Bear Creek Environmental

Stowe Mountain Resort
SMR 2000 Community Plan
Water Quality Management Plan

2012 Monitoring Report

May 31, 2013

297 East Bear Swamp Road
Middlesex, Vermont 05602
Phone: (802) 223-5140
Fax: (802) 229-4410
email: bearcrk@sover.net

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Prepared by:

Mary M. Nealon
Principal/Aquatic Biologist

and

Emily Kinghorn
Environmental Scientist

Prepared for:

Stowe Mountain Resort
Stowe, Vermont

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TABLE OF CONTENTS

Stowe Mountain Resort
SMR 2000 Community Plan
Water Quality Management Plan

2012 Monitoring Report

EXECUTIVE SUMMARY

- Bear Creek Environmental, LLC (BCE) was retained by Stowe Mountain Resort (SMR) to conduct water quality monitoring and sediment assessments in the West Branch of the Little River watershed as part of the SMR Community 2000 Master Development Plan (MDP). The purpose of the water quality monitoring program is to provide information and guidance for water quality protection during construction and development at Spruce Peak.

- BCE monitored water quality at sixteen stream stations during the 2012 monitoring period. The monitoring stations are within the vicinity of Spruce Peak and are located within the West Branch of the Little River watershed and Pinnacle Brook watershed.

- SMR conducted monitoring at all the stations specified in the Settlement Agreement during 2012-2013, in addition to conducting monitoring on Little Spruce Brook, the lower West Branch station, Pinnacle Brook and supplemental stations on Big Spruce Brook, the upper West Branch, Ski Club Brook (a tributary to Big Spruce), and Gondola Brook and Long Trail Brook (tributaries in the vicinity of the Mansfield base area). Additionally, samples were collected during runoff events from the outlets of five sediment basins.

- Compared with previous years, the 2012-2013 monitoring period had generally low flows. The annual peak flows on the West Branch and Ranch Brook for water year 2012 were the second lowest and lowest on record, respectively. Flows on the West Branch were generally low during the summer months. Based on provisional flow data, May 23, 2013 storm event resulted in peak flows for the West Branch that are the highest of record so far for the 2013 water year.

- For the 2012-2013 monitoring season, there were five event-based sampling rounds during storm or melt events that resulted in significant runoff. Each event-based sample was analyzed for pH, chloride, total suspended solids (only 2012), turbidity, conductivity, and temperature. Turbidity values reported in 2012-2013 were generally low compared with previous years, with the exception of the May 23, 2013 event.

- The outlet of the Mansfield sediment basin was sampled on five occasions during the 2012-2013 monitoring period. The basin was found to be providing good treatment of stormwater during the summer and fall 2012 sampling events, and during the large rain

event in May 2013. The paving of the Mansfield parking lot in 2007 has helped reduce the amount of sediment coming off the parking area during the summer and fall. Turbidity values for winter melt events were generally lower in 2013 than in the 2011-2012 monitoring period, indicating that the revised snow plowing plan (developed in fall 2012) and stormwater treatment measures are improving water quality.

- The Agency of Natural Resources (ANR) placed the West Branch of the Little River from river mile 7.5 to 8.0 on the draft 303(d) list of impaired waters. In response to written comments received by Stowe Mountain Resort, the West Branch was moved to the B list (impaired but does not require the development of a TMDL). A 1272 order was issued by the ANR in early May 2012 with measures for improving stormwater treatment and sediment control. A plan for improving water quality in the West Branch in the vicinity of the base area has been developed by VHB. SMR implemented this plan during the 2012-2013 monitoring period.

- In the West Branch subwatershed, extensive erosion prevention and control measures (EPSC Program) were implemented by SMR in in the 2012-2013 monitoring period in addition to routine maintenance. Major improvements to the Snowplant, the Mountain Operations area, and the Mansfield Exit area were put into effect. The on mountain stream run-off at the Mansfield Exit area was separated from stormwater and now discharges into the West Branch directly, thereby increasing handling capacity of the Mansfield Exit Basin.

- In accordance with a 1272 order issued in May 2010, SMR implemented erosion and sediment control practices in the upper Big Spruce watershed to improve water quality. The ditchline adjacent to Big Spruce Road was reshaped and armored in September 2012. Additional stormwater management is recommended in the vicinity of Sensation Lot and Big Spruce Road to reduce sediment inputs to the Big Spruce Basin.

- Naturally occurring mass failures in the West Branch and Big Spruce watersheds are contributing sediment to surface waters during precipitation events. The unstable channel and banks along Ski Club Brook, located on private land not control by SMR, is also a sediment source.

- Macrobenthic sampling to assess the biological integrity of streams within the vicinity of Stowe Mountain Resort took place at seven monitoring stations during fall 2012. The control station, located at the picnic area in Smuggler's Notch, upstream of the Resort on the West Branch, was found to have fair to good biological integrity. This upper station may be impacted by acid precipitation. All three West Branch stations within and below the resort had good biological integrity and met Class B2-3 biocriteria. The favorable monitoring period and the improved stormwater treatment on the Mansfield side of the resort are likely factors that contributed to this good biological integrity. The Big Spruce station above the confluence of Little Spruce had good biological integrity, while the station downstream of the Little Spruce confluence had very low densities and did not meet Class B2-3 biocriteria. Pinnacle Brook, the reference stream, was also found to have good biological integrity in 2012.

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1.0 INTRODUCTION

Bear Creek Environmental, LLC (BCE) was retained by Stowe Mountain Resort (SMR) to conduct water quality monitoring and sediment assessments in the West Branch of the Little River watershed. This report summarizes the monitoring activities associated with the Water Quality Management Plan (WQMP) from summer 2012 through spring 2013 as part of the SMR Community 2000 Master Development Plan (MDP).

The purpose of the WQMP is to provide information and guidance for water quality protection during construction and development at Spruce Peak. SMR began the implementation of this plan in 1999. One primary objective of the WQMP is to document water quality conditions throughout the implementation of the MDP. Another objective is to show that the MDP will not result in any undue water pollution to the waters of Vermont according to Criterion 1 of Act 250. As part of the MDP, Spruce Peak construction started in 2003. The data collected in summer 2012 through spring 2013 represents the tenth year of monitoring during construction.

Big Spruce Brook was placed on the Part C of the 2008 Vermont List of Priority Waters by the Agency of Natural Resources (ANR) as in need of further assessment to determine compliance with the Vermont Water Quality Standards (VWQS). In 2010, Big Spruce Brook was moved to Part B of the Vermont Priority Water List, based on monitoring data from the past four years. Waters listed on Part B are considered impaired, but do not require the development of a Total Maximum Daily Load (TMDL). Rather, the development of a water quality remediation plan is required so that the VWQS are attained. The Agency of Natural Resources issued a 1272 order on May 6, 2010 to serve as a water quality remediation plan to address sources of iron and sediment identified in Big Spruce Brook.

The West Branch was placed on the 2012 list of impaired waters by the ANR. Based on a meeting held between ANR and SMR on March 15, 2012, and written comments dated April 11, 2012 (see page 1 to 4 of Appendix 2), the West Branch was moved to Part B of the Vermont Priority Waters List. A 1272 order was issued by Pete LaFlamme of the ANR on May 3, 2012 (Appendix 2 pages 5 through 7), to provide steps to be implemented to improve water quality of the West Branch. These steps are summarized in Section 7.0 of this report.

Spruce Peak Realty began construction on two Mountain Cabin buildings in 2011 and construction efforts were ongoing during the 2012 season. According to Rob Apple, construction plans for the 2013 season are uncertain.

2.0 STUDY AREA AND METHODLOGY

BCE monitored water quality at sixteen stream stations (see page 1 of Appendix 1) during the 2012 monitoring period. Seven of these monitoring stations were previously selected by Pioneer Environmental Associates, LLC (Pioneer) based on their proximity to construction activities. The rationale for station selection is reported in Pioneer's Quality Assurance Project Plan (QAPP) dated February 2002. Two additional monitoring stations were voluntarily added by Stowe Mountain Resort during the 2006 monitoring period to provide data for the West Branch and Big Spruce Brook. Based on a recommendation from Bear Creek Environmental, turbidity monitoring of the outflow of three sediment basins was added during 2007. A new monitoring station on Big Spruce Brook at river mile 0.7 was added in 2009 to offer

background turbidity data immediately upstream of the Big Spruce Basin. In 2010, two stations on Ski Club Brook were added to monitor road runoff from the Big Spruce Access Road, upstream of the Big Spruce sediment basin. A station on the West Branch at river mile 8.8 was added in 2011 to provide a reference/control biomonitoring station upstream of the resort. Stations near the mouth of Gondola Brook and Long Trail Brook and the Mansfield Exit Basin outlet were added during spring 2012 to better understand sediment sources of to the West Branch. In November 2012, SMR submitted a revised Snow Plowing Plan to the Vermont Agency of Natural Resources (VANR) in order to reduce water quality impacts on the West Branch. A revised monitoring plan, including recommendations from Steve Fiske (DEC), was submitted to VANR in December 2012. The Revised Monitoring Plan added three baseflow monitoring stations (Longtrail Trib 0.1, Gondola Brook 0.1, and Little Spruce Brook 0.1), removed the total dissolved phosphorus parameter from baseflow samples, and added the chloride parameter to event-based surface water quality sampling. Correspondence relating to the monitoring program for 2013 is provided on pages 8 through 15 in Appendix 2.

The monitoring stations at Stowe Mountain Resort are located within the West Branch of the Little River watershed and Pinnacle Brook watershed. The drainage areas of the subwatersheds are in include in Table 1.

Table1. Drainage Ares of Subwatersheds in the Vicinity of SMR

Subwatershed	Description	Drainage Area (Sq. miles)
West Branch	Above confluence with Pinnacle Brook	4.81
Pinnacle Brook	Tributary to West Branch	2.31
Big Spruce Brook	Tributary to West Branch	0.78
Little Spruce Brook	Tributary to Big Spruce Brook	0.12
Ski Club Brook	Tributary to Big Spruce Brook	0.02
Gondola Brook	Tributary to Long Trail Tributary	0.90
Longtrail Tributary	Tributary to West Branch	1.44

The station numbering of the monitoring stations was revised in 2006 to provide a spatial reference to the station and to be consistent with the way the Vermont Department of

Environmental Conservation (DEC) numbers their stations. The first two letters of the station name is short for the surface water: West Branch of Little River (WB), Big Spruce Brook (BS), Little Spruce Brook (LS), Pinnacle Brook (PB), Ski Club Brook (SC), Gondola Brook (GB), and Long Trail Brook (LT). The number in the station name stands for river mile and is the distance from the mouth. The six sediment basin outflow sampling locations are identified as outlets. A brief description of the stations and the rationale for sampling is provided below.

West Branch of Little River above Stowe Mountain Resort - WB8.8: Located behind the picnic area off Route 108 in Smugglers Notch, this upper monitoring station was added in 2011 to provide a local control station upstream of Stowe Mountain Resort.

West Branch of Little River at Barnes Camp - WB8.2: Located upstream of the resort near Barnes Camp, this station offers a background turbidity monitoring station upstream of the Mansfield Basin and development at the Mansfield Base area. This station was added in 2011 to better understand sources of turbidity to biomonitoring station WB8.0.

West Branch of Little River below Longtrail Tributary - WB8.0 (MS-16B): This station on the West Branch is located directly downstream of the intermountain connector lift and upstream of the discharge from the sedimentation basin that treats the stormwater from the Mt. Mansfield parking lot. It was added in 2006, per the recommendation of Steve Fiske, to bracket the Mt. Mansfield sedimentation basin.

West Branch of Little River above Big Spruce Brook - WB7.5 (MS-8): This station is located on the West Branch above the Big Spruce confluence. The station extends from the bridge at the entrance of the resort downstream to the first section of rock riprap. The purpose of sampling WB7.5 is to evaluate the water quality and biological community upstream of the Spruce Hamlet project and the golf course, yet downstream of the Mansfield Basin. Per the Settlement Agreement, sampling at WB7.5 is required annually until the year after completion of build out.

West Branch of Little River below Snowmaking Pond Outlet - WB6.9: This station is located on the West Branch downstream of the snowmaking pond outlet. The station is representative of water quality at the downstream end of the resort.

West Branch of Little River above Pinnacle Brook Confluence - WB6.5 (MS-14): This station on the West Branch is located immediately above the confluence of Pinnacle Brook. The lower West Branch station is located below the Spruce Hamlet development and much of the drainage from the golf course. The Settlement Agreement specifies that monitoring at WB6.5 be conducted every other year until the year after completion of build-out. SMR has gone beyond this agreement and has sampled WB6.5 annually.

Gondola Brook – GB0.1: The Gondola Brook station is located at the mouth of Gondola Brook, just downstream of the crossing that enters the Mansfield Basin Parking Lot. The station was added in 2012 to better track sources of turbidity.

Long Trail Brook – LT0.1: The Long Trail Brook station is located at the mouth of Long Trail Brook, just upstream of the crossing that enters the northernmost parking lot at the resort. The station was added in 2012 to better track sources of turbidity.

Big Spruce Brook below Ski Trails – BS0.9 (MS-9): This station is located on Big Spruce Brook above the golf course limits. BS0.9 acts as the background water chemistry station for the golf course, and is located below the ski and lift construction and existing ski trails. Per the Settlement Agreement, no sampling is required at this station during the construction phase.

Big Spruce Brook above basin – BS0.7: Located on Big Spruce above the outlet of the Big Spruce station, this station was added voluntarily in 2009 by SMR to provide turbidity data upstream of the basin.

Big Spruce upstream of Club House – BS0.3 (MS-10A): This station on Big Spruce Brook is located immediately downstream of the new golf course bridge and upstream of the

confluence with Little Spruce Brook. This station was added voluntarily by Stowe Mountain Resort following a site visit with Steve Fiske (DEC) in July 2006.

Big Spruce at Mouth – BS0.2 (MS-10): Located on Big Spruce Brook above the confluence of the West Branch, BS0.2 covers the area between the bridge crossing at the ski hostel and the bedrock outcrop, which is below the confluence of Little Spruce Brook. BS0.2 serves as the downstream monitoring station for the golf course. The Settlement Agreement calls for annual monitoring at this station until the year after completion of build-out.

Little Spruce Brook – LS0.1 (MS-11): Located on Little Spruce Brook below the Spruce Hamlet Development, LS0.1 serves as a monitoring station downstream of the Spruce Hamlet Development. Sampling at this station during construction is not required by the Settlement Agreement. Stowe Mountain Resort (SMR) conducted voluntary monitoring on Little Spruce throughout the construction phase.

Pinnacle Brook Lower– PB0.1 (MS-13): PB0.1 serves as the local/reference site. Below the upper monitoring station, a very small portion of the golf course (holes 7 and 8) drains toward Pinnacle Brook. The stump dump and the gravel pit also are located between the two Pinnacle Brook stations. The stump dump was covered and seeded in August 2006 and the gravel pit was closed off and seeded in August 2006 as well. Although no monitoring of Pinnacle Brook is required by the Settlement Agreement during the construction phase, SMR has voluntarily sampled PB0.2 throughout the construction phase.

Ski Club Brook – SC0.2: The upper Ski Club Brook monitoring station is located near the Ski Club, where a couple of small drainages come together. The station was added in 2010 to provide turbidity data above a steep section of the Spruce Peak Access Road, where road runoff has been a concern.

Ski Club Brook – SC0.1: The lower Ski Club Brook monitoring station is located at the mouth of Ski Club Brook, just upstream of the culvert that passes under the Spruce Peak

Access Road to the Big Spruce Basin. The station was added in 2010 to provide turbidity data to better understand the sediment contribution to the basin.

Mt. Mansfield Basin Outlet (OUTLET 1): Outlet 1 drains from the Mansfield sedimentation basin into the West Branch between stations WB8.0 and WB7.5.

Snowmaking Pond Outlet (OUTLET 2): Stormwater is collected from the golf course and other developed areas of the resort and piped to the former snowmaking pond. Outlet 2 drains into the West Branch downstream of the confluence of Big Spruce Brook.

Big Spruce Basin (OUTLET 3): Outlet 3 drains into Big Spruce Brook immediately downstream of BS0.7.

Mount Mansfield Exit Basin (OUTLET 4): Outlet 4 drains from the Mansfield Exit Basin into the West Branch immediately downstream of the access road bridge. The station was added in spring 2012 to better track sources of turbidity.

Upper Barnes Camp Basin Outlet (OUTLET 5): Outlet 5 drains from the Upper Barnes Camp Basin and is only sampled when there is a discharge to the West Branch. Generally, outflow from the basin dissipates in a drainage swale prior to discharge to the West Branch.

Lower Barnes Camp Basin Outlet (OUTLET 6): Outlet 6 drains from the Lower Barnes Camp Basin and is only sampled when there is a discharge to the West Branch. Generally, outflow from the basin dissipates in the forest duff and only reaches the West Branch during significant precipitation events or under wet conditions.

Table2 provides a list of monitoring parameters evaluated at the 2012-2013 monitoring stations.

Table 2. 2012-2013 Water Quality Monitoring Stations at Stowe Mountain Resort					
Station	**Location**	**Monitoring Parameter**			
		Baseflow	**Turbidity**	**Sediment (pebble counts)**	**Biomonitoring**
WB8.8	West Branch at picnic area above SMR	+		+	+
WB8.2	West Branch above Barnes Camp		+		
WB8.0 (MS-16B)	West Branch below Barnes Camp	+	+	+	+
WB7.5 (MS-8)	West Branch above Big Spruce	✓	✓	✓	✓
WB6.9	West Branch below snowmaking pond		+		
WB6.5 (MS-14)	West Branch above Pinnacle Brook confluence	✓	✓	✓	✓
LT0.1	Long Trail Tributary at Mansfield Entrance		+		
GB0.1	Gondola Brook at Mansfield Entrance		+		
BS0.9 (MS-9)	Big Spruce Brook below ski trails		+		
BS0.7	Big Spruce above Big Spruce Basin		+		
BS0.3 (MS-10A)	Big Spruce upstream of Club House	+	+	+	+
BS0.2 (MS-10)	Big Spruce Brook at mouth	✓	✓	✓	✓
LS0.1 (MS-11)	Little Spruce Brook		+		
PB0.1 (MS-13)	Lower Pinnacle Brook	+	+	+	+
SC0.2	Upper Ski Club Brook		+		
SC0.1	Lower Ski Club Brook		+		
Outlet 1	Mansfield Basin		+		
Outlet 2	Snowmaking Pond		+		
Outlet 3	Big Spruce Basin		+		
Outlet 4	Mansfield Exit Basin		+		
Outlet 5	Upper Barnes Camp Basin		+		
Outlet 6	Lower Barnes Camp Basin		+		
+ - additional voluntary monitoring by Stowe Mountain Resort not required in Settlement Agreement					

Table 3 shows the drainage and approximate elevation of the seven biomonitoring stations.

Table 3. Drainage and Elevation of Biomonitoring Stations			
Station	**Location**	**Drainage Area (sq. mi.)**	**Elevation (feet)**
BS0.3	Big Spruce Brook near Golf Cottage, above Little Spruce Brook	0.73	1470
BS0.2	Big Spruce Brook near Hostel, below Little Spruce Brook	0.76	1420
WB8.8	West Branch at picnic area upstream of resort	1.18	1605
WB8.0	West Branch upstream of Mansfield Basin	2.92	1480
WB7.5	West Branch downstream of Mansfield Basin	3.56	1410
WB 6.5	West Branch above confluence with Pinnacle Brook	4.81	1250
PB0.1	Pinnacle Brook at mouth	2.31	1255

3.0 MOUNT MANSFIELD CLIMATE

The West Branch watershed lies exclusively within the Northern Green Mountains biophysical region. This region is characterized by Thompson and Sorenson (2005) as having high elevations and cool summers. The Green Mountains have a strong influence on the weather resulting in an abundance of precipitation in the form of both rain and snow. Precipitation within the West Branch watershed averages 53 inches annually (USGS, Scott Olson, pers. comm., 2004). On the top of Mount Mansfield annual precipitation averages over 78 inches. For the 2012 calendar year, 73.0 inches of precipitation was reported at the Mount Mansfield weather station operated by WCAX. Precipitation increases with elevation, at about an inch per 1000 feet of elevation (Wemple, 2002). Mount Mansfield receives more precipitation than most areas of the State. An orographic effect often occurs on Mount Mansfield.

