Water Quality Monitoring in the Upper Winooski River Headwaters

2018

E. coli, chloride, phosphorus, and turbidity levels in the streams of

Cabot-Marshfield-Plainfield

Planting trees along Old Schoolhouse Common Trail Marshfield, Vt

The Friends of the Winooski River in Cooperation with
The Conservation Commissions of Cabot, Marshfield, and Plainfield
with support from the
R.A. LaRosa Grants Program

Prepared by Steve Fiske and Shawn White for
The Vermont Department of Environmental Conservation
January 2019

Water Quality Monitoring by the Winooski Headwaters Partnership

The Winooski Headwaters Partnership is composed of the Conservation Commissions of Plainfield, Marshfield, and Cabot; the Friends of the Winooski River; and community members of Headwaters towns. The Headwaters Partnership has been conducting water quality monitoring of the Winooski River and several of its tributaries since 2007. Parameters of interest have included *E. coli,* total phosphorus, total nitrogen, turbidity, chloride, and alkalinity. Monitoring sites have been chosen based on recreational contact, suspected pollutant sources, locations of waste water treatment plants, and a population of a Vermont listed threatened species. The following report describes the results of the Headwaters Partnership 2018 monitoring.

Methods

Total phosphorus and turbidity samples were collected by Headwaters volunteers on six dates: four during freshet flow conditions (6/19, 7/6, 8/18 and 9/11), and two targeting base flow conditions (7/24 and 9/19, although flow conditions on 7/24 were considered freshet at some sites – see below). Samples collected under base flow conditions are used for trend monitoring and TP loading from point sources, whereas samples collected under event flows are used to rank watersheds for nutrient export from runoff and instream erosion. Eight sites on the Winooski main-stem were sampled: two bracketing the village of Cabot (WIN86.9 and WIN85.5), two in Cabot flats (WIN83.8 and WIN82.8), two bracketing the village of Marshfield (WIN82.6 and WIN81.6) and two bracketing the village of Plainfield. A population of *M. margaritifera* are located near WIN72.8 near Martin Bridge in Marshfield. Eleven sites on nine Winooski River tributaries were also sampled: Great Brook (GB0.1), Wells Brook (WB01.), Nasmith Brook (NAB0.8), Beaver Meadow Brook (BMB0.2), Creamery Brook (CB0.1), Jug Brook (JB0.1), Cabot Recreation Field Tributary (RECFIELDTRIB0.1 and RECFIELDTRIB1.4), South Walden Tributary (SWT0.2), and Goat Farm Tributary (GFT0.1 and GFT0.6).

E. coli samples were also collected at the Winooski River mainstem sites and the Great Brook and Nasmith Brook sites on 6/26, 7/24, 8/21, and 9/18. The dates of the *E. coli* sampling were predetermined and did not target base or freshet flow due to volunteer availability and sample holding time. However, no significant rainfall >0.25 inches fell prior to sampling on these dates with the exception of 7/24, when ~0.5 inches were measured the morning of sample collection. Chloride was tested once at all sites under base flows on 9/18. Descriptions of the sampling site locations, including lats and longs are shown in **Appendix A**. Samples were analyzed at the Vermont Department of Environmental Conservation La Rosa laboratory by laboratory staff. Individual sample results, including the results for duplicate and blank samples, are listed in **Appendices B** and **C**. Quality assurance measures (duplicate sample relative percent differences) and control blank met target values in all cases.

Results

The summer of 2018 was relatively dry with long dry spells between rain events and no rain events of over 1 inch in a 24-hour period before the four freshet collections with the exception of the 6/19 event, when over 1.5 inches fell. Otherwise, rain events ranged from 0.55 inches to 0.85 inches 24 hours previous to sample collection (**Table 1**). As a result, only the 6/19 was considered a high flow on 6/19 when over 1.5 inches fell the morning of sampling. On all other event sampling dates stream flows were observed as moderate.

Table 1. Rainfall on the sampling date and 1-4 days before sampling. Rainfall amounts for the day of sampling were obtained using rain gauges from Plainfield (George Springston), and Cabot (Gary Gulka).

Plainfield

Date	rainfall the day of sampling before 8 am (day 0)	rainfall on the day prior to sampling (day 1)	cumulative rainfall 2 days before sampling (days 1&2)	cumulative rainfall 3 days before sampling (days 1,2,&3)
6/19/2018*	**1.83**	**0**	**0**	**.02**
6/26/2018	**0**	**.05**	**.16**	**.16**
7/6/2018*	**.12**	**0**	**0**	**0**
7/24/2018*	**.56**	**.30**	**.30**	**.30**
8/18/2018*	**.46**	**0**	**.60**	**.61**
8/21/2018	**0**	**0**	**0**	**.46**
9/11/2018*	**.80**	**0**	**0**	**0**
9/18/2018	**0**	**0**	**0**	**0**

