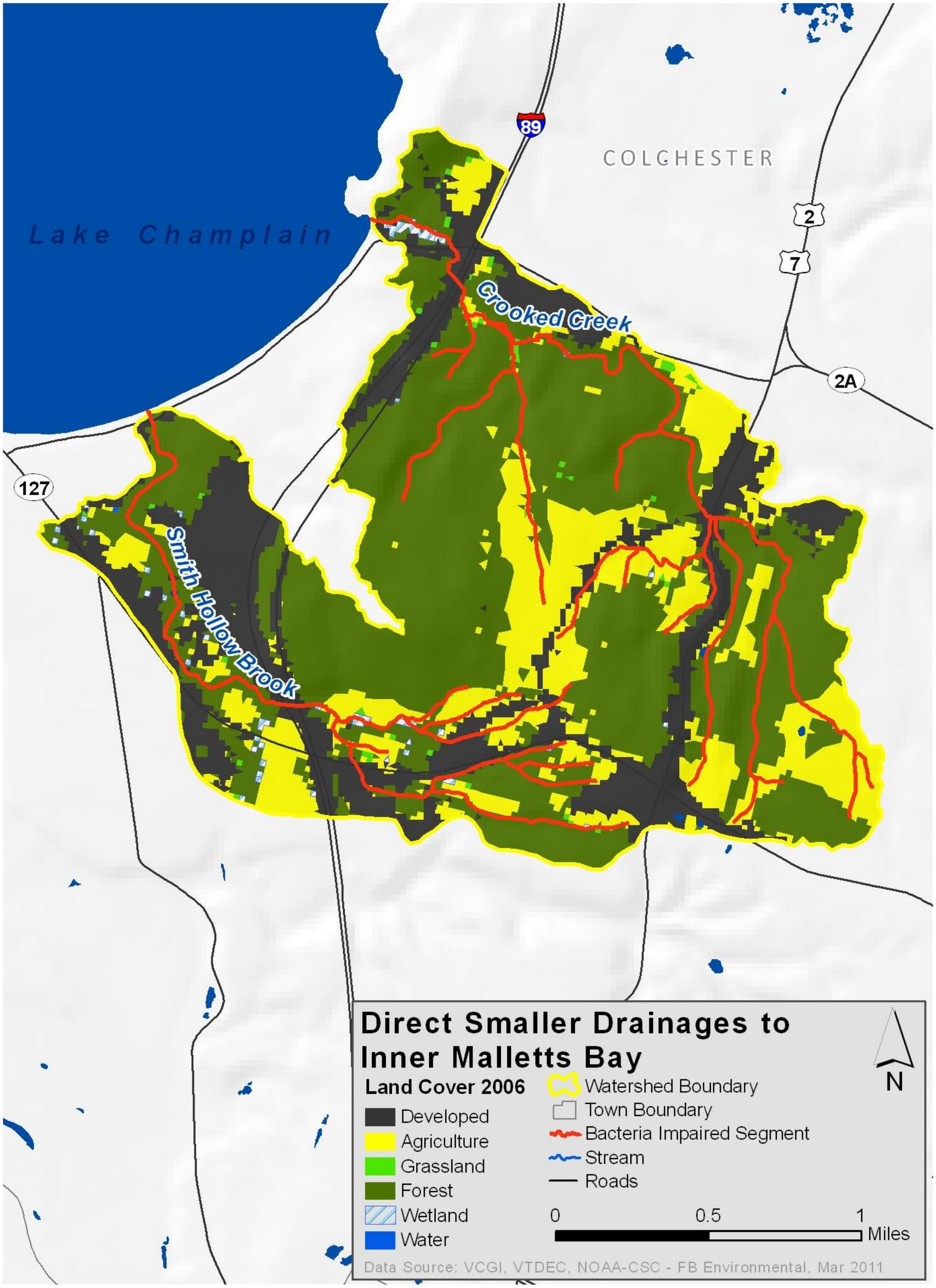

Figure 2: ***Map of The Direct Drainages to Malletts Bay watershed with impaired segment and land cover indicated.***