4.0 WEATHER AND FLOW DURING THE 2012-2013 MONITORING PERIOD

Unitized annual peak stream flow values for the period of record from the West Branch and Ranch Brook are presented below in Table 4 and graphed in Figure 1. The West Branch watershed experienced four extreme flow events, two during 2010 and two during 2011. The

Ranch Brook watershed experienced three extreme flow events, one in 2010 and two in 20ll. The unitized peak flows for the West Branch and Ranch Brook during 2012 were not nearly as high as in the previous two years. Overall, the 2012 annual peak flows on both streams are very low compared with all years on record. The lowest peak flow for the period of record was observed on Ranch Brook in 2012 and the second lowest peak flow was observed on the West Branch. The 2012 unitized peak flow on the West Branch was approximately one-six the value of the peak flow in 2010.

Table 4. Annual Peak Flows
West Branch and Ranch Brook USGS Gaging Stations

Water Year	West Branch		Ranch Brook	
	Date	Unitized Peak Flow (cfs/sq. mi.)	Date	Unitized Peak Flow (cfs/sq. mi.)
2001	Aug. 31, 2001	81.0	Apr. 24, 2001	79.7
2002	May 17, 2002	85.8	Apr. 14, 2002	88.7
2003	Jun. 14, 2003	60.4	Mar. 29, 2003	52.1
2004	Nov. 20, 2003	91.0	Nov. 19, 2003	96.3
2005	Aug. 31, 2005	52.0	Aug. 31, 2005	55.8
2006	May 19, 2006	108.8	May 19, 2006	99.7
2007	Oct. 28, 2006	66.4	Oct. 28, 2006	93.2
2008	Jul. 24, 2008	87.4	Jul. 20, 2008	127.1
2009	May 10, 2009	127.4	May 10, 2009	83.9
2010	**Aug. 04, 2010**	**372.6**	Aug. 04, 2010	95.0
2010	**Sep. 30, 2010**	**233.4**	**Sep. 30, 2010**	**297.4**
2011	**Apr. 27, 2011**	**306.2**	**Apr. 27, 2011**	**258.7**
2011	**Aug. 28, 2011**	**204.9**	**Aug. 28, 2011**	**121.3**
2012	June 27, 2012	60.0	March 08, 2012	42.6
Median		86.6		90.9
Mean		124.9		114.6
Maximum	Aug. 04, 2010	372.6	Sep. 30, 2010	297.4

Extreme flow events in bold font

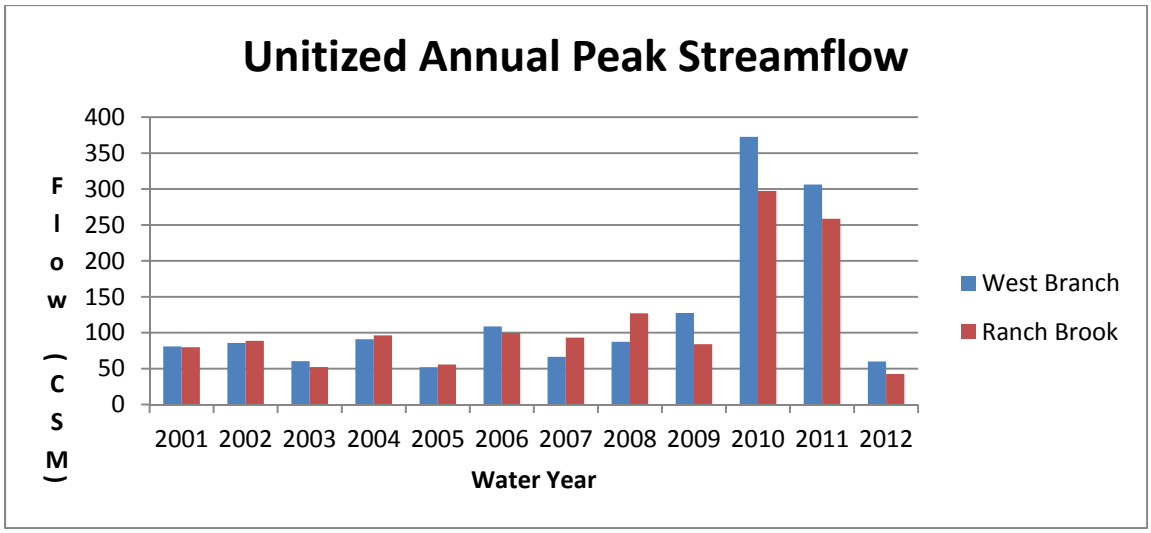

Figure 1. Annual unitized peak stream flow values for the West Branch and Ranch Brook

Based on data from U.S.G.S., the March 8, 2012 event resulted in the peak stream flow values for the year on Ranch Brook. The peak flow on Ranch Brook was 162 cfs (42.6 cfs/sq. mile). Peak flow data for the West Branch was not available for the majority of the event and the hydrographs could not be compared. The June 27, 2012 rain event resulted in the annual peak stream flow value for the West Branch. The peak flow on the West Branch was 280 cfs (60.0 cfs/sq. mile), compared with 138 cfs (36.3 cfs/sq. mile) on Ranch Brook. The peak flow in the West Branch was approximately 1.65 times the peak flow on Ranch Brook. Figure 2 shows the hydrographs, including the ascending and descending limbs, for the West Branch and Ranch Brook from June 26, 2012 to June 30, 2012.

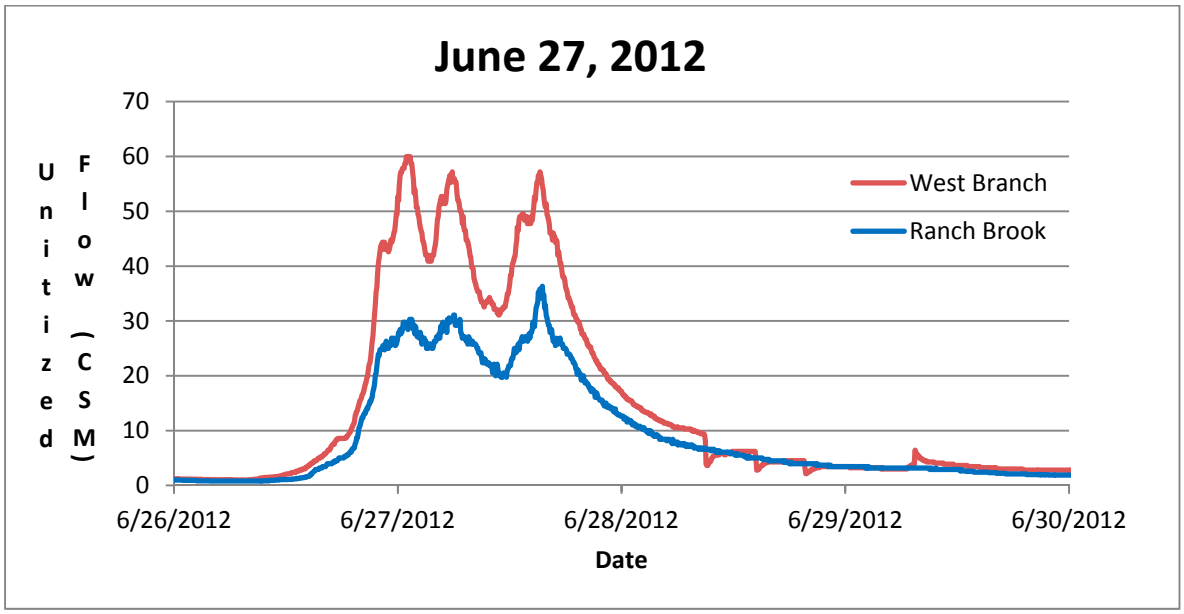

Figure 2. Unitized hourly stream flow for Ranch Brook and West Branch for June 27, 2012

5.0 WATER QUALITY STANDARDS

The Vermont Water Quality Standards (VWQS) (State of Vermont Water Resources Board, effective December 30, 2011) were used to evaluate water quality parameters. Table 5 shows the water quality standards used for comparison in this study. There are no established standards for conductivity or total suspended solids. Therefore, there are no comparisons against standards for these analytes in the tables and text. According to the VWQS, in general total phosphorus loads should be limited so as not to "contribute to the acceleration of eutrophication or the stimulation of the growth of aquatic biota in a manner that prevents the full support of uses."

Table 5. Vermont Water Quality Standards for Class B Waters

Parameter	Standard
pH	6.5 – 8.5 s.u.
Nitrate-nitrogen	≤ 5.0 mg/L
Turbidity	10 NTU

5.1 Baseflow Sampling Results

Baseflow chemistry monitoring occurred at each macroinvertebrate assessment site during fall 2012. Monitoring parameters included: Alkalinity, pH, chloride, conductivity, nitrate, total Kjeldahl nitrogen (TKN), total phosphorus, total dissolved phosphorus, and water temperature. The results of baseflow water chemistry from 2000 through 2012 are found on pages 2 through 10 of Appendix 1. During 2012, baseflow sampling took place on September 13, three days prior to the collection of the macroinvertebrate kick net samples.

Alkalinity

Alkalinity indicates the buffering capacity of water. Aquatic life requires buffering capacity to minimize the impact of acid precipitation. Low alkalinity values, especially those below 4 mg/L as CaCO3, suggest that a stream is critically acidified and the macroinvertebrate community would be likely impacted.

Figure 3 shows the mean alkalinity values for the biomonitoring stations for fall 2003 through fall 2012. All stations had mean alkalinity values of less than 20 mg/L as CaCO3, with the exception of both Big Spruce stations (BS0.3, BS0.2) with had values of 30 mg/L and 36 mg/L as CaCO3 respectively. Alkalinity shows an increasing trend from upstream to downstream on both the West Branch. For the September 2012 sampling round, the lowest Big Spruce station (BS0.2) had the highest reported alkalinity value of 36 mg/L as CaCO3. This is higher than the long term average of 19 mg/L. The stations with the lowest alkalinity values were lower Pinnacle Brook (PB0.1) and the upper West Branch (WB8.0 and WB8.8). These low alkalinity values indicate that Pinnacle Brook and the upper West Branch have a very low buffering capacity and are susceptible to the impacts from acid precipitation.

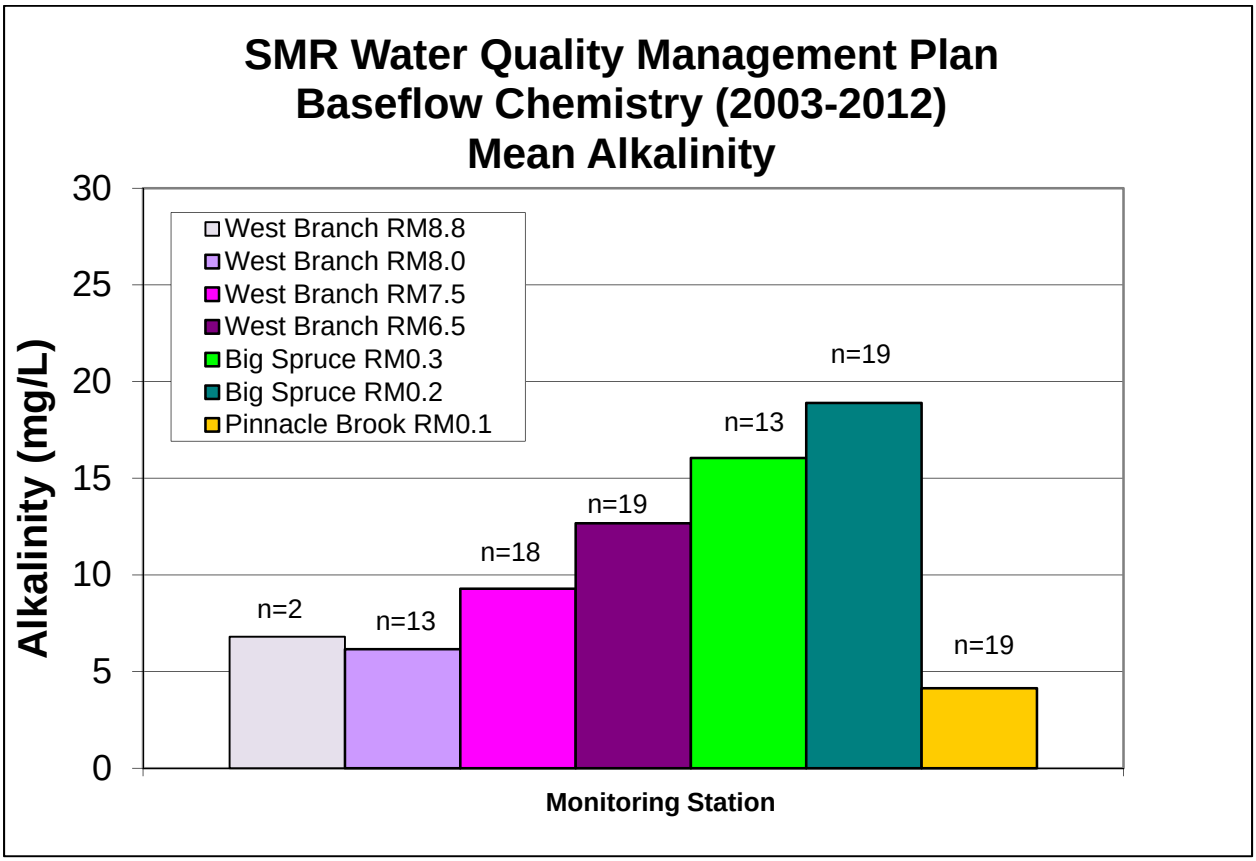

Figure 3. Mean alkalinity for biomonitoring stations

pH

The pH values for baseflow samples collected on September 13, 2012 were within the water quality standard limits of 6.5 – 8.5 s.u., with the exception of the upper West Branch (WB8.0 and WB7.5). The pH value for the West Branch station WB8.0 was the lowest on record for that station and had a value of 4.5 s.u. at the time of the 2012 baseflow sample. However, this value is suspect as this is not consistent with typical baseflow pH values for that station. Endyne staff confirmed this was the recorded value on the bench sheet. Water quality data collected under baseflow conditions in the spring would likely show lower pH values than the ones reported for the fall period.

Conductivity

Mean conductivity levels were highest on lower Big Spruce Brook and lowest on Pinnacle Brook, as shown in Figure 4 below. The lower conductivity found on Pinnacle Brook reflects an undeveloped watershed. Road salt, dissolved solids, and elevated metals are likely reasons for the higher conductivity values reported for the West Branch and Big Spruce Brooks. There is a trend of increasing conductivity on the West Branch from upstream to downstream.

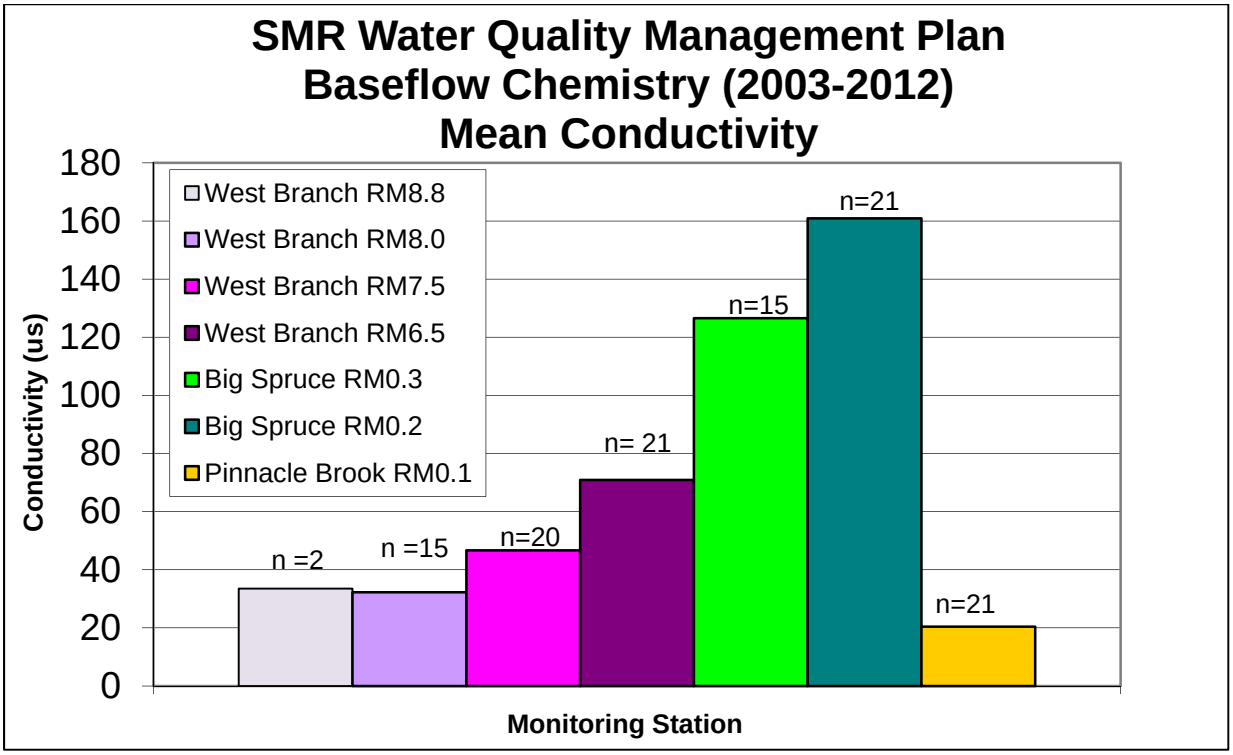

Figure 4. Mean conductivity for biomonitoring stations

Nutrients

The seven biomonitoring stations were monitored for nutrients in 2012. Total dissolved phosphorus concentrations were low (<0.010 mg/L) at all monitoring stations, and were less than or equal to the reporting limit of 0.005 mg/L at six of the seven stations sampled in 2012. The results of the monitoring indicate that nitrate-nitrogen concentrations were all well below the water quality standard of 5 mg/L at all stations. The highest nitrate concentration reported on September 13, 2012 was 0.67 mg/L at the picnic area in the notch on the upper West Branch (RM8.8).

5.2 Event-based Sampling Results

For the 2012-2013 monitoring season, Bear Creek Environmental, LLC conducted five event-based monitoring rounds. These samples were collected during storm events that resulted in significant runoff (approximately greater than 0.5 inches of rain in 24 hours). In the case of the winter/spring events, sampling coincided with warm temperatures and/or rain that caused a significant snowmelt. Each event-based sample was analyzed for pH, chloride, total suspended solids (only 2012), turbidity, conductivity, and temperature. In addition, Stowe Mountain Resort conducted turbidity monitoring on one occasion between June 2011 and June 2012. This in-house monitoring targeted 28 stations.

The first of the four event-based sampling rounds for the 2012-2013 monitoring period was completed by Bear Creek Environmental during summer 2012. One sampling round took place during early fall 2012, two rounds occurred during January 2013, and one round was sampled in late spring 2013. The results of event-based water chemistry sampling from 2000 through 2013 are found on pages 11 through 34 of Appendix 1. Hourly precipitation data are available from the weather station at the turf care center for two of the five events during the 2012-2013 monitoring period.

June 27, 2012

Bear Creek Environmental, LLC conducted the first round of event-based monitoring on June 27, 2012. The rain gage at SMR had 1.33" of rain in it when it was emptied on the morning of June 27, but had not been emptied the previous day according to Mike Manley (SMR). Approximately 1.0" of rain fell on June 27, 2012 after the gage was emptied in the morning, making the total for the event 2.33". Roughly 0.4" of rain fell during sampling, which was conducted between 11:55 am and 1:40 pm. As shown below in Figure 5, the hydrograph peaked at just less than 300 cfs around 3:15 pm on June 27, following the completion of sampling. Field notes indicated that the heavy rain changed to light rain just after 12:00 pm on June 27.

