A Study of *E. coli* Levels at High Bridge Brook
Waitsfield, Vermont

Lecia Babeu, Elizabeth Lewis, and Audrey Reid

**Watershed Description and Opportunity Statement**

High Bridge Brook is first order stream and tributary to the Mad River. It is located in a rural Waitsfield VT with minimal development around it. High Bridge Brook is a small brook made up mostly of riffle-pool reach sequences. The Mad River then flows into the Winooski River and ultimately into Lake Champlain. The sampling site for this study was located off of Brook Rd in Waitsfield VT. A large cement culvert emptied another tributary into High Bridge Brook upstream of where the samples were taken. The Vermont Department of Environmental Conservation measured *Escherichia coli* levels in many Vermont streams during the summer of 2009, with High Bridge Brook having some of the highest levels of *E. coli* measured. The Friends of the Mad River also collected *E. coli* samples from High Bridge Brook once a month throughout the summer.

Coliforms are fecal bacteria that are used as indicators of sewage contamination as coliform is present in human and animal feces. Most fecal bacteria are not harmful, but their presence indicates the possibility of pathogenic bacteria and viruses being present in the water from human and animal wastes. The presence of fecal bacteria may also suggest that pathogenic microorganisms may be present in stream water making it unsafe for swimming in. High levels of fecal bacteria may also cause turbid water, bad odors, and increased oxygen demand in addition to being a human health concern. Total coliforms, fecal coliforms, *Escherichia coli*, fecal streptococci, and enterococci can all be used as fecal bacteria indicators. Total coliforms and *E. coli* are most commonly tested as water quality indicators. Fecal coliforms may be from human or animal sources, but can also be from soil or submerged wood, so are not always representative of unsafe fecal contamination. Total coliforms are no longer used as an indicator for recreational water safety for this reason, but is often still used as an indicator for drinking water due to that fact that elevated total coliforms represents influence of an outside source on the tested water body. *E. coli* is a single species of fecal coliform that is only present from fecal additions from humans and warm blooded animals to streams, which is why it is a useful indicator of human health risk associated with stream water contact. *E. coli* is a better indicator for digestive system illness borne from swimming in contaminated waters whereas total coliforms are more representative of stream water quality (U.S. Environmental Protection Agency 2006). High levels of *E. coli* in streams may contaminate drinking water if the stream is used as a drinking water source and can also lead to the closure of water bodies for recreational uses like swimming due to human health risks. It has been found in previous studies that fecal bacteria can survive in stream sediments for extended periods and even grow in sediments. High *E. coli* levels may indicate that there is a large amount of animal or human waste entering the stream as non-point source runoff from
surrounding pasture land, or untreated human sewage inputs (Jamieson et al. 2005) *E. coli* levels in streams can also be affected by seasonality due to slowing of bacterial growth during periods of colder temperatures.

The purpose of this study was to measure total coliform and *E. coli* levels in High Bridge Brook in Waitsfield, Vermont to see the change from the samples taken over the summer by citizen groups. The highest levels of these generally occur in the summer months where temperatures are warmer so we expected to see lower levels simply due to the late fall water and air temperatures.

Site Photos and GIS Map of Mad River Watershed

Photo 1: The High Bridge Brook Sampling Site
Photo 2. The sampling site. Note the culvert.

Photo 3. Upstream of the sampling site.
Photo 4. Close-up of streambed. Note iron sludge indicating oxidation.
Mad River Watershed

Legend
Stream Orders

Map Created by Lecia Babeu, Liz Lewis, and Audrey Reid on October 7, 2009 from provided data.
Methods

Data on summer *E. coli* levels was gathered by the Friends of the Mad River. Samples were collected on Jun 16, 2008, June 29, July 13, July 27, August 10, and August 24, 2009.

Samples for the autumn season of 2009 were collected on October 30, November 6, and November 13, 2009. To get the water samples from High Bridge Brook, we took sealed plastic bottles and inverted them straight down into the water, about 6 inches deep, facing directly upstream while standing downstream. While the bottle was under the water, we turned it rightside up to completely fill the bottle and carefully capped it making sure not to touch the rim. This was repeated three times to gather three samples in about the same area for three weeks.

These samples were taken back to the lab within an hour of the sample being taken. Using sterile pipettes, water was removed from the sampling bottle until only 100mL remained. Colilert was then added to the sample and completely dissolved. The water solution was then poured into a Quanti-tray and sealed. The tray was then put in an incubator at about 35°C for 24-26 hours. This was repeated for all samples taken.

To interpret the results, we looked for fluorescence by holding a UV light 5 inches away from the Quanti-tray in a dark environment. We counted the number of small and large wells that fluoresce separately and used an Idexx Quanti-Tray/2000 MPN Table to determine the Most Probable Number. If the wells were yellow, the sample was positive for total coliforms. If the samples were yellow and showed fluorescence, then the sample was also positive for EColi. This was repeated for all the samples.