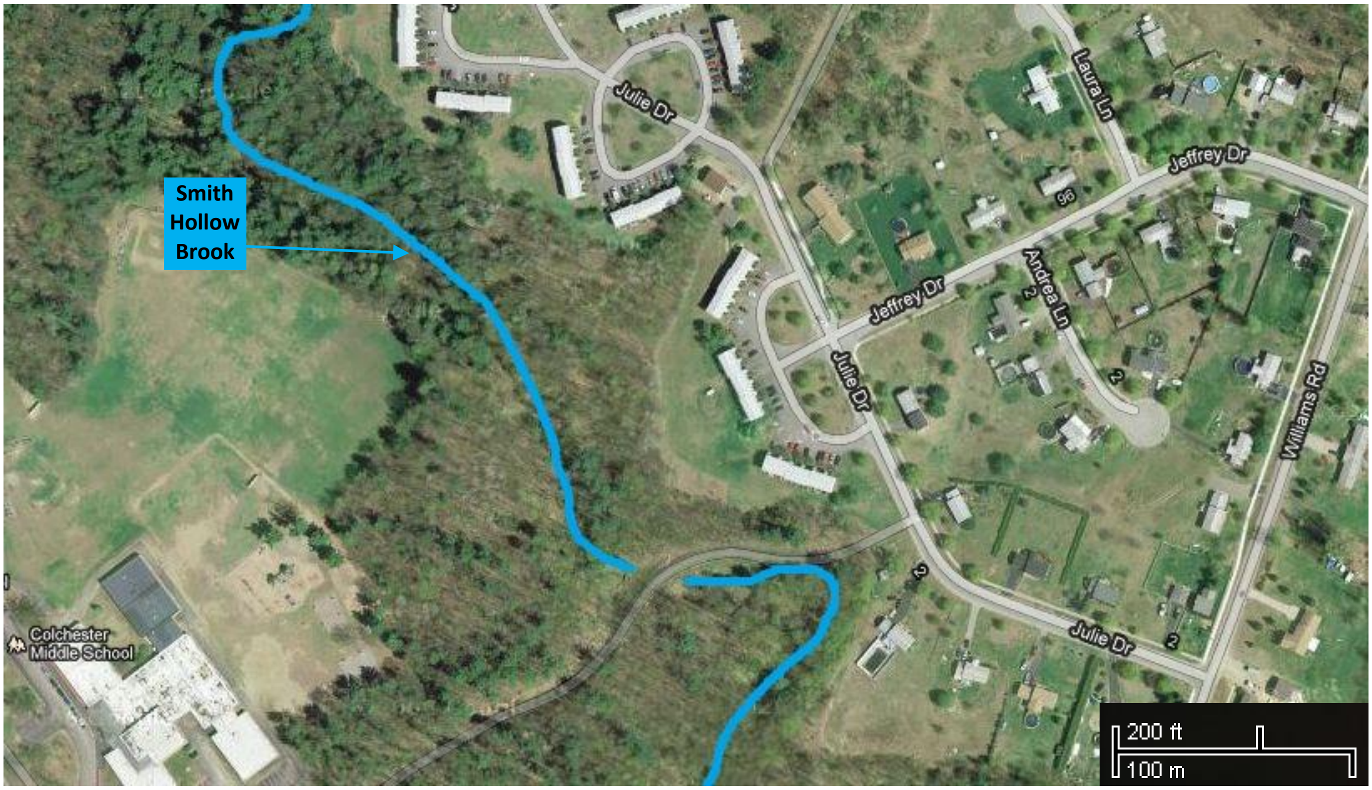

Figure 3: ***Aerial view of Smith Hollow Brook as it passes between developments near the Colchester Middle School (Source: Google Maps)***

Figure 3 provides a more detailed aerial view of Smith Hollow Brook as it passes through municipal and residential development near Blakely Road. Residential development occurs in some locations adjacent to the stream. Figure 4 below displays an area of Crooked Creek that has multiple residential units very close to a wetland area the stream passes through. A stream geomorphic assessment of Smith Hollow Brook in 2007 found that the watershed is covered with 10.5% impervious surfaces (Fitzgerald, 2007). Impervious surfaces can negatively impact surface water quality due to stormwater runoff.