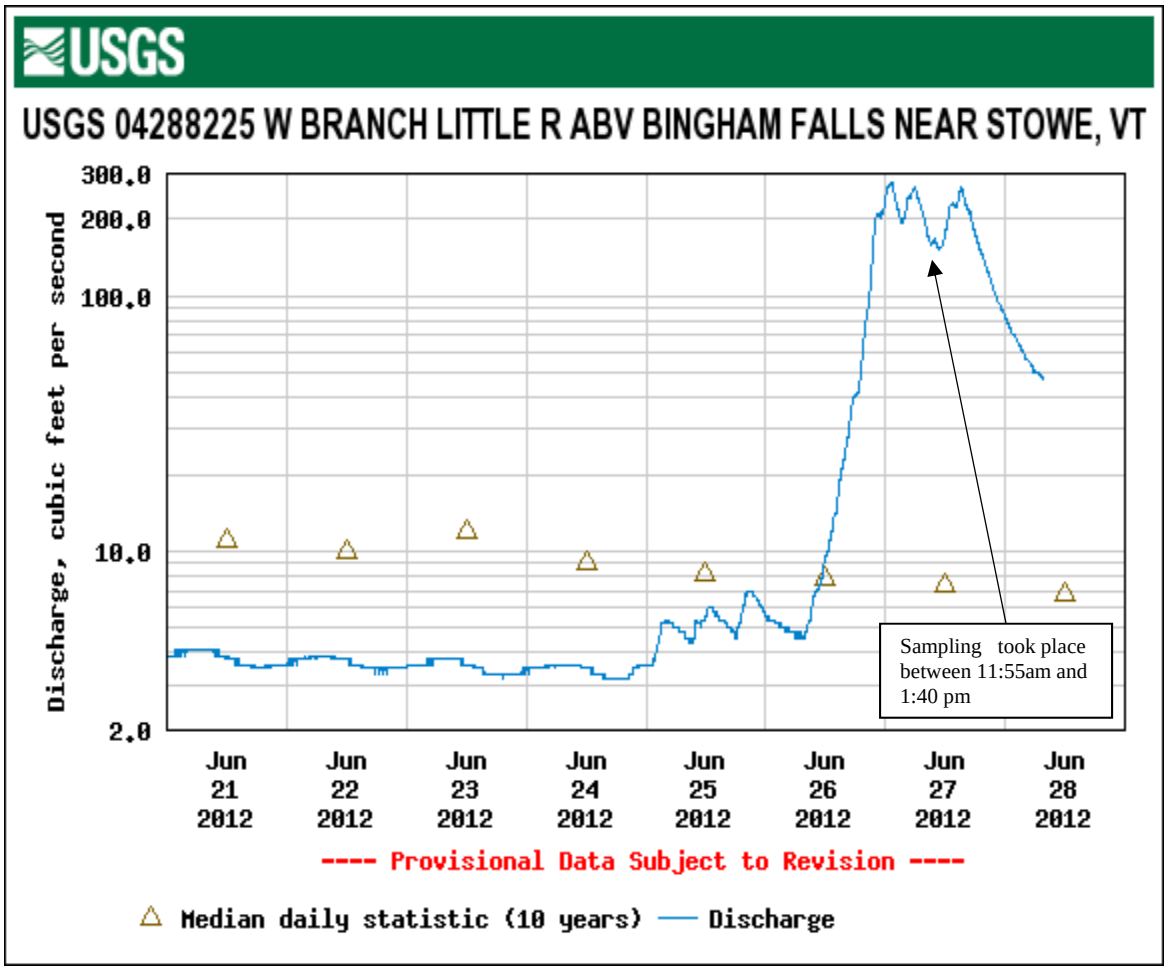

Figure 5: West Branch hydrograph for June 27, 2012 sampling event.

As shown in Figure 6, turbidity values at all surface water stations were well below the water quality standard of 10 NTU. The turbidity results for the West Branch ranged

between 1.6 and 7.3 NTU. The Mansfield Basin was not a source of sediment, and had a turbidity value of 5.66 NTU. The runoff from the Mansfield parking lot into the Mansfield Basin was noted to be clear. The swale to Big Spruce Basin was sampled and had an elevated turbidity value of 69.1 NTU. Field notes indicate dirt piles along the Sensation Lot and the Sensation Parking lot runoff were contributing sediment to the Big Spruce Basin.

The range of turbidity values by station on June 27, 2012 are shown on the map in Figure 7. The highest turbidity value for the June 27, 2012 event was reported for the Big Spruce Basin Outlet (30.1 NTU) and the Snowmaking Pond Outlet (20.1 NTU).

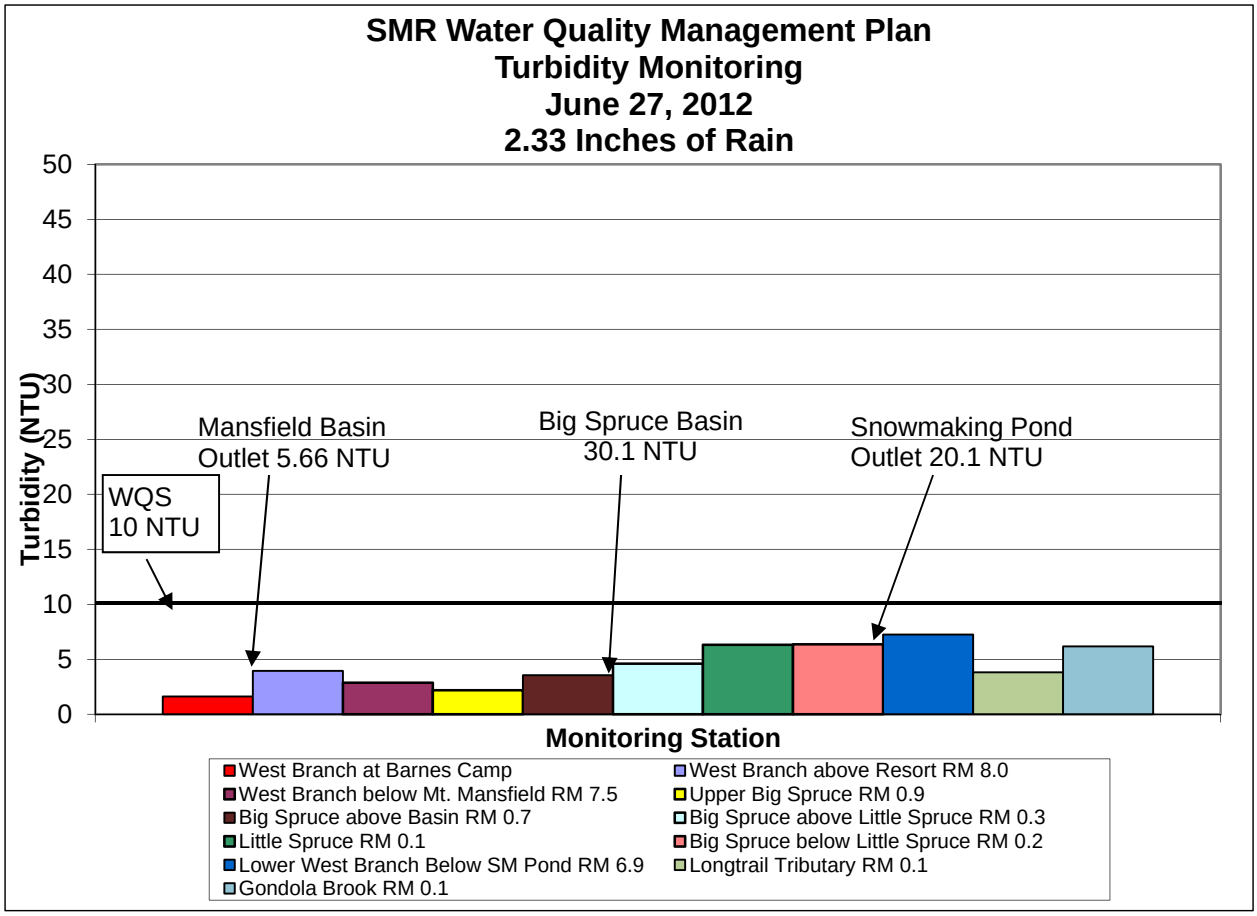

Figure 6. Turbidity results from June 27, 2012

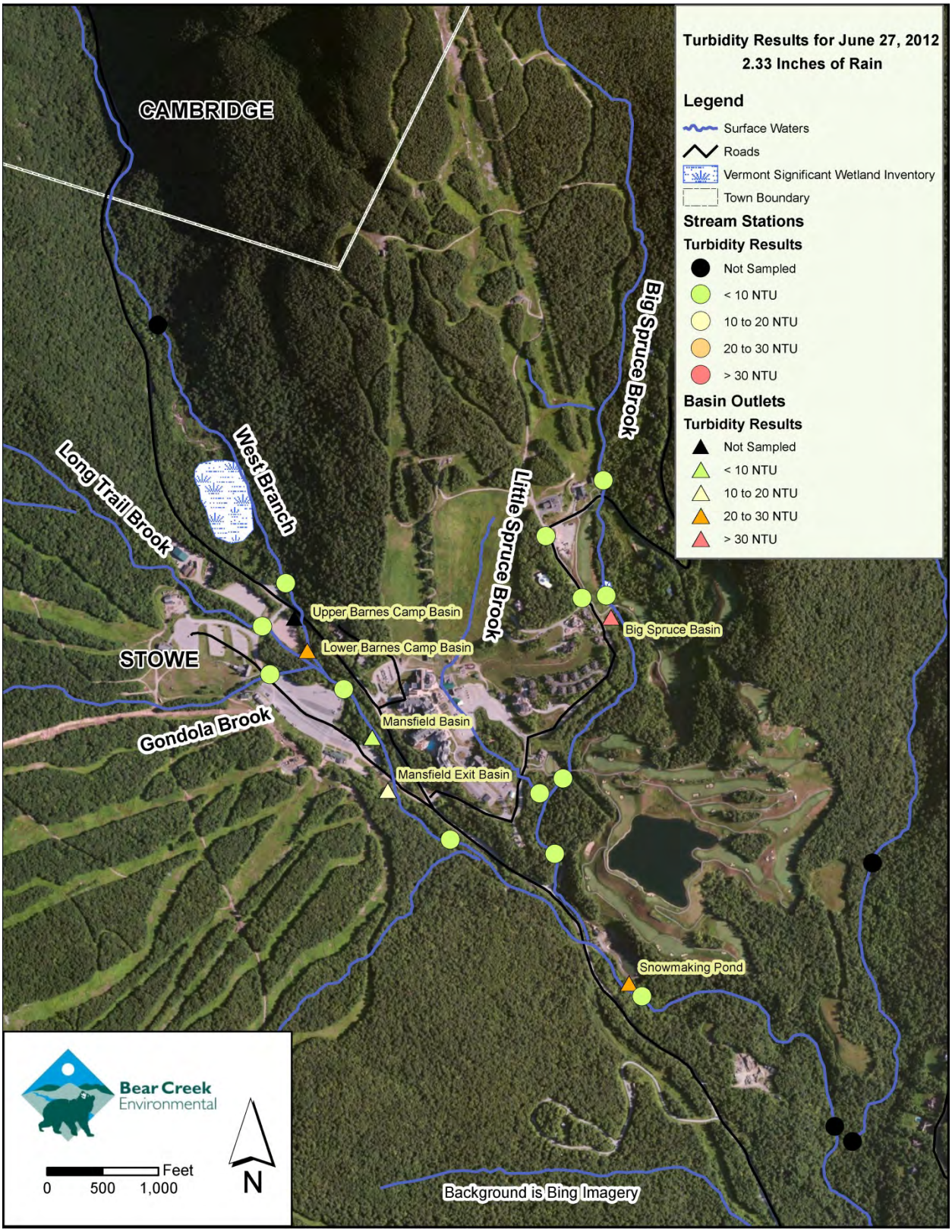

Figure 7. Turbidity Results for June 27, 2012 – 2.33 Inch Rain Event

September 5, 2012

The second round of event based sampling took place between 6:50 am and 8:20 am on September 5, 2012. As reported by Bryan Picard of Stowe Mountain Resort, rainfall amounts at the resort from approximately10:00 pm on September 4, 2012 to 5:00 am on September 5, 2012, totaled 2.15". Most of the rain occurred in the early morning hours (between 1 and 5 am). Light rain was observed during sampling. Based on data from the USGS, flows in the West Branch peaked around 5:00 am. Sampling occurred a few hours after the peak of the hydrograph (Figure 8).

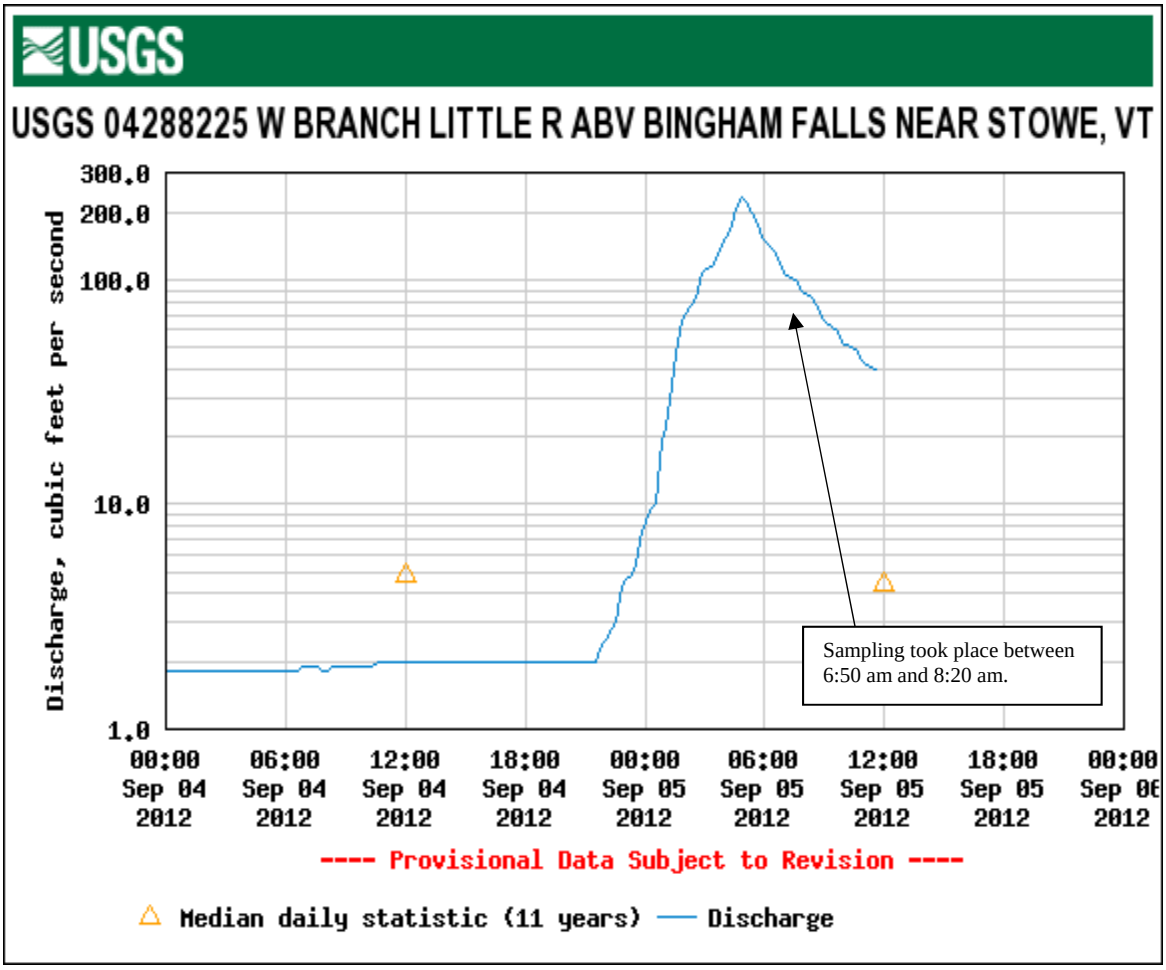

Figure 8: West Branch hydrograph for September 5, 2012

All surface water quality stations, except for the West Branch below the Snowmaking Pond station, had turbidity values less than 5 NTU for the September 5, 2012 rain event (Figure 9). The West Branch below the Snowmaking Pond station had a turbidity value of 7.2 NTU, which is still below the water quality standard of 10 NTU. Outflow from the Big Spruce

Basin, the Snowmaking Pond, and Mansfield Basin were noted to be slightly to moderately turbid at the time of sampling, but did not have elevated turbidity values. The outlet of the Snowmaking Pond was noted to have a high flow.

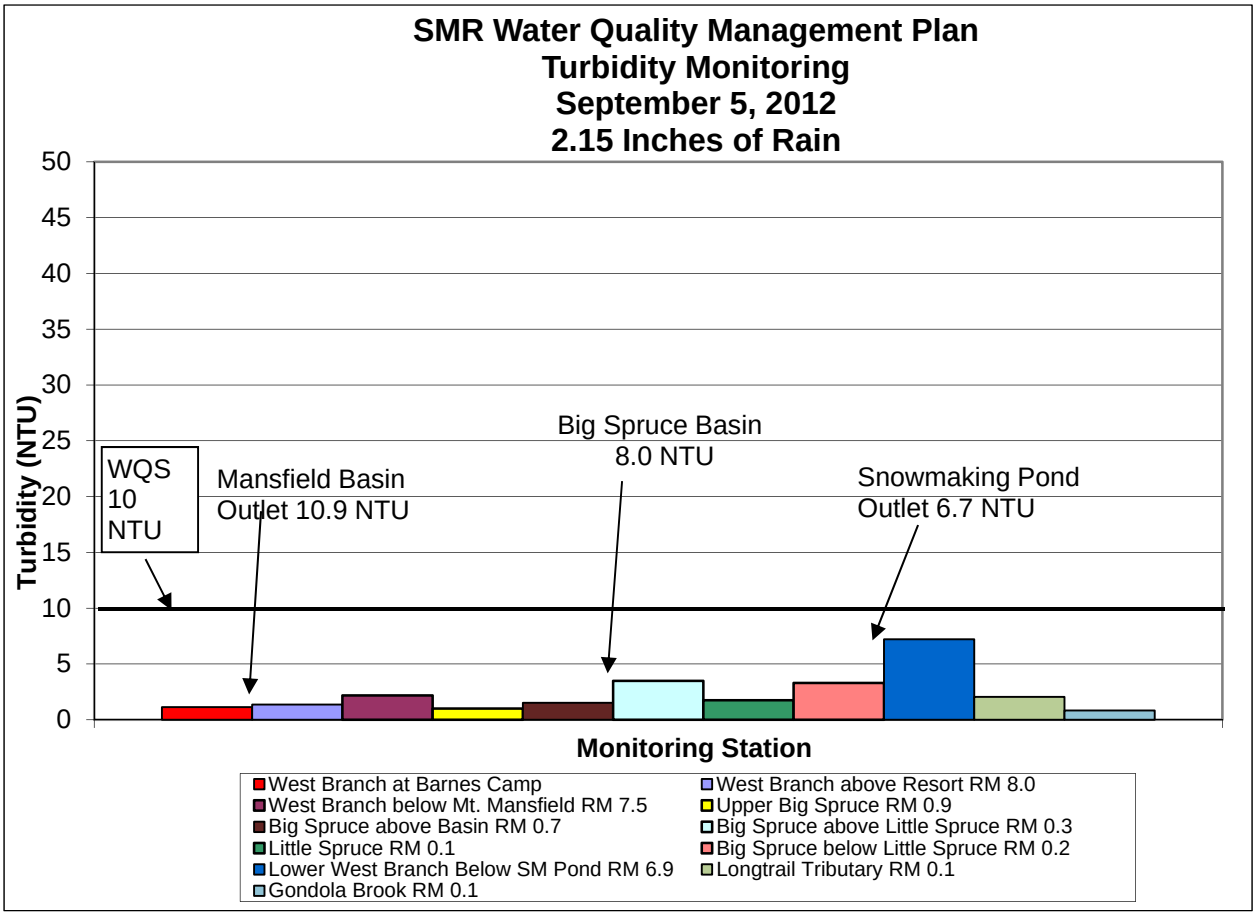

Figure 9. Turbidity results from September 5, 2012

January 14, 2013

Unseasonably warm temperatures occurred in Vermont during mid-January 2013. Daily high temperatures of 38, 48, and 47 degrees Fahrenheit were observed at the WCAX weather station on Mount Mansfield for January 12, 13, and 14,respectively. According to the Morrisville, VT weather station (Weather Underground), the maximum daily temperature for January 14, 2012 exceeded 50 degrees Fahrenheit. Sampling took between 11:45 a.m. and 2:15 p.m. Field notes indicate that the temperature was 43 degrees Fahrenheit at the time of arrival and 38 degrees Fahrenheit at the completion of sampling. The hydrograph (Figure 10) shows that sampling was conducted just before the West Branch peaked at around 80 cfs.