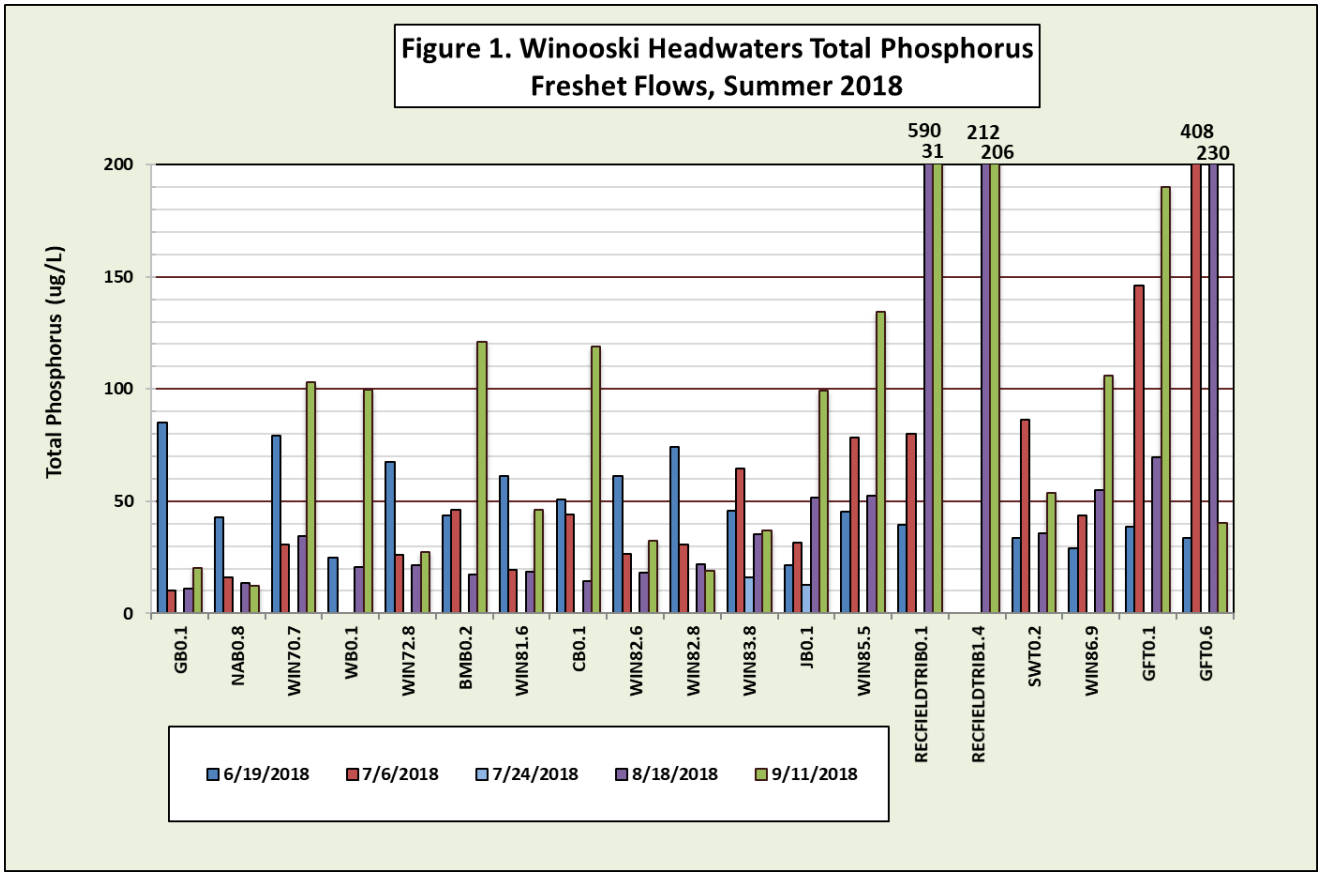
Cabot

Date	rainfall the day of sampling before 8 am (day 0)	rainfall on the day prior to sampling (day 1)	cumulative rainfall 2 days before sampling (days 1&2)	cumulative rainfall 3 days before sampling (days 1,2,&3)
6/19/2018*	**1.15**	**0**	**0**	**0.03**
6/26/2018	**0**	**.09**	**.20**	**.20**
7/6/2018*	**.57**	**0**	**0**	**0**
7/24/2018*	**.53**	**.29**	**.29**	**.29**
8/18/2018*	**.74**	**0**	**1.67**	**1.74**
8/21/2018	**0**	**0**	**.03**	**.77**
9/11/2018*	**.85**	**0**	**0**	**0**
9/18/2018	**0**	**0**	**0**	**0**

Total Phosphorus TP-Freshet flow

Total phosphorus (TP) levels in samples collected under "freshet" flows (**Figure 1**) were above 50ug/l and ranged up to 590ug/l for several sites on all rain event dates the sampled except July 24th. On July 24th, despite the ~0.3 inches of rain that fell the day before sampling and the half an inch the day of sampling, only two sites (WIN83.8 and JB0.1) were described as having the observable increases in flow characteristic of freshet flow conditions. The flow levels for all other locations on July24th were described by samplers as base flow.

The highest TP was found in two tributaries, Goat Farm Trib (GFT), and Rec Field Trib (RFT) in the upper headwaters of Cabot. Two sites were located on each of these tributaries in 2018 to see if a TP source could be bracketed by locating an upper site on each trib above a significant sub-watershed tributary. The GFT sites showed TP to be higher at the upper most site on two occasions (7/6 and 8/18), indicating a source from further up in the streams' watersheds. On 9/11, however, the TP on this stream was higher at the lower site, indicating either TP loading from the bracketed watershed or instream bank instability below the upper site. RFT was sampled at both sites 0.1 and 1.4 on two occasions: 8/18 and 9/11. On both dates the TP was elevated at both sites (over 200ug/l). TP did however consistently increase at the lower location more than doubling on 8/18 from 212ug/l to 590ugl and from 206ugl to 306ug/l on 9/11. This shows that TP is entering the stream from both above the upper site and from either in-stream erosion or the bracketed sub watershed. Based on these results for both watersheds, it is recommended that a geomorphic assessment be done to quantify the stability of the stream bed and banks as potential sources of TP, and to identify specific erosional problems within these watersheds. It is also recommended that the farm practices within these watersheds be evaluated for potential TP sources and practical corrective management practices that could be implemented to reduce TP entering the streams.



Total Phosphorus TP-Base flow

The Vermont Water Quality standards for TP are applied only under base flow conditions and depend on the size of the stream and its gradient. For Small High Gradient (SHG) streams the standard is 12ug/l and for Medium High Gradient (MHG) streams the standard is 15ug/l. The smaller headwater streams are SHG streams (Goat Farm Trib, South Walden Trib, Recreation Fields Trib, Jug Brook, Creamery Brook, Beaver Meadow Brook, and Wells Brook). The MHG streams are the main stem Winooski River, Nasmith Brook, and Great Brook.

Base flows were recorded on two sample dates (7/24 and 9/18) at most locations. At two locations, JB0.1 and WIN 83.8, the stream conditions were characterized as freshet flow on these dates. The other exception was on Wells Brook where stream conditions were considered as base flow on 7/6.

Total phosphorus levels during base flow conditions are shown in **Figure 2**. All SHG streams were above the SHG standard on July 24th. The SHG streams in the Cabot Headwaters were also above the SHG TP standard on the 9/18 date. GFT 0.1 had the highest base flow TP on both dates with TP levels of 48ug/l and 25ug/l. The upper GFT 0.6 site was dry on both dates and could not be sampled. These results indicate that there is either high ground water TP and or a source of TP entering the stream within the watershed. It is recommended that sources of TP be explored within the GFT watershed. While not as high as GFT, SWT, RFT, and WIN86.9 all showed

slightly elevated TP. Jug Brook and Creamery Brook had the lowest TP levels or the SHG streams at base flow indicating their high quality. The MHG main stem WIN sites were all at or above the 15ug/l TP standard but below 20ug/l with the exception of WIN 70.7, which had TP values of 30ug/l on the 7/24 sample date. Great Brook and Nasmith Brook had the lowest TP on all occasions and were at or below the MHG TP standard indicating that both these streams are of high quality.

