VERMONT
ENVIRONMENTAL CONSERVATION

North Branch of the Deerfield River

Watershed Description

This bacteria TMDL summary applies to a 1-mile reach of the North Branch of the Deerfield River, hereafter referred to as the "North Branch." The North Branch arises on the eastern slopes of the Green Mountains in the town of Dover. Many of the smaller tributaries of the river begin on the northern and eastern slopes of Mount Snow, a popular ski mountain located in Dover (Dover, 2008). The major tributary of the North Branch, Blue Brook arises in the town of Stratton and flows south through the valley of western Dover before meeting with the North Branch on the eastern side of Vermont Rte. 100 near its intersection with Blue River Road.

The North Branch flows in a shallow, broad course through the village of West Dover before passing into the town of Wilmington. The impaired segment of the North Branch ends shortly after the river passes into Wilmington. The North Branch itself ends after approximately 11 miles of river length when it enters Harriman Reservoir in Wilmington (Deerfield, 2008). Dover has a year round population of around 1,400 people with many more seasonal residents due to the year round resort located at Mount Snow (Dover, 2008). Wilmington has a population of 2,300 (Wilmington, 2010).

The bacteria-impaired segment of the North Branch begins where another tributary enters the river in the Sitzmark Golf Course in Wilmington and runs approximately 1 mile upstream. The North Branch watershed (Figure 1) covers 11 square miles, in Stratton, Wardsboro, Dover, and Wilmington. Overall, land use in the watershed is 85% forested, 6.5% agricultural, 7.5% developed, and 1% wetland, as shown in Figure 2 (based on 2006 Land Cover Analysis by NOAA-CSC).

Waterbody Facts (VT12-05)

- **Towns:** Dover, Wilmington
- **Impaired Segment Location:** Vicinity of West Dover Village
- **Impaired Segment Length:** 1 mile
- **Classification:** Class B
- **Watershed Area:** 11 square miles
- **Planning Basin:** 12 – Deerfield River

