

Water Quality Monitoring in the Upper Winooski River Headwaters

2011

Bacteria and Nutrients

Within the towns of Cabot-Marshfield-Plainfield

By

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Winooski River at Martin Bridge May Flood 2011

For

**Friends of the Winooski River in Cooperation with
The Conservation Commissions of Cabot, Marshfield, and Plainfield**

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E.coli – Bacteria

Fecal coliform bacteria are a particular group of bacteria primarily found in human and animal intestines and wastes. *Escherichia coli* (*E. coli*) is one of the fecal coliform bacteria widely used as an indicator organism to show the presence of such wastes in water and the possible presence of pathogenic (disease-producing) organisms. When *E. coli* is found in waters, its presence is not the problem of concern itself but is rather an indicator of the presence of fecal contamination (most strains of *E. coli* are not pathogenic) from humans or animals. *E. coli* monitoring is commonly conducted to ensure that the water is safe for swimmers and other contact recreational activities; a relationship can often be established between high bacteria concentrations and its sources such as rainfall runoff from urban streets, waterfowl or other wildlife congregations, pastured animals, and untreated waste (septic) water. Bacteria are measured in organisms or colony-forming units per 100 milliliters of water (cfu/100 mL). Vermont’s Class B water quality standard sets the maximum tolerable *E. coli* level at 77 colonies per 100 ml of sampled water. This is a very conservative standard and translates into a potential risk of contracting a gastrointestinal health illness of <4 people in a 1,000 after ingestion of water. The federal Environmental Protection Agency (EPA) currently recommends a slightly less stringent standard of 235 cfu/100mL. This equals a risk factor of about 8 illnesses/1,000 ingestions.

Bacti Monitoring

In 2010 and or 2011 the upper Winooski volunteers sampled 25 locations from Cabot to Plainfield. Thirteen locations were on the main stem of the Winooski River, which was shown in 2010 to have a chronic bacti problem under base flow conditions from below Cabot to Plainfield. Twelve tributaries were also sampled in 2010 and or 2011 in an attempt to identify potential bacteria source sub watersheds. Samples were collected on a bi-weekly basis in 2011 from June 21st, thru August 17th resulting in 5 samplings over the summer from most locations. **Table 1** below lists all sites sampled in 2010, and 2011. Maps in **appendix 1** show the locations of these sites and give a visual representation of categorical bacteria levels of the sites in 2011. All the bacti data are presented in **Appendix 2**.

Table 1 Bacti monitoring locations for 2010, and 2011 Cabot-Marshfield-Plainfield, Vt. Shaded locations are Winooski main stem sites. All others are tributary streams to Winooski River. Sites listed from the headwaters in Cabot to Plainfield in downstream order by River Mile. Tributaries are listed in order that they enter main stem .

River Location	Latitude	Longitude	Description
REC FIELD TRIB	44.4064	72.3084	Rec Field trib. Adjacent to Cabot rec fields above town
TRB G 0.1	44.4025	72.3109	Trib G In center of Cabot village site above main street, behind garage.
WIN 85.5	44.3984	72.3244	By Larry’s Ball field below Cabot village.
TRB F 0.1	44.3928	72.3215	Trib F adjacent to Cabot Cheese treatment ponds
JB 0.1	44.3923	72.3310	Jug Brook immediately below Rt 215 in lower cabot
WIN 84.1	44.3906	72.3307	Immediately above sawmill road bridge at Cabot WWTF
WIN 83.8	44.3829	72.3325	Durant cemetery below Cabot WWTF
WIN 83.5	44.3800	72.3328	Upper Gould flats, above farm road crossing 50m