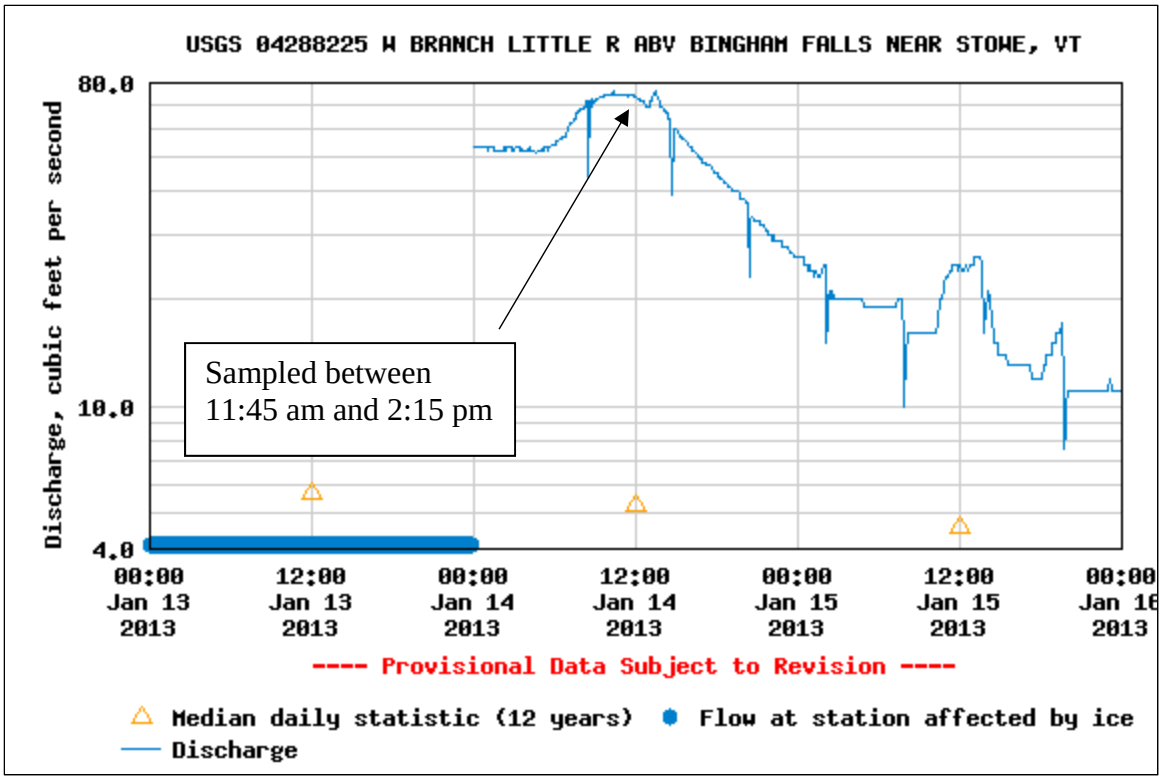

Figure 10: West Branch hydrograph for January 14, 2013

All the surface water quality stations sampled had turbidity values less than 10 NTU (Figure 11). At the time of sampling, the turbidity of all samples except the Mansfield Basin outflow was noted to be clear or slightly turbid. The turbidity of the Mansfield Basin outflow was 46.2 NTU and was noted to be greyish in color. The turbidity of the Snowmaking Pond and Big Spruce Basin outlets were low.

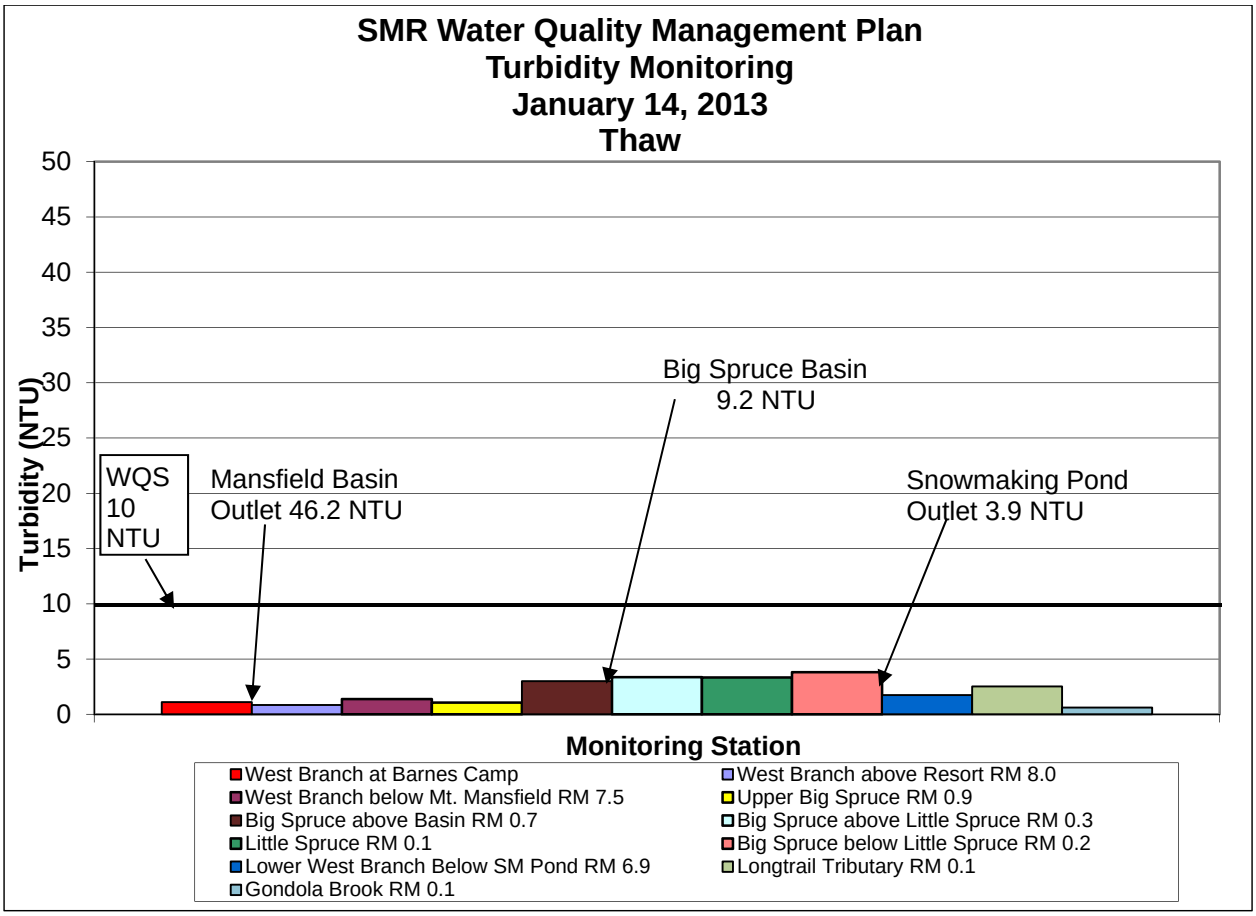

Figure 11. Turbidity results from January 14, 2013

January 31, 2013

Another stint of unseasonably warm weather in Vermont occurred at the end of January 2013. Daily high temperatures of 46 and 47 degrees Fahrenheit were observed at the WCAX weather station on Mount Mansfield for January 30 and 31. The Morrisville, Vermont weather station (Weather Underground) indicated that the high temperature for January 31, 2013 was 50 degrees Fahrenheit, which occurred at 12:01 a.m. and decreased throughout the day. The air temperature during sampling, which took place between 9:35 and 11:30 a.m. on January 31, was noted to be around 34 degrees Fahrenheit at the resort. The thaw event coincided with a rain event that totaled 1.69" of rain fall over a 36-hour period. According to the weather station at the golf course, the rain event began on the morning of January 30 and continued through mid-day on January 31 (Figure 12). Peak stream flows were unavailable from the USGS for both the West Branch and Ranch Brook

stream gages due to ice buildup. Figure 13 shows that the gage height for the West Branch peaked around 3.2 feet around 9:00 a.m. on January 31, 2013.

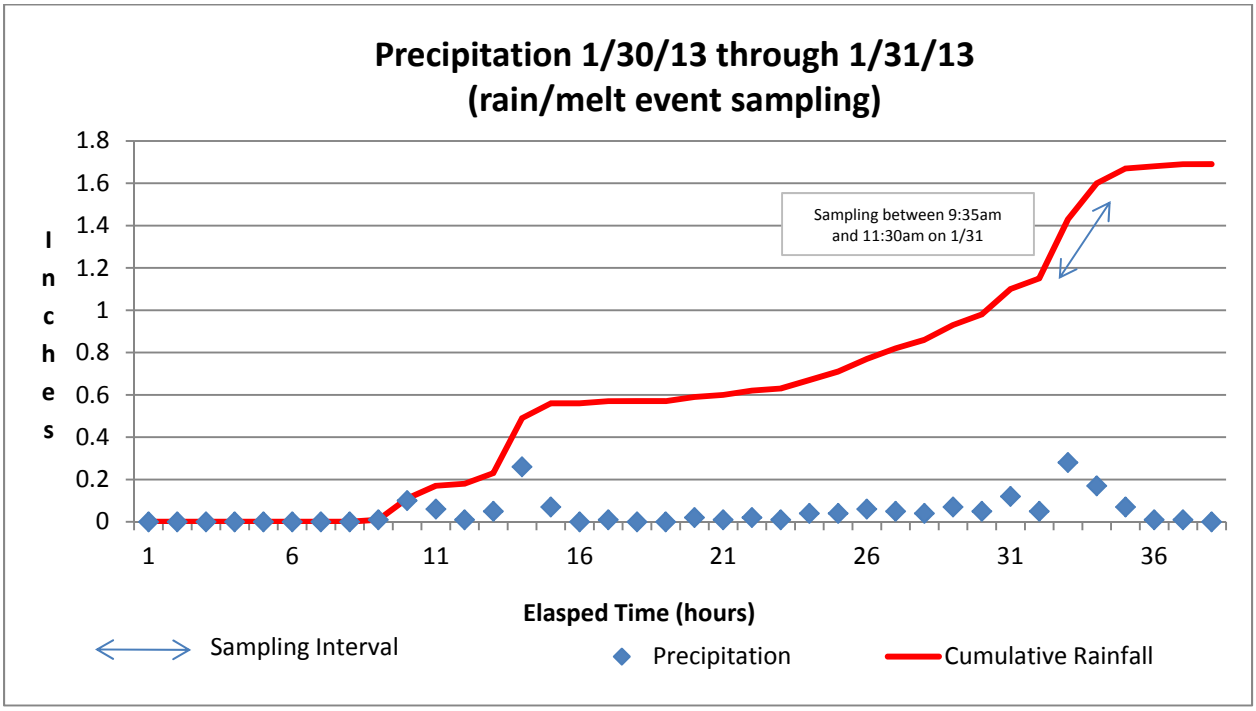

Figure 12. Hourly precipitation totals and cumulative rainfall for the 1/31/13 sampling round.

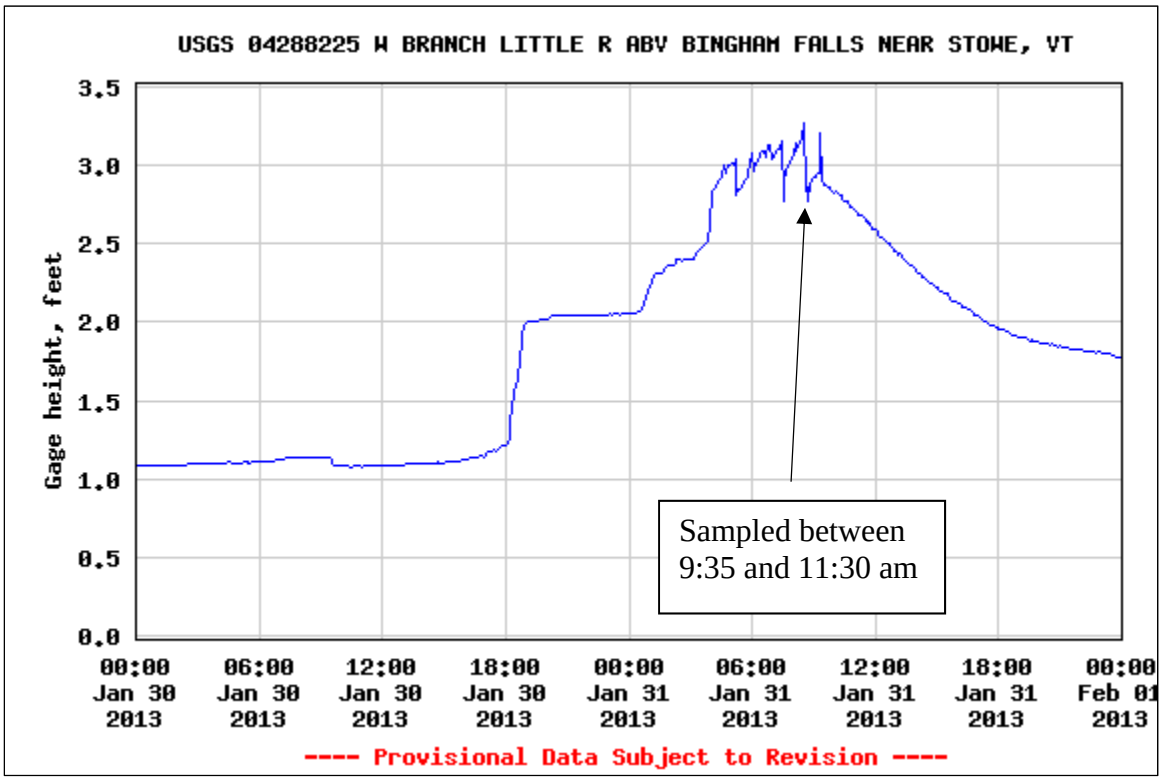

Figure 13: West Branch gage height for January 31, 2013

All of the stream samples collected during the afternoon of January 31, 2013 had turbidity values less than the water quality standard of 10 NTU (Figure 14) with the exception of the lower Ski Club Brook station. The Mansfield Basin outlet had a turbidity value of 71.9 NTU and was noted to be turbid. The tributary that used to flow into the Mansfield Exit Basin (which was separated in August 2012) was inadvertently sampled instead of the Mansfield Exit Basin outflow. This tributary had a very low turbidity value of 1.5 NTU. The Big Spruce Basin outlet had a turbidity value of 46.9. The range of turbidity values by station on January 31, 2013 are shown on the map in Figure 15.

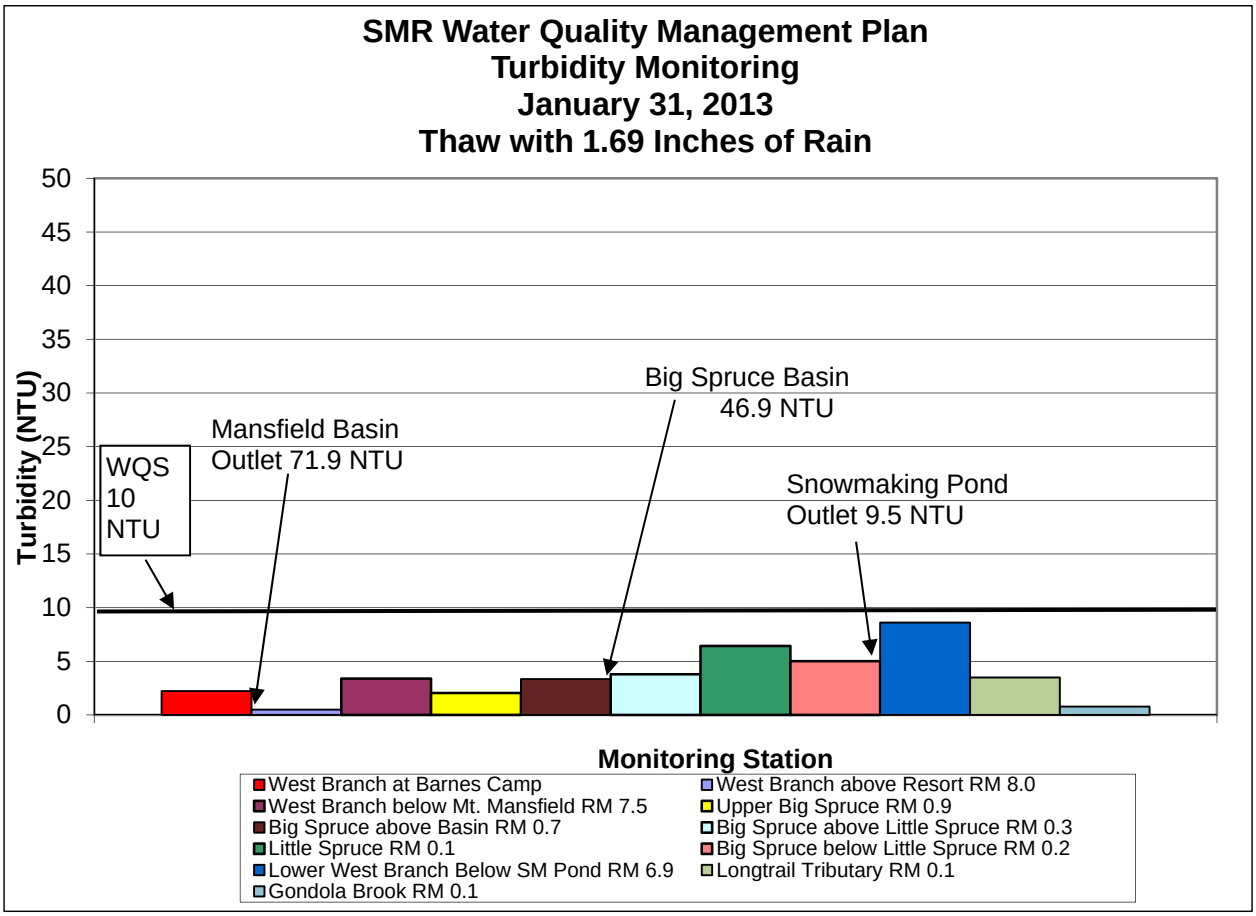

Figure 14. Turbidity results from January 31, 2013

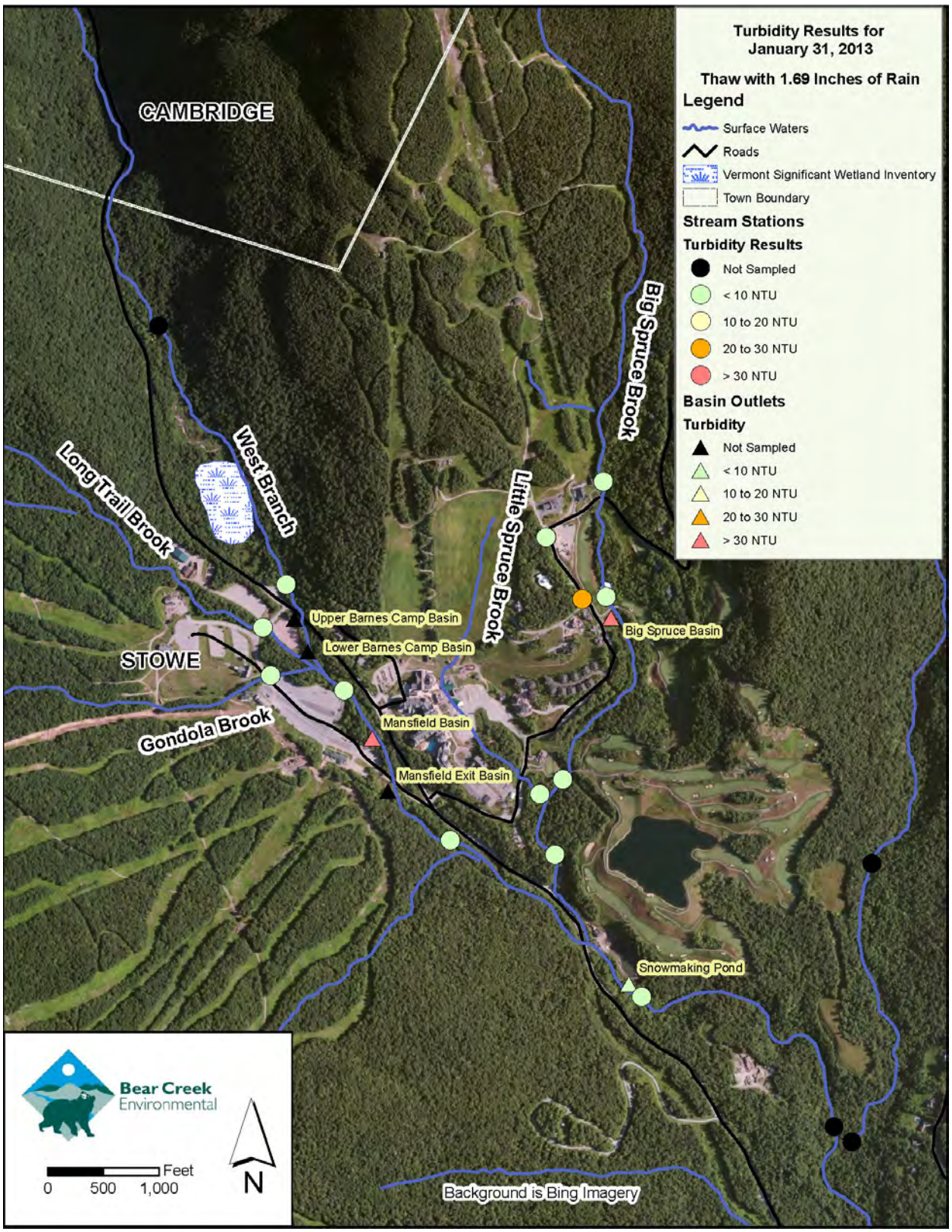

Figure 15. Turbidity results from January 31, 2013

May 23, 2013

The final round of event-based sampling for the 2012-2013 monitoring period took place on May 23, 2013 between 6:45 p.m. and 8:20 p.m. Stream flows were already elevated on May 23, 2013, as scattered rain showers had been in the area from May 21 to May 23. The total rainfall for the event, which spanned approximately 3.5 days, was 3.78 inches according to Kevin Komer, the golf course superintendent (Figure 16). At the time of sampling 2.96 inches of rain had fallen, with 1.02 inches of rain falling between 6:00 and 8:00 p.m. on May 23. Rain was heavy at the beginning of sample collection, changed to a light drizzle, and finally stopped around 7:30 p.m. The majority of sampling took place on the ascending limb of the hydrograph (Figure 17). Stream flows on the West Branch increased significantly and quickly during sampling. Provisional data from the U.S.G.S. stream gage indicate that the flow was approximately 287 cfs at 6:45 p.m. and 454 cfs at 8:20 p.m. on May 23, reaching peak discharge (> 600 cubic feet per second) during sampling around 7:15 p.m.

