



2016 Mad River Watershed Report to LaRosa

Summary

In 2016, Mad River Watch program volunteers drew samples on six dates at 32 sites on June 13, June 27, July 11, July 25, August 8, and August 22. 12 sample sites were located on the main stem of the Mad River, 19 on tributaries, and one on Blueberry Lake.

The Friends of the Mad River lab analyzed samples from 12 of our 32 sites for *E. coli* (using the IDEXX QuantiTray method), and collected other information on each sampling date including temperature and flow (data from USGS gauge in Moretown).

Through the LaRosa partnership, samples from 23 of 32 sites, 5 on the main stem of the Mad River and 18 on tributaries were analyzed for phosphorus, nitrogen, and turbidity.

Vermont Water Quality Standards

The Vermont Water Quality Standards set the allowable limits for *E. coli*, total Phosphorus, turbidity, total nitrogen for the Class B2 (cold water fishery) waters of the Mad River and its tributaries as follows:

E. coli

Not to exceed 235 per milliliter; this is considered a “Beach Action Value” that corresponds to 8 illnesses per 1,000 swimmers and is slightly more conservative than EPA’s base recommendation of 410 *E. coli* per milliliter

Turbidity

Not to exceed 10 NTU

Total Phosphorus

Not to exceed 12 µg/l

Total Nitrogen

Not to exceed 5 mg/l

Phosphorus

Of the total of 138 samples analyzed for total Phosphorus, 67 sites (49 percent) exceeded the standard of 12 µg/l. This is an increase from last year, where 33 percent of samples had exceeded the water quality standard, yet the flow conditions during sampling varied between sampling seasons. Nine of the samples exceeding the standard were located on the main stem of the river and 58 were on tributaries.

Table 1. 2016 Total Phosphorus at 23 sites in the Mad River Watershed (µg/l)

		6/13/2016	6/27/2016	7/11/2016	7/25/2016	8/8/2016	8/22/2016
FLOW CONDITION -->		HR	LS	HD	LS	LS	HD
FLOW CATEGORY/LEVEL -->		MB	LB	MF	LB	LB	MF
(Generalized Across Sites)							
SITE LOCATION	SITE #						
Warren Store (Freeman Brook)	4	6.64	7.79	6.86	9.78	6.22	12.1
Bottom of Sugarbush Acces Rd (Clay Brk)	8	36	8.49	18.1	7.18	6.58	14.1
Route 100 crossing (Folsom Brook)	10	16	17	19.1	19.8	16.9	29.2
"Dip" on East Warren Rd. (N. Folsom Brook)	10.6	9.42	10	8.8	10.2	11.2	15.9
Yurt Property (Folsom Brook)	10.8	9.23	12	11.4	11.3	13	18.7
Sugarbush Health Club (Rice Brook)	11	7.76	6.35	5.25	7.28	<5	8.03
Inferno Road Crossing (Clay Brook)	12	22.3	6.24	5.64	7.46	105	6.59
German Flats, Rt 17 (Chase Brk)	16	12.7	5.55	5.55	5.01	11.3	9.17
German Flats, Rt 17 (Mill Brk)	17	13.9	13.5	7.23	13.7	11.2	7.63
Battleground Condos (Mill Brk)	17.1	12.7	<5	8.94	<5	<5	7.34
Mill Brook	18.1	19.2	6.13	10.7	5.39	5.6	12.7
Waitsfield Covered Bridge (Mad River)	20	8.56	6.81	8.03	16.9	21.2	20.5
Joslin Hill Road Culvert (High Bridge Brook)	20.1	12.2	13.1	28.4	13.2	10.6	46.4
High Bridge Brook North Split	20.1-1	14.5	15.3	20.2	15.3	15.6	63.1
High Bridge Brook Middle Split	20.1-2	9.06	10.6	11.1	10.5	11.4	28.1
High Bridge Brook South Split	20.1-3	14.2	28.3	29.9	25.1	27.8	48.8
Route 100 Bridge (Shepard Brook)	24	13.8	6.18	11.5	8.68	6.99	19.7
Route 100 Bridge (Dowsville Brook)	25	11.8	10.7	11	10	12.4	31.3
North Road near Moretown (Mad River)	26	8.36	7.32	9.22	7.23	7.84	146
Moretown Villa ge Swim Access (Mad River)	27	10.5	7.45	9.18	9.51	9.57	38.8
Ward Clapboard Mill (Mad River)	28	12.5	7.26	10.6	7.88	9.91	32.6
Near Stevens Brook Road (Welder Brook)	28.05	11.5	12.7	14.6	15.4	10.4	29.6
Lover's Lane Bridge (Mad River)	31	9.55	9.92	14.9	17.3	8.24	23.7

