

Biological and Aquatic Life Use Attainment Assessment of Allen Brook

March 6, 2006



Photo: Allen Brook RM 2.4

Prepared by

Vermont Department of Environmental Conservation
Water Quality Division
Biomonitoring and Aquatic Studies Section
RA La Rosa Environmental Laboratory
103 South Main Street
Waterbury, VT
05671

Biological Assessment Summary Fact Sheet – Allen Brook

1. *Description of impaired water body*

- Allen Brook (**Figure 1**) is managed as a Class “B”, cold water fish habitat water. Allen Brook is a low to moderate gradient stream draining an extensive area of expanding urban use from formerly agricultural lands. It is located entirely in the Town of Williston, and is currently listed as non-support for Aquatic Life Use (impaired) over a portion that extends over 6.6 miles of stream, from river mile (RM) 1.0 to river mile 7.6. As a result of an evaluation of increased longitudinal biological monitoring by the Vermont Department of Environmental Conservation (VTDEC) and the Vermont Agency of Transportation (VTRANS) conducted from 2002-2005 and in conjunction with a more accurate adjustment of measured stream miles and completed land use mapping, VTDEC is proposing to revise the portion of Allen Brook is found to be non-supporting for Aquatic Life Use. The proposed revision identifies the reach from RM 1.0 to mile 5.0, a distance of 4 miles, as non-support for Aquatic Life Use. Monitoring data confirm that Allen Brook upstream of RM 5.0 is currently supporting Aquatic Life Uses.

2. *Description of Data used to characterize impairment.*

- Fish community – From 1987-2005, VTDEC conducted 10 fish community assessments from 6 sites within the stream section designated as impaired. Aquatec Biological Sciences (ABS) conducted 16 assessments at 4 sites from 2002-2005 within the impaired reach for VTRANS. Both VTDEC and ABS fish community assessments in the impaired reach from all years show 6 *poor* ratings, 11 *fair* ratings, and 9 *good* ratings. With the exception of a 1989 *fair* assessment at RM 7.6, all *fair* and *poor* ratings have been between RM 2.4 and 4.6. All fish community assessments from RM 6.0 and 6.5 (2002-2005) were rated *good*.
- Macroinvertebrates – VTDEC has conducted 8 macroinvertebrate community assessments at 4 sites within the stream section designated as impaired. Additional assessments were conducted by Aquatec Biological Sciences (ABS) for VTRANS, and approved by VTDEC in 2002, 2003, 2004 and 2005 at 4 sites. VTDEC and ABS macroinvertebrate community assessments are represented by 4 *fair* ratings, 3 *good-fair* ratings, 10 *good* ratings, 9 *Vg-good* ratings, and 1 *Excellent* rating. All 3 *fair* ratings since 1999 have been at site RM 4.3. RM 2.4 has been rated as *good* or better since 1999 when it was last rated as *fair*. All macroinvertebrate community assessments from RM 6.0, 6.5, and 8.2 have been rated good or better with exception of one g-fair rating at RM 6.0 in 2002.

3. *Stressor Identification:*

- Assessment of the characteristics of the biological communities and physical habitat implicates stormwater as the primary stressor. Specifically, stormwater components related to hydrological modification, sediment discharge and nutrient enrichment appear to be the most significant contributors to the observed impairment.

4. *Summary statement - overall “weight-of-evidence” summary of findings:*

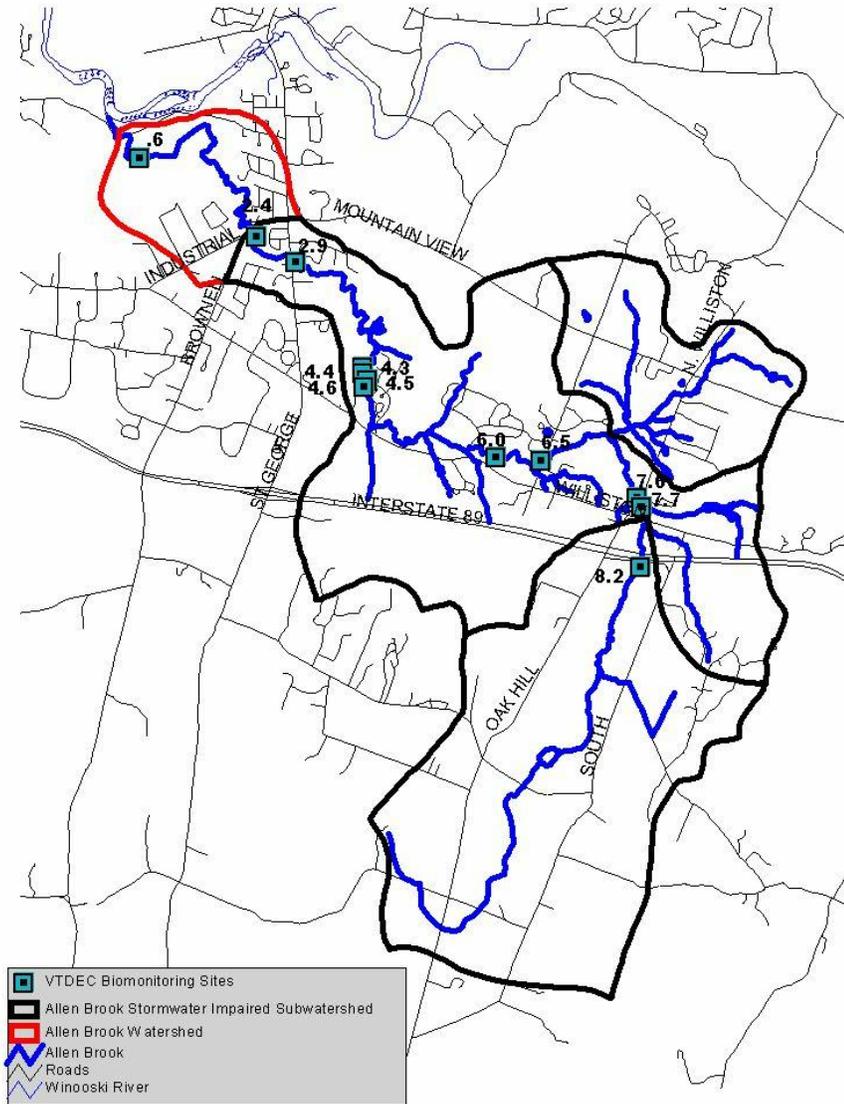
- The data indicate that the level of impairment is relatively moderate and is defined primarily by certain characteristics of the fish community at sites RM 2.4, 2.9, and 4.3. Impairment status is confirmed by data gathered within the last five years at these sites. Below criteria findings were also noted at RM 4.6 and 7.6, though both sites were sampled in 1989. Macroinvertebrate community characteristics showed *fair* condition at RM 4.3 in 2002, 2003, and 2005. The macroinvertebrate community characteristics have indicated *good* condition at RM 2.4 since 1999.