WIN 82.6	44.3519	72.3470	At Rt 2 bridge just above Marshfield Village
MOB 0.1	44.3593	72.3359	Mollys Brook, below Mollys Falls just above confluence with Winooski
TRB E 0.1	44.3569	72.3424	Trib E. Just below Rt 215, trib entering from west by red house.
TRB D 0.1	44.3544	72.34453	Trib D enters from east side, below horse farms.
WIN 81.6	44.3501	72.3566	Below Marshfield WWTF, at flower farm
WIN 72.8	44.2871	72.4090	At Martin Bridge
WB 0.1	44.28341	72.41726	Wells Brook just Above Rt 2
TRB C 0.1	44.2815	72.4131	Trib C Below RR bed crossing.
TRB B 0.2	44.2753	72.4146	Trib B Above residential area, below agricultural land.
TRB B 0.1	44.2792	72.4176	Trib B Below RR bed crossing, below residential area in Plainfield.
WIN 71.5	44.2794	72.4201	Below Trib B confluence near coop
TRB A 0.1	44.2789	72.4241	Trib A entering from north, above Rt 2, near elder housing
WIN 71.4	44.2775	72.4258	Below Bridge and Dam in Plainfield Village
WIN 71.3	44.2758	72.4287	Above discharge at WWTF Plainfield, below Great brook.
WIN 70.7	44.2733	72.4322	Below Plainfield WWTF at rip rap bank

For the second consecutive year the geometric mean of bacteria counts (GMB) show that from the headwater most location, just below Cabot Village WIN 85.5 thru Marshfield to the Martin Bridge WIN 72.8 just above Plainfield Village the GMB is between 95 and 230. (see **table 2**)

These levels of bacteria are just above the VT water quality standard for bacteria which is 77, and the EPA standard of 235. Bacteri counts then rose to about a GMB of 280 at WIN 71.5 on the main stem about adjacent to the food coop. This GMB is above the EPA standard for safe swimming water. At the lowest site sampled in 2011 WIN 71.4 the GMB rose to 488, WELL above both the VT and EPA level for safe swimming. The only tributary to have a GMB over the VT and EPA standard was Trib B 0.1, this tributary enters the main stem just above WIN 71.5. This indicates that this trib is partially responsible for the higher bacteri counts within the main stem sites in Plainfield; however the dates that this trib had its highest bacteri counts was not the same date that the highest bacteri counts occurred in the main stem. This indicates other bacteri sources are present in this section of the river that have yet to be identified. The source(s) of bacteri in Trib B are also unknown at this time. A location was sampled on Trib B at RM 0.2, above the lower residential area near town and below its upper agricultural watershed. These samples showed higher counts at the lower RM site on all occasions; however on one occasion the upper RM 0.2 site did have a bacteri count of over 300. Bacteri counts on a given day ranged widely at all locations. All locations on the main stem recorded a bacteri count of over 200 on at least one occasion. The lowest site WIN 71.4 was always above the state and EPA standard on all five samplings; while the location 71.5 was above both standards on 4/5 sampling dates. The highest recorded bacteri count of 1550 was found at these locations WIN 71.4 AND 71.5 on the same date July 19,2011.

Based on the above findings it is recommended that an effort to begin determining bacteri sources be launched in 2012. Of primary importance is the Plainfield Village area; which has consistently recorded the highest GMB, and individual bacteri counts on a given day. Secondly other than Trib B, none of the tributaries in the watershed appear to be significant contributors of bacteri to the main stem. As such it is recommended that future monitoring concentrate on documenting the bacteri levels of the main stem. This monitoring will both document the bacteri impact in the main stem and record improvement over time as sources are identified and corrected. It will also inform swimmers of the Upper Winooski to know what the level of health risk is over the course of a summer,

with results posted on the Friends of the Winooski Watershed WEB site within two weeks or less of sample collection.

Table 2: The Geometric Mean Bacti Cts (GMB) from River Mile Locations on the Upper Winooski River and its Tributaries Table 2 reads from headwaters in Cabot (top) to Plainfield Village (bottom). Tribs placed where they enter the Winooski

River Location	2010 gm #/100ml	2011 gm #/100ml
REC FIELD TRIB		53
TRB G 0.1		14
WIN 85.5	51	107
TRB F 0.1		20
JB 0.1	67	
WIN 84.1	118	117
WIN 83.8	137	223
WIN 83.5		194
MB 0.1		63
TRB E 0.1		51
TRB D 0.1		87
WIN 82.6	236	232
WIN 81.8	193	
WIN 81.6	149	95
WIN 78.1	80	
WIN 72.8	162	229
WB 0.1	70	13
TRB C 0.1		31
TRB B 0.1		335
WIN 71.5		280
TRB A 0.1		34
TRB B 0.2		57
WIN 71.4	371	488
WIN 71.3	262	
WIN 70.7	268	