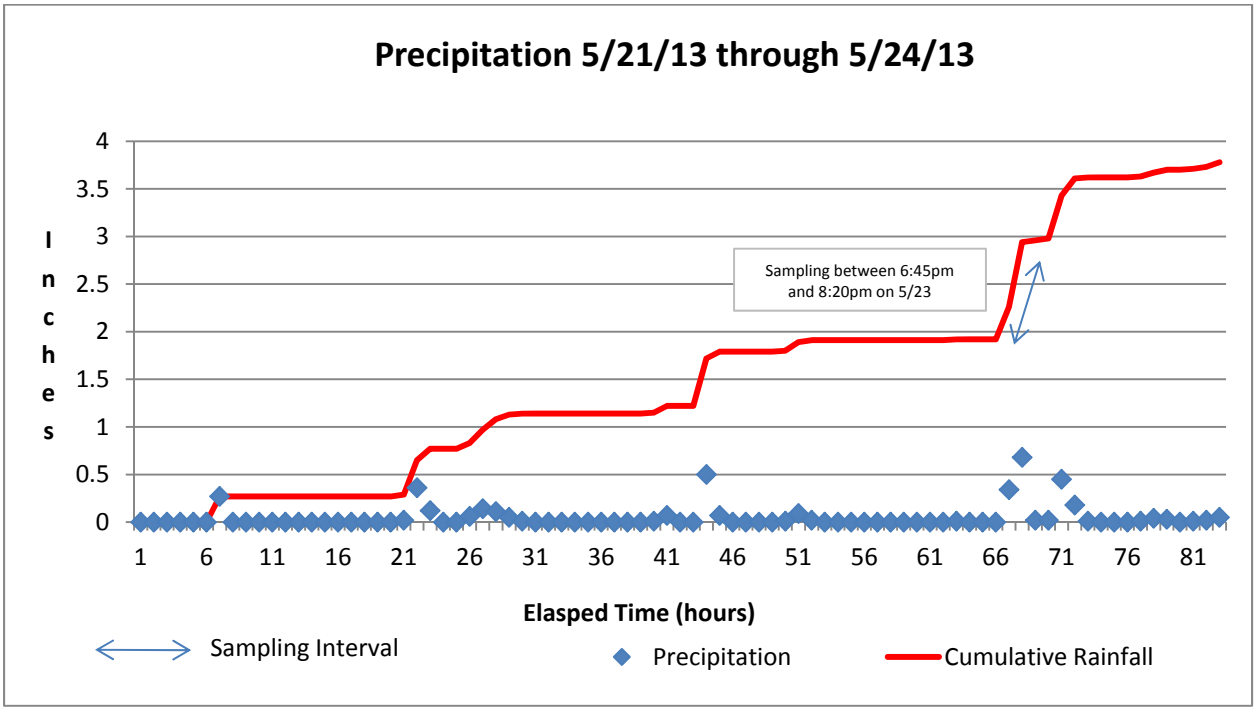

Figure 16. Hourly precipitation totals and cumulative rainfall for the 5/23/13 sampling round.

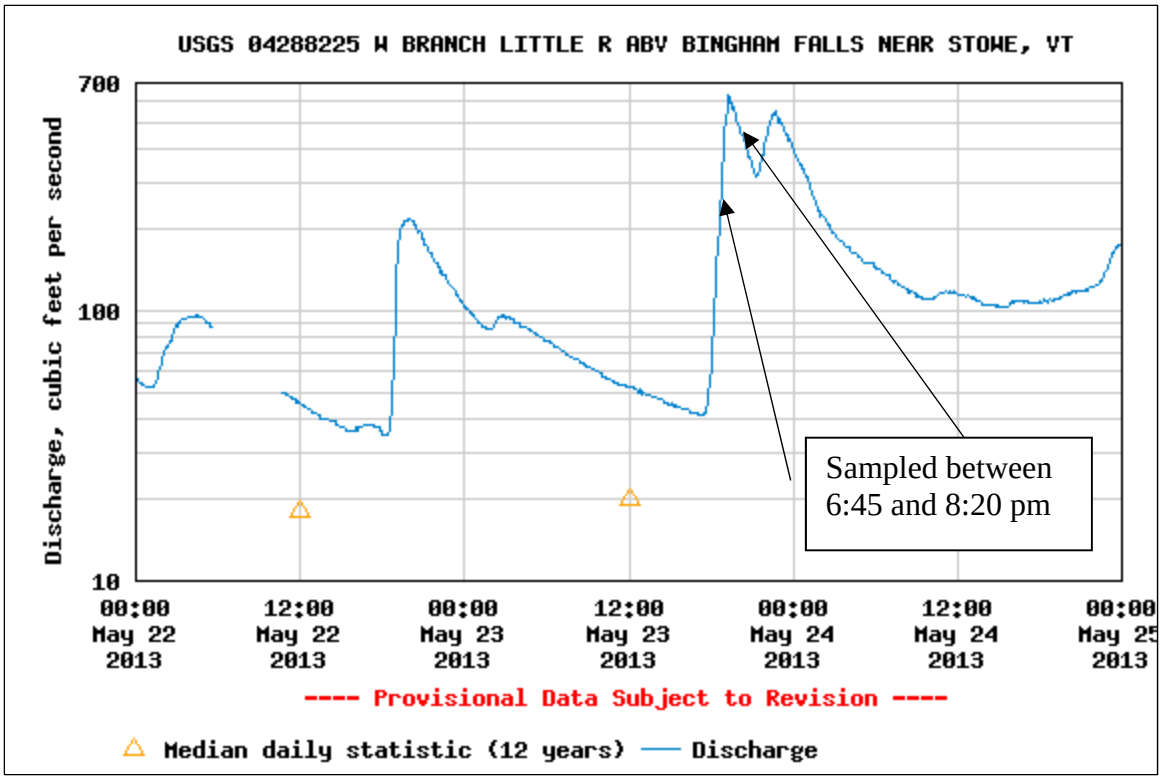

Figure 17: West Branch discharge for May 22 through May 25, 2013

According to BCE field notes taken during sampling, all surface waters appeared turbid to very turbid. Outlet discharges were noted to all be slightly to moderately turbid. Lab results confirmed that all stream samples collected on May 23 had turbidity values greater than the water quality standard of 10 NTU (Figure 18). The Mansfield Exit Basin and Big Spruce Basin outlets had turbidity values greater than 100 NTU, while the Mansfield Basin and Snowmaking Pond outlets had turbidities less than 30 NTU. The range of turbidity values by station on May 23, 2013 are shown on the map in Figure 19. Please note that the turbidity categories on the map legend are different than previous maps in the report as a result of much higher turbidities for this extremely high flow event. Background turbidity levels were high for this event, as indicated by the elevated turbidity for the West Branch station at Barnes Camp (RM8.2) on May 23 of 105 NTU.

The highest surface water turbidities were seen at the West Branch RM7.5 station and the Ski Club Brook downstream station. The Ski Club Brook downstream station had a much higher turbidity value (139 NTU) than the upstream station (48 NTU). Geomorphically, Ski

Club Brook has historically incised and is currently undergoing a widening process is resulting in eroded banks. Ski Club Brook, located outside of lands owned by the SMR, is a major source of sediment to Big Spruce Basin and Big Spruce Brook. The sample from the Big Spruce Basin outlet had a turbidity of 184 NTU.

Due to extremely high flows, there was difficulty in collecting the West Branch stream station below the Snowmaking Pond (RM6.9); as a result, the sample contained mostly water from the Snowmaking Pond outlet which effectively discharging water of much lower turbidity into the West Branch.

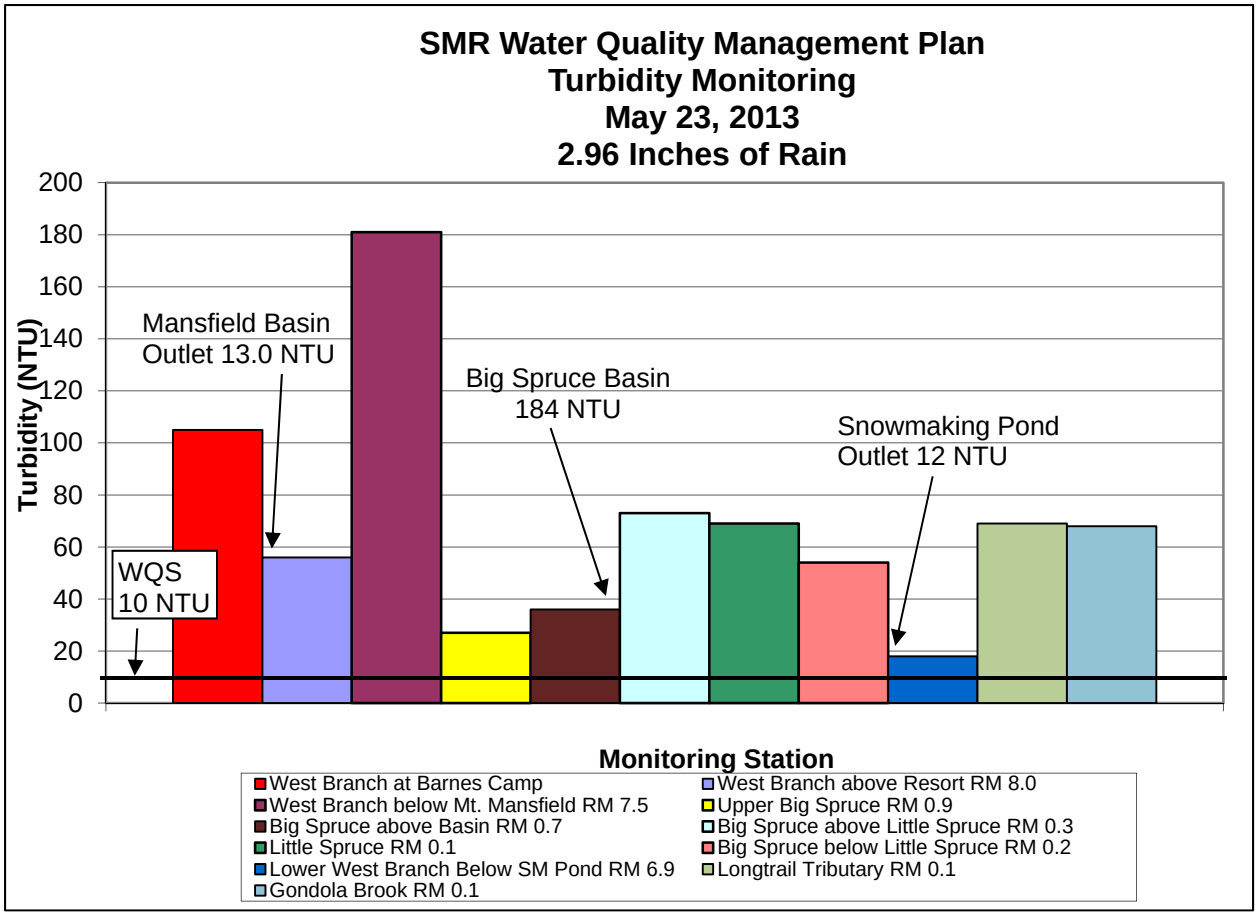

Figure 18. Turbidity results from May 23, 2013

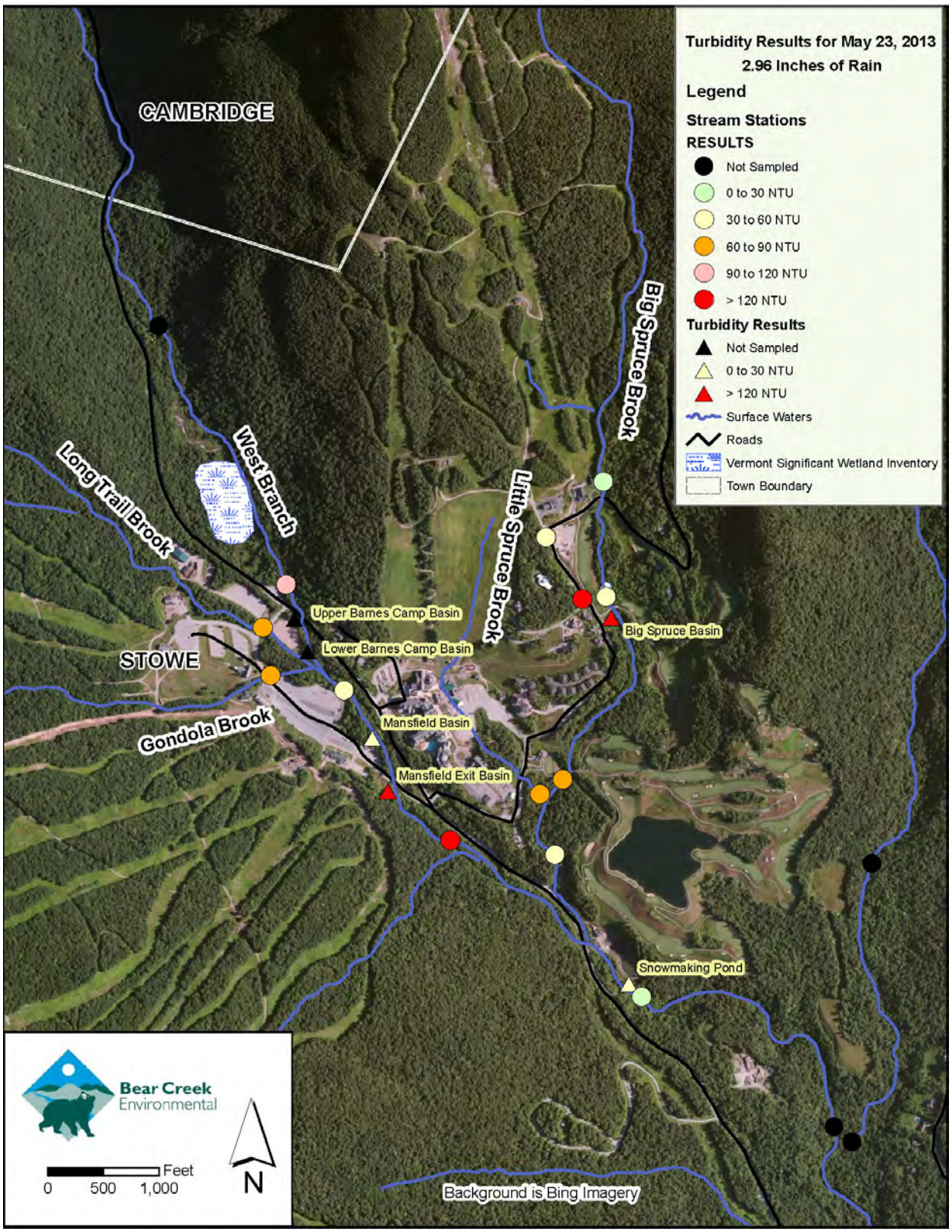

Figure 19. Turbidity results from May 23, 2013

The event-based chemistry results for 2000 to 2013 are summarized in Appendix 1. A mean value, maximum value, and the sample size are presented for the construction monitoring that has occurred between 2003 and 2013.

pH

The following mean pH values were reported for the period (2003-2013):

- WB8.2 (West Branch above Barnes Camp, 2010-2013) – 6.81 s.u.
- WB8.0 (West Branch below Barnes Camp, 2006-2013) – 5.70 s.u.
- WB7.5 (West Branch above Big Spruce Brook) – 6.48 s.u.
- WB6.5 (Lower West Branch) – 6.17 s.u.
- BS0.9 (Upper Big Spruce) – 4.95 s.u.
- BS0.7 (Big Spruce above basin, 2009-2013) – 6.00 s.u.
- BS0.3 (Big Spruce above Little Spruce, 2006-2013) – 6.14 s.u.
- BS0.2 (Lower Big Spruce) – 6.25 s.u.
- LS0.1 (Little Spruce Brook) – 6.37 s.u.
- SC0.2 (Upper Ski Club Brook, 2010-2013) – 6.01 s.u.
- SC0.1 (Lower Ski Club Book, 2010-2013) – 5.94 s.u.
- LT0.1 (Lower Long Trail Brook, 2012-2013) – 4.99 s.u.
- GB0.1 (Lower Gondola Brook, 2012-2013) – 5.06 s.u.

Event-based sampling reveals that streams in the vicinity of Stowe Mountain Resort are critically acidified. Only West Branch RM8.2 (Barnes Camp) has a mean pH value that is within the VWQS of 6.5 s.u. to 8.5 s.u. In particular, the high elevation streams and undeveloped watersheds appeared to be severely acid stressed.

Conductivity

In general, conductivity levels were highest on Little Spruce Brook and lowest on upper West Branch and Pinnacle Brook. Event-based monitoring did not take place on Pinnacle Brook during the 2012-2013 monitoring period. The mean conductivity for 2003-2013 for each of the monitoring stations is provided below in Figure 20.