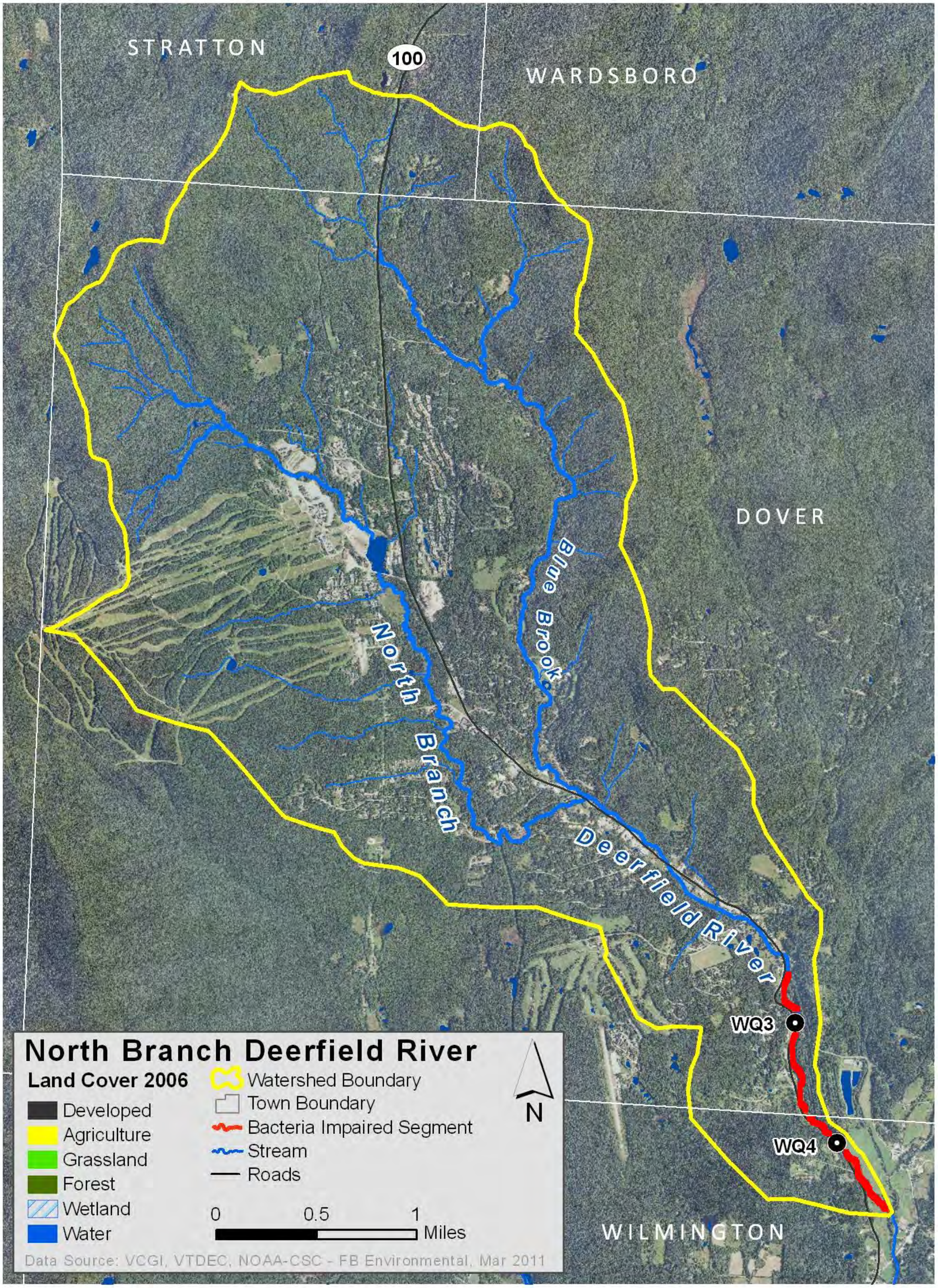

Figure 1: ***Map of North Branch watershed with impaired segment and sampling stations indicated. Insert area corresponds to figure 4 below.***