Stormwater flows off impervious surfaces such as driveways, rooftops, and roads when it rains. On these surfaces the water collects a suite of pollutants, including bacteria (VTDEC, 2009). Much of the stormwater that reaches the brook is carried within municipally owned drainage networks called storm sewers (Smartwaterways, 2010). Due to the amount of development within the town of Colchester, the municipality is one of nine municipalities within Vermont regulated by the Environmental Protection Agency (EPA) under the National Pollutant Discharge Elimination System (NPDES) and must retain a permit for their storm sewer system. The town's storm sewer is referred to as a municipal separate storm sewer system (MS4). Stormwater that enters the MS4 is discharged into the brook at outfalls; this may include bacteria from a variety of possible sources (Smartwaterways, 2010). In order to meet the requirements of its permit, Colchester must employ a variety of best management practices (BMPs). Educating citizens about the pervasiveness of stormwater and constructing BMPs aimed at reducing pollutant loads are components of the MS4 permit.

Many wetland acres within the Northern Lake Champlain Basin and within the direct drainages watershed have been destroyed or degraded by urbanization and land development activities (VTDEC, 2009). Several wetland areas remain intact within the watershed (Colchester, 2007). Wetlands play a critical role in reducing runoff pollution and help with flood attenuation. Removing wetlands and developing along a stream's banks, as seen in the direct drainages watershed, restricts the brooks access to its natural flood plain. It also converts areas that once played a critical role in filtering runoff, into areas generating polluted stormwater directly adjacent to the brook (VTANR, 2007). Figure 4 displays a wetland area along Crooked Creek near its mouth.

Figure 4: ***Aerial view of Crooked Creek displaying the proximity of residential development to the stream, near where it outlets into Inner Malletts Bay (left) (Source: Google Maps).***

Why is a TMDL needed?

The direct drainages to inner Mallets Bay are considered a Class B, cold water fishery with designated uses including swimming, fishing and boating (VTDEC, 2008). Samples have been collected from the sampling stations shown in Figure 1 near the outlet of each stream. Bacteria data from these sampling locations have consistently exceeded Vermont's water quality criteria for *E.coli* bacteria. Table 1 below provides bacteria data collected at these sampling locations from 2005. Table 1 provides the water quality criteria for *E.coli* bacteria along with the individual sampling event bacteria results and geometric mean concentration statistics for one sampling season on the direct drainages. For the direct drainages, Vermont's current single sample water quality criterion is exceeded in almost every single sampling event.

Due to the elevated bacteria measurements presented in Table 1, the direct drainages to Inner Mallets Bay for their entire length, did not meet Vermont's water quality standards, were identified as impaired and placed on the 303(d) list. The 303(d) listing states that use of the direct drainages for contact recreations (i.e., swimming) are impaired. The Clean Water Act requires that all 303(d) listed waters undergo a TMDL assessment that describes the impairments and identifies the measures needed to restore water quality. The goal is for all waterbodies to comply with state water quality standards.

Potential Bacteria Sources

Both Smith Hollow Brook and Crooked Creek were identified as "hot spots" for bacterial contamination to Inner Malletts Bay as far back as 1991 (Colchester, 2003). There are many possible sources of bacterial contamination to the direct drainages including; failing septic systems, illicit discharges to Colchester's MS4, stormwater from developed areas, and wildlife.

E. coli is a bacteria naturally found within the intestinal tract and thus fecal matter of warm blooded animals such as dogs, cows, birds, and humans. Its presence within surface water is a strong indication of fecal matter contamination (USDA, 2000). One potential source of fecal matter contamination to surface waters is sewage entering from failing or malfunctioning septic systems (VTDEC, 2009). Nearly all of Colchester's residents within the direct drainages watershed rely on onsite septic disposal systems to treat their wastewater. Only a small portion of the watershed near the headwaters is serviced by sanitary sewer (Colchester, 2007). A 1996 Wastewater Facility Planning Update for Colchester found there were multiple areas of town where onsite systems were maintained infrequently or never. One of the areas identified, around Lakeshore Drive, surrounds the outlets of both Smith Hollow Brook and Crooked Creek (Colchester, 2003).