Two sites, at the North and South split of High Bridge Brook (20.1-1 and 20.1-3) were in violation on each of the sampling days, regardless of the flow conditions. This indicates that the areas upstream of these sites are consistently contributing to the phosphorus input into the watershed. However, as this is the first year these sites have been sampled, more data are required to better understand these inputs.

On August 22, the highest number of violations for a single sampling day was recorded. The FMR flow conditions that day were High and Declining, based on Moretown USGS Gage information, following a storm event that had occurred just prior to sampling. Volunteers also recorded the DEC flow category and level for each site (Table 5), which was generalized across the watershed by

using the most common flow observation, MF, or Medium Flooding.

Three other sites, Folsom Brook at the Route 100 crossing (10), High Bridge Brook at the Joslin Hill Road culvert (20.1), and Welder Brook near Stevens Brook Road (28.05), had four violations out of the six sampling days. These include sampling days where the Flow Condition at the Moretown gage was Low and Steady, and the generalized DEC Flow Category and Level showed conditions of Low Base flow.

The site on Clay Brook at the Inferno Road crossing (12) produced an outlier sample on August 8, 2016 where the phosphorus concentration was 105 µg/l, far higher than any other sample of the season. This specific data point should likely be discounted as either an anomaly (a one-time input) or as a mistake made during sampling or analysis.

Based on this year's sampling, it would appear that High Bridge Brook, particularly at the North and South splits, is a tributary that may be a major source of phosphorus input, and thus a source of concern. It also would appear that high phosphorus values are more common when the flow conditions are high, indicating significant input from stormwater runoff.

Quality Control for Total Phosphorus

The average relative percent difference (RPD) of phosphorus field duplicate samples for the six sampling dates was 21.79%, which is within the estimated range of precision specified in the Quality Assurance Project Plan (QAPP) – less than or equal to 30% RPD. One field sample duplicate taken on June 13 when flow conditions were high and rising showed a difference of 71.96%. Another field sample duplicate on August 8 during low and steady flow conditions had a difference of >100.0%. In this case, both samples had a very high phosphorus value that might indicate a sampling error. These large differences may have been due to sampling procedure (timing) and the variation in flow regime.

Field blanks were also collected at each site during sampling. All field blanks had only trace phosphorus.

Data completeness for the 2016 season is 100%.

Nitrogen

Out of 138 samples taken and analyzed for Total Nitrogen, none exceeded the standard of 5 mg/l. The highest value found during the sampling season was 0.78 mg/l. This was our first year of sampling for total nitrogen, so there is no historical data to which to compare.

Table 2. 2016 Total Nitrogen at 23 sites in the Mad River Watershed (mg/l)