5. *Recommended biological assessment needs:*

- Biomonitoring should continue at several key reaches of stream that are likely to respond to watershed improvements. In order to continue evaluating long-term biological condition and response to the stormwater hydrologic TMDL management planned in the watershed, it is recommended that priority be given to monitoring

sites 2.4 (a more representative site than the historic 2.9 site) and 4.3 located within the impaired 4 mile reach, and RM 6.5, upstream of the impaired reach.

Figure 1: Approximate locations of biomonitoring sites within the Allen Brook Watershed.



Discussion of Biological Assessment Results

Description of Impaired Waterbody

The portion of Allen Brook between river miles (RM) 1.0 and 5.0 has been identified (draft 2006 303(d) list of impaired waters) by the State of Vermont as impaired pursuant to the Clean Water Act, Section 303(d). The primary impairment is a failure to support Aquatic Life Uses (ALUs) of Vermont Class B Water Quality Standards. **Table 1 and Figure 1** list the locations of the biomonitoring sites and show the approximate locations of these sites respectively.

Table 1: Biomonitoring sites locations and watershed parameters on Allen Brook in Williston Vt. for Fish and/or Macroinvertebrate assessments, including Water Quality, and Habitat measure.

Site (RM)	Community	Description	Latitude	Longitude	Elev ft	D.A. Km ²
0.6	F	At Phase 1 Griswold Farm section	442813	730801	210	37.6
2.4	MF	Just upstream of Industrial Avenue crossing.	442749	730703	300	35.2
2.9	MF	Located approx. 20m above Rt2A.	442741	730645	361	34.8
4.3	MF	Located adjacent to Allen Brook Lane, approx.170m below the lower Talcott Road Crossing	442704	730609	374	25.5
4.6	F	Located 10m above the lower Talcott Road crossing.	442656	730612	374	25.3
6	MF	Located above McMullen Lane cul-de-sac, into wooded area.	442633	730509	390	20.2
6.5	MF	Located 50m below Old Stage Road crossing near Brookside Drive	442633	730447	420	19.6
7.6	MF	Located 10m below N.Williston Road bridge.	442620	730401	479	13.4
8.2	MF	Located above South Road culvert (above I-89)	442558	730401	518	10.1

Land use within the impaired segment of the watershed is currently exhibiting a trend of conversion from agricultural use to residential and commercial use. The upper portion of the watershed is predominately comprised of light agriculture and forest. The remaining mid and lower reaches are progressively urbanized in a downstream direction.

The current report makes corrections to previously designated river mile descriptions. The impaired reach was previously described as 5.5 miles in length from RM 1.0 to RM 6.5. Recalculation of river miles show that the site previously described as RM 6.5 is actually RM 7.6 based on coordinate location and re-measurement of RM distance. RM designations for all sites on Allen Brook have been corrected (**Table 1 and Figure 1**).

Delineation of the upper and lower boundaries of the impaired reach **Table 2** is based the information below. Fish community data from RM 0.6 show three years of data indicating *good* biological condition and meeting applicable ALUs. Fish and macroinvertebrate data collected since 2002 at RM 6.0 and RM 6.5 on seven occasions showed a *good* condition. In 2002 both sites were rated as *fair-good* condition. Additionally, macroinvertebrate data at RM 8.2 rated *good* to *excellent* on four occasions. The watershed at this headwater location is primarily forested and agriculture, with relatively little urban landuse. Fish data at RM 2.4 and fish and macroinvertebrate data at RM 4.3 continue to show *fair* biological conditions not meeting applicable Aquatic Life Uses. These data, in conjunction with information about land use and stream gradient data suggest that the lower extent of the impaired reach be designated at RM 1.0 and the upper extent of the impaired reach be designated at RM 5.0, just upstream of the upper Talcott Road crossing.

Table 2: Biomonitoring sites location and overall Aquatic Life Use Support (ALUS) assessment for the fish and/or macroinvertebrate community, by site and year, on Allen Brook. All data either collected by VTDEC or collected by another party*, submitted and approved by VTDEC.

Site (RM)	Date	Overall ALS determination	Fish Assessment	Macroinvertebrates Assessment	
0.6	9/24/1997	Good	Good	-	
	8/28/1998	Good	Good	-	
	10/17/2000	Good	Good	-	
2.4	10/12/1999	Fair	-	Fair	
	10/5/2000	Good	-	Good	
	10/21/2002 *	Poor	Poor	Good	
	10/4/2003*	Poor	Poor	Vg-Good	
	9/5/2003	Poor	Poor	Good	
	10/13/2004*	Fair	Fair	G-Fair	
	10/4/2005	Fair	Fair	Good	
2.9	8/17/1987	Poor	Poor		
	8/21/1991	Poor	Poor	Good	
4.3	10/12/1999	Fair	Fair		
	10/22/2002*	Fair	Fair	Fair	
	9/5/2003	Fair	Fair	Fair	
	10/4/2003*	Fair	Fair	Vg-Good	
	10/13/2004*	Fair	Fair	Good	
	10/4/2005	Fair	Fair	Fair	
4.6	8/17/1989	Fair	Fair	-	
	10/22/2002*	G-Fair	Good	G-Fair	
	10/4/2003*	Good	Good	Vg -Good	
	10/13/2004*	Good	Good	Good	
	10/12/2005*	Good	Good	Vg -Good	
	6.5	10/22/2002*	G-Fair	Good	G-Fair
		10/4/2003*	Good	Good	Vg- Good
10/13/2004*		Good	Good	Vg Good	
10/6/2005		Good	Good	Vg-Good	
10/12/2005*		Good	Good	Vg- Good	
7.6	8/7/1989	Fair	Fair	-	
8.2	9/5/1992	Vg- Good	NA	Vg-Good	
	10/11/1995	Vg-Good	NA	Vg-Good	
	10/5/2000	Excellent	-	Excellent	
	10/4/2005	Good	-	Good	

Methods

VTDEC uses standard protocols for assessing the biological condition of stream sites. Segments of Allen Brook containing a mix of pools, runs and riffles were targeted for the purposes of biological community assessments. For the purposes of macroinvertebrate community assessments, the sampled segments are designated as Warm Water Moderate Gradient (WWMG) wadeable macroinvertebrate stream type. Fish community assessments were carried out using the Mixed Water Index of Biotic Integrity (MWIBI).

