

**Aquatic Life Support Use  
Assessment of Centennial Brook  
2009**



**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 - Centennial Brook

### 1. *Description of water body:*

- The Centennial Brook watershed is located in Burlington and South Burlington (figure 1). The entire stream and its tributaries from the headwaters to its confluence with the Winooski River are designated as impaired due to non-support of aquatic life designated uses (fair-poor biological condition). Impairment finding is based on the results from assessments of biological condition at river miles (RMs) 0.1 and 0.2. Most of the upper watershed is of urban land use. The mid to lower section is wetland and is preserved as UVM's Centennial Woods Natural Area. Below that, the stream gradient increases to moderate for the remaining 0.5 miles into the Winooski River.

### 2. *Description of biological data used to characterize impairment:*

- All biological data were collected from 1993-2005. Locations sampled – RM 0.1 (fish-3 events; macroinvertebrates-5 events); RM 0.2 (fish-2 events); RM 1.2 (fish-1 event, macroinvertebrates-1 event); Tributary to Centennial RM 0.1 (fish-1 event).
- Fish community - DEC has conducted 7 sampling events from 3 sites between 1993-2004. The fish assemblage was evaluated using the Mixed Water Index of Biotic Integrity (MWIBI) at RM 0.1 (3 samples) and RM 0.2 (2 samples). Samples from RM 1.2 and Trib 1 from RM 0.1 were not assessed using the MWIBI because the drainage area at those points is too small for criteria to be applied. The MWIBIs at RM 0.1 in 1993, 1994 and 2003 were 29 (*fair*), 33 (*good*) and 35 (*good*) respectively. RM 0.2, sampled in 2004 and 2005 scored a 27 (*fair*), and 29(*fair*).
- Macroinvertebrate Community – DEC has conducted 6 Macroinvertebrate community sampling events from 2 sites from 1993-2004. Centennial Brook is classified as a Warm Water Moderate Gradient wadeable stream for purposes of macroinvertebrate assessments. Five samples from RM 0.1 were evaluated to list the stream as impaired. The macroinvertebrate assemblage at RM 0.1 rated *poor* on all 5 occasions sampled.