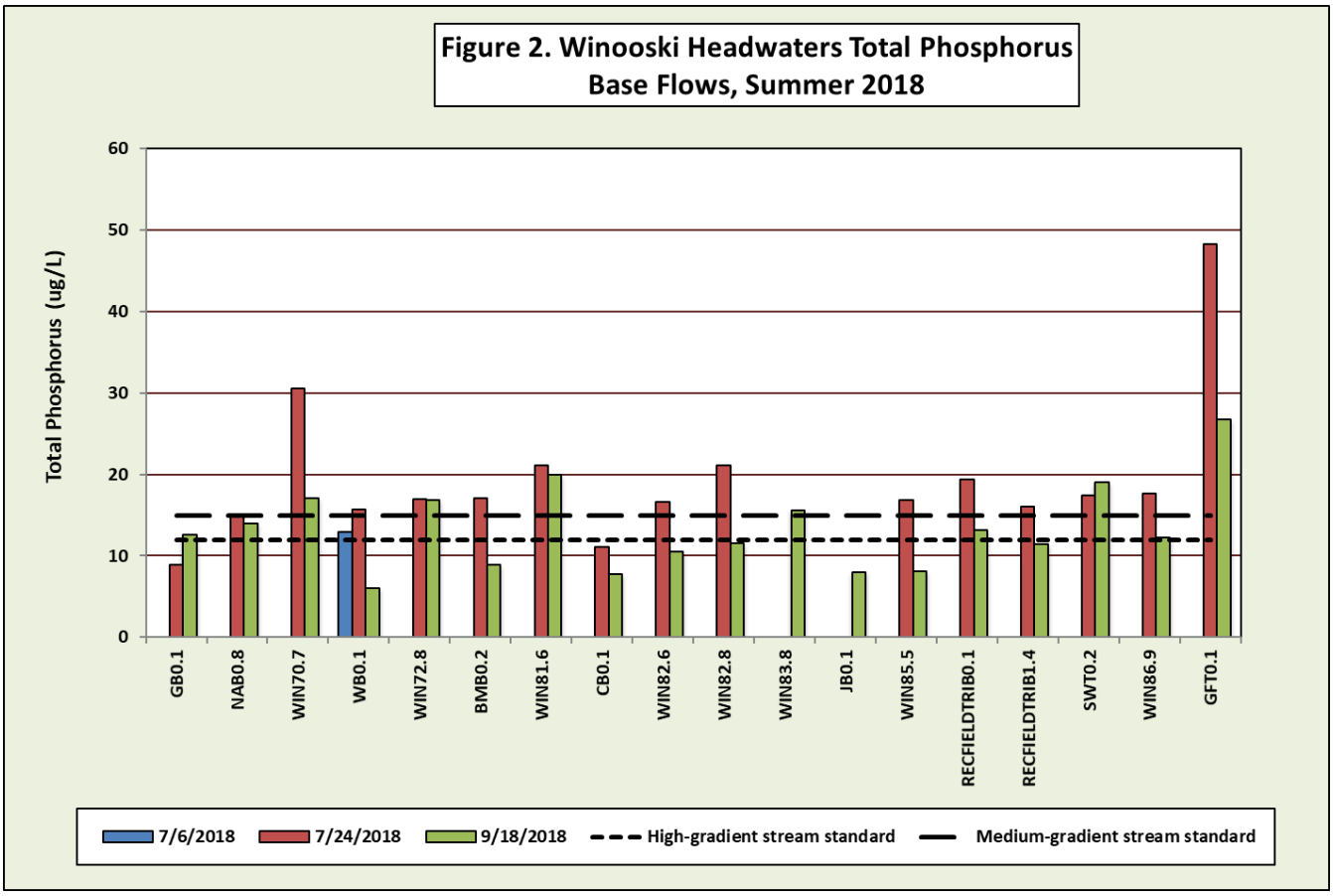


Figure 3 presents the overall mean TP at all sites under all flow conditions. These results point toward GFT and RFT as having the highest TP concentrations. While these are small streams with low overall discharge, they are significant sources of TP for the upper Winooski watershed. **Figure 4** shows the mean TP at all sites sampled multiple years since 2007. These TP values do not take into consideration the differences in flow levels samples between years but is meant to give an overall picture of TP levels, and is a start at looking at trends over time. The highest concentrations of TP were from 2016, followed by 2013, at many but not all locations. Nasmith Brook, Jug Brook and WIN72.8 have the longest sample record of all sites. Nasmith, and Jug Brook have generally had the lowest overall TP. Nasmith Brook was, however, high in 2011 - a year when both a spring, and late summer floods occurred.