		6/13/2016	6/27/2016	7/11/2016	7/25/2016	8/8/2016	8/22/2016
FLOW CONDITION -->		HR	LS	HD	LS	LS	HD
FLOW CATEGORY/LEVEL -->		MB	LB	MF	LB	LB	MF
(Generalized Across Sites)							
SITE LOCATION	SITE #						
Warren Store (Freeman Brook)	4	0.36	0.59	0.38	0.45	0.78	0.36
Bottom of Sugarbush Acces Rd (Clay Brk)	8	0.28	0.52	0.66	0.47	0.62	0.37
Route 100 crossing (Folsom Brook)	10	0.48	0.69	0.41	0.44	0.54	0.48
"Dip" on East Warren Rd. (N. Folsom Brook)	10.6	0.46	0.62	0.33	0.57	0.5	0.56
Yurt Property (Folsom Brook)	10.8	0.17	0.36	0.23	0.23	0.38	0.29
Sugarbush Health Club (Rice Brook)	11	0.24	0.31	0.25	0.37	0.45	0.33
Inferno Road Crossing (Clay Brook)	12	0.23	0.32	0.19	0.29	0.37	0.26
German Flats, Rt 17 (Chase Brk)	16	0.26	0.33	0.21	0.29	0.4	0.29
German Flats, Rt 17 (Mill Brk)	17	0.19	0.3	0.24	0.29	0.43	0.21
Battleground Condos (Mill Brk)	17.1	0.23	0.43	0.32	0.39	0.72	0.22
Mill Brook	18.1	0.21	0.33	0.23	0.31	0.4	0.24
Waitsfield Covered Bridge (Mad River)	20	0.35	0.32	0.22	0.27	0.38	0.35
Joslin Hill Road Culvert (High Bridge Brook)	20.1	0.4	0.64	0.38	0.49	0.69	0.53
High Bridge Brook North Split	20.1-1	0.28	0.52	0.3	0.4	0.6	0.65
High Bridge Brook Middle Split	20.1-2	0.49	0.61	0.5	0.53	0.69	0.48
High Bridge Brook South Split	20.1-3	0.4	0.11	0.29	0.42	0.45	0.43
Route 100 Bridge (Shepard Brook)	24	0.17	0.15	0.17	0.22	0.29	0.2
Route 100 Bridge (Dowsville Brook)	25	0.13	0.2	0.13	0.17	0.23	0.18
North Road near Moretown (Mad River)	26	0.24	0.44	0.22	0.31	0.46	0.33
Moretown Village Swim Access (Mad River)	27	0.24	0.44	0.21	0.32	0.44	0.32
Ward Clapboard Mill (Mad River)	28	0.24	0.43	0.23	0.29	0.44	0.31
Near Stevens Brook Road (Welder Brook)	28.05	0.21	0.26	0.22	0.27	0.29	0.31
Lover's Lane Bridge (Mad River)	31	0.26	0.41	0.25	0.27	0.37	23.7

Quality Control for Total Nitrogen

The average relative percent difference (RPD) of nitrogen field duplicate samples for the six sampling dates was 3.85%, well within the estimated range of precision specified by the Quality Assurance Project Plan (QAPP) – less than or equal to 20% RPD. One field sample “actual” sample (18.1, 6/27/16) never made it back to the lab, so the duplicate’s Nitrogen value was used as actual and the two were removed from the RPD data calculation.

Field blanks were also taken at each sampling. All field blanks only had trace amounts of nitrogen, suggesting that no environmental factors affected the actual samples.

Data completeness for the 2016 season is 99.27% because the 6/27/16 sample that was lost.

Turbidity

Among the 138 samples taken and analyzed for turbidity, 9 of them did not meet turbidity standard of 10 NTU. The South Split of High Bridge Brook (20.1-3) is the most consistent site to violate the turbidity standard. This site is located in an incised stream cutting through eroding slopes. Onsite, before and during sampling, turbidity was visible and caused samplers to consider the possibility of a clay vein in the surficial material. It is worth noting also, however, that the stream discharge at this site is very small. The samplers indicated a “trickle” of water during dry days. The only instance when another site exceeded the standard was on August 22, where five sites exceeded the standard. Due to a storm just prior to the sampling, the FMR flow condition was High and Decreasing, and DEC Category and Level was Medium Flooding, as discussed above. This would suggest the increased stream flow is a factor in the higher number of high values that day.