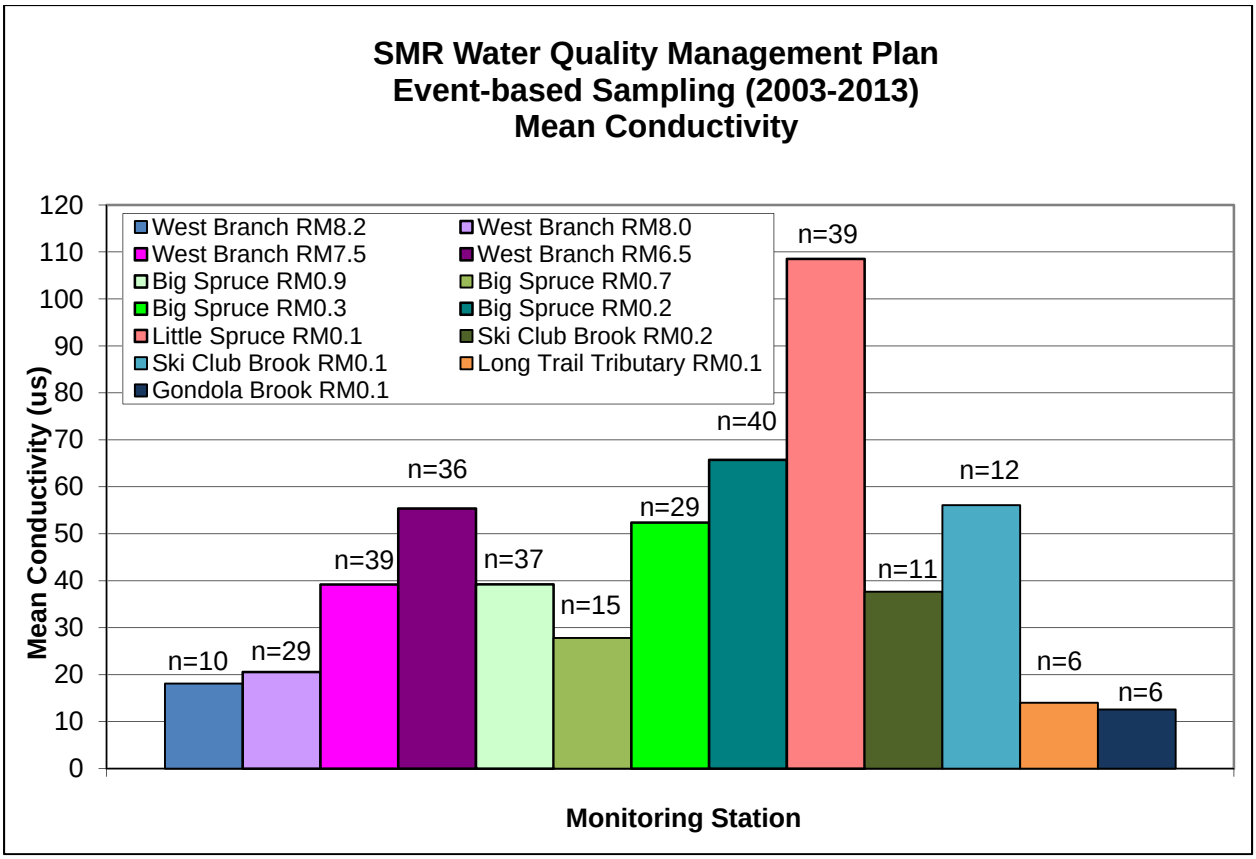

Figure 20. Mean conductivity reported for event-based sampling rounds for 2003 through 2013

6.0 EPSC PROGRAM AND MONITORING

Turbidity monitoring conducted by BCE and SMR is used by the resort to identify problem areas and target these areas for improvement. As discussed in Section 5.2, BCE sampled five precipitation/snow melt events during the 2012-2013 monitoring period. SMR personnel also collected event-based samples and analyzed them for turbidity on October 1, 2012. BCE sampled on June 27, 2012, September 5, 2012, January 14 and 31, 2013, and May 23, 2013. The combination of the BCE and SMR monitoring resulted in a total of six events being sampled. The turbidity results for each station by event are presented in Table 6 below. The final column shows the station's average turbidity for the monitoring period. In general, turbidity values were highest on the Spruce side of the resort, which includes Big Spruce, Little Spruce, and Ski Club Brooks. The May 23, 2013 rain event produced high turbidity values at most surface water stations, with the highest values at West Branch RM7.5 (181 NTU) and the

downstream station on Ski Club Brook at RM0.1 (139 NTU). Even the West Branch station at RM8.2 (located above the Resort) had a turbidity value that exceeded 100 NTU.

Table 6. Event-Based Sampling Turbidity Results 2012-2013
Stowe Mountain Resort

Station	June 27, 2012	Sep. 5, 2012	Jan. 14, 2013	Jan. 31, 2013	May 23, 2013	Average
WB8.2 (above SMR)	1.62	1.13	1.11	2.22	105	**22.2**
WB8.0	3.95	1.36	0.84	0.50	56	**12.5**
WB7.5	2.87	2.18	1.38	3.39	181	**38.2**
WB6.9	7.25	7.22	1.75	8.60	18[1]	**8.6**
LT0.1	3.82	2.05	2.52	3.50	69	**16.2**
GB0.1	6.18	0.84	0.62	0.78	68	**15.3**
BS0.9	2.19	1.00	1.06	2.05	27	**6.7**
BS0.7	3.55	1.53	3.01	3.35	36	**9.5**
BS0.3	4.61	3.49	3.36	3.80	73	**17.7**
BS0.2	6.37	3.30	3.82	5.02	54	**14.5**
LS0.1	6.32	1.75	3.33	6.43	69	**17.4**
SC0.2	6.25	1.29	2.30	3.47	48	**12.3**
SC0.1	5.56	3.75	3.78	25.8	139	**35.6**
Outlet 1 (Mansfield Basin)	5.66	10.9	46.2	71.9	13	**29.5**
Outlet 2 (Snowmaking Pond)	20.1	6.69	3.86	9.50	12	**10.4**
Outlet 3 (Big Spruce Basin)	30.1	8.02	9.20	46.9	184	**55.6**
Outlet 4 (Mansfield Exit Basin)	18.4	Not Sampled	Not Sampled	Not Sampled	122	**29.2**
Outlet 6 (Lower Barnes Camp Basin)	21.5	Not Sampled	Not Sampled	Not Sampled	Not Sampled	**21.5**

Stream station turbidity exceeds 10 NTU
Sediment basin outflow with elevated turbidity (> 100 NTU)
[1]Sample was collected below the snowmaking pond outlet, where the outflow flow was not well mixed with the stream flow.

These monitoring results were used to identify the major problem areas, which are summarized below by subwatershed. Stowe Mountain Resort (SMR) expanded its program during the 2007 construction season to promote erosion prevention and sediment control across the resort.

This program has been continued over the past few years. A report (e-mailed by Rob Apple to BCE on March 29, 2013) describing the erosion prevention/sediment control (EPSC) improvement projects are provided in Appendix 3. During spring 2012, as part of routine maintenance at the resort, accumulated sand from the winter was removed from parking lots, roads, culvert inlets, swales, water bars, stone check dams and sediment basins to prevent sediment reaching surface waters (Appendix 3, pages 1 and 2).

Big Spruce Brook Subwatershed

The turbidity values on Big Spruce Brook were less than 10 NTU on all sampling dates in the 2012-2013 monitoring period, with the exception of the May 23, 2013 rain event. The Big Spruce swale that receives stormwater runoff from Sensation Lot and the Big Spruce Access Road, however, has continued to show elevated turbidity values. In response to elevated levels during a May 2012 sampling event (2011-2012 monitoring period), SMR regraded the parking lot and established two additional shallow swales during spring 2012 in effort to redirect runoff to a grass line swale that surrounds the perimeter of the parking lot. Despite these efforts, the swale showed an elevated turbidity value (69.1 NTU) on the June 27, 2012 sampling event.

EPSC activities on the Spruce site of the report are reported in the 2012 EPSC Annual Monitoring report, which is included in Appendix 3 of this report. Highlights for the EPSC are provided below.

<u>Big Spruce Basin</u>

Big Spruce Basin was dewatered and sediment was removed on September 23, 2012 (refer to page 33 of Appendix 3).

<u>Big Spruce Road</u>

The ditchline adjacent to Big Spruce Road was reshaped and armored and sediment was removed from all sediment basins and check dams (refer to pages 25 and 26 of Appendix 3).

Sensation Lot

The swales through the Sensation Lot, which receives traffic year-round, were re-established to split flows into three different areas, thereby dispersing the water and avoiding rilling. The sediment basin at the far end of the lot was cleaned out and enlarged and the swale from the basin to the Big Spruce Road swale was re-armored (refer to page 27 of Appendix 3).

West Branch Subwatershed

A 1272 order was issued by Pete LaFlamme, Director of the Watershed Management Division of the Vermont Agency of Natural Resources on May 3, 2012 to address the ANR's finding of an impairment of West Branch of the Little River between river mile (RM) 7.5 and 8.0. The 1272 order specified a timeframe for establishing methods and procedures for eliminating or controlling stormwater discharges. VHB worked with SMR and Bear Creek Environmental, LLC to reduce sediment loading and peak stormwater runoff rates to the upper West Branch. Erosion control and stormwater improvement measures that were implemented during summer and fall 2012 (described below) appear to have been successful. Water quality results from the upper West Branch show low turbidity levels. Stormwater improvements measures completed as part of the Mansfield 1272 order are summarized below. Improvement efforts targeted three opportunities as outlined in the Memorandum prepared by Krista Reinhart dated May 18, 2012 (Vanasse Hangen Brustlin, Inc., 2012).

1. Upgrades to existing and retrofit of new stormwater management
2. Protection and/or maintenance of riparian buffers
3. Modifications to snowplowing, snow piling, and sanding operations.

Snowplant Workroad

In June 2012, major improvements in the vicinity of the snowplant occurred (refer to pages 3 through 5 of Appendix 3) . Existing swales around the snowplant were cleaned out and armored and rip rap stone check dams were installed to slow flows and remove sediment. A culvert was replaced along the work road adjacent to the plant, which is only used in the winter. The flow through the culvert was redirected into a new sediment basin that discharges into a low lying forested area (Figure 21).

Figure 21. Erosion control and stormwater management improvements in vicinity of Snowplant Work road, photo taken May 13, 2013 by Mary Nealon of BCE.

Upper Barnes Camp

Improvements to swales along the Upper Barnes lot were implemented by the resort during June 2012 (refer to pages 6 and 7 of Appendix 3).

Midway Lot

In mid-June 2012, the stormwater management system at the Middle Midway lot was improved to through the conveyance of stormwater to a newly designed dry swale. The Gondola base swale was reshaped and armored and stone check dams were built to improve the treatment of stormwater runoff from the Midway parking lots (refer to pages 8 and 9 of Appendix 3). Improvements to the Upper Midway lot occurred in mid-July, 2012 with the construction of an inline dry swale that leads to the Lower Midway dry basin (refer to page 15 of Appendix 3).

Lower Barnes Camp Parking Lot

The perimeter swale along the Lower Barnes Camp Parking Lot was re-established and the area of the lot adjacent to the forebay was armored to prevent erosion during July 2012 (refer to page 10 of Appendix 3).

Mansfield Base Area

Improvements to the parking area in the Mansfield Base Area were implemented by the resort during August 2012. This included re-grading were necessary, enlarging/reshaping water bars, and seeding and mulching disturbed areas (refer to pages 18 and 19 of Appendix 3).

Mansfield Parking Lot

The Mansfield Parking Lot was re-graded in order to direct stormwater into the recently upgraded systems, which aims to protect the unpaved Bus Lot from surface flows over the paved Mansfield Lot. At the Mountain Operations Center two new culverts were installed underneath the entrance stairs and the work road. The new culverts are larger than the previous ones in order to better handle higher flow events (refer to pages 29 through 32 of Appendix 3).

Mansfield Exit Area

During August 2012, the on-mountain stream run-off was diverted from this area and now directly discharges into the West Branch (see Figure 22). Multiple culverts were replaced or realigned to make this stream/stormwater separation. The separation was implemented in order to increase the handling capacity of the current storm water system (refer to pages 21 and 22 of Appendix 3).

Figure 22. Separation of on mountain stream run-off and stormwater at Mansfield Exit; photo taken on May 13, 2013, by Mary Nealon of BCE.

7.0 SEDIMENT ASSESSMENT

BCE conducted pebble counts at specified sediment monitoring stations to evaluate channel materials. A substrate summary table of the pebble counts is included in Appendix 4 on page 1. The results of each pebble count are shown on pages 2 through 15 of Appendix 4.

Embeddedness:

Embeddedness was assessed at the seven biomonitoring stations. Three of the four West Branch stations (RM 8.8, RM 8.0, and RM6.5), both Big Spruce Stations (RM0.2 and RM0.3) and Pinnacle Brook had embeddedness estimates of 0-25% (very good) in 2012 and met the future target goals. One of the West Branch stations (RM7.5) received an embeddedness rating of 26-50% and did not meet the future target goal of less than 25 percent.

Channel Materials:

The pebble count data serve as an important tool for understanding improvement in habitat from remediation efforts as well as impacts from catastrophic flood events. As shown below in Figure 23, the percentage of particles less than 8 mm met the target threshold of less than or equal to 20 percent of the substrate composition at all seven stations in 2012. Both the graph of the percentage of particles less than 8 mm and the percent fines (Figure 24), indicate there was a shift toward smaller particle sizes in 2010. A high flow event in August 2010 was the primary cause and the percentage of fines has generally decreased since 2010 as the sediment works its way through. This shift can be seen for each station on the graphs in Appendix 4. All the monitoring stations in 2012 met the targets for percent fines.

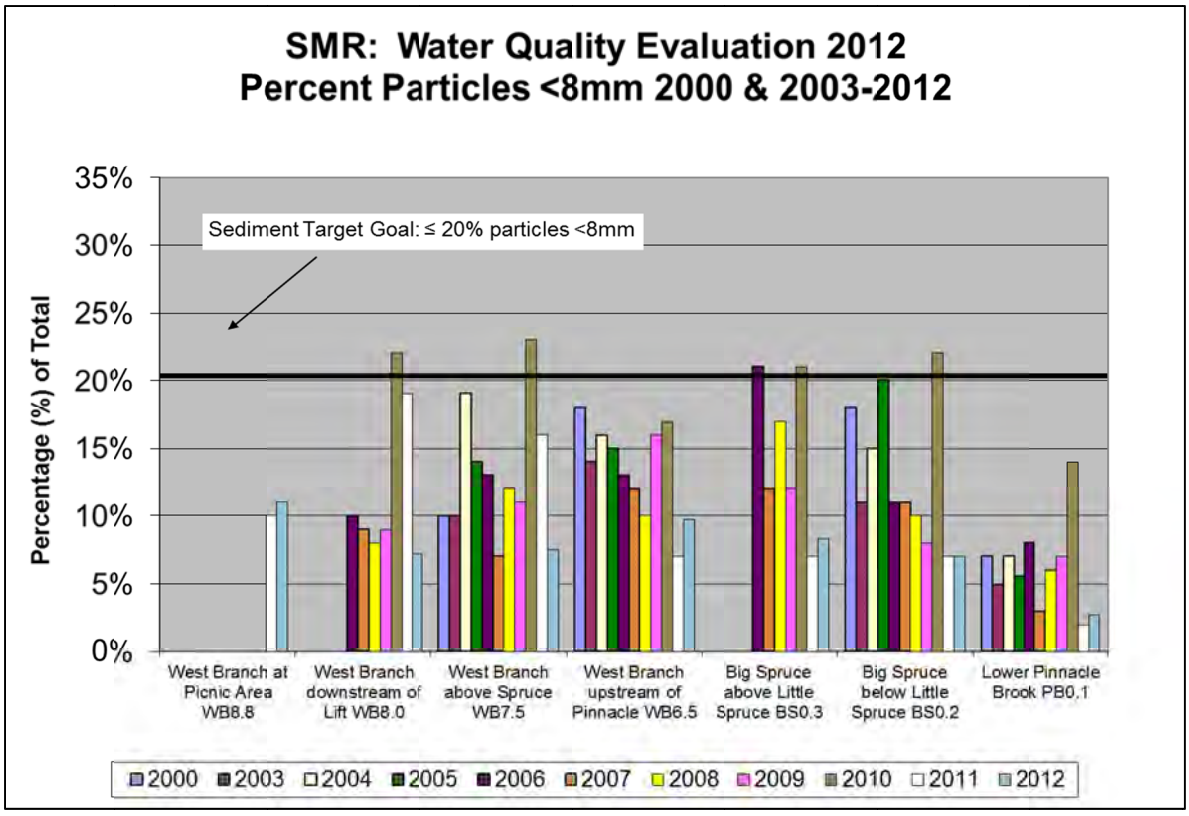

Figure 23. Substrate Assessment – Percent particles less than 8 mm.

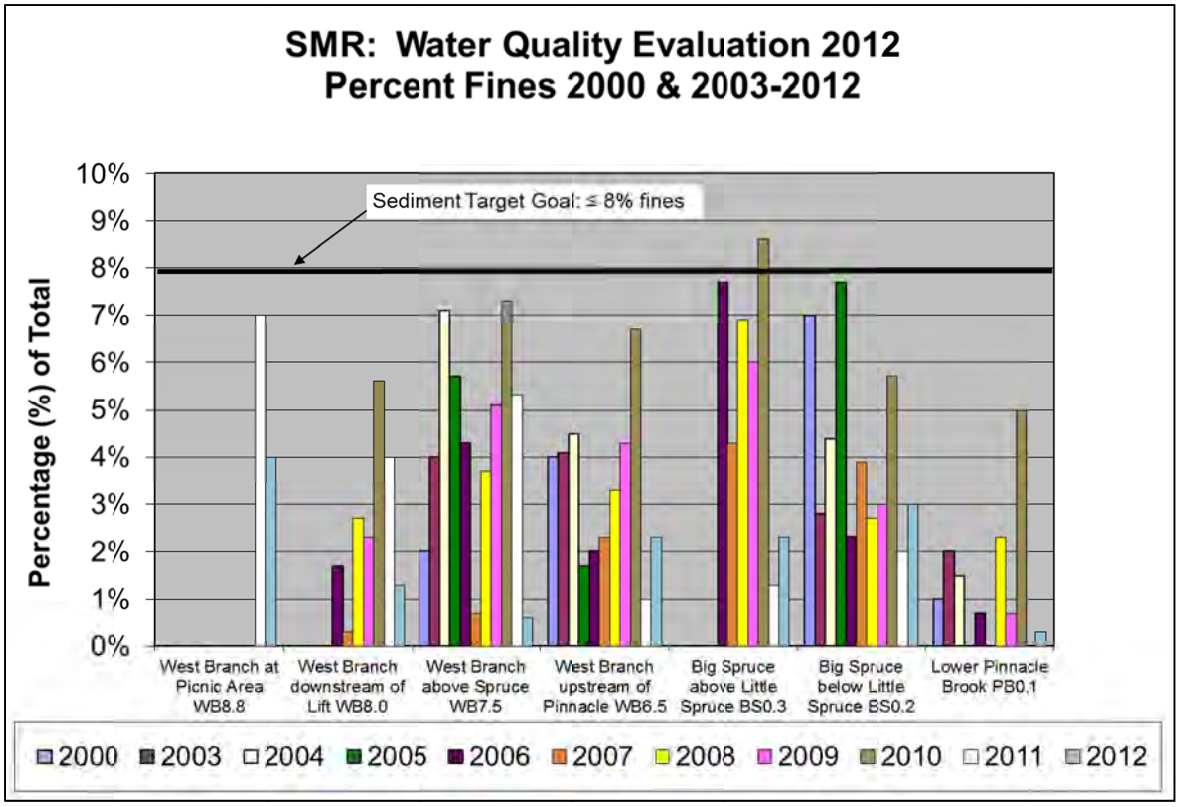

Figure 24. Substrate Assessment – Percent fines

The seven monitoring stations met all three target goals for sediment in 2012, with the exception of the West Branch RM7.5. The West Branch RM7.5 met two of the three target goals in 2012. Streams in the vicinity of SMR will continue to be monitored for changes in channel substrate condition as the MDP continues to be implemented.

8.0 BIOMONITORING AND HABITAT ASSESSMENT

Macroinvertebrate kick net sampling and habitat assessments were conducted by Catherine Szal on September 16, 2012. Biomonitoring and habitat assessments were conducted on the four West Branch stations, two Big Spruce Brook stations, and one Pinnacle Brook station. The sampling took place under moderate flow conditions. Two replicate kick net samples were collected at each station with the exception of Big Spruce RM 0.3, where habitat is limited. Figure 25 shows the flow conditions in the West Branch for the past five monitoring years. During the 2010 field season, a large flood event occurred during early August, causing major damage at the resort and changes to the channel morphology and extreme scouring of the bed. A second flood event took place about a week after the kick net samples were collected on

September 26, 2010. During 2011, the daily mean stream flow exceeded 250 cfs as a result of Tropical Storm Irene. During July 2008, stream flows were higher than average, causing scouring of the substrate on a regular basis during the mid-portion of the summer. A number of large storm events preceded the kick net sampling performed by Bear Creek Environmental in 2006. The 2009 and 2012 monitoring seasons are characterized as having low to moderate flows. Stream flow conditions prior to sampling appear to be strongly correlated with density and richness of macroinvertebrates in the West Branch and tributaries (Bear Creek Environmental, 2010).