Figure 3. Winooski Headwaters Mean Total Phosphorus All Flows, Summer 2018

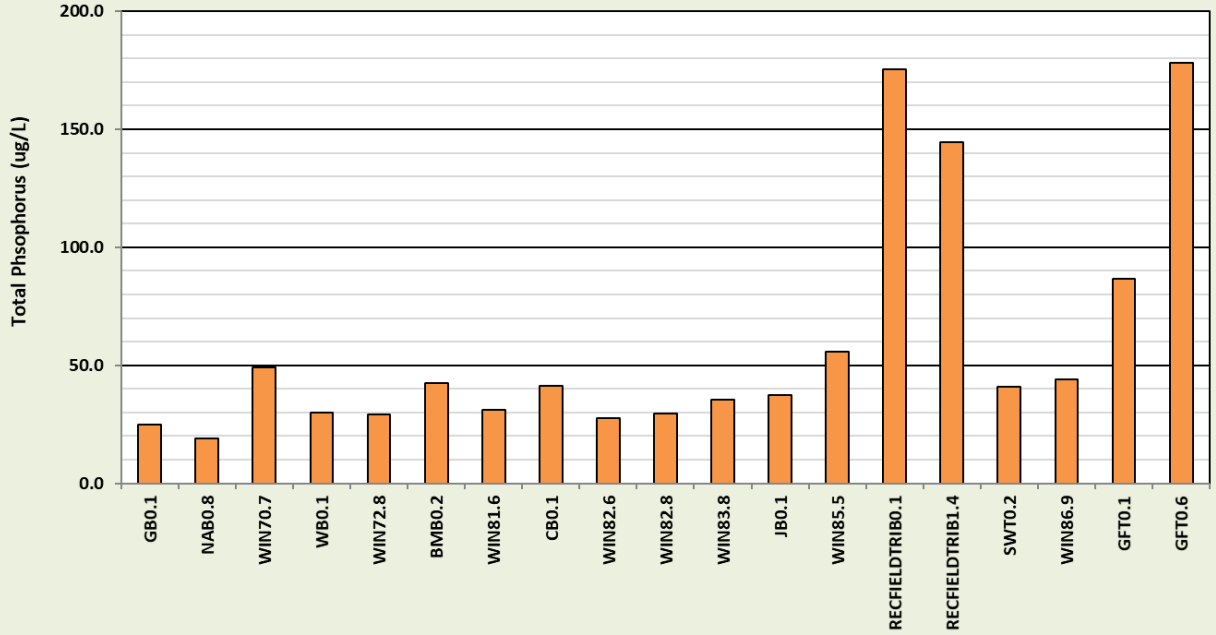


Figure 4. Headwaters Total Phosphorus Levels All Flows, 2009-2018

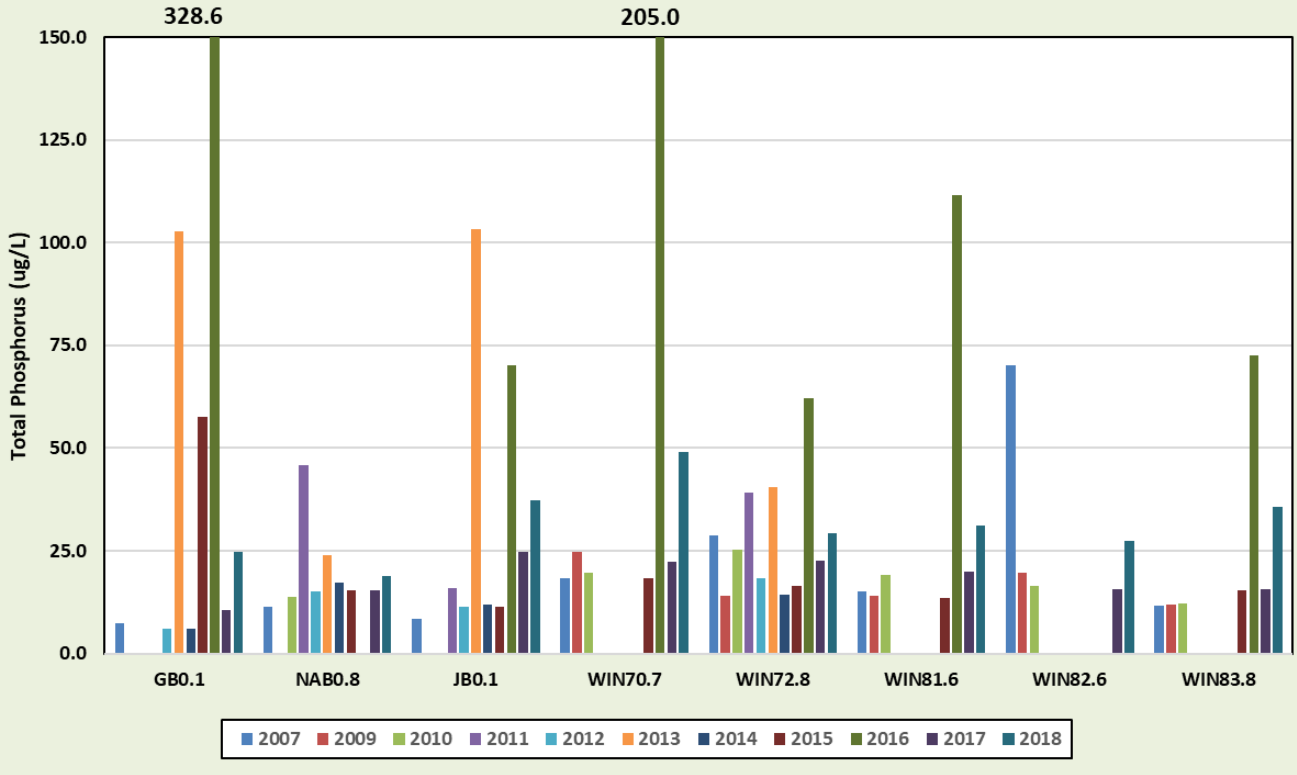
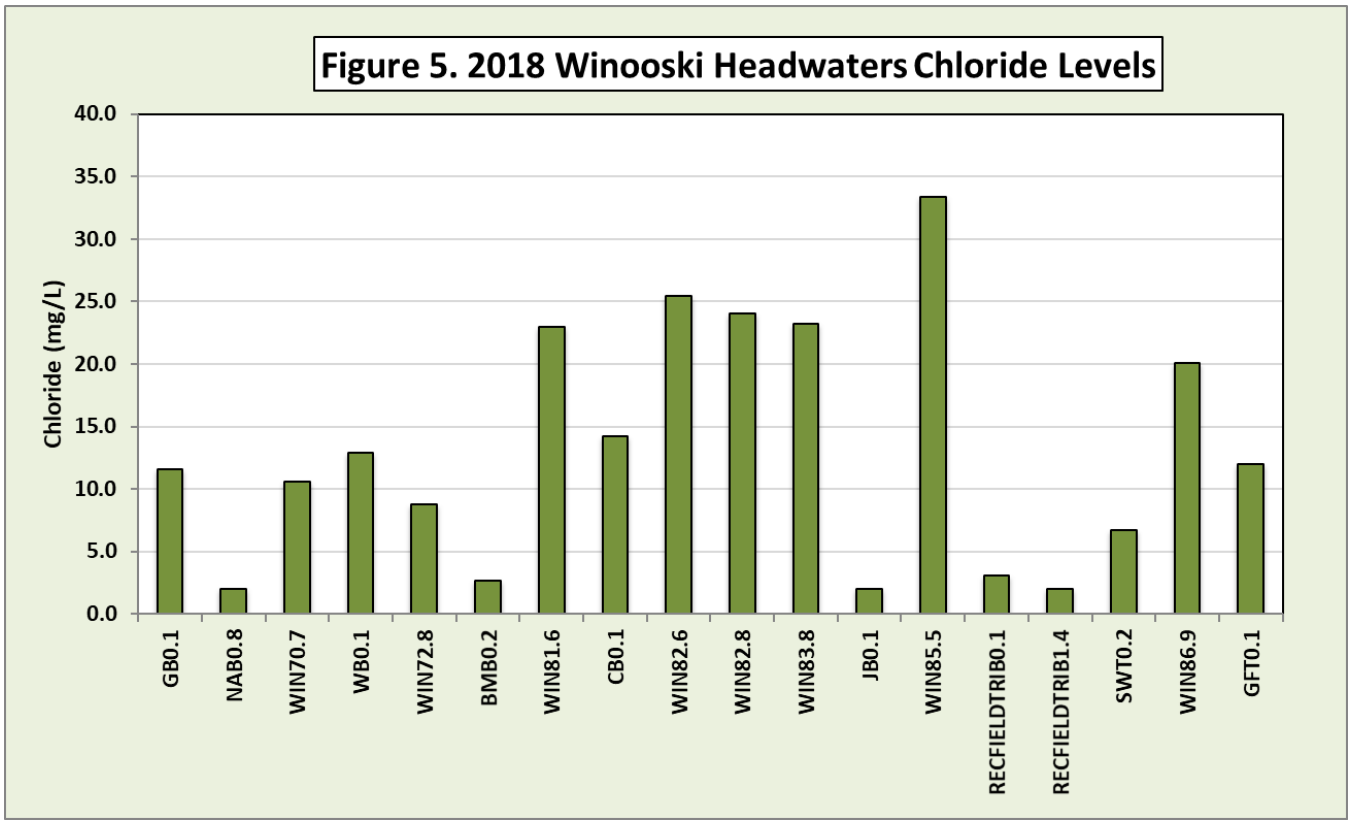


Figure 5 shows the chloride results from a single sampling under base flows on 9/18. The main stem sites from Marshfield up through Cabot had the highest chloride levels and were above 20mg/l. The site immediately below Cabot village was highest at over 30mg/l. These results indicate that chloride levels within these village settings is slightly elevated from background, likely due to a higher concentration of roads and road salt use. No locations are close to the aquatic life water quality standards of 230mg/l chronic or 860mg/l acute values. Nasmith Brook and Jug Brook have the lowest concentrations of chloride, at background "natural" levels a reflection of their highly forested watersheds.



E. coli Background and Results

Fecal coliform bacteria are a group of bacteria primarily found in human and animal intestines and feces. *Escherichia coli* (*E. coli*) is one of the fecal coliform bacteria widely used as an indicator organism to detect the presence of fecal material 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 (most strains of *E. coli* are not pathogenic), but is rather an indicator of the presence of other pathogens found in fecal matter from humans or animals. *E. coli* monitoring is commonly conducted to inform people whether 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, pet waste, and untreated waste (septic or sewage) wastewater. Vermont's *E. coli* criteria matches the

EPA recommendations: "Not to exceed a *geometric mean of 126 organisms /100ml* obtained over a representative period of 60 days, and no more than *10% of samples above 235 organisms/100 ml"*. This equals to a *risk factor of about 36 illnesses/1,000 ingestions*. The EPA also provides an *E. coli* "Beach Action Value" (BAV) of 235 MPN/mL for single water samples. States can adopt this value and use it to close a recreational water site to the public when *E. coli* levels are above this standard.

Descriptions and locations of the 10 sites sampled for bacteria (*Escherichia coli*) are given in **Appendix 1**. **Table 2** and **Figure 6** below show the geometric mean of the *E. coli* results at locations sampled on four dates in 2018. Great Brook and Nasmith Brook had low *E. coli* for all sample events and represent the cleanest locations for swimming and contact recreation. All main stem Winooski River sites from WIN 83.8, just above the hydropower station, downstream to WIN 70.7 below the Plainfield WWTF were all above the geometric mean standard of 126 mpn/ml. These high levels were primarily due to the samples collected on July 24, which were collected after a rain event the day before (**Figure 7**). The two uppermost Winooski River sites were also high on that day and violated the single sample standard of 235 mpn/ml. High levels of *E. coli* also occurred on Sept 18 at the three Winooski River sites in Marshfield. The highest for that day >800 mpn/ml being just above town at WIN 82.6. This location is below the Hydro station, and field observations indicate samples were collected just after the hydro station was generating: "hydro appeared to be draining a generation flow from overnight". The site immediately above the Hydro station WIN 82.8 was only 52 mpn/ml. These observations indicate that the high *E. coli* at WIN 82.6 was due to the resuspension of instream *E. coli* by high flows from the Hydro station.

Table 2: Geometric mean *E. coli* levels over time at all locations sampled from 2007-2018.