The MWIBI requires a minimum of five species of native fish in order to be reliably calculated. Sampling guidelines require that the section of sampled stream exhibit a representative mix of habitat types found in the stream. Macroinvertebrate community data was assessed using threshold criteria developed for WWMG wadeable streams in Vermont. Analyses of data from reference streams throughout Vermont indicate that streams within the Champlain Valley are appropriately evaluated using this model.

Discussion of Data

Fish Community - Fish community IBI and metrics are presented in **Table 3**. The fish community at river mile 8.2 has not been assigned a condition description due to too few species present (2-3) for application of the MWIBI. At RM 7.6, a little more than a half-mile downstream, seven species were collected. The healthy condition of the macroinvertebrate community as well as best professional judgment of habitat conditions at RM 8.2 suggest that the low fish species richness is a result of natural conditions and not watershed disturbance.

From 1987 to 1991, the fish community was assessed four times at three sites, resulting in the designation of the reach between RM 1.0-7.6 as impaired. Two evaluations at RM 2.9 were *poor* and one evaluation each at RM 4.6 and RM 7.6 were *fair*. Three sites (RM 4.4, 4.5, and 6.5) were not rated due to habitat and sampling effort limitations, specifically: the length of segment sampled was shorter than required by Department protocols; and the habitat diversity requirement for representative sampling was not met.

Between 1999 and 2005, VTDEC and Aquatech Biological Sciences (ABS) sampled and assessed four sites (RM 2.4, 4.3, 6.0, and 6.5) a total of 22 times. MWIBI scores from RM 2.4 and 4.3 ranged from 25-29 indicating *poor* to *fair* biological integrity and failing to support Aquatic Life Uses for Class B waters. Data from RM 6.0 and 6.5, however, showed *good* ratings, with MWIBI values ranging from 31-35, indicating support of Class B Aquatic Life Uses.

At Allen Brook sites that scored *fair* or *poor*, community stress was indicated by the dominance of tolerant and generalist species (primarily creek chub and white sucker) and an absence of intolerant species. Additionally, there was only scant representation by specialist feeders (benthic insectivore species), i.e., tessellated darter and longnose dace.

Macroinvertebrate community- Macroinvertebrate community metrics and assessment determinations are presented in **Table 4**. From 1991-2000, the macroinvertebrate community was assessed at three sites: RM 2.4, 2.9, and 8.2. The uppermost location RM 8.2 was determined to be in *Vg-good* condition, and site RM 2.9 *good* condition. The lowest site at RM 2.4 was assessed as *fair* in 1999, and *good* in 2000.

The most recent macroinvertebrate community monitoring conducted by VTDEC and Aquatech Biological Sciences (ABS) occurred in 2002, 2003, 2004 and 2005 at four sites: RM 2.4, 4.3, 6.0, and 6.5. The uppermost site, RM 8.2, was sampled in 2000 and 2005 with assessment results of *excellent* and *good* respectively. This site supports a diverse macroinvertebrate community. The community is moderate to low in density, but high in both total taxa richness and EPT (mayflies, stoneflies, and caddisflies) taxa richness. The 2005 data do show a decrease in both these metrics. The densities of tolerant Diptera *Chironomidae* and *Oligochaeta* have been low with EPT species dominating the community. The Bio Index has been consistently in the *very good* to *excellent* range indicating organic/nutrient enrichment is not a significant influence on the macroinvertebrate community at RM 8.2.

Assessments in 2002, 2003, 2004 and 2005 at the next two sites moving downstream (RM 6.5 and 6.0) have consistently been rated as *very good* or *vg-good* since 2002. The community metrics at both these sites, that are located only 0.5 miles apart, have always been very similar. Compared to the upper site (RM 8.2), the density, richness and bio - index all increase significantly, while the number of EPT and the ratio of EPT /EPT plus Chironomidae (EPT/EPTc) do not change significantly. These changes generally indicate slight organic enrichment stress from sediment and nutrients. The orders Diptera or Trichoptera or Plecoptera are dominant (**Table 5**) from one year to the next. The dominant taxa in these orders are reflected in an increase in collector and or shredder - herbivores, evident in the functional group composition (**Table 6**) at these two sites.

Annual macroinvertebrate assessments in 2002, 2003, 2004 and 2005 at RM 4.3 have consistently received the lowest macroinvertebrate assessment ratings of all the sites on Allen Brook. The site has scored *fair* on three occasions, *good*

twice and *vg-good* once. The density has been variable at this site ranging from high >4,500 to moderate +1,000. Taxa richness has been high usually > 40, but EPT richness has often been below expectations <16 and the major reason for the *fair* ratings. The Bio Index has been consistently elevated compared to the above sites, increasing consistently to above 5.00 on most occasions, indicating a general increase in the moderately tolerant taxa in the orders Diptera or Trichoptera (**Table 5**) at the site. The functional group composition (**Table 6**) shows a dominance of collector filterers at the site. This indicates an increase in the fine particulate organic matter as a food source at this site compared to sites above it.

The lowest site where VTDEC has assessed the macroinvertebrate community (RM 2.4) has consistently had a high density of animals (3400-5100/kn) and a relatively high Bio Index value (always over 5.00 except for one sample event 2002). In most years the richness and EPT taxa numbers have also been in the higher range of values for the WWMG streams. This combination of metric values generally indicates that organic enrichment is altering the macroinvertebrate community composition. In 1999 this resulted in a community rating of *fair*. In subsequent years thru 2005, a total of six assessments, conditions seem to have improved slightly at RM 2.4 with five *good* and one *Vg-good* macroinvertebrate bioassessment rating. There is continued evidence of enrichment as evidenced by the functional group composition (**Table 6**), with either the percent algae shredders or scrapers often elevated.