Table 3. Turbidity at 23 sites in the Mad River Watershed (NTU)

		6/13/2016	6/27/2016	7/11/2016	7/25/2016	8/8/2016	8/22/2016
FLOW CONDITION -->		HR	LS	HD	LS	LS	HD
FLOW CATEGORY/LEVEL -->		MB	LB	MF	LB	LB	MF
(Generalized Across Sites)							
SITE LOCATION	SITE #						
Warren Store (Freeman Brook)	4	0.57	0.24	0.73	0.53	<0.2	1.18
Bottom of Sugarbush Acces Rd (Clay Brk)	8	10.6	0.56	2.91	1.33	0.44	4.33
Route 100 crossing (Folsom Brook)	10	0.43	0.56	1.07	0.83	1.1	2.18
"Dip" on East Warren Rd. (N. Folsom Brook)	10.6	0.97	0.45	0.26	0.41	<0.2	0.47
Yurt Property (Folsom Brook)	10.8	0.38	0.39	0.57	0.40	0.28	0.90
Sugarbush Health Club (Rice Brook)	11	0.86	<0.2	0.25	0.47	0.36	<0.2
Inferno Road Crossing (Clay Brook)	12	3.93	0.34	0.97	0.56	7.34	0.31
German Flats, Rt 17 (Chase Brk)	16	2.15	<0.2	0.37	0.34	<0.2	0.42
German Flats, Rt 17 (Mill Brk)	17	2.26	<0.2	0.34	0.24	6.27	0.34
Battleground Condos (Mill Brk)	17.1	1.84	<0.2	0.47	<0.2	<0.2	0.27
Mill Brook	18.1	3.62	0.21	1.48	1.03	<0.2	1.63
Waitsfield Covered Bridge (Mad River)	20	2.12	1.27	<0.2	3.77	1.28	5.44
Joslin Hill Road Culvert (High Bridge Brook)	20.1	1.61	2.29	7.06	2.33	0.48	9.55
High Bridge Brook North Split	20.1-1	0.53	0.41	1.23	0.37	<0.2	8.08
High Bridge Brook Middle Split	20.1-2	0.82	0.60	1.54	0.56	0.25	5.23
High Bridge Brook South Split	20.1-3	1.94	97.5	12.8	15.3	17	19.6
Route 100 Bridge (Shepard Brook)	24	1.65	0.32	1.80	0.32	<0.2	5.39
Route 100 Bridge (Dowsville Brook)	25	4.68	2.23	2.21	0.92	0.77	15
North Road near Moretown (Mad River)	26	2.25	1.02	2.20	1.37	1.43	12.1
Moretown Village Swim Access (Mad River)	27	2.89	0.83	2.43	1.12	0.90	17.4
Ward Clapboard Mill (Mad River)	28	3.16	0.93	2.84	1.05	0.98	10.7
Near Stevens Brook Road (Welder Brook)	28.05	1.75	1.07	1.98	2.23	0.58	4.06
Lover's Lane Bridge (Mad River)	31	3.42	1.15	4.82	3.37	1.66	5.27

Quality Control for Turbidity

The average relative percent difference (RPD) of turbidity field duplicate samples for the six sampling dates was 13.63%, which is within the estimated range of precision specified in the QAPP

(less than or equal to 15% RPD). Though it must be noted that on July 11, it is clear that the actual sample and field blank for the Waitsfield Covered Bridge site (20) were originally switched, which resulted in an initial RPD of 23.27%. However, when this mistake was corrected, the accurate RPD is 13.63%.

All field blanks taken, when corrected for mis-labeled or mis-sampled 7/11/16 actual and blank, showed only trace turbidity.

Data completeness for the 2016 season is 100%.

E. coli

On the sampling dates of June 27, July 25, and August 8 the flow of the Mad River at the Moretown gage was Low and Steady (LS), or Low Baseflow (LB) using DEC's categorization. On June 13, July 11, and August 22 the flow was High and Rising (HR) and High and Decreasing (HD). Regarding DEC values, our volunteers recorded flow observations as Medium Base (MB) on June 13, and as Medium Flooding (MF) on July 11 and August 22.

Of the 72 samples analyzed, 5 had unfavorable values of *E. coli* for recreation (235 *E. coli* per 100 milliliters). Four of these violations were on the sampling date of August 22 when FMR's flow condition of the Mad River was High and Decreasing. These four violations were on the Mad River (in Waitsfield and Moretown) and include: Tremblay Road (21.5), Meadow Bridge Road (23), the Moretown Village Swim Access (27), and the Ward Swimhole (29).