***E. coli* Geometric Mean Under Dry Conditions**											
Site ID	**2007**	**2008**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
WIN70.7		149	268		245	159	105	302	164	253	272
WIN72.8			162	214	168	150	181	137	152	162	334
WIN81.6	256	134	150		223	120	178	154	67	93	265
WIN82.6		41	236	56	442	214	338	113	66	101	425
WIN82.8				171	541	128	485	170	119	132	253
WIN83.8	187	83	128	175	143	110	137	179	88	136	221
WIN85.5			51	78	94	74	112	61	40	86	57
WIN86.6						48	137	29	41	113	54
GB0.1	39	58					12		5	87	54
NAB 0.8	9							14		20	22
	Exceeds EPA standards for the annual geometric mean (126 mpn/ml)										

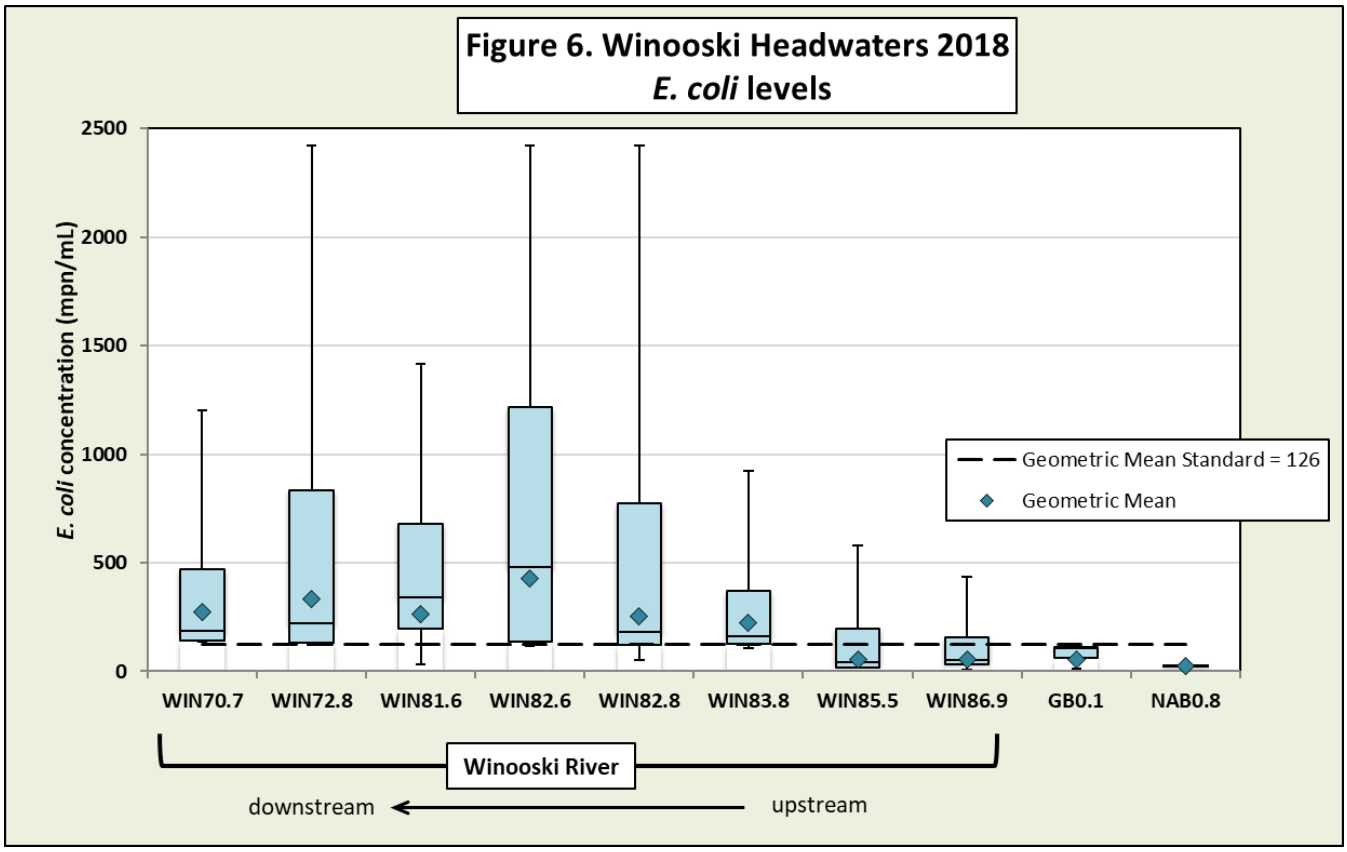


Figure 6. Winooski Headwaters 2018
E. coli levels
E. coli concentration (mpn/mL)
2500
2000
1500
1000
500
0
Geometric Mean Standard = 126
Geometric Mean
WIN70.7
WIN72.8
WIN81.6
WIN82.6
WIN82.8
WIN83.8
WIN85.5
WIN86.9
GB0.1
NAB0.8
Winooski River
downstream
upstream

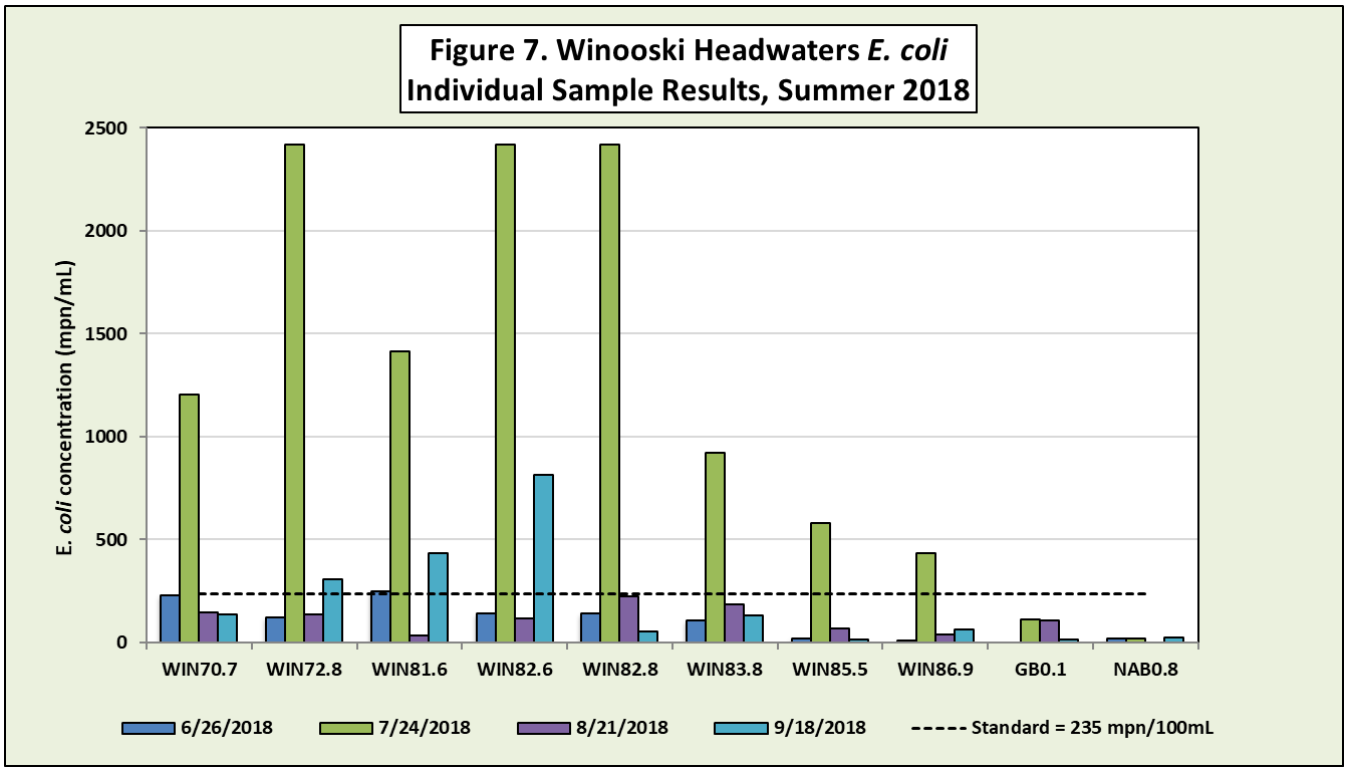


Figure 7. Winooski Headwaters E. coli
Individual Sample Results, Summer 2018
E. coli concentration (mpn/mL)
2500
2000
1500
1000
500
0
WIN70.7
WIN72.8
WIN81.6
WIN82.6
WIN82.8
WIN83.8
WIN85.5
WIN86.9
GB0.1
NAB0.8
6/26/2018
7/24/2018
8/21/2018
9/18/2018
Standard = 235 mpn/100mL