A number of freshwater mussel species including two uncommon species are present in Allen Brook. At site RM 2.4 the Creek Heelsplitter, *Lasmigona compressa*, and the Triangle Floater, *Alasmidonta undulate*, have been observed on all visits. Several live Creek Heelsplitters were observed, but only fresh shells of the Triangle Floater have ever been found. At RM 4.3, fresh shells of both species were observed in 2005.

Habitat observations and water quality measures - **Tables 7 and 8** are a compilation of selected habitat observations and water quality data respectively collected at all Allen Brook biomonitoring sites sampled by VTDEC. Habitat observations show a general trend of decreased canopy cover from the uppermost to lowest site. The silt rating, embeddedness, and percent sand within the riffle macroinvertebrate habitat all generally increase at the downstream sites, with RM 2.4 and 4.3 receiving high silt and fair embeddedness rating some years. In 2005, a macro algae (filamentous green) percent cover score shows an increase in macroalgae cover at the sites moving in a downstream direction. The uppermost site RM 8.2 scored 0 (range 0-100) or no macroalgae present. The mid site (RM 6.5) scored 25 and the two lowest sites (RM 4.3 and 2.4) both scored about 40.

Water quality measures have been collected mostly at the time of bioassessment. In 2005, numerous water quality measures were collected at RM 4.3, the site with the consistently lowest biological condition ratings. The stream is moderately alkaline with an alkalinity generally greater than 100 mg/l. The pH generally ranges from 7.3 to 8.3.

Conductivity is moderate generally near 300 even at the upper site RM 8.2. At RM 4.3, where numerous measurements were made in 2005, the conductivity exceeded 900 umhos/cm on several occasions. The high conductivities were all associated with increases in chloride and sodium, indicating a connection to road salt influences in the watershed.

Turbidity was rarely observed to exceed the cold water 10 NTU criterion even during most freshet events. Only one value exceeded the 10 NTU criterion (19.2 NTU) during a freshet event in June 2005. Turbidity has, however, always been slightly elevated even during base flow samplings. For example, at RM 4.3 in 2005, base flow and freshet turbidity averaged 2.85 (range 0.74-9.3) and 6.44 (range 2.5-19.2) NTU respectively.

Dissolved phosphorus at RM 4.3 in 2005, with a total of 16 observations, averaged 18 ug/l (range 13-24) and 35 ug/l (range 20-48) during base and freshet flows respectively.

The above habitat observations and water quality data generally indicate elevated levels of sediment and associated nutrients, as well as other stressors such as chloride. These stressors are generally associated with impervious surfaces and stormwater within a watershed.

Confidence in the implications of the data

The Department is highly confident that the 4-mile segment of Allen Brook between RM 1.0 and 5.0 currently proposed for 303(d) listing as impaired is indeed impaired for Aquatic Life Uses. Historical and current data confirm *poor-fair* fish community condition between river miles 2.4 and 2.9. An appropriate reference condition exists for the habitat type of this section allowing an IBI to be appropriately applied. Similarly, for macroinvertebrates, the habitat of the three sampled sites is consistent with the reference model used to evaluate population data.

Stressor Identification

VTDEC has relied primarily on biological inference to identify the stressors that are the most likely significant contributors to the observed impairments. Assessment of the characteristics of the biological communities and physical habitat provide a strong inference that habitat alteration related to sediment discharge and hydrologic modifications related to stormwater are significant contributors to the observed impairments. It is likely, given the level of activity in the watershed, as well as the complexity and diversity of the landscape in the Allen Brook watershed, that factors other than “sediment” (e.g. nutrients and hydrology) contribute to the impacts as well. Because of the lack of steady-state point discharges in the Allen Brook watershed, it is highly likely that contributing stressors originate from event-based discharges. DEC has identified sediment as the primary stressor of concern and is most likely the principal cause of impairments. The strategy of identifying a single pollutant has been done for the purpose of developing identifiable targets for management action. It is presumed that managing the Allen Brook watershed for sediment discharge will also result in the management of co-related potential stressors, including hydrology and nutrients.

Future watershed management actions resulting from TMDL development are expected to result in improved biologic condition. Geomorphologic adjustments in response to management actions may have a significant effect on the time needed to affect a full recovery of the biological communities in Allen Brook. Given the moderate nature of the observed impairment, there is reasonable assurance that aggressive stormwater control management will result in the restoration of aquatic life uses.

Summary Statement Overall Weight of Evidence

Biological assessment data for Allen Brook provide the basis for impairment designation of 4 miles of Allen Brook between RM 1.0 and 5.0. These data are of high quality and demonstrate a pattern of impairment over time and space. The data indicate that the level of impairment is relatively moderate and is defined primarily by certain characteristics of the fish community characterized at sites RM 2.4, 2.9 and 4.3, with positive but less compelling evidence of impairment from the macroinvertebrate community characteristics at RM 4.3.

Recommended monitoring

Biomonitoring should continue at several key stream reaches that have shown impaired biological communities in past years and improved condition in recent years. It is recommended that priority be given to continue monitoring sites RM 2.4 (a more representative site than the historic RM 2.9 site), RM 4.3, and RM 6.5 to continue evaluating their long-term biological condition and response to storm-water management implementation planned in the watershed. Although the lowest site RM 0.6 has been assessed as good, it should also be evaluated periodically. An additional monitoring site between RM 0.6 and RM 2.4 would help to further delineate the lower boundaries of the impaired reach. The fish assemblage at RM 7.6 should be sampled because of its low score in 1989. Conditions there may have improved to bring it more in line with the *good* conditions observed at RM 6.5. The uppermost site, RM 8.2, which has been used as a reference site, should be assessed on a periodic basis to evaluate long-term variability in biological condition.

Table 3: Fish community metrics from stations on Allen Brook. Samples collected by DEC unless as noted by Aquatec Biological Services (ABS). Data in *Italics* could not be scored for the MWIBI. Dates with asterisks were data sampled by Aquatec Biological Services (ABS). Bolded IBI values do not meet Class B Aquatic Life Use Support Biocriteria threshold.