### 3. *Stressor identification:*

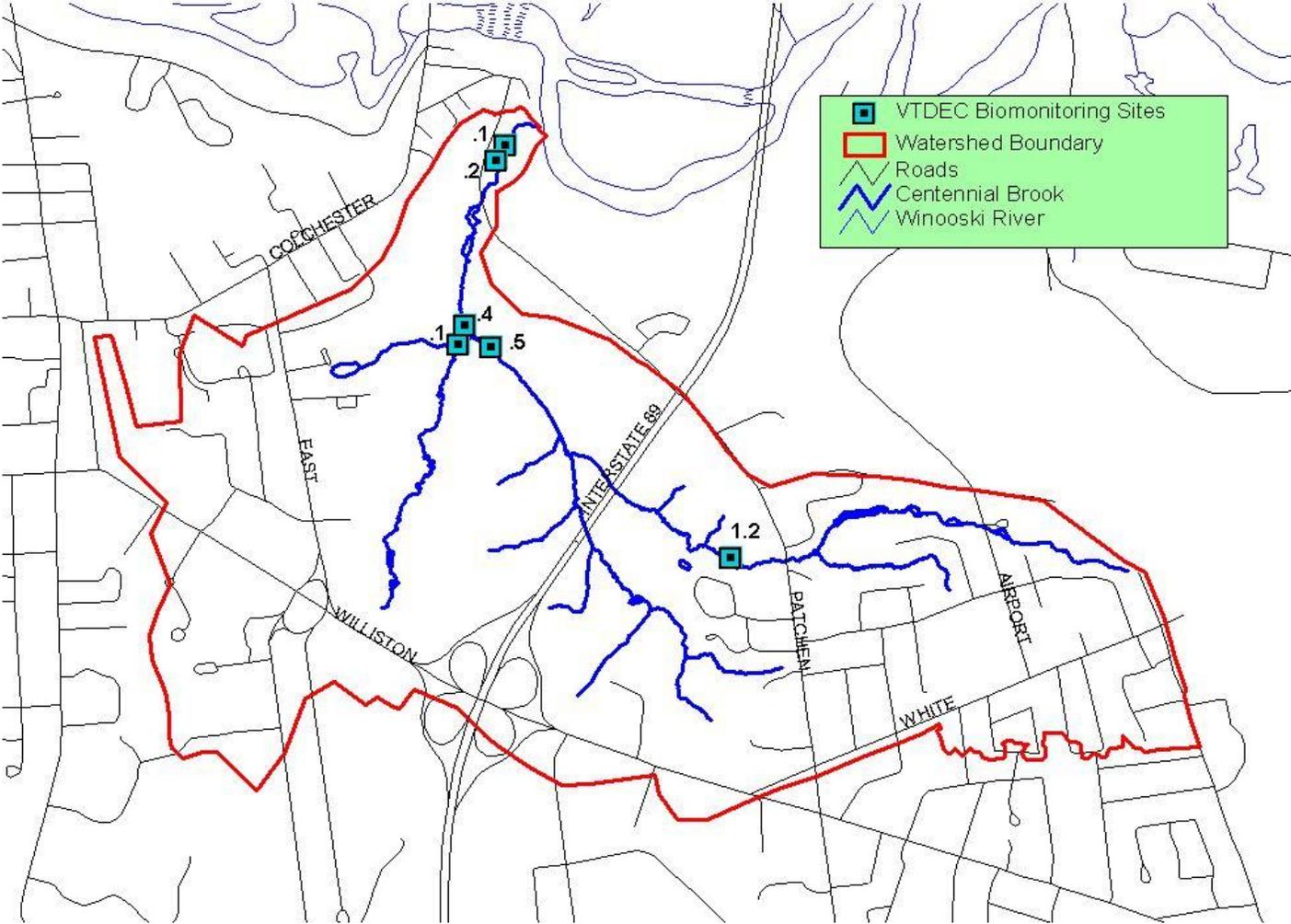
- Assessment of the characteristics of the biological communities and water quality, and physical habitat are inconclusive in regards to the identification of a single most significant stressor responsible for the impairment. Chloride levels averaged 491mg/l for ten months of data collected in 2005-2006-exceedingv the EPAs Chronic Water Quality Criterion for aquatic life of 230 mg/l. It is highly probable that multiple factors related to watershed development, erosion and urban runoff resulting in alterations to the biological, chemical and physical characteristics of the stream are contributing to the impairment. Therefore, the primary stressor is identified as stormwater.

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

- Biological assessment data from Centennial Brook provide the basis for impairment designation. Biological data from RM's 0.1 and 0.2 are used to presume whole watershed impairment. The data are of high quality and are representative of current conditions.

6. *Recommendations:* Fish and macroinvertebrate communities should be sampled at RM 0.2 and 0.1 respectively once every 5 years in conjunction with the 5-year sampling rotation used by the DEC. These sites will be sampled in 2009 since this watershed falls into the rotation schedule for this year.

Figure 1. Sampling site locations for Centennial Brook.



## Biological Assessment of Centennial Brook

### 1. Description of Impaired Watershed

The entire stream and its tributaries from the headwaters to its confluence with the Winooski River are designated as impaired due to non-support of Class B Aquatic Life Use. Impairment finding is based on the results of assessments of biological condition at river miles (RM) 0.1 and 0.2 (Figure 1, Table 1).

The Brook is a small 2<sup>nd</sup> order tributary to the Winooski River, with its confluence located about ½ mile above the Winooski One Dam. The total watershed size of the brook is 3.1 km<sup>2</sup>. The lower main stem of the brook is 0.8 miles in length. At RM 0.8 a major tributary enters from the south. This tributary is 0.8 miles in length with a watershed size of about 1.0 km<sup>2</sup> and drains the I-89 interchange and Route 2 east of the interchange in S. Burlington. The upper main stem continues another 1.3 miles in length from the confluence of the south branch, with a watershed of about 1.1 km<sup>2</sup> originating at the Burlington International Airport. The middle-lower portion of the watershed bounded by I-89, East Avenue and Grove Street contains the 100-acre Centennial Woods Natural Area owned by the University of Vermont. It is one of the few permanently protected areas in the City of Burlington and was created for the purpose of ecosystem protection and research. This wetland is made up of mature conifer stands, mixed hardwoods, old field, streams and wetlands.