The last violation was on August 8, when flow conditions were low and steady, on the Mad River at the Lareau Swimhole (Site 19). This sample showed that there was 410.6 *E. coli* per 100 mL, which is a value much higher than any other sample taken at the site over the season. This site is used by many people for swimming and overuse or inappropriate use could be responsible.

E. coli concentrations for Blueberry Lake were very low, ranging from 3 to 24 *E. coli* per 100 mL, except for the sample collected on August 8 which resulted in 157.6 *E. coli* per 100 mL.

Table 4. 2016 *E. coli* at 12 sites in the Mad River Watershed (*E. coli*/100 ml)

		6/13/2016	6/27/2016	7/11/2016	7/25/2016	8/8/2016	8/22/2016	
FLOW CONDITION -->		HR	LS	HD	LS	LS	HD	
FLOW CATEGORY/LEVEL --> (Generalized Across Sites)		MB	LB	MF	LB	LB	MF	# Violations per site
SITE LOCATION	SITE #							
Blueberry Lake	BBL	3	2.0	3.1	7.4	157.6	24	0
Warren Falls (Mad River)	1	77.1	6.3	38.9	5.2	11	19	0
Bobbin Mill (Lincoln Brook)	2	222.4	11.0	23.8	24.1	3	17	0
Warren Store (Freeman Brook)	4	8.5	151.5	47.1	26.2	7.5	33	0
Warren Riverside Park (Mad River)	7	22.6	10.9	43.2	25.9	9.8	9	0
Lareau Swimhole (Mad River)	19	58.3	19.5	58.1	58.3	410.6	65.4	1
Couples Club Field (Mad River)	19.2	40.4	13.0	28.5	70.6	133.4	80	0
Waitsfield Covered Bridge (Mad River)	20	123.6	19.7	14.2	39.3	52.7	98	0
Tremblay Road (Mad River)	21.5	52.8	20.2	33.3	28.7	33.1	328.2	1
Meadow Road Bridge (Mad River)	23	18.5	5.1	23.3	13.2	18.7	920.8	1
Moretown Village Swim Access (Mad R	27	101.7	115.3	108.1	78	32.7	435.2	1
Ward Swimhole (Mad River)	29	172.2	61.3	143.9	60.5	13.5	579.4	1

DEC Flow and Level

In 2015, the Vermont DEC formalized a protocol to capture flow data and make qualitative observations on the flow condition at their respective sites. The Mad River Watch program has historically used a different categorization, based on the Moretown USGS Gage discharge information. Volunteers determine flow to be Low (L), Medium (M), or High (H), as well as the level to be Base (B), Flooding (F), or Hydro (H) conditions. These observations are made and recorded at each site during sampling and then generalized across the watershed to more easily make comparisons.

Table 5 illustrates the FMR Flow Condition, the DEC Flow Category and Level, and the river discharge (cfs) at 8:00 am at on each of the sampling days at the Moretown USGS Gage.