Appendices

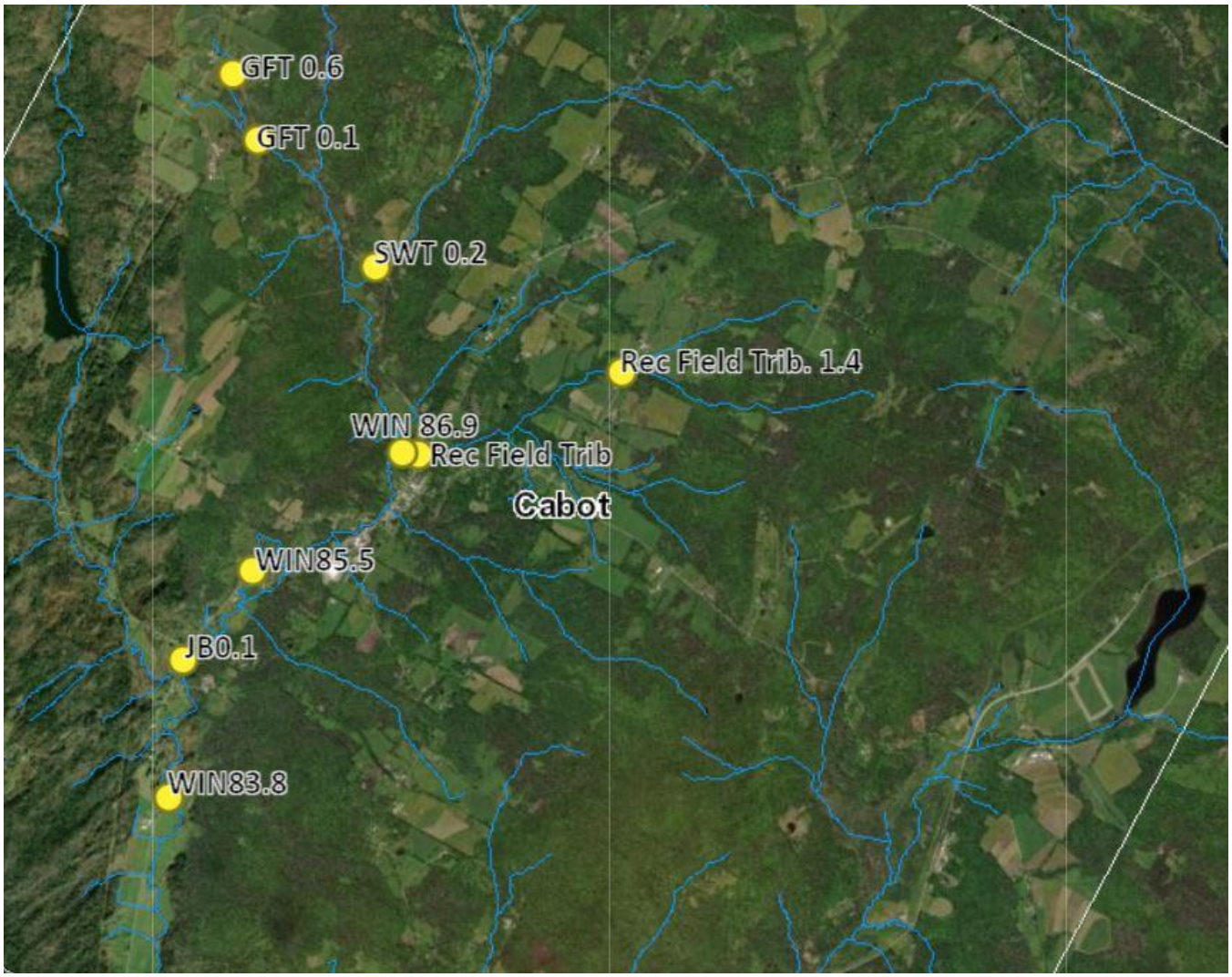
Appendix A. Site Descriptions and Maps

Upper Winooski Headwaters water quality monitoring sites in 2018 (19 total). Main stem sites are in **bold** and are listed upstream to downstream. Tributaries are listed as they enter main stem. *E. coli* testing sites (11 total) included all of the Winooski River sites, plus the Nasmith and Great Brook sites.

Stream	Site ID	Lat	Long	Description
Winooski River	WIN 86.9	44.40651	72.30995	Above Cabot Plains Brook, adjacent to Cabot Rec Fields
Goat Farm Trib[1]	GFT 0.1	44.42794	72.32381	Above Houston Hill Road lower site
Goat Farm Trib[1]	GFT 0.6	44.43248	72.32624	Below Houston Hill road upper site
S.Walden Trib[1]	SWT 0.2	44.41932	72.31259	S.Walden Trib at crossing with Houston Hill Road
Rec Field Trib[1]	RECFIELD TRIB0.1	44.4064	72.3084	Rec Field trib. Adjacent to Cabot rec fields
Rec Field Trib[1]	RECFIELD TRIB1.4	44.41203	72.2888	Below Menard Road
Winooski River	WIN85.5	44.3984	72.3244	Winooski R by Larry's Ball field below Cabot village
Jug Brook[1]	JB0.1	44.3923	72.331	Jug Brook immediately below Rt 215 in lower cabot
Winooski River	WIN83.8	44.3829	72.3325	Winooski at storage bldg in Durrant Cemetery bl WWTF
Winooski River	WIN82.8	44.3604	72.3353	Winooski R just above GMP generation station
Winooski River	WIN82.6	44.3519	72.3470	At Rt 2 bridge just above Marshfield Village
Creamery Brook[1]	CB 0.1	44.35129	72.35524	Creamery Brook at Rt 2 crossing
Winooski River	WIN81.6	44.3501	72.3566	Winooski R below Marshfld WWTF ab Flower Farm
Beaver Meadow[1]	BMB 0.2	44.33032	72.37639	Beaver Meadow Brook above first town bridge.
Nasmith Brook	NAB0.8	44.29811	72.387455	At Paradise swimming hole, below RR bed
Wells Brook[1]	WB0.1	44.28341	72.41726	Wells Brook at Rt 2 crossing, Mouth
Winooski River	WIN72.8	44.2871	72.409	Winooski R @ Martin Bridge in Marshfield;
Great Brook	GB0.1	44.2767	72.4267	Great Brook just above confluence with Winooski
Winooski River	WIN70.7	44.1624	72.2556	Winooski R below the Plainfield WWTF.