Site	Date	IBI	Richness	Intol Species	Benthic Insect	% CC&WS	% GenFeed	% Insect	% TCarnivore	% Anomolie	Density / 100m2
0.6	9/24/1997	31	13	0	2	19.5	45.0	53.0	2.0	0.2	136.6
	8/28/1998	35	16	1	2	12.6	49.7	50.3	0.0	0.8	93.4
	10/17/2000	31	15	1	1	17.7	73.6	25.9	0.5	0.3	139.7
2.4	10/22/2002*	25	6	0	1	19.8	71.6	28.5	0.0	0.0	38.7
	9/5/2003	25	9	0	2	72.6	81.0	19.0	0.0	0.9	50.2
	10/4/2003*	25	8	0	2	36.5	67.8	32.2	0.0	0.0	111.0
	10/13/2004*	27	7	0	2	39.1	45.8	54.2	0.0	0.0	56.3
	10/4/2005	27	8	0	2	32.9	48.4	51.6	0.0	0.0	179.4
	10/12/2005*	29	7	0	1	27.1	37.7	62.4	0.0	0.0	61.8
2.9	8/17/1987	23	7	0	2	39.8	64.9	35.1	0.0	0.0	58.0
	8/21/1991	25	7	0	2	57.4	65.1	34.9	0.0	0.0	96.9
4.3	10/12/1999	29	10	0	2	8.8	77.4	22.6	0.0	0.3	202.4
	10/22/2002*	29	9	0	2	27.2	76.1	23.9	0.0	0.0	30.7
	9/5/2003	29	8	0	2	23.0	48.3	51.7	0.0	1.9	78.5
	10/4/2003*	29	8	0	2	9.6	76.4	23.6	0.0	0.0	67.8
	10/13/2004*	27	8	0	2	26.9	65.7	34.3	0.0	0.0	60.5
	10/6/2005	27	8	0	2	21.6	64.1	35.9	0.0	0.4	223.4
	10/12/2005*	27	8	0	2	21.7	83.5	16.5	0.0	0.0	48.5
4.6	8/17/1989	27	8	0	2	36.9	76.0	24.0	0.0	3.0	207.6
6	10/22/2002*	35	9	0	2	16.5	46.1	53.9	0.0	0.0	38.3
	10/4/2003*	35	9	0	2	34.5	39.2	60.8	0.0	0.0	105.8
	10/13/2004*	31	9	0	2	20.0	29.7	70.3	0.0	0.0	48.8
	10/12/2005*	33	8	0	2	25.4	37.6	61.9	0.5	0.0	47.3
6.5	8/7/1989	35	7	0	2	8.2	27.7	72.3	0.0	0.0	802.1
	10/4/2003*	31	6	0	2	25.7	31.6	68.4	0.0	0.0	80.8
	10/22/2002*	35	8	0	2	15.0	43.4	56.6	0.0	0.0	37.7
	10/13/2004*	33	8	0	2	15.6	29.8	70.2	0.0	0.0	54.5
	10/6/2005	35	7	0	2	11.6	24.2	75.8	0.0	0.0	189.6
	10/12/2005*	33	6	0	2	21.9	38.4	61.6	0.0	0.0	37.8
7.6	8/7/1989	29	7	0	1	45.4	55.4	41.3	3.3	0.0	268.8
8.2	8/7/1989		2	0	0	<i>10.4</i>	<i>10.4</i>	<i>89.6</i>	<i>0.0</i>	<i>0.0</i>	<i>98.8</i>
	9/5/1992		3	0	0	28.5	28.5	71.5	0.0	2.0	203.3

Table 4: The macroinvertebrate community assessment, and metrics from sites on Allen Brook, Williston Vt. The Bolded fair assessments do not meet Class B Aquatic Life Use Support Biocriteria threshold. * indicates data collected by Aquatic Biological Sciences (ABS) and accepted by VTDEC.

Site	Date	Assessment	Density	Richness	Ept	PMA O	BI	% Oligochaeta	Ept /EptC	PPCS F
2.4	10/12/1999	Fair	3990	42.0	16.0	67.2	5.69	0.0	0.52	0.50
	10/5/2000	Good	5594	51.0	24.0	64.5	5.33	0.0	0.75	0.42
	10/21/2002*	Good*	3704	49.0	16.0	69.3	4.21	0.2	0.74	0.55
	9/5/2003	Good	3470	51.0	19.0	61.5	5.16	0.0	0.75	0.51
	10/4/2003*	Vg-Good*	3652	63.0	22.0	82.3	5.19	1.9	0.78	0.77
	10/13/2004	G-Fair	1244	38.0	16.0	54.8	4.78	0.0	0.42	0.49
	10/4/2005	Good	5164	52.5	22.0	66.5	4.97	0.0	0.86	0.48
10/12/2005*	Good*	3828	57.0	24.0	68.4	5.40	0.0	0.59	0.51	
2.9	8/21/1991	Good	3010	44.0	17.5	68.7	4.84	0.0	0.79	0.51
4.3	10/21/2002*	Fair*	3672	48.0	14.0	56.6	4.48	1.2	0.53	0.59
	9/5/2003	Fair	1524	35.0	10.0	61.7	5.42	0.0	0.64	0.55
	10/4/2003*	Vg-Good*	2464	62.0	19.0	66.1	5.10	0.8	0.62	0.66
	10/13/2004	Good	582	40.0	16.0	54.3	4.91	0.3	0.51	0.49
	10/4/2005	Fair	4568	31.0	12.5	51.5	5.38	0.0	0.87	0.30
	10/12/2005*	Good*	1298	40.0	16.0	72.5	5.00	0.0	0.73	0.66
6.0	10/21/2002*	G-Fair*	4752	69.0	23.0	42.3	4.04	0.1	0.64	0.39
	10/4/2003*	Vgood*	3856	56.0	19.0	64.4	4.16	0.2	0.76	0.54
	10/13/2004	Good	1804	35.0	19.0	44.4	3.00	0.0	0.51	0.44
	10/12/2005*	Vgood*	925	54.0	18.0	69.2	4.21	0.0	0.62	0.67
6.5	10/21/2002*	G-Fair*	5176	67.0	19.0	40.2	4.48	1.4	0.71	0.41
	10/4/2003*	Vgood*	2356	45.0	18.0	60.5	3.73	0.5	0.79	0.51
	10/13/2004	VGood	1034	47.0	24.0	55.3	3.77	0.0	0.67	0.52
	10/6/2005	Vg-Good	1044	40.0	18.0	69.9	4.30	0.3	0.84	0.67
	10/12/2005*	Vgood*	1464	52.0	23.0	67.9	4.74	0.3	0.56	0.64
8.2	9/5/1992	Vgood	1184	47.0	19.5	68.6	3.98	0.1	0.62	0.59
	10/11/1995	Vg-Good	936	40.0	19.0	69.6	3.22	1.0	0.93	0.62
	10/5/2000	Exc	1836	51.5	22.5	74.6	3.12	0.6	0.87	0.67
	10/4/2005	Good	1402	37.0	17.0	70.4	3.25	0.2	0.85	0.65