Results

**Table 1.** Summer data from the Friends of the Mad River

<table>
<thead>
<tr>
<th>Date</th>
<th>E.coli per 100 mls</th>
<th>Water Temp F</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-Jun-08</td>
<td>129.6</td>
<td>54</td>
</tr>
<tr>
<td>29-Jun-09</td>
<td>&gt;2419.2</td>
<td>61.5</td>
</tr>
<tr>
<td>13-Jul-09</td>
<td>51.2</td>
<td>56</td>
</tr>
<tr>
<td>27-Jul-09</td>
<td>81.3</td>
<td>61.5</td>
</tr>
<tr>
<td>10-Aug-09</td>
<td>34.1</td>
<td>60</td>
</tr>
<tr>
<td>24-Aug-09</td>
<td>4.1</td>
<td>65</td>
</tr>
</tbody>
</table>

**Table 2.** Coliform and *E. coli* Results from Testing on 10.30.09

Time: 2:15 pm
Water Temperature: 47.3°F  
Weather Conditions: Overcast, previous days drizzling rain.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Coliform (Large out of 49)</th>
<th>Coliform (Small out of 48)</th>
<th>E. coli (Large out of 49)</th>
<th>E. coli (Small out of 48)</th>
<th>Total E. coli per 100mls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>49</td>
<td>45</td>
<td>8</td>
<td>0</td>
<td>8.6</td>
</tr>
<tr>
<td>Sample 2</td>
<td>49</td>
<td>45</td>
<td>5</td>
<td>2</td>
<td>7.3</td>
</tr>
<tr>
<td>Sample 3</td>
<td>49</td>
<td>47</td>
<td>6</td>
<td>2</td>
<td>8.4</td>
</tr>
</tbody>
</table>

Table 3. Coliform and E. coli Results from Testing on 11.06.09  
Time: 2:15 pm  
Water Temperature: 38.3°F  
Weather Conditions: Overcast, Snow on the mountains

<table>
<thead>
<tr>
<th>Sample</th>
<th>Coliform (Large out of 49)</th>
<th>Coliform (Small out of 48)</th>
<th>E. coli (Large out of 49)</th>
<th>E. coli (Small out of 48)</th>
<th>Total E. coli per 100mls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>49</td>
<td>18</td>
<td>0</td>
<td>0</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Sample 2</td>
<td>49</td>
<td>34</td>
<td>0</td>
<td>0</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Sample 3</td>
<td>49</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>&lt;1.0</td>
</tr>
</tbody>
</table>

Table 4. Coliform and E. coli Results from Testing on 11.13.09  
Time: 2:00 pm  
Water Temperature: 35.6°F  
Weather Conditions: Sunny, warm

<table>
<thead>
<tr>
<th>Sample</th>
<th>Coliform (Large out of 49)</th>
<th>Coliform (Small out of 48)</th>
<th>E. coli (Large out of 49)</th>
<th>E. coli (Small out of 48)</th>
<th>Total E. coli per 100mls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>49</td>
<td>43</td>
<td>2</td>
<td>0</td>
<td>2.0</td>
</tr>
<tr>
<td>Sample 2</td>
<td>49</td>
<td>38</td>
<td>1</td>
<td>0</td>
<td>1.0</td>
</tr>
<tr>
<td>Sample 3</td>
<td>49</td>
<td>45</td>
<td>0</td>
<td>1</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Discussion of Results

Overall, E. coli levels were much higher in the summer months than in the autumn months. Concentrations peaked at >2419.2 E. coli per 100mls of water (the highest concentration possible) on June 29 2009. Concentrations were at their lowest on November 6, 2009, at <1.0 E. coli per 100mls of water.

Previous studies have shown that fecal coliform and E. coli concentrations greatly vary over time (Schilling et al. (2008) (Whitman et al. (2008). Thus, it is expected that the concentrations in High Bridge Brook also varied through the course of our study.

It was particularly interesting that even though our final samples were taken when the stream was close to freezing (temperature was 35.6 °F) that some E.coli were still found in the samples. While our methods always assume
that their might be some *E. coli* in our samples even though it may not show during the tests (thus why the concentration is never 0, but instead <1) our samples from the coldest day still had active *E. coli* colonies (<1). This is because freezing does not necessarily kill *E. coli* (Schutz (2009)).

According to the Vermont Department of Environmental Conservation, the Mad River as a whole is considered impaired due to high *E. coli* levels, and is unsuitable for contact recreation. These high *E. coli* levels are attributed to failing septic systems and other non-point sources (Vermont Department of Environmental Conservation (2008)). Additionally, we observed that a lot of people walk their dogs near our sampling area. A recent studied showed that fecal contamination increases when the watershed includes an area with high dog activity (Garfield and Walker (2008)).

The Vermont Water Quality Standards state that for a Class B water body (one that is not directly used as a public water supply or has a high ecological value) *E. coli* levels should not exceed 77 organisms per 100 ml (State of Vermont Natural Resources Board Water Resources Panel (2008)). These standards were exceeded during June and July, but not August, October, or November.

According to the results of this study, in general *E. coli* levels in High Bridge Brook exceed the Vermont Water Quality standards only in the months of June and July. Caution should still be taken, in addition to efforts to decrease *E. coli* levels. Additional monitoring should be conducted to draw a more accurate trend of *E. coli* levels in this tributary.

Additional Studies

The site is still monitored by the Friends of the Mad River. More information and data can be found on their website, which is listed in the Resources Section.

Resources

**Vermont Department of Environmental Conservation:**
http://www.anr.state.vt.us/dec/dec.htm

**Friends of the Mad River:** http://www.friendsofthemadrive.org/
Sources