There may be a number of physical deficiencies for existing development within the drainages watershed including non conforming septic disposal systems and marginally suited soils for septic disposal. Furthermore, in 2007 many of the onsite disposal systems within town were found to be old and nearing the end of their useful lives (Colchester, 2007). When systems are old, unmaintained, or placed on soils with poor suitability they can malfunction and release bacteria to nearby surface waters (USEPA, 2002). A microbial source tracking study conducted by the town of Colchester in 2001 attempted to identify sources contributing bacteria to Malletts Bay. This study collected water samples from a variety of locations, including the outlet of Smith Hollow Creek. *E.coli* bacteria in the samples were isolated and their source organism was identified. While the study could not identify the major source of bacterial contamination to Mallets Bay, samples from the outlet of Smith Hollow Creek did contain some *E.coli* attributed to human sources (Colchester, 2003). These factors combine to make failing septic systems in the drainages watershed a potential source of bacterial contamination.

Colchester's Department of Public Works (DPW), attempts to locate illicit discharges to its storm sewer as part of their MS4 permit. Illicit discharges are any discharge to the storm sewer or to streams that contain any substances other than stormwater. These discharges can include sanitary sewer pipes from a residence or an under drain from a mechanics garage that are connected into the MS4 (Colchester, 2008). Sometimes residents will make illicit connections to the MS4 sending their wastewater into the storm sewer rather than a septic system or sanitary sewer, which is called a "direct discharge." Also, "indirect discharges" can occur when failing septic systems near the MS4 network leach sewage into the storm sewer (Colchester, 2008). Both types of illicit discharges have the potential to contribute bacteria (and other pollutants) to the MS4 which can reach the direct drainages at one of the MS4 outfalls on the streams (Colchester, 2008). Smith Hollow Brook and Crooked Creek have been identified by the DPW as high priority areas for Illicit Discharge Detection and Elimination (IDDE) testing. As of 2008, no illicit discharges had been detected at MS4 outfalls on these streams.

Given the impervious surfaces within the drainages watershed, and the extensive MS4 network in Colchester, stormwater is another potential source for bacterial contamination. There are a multitude of possible sources for bacteria in stormwater. When animal waste is not disposed of properly and left near the stream or on impervious surfaces that fecal matter can contaminate the stream. One of the most widely documented and likely source of *E. coli* in stormwater from some urban areas is pet fecal matter, specifically that of dogs. If residents are not properly disposing of their pet's fecal matter or not picking fecal matter up from streets where storm drains catch runoff, it can enter and contaminate the direct drainages. This fecal matter can be a major source of bacterial contamination, especially in areas where residential development is so prevalent around the drainages (Smartwaterways, 2010).

During a 2003 study of high bacteria levels within Inner Malletts Bay, wildlife sources were identified as a possible cause of elevated bacteria levels (Colchester, 2003). Species such as deer, raccoons, birds, and beavers are possible sources of *E.coli* to surface water when they live in large enough quantities on or near the streams. There is a large section of town mapped as a deer wintering area within the drainages watershed to the east of Interstate 89 (Colchester, 2007). The microbial source tracking done by the town in 2001 identified deer, more than any other species, as the source of *E.coli* bacteria in water samples (Colchester, 2003). The known concentration of deer and other animals within the watershed, as well as the identification of deer during the microbial source tracking, makes wildlife another potential source of bacterial contamination.

Recommended Next Steps

The town of Colchester has taken a proactive approach to dealing with the problems faced by the direct drainages to Inner Mallets Bay. Colchester was Vermont's first recipient of an EPA grant for the development of an Integrated Water Resources Management Plan. The planning process has identified many positive goals for water quality within Colchester including long-term sustainability, community involvement, prioritization of pollutant problems, and public outreach (Colchesterwaters, 2011). The town has also partnered with community organizations, stakeholders, and the other MS4 regulated communities within Vermont to form the Regional Stormwater Education program (RSEP) in 2003. This collaborative works to encourage residents to get personally involved in reducing stormwater pollution. While the focus has been centered on stormwater's other pollutants and nutrients, the town and its partners have worked to address stormwater related bacterial issues as well (Smartwaterways, 2010). These programs are working to address the problems faced by the direct drainages.