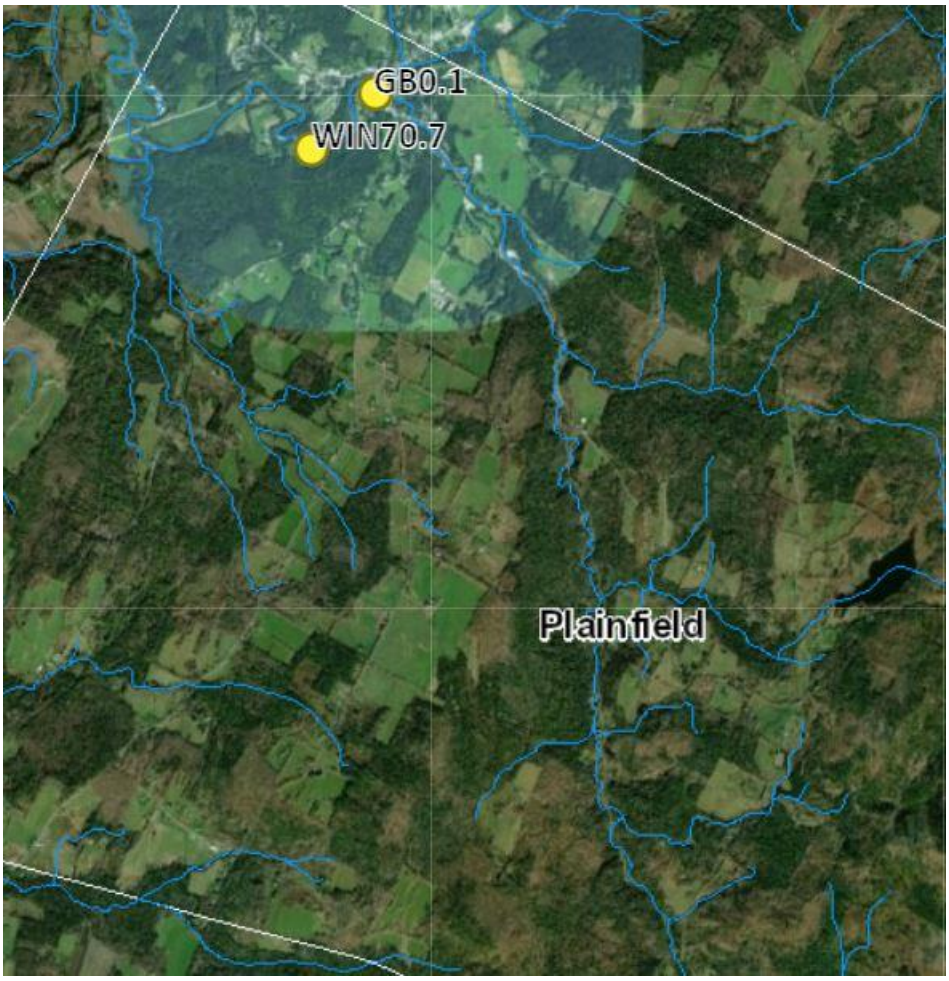
[1]Small High Gradient streams for TP criteria under base flow. All other streams are Medium High Gradient.

Headwaters Partnership Cabot, VT Sampling Sites for 2018



Headwaters Partnership Marshfield, VT Sampling Sites 2018

Headwaters Partnership Marshfield/Plainfield, VT Sampling Sites 2018



Appendix B: 2018 *E. coli* concentration results for each site and date. RPD= relative percent difference between duplicate samples collected same date at a site. Data set includes 10% duplicates and Blank samples for quality control.

Sample Number	Location	Date	Final E. coli (mpn/100ml)	RPD (%)
181385-09	GB0.1	7/24/2018	110.04	
181641-13	GB0.1	8/21/2018	104.97	
181950-09	GB0.1	9/18/2018	13.5	
181150-11	NAB0.8	6/26/2018	20.34	
181385-07	NAB0.8	7/24/2018	19.89	
181385-14	NAB0.8 BLANK	7/24/2018	< 1	
181385-13	NAB0.8 DUP	7/24/2018	23.34	15.96
181950-07	NAB0.8	9/18/2018	24.33	
181150-14	WIN70.7	6/26/2018	228.18	
181385-10	WIN70.7	7/24/2018	1203.33	
181641-14	WIN70.7	8/21/2018	145.49	
181950-10	WIN70.7	9/18/2018	137.61	
181950-12	WIN70.7 DUP	9/18/2018	177.95	25.57
181150-12	WIN72.8	6/26/2018	121.12	
181385-08	WIN72.8	7/24/2018	2419.57	
181641-12	WIN72.8	8/21/2018	137.61	
181950-08	WIN72.8	9/18/2018	307.59	
181150-10	WIN81.6	6/26/2018	248.09	
181385-06	WIN81.6	7/24/2018	1413.61	
181641-10	WIN81.6	8/21/2018	32.25	
181950-06	WIN81.6	9/18/2018	435.17	
181150-09	WIN82.6	6/26/2018	139.58	
181385-05	WIN82.6	7/24/2018	2419.6	
181641-07	WIN82.6	8/21/2018	118.74	
181641-09	WIN82.6-BLANK	8/21/2018	< 1	
181641-08	WIN82.6-DUP	8/21/2018	104.97	12.31
181950-05	WIN82.6	9/18/2018	816.41	
181150-06	WIN82.8	6/26/2018	142.09	
181150-08	WIN82.8-BLANK	6/26/2018	< 1	
181150-07	WIN82.8-DUP	6/26/2018	150.01	5.42
181385-04	WIN82.8	7/24/2018	2419.6	
181641-06	WIN82.8	8/21/2018	224.68	
181950-04	WIN82.8	9/18/2018	52.91	
181150-05	WIN83.8	6/26/2018	105.37	
181385-03	WIN83.8	7/24/2018	920.84	
181641-05	WIN83.8	8/21/2018	187.19	
181950-03	WIN83.8	9/18/2018	131.69	

181150-04	WIN85.5	6/26/2018	17.31	
181385-02	WIN85.5	7/24/2018	579.43	
181641-02	WIN85.5	8/21/2018	69.07	
181641-04	WIN85.5-BLANK	8/21/2018	< 1	
181641-03	WIN85.5-DUP	8/21/2018	66.31	4.08
181950-02	WIN85.5	9/18/2018	14.8	
181150-01	WIN86.9	6/26/2018	8.6	
181150-03	WIN86.9-BLANK	6/26/2018	< 1	
181150-02	WIN86.9-DUP	6/26/2018	9.79	12.94
181385-01	WIN86.9	7/24/2018	435.17	
181385-12	WIN86.9 BLANK	7/24/2018	< 1	
181385-11	WIN86.9 DUP	7/24/2018	517.21	17.23
181641-01	WIN86.9	8/21/2018	37.25	
181950-01	WIN86.9	9/18/2018	63.14	
	Average Relative Percent Difference			**13.36**

Appendix C. 2018 results for Total Phosphorus, Turbidity, and Chloride from the Upper Winooski Headwaters and tributaries. Results include 10% duplicate and blank samples. RPD is the relative percent difference between a sample and the duplicate sample collected at same day and site.