Table 5: Percent composition of individuals from macroinvertebrate taxonomic orders from sites on Allen Brook by site and date.

Site	Date	Coleoptera%	Diptera%	Ephemeroptera%	Plecoptera%	Trichoptera%	Oligochaeta%
2.4	10/12/1999	10.6	43.8	12.4	10.5	22.2	0.0
	10/5/2000	4.2	26.9	8.0	14.2	46.6	0.0
	10/21/2002*	9.5	24.9	15.4	26.2	22.1	0.2
	9/5/2003	16.9	25.8	3.7	0.9	52.0	0.0
	10/4/2003*	21.0	19.8	17.9	9.0	29.5	1.9
	10/13/2004*	5.8	56.6	7.8	10.7	18.8	0.0
	10/4/2005	6.6	19.7	7.1	7.9	58.2	0.0
	10/12/2005*	4.0	41.4	37.5	3.2	13.2	0.0
2.9	8/21/1991	19.5	17.6	11.4	0.3	49.6	0.0
4.3	10/21/2002*	7.8	45.0	7.0	19.2	18.7	1.2
	9/5/2003	18.1	32.0	3.9	0.8	44.4	0.0
	10/4/2003*	15.7	34.7	6.3	1.9	38.0	0.8
	10/13/2004*	3.1	50.7	6.2	17.2	22.4	0.3
	10/4/2005	5.4	15.8	0.8	0.3	77.5	0.0
	10/12/2005*	7.6	28.8	12.0	8.0	43.6	0.0
6	10/21/2002*	7.8	37.7	7.1	40.7	5.3	0.1
	10/4/2003*	11.8	25.2	3.4	31.7	27.0	0.2
	10/13/2004*	2.3	53.0	6.0	23.2	15.4	0.0
	10/12/2005*	12.4	37.8	4.6	14.4	30.5	0.0
6.5	10/21/2002*	2.4	30.4	7.6	50.4	7.2	1.4
	10/4/2003*	12.2	23.4	8.8	36.0	17.1	0.5
	10/13/2004*	1.0	39.0	11.5	28.0	20.4	0.0
	10/6/2005	19.3	16.1	5.5	7.2	50.9	0.3
	10/12/2005*	5.2	43.4	14.2	9.6	26.2	0.3
8.2	9/5/1992	22.0	31.1	7.0	4.5	34.0	0.1
	10/11/1995	17.6	8.7	8.0	28.2	31.1	1.0
	10/5/2000	6.6	16.4	17.4	15.3	38.0	0.6
	10/4/2005	20.5	16.4	5.1	15.9	41.1	0.2

Table 6: Percent composition of macroinvertebrate functional feeding guilds from sites on Allen Brook by site and date.

Site	Date	CGatherer%	CFilterer%	Predator%	ShredDetritus%	ShredHerbivore%	Scraper%
2.4	10/12/1999	26.3	20.4	2.3	0.5	33.4	14.2
	10/5/2000	16.5	44.1	2.7	0.0	26.3	8.2
	10/21/2002*	24.4	21.2	13.4	22.7	3.0	13.3
	9/5/2003	14.5	55.1	5.3	0.3	0.6	22.9
	10/4/2003*	22.7	29.6	12.7	4.2	4.6	23.3
	10/13/2004*	43.7	23.6	13.3	0.6	8.4	6.5
	10/4/2005	11.1	62.0	5.9	0.1	9.7	9.8
	10/12/2005*	12.5	22.2	21.8	0.0	5.2	36.1
2.9	8/21/1991	17.0	38.1	4.8	0.0	0.4	37.3
4.3	10/21/2002*	28.4	23.6	10.0	19.2	4.2	9.5
	9/5/2003	26.0	50.7	2.6	0.5	1.6	17.8
	10/4/2003*	20.1	40.9	13.5	0.5	2.8	17.9
	10/13/2004*	25.2	23.4	21.0	10.7	12.8	6.6
	10/4/2005	10.8	79.1	2.2	0.0	1.3	6.1
	10/12/2005*	12.5	47.5	8.0	7.7	4.0	14.9
6	10/21/2002*	24.0	8.3	14.7	20.0	18.4	8.7
	10/4/2003*	15.6	27.0	13.2	4.0	25.8	11.9
	10/13/2004*	51.1	14.9	24.1	0.2	5.5	3.2
	10/12/2005*	28.5	28.0	16.1	4.6	4.6	15.0
6.5	10/21/2002*	21.3	7.4	10.7	35.9	14.1	5.3
	10/4/2003*	12.6	15.3	19.5	2.5	28.4	16.1
	10/13/2004*	28.4	22.9	7.4	8.5	23.1	4.7
	10/6/2005	13.5	48.9	10.1	0.0	5.2	22.1
	10/12/2005*	29.8	27.9	14.8	3.0	9.0	14.2
8.2	9/5/1992	25.9	31.9	9.6	0.5	0.2	30.8
	10/11/1995	9.6	26.3	13.1	18.6	4.5	21.2
	10/5/2000	22.8	31.0	15.9	1.2	4.6	17.4
	10/4/2005	15.6	38.4	11.0	0.5	11.0	23.5

Table 7 Habitat observations collected at the time as VTDEC macroinvertebrate collections on Allen Brook. Silt rating H-high , M-moderate, L-low. Substrate composition in italics is observational only.