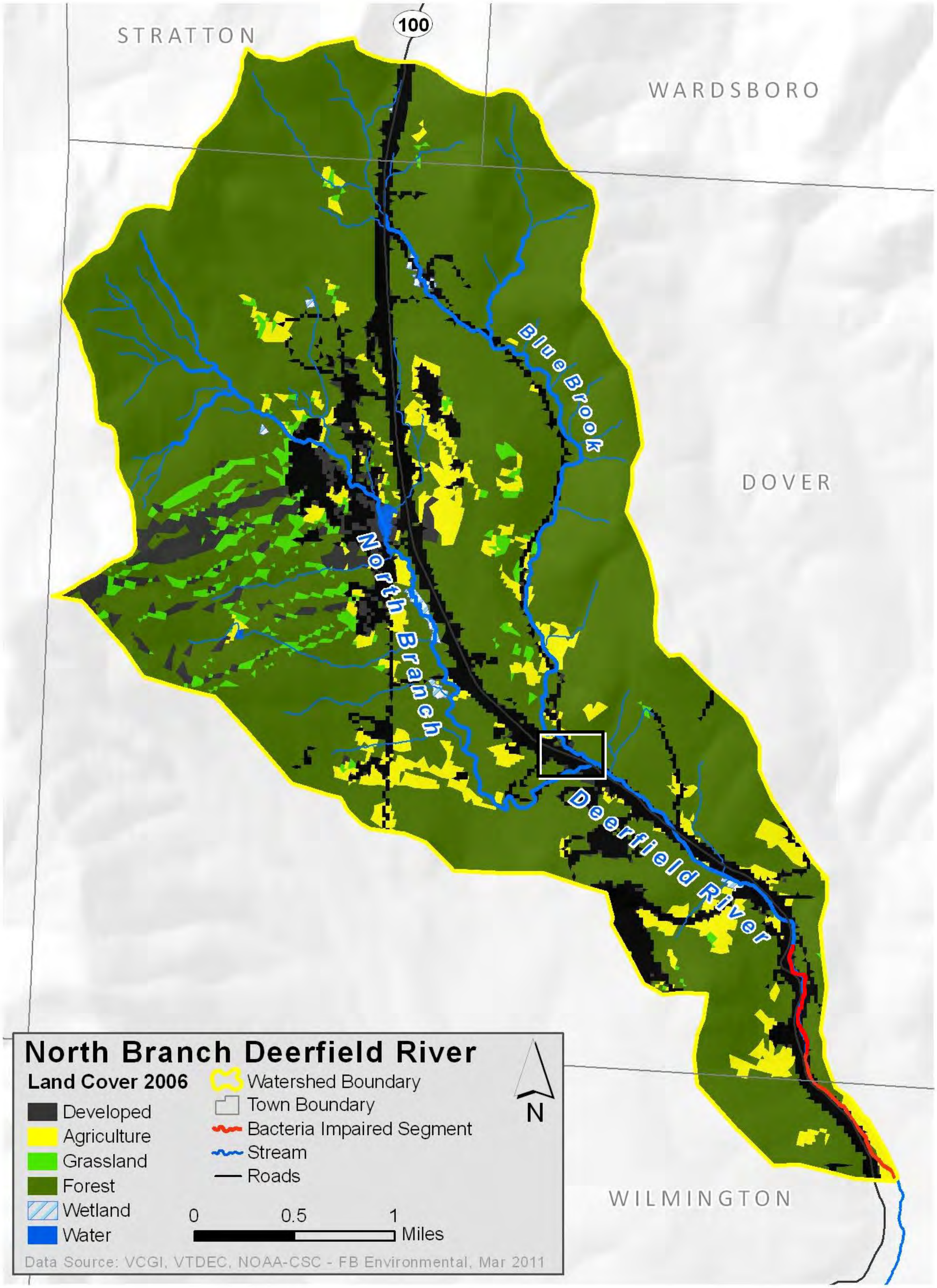

Figure 2: ***Map of North Branch watershed with impaired segment and land cover indicated.***