### 2. Methods

The Warm Water Medium Gradient (WWMG) macroinvertebrate biocriteria and best professional judgment were used to evaluate the macroinvertebrate community of Centennial Brook. The fish assemblage of Centennial Brook was evaluated using the Mixed Water Index of Biotic Integrity (MWIBI). Both communities were used to list Centennial Brook as impaired for Aquatic Life Support (ALS) for Class B waters. Sites located upstream of RM 0.2 had insufficiently small drainage areas to effectively apply fish or macroinvertebrate indexes. The reach of stream at the base of the watershed should reflect the overall condition of Centennial Brook.

### 3. Discussion of Data Used to Characterize Impairments

The biological assessment information used to determine impairment was near mouth at RM 0.1 and 0.2. Table 1 shows locations of sampled sites. Fish assessments from RM 0.1 were: *fair* in 1993 and *good* in 1994 and 2003. RM 0.2 was sampled in 2004 and 2005 and scored *fair* both years. Macroinvertebrate assessments from RM 0.1 were poor all five years sampled 1993, 2000, 2003, 2004, and 2005 (Table 2).

*Fish Community*- Table 3 shows the MWIBI scores and metrics for all years sampled. The MWIBI scores at RM 0.1 were 29 (*fair*), 33 (*good*) and 35 (*good*). Species richness at this site was undoubtedly augmented by fish moving up stream the short distance from the Winooski River. Addition of these species to the catch at RM 0.1 probably masked the response to conditions in Centennial Brook by increasing the IBI score in the species richness metrics. This is borne out by the 2004 and 2005 samples at RM 0.2 which supported only five species as opposed to the eight to thirteen species collected at RM 0.1. The RM 0.2 site MWIBI was 27 (*fair*) for both years. The lower MWIBI score at RM 0.2 reflected fewer benthic insectivore and intolerant species at this site. Scores at RM 0.1 were elevated into the good range two out of three times by the addition of species from both categories.

*Macroinvertebrate Community*- Table 4 shows the macroinvertebrate community assessments and metrics for all five years sampled. The community is absent of the water quality-sensitive orders (Plecoptera) and (Ephemeroptera), (Table 5a), for four of the five years. As a result, the EPT taxa richness is extremely low and the overall community taxa richness is low. The community is typically dominated by only a few (2-3) tolerant species from the orders Diptera, Isopoda, and or Trichoptera. Most years, tolerant Trichoptera Hydropsychidae *Hydropsyche betteni* and *Cheumatopsyche sp.* dominated the community, resulting in a high Bio Index value (>6.00) and a high EPT/EPT&c, but very low numbers of EPT taxa. In fact, only 2-3 Trichoptera taxa made up the EPT taxa present in all years. In

2000 the community was dominated by the Diptera Chironomidae, with only 1 taxon of Ephemeroptera present and Plecoptera again absent. The resulting PMA-O in 2000 was fair and the EPT/EPT&c also low. As a result of the dominance of Hydropsychidae taxa, the functional group composition was hyper-dominated by filter feeders, with the exception of 2000, when the herbivore shredder Chironomidae co-dominated the community (Table 5b). In all years sampled, the richness rated *fair*, EPT- *poor* and Bio Index rated *fair-poor*, clearly supporting the finding of an impaired macroinvertebrate community that has been both functionally and structurally degraded.

#### 4. Stressor Identification

The DEC has relied primarily on biological inference and assessment of site habitat observations to identify the stressors that are the most likely significant contributors to the observed impairments. The biological fingerprint of Centennial Brook as described above implies that the impairment is a result of undefined factors related to erosion, land development and urban runoff. The dominant taxa are generally tolerant of elevated temperature, are generalist feeders tolerant of siltation as well as organic enrichment and moderately low dissolved oxygen.

A number of water quality and habitat observations and measures corroborate these stressors as significant in Centennial Brook. Table 6 shows a number of physical habitat observations made during biological sampling at RM 0.1. Elevated levels of embeddedness (>50%), a high silt rating (3-5), and significant levels of sand in the substrate are all indicators of stream channel erosion and urban sediment wash-off as significant stressors. In 2003 macro algae cover was elevated suggesting elevated nutrient levels. The absence of a moss community suggests sediment and frequent scour as a stress.