Table 5. DEC Flow Category and Level

0		6/13/2016	6/27/2016	7/11/2016	7/25/2016	8/8/2016	8/22/2016
FLOW CONDITION -->		HR	LS	HD	LS	LS	HD
FLOW CATEGORY/LEVEL --> (Generalized Across Sites)		MB	LB	MF	LB	LB	MF
Moretown Flow Gage Discharge (cfs)		296	43.3	187	49	23.5	253
SITE LOCATION	SITE #						
Blueberry Lake	BBL	MB	LB	HF	LB	No Flow	HF
Warren Falls (Mad River)	1	MB	LB	HF	LB	LB	HF
Bobbin Mill (Lincoln Brook)	2	MB	LB	MF	LB	LB	HF
Warren Store (Freeman Brook)	4	MB	LB	MF	LB	LB	HF
Warren Riverside Park (Mad River)	7	MB	LB	MF	LB	LB	HF
Bottom of Sugarbush Access Rd (Clay Brk)	8	MB	LB	MF	LB	LB	HF
Route 100 crossing (Folsom Brook)	10	MB	LB	MF	LB	LB	HF
"Dip" on East Warren Rd. (Folsom Brook N)	10.6	MB	LB	LB	LB	LB	MF
Folsom Brook (S tributary)	10.8	MB	LB	LB	LB	LB	MF
Sugarbush Health Club (Rice Brook)	11	MF	MB	MF	LB	LMB	MB
Inferno Road Crossing (Clay Brook)	12	HF	MB	MF	LB	MB	MB
German Flats, Rt 17 (Chase Brk)	16	MF	MB	MF	LB	LMB	MB
German Flats, Rt 17 (Mill Brk)	17	MF	MB	MF	LB	LMB	MHF
Mill Brook east of MRG	17.1	HF	MB	MF	MB	LB	MF
Mill Brook	18.1	MF	MB	MF	LB	LB	MF
Lareau Swimhole (Mad River)	19	MB	LB	MB	LB	LB	MF
Couples Club Field (Mad River)	19.2	MB	LB	MB	LB	LB	MF
Waitsfield Covered Bridge (Mad River)	20	MF	LB	MF	LB	LB	MF
Joslin Hill Road Culvert (High Bridge Brook)	20.1	MF	LB	MF	MB	LB	MF
High Bridge Brook North	20.1-1	MF	LB	MF	MB	LB	MF
High Bridge Brook Mid	20.1-2	MF	LB	MF	MB	LB	MF
High Bridge Brook South	20.1-3	LF	LB	MF	MB	No Flow	MF
Tremblay Road (Mad River)	21.5	MB	LB	MB	LB	LB	MF
Meadow Road Bridge (Mad River)	23	MB	LB	MB	LB	LB	MF
Route 100 Bridge (Shepard Brook)	24	MB	LB	MB	LB	LB	MF
Route 100 Bridge (Dowsville Brook)	25	MB	LB	MB	LB	LB	MF
North Road near Moretown (Mad River)	26	HB	LB	MB	MF	LB	HF
Moretown Village Swim Access (Mad River)	27	HF	LB	HF	MF	LB	HF
Ward Clapboard Mill (Mad River)	28	HF	LB	HF	MF	MB	HF
Near Stevens Brook Road (Welder Brook)	28.05	HF	MB	MB	MB	LB	HF
Ward Swimhole (Mad River)	29	MB	LB	MB	LB	MB	HF
Lover's Lane Bridge (Mad River)	31	MF	LB	HF	MB	MB	MF

Conclusions

Based on our analysis of the sampled total phosphorus data we would conclude that the sites at the North (20.1-1) and South (20.1-3) Splits of High Bridge Brook represent areas where phosphorus inputs are significant enough to justify further monitoring and source research. As this was our first year sampling at these sites, additional data should be collected in order to determine whether this was indicative of this season alone or whether it is a recurring problem at these sites.

Three other sites, Folsom Brook at the Route 100 crossing (1), Mill Brook at German Flats at Route 17 (17), and Welder Brook at Stevens Brook Road (28.05) had values that violated the phosphorus standard on dates where the watershed showed base flow conditions. This indicates that further sampling data on these tributaries is in order. Additional data can be collected at the same sites, or at new sites located upstream and at specific confluences to gain a better spatial understanding as to where the phosphorus inputs may be originating.

Nitrogen loading in the watershed does not appear to be an issue, as there were no violations of the water quality standards. However, as this was our first year sampling for total nitrogen, further sampling should be conducted in order to produce a historical record, and determine if any trends are apparent.

Sampling in the watershed during 2016 did not indicate any big turbidity challenges, except in the South Split of High Bridge Brook (20.1-3), which has consistently violated the turbidity standard throughout the sampling season. The only other time when the standard was violated at other sites was during a high flow condition event, where additional runoff would contribute to larger than normal sediment loading.

Only 6 of the 72 samples for *E. coli* were greater than 235 organisms/100ml. One at the Lareau Swinhole (19, 8/8/16), appears to be an anomaly from an unknown source. The other four samples registering greater than 235 organisms/100ml were on August 22 when the flow category was recorded as "F" (a freshet) which may have flushed *E.coli* materials containing *E. coli* organisms into the River from the adjacent land.