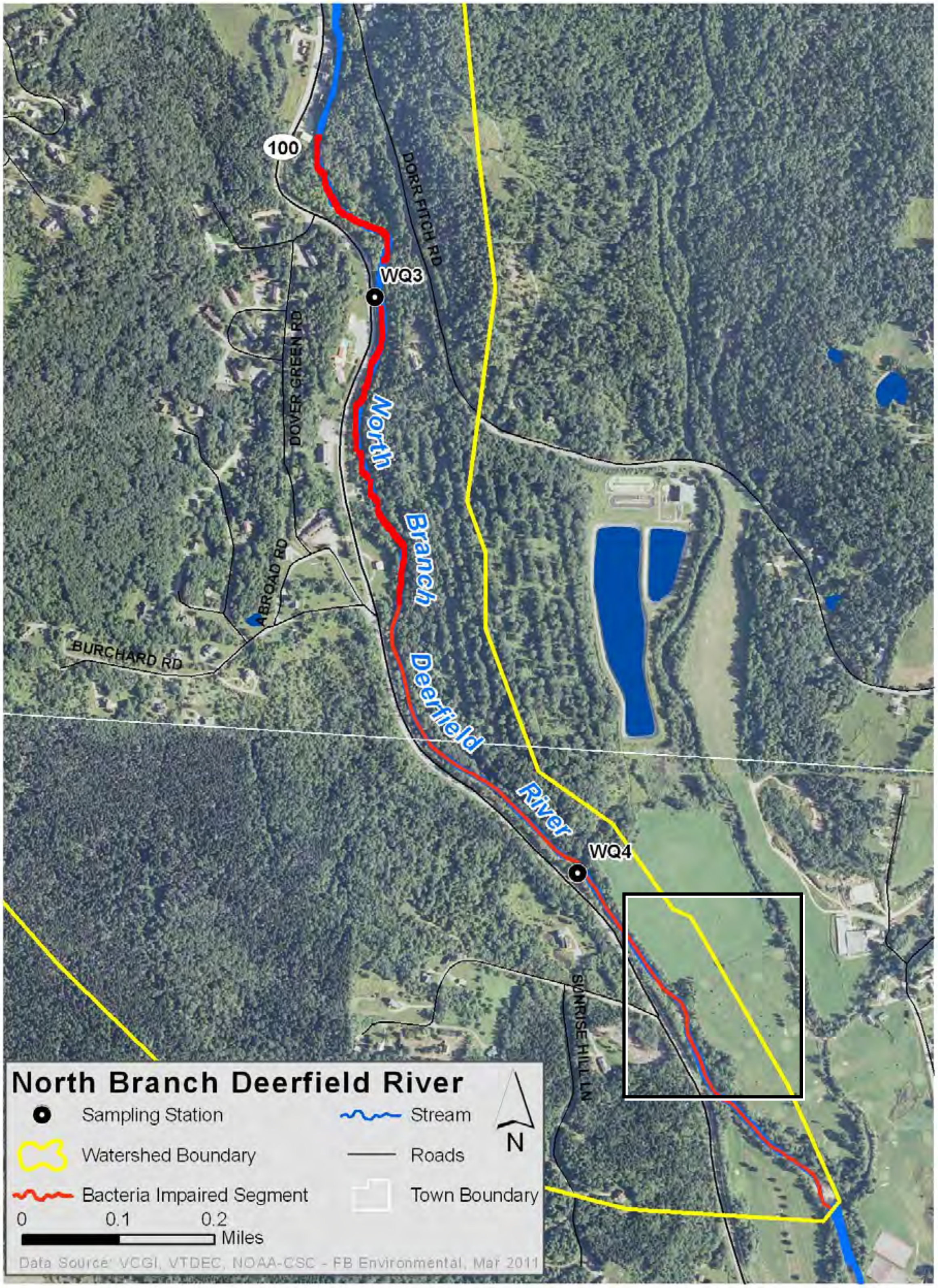

Figure 3: ***Map of North Branch watershed impaired segment and sampling stations indicated. Insert area corresponds to figure 5 below.***

Figure 4: ***Aerial view of the North Branch as it follows along VT Rte. 100 in Dover . The confluence with Blue Brook takes place opposite of the intersection of Edward's Village Loop and Vt. Rte. 100 (Source: Google Maps).***

Both Dover and Wilmington are characterized by high mountainous terrain with thin soils and steep slopes. Both towns have a high percentage of land with slopes greater than 15% (Dover, 2008; Wilmington, 2010). These factors make development within the towns difficult. Figure 4 provides a more detailed aerial view of the North Branch as it flows along VT Rte. 100 in central Dover. Much of the commercial and residential development within Dover is concentrated around the river and its tributaries, like the area shown in Figure 4 above. Land use and settlement patterns within Dover and Wilmington have been significantly influenced by the presence of Mount Snow (Dover, 2008).

Large sections of the North Branch's floodplain have residential and commercial development within them (SGA, 2006). The Deerfield Valley in Dover and Wilmington have experienced several dramatic development growth periods over the last 30 years. Much of this growth took place during a time when no zoning regulations were in place, and as a result development took place in wetland areas, within floodplains, and along stream corridors (Dover, 2008). Wetlands play a critical role in reducing runoff pollution and flood attenuation. Removing or decreasing wetlands and developing along a stream's bank, as seen in the North Branch watershed, restricts the rivers access to its natural flood plain and decreases the watershed's ability to attenuate flooding (SGA, 2006). The North Branch does not have a history of frequent flooding. However, significant flooding events in the area occurred as recently as 2000 (SGA, 2006). Flooding can cause damage to homes, businesses, and infrastructure such as sanitary sewer pipes and onsite septic disposal systems (USEPA, 2005).

Development has encroached upon the North Branch most visibly in central Dover and in the village of West Dover along the bacteria impaired segment of the river, as shown in Figure 5. The presence of VT Rte.100 and other development causes high volumes of stormwater to enter the river during rain events. Stormwater flows off of impervious surfaces such as roads, sidewalks, and rooftops when it rains. As stormwater flows over impervious surfaces in a developed area, it picks up a suite of pollutants, including bacteria (Smartwaterways, 2010). Stormwater can flow directly into the river or into one of the many separate storm sewers that empty into the river (Smartwaterways, 2010). Storm sewers are pipes that carry water way from impervious surfaces such as roads and parking lots to the nearest surface water. Where the storm sewer releases the water into the river is called an outfall. Stormwater outfalls on the North Branch are regulated by Vermont DEC, and the North Branch has a total of 10 permitted stormwater outfalls along it (North Branch).

Why is a TMDL needed?