Sample Number	Location	Date	Chloride (mg/L)	TP (ug P/L)	Turbidity (NTU)	RPD, Chloride	RPD, TP	RPD, Turbidity
181151-14	BMB 0.2	6/19/2018		43.6				
181265-16	BMB 0.2	7/6/2018		46.1				
181386-13	BMB 0.2	7/24/2018		17.1				
181642-17	BMB 0.2	8/18/2018		17.4				
181872-16	BMB 0.2	9/11/2018		121	81.7			
181945-16	BMB 0.2	9/18/2018	2.69	8.91				
181151-12	CB 0.1	6/19/2018		50.9				
181265-14	CB 0.1	7/6/2018		44.1				
181386-11	CB 0.1	7/24/2018		11.1				
181642-15	CB 0.1	8/18/2018		14.3				
181872-12	CB 0.1	9/11/2018		119	33.8			
181945-12	CB 0.1	9/18/2018	14.2	7.8				
181945-14	CB 0.1-BLANK	9/18/2018	< 2	< 5				
181945-13	CB 0.1-DUP	9/18/2018	14	7.46		1.42	4.46	
181151-18	GB0.1	6/19/2018		85.2				
181265-20	GB0.1	7/6/2018		10.2				
181386-17	GB0.1	7/24/2018		8.88				
181642-21	GB0.1	8/18/2018		11.2				
181872-20	GB0.1	9/11/2018		20.4	15.7			
181945-20	GB0.1	9/18/2018	11.6	12.6				
181151-02	GFT0.1	6/19/2018		38.8				
181265-04	GFT0.1	7/6/2018		146				
181386-02	GFT0.1	7/24/2018		48.3				
181642-02	GFT0.1	8/18/2018		69.5				
181642-04	GFT0.1-BLANK	8/18/2018		< 5				

181642-03	GFT0.1-DUP	8/18/2018		61.9			11.57	
181872-02	GFT0.1	9/11/2018		190	18.7			
181945-02	GFT0.1	9/18/2018	12	26.7				
181151-03	GFT0.6	6/19/2018		33.7				
181265-22	GFT0.6	7/6/2018		408				
181642-23	GFT0.6	8/18/2018		230				
181872-03	GFT0.6	9/11/2018		40.2	4.08			
181151-08	JB0.1	6/19/2018		21.4				
181265-08	JB0.1	7/6/2018		31.7				
181386-07	JB0.1	7/24/2018		12.7				
181642-09	JB0.1	8/18/2018		51.6				
181872-08	JB0.1	9/11/2018		99.1	20.2			
181945-08	JB0.1	9/18/2018	< 2	8.01				
181151-15	NAB0.8	6/19/2018		42.9				
181265-17	NAB0.8	7/6/2018		16.1				
181386-14	NAB0.8	7/24/2018		15.1				
181386-21	NAB0.8-DUP	7/24/2018		15.3			1.32	
181642-18	NAB0.8	8/18/2018		13.4				
181872-17	NAB0.8	9/11/2018		12.2	0.59			
181945-17	NAB0.8	9/18/2018	< 2	14				
181151-05	Rec Field Trib	6/19/2018		39.5				
181265-06	Rec Field Trib.	7/6/2018		80				
181386-04	Rec Field Trib.	7/24/2018		19.4				
181642-06	Rec Field Trib.	8/18/2018		589.8				
181872-05	Rec Field Trib.	9/11/2018		310	80.1			
181945-05	Rec Field Trib.	9/18/2018	3.05	13.2				
181386-05	Rec Field Trib. 1.4	7/24/2018		16				
181642-07	Rec Field Trib. 1.4	8/18/2018		212				
181872-06	Rec Field Trib. 1.4	9/11/2018		206	64.5			
181945-06	Rec Field Trib. 1.4	9/18/2018	< 2	11.4				
181151-04	SWT0.2	6/19/2018		33.6				

181265-05	SWT0.2	7/6/2018		86.5				
181386-03	SWT0.2	7/24/2018		17.4				
181642-05	SWT0.2	8/18/2018		35.9				
181872-04	SWT0.2	9/11/2018		53.6	8.04			
181945-04	SWT0.2	9/18/2018	6.67	19				
181151-16	WB0.1	6/19/2018		24.7				
181265-18	WB0.1	7/6/2018		12.9				
181386-15	WB0.1	7/24/2018		15.7				
181642-19	WB0.1	8/18/2018		20.7				
181872-18	WB0.1	9/11/2018		99.6	19.7			
181945-18	WB0.1	9/18/2018	12.9	6.07				
181151-19	WIN70.7	6/19/2018		79.2				
181151-21	WIN70.7 - Blank	6/19/2018		< 5				
181151-20	WIN70.7 - Dup	6/19/2018		70.7			11.34	
181265-21	WIN70.7	7/6/2018		30.5				
181386-18	WIN70.7	7/24/2018		30.6				
181642-22	WIN70.7	8/18/2018		34.5				
181872-21	WIN70.7	9/11/2018		103	17.9			
181945-21	WIN70.7	9/18/2018	10.6	17.1				
181151-17	WIN72.8	6/19/2018		67.5				
181265-19	WIN72.8	7/6/2018		25.9				
181386-16	WIN72.8	7/24/2018		17				
181642-20	WIN72.8	8/18/2018		21.5				
181872-19	WIN72.8	9/11/2018		27.3	7.5			
181945-19	WIN72.8	9/18/2018	8.79	16.8				
181151-13	WIN81.6	6/19/2018		61.3				
181265-15	WIN81.6	7/6/2018		19.3				
181386-12	WIN81.6	7/24/2018		21.1				
181642-16	WIN81.6	8/18/2018		18.4				
181872-13	WIN81.6	9/11/2018		46.2	11.1			
181872-15	WIN81.6-BLANK	9/11/2018		< 5	0.29			

181872-14	WIN81.6-DUP	9/11/2018		46.4	15.2		0.43	31.18
181945-15	WIN81.6	9/18/2018	23	20				
181151-11	WIN82.6	6/19/2018		61.2				
181265-13	WIN82.6	7/6/2018		26.3				
181386-10	WIN82.6	7/24/2018		16.6				
181642-12	WIN82.6	8/18/2018		18.1				
181872-11	WIN82.6	9/11/2018		32.3	5.4			
181945-11	WIN82.6	9/18/2018	25.4	10.5				
181642-14	WIN82.6-BLANK	8/18/2018		< 5				
181642-13	WIN82.6-DUP	8/18/2018		18.5			55.17	
181151-10	WIN82.8	6/19/2018		74				
181151-22	WIN82.8-BLANK	6/19/2018		< 5				
181265-10	WIN82.8	7/6/2018		30.8				
181265-12	WIN82.8-BLANK	7/6/2018		5				
181265-11	WIN82.8-DUP	7/6/2018		31.2			1.29	
181386-09	WIN82.8	7/24/2018		21.1				
181642-11	WIN82.8	8/18/2018		21.8				
181872-10	WIN82.8	9/11/2018		18.9	2.46			
181945-10	WIN82.8	9/18/2018	24	11.5				
181151-09	WIN83.8	6/19/2018		45.6				
181265-09	WIN83.8	7/6/2018		64.4				
181386-08	WIN83.8	7/24/2018		15.9				
181642-10	WIN83.8	8/18/2018		35.1				
181872-09	WIN83.8	9/11/2018		36.8	5.13			
181945-09	WIN83.8	9/18/2018	23.2	15.6				
181151-07	WIN85.5	6/19/2018		45.2				
181265-07	WIN85.5	7/6/2018		78.2				
181386-06	WIN85.5	7/24/2018		16.8				
181642-08	WIN85.5	8/18/2018		52.5				
181872-07	WIN85.5	9/11/2018		134.4	40.4			
181945-07	WIN85.5	9/18/2018	33.4	8.05				

181151-01	WIN86.9	6/19/2018		29.1				
181265-01	WIN86.9	7/6/2018		43.8				
181265-03	WIN86.9-BLANK	7/6/2018		< 5				
181265-02	WIN86.9-DUP	7/6/2018		45.1			2.92	
181386-01	WIN86.9	7/24/2018		17.7				
181386-20	WIN86.9-BLANK	7/24/2018		7.18				
181386-19	WIN86.9-DUP	7/24/2018		20.2			13.19	
181642-01	WIN86.9	8/18/2018		55.1				
181872-01	WIN86.9	9/11/2018		106	18.5			
181945-01	WIN86.9	9/18/2018	20.1	12.2				
	Average Relative Percent Difference					**1.42**	**11.30**	**31.18**