Site	Date	% Canopy	Silt Rating	Embeddedness rating	% Sand	% Gravel	% CGravel	% Cobble	% Boulder	% Ledge	wt ave 0-100 Macro Algae
2.4	10/12/1999	50	m	Good	<i>10</i>	<i>25</i>	<i>37</i>	<i>25</i>	<i>3</i>	0	
2.4	10/5/2000	40	h	Vgood	14	34	25	31	3	0	
2.4	9/5/2003	50		Fair	14	25	27	18	9	7	22
2.4	10/4/2005	40	m	Good	5	21	36	30	7	0	41
2.9	8/21/1991	50	m	Fair	<i>10</i>	<i>15</i>	<i>25</i>	<i>25</i>	<i>15</i>	0	
4.3	9/5/2003	40	l	Fair	6	15	28	32	19	0	26
4.3	10/4/2005	70	h	Good	3	13	30	45	9	0	39
6.5	10/6/2005	90	m	Good	3	8	29	37	23	0	25
8.2	9/5/1992	50		Good	<i>5</i>	<i>20</i>	<i>20</i>	<i>35</i>	<i>10</i>	0	
8.2	10/11/1995	60	m	Good	<i>5</i>	<i>15</i>	<i>20</i>	<i>25</i>	<i>35</i>	0	
8.2	10/5/2000	80		Vgood	<i>5</i>	<i>15</i>	<i>20</i>	<i>25</i>	<i>35</i>	0	
8.2	10/4/2005	80	l	Good	4	14	27	40	15	0	0

Table 8: Water chemistry parameters for Allen Brook. RM = river mile. See end of table for parameter abbreviations.

Site (RM)	Date	Color Pt Co units	Water Temperature ° C	Dissolved Oxygen mg/l	Dissolved Oxygen % Saturation
2.4	10/12/1999	40	8.0		
2.4	10/5/2000	40	10.0		
2.4	9/5/2003		16.9	9.64	100.6
2.4	8/26/2004	12	18.5	9.49	101.8
2.4	10/4/2005	30	15.0	9.15	90.5
2.9	8/17/1987		23.0		
2.9	8/21/1991		19.0		
2.9	8/21/1991		19.0		
2.9	8/21/1991		20.0		
4.3	10/12/1999		9.0		
4.3	9/5/2003		19.4	7.42	79.8
4.3	6/15/2005		19.8	7.24	82.6
4.3	6/30/2005		20.6	7.72	87.3
4.3	7/6/2005		19.7	7.95	88.1
4.3	7/22/2005		24.0		
4.3	7/22/2005		24.0		
4.3	7/27/2005		21.5	6.51	57.6
4.3	8/9/2005		24.5	7.37	88.9
4.3	8/29/2005		21.5		
4.3	8/29/2005		21.5	6.58	78.0
4.3	9/19/2005		15.9	9.10	92.6
4.3	9/19/2005		15.9	9.10	92.6
4.3	9/27/2005		16.4	10.00	104
4.3	10/11/2005		13.0	8.90	83.5
4.3	10/21/2005		8.8	9.07	74.1
4.3	11/7/2005		9.6	10.34	91.8
4.3	11/14/2005		7.9	12.33	105
4.3	11/23/2005		1.5	4.43	32.3
4.3	12/12/2005		0		
4.5	9/8/2004	33	17.8	8.29	87.7
8.2	9/5/1992		14.0		
8.2	8/31/1994		14.0		
8.2	10/5/2000	40	9.5		
8.2	10/4/2005	45	18.7	9.25	97.5

Table 8 continued

Site (RM)	SampleDate	pH std.units	Alk mg/l	Cond μ mhos/cm	Cl mg/l	Na mg/l	K mg/l	TSO4 mg/l	Ca mg/l	Mg mg/l	THC mg/l
2.4	10/12/1999		129	758							
2.4	10/5/2000	7.99	151	579							
2.4	9/5/2003	8.03	145	710	131	73.4	2.86	18.0	51.1	14.6	
2.4	8/26/2004	8.36	154	548	74.3	46.7	2.23	10.6	48.1	11.5	167
2.4	10/4/2005	8.39	124	550	85.4	48.0	2.93	14.7	41.1	10.1	144
2.9	8/17/1987	7.93	145	432						22.4	
2.9	8/21/1991	8.11	125	185						14.0	
2.9	8/21/1991			280						6.45	
2.9	8/21/1991			280						8.12	
4.3	10/12/1999									13.3	
4.3	9/5/2003	7.90	199	949	198	95.0	3.55	17.1	71.4	13.3	
4.3	6/15/2005	7.89	150	745	130	79.8	2.74	10.8	58.6	12.3	
4.3	6/30/2005	7.56		379	58.4	34.7	3.11	12.6	27.8	9.56	
4.3	7/6/2005	7.94	108	477	77.5	48.4	3.27	10.9	38.1	15.6	
4.3	7/22/2005		159	588	114	60.5	2.59	11.6	52.8	15.7	
4.3	7/22/2005		156		108	57.1	2.57	11.8	49.3	5.65	
4.3	7/27/2005	7.70	138	998	181	101	2.79	13.1	49.3	5.71	
4.3	8/9/2005	7.67	126	473	65.8	37.1	2.21	7.42	39.6	7.82	
4.3	8/29/2005		149		128	65.2	2.94	15.0	53.4	8.75	
4.3	8/29/2005	7.59	160	744	127	65.8	2.9	15.1	53.3	8.23	
4.3	9/19/2005	7.32		307	43.1	25.3	2.91	10.4	25.5	7.87	86.9
4.3	9/19/2005	7.32		307	43.6	25.5	2.96	10.5	25.8	8.61	88.1
4.3	9/27/2005	7.51	101	488	78.2	47.1	4.33	14.7	35.4	12.8	121
4.3	10/11/2005	7.40	111	481	70.5	41.3	2.93	14.5	36.8	5.68	128
4.3	10/21/2005	7.43	105	443	64.0	38.1	2.32	14.6	34.5	8.23	120
4.3	11/7/2005	7.96	98.4	397	58.9	36.1	2.37	12.8	33.4	7.87	116
4.3	11/14/2005	8.16	107	409	64.9	38.6	1.92	14.0	35.6	8.61	124
4.3	11/23/2005	6.78	79.9	338	47.9	29.4	2.09	11.0	26.5	6.26	91.9
4.3	12/12/2005	6.99	100	439	67.8	37.8	1.88	14.3	33.4	8.20	117
4.4	8/17/1989	7.95	139	390							
4.5	8/17/1989	8.05	139	390							
4.5	9/8/2004	7.78	160	622	90.3	54.8	2.47	11.3	50.3	12.8	178
4.6	8/17/1989	8.05	139	390							
6.5	8/7/1989	7.90	97	390							
8.2	8/7/1989	8.05	75	240							
8.2	9/5/1992	8.02	96	293							
8.2	8/31/1994			240							
8.2	10/11/1995	8.00	96	293							
8.2	10/5/2000	7.84	108	308							
8.2	10/4/2005	8.15	86.1	297	33.5	19.0	2.69	7.76	26.8	5.80	90.3