Water Quality data were collected at RM 0.1 in 2003 and 2005-06. These data show Centennial Brook to be on the alkaline side with pH values from 7 to 8 and alkalinity from 100 to 180 mg/l. Mid-summer temperatures were as high as 24.9 C. Dissolved Oxygen (D.O.) percent saturation was generally over 80%. The D.O. however did show that in the fall of the year it could drop to as low as 39% saturation. Turbidity and total suspended solids (TSS) were found to be slightly elevated even at base flows, suggesting some level of background turbidity in the system. Total dissolved Phosphorus (TDP) generally ranged from 10-20ug/l P; Total Nitrogen (TN) ranged from 0.4 to 2.9 mg/l N, and was generally over 1.0 mg/l during freshet events. Stream conductance was elevated, a good indication of an urban watershed. The principle driver of the elevated conductivity appears to be high chloride levels (mean of 491 mg/l, maximum 1040mg/l), most likely originating from impervious surface deicing activities. The mean chloride concentration is above the EPA criteria continuous concentration (chronic) water quality criterion for aquatic life (230 mg/l), and the maximum is above the criteria maximum (acute) concentration (860mg/l). This warrants further investigation into the potential contribution of chloride to the observed impairment, and a need to look at chloride management within the watershed. No priority pollutant metals were found to be elevated; most were below detection limits.

#### 5. Confidence in the Implications of the Data :

The VTDEC is confident of the evaluation of impaired condition of the aquatic biota in Centennial Brook. The *poor* condition of the macroinvertebrate community in 1993, 2000, 2003, 2004, and 2005 and the *fair* condition of the fish community in 1993, 2004, and 2005 support the impaired listing. Observations of high levels of silt in the substrate, moderate embeddedness, and algae growth; and water quality measures showing periodic high turbidity, temperature, chloride, and low D.O. add to the weight of evidence supporting the determination of impairment due to stormwater.

*6. Summary Statement: Overall Weight of Evidence*

Biological assessment data from Centennial Brook provide the basis for impairment designation. Biological data from RM's 0.1 and 0.2 were used to list Centennial Brook as impaired. The data are of high quality and are representative of current conditions.

*7. Recommended Monitoring:* Fish and macroinvertebrate communities should be sampled at RM 0.2 and 0.1 respectively once every 5 years in conjunction with the 5-year sampling rotation used by the DEC. These sites will be sampled in 2009 since this watershed falls into the rotation schedule for this year.

**Table 1.** Biological sampling stations on Centennial Brook. “M” - macroinvertebrate, “F”-fish.

Location	Station (RM)	Community	Description	Latitude	Longitude	Drainage Area-km <sup>2</sup>	Elevation -feet
Centennial Brook	0.1	Fish, Macroinvertebrates	100m above Confluence with Winooski River	442910	731100	3.1	158
	0.2	Fish	Immediately downstream from Grove Street Bridge	442905	731104	3.0	160
	1.2	Fish, Macroinvertebrates	0.25 mi west of Patchen Road crossing, below sink hole. (where stream goes underground for short distance)	442827	731026	1.2	240
Tributary to Centennial Bk.	0.1	Fish	Upstream of wetland and main tributary junction, below baseball diamond and just below hospital tributary	442850	731109	1.3	220

**Table 2:** Biomonitoring sites locations and overall Aquatic Life Use Support (ALS) assessment using the fish and/or macroinvertebrate community, by site and year, on Centennial Brook. All data collected by VTDEC.

		Overall	Fish	Macroinvertebrates
Site (RM)	Date	ALS determination	Assessment	Assessment
0.1	1993	Poor	Fair	Poor
	1994	Poor	Good	Poor
	2003	Poor	Good	Poor
	2004	Poor		Poor
	2005	Poor		Poor
0.2	2004	Fair	Fair	
	2005	Fair	Fair	

**Table 3.** Fish assemblage metrics evaluated using the Mixed Water Index of Biotic Integrity (MWIBI) for Centennial Brook and its tributary.