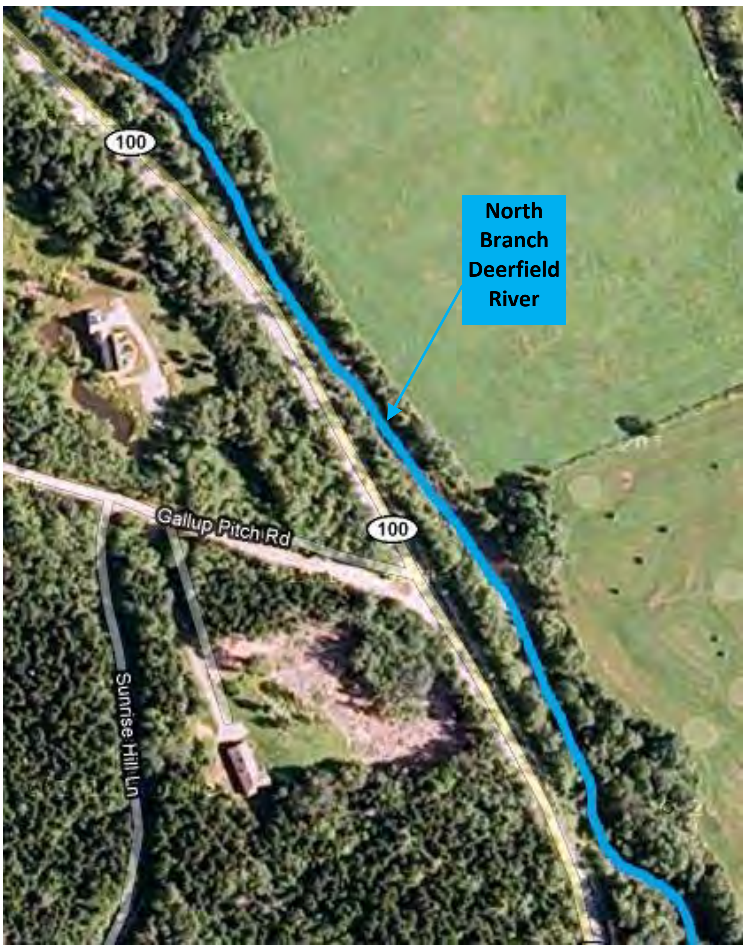

Figure 5: ***Aerial view of the impaired segment of North Branch after the Village of West Dover as it continues to follow VT Rte. 100 (Source: Google Maps).***

The North Branch is a Class B, cold water fishery with designated uses including swimming, fishing and boating (VTDEC, 2008). Since 2005 samples have been collected year round from the sampling stations shown in Figure 1 and Figure 3. Bacteria data from sampling locations WQ3 and WQ4 have exceeded Vermont's water quality criteria for *E.coli* bacteria. Table 1 below provides bacteria data collected at these sampling locations from 2005-2009. 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 the North Branch. For the North Branch, the current single sample water quality criterion is exceeded in nearly 20% of the samples.

Due to the elevated bacteria measurements presented in Table 1, the North Branch from its confluence with a tributary in Wilmington upstream for 1 mile, did not meet Vermont's water quality standards, was identified as impaired and was placed on the 303(d) list. The 303(d) listing states that use of the North Branch for contact recreation (i.e., swimming) is 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

There are several potential sources of bacterial contamination to the North Branch. These sources include: leaking sanitary sewer pipes, stormwater runoff from developed areas, and failing or malfunctioning septic systems. Vermont's 303(d) listing of the North Branch for contact recreation impairment does not specify a known source of bacterial contamination, and notes that further investigations are required to locate the source(s) (VTDEC, 2008).

Both Dover and Wilmington have areas of town that are serviced by a wastewater treatment facility. The majority of residential and commercial development along the North Branch's bacteria impaired segment is serviced by sanitary sewer. In Dover, the wastewater treatment plant serves the Village of West Dover and is located just outside of the impaired segment's watershed off of Dorr Fitch Road. This treatment plant is operated by North Branch Fire District #1. Sewer lines entering the treatment plant cross over the North Branch at several locations. The facility and sewer pipes that carry the wastewater were constructed in the 1970's (Dover, 2008) and given the age of the infrastructure, leaks within the sanitary sewer pipes could pose a significant E. coli source if failure were to occur. However, current testing and monitoring of the infrastructure according to operating permit conditions do not show this infrastructure as a current contributing source.

One way of testing for sewer leaks is to test for optical brighteners. These chemicals are added to laundry detergents to make whiter whites and brighter colors. Optical brighteners give off fluorescence in their excited state when light from specific ranges of the spectrum are shined on them. Water from washing machines is carried from homes and businesses in the sanitary sewer. If leaking sanitary sewers are suspected, the presence of optical brighteners in the North Branch's water is one indication that leaks are present (Tavares et. al., 2009). The age of the sanitary sewer infrastructure and the fact that the lines cross the river in multiple locations, makes leaking sanitary sewer pipes a possible source of bacterial contamination; however, current adherence to operating permit conditions do not show this as a current concern.

There are a multitude of possible bacteria sources in stormwater. *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. Testing for *E. coli* helps to indicate the presence of other water borne fecal pathogens that can pose serious threats to human health (USDA, 2000). One of the most widely documented and likely sources of *E. coli* in stormwater from urban areas is pet fecal matter, specifically that of dogs. Residential homes, condominiums, restaurants, and hotels are present along the banks of the North Branch and its tributaries. There are also many storm sewer outfalls on the river in the more developed areas (North Branch). 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 and deposit it in the river, that fecal matter can enter and contaminate the North Branch. This fecal matter can be a major source of bacterial contamination, especially in areas where development is so prevalent around the river (Smartwaterways, 2010). Given the proximity of development to the river, stormwater is another possible source of bacterial contamination.