Water Quality Monitoring Results

Five stream reaches **Table 3** were sampled in 2011 for nutrients (total nitrogen and phosphorus),and Chloride **Table 4**. The streams were sampled monthly from June thru August. A September sampling was lost due to the LaRosa lab lost to Tropical Storm Irene flooding. Also lost was all the field measure and observation taken on site at the time of sampling. The first two sampling were during base flow conditions in June and July. These data show very low levels of Chloride at all locations, with the exception of Winooski River Chloride was below or at reportable limits of 2 mg/l. This indicates there is presently no chloride buildup in the ground water in these streams at present. The Winooski River at 72.8 – Martin Bridge recorded measurable but low levels of chloride with an average of 6.0 mg/l. Nutrients were also very low under base flow sampling from Guernsey Brook GUB, Jug Brook JB, and Marshfield Brook MB. Naismith Brook and Winooski River 72.8 had moderate levels of TP in June and low levels in July both under base flow conditions. The event flow sample collected in August had the highest nutrient levels at all locations. This indicates that at all locations particulates increase during freshet flows carrying nutrients. The highest levels reported under freshet flows were again from Naismith Brook and the Winooski River 72.8. This indicates that at these two stream reaches nutrients carried by sediment is elevated, which indicates that runoff from nonpoint sources is highest above these locations.

It is recommended that water quality monitoring continue at about six locations every year. The Winooski 72.8 should continue yearly as a sentinel location for the watershed and site of the rare mussel population of Eastern Pearlshell. I would also recommend that Guernsey Brook and Jug Brook also be sampled for a second consecutive year as these seems to be very high quality waters. Naismith Brook should be resampled as it seems to be sensitive to nonpoint runoff, and it would be good to document if TS Irene has exposed or destabilized its streambed enough to cause increased nutrient export. For similar reasons it would be good to add Great Brook in Plainfield, and Creamery Brook in Marshfield in 2012.

Table 3: Locations of water quality monitoring stream reaches sampled in 2011.

River Location	Latitude	Longitude	Description
JB 0.1	44.3923	72.3310	Jug Brook immediately below Rt 215 in lower Cabot.
MB 0.1	44.3476	72.3569	Marshfield Brook behind Old Schoolhouse Common at VAST bridge.
GUB 0.9	44.3051	72.4093	Guernsey Brook below Jake Martin Road culvert.
NB 0.2	44.3012	72.3959	Naismith Brook behind Twinfield soccer field.
WIN 72.8	44.2871	72.4090	Winooski River at Martin Bridge

Table 4: The results of Water Quality parameters at five stream locations in the upper Winooski River 2011.

Location RM	Date	Flow	Chloride mg/l	TN mg-N/l	TP ug/l
JB 0.1	6/20/2011	Base	< 2	0.26	11.3
JB 0.1	7/19/2011	Base	< 2	0.23	12.4
JB 0.1	8/16/2011	Freshet	< 2	0.36	24.0
JB 0.1	average		<2	0.3	15.9
MB 0.1	6/20/2011	Base	2.0	0.28	10.8
MB 0.1	7/19/2011	Base	2.2	0.32	13.1
MB 0.1	8/16/2011	Freshet	< 2	0.41	22.0
MB 0.1	average		2.1	0.3	15.3
GUB 0.9	6/20/2011	Base	< 2	0.18	8.1
GUB 0.9	7/19/2011	Base	< 2	0.19	8.2
GUB 0.9	8/16/2011	Freshet	< 2	0.33	21.9
GUB 0.9	average		<2	0.2	12.7
NB 0.2	6/20/2011	Base	< 2	0.25	29.0
NB 0.2	7/19/2011	Base	< 2	0.24	16.3
NB 0.2	8/16/2011	Freshet	< 2	0.48	92.0
NB 0.2	average		<2	0.3	45.8
WIN 72.8	6/20/2011	Base	3.9	0.31	25.8
WIN 72.8	7/19/2011	Base	9.5	0.31	13.7
WIN 72.8	8/16/2011	Freshet	4.2	0.59	83.4
WIN 72.8	average		5.9	0.4	41.0

Appendix 1: Maps showing locations of Bacteria sampling sites in the Upper Winooski River 2011.