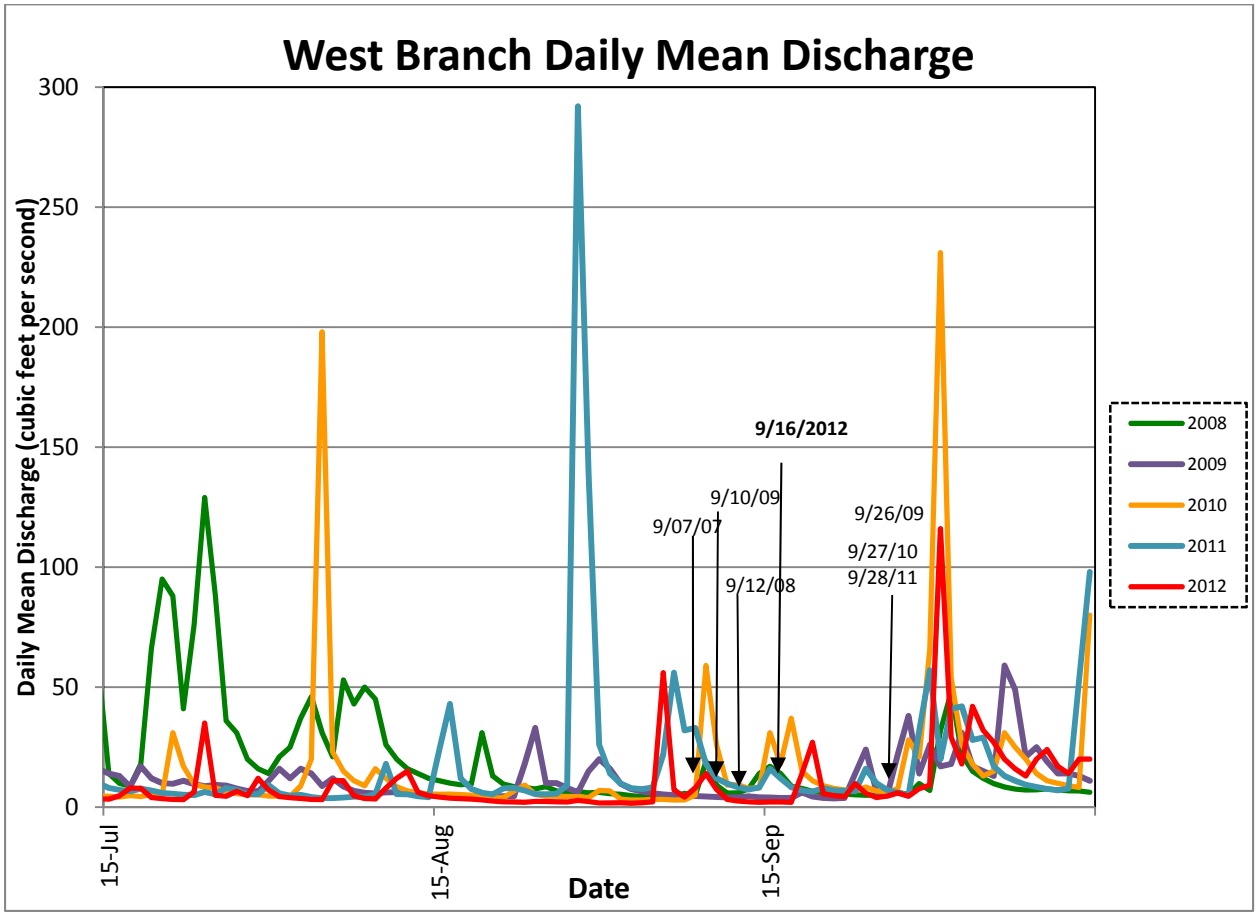

Figure 25. Daily mean discharge on West Branch between mid-July and mid-October for monitoring years 2007 through 2012

8.1 Habitat Assessment

Qualitative habitat assessments were made at the seven biomonitoring stations on September 16, 2012. Field sheets from these habitat assessments are provided on pages 1 through 14 of Appendix 5. Silt ratings and CPOM ratings for each station are provided

below in Table 6. The silt is rated from 0 to 5 by the biologist. A rating of 0 indicates silt is absent, while a rating of 5 reflects considerable silt as evidenced by a chocolate brown color. Silt can impair aquatic insects by clogging gills. The lower Big Spruce Station (BS0.2) had a high silt rating in 2012, although the biologist noted this silt was high in organics. Embeddedness ratings taken as part of the pebble count and biomonitoring are also provided in Table 7 to understand habitat conditions.

Table 7. Substrate Embeddedness and Silt Ratings

Stream	RM	Silt Rating (0-5)	Pebble Count Embeddedness (Percentage)	Biomonitoring Embeddedness (Percentage)
West Branch	8.8	2	0-25	5-25 (closer to 25)
	8.0	2	0-25	5-25
	7.5	3	26-50	5-25 (closer to 25 in some places)
	6.5	2	0-25	5-25 (25-50 in some places)
Big Spruce Brook	0.3	3	0-25	5-25 (close to 10)
	0.2	3-4	0-25	5-25 (close to 10)
Pinnacle Brook	0.1	2	0-25	5-25 (close to 5)
Silt rating (0 – none; 5- chocolate)				

West Branch of Little River – RM 8.8:

There was light sand and silt noted at West Branch RM8.8 station. Embeddedness was estimated to be 25%. Stream bank stability was fair (25-50% stable). The canopy was partly open given the start of leaf fall, and the percent canopy was 70 percent (Figure 26).

Figure 26. West Branch RM 8.8 in picnic area off of Route 108 (9/16/2012)

West Branch of Little River – RM 8.0:

West Branch RM 8.0 is located downstream of the transfer lift crossing. Sandy and silt patches in the substrate were noted with embeddedness ranging from 5-25 percent (very good). Bank stability was good (50-75% stable). Canopy cover was estimated to be 50 percent. The diatom cover was 90 percent. Iron staining was common, with several iron seeps present. A strong iron seep was noted along the west side of the channel, adjacent to the Mansfield parking lot (Figure 27).

Figure 27. Iron staining at West Branch RM8.0 (9/16/2012)

West Branch of Little River RM 7.5:

The August 4, 2010 flood event resulted in bank erosion and a buildup of sediment near the upper end of West Branch RM7.5. The high flows in August 2010 also exacerbated the stability of the valley wall, creating further instability of mass failures. In fall 20ll, very little CPOM was noted; in 2012, little to moderate CPOM was noted. This suggests that the leaf pack is reestablishing in this area. Embeddedness was estimated to be 5-25% with a lot of sand and gravel in interstitial spaces. Slight iron staining was noted. Bank stability was rated as good (50-75% stable). Canopy cover was estimated to be 80 percent, as shown in Figure 28.

Figure 28. West Branch RM7.5 (9/16/2012)

West Branch of Little River (RM 6.5):

The lowest West Branch monitoring station was impacted by the August 4, 2010 high flow event, but the changes were not as dramatic as the other monitoring stations on the West Branch and Big Spruce Brook. The overall channel morphology was noted to be better in 2012 than in 2011 (Figure 29). Figure 30 shows an area of bank erosion near the confluence with Pinnacle Brook. Sand and gravel appear to be moving through this area. Bank stability was rated as good (50-75% stable). Substrate embeddedness was rated as 5-25 percent within the area the kick net samples were collected, and 0-25 percent within the pebble count reach. The diatom coverage was approximately 90 percent. Canopy cover was estimated to be 60 percent.

Figure 29. West Branch RM 6.5 above the confluence with Pinnacle Brook (9/16/12)

Figure 30. West Branch RM 6.5. had bank erosion at the downstream end (9/16/12)

Big Spruce RM 0.3:

Several active iron seeps were noted in 2012. One major iron seep was remediated in October 2010 using limestone to intercept and treat the groundwater; however, the limestone became clogged and repair work was conducted in late fall 2011 to allow the groundwater to flow freely through the limestone treatment area. For this reason, one kick net sampling was conducted immediately upstream of the active iron seep in 2012 (Figure 31). The site was 5-25 percent embedded, with an estimate of 10 percent overall. Bank stability was rated as good (50-75% stable). Canopy cover was 60 percent at the time of sampling.

Figure 31. Big Spruce Brook RM 0.3 (9/16/12)

Big Spruce - RM0.2:

Big Spruce RM0.2 appeared to be in a more stable condition than the previous year. In 20ll, this area was noted to be undergoing several channel adjustment processes (Figure 32). In 2012, an area of bank failure was noted on the left bank when looking downstream. Bank

stability was rated as fair (25-50% stable). The embeddedness was rated as 5-25 percent (very good), although the silt rating was high. Percent canopy cover averaged 60 percent. Figure 33 shows a downstream view of the station.

Figure 32. Exposed banks at Big Spruce RM0.2 from high shear stress during August 4, 2010 event (9/28/11)

Figure 33. Looking downstream from footbridge at Big Spruce RM0.2 (9/16/12)

Pinnacle Brook – RM0.1:

According to the 2011 report, the August 2010 high flow event did not have as much of an effect on the Pinnacle Brook RM0.1 station. In 2012, bank stability was rated as excellent (75-100 percent stable). Embeddedness was very good (5 to 25 percent). Quite a bit of gravel was noted to be moving through this station. Canopy cover was approximately 70 percent. There was 90% diatom cover and a trace of blue-green algae. Figure 34 shows the Pinnacle Brook monitoring station.

Figure 34. Pinnacle Brook monitoring station (9/16/12)

8.2 Biomonitoring Results

The macroinvertebrate taxa list for the duplicate kick net samples collected during fall 2012 are found in Appendix 5 on pages 15 through 21. The macroinvertebrate kick net samples were processed and identified by Catherine Szal. A summary of the biometrics, percent

composition of the orders, and percent composition of the functional feeding groups for each station is included on pages 22 through 35 of Appendix 5.

All biomonitoring stations sampled during 2012 in the vicinity of SMR are located below 2,500 feet in elevation. All seven sampling stations fall into the stream type "small-size high gradient" (SHG). For this reason, the Class B (2-3) scoring guidelines for SHG were applied. The outcomes of the scoring guidelines are summarized in Tables 8 through 14 below. The Class B2-3 threshold values are provided at the bottom of each table. Sampling dates where the biological integrity is good or better and the samples meet Class B biocriteria are highlighted in green.

The weather conditions in 2010 and 2011 were unusual and extreme as discussed in earlier sections of this report. The 2012 monitoring period did not have events that were as extreme as previous years.

West Branch of Little River – RM 8.8: Station RM8.8 is located at the picnic area in Smugglers Notch off of Route 108. This is the second year the West Branch upstream of Stowe Mountain Resort has been sampled by Stowe Mountain Resort. Steve Fiske of the Vermont DEC also sampled the West Branch above the resort in the vicinity of RM8.8 in early September 2007 and 2011. This background/control station did not meet the Class B2-3 biocriteria in 2012 because of low Richness, and EPT Richness. The mean EPT Richness has been below the threshold value of 16 for three of the four sampling dates. The September 2011 sampling conducted by the DEC took place only two weeks after Tropical Storm Irene, and the high richness values may have been influenced by the drift of insects caused by the high flows. The low EPT Richness values may be attributed impacts from acid precipitation as a result of the poor buffering capacity (i.e. low alkalinity).

Table 8. Macroinvertebrate Results
West Branch of Little River RM 8.8
Picnic Area off of Route 108 in the Notch

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
9/7/2007	1124.5	30	**14**	77.4	2.37	0.3	0.75	0.63	Class B2-3 Not Supported: Fair
9/9/2011[1] DEC	379.2	36	19	63.8	2.18	1.6	0.77	**0.38**	Class B2-3 Supported: Good
9/28/2011[1] BCE	**275.5**	**23.5**	**15.5**	54	1.12	0.0	0.91	**0.35**	Class B2-3 Not Supported: Fair
9/16/12 BCE	427.2	**24.5**	**15.5**	61.3	1.19	0.2	0.88	0.46	Class B2-3 Not Supported: Fair to Good
Annual Mean 2006-2012	626.4	28.1	**15.6**	65.9	1.74	0.4	0.82	0.49	Fair to Good
Annual Mean 2006-2009	1124.5	30.0	**14.0**	77.5	2.37	0.3	0.75	0.63	Fair
Class B2-3	≥300	≥27	≥16	≥45	≤4.50	≤12	≥0.45	≥0.40	

Bold denotes value does not meet the proposed macroinvertebrate biocriteria threshold
[1]Large flood event in August 2011
Note: DEC and BCE station locations are not exact, but are within the same reach

West Branch of Little River – RM 8.0: The upper West Branch station was added in 2006 to provide a control station on the West Branch that is located above the discharge from the Mount Mansfield sedimentation basin. Bear Creek Environmental sampled at Stowe Mountain Resort in mid-September 2012 under baseflow conditions following a field season with stable flow conditions. These September 2012 samples are the first set of samples that have met Class B2-3 water quality standards in the seven years of monitoring. Steve Fiske also collected kick net samples during fall 2012 and sampled on October 24, 2012 following a freshet event that took place on October 19, 2012 (Figure 35).

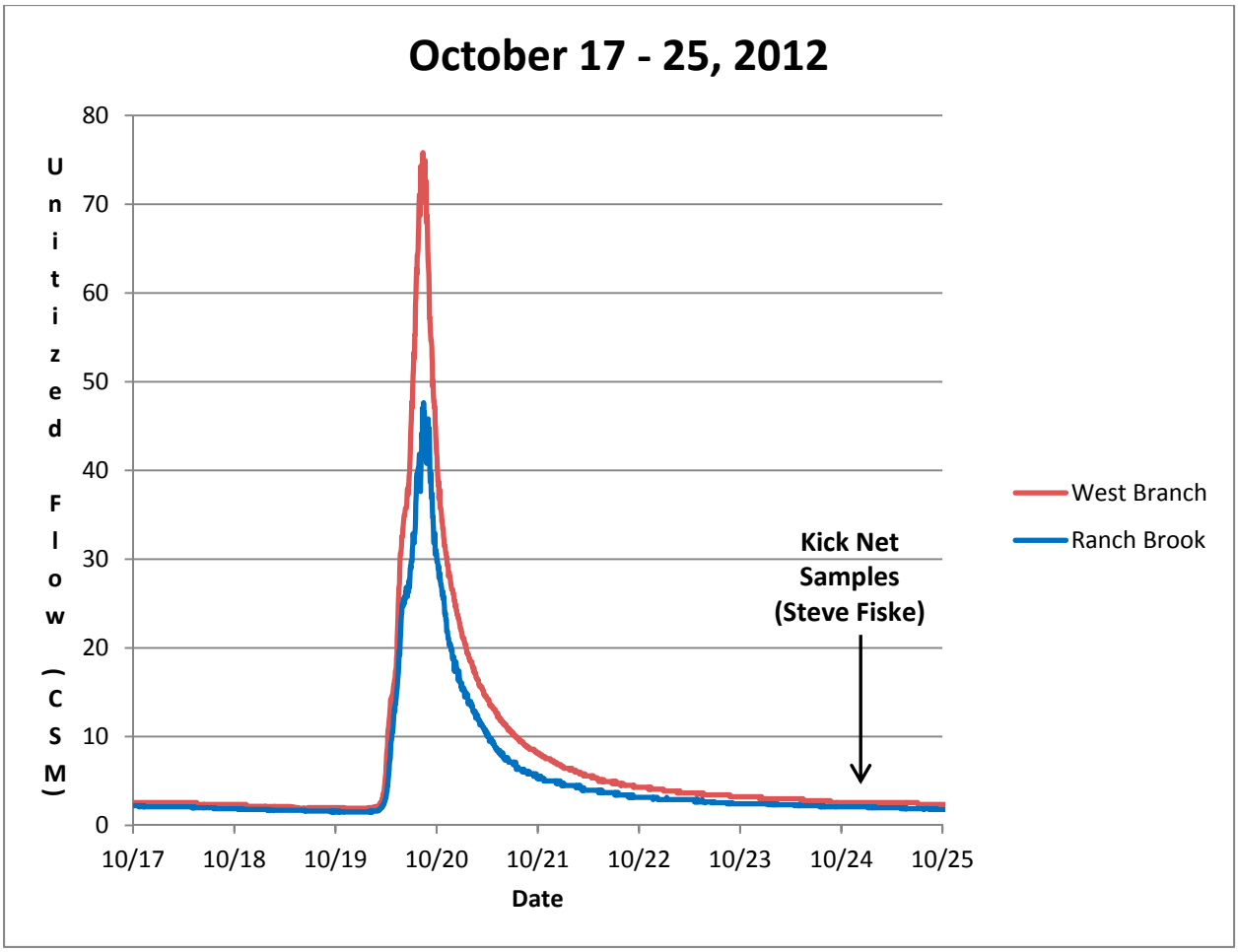

Figure 35. Unitized flows for the West Branch and Ranch Brook from October 17 through 25, 2012. Kick net samples on the West Branch were collected following the October 19, 2012, high flow event.

Other than the Pinkham Pearson Coefficient of Similarity (PPCS) index, the metrics met Class B2-3 biocriteria. The PPCS reflects a shift in functional feeding groups possibly due to rapid recolonization after the freshet event.

Table 9. Macroinvertebrate Results
West Branch of Little River RM 8.0 (MS-16b)
Above Discharge from Mount Mansfield Parking Area

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
10/10/2006 BCE	**199.5**	**26**	**13.5**	65	2.19	10.0	0.89	0.61	Class B2-3 Not Supported: Fair
9/7/2007 BCE	682	**26**	**15.0**	60	3.01	**13.0**	0.93	0.42	Indeterminate for Class B2-3: Fair
9/7/2007 ANR	1204	33	**14.0**	63	3.50	8.0	0.87	**0.36**	Class B2-3 Not Supported: Fair

Table 9. Macroinvertebrate Results
West Branch of Little River RM 8.0 (MS-16b)
Above Discharge from Mount Mansfield Parking Area

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
9/12/2008 BCE	**184.5**	**24.0**	**13.5**	65	3.38	9.3	0.93	**0.34**	Class B2-3 Not Supported: Fair
9/10/2009 BCE	567	**23.5**	**14.5**	69	3.29	1.5	0.94	0.55	Class B2-3 Not Supported: Fair
9/27/2010[1] BCE	**77**	**15.5**	**9.0**	59.5	2.13	0.8	0.90	**0.35**	Class B2-3 Not Supported: Poor
9/28/2011[1] BCE	**89.5**	**20.0**	**13.5**	67	2.13	6.1	0.91	0.52	Class B2-3 Not Supported: Poor
9/16/012 BCE	399.5	29.5	17.5	78.3	2.49	2.7	0.89	0.46	Class B2-3 Supported: Good
10/24/12[2] DEC	837.0	30.0	17.0	68.1	2.58	8.2	0.69	**0.34**	Class B2-3 Not Supported: Fair to Good
Annual Mean (2006-2012)	382.7	**24.0**	**13.7**	65.8	2.70	6.23	0.89	0.45	Fair
Annual Mean (2006-2009)	473.5	**25.8**	**14.0**	65.2	3.03	7.8	0.91	0.47	Fair
Class B2-3	≥300	≥27	≥16	≥45	≤4.50	≤12	≥0.45	≥0.40	

Bold denotes value does not meet the proposed macroinvertebrate biocriteria threshold
[1]Large flood events in August 2010 and August 2011
[2]Sampled five days following a freshet event.

West Branch of Little River RM 7.5: The middle West Branch station is located below the discharge from the Mt. Mansfield sedimentation basin. The 2012 kick net samples met Class B2-3 biometrics and had good biological integrity. These 2012 samples were collected following a stable flow period. Kick net samples collected during fall 2007 and 2009 also reflect good biological integrity, and were collected following a prolonged low flow period. Low density and richness numbers in 2008, 2010, and 2011 are attributed to scouring of the substrate from high flow events that occurred in July 2008 and August 2010 and 2011. The density and richness metrics for 2006 may also reflect impacts from scouring velocities prior to sampling. The higher Richness and EPT values for WB7.5 for low and moderate flow years points to hydrology being a key factor in influencing the biological integrity.