Table 8 continued

Site (RM)	Sample Date	Flow Type	Turb NTU	TSS mg/l	TP ug/l	TDP ug/l	TN mg/l	TNOX mg/l
2.4	9/5/2003	Base	1.80		42.0		0.72	
2.4	8/26/2004	Base	1.74	1.60	30.0	20.0	0.67	0.26
2.4	10/4/2005	Base	1.61		24.7	18.3	0.42	0.09
4.3	9/5/2003	Base	4.40		33.0		0.40	
4.3	6/15/2005	Freshet	4.08	6.02	51.3	19.7	0.72	0.19
4.3	6/30/2005	Freshet	19.2	23.4	107	43.9	0.95	0.24
4.3	7/6/2005	Freshet	5.49	10.9	60.1	33.4	0.78	0.18
4.3	7/22/2005	Base	2.30	7.52	23.4	13.0	0.44	0.06
4.3	7/22/2005	Base	1.71	1.50	25.3	14.6	0.45	0.06
4.3	7/27/2005	Base	9.31	14.7	50.9	21.7	0.59	0.13
4.3	8/9/2005	Base	2.33	3.17	30.7	18.4	0.49	0.05
4.3	8/29/2005	Base	2.21	2.59	32.7	19.4	0.49	0.05
4.3	8/29/2005	Base	2.83	1.67	31.5	17.9	0.42	0.05
4.3	9/19/2005	Freshet	6.27	6.95	62.1	42.2	0.78	0.14
4.3	9/19/2005	Freshet	6.43	7.53	70.0	42.7	0.77	0.14
4.3	9/27/2005	Freshet	3.20	5.73	73.4	48.2	0.75	0.16
4.3	10/11/2005	Freshet	4.43	7.64	43.7	25.5	0.68	0.21
4.3	10/21/2005	Base	1.42	1.99	30.5	23.7	0.60	0.28
4.3	11/7/2005	Freshet	2.45	3.74	33.6	20.4	0.41	0.11
4.3	11/14/2005	Base	1.26	1.70	18.2	12.9	0.37	0.18
4.5	9/8/2004	Base		1.91	32.0	21.0	0.58	0.21
8.2	10/4/2005	Base	0.74		42.2	38.8	0.57	0.20

Table 8 continued

Site (RM)	Date	Fe ug/l	Mn ug/l	Ni ug/l	Cr ug/l	Cu ug/l	Zn ug/l	Al ug/l	As ug/l	Ag ug/l	Be ug/l	Se ug/l	Sb ug/l	Ti ug/l
2.4	9/5/2003	176	69.7	<10	<5	<10	<5		<1	<1	<1	<5	<10	<1
2.4	8/26/2004	300	26.7		5	<10	<10		<1					
2.4	10/4/2005	78.3	18.1	<5	5	<10	<10		<1					
4.3	9/5/2003	148	144	<10	5	<10	<25		<5	<1	<1	<5	<10	<10
4.3	6/15/2005	108	171	<5	5	<10	<10		<1	<1	<1	<5	<10	<1
4.3	6/30/2005	212	69.3	<5		<10	<10		<1	<1	<1	<5	<10	<1
4.3	7/6/2005	131	49.7	<5	5	<10	<10		<1	<1	<1	<5	<10	<1
4.3	7/22/2005	54.8	70.1	<5	5	<10	<10		<1	<1	<1	<5	<10	<1
4.3	7/22/2005	57.1	66.6	<5	5	<10	<10		<1	<1	<1	<5	<10	<1
4.3	7/27/2005	54.2	139	<5	5	<10	<10		<1	<1	<1	<5	<10	<1
4.3	8/9/2005	112	63.3	<5	5	<10	<10		<1	<1	<1	<5	<10	<1
4.3	8/29/2005	51.3	87.9	<5	5	<10	<10		<1			<5		
4.3	8/29/2005	50.0	82.0	<5	5	<10	<10		<1			<5		
4.3	9/19/2005	132	29.3	<5	5	<10	<10		<1					
4.3	9/19/2005	149	30.5	<5	5	<10	<10		<1					
4.3	9/27/2005	121	36.9	<5	5	<10	<10	16.6	<1					
4.3	10/11/2005	117	77.1	<5	5	<10	<10		<1					
4.3	10/21/2005	112	69.6	<5	5	<10	<10		<1					
4.3	11/7/2005	84.4	42.4	<5	5	<10	<10		<1					
4.3	11/14/2005	122	57.3	<5	5	<10	<10		<1					
4.5	9/8/2004	417	90.9	<5	5	<10	<10	10	<1					
8.2	10/4/2005	56.3	6.81	<5	<5	<10	<10		1					

Alk - Alkalinity
 Cond- Specific conductance
 Cl - Chloride
 Na - Sodium
 K - Potassium
 TSO4 - Total sulfates
 Ca - Calcium
 Mg- Magnesium
 THC- Total hardness
 Turb - Turbidity

TSS - Total suspended solids
 TP - Total phosphorus
 TDP - Total dissolved phosphorus
 TN - Total nitrogen
 TNOX - Total nitrates-nitrites
 Fe- Iron
 Mn - manganese
 Ni - Nickel
 Cr - Chromium

Cu - Copper
 Zn - Zinc
 Al - Aluminum
 As - Arsenic
 Ag - Silver
 Be - Beryllium
 Se - Selenium
 Sb - Antimony
 Ti - Titanium