****Will be sent later****

Appendix 2: Bacti counts by station location and date, and the geometric mean

Location		Date	bacti
WIN 85.5		21-Jun-11	193.49
WIN 85.5		5-Jul-11	72.73
WIN 85.5		19-Jul-11	52.91
WIN 85.5		2-Aug-11	49.54
WIN 85.5		17-Aug-11	378.44
WIN 85.5	geo mean		106.8987
WIN 84.1		21-Jun-11	98.54
WIN 84.1		5-Jul-11	108.6
WIN 84.1		19-Jul-11	64.37
WIN 84.1		2-Aug-11	73.28
WIN 84.1		17-Aug-11	435.17
WIN 84.1	geo mean		117.0453
WIN 83.8		21-Jun-11	365.4
WIN 83.8		5-Jul-11	60.15
WIN 83.8		19-Jul-11	204.59
WIN 83.8		2-Aug-11	209.82
WIN 83.8		17-Aug-11	579.43
WIN 83.8	geo mean		222.6113
WIN 83.5		21-Jun-11	117.18
WIN 83.5		5-Jul-11	109.81
WIN 83.5		19-Jul-11	101.68
WIN 83.5		2-Aug-11	307.59
WIN 83.5		17-Aug-11	686.67
WIN 83.5	geo mean		194.2183
WIN 82.8		21-Jun-11	184.18
WIN 82.8		5-Jul-11	121.12
WIN 82.8		19-Jul-11	133.44
WIN 82.8		2-Aug-11	290.93
WIN 82.8		17-Aug-11	770.1
WIN 82.8	geo mean		231.6413
WIN 82.7		21-Jun-11	57.31
WIN 82.6		21-Jun-11	23.51
WIN 82.6		5-Jul-11	111.23
WIN 82.6		19-Jul-11	90.75
WIN 82.6		2-Aug-11	40.44
WIN 82.6		17-Aug-11	816.41
WIN 82.6	geo mean		95.23753
WIN 72.8		21-Jun-11	118.74

WIN 72.8		5-Jul-11	195.59
WIN 72.8		19-Jul-11	613.14
WIN 72.8		2-Aug-11	146.72
WIN 72.8		17-Aug-11	298.66
WIN 72.8	geo mean		228.5777
WIN 71.5		21-Jun-11	124.98
WIN 71.5		5-Jul-11	261.25
WIN 71.5		19-Jul-11	1553.12
WIN 71.5		2-Aug-11	76.88
WIN 71.5		17-Aug-11	435.17
WIN 71.5	geo mean		279.1996
WIN 71.4		21-Jun-11	307.59
WIN 71.4		5-Jul-11	410.58
WIN 71.4		19-Jul-11	1553.12
WIN 71.4		2-Aug-11	410.58
WIN 71.4		17-Aug-11	344.11
WIN 71.4	geo mean		488.1283
WB 0.1		21-Jun-11	27.18
WB 0.1		5-Jul-11	3.06
WB 0.1		19-Jul-11	1
WB 0.1		2-Aug-11	26.21
WB 0.1		17-Aug-11	185.01
WB 0.1	geo mean		13.21681
TRB G 0.1		21-Jun-11	18.49
TRB G 0.1		5-Jul-11	14.8
TRB G 0.1		19-Jul-11	1
TRB G 0.1		2-Aug-11	15.96
TRB G 0.1		17-Aug-11	119.83
TRB G 0.1	geo mean		13.92385
TRB F 0.1		21-Jun-11	7.38
TRB F 0.1		5-Jul-11	9.69
TRB F 0.1		19-Jul-11	60.86
TRB F 0.1		2-Aug-11	17.49
TRB F 0.1		17-Aug-11	46.38
TRB F 0.1	geo mean		20.39701
TRB E 0.1		21-Jun-11	20.64
TRB E 0.1		5-Jul-11	29.17
TRB E 0.1		19-Jul-11	18.49
TRB E 0.1		2-Aug-11	159.67
TRB E 0.1		17-Aug-11	201.42
TRB E 0.1	geo mean		51.37854