Many of the residents within the watershed live in areas that are not serviced by a wastewater treatment facility (Dover, 2008; Wilmington, 2010). These residents rely on onsite septic disposal (septic) systems to treat their wastewater. Much of the development outside of the sewer serviced area near Mount Snow is close to the North Branch and its tributaries. If these septic systems were to fail or malfunction they could release dangerous levels of bacteria to the river or its tributaries. Failed septic systems can have a negative impact on the quality of life, human health, and environmental quality through the release of bacteria and other pathogens (WRC, 2006).

There are several reasons why failing septic systems are a possible cause of bacterial contamination to the North Branch. There are several factors that can limit a septic system from functioning properly. They must be well maintained through regular inspections and must be pumped out regularly. They also must be set in soils that are adequate for septic waste disposal. Soils on steep slopes, with a shallow depth to bedrock, with a high water table, with a high flood potential, that drain to quickly, or clay soils with low permeability, are all limiting factors for adequate disposal of septic waste (Dover, 2008). Onsite septic management has been identified as one of the principal surface water planning issues within Windham County and the North Branch watershed (WRC, 2006).

Most of the North Branch watershed is covered with soils that are not suitable for septic waste disposal. It has been documented that many of the residential septic systems within the region are pumped too infrequently or not at all, which makes them prone to failure. Nearly one third of the regions housing was constructed prior to 1940, which raises concerns about the piping and infrastructure of the onsite systems located at such properties (WRC, 2006). Furthermore, the flooding from 2000 within the North Branch watershed could have damaged septic systems. When the soil around a septic system becomes saturated the system itself can be damaged and fail if it is not properly inspected and cleaned out after the flood (USEPA, 2005). When systems are old, unmaintained, or placed on soils with poor suitability they can malfunction and release high concentrations of bacteria to nearby surface waters (USEPA, 2002). These characteristics of the North Branch watershed make failing or malfunctioning septic systems a possible source of bacterial contamination.

Recommended Next Steps

It is important for the towns of Dover and Wilmington, local stakeholders, as well as other community and watershed based groups to implement education and outreach programs, restoration programs, and the identification of land use activities that might be influencing *E. coli* levels. Citizens should be reminded of the importance of picking up after ones pet, especially in developed areas near the river.

Additional bacteria data collection may be beneficial to support identification of sources of potentially harmful bacteria in the North Branch watershed. For example, continued and expanded sampling upstream and downstream of potential bacteria sources (a practice known as "bracket sampling") may be beneficial for identifying and quantifying sources. 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 (Dover, 2008; Wilmington, 2010; WRC, 2006; SGA, 2006) have recommended the following actions to support water quality goals in North Branch:

- Sewer Leaks – Continue testing and monitoring according to operating permit conditions.
- Stormwater – Implement stormwater control projects whenever possible, especially around outfalls to the North Branch and its tributaries. Expand citizen education about the negative impacts of stormwater, with a focus on the importance of picking up after one's pet.
- Septic Systems- Ensure that new development has properly designed, constructed and inspected onsite septic disposal systems. Research the viability of alternative onsite management systems such as composting toilets and gray water recycling. Discourage development in soils that are too steep or otherwise not suited for septic waste disposal. Support programs that assist with the replacement or upgrading of failed onsite septic systems or expansion of the municipal wastewater system to reach more residences.
- Land Use Protection – Land in the northern sections of the watershed have minimal impact from development. These areas should be pinpointed for land conservation to ensure that they remain intact. Landowners should be encouraged and incentives should be in place for them to place conservation easements on important lands within the watershed, such as; contiguous forest land, wetland areas, and floodplains.
- Flood Plain Protection and Riparian Corridors – Ordinances should be enacted to limit further floodplain encroachment. Encourage landowners to install buffers, and other tools that protect shoreline and/or riparian areas. Seek to enhance buffers through a combination of buffer plantings, land conservation, and incentive programs.

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 North Branch.

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.

North Branch, Vicinity of West Dover Village (1 mile).