Site (RM)	Date	MWIBI	Species Richness	No. of Intolerant Species	No. of Benthic Insectivore Species	% White Sucker and Creek Chub	% Generalist Feeders	% Insectivores	% Top Carnivores	% Anomalies	Density (#/100m <sup>2</sup> )
0.1	9/24/1993	<b>29 (Fair)</b>	8	0	1	46	57	41	2	0	72
	8/31/1994	<b>33 (Good)</b>	9	0	2	25	49	39	11	1	45
	10/13/2003	<b>35 (Good)</b>	13	1	2	9	78	18	4	1	58
0.2	10/7/2004	<b>27 (Fair)</b>	5	0	0	28	46	52	2	0	25
	10/3/2005	<b>29 (Fair)</b>	7	0	0	25	58	40	1	0	90
1.2	8/31/1994	-	3	0	0	0	100	0	0	0	53
Tributary 0.1	8/31/1994	-	3	0	0	70	100	0	0	0	82

MWIBI Range: 9-25 (Poor), 27-29 (Fair), 33-35 (Good), 37 (Very Good), 41-45 (Excellent).

**Table 4.** Macroinvertebrate community metrics from Centennial Brook, and Class B biocriteria for WWMG streams used to base “best professional judgment” assessments. Bolded metrics are considered well below Class B expectation

Site (RM)	Date	Assessment (WWMG)	Density	Richness	Ept	PMA-O	BI (0-10)	Oligochaeta%	Ept/EptC	PPCS-F
0.1	9/30/1993	<b>Poor</b>	<b>183.5</b>	<b>12.5</b>	<b>2.0</b>	<b>43.1</b>	<b>6.80</b>	0.0	0.92	<b>0.31</b>
	9/13/2000	<b>Poor</b>	635.7	26.5	<b>3.0</b>	<b>43.0</b>	<b>6.42</b>	0.7	0.35	0.54
	10/13/2003	<b>Poor</b>	923.0	21.5	<b>2.0</b>	47.0	<b>6.39</b>	1.3	0.83	0.53
	10/7/2004	<b>Poor</b>	409.3	22.0	<b>4.0</b>	46.3	<b>6.46</b>	0.0	0.53	0.46
	10/3/2005	<b>Poor</b>	<b>227.0</b>	<b>19.0</b>	<b>2.0</b>	45.8	<b>6.59</b>	4.4	0.90	0.40
1.2	10/13/1994		1004.0	<b>15.5</b>	<b>3.5</b>	<b>40.7</b>	<b>6.95</b>	4.7	0.87	0.41
WWMG Class B Threshold Criteria			>300	>30	>16	>45	<5.40	<12	>0.45	>0.40

**Table 5 a and b.** Percent composition of the macroinvertebrate community major orders (a) and functional feeding groups (b) from the Centennial Brook sites. Bolded values indicate orders or groups that are highly different from the WWMG model.

**A**

Station	Date	Coleoptera%	Diptera%	Ephemeroptera%	Plecoptera%	Trichoptera%	Oligochaeta%	OtherOrders%
0.1	9/30/1993	0.2	12.2	<b>0</b>	<b>0</b>	<b>83.9</b>	0	3.6
	9/13/2000	0.2	<b>68.8</b>	1.3	0	26.8	0.7	2.2
	10/13/2003	1.2	20.1	<b>0</b>	<b>0</b>	<b>71.5</b>	1.3	5.9
	10/7/2004	1.3	<b>55.4</b>	<b>0</b>	<b>0</b>	42.0	0	1.3
	10/3/2005	0.8	11.9	<b>0</b>	<b>0</b>	<b>80.6</b>	4.4	2.2
1.2	10/13/1994	0.6	7.2	<b>0</b>	<b>0</b>	48.0	4.6	<b>39.6</b> (Isopoda)

**B**

Station	Date	Collector Gatherer	Collector Filterer	Predator	Shredder Detritus	Shredder Herbivore	Scraper
0.1	9/30/1993	8.3	<b>84.9</b>	4.1	<b>0.0</b>	2.5	<b>0.2</b>
	9/13/2000	20.6	39.2	5.5	0.9	<b>33.1</b>	<b>0.2</b>
	10/13/2003	18.2	<b>71.7</b>	3.8	0.8	4.3	<b>1.2</b>
	10/7/2004	27.4	<b>58.6</b>	3.3	0.7	9.4	<b>0.7</b>
	10/3/2005	10.6	<b>81.9</b>	2.6	0.9	3.1	<b>0.9</b>
1.2	10/13/1994	<b>44.0</b>	49.2	3.5	0.2	2.5	<b>0.6</b>

**Table 6.** Selected physical and algae measures and observations from Centennial Brook during time of biological assessments. Substrate composition determined by pebble counts, \* Indicates substrate composition estimated by observation that year. Algae coverage summarized as a mean weighted average (range 0-10) for three algae types Micro (Diatom & Blue Green), Macro (Filamentous), and Moss.