TRB D 0.1		5-Jul-11	22.55
TRB D 0.1		19-Jul-11	209.82
TRB D 0.1		2-Aug-11	137.35
TRB D 0.1	geo mean		86.61784
TRB C 0.1		21-Jun-11	13.23
TRB C 0.1		6-Jul-11	47.11
TRB C 0.1		19-Jul-11	24.91
TRB C 0.1		2-Aug-11	43.21
TRB C 0.1		17-Aug-11	42.57
TRB C 0.1	geo mean		30.98467
TRB B 0.2		19-Jul-11	22.81
TRB B 0.2		2-Aug-11	21.33
TRB B 0.2		17-Aug-11	387.32
TRB B 0.2	geo mean		57.33177
TRB B 0.1		21-Jun-11	816.41
TRB B 0.1		6-Jul-11	1046.24
TRB B 0.1		19-Jul-11	122.29
TRB B 0.1		2-Aug-11	58.78
TRB B 0.1		17-Aug-11	689.27
TRB B 0.1	geo mean		335.2046
TRB A 0.1		21-Jun-11	9.6
TRB A 0.1		5-Jul-11	9.79
TRB A 0.1		19-Jul-11	224.68
TRB A 0.1		2-Aug-11	27.85
TRB A 0.1		17-Aug-11	72.27
TRB A 0.1	geo mean		33.54906
REC FIELD TRIB		21-Jun-11	129.06
REC FIELD TRIB		5-Jul-11	75.89
REC FIELD TRIB		19-Jul-11	18.49
REC FIELD TRIB		2-Aug-11	9.6
REC FIELD TRIB		17-Aug-11	240.03
REC FIELD TRIB	geo mean		52.97732
MOB 0.1		21-Jun-11	22.3
MOB 0.1		5-Jul-11	61.27
MOB 0.1		2-Aug-11	75.41
MOB 0.1		17-Aug-11	151.52
MOB 0.1	geo mean		62.85834

Appendix 3: Quality assurance measures for WQ and Bacti sampling in 2011

The relative percent difference in Bacti counts between duplicates ranged from 34 to 6. This is an acceptable level of variation and likely reflects true conditions in the field. The blank samples all reported Bacti <1 indicating proper field collection and no on site contamination.

Table of Duplicate Bacti samples

Location	Date	relative percent difference bolded
WIN 72.8	21-Jun-11	84
WIN 72.8	21-Jun-11	119
		34
WIN 72.8	5-Jul-11	185
WIN 72.8	5-Jul-11	196
		6
WIN 72.8	19-Jul-11	488
WIN 72.8	19-Jul-11	613
		23
WIN 72.8	2-Aug-11	119
WIN 72.8	2-Aug-11	147
		21
WIN 72.8	17-Aug-11	272
WIN 72.8	17-Aug-11	299
		9

Table of Blank Bacti samples

Location	Date	Bacti ct
WIN 72.8	21-Jun-11	<1
WIN 72.8	5-Jul-11	<1
WIN 72.8	19-Jul-11	<1
WIN 72.8	2-Aug-11	<1
WIN 72.8	17-Aug-11	<1

The relative percent difference and blank samples for the WQ samples show acceptable differences in duplicates with the RPD ranging from 2 to 30 percent. The 30 percent is mostly due to the extremely low values reported for these samples; which makes even small difference have a higher RPD. The blank samples for TP and TN however show a problem with the blanks. The values reported are significantly higher than that of the actual samples, which all appear to be within an expected reasonable range. The likely reason for this is that the distilled water for the blanks is being held to long before use. At time the distilled water was held unrefrigerated for up to two weeks before sample collection. It is recommended in the future that the distilled water be refrigerated, and used within several days of receiving from the lab.

Water Quality duplicate and Blank samples.

Location	Date	Chloride mg/l	TN mg-N/l	TP ug/l
WIN 72.8	6/20/2011	3.92	0.31	25.8
WIN 72.8	6/20/2011	4.02	0.3	25.1
	relative % diff	2.52	3.28	2.75
WIN 72.8	7/19/2011	9.5	0.31	13.7
WIN 72.8	7/19/2011	9.47	0.41	16.9
		0.32	27.78	20.92
WIN 72.8	8/16/2011	4.21	0.59	83.4
WIN 72.8	8/16/2011	4.1	0.51	82
		2.65	14.55	1.69
WIN 72.8 BLANK	7/19/2011	< 2	0.28	252
WIN 72.8 BLANK	8/16/2011	< 2	< 0.1	66.4