The Town of Colchester, local stakeholders, as well as other community and watershed based groups are encouraged to continue implementing education and outreach programs, restoration programs, and the identification of land use activities that might be influencing *E. coli* levels. Colchester could specifically target education and outreach efforts to residential areas that surround Crooked Creek, with a special focus on the Lakeshore Drive area near its outlet. This area was identified as a potential hot spot for septic system failure (Colchester, 2003). However, it is important to note that readings from Smith Hollow Brook still exceed Vermont's water quality criteria on multiple occasions. The town has made funding available for residents that wish to replace or update an existing onsite system in town. A focused effort could be made in these areas to encourage residents to inspect their septic systems and remind them of the town's willingness to assist in replacing failing systems.

Citizens throughout the watershed, especially in residential areas near the drainages should be reminded of the importance of picking up after pets. While the MS4 communities in Vermont are already collaborating through RSEP, a focused marketing effort could be made in the greater Burlington area to raise public awareness about bacteria in stormwater. Marketing campaigns and advertisements on TV, in radio, and in print that display in a unique and compelling way the problems associated with improperly disposed of pet waste would be beneficial. Funds are available to assist communities and organizations with outreach and education from the Non Point Source Grant Program (319 Program), the Lake Champlain Basin Program, and many other nonprofit, governmental, and private organizations.

An example of a successful outreach and education effort is the "Scoop the Poop Campaign." This collaborative effort between Burlington Eco Info and the Burlington Neighborhood Project which started in the early 2000s provides information on how pet waste can impact water quality and can ultimately lead to public health hazards and beach closures (EcoInfo). Efforts that make direct connections between behaviors that are good for streams and recreational activities that people enjoy, such as swimming in Lake Champlain, gives educational messages positive and lasting impact.

Additional bacteria data collection may also be beneficial to support identification of sources of potentially harmful bacteria in the direct drainages watershed. For example, continued and expanded sampling upstream and downstream of potential illicit discharges (a practice known as "bracket sampling") may be beneficial for identifying and quantifying sources. A potential location to undertake "bracket sampling" is in the residential area around Crooked Creek, shown in figure 4, near East Lakeshore Drive, Bay Road, and Sunset View Road. Since the sampling station on Crooked Creek is near its outlet into Lake Champlain, sampling at various intervals upstream from the outlet and comparing the results could help to locate a potential hot spot of bacteria loading to the creek. Sampling activities focused on capturing bacteria data under different weather conditions (e.g., wet and dry) may also be beneficial in support of source identification. Field reconnaissance surveys focused on stream buffers, stormwater runoff, and other source identification may also be beneficial.

Previous investigations and concerned groups (Smartwaterways, 2010; CCRPC, 2006; Colchester, 2003; Colchester, 2007; Champlain, 1996) have recommended the following actions to support water quality goals in the direct drainages to Inner Mallets Bay:

- Stormwater – Continue and expand citizen education about the negative impacts of stormwater, with a focus on the importance of picking up after one's pet. Develop stronger enforcement mechanisms to ensure the scooping and correct disposal of pet fecal matter. Continue to hold workshops on new and simple ways to reduce the impact of stormwater from ones property with BMPs such as rain barrels and rain gardens.
- Illicit Discharges and Septic Malfunction – Expand testing for illicit discharges using a variety of detection methods. Educate citizens on proper septic system maintenance and how to make sure systems are functioning properly. Provide more cost sharing funds to the town from state or federal agencies to help with septic system replacement or upgrades.
- Riparian Corridor – Encourage landowners to install buffers, and other tools that protect shoreline and/or riparian areas. Institute further controls on riparian buffers.

Several of the steps outlined above are ongoing and should be continued and enhanced to focus on the goals of bacteria TMDL implementation. If implemented, these actions will provide a strong basis toward the goal of mitigating bacteria sources and meeting water quality standards in the direct smaller drainages to Inner Mallets Bay.

Bacteria Data

Vermont's current criteria for bacteria are more conservative than those recommended by EPA. For Class B waters, VTDEC currently utilizes an E. coli single sample criterion of 77 organisms/100ml. Although, Vermont is in the process of revising their bacteria WQS to better align with the National Recommended Water Quality Criteria (NRWQC) of a geometric mean of 126 organisms/100ml, and a single sample of 235 organisms/100ml. Therefore, in Table 1 below, bacteria data were compared to both the current VTWQS and the NRWQC for informational purposes.