***WB ID*:** VT12-05

Characteristics: Class B

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

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: **82%**

Percent Reduction to meet NRWQC:

Single sample: **46%**

Geometric mean: **Complies**

Data: 2005 – 2009

Table 1: *E.coli* (organisms/100 mL) Data for North Branch (2005-2009) and Geometric Mean (organisms/100mL) for each Station based on Calendar Year.

Station Name	Station Location	Date	Result	Geometric Mean**
WQ3	Upstream	11/9/09	4	5
WQ3	Upstream	9/2/09	14	
WQ3	Upstream	7/15/09	63	
WQ3	Upstream	3/4/09	1	
WQ3	Upstream	2/4/09	1	
WQ3	Upstream	1/7/09	3	
WQ3	Upstream	12/5/07	6	15
WQ3	Upstream	11/14/07	3	
WQ3	Upstream	10/3/07	17	
WQ3	Upstream	9/19/07	40	
WQ3	Upstream	8/15/07	68	
WQ3	Upstream	7/24/07	118	
WQ3	Upstream	7/18/07	244	
WQ3	Upstream	6/13/07	38	
WQ3	Upstream	5/17/07	20	
WQ3	Upstream	4/25/07	3	
WQ3	Upstream	3/14/07	4	
WQ3	Upstream	2/21/07	10	
WQ3	Upstream	1/10/07	1	

*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.

Station Name	Station Location	Date	Result	Geometric Mean**
WQ3	Upstream	12/13/06	7	8
WQ3	Upstream	11/15/06	3	
WQ3	Upstream	10/18/06	105	
WQ3	Upstream	9/13/06	15	
WQ3	Upstream	8/9/06	13	
WQ3	Upstream	7/12/06	215	
WQ3	Upstream	6/7/06	59	
WQ3	Upstream	5/10/06	10	
WQ3	Upstream	4/19/06	0	
WQ3	Upstream	3/8/06	3	
WQ3	Upstream	2/8/06	0	
WQ3	Upstream	1/11/06	23	
WQ3	Upstream	12/7/05	34	46
WQ3	Upstream	11/21/05	142	
WQ3	Upstream	10/19/05	21	
WQ3	Upstream	9/14/05	148	
WQ3	Upstream	8/17/05	432	
WQ3	Upstream	7/13/05	328	
WQ3	Upstream	6/15/05	74	
WQ3	Upstream	5/11/05	28	
WQ3	Upstream	4/20/05	50	
WQ3	Upstream	3/9/05	19	
WQ3	Upstream	2/16/05	7	
WQ3	Upstream	1/12/05	3	
WQ4	Downstream	11/9/09	2	3
WQ4	Downstream	9/2/09	4	
WQ4	Downstream	7/15/09	150	
WQ4	Downstream	3/4/09	2	
WQ4	Downstream	2/4/09	0	
WQ4	Downstream	1/7/09	4	

*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.

Station Name	Station Location	Date	Result	Geometric Mean**
WQ4	Downstream	12/5/07	2	7
WQ4	Downstream	12/5/07	2	
WQ4	Downstream	11/14/07	5	
WQ4	Downstream	11/14/07	14	
WQ4	Downstream	10/3/07	4	
WQ4	Downstream	9/19/07	29	
WQ4	Downstream	9/19/07	1	
WQ4	Downstream	8/15/07	27	
WQ4	Downstream	8/15/07	224	
WQ4	Downstream	7/18/07	25	
WQ4	Downstream	7/18/07	63	
WQ4	Downstream	6/13/07	18	
WQ4	Downstream	6/13/07	137	
WQ4	Downstream	5/17/07	14	
WQ4	Downstream	5/17/07	70	
WQ4	Downstream	4/25/07	0	
WQ4	Downstream	3/14/07	7	
WQ4	Downstream	3/14/07	8	
WQ4	Downstream	2/21/07	8	
WQ4	Downstream	2/21/07	0	
WQ4	Downstream	1/10/07	2	
WQ4	Downstream	1/10/07	2	
WQ4	Downstream	12/13/06	12	16
WQ4	Downstream	11/15/06	2	
WQ4	Downstream	10/18/06	132	
WQ4	Downstream	9/13/06	10	
WQ4	Downstream	8/9/06	150	
WQ4	Downstream	7/12/06	155	
WQ4	Downstream	6/7/06	64	
WQ4	Downstream	5/10/06	6	
WQ4	Downstream	4/19/06	9	
WQ4	Downstream	3/8/06	1	
WQ4	Downstream	2/8/06	5	
WQ4	Downstream	1/11/06	27	

*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.