Table 10. Macroinvertebrate Results
West Branch of Little River RM7.5 (MS-8)
Below Lower Entrance to Mount Mansfield (Above Big Spruce Brook Confluence)

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
Sept. 2000 PEA	**118**	**24.5**	**13**	55	2.08	1.9	0.76	0.40	Class B2-3 Not Supported: Fair
Sept. 2000 VANR	605	**22**	**12**	55	3.13	0.0	0.70	**0.39**	Class B2-3 Not Supported: Fair
Sept. 2001 VANR	**130**	**25.5**	**15**	72	2.68	0.40	0.80	0.47	Class B2-3 Not Supported: Fair
Oct. 2003 PEA[1]	**123.5**	**18.5**	**8.5**	49	3.56	**44.0**	0.57	0.41	Class B2-3 Not Supported: Poor
Nov. 2004 PEA	**165.5**	**25**	**14**	58	1.45	**14.1**	0.90	0.54	Class B2-3 Not Supported: Fair
Sept. 2005 BCE	**179**	34	**15**	73	2.19	**23**	0.80	0.47	Class B2-3 Not Supported: Fair
10/10/2006 BCE	**185.5**	**26**	17	64	1.76	5.9	0.91	0.60	Class B2-3 Not Supported: Fair
9/7/2007 BCE	629	28.5	17.5	65	2.28	3.3	0.93	0.44	Class B2-3 Supported: Good
9/12/2008 BCE	**213.5**	**26.5**	16.0	67	2.89	2.5	0.91	0.48	Class B2-3 Not Supported: Fair
9/10/2009 BCE	477.5	28	16.5	71	2.45	1.8	0.86	0.44	Class B2-3 Supported: Good
9/26/2009 BCE	350.0	28.5	19.0	70	1.95	1.7	0.90	0.50	Class B2-3 Supported: Good
9/27/2010[2] BCE	**88**	**23**	**14.5**	65	2.63	7.3	0.92	0.49	Class B2-3 Not Supported: Poor
9/28/2011[2] BCE	**99.5**	**19.5**	**13**	68	2.23	1.5	0.88	0.51	Class B2-3 Not Supported: Poor
9/16/12 BCE	417.3	30.0	18.0	69.4	2.83	0.6	0.91	0.43	Class B2-3 Supported: Good
Annual Mean (2006-2012)	**292.4**	**26.0**	16.3	67.0	2.40	3.3	0.91	0.49	Fair
Annual Mean (2006-2009)	360.4	27.3	17.1	66.6	2.28	3.4	0.91	0.50	Good
Class B2-3	≥300	≥27	≥16	≥45	≤4.50	≤12	≥0.45	≥0.40	

Bold denotes value does not meet the proposed macroinvertebrate biocriteria threshold
[1] Petroleum spill in 2003
[2]Large flood event in August 2010

West Branch of Little River (RM 6.5): The lower West Branch station has passed the Class B2-3 in six of the eleven years sampled. Historically, biomonitoring results appear to be correlated with the flow regime prior to sample collection. In years when the flow regime has been stable, the samples have met Class B2-3 biocriteria. In years when the substrate has been scoured due to high flow events, the biological integrity has been fair.

During the 2012 monitoring season, three sets of kick net samples were collected. The first two sets of samples were collected following a prolonged period with stable flow conditions. The August 30, 2012 samples collected by the DEC resulted in very good biological integrity, while the September 16, 2012 samples collected by BCE resulted in good biological integrity. In mid-October, 2012, the DEC sampled a high flow (freshet) event where provisional data from the USGS indicate flows reached approximately 350 cfs (74 csm) on the West Branch 180 cfs (47 csm) on Ranch Brook. Based on results reported by the DEC, the biological communities at West Branch RM6.5 had fair to good biological integrity with the PPCS not meeting the threshold value for Class B2-3. The PPCS failure is likely due to a shift in the community from a rapid recolonization following the freshet event. Overall, the community at RM6.5 responded well to the stress of the high flow event.

Table 11. Macroinvertebrate Results
West Branch of Little River RM 6.5 (MS-14)
Above Pinnacle Brook

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
Sept. 2000 PEA	420	38	21	70	3.35	0.4	0.69	0.44	Class B1 Supported: V.Good
Oct. 2003[1] PEA	**135**	24.5	**14**	58	3.62	**19.5**	0.64	0.56	Class B2-3 Not Supported: Fair
Nov. 2004 PEA	364	38	23.5	65	3.01	**14.1**	0.90	0.65	Indeterminate
Sept. 2005 BCE & DEC	352	43	24	80	1.91	9.2	0.83	0.52	Class B2-3 Supported: Good
10/10/2006 BCE	**212**	30.5	20.5	70	1.86	1.8	0.90	0.67	Class B2-3 Not Supported: Fair
9/7/2007 BCE	626	27	16.0	81	2.06	1.8	0.91	0.59	Class B2-3 Supported: Good
9/12/2008 BCE	**272**	**25**	**15.0**	64	3.40	2.7	0.95	0.52	Class B2-3 Not Supported: Fair
9/12/2008 DEC	302	35	20	73.7	2.90	1.7	0.91	0.60	Class B2-3 Supported: Good
9/10/2009 BCE	593	30	18.5	74.7	2.47	0	0.90	0.52	Class B2-3 Supported: VG to Good
9/11/2009 DEC	694.5	44	26	76.7	2.86	1.7	0.87	0.59	Class B2-3 Supported: VG to Exc.
9/27/2010[2] BCE	**158.5**	31.5	21.5	64	2.67	2.0	0.95	0.53	Class B2-3 Not Supported: Fair
9/9/2011[2] DEC	**266**	43	23	69.7	3.45	1.9	0.92	0.62	Class B2-3 Not Supported: Fair

Table 11. Macroinvertebrate Results
West Branch of Little River RM 6.5 (MS-14)
Above Pinnacle Brook

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
9/28/2011[2] BCE	**207.5**	**25.5**	18	53	3.98	0.6	0.96	0.41	Class B2-3 Not Supported: Fair
8/30/2012 DEC	936.0	39.7	23.7	71.5	2.67	1.0	0.84	0.49	Class B2-3 Supported: V.Good
9/16/2012 BCE	340.9	34.5	22.0	73.0	2.47	1.2	0.83	0.45	Class B2-3 Supported: Good
10/24/12[3] DEC	589.5	42.0	29.0	60.5	1.64	3.6	0.93	**0.29**	Class B2-3 Not Supported: Fair to good
Annual Mean (2006-2012)	398.0	32.7	20.5	69.9	2.63	1.69	0.91	0.55	Good
Annual Mean (2006-2009)	442.2	31.1	19.1	73.9	2.43	1.7	0.91	0.59	Good
Class B2-3	≥300	≥27	≥16	≥45	≤4.50	≤12	≥0.45	≥0.40	

Bold denotes value does not meet the proposed macroinvertebrate biocriteria threshold
[1] Petroleum spill in 2003
[2]Large flood event in August 2010
[3]Sampled five days after a freshet event

Big Spruce RM 0.3: A new biomonitoring station was added on Big Spruce Brook during 2006 to provide a second set of data to evaluate compliance with Class B2-3 biocriteria. Big Spruce Brook at river mile 0.3 passed the Class B2-3 biocriteria in two of the seven years sampled (see Table 11). A summary of the monitoring years is as follows:

- 2006 – low density; evidence of recolonization of macroinvertebrate community following high flow event.
- 2007 – passed Class B2-3 biocriteria; favorable monitoring year in terms of flow.
- 2008 – low density, richness and EPT; heavy iron precipitate, heavy silt, and high flow events prior to sampling.
- 2009 – low richness and EPT; limited riffle habitat to avoid sampling in heavy iron seep and moderate to high silt levels.
- 2010 – low density, richness and EPT due to scouring from August 4 flood event.
- 2011 – low density, richness, and EPT due to scouring from August 28 (Tropical Storm Irene) flood event; limited riffle habitat to avoid sampling in heavy iron seep.

- 2012 - passed Class B2-3 biocriteria; favorable monitoring year in terms of flow.

The trend in biological integrity at Big Spruce RM 0.3 is similar to other stations. The biological integrity has been good and has passed Class B2-3 biocriteria when flows were stable prior to sampling. In years when flood flows have occurred during the summer or fall prior to sampling, the biological integrity has been poor.

Table 12. Macroinvertebrate Results
Big Spruce Brook RM 0.3 (MS10-a)
Upstream of Club House

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
10/10/2006 BCE	**207**	29.5	17.5	72	2.77	0.5	0.89	0.46	Class B2-3 Not Supported: Fair
9/7/2007 BCE	314.5	36.5	20.5	84	2.04	0.1	0.78	0.64	Class B2-3 Supported: Good
9/12/2008 BCE	**125**	**25.5**	**12.0**	72	1.59	1.5	0.87	0.44	Class B2-3 Not Supported: Fair
9/10/2009 BCE	358.5	**25.5**	**13.0**	79	2.38	0.3	0.68	0.50	Class B2-3 Not Supported: Fair
9/27/2010[1] BCE	**64**	**20.0**	**13.0**	66	2.44	3.1	0.77	0.53	Class B2-3 Not Supported: Poor
9/28/2011[1] BCE[1]	**99**	**22.0**	**13.0**	74	2.50	3.0	0.90	0.41	Class B2-3 Not Supported: Poor
9/16/2012	346.0	38.0	20.0	56.3	3.17	1.2	0.45	0.48	Class B2-3 Supported: Good
Annual Mean (2006-2012)	**216.3**	28.2	**15.6**	71.9	2.41	1.4	0.79	0.49	Fair
Annual Mean (2006-2009)	**251.3**	29.3	**15.8**	76.8	2.20	0.6	0.81	0.51	Fair
Class B2-3	≥300	≥27	≥16	≥45	≤4.50	≤12	≥0.45	≥0.40	

Bold denotes value does not meet the proposed macroinvertebrate biocriteria threshold
[1]Large flood event in August 2010

Big Spruce - RM0.2: The macroinvertebrate results for Big Spruce RM0.2 did not track with the other biomonitoring stations in 2012. Although seven of the eight metrics passed in 2012, the mean density was suppressed and did not meet the Class B2-3 biocriteria.

Table 13. Macroinvertebrate Results
Big Spruce Brook RM0.2 (MS-10)
At Mouth

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
Sept. 2000 PEA	**207**	39.5	20.5	71	3.45	2.7	0.66	0.62	Class B2-3 Not Supported: Fair
Oct. 2003 PEA	**261**	35	21	60	1.76	1.5	0.76	0.45	Class B2-3 Not Supported: Good to Fair
Nov. 2004 PEA	1224	35	**14**	**44**	4.24	2.0	**0.26**	0.48	Class B2-3 Not Supported: Fair
Sept. 2005 BCE	**209**	44	19	67	2.45	**12.6**	0.70	0.56	Class B2-3 Not Supported: Fair
10/10/2006 BCE	**181.5**	**24**	**14.5**	69	2.74	0.3	0.84	0.45	Class B2-3 Not Supported: Fair
9/7/2007 BCE	500.5	29.5	18.0	77	2.37	0	0.67	0.48	Class B2-3 Supported: Good
9/12/2008 BCE	**225**	29.5	17.0	83	2.27	0.2	0.87	0.56	Class B2-3 Not Supported: Fair to good
9/10/2009 BCE	474.5	29.0	17.5	83	2.93	0.8	0.71	0.52	Class B2-3 Supported: Good
9/26/2009 BCE	322.5	35.5	22.0	80	1.87	0.5	0.88	0.62	Class B2-3 Supported: Good
9/27/2010[1] BCE	**105**	**25.5**	**14.5**	70	3.44	0.5	0.65	0.65	Class B2-3 Not Supported: Fair to Poor
9/28/2011[1] BCE	**166.5**	36	19.5	73	2.84	3.6	0.70	0.52	Class B2-3 Not Supported: Fair
9/16/2012 BCE	**187.0**	32.5	17.5	63.5	2.49	0.9	0.66	0.44	Class B2-3 Not Supported: Fair
Annual Mean (2006-2012)	**297.0**	31.9	18.7	80.3	2.79	0.7	0.80	0.57	Good to Fair
Annual Mean (2006-2009)	326.4	28.0	16.8	78.0	2.58	0.3	0.77	0.50	Good to Fair
Class B2-3	≥300	≥27	≥16	≥45	≤4.50	≤12	≥0.45	≥0.40	

Bold denotes value does not meet the proposed macroinvertebrate biocriteria threshold
[1]Large flood event in August 2010

Pinnacle Brook – RM0.1: Pinnacle Brook acts as a local control/reference station for the other biomonitoring stations at Stowe Mountain Resort. The 2012 macroinvertebrate results from the lower Pinnacle Brook station indicate the biological integrity was excellent as summarized in Table 13. Class B2-3 biocriteria has been met in ten of the eleven years of monitoring. Although the Pinnacle Brook and Ranch Brook are located adjacent to the West Branch watershed, these drainages appeared to have been spared the extreme high flows events and localized flooding that took place on August 4, 2010 within the West Branch

watershed. Tropical Storm Irene, which took place in late August 2011, was more wide spread. The 2011 monitoring results for Pinnacle Brook reflect the lowest density of the ten years of monitoring. The lower density of the 2011 kick net samples may be attributed to Tropical Storm Irene.

Table 14. Macroinvertebrate Results
Pinnacle Brook MS-13
At Mouth

Year	Density	Richness	EPT	PMA-O	BI	% Oligo.	EPT/ EPT+C	PPCS-FG	Outcome
Sept. 2000 PEA	714	35.5	21.5	72	2.05	0.0	0.68	0.56	Class A1 Supported: Exc.
Oct. 2003 PEA	1098	28	16.5	65	1.20	0.4	0.91	0.40	Class B2-3 Supported: Good
Nov. 2004 PEA	499	32.5	17.5	58	2.17	3.1	0.76	0.53	Class B2-3 Supported: Good
Sept. 2005 BCE	601	53	22	67	2.43	**14.0**[1]	0.64	0.47	Class B2-3 Supported: Very Good to good
10/10/2006 BCE	499	30	18	70	1.61	0	0.90	0.65	Class B2-3 Supported: Good
9/7/2007 BCE	791.5	28	18	79	2.00	0	0.79	0.58	Class B2-3 Supported: Good
9/12/2008 BCE	411.5	33.5	17.5	61	2.58	1.5	0.64	**0.39**[2]	Indeterminate for Class B2-3: Good
9/10/2009 BCE	649.5	30	18	74	3.17	0.2	0.68	0.68	Class B2-3 Supported: Good to very good
9/27/2010 BCE	439	30.5	19	80	1.94	0.6	0.75	0.56	Class B2-3 Supported: Good to very good
9/28/2011[3] BCE	320.5	28.5	17.5	69	2.01	0.4	0.83	0.45	Class B2-3 Supported: Good
9/16/2012 BCE	607.7	37.5	21.5	77.1	1.97	0	0.74	0.54	Class A1 Supported: Exc.
Annual Mean (2006-2011)	531.2	31.1	18.5	72.9	2.18	0.4	0.76	0.55	Good to very good
Annual Mean (2006-2009)	587.9	30.4	17.9	71.0	2.34	0.4	0.75	0.58	Good to very good
Class B2-3	≥300	≥27	≥16	≥45	≤4.50	≤12	≥0.45	≥0.40	

[1]high percentage of Oligochaeta in 2005 not associated with deposition (Naididae)
[2]Functional feeding group metric is dissimilar to the reference Class B2-3 community because it is critically acidified. Overall biological integrity is good.
[3]Flood event in late. August 2011 (Tropical Storm Irene)
Bold denotes value does not meet the proposed macroinvertebrate biocriteria threshold

9.0 WATER QUALITY SUMMARY

This section presents a water quality summary of the assessment streams based on field observations, biomonitoring data and water chemistry data.

9.1 West Branch of the Little River

The water quality summary for the three West Branch monitoring stations is provided in Table 15.

Table 15. West Branch of Little River Water Quality Summary (2012)

Station	Location	Category				Water Quality Concerns
		Physical	Water Chemistry	Sediment Targets	Aquatic Life Support (Class B Biocriteria	
WB8.8	Above SMR in picnic area	Good habitat	Low alkalinity	Meets all three targets	Class B203 not supported (fair to good biological integrity)	None
WB8.0 (MS-16B)	Above Mount Mansfield sedimentation basin	Fair habitat quality, hydrologic regime (stormwater improvements in 2012)	Low alkalinity and low turbidity	Meets all three targets	Class B2-3 not supported	Iron seeps
WB7.5 (MS-8)	Above Big Spruce Confluence	Hydrologic regime (stormwater improvements in 2012)	Low alkalinity and low turbidity	Meets two of three targets	Class B2-3 supported	Light iron staining; moderate silt rating
WB6.5 (MS-14)	Above Pinnacle Brook Confluence	Hydrologic regime (stormwater improvements in 2012)	Low alkalinity and low turbidity	Meets all three targets	Class B2-3 supported	Iron staining

9.2 Big Spruce Brook

Field observations, water chemistry data, and biomonitoring data provide evidence that Big Spruce is impacted by sediment (Table 16). Sources of sediment at the Big Spruce sampling stations during 2012-2013 include eroding stream banks and discharges from the Big Spruce Sediment Basin. The iron seep, located at Big Spruce Brook RM 0.3 was remediated in fall 2010, and monitoring will continue to evaluate the success of the limestone treatment. SMR is taken additional measures in 2012 to improve stormwater treatment at the Sensation Lot. The resort will continue to evaluate the effectiveness of these measures.

Table 16. Big Spruce Watershed Water Quality Summary (2012)

Station	Location	Category				Water Quality Concerns
		Physical Habitat	Water Chemistry	Sediment Targets	Aquatic Life Support (Class B Biocriteria	
BS0.3 (MS-10A)	Big Spruce upstream of Little Spruce	Hydrologic regime; Ski Club Brook channel instability	Moderate alkalinity; Big Spruce Basin outflow	Meets all three targets	Class B2-3 supported	Moderate silt; iron staining (heavy iron seep downstream of Golf Bridge)
BS0.2 (MS-10)	Big Spruce at mouth	Eroding stream banks; Hydrologic regime	Moderate alkalinity	Meets all three targets	Class B2-3 not supported	Moderate to high silt

9.3 Pinnacle Brook

The habitat survey, biomonitoring data, and water quality data for fall 2012 provide evidence that Pinnacle Brook is not being impacted by the golf course, the stump dump or the gravel pit. The lower Pinnacle Brook station met the Class B2-3 biocriteria in 2012 and has excellent biological integrity (Table 17).

Table 17. Pinnacle Brook Watershed Water Quality Summary (2011)						
Station	**Location**	**Category**				**Water Quality Concerns**
		Physical	**Water Chemistry**	**Sediment Targets**	**Aquatic Life Support (Class B Biocriteria**	
PB0.1 (MS-13)	Lower Pinnacle Brook	Stable banks, good riparian corridor	Low alkalinity	Meets all three targets	Class B2-3 supported	Critically acidified

10.0 PROPOSED 2012-2013 MONITORING

The proposed 2012 monitoring design is provided in Table 18. This proposed stations are consistent with the revised monitoring plan dated December 3, 2012

Table 18. 2012-2013 Water Quality Monitoring Stations at Stowe Mountain Resort					
Station	**Location**	**Monitoring Parameter**			
		Baseflow	**Turbidity**	**Sediment (pebble counts)**	**Biomonitoring**
WB8.8	West Branch above the resort in the picnic area	+		+	+
WB8.2	West Branch above Barnes Camp		+		
WB8.0 (MS-16B)	West Branch below Barnes Camp	+	+	+	+
WB7.5 (MS-8)	West Branch above Big Spruce	✓	✓	✓	✓
WB6.9	West Branch below snowmaking pond outlet		✓		
WB6.5 (MS-14)	West Branch above Pinnacle Brook confluence	✓		✓	✓
LT0.1	Long Trail Brook at Mansfield Entrance	X	+		
GB0.1	Gondola Brook at Mansfield Entrance	X	+		
BS0.9 (MS-9)	Big Spruce Brook below ski trails		+		
BS0.7	Big Spruce above Big Spruce Basin		+		
BS0.3 (MS-10A)	Big Spruce upstream of Club House	+	+	+	+

Table 18. 2012-2013 Water Quality Monitoring Stations at Stowe Mountain Resort					
Station	**Location**	**Monitoring Parameter**			
		Baseflow	**Turbidity**	**Sediment (pebble counts)**	**Biomonitoring**
BS0.2 (MS-10)	Big Spruce Brook at mouth	✓	✓	✓	✓
LS0.1 (MS-11)	Little Spruce Brook near mouth	X	+		
PB0.2 (MS-13)	Lower Pinnacle Brook	+		+	+
SC0.2	Upper Ski Club Brook		+		
SC0.1	Lower Ski Club Brook		+		
Outlet 1	Mansfield Basin		+		
Outlet 2	Snowmaking Pond		+		
Outlet 3	Big Spruce Basin		+		
Outlet 4	Mansfield Exit Basin		+		
Outlet 5	Upper Barnes Camp Basin Outlet[1]		+		
Outlet 6	Lower Barnes Camp Basin Outlet[1]		+		
+ - additional voluntary monitoring by Stowe Mountain Resort not required in Settlement Agreement X – Station added per request of Steve Fiske (email of October 1, 2012) [1] Basin outlet sampled only if there is a discharge to waters of the state.					

Table 19 provides a schedule of tasks and products proposed for the 2013-2104 monitoring and reporting season. 2013-2014 represents the eleventh year of monitoring during construction and is the twelfth year of monitoring since 2000 when the project was initiated.

Table 19. 2013-2014 Schedule of Tasks and Products	
Date	**Task**
June 2013-May 2014	Event-based water chemistry sampling (4 rounds (approximately one per season))
Late summer/early fall 2013	One round of base flow water chemistry sampling at 10 stations
September/October 2013	Substrate assessment (pebble counts) at biomonitoring stations
September/October 2013	Macroinvertebrate kicknet sampling/habitat survey
May 2014	Submit annual report for construction year 11

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