Direct Smaller Drainages to inner Mallets Bay, entire length (18 miles).

***WB ID*:** VT05-09

Characteristics: Class B

Impairment: *E. coli* (organisms/100 mL)

Current Water Quality Criteria for E. coli:

Single sample: 77 organisms/100 mL

NRWQC for E. coli:

Single sample: 235 organisms/100 mL

Geometric mean: 126 organisms/100 mL

Percent Reduction to meet TMDL (Current):

Single Sample: **97%**

Percent Reduction to meet NRWQC:

Single sample: **90%**

Geometric mean: **53%**

Data: 2005, Town of Colchester

Table 1: *E.coli* (organisms/100 mL) Data for The Direct Smaller Drainages to Inner Malletts Bay (2005) and Geometric Mean (organisms/100mL) for each Station based on Calendar Year.

Station Name	Station Location	Date	Result	Geometric Mean**
Smith Hollow Creek		8/31/2005	2420	
Smith Hollow Creek		8/29/2005	641	
Smith Hollow Creek		8/24/2005	416	
Smith Hollow Creek		8/17/2005	272	
Smith Hollow Creek		8/17/2005	1550	
Smith Hollow Creek		8/10/2005	105	
Smith Hollow Creek		8/8/2005	135	
Smith Hollow Creek		8/3/2005	179	
Smith Hollow Creek		8/1/2005	248	
Smith Hollow Creek		7/27/2005	2420	
Smith Hollow Creek		7/25/2005	154	
Smith Hollow Creek		7/20/2005	248	
Smith Hollow Creek		7/18/2005	218	242
Smith Hollow Creek		7/13/2005	144	
Smith Hollow Creek		7/11/2005	161	
Smith Hollow Creek		7/7/2005	93	
Smith Hollow Creek		7/5/2005	79	
Smith Hollow Creek		6/29/2005	115	
Smith Hollow Creek		6/27/2005	40	
Smith Hollow Creek		6/22/2005	387	
Smith Hollow Creek		6/20/2005	108	
Smith Hollow Creek		6/15/2005	435	
Smith Hollow Creek		6/13/2005	197	
Smith Hollow Creek		6/8/2005	365	
Smith Hollow Creek		6/6/2005	116	

*Shaded cells indicate single sample and geometric mean used to calculate percent reduction.
**Only geometric mean values calculated with 5 data points or more are used to determine percent reduction.

Table 1: *E.coli* (organisms/100 mL) Data for The Direct Smaller Drainages to Inner Malletts Bay (2005) and Geometric Mean (organisms/100mL) for each Station based on Calendar Year (continued).

Station Name	Station Location	Date	Result	Geometric Mean**
Crooked Creek		8/31/2005	2420	731
Crooked Creek		8/29/2005	461	
Crooked Creek		8/24/2005	205	
Crooked Creek		8/17/2005	1730	
Crooked Creek		8/17/2005	411	
Crooked Creek		8/10/2005	284	
Crooked Creek		8/8/2005	866	
Crooked Creek		8/3/2005	866	
Crooked Creek		8/1/2005	1120	
Crooked Creek		7/27/2005	2420	
Crooked Creek		7/25/2005	1120	
Crooked Creek		7/20/2005	548	
Crooked Creek		7/18/2005	260	
Crooked Creek		7/13/2005	199	
Crooked Creek		7/11/2005	1990	
Crooked Creek		7/7/2005	93	
Crooked Creek		7/5/2005	189	
Crooked Creek		6/29/2005	2420	
Crooked Creek		6/27/2005	222	
Crooked Creek		6/22/2005	2420	
Crooked Creek		6/20/2005	326	
Crooked Creek		6/15/2005	641	
Crooked Creek		6/13/2005	2420	
Crooked Creek		6/8/2005	2420	
Crooked Creek		6/6/2005	2420	

*Shaded cells indicate single sample and geometric mean used to calculate percent reduction.
**Only geometric mean values calculated with 5 data points or more are used to determine percent reduction.

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