Station Name	Station Location	Date	Result	Geometric Mean**
WQ4	Downstream	12/7/05	18	35
WQ4	Downstream	11/21/05	122	
WQ4	Downstream	10/19/05	13	
WQ4	Downstream	9/14/05	75	
WQ4	Downstream	8/17/05	175	
WQ4	Downstream	7/13/05	284	
WQ4	Downstream	6/15/05	63	
WQ4	Downstream	5/11/05	19	
WQ4	Downstream	4/20/05	27	
WQ4	Downstream	3/9/05	23	
WQ4	Downstream	2/16/05	23	
WQ4	Downstream	1/12/05	2	

*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.

References

Deerfield (2008). Deerfield River Watershed Assessment Report: 2004-2008. The Commonwealth of Massachusetts, Executive Office of Environmental Affairs. Available online at: www.mass.gov/Eoeea/docs/eea/water/wap_deerfield_2004.pdf, accessed online on March 28, 2011.

Dover (2008). Town of Dover, Vermont. Town Plan. Adopted by the Board of Selectmen October 7, 2008. Available online at: www.doververmont.com/dover-town-plan-2008, accessed online on March 28, 2011.

Mallin, ET. al. (2007). Mallin, M.A., L.B. Cahoon, B.R. Toothman, D.C. Parsons, M.R. McIver, M.L. Ortwine and R.N. Harrington. 2007. Impacts of a raw sewage spill on water and sediment quality in an urban estuary. Mar. Pollution Bull. 54:81-88

North Branch (Undated) North Branch Deerfield River Permitted Stormwater Discharges. West Dover, VT. Waterbody ID VT12-05. Available online at: http://www.anr.state.vt.us/dec//waterq/stormwater/docs/swimpairedwatersheds/sw_nbrdeerfielddischarges.pdf, accessed online on March 30, 2011.

SGA (2006). Phase 1 and 2 Stream Geomorphic Assessments. North branch of Deerfield River Watershed. Windham County, Vermont. Final Report: January 30, 2006. Produced by: Bear Creek Environmental. Produced for: Vermont Department of Environmental Conservation. Available online at: www.vtwaterquality.org/rivers/docs/FinalReports/rv_P2_NorthbranchDeerfield.pdf, accessed online on April 1, 2011.

Smartwaterways (2010). Chittenden County Regional Stormwater Education Program, Smartwaterways (website). www.smartwaterways.org, last updated in 2010. Accessed online on: March 10, 2011.

Tavares et. al. (2009). Tavares, M.D., M.I.H. Spivey, M.R. McIver and M.A. Mallin. 2008. Testing for Optical Brighteners and Fecal Bacteria to Detect Sewage Leaks in Tidal Creeks. University of North Carolina Wilmington, Center for Marine Sciences. Available online at: http://people.uncw.edu/hillj/classes/EVS595/Optical%20brightener%20paper%20for%20NCAS.pdf, accessed online on February 7, 2011.

USDA (2000). Waterborne Pathogen Information Sheet, Principal Pathogens of Concern, *Escherichia coli (E. coli).* United States Department of Agriculture, Natural Resources Conservation Service, Watershed Science Institute. June 2000.

USEPA (2002). Onsite Wastewater Treatment Systems Manual – Office of Water, Office of Research and Development – EPA/625/R-00/008. Available online at: www.epa.gov/owm/septic/pubs/septic_2002_osdm_all.pdf, accessed online on January 27, 2011

VTDEC (2008). State of Vermont, 2008, 303(d) List of Waters, Part A – Impaired Surface Waters in Need of TMDL, October 2008 (Approved by USEPA September 24, 2008). Prepared by: Vermont Department of Environmental Conservation, Water Quality Division, Waterbury, VT.

VTDEC (2010). Progress Report on River Basin Water Quality Management Planning During 2009. A Report for: House and Senate Committees on Agricultural and Natural Resources and Energy. Prepared by: Vermont Agency of Natural Resources, Department of Environmental Conservation, Water Quality Division, Waterbury, VT. January, 2010

Wilmington (2010). Wilmington town Plan. Adopted September 15, 2010. Available online at: www.wilmingtonvermont.us/, accessed online on March 28, 2011.

WRC (2006). Windham Regional Plan. Adopted October 24, 2006. Windham Regional Commission, Dover, VT. Available online at: www.rpc.windham.vt.us/pubs/2006_Windham_Regional_Plan.pdf, accessed online on March 28, 2011.