Station	Date	Canopy %	Silt Rating (1-5)	Embeddedness	Sand	Gravel	Coarse Gravel	Cobble	Boulder	Micro Algae (0-10)	Macro Algae (0-10)	Moss (0-10)
0.1	9/30/1993	80	3	25-50	10*	5	30	40	15			
	9/13/2000	80	4	25-50	11	16	28	34	10			
	10/13/2003	70	3	25-50	7	13	14	59	7	1.0	2.6	0.1
	10/7/2004	80	5	50-75	10*	15	25	35	15			
	10/3/2005	100	4	25-50	3	13	19	37	16	0.7	0.0	0.0
1.2	10/13/1994	90	1	<25	5*	5	25	50	15			

**Table 7:** Water chemistry parameters for Centennial Brook. RM = river mile.  
See end of table for parameter abbreviations.

Site (RM)	Date	Color Pt Co units	Time	Water Temperature °C	Dissolved Oxygen mg/l	Dissolved Oxygen % Saturation
0.1	9/24/1993			12		
0.1	9/30/1993			9.5		
0.1	8/31/1994		930	14.5		
0.1	9/13/2000	60		16		
0.1	10/13/2003		1000	11.9		
0.1	6/16/2005		1148	17.1	8.44	89.9
0.1	6/29/2005		1030	23.5	7.22	86.6
0.1	7/7/2005		955	20.1	7.91	87.6
0.1	7/19/2005		1101	24.9		
0.1	7/27/2005		1332	21.7	7.69	88.5
0.1	8/9/2005		1011	21.5	7.81	92.5
0.1	8/26/2005		1050	16.7	8.07	82.7
0.1	8/29/2005		1340	21.7	8.11	93.9
0.1	9/19/2005		1245	17.7	8.35	87.1
0.1	9/27/2005		1015	15.6	8.59	87.0
0.1	10/11/2005		1040	12.9	8.58	80.5
0.1	10/21/2005		1030	7.5	7.41	61.8
0.1	11/7/2005		1100	9.9	10.01	89.4
0.1	11/7/2005		1105			
0.1	11/14/2005		1015	7.2	10.84	92.7
0.1	11/23/2005		1200	2.6	5.26	39.4
0.1	12/12/2005		1145	0.3		
0.1	1/11/2006		945	0.8		
0.1	1/12/2006		1158	2		
0.1	2/8/2006		1255	0.7		
0.1	2/16/2006		1200	0.2		
0.1	3/10/2006		1130	0.1	13.88	99.1
0.1	4/5/2006		1300	5.8		
0.2	10/7/2004	40	1030	10.1		
0.5	8/31/1994		1100	14.5		
1.2	8/29/1994		1215	16.5		
1.2	10/13/1994			6.5		
0.1	8/31/1994		1130	13.5		

Table 7 continued.

Site (RM)	SampleDate	pH std.units	Alk mg/l	Cond (field) $\mu$ mhos/cm	Cond (lab) $\mu$ mhos/cm	Cl mg/l	Na mg/l	K mg/l	TSO4 mg/l	Ca mg/l	Mg mg/l	THC mg/l
0.1	9/24/1993			588								
	9/30/1993	8.40	160.0	965								
	8/31/1994			1315								
	9/13/2000	8.16	92.6	673								
	10/13/2003	7.98		1072	1700	468	260.0	7.00	33.0	82.3	23.3	
	6/16/2005	7.83	139.0	1565		405	227.0	4.01	20.2	67.7	395.0	
	6/29/2005	8.01	177.0	2397		625	353.0	5.21	34.1	95.8	27.2	
	7/7/2005	8.03	133.0	1650		439	250.0	4.60	23.2	67.9	18.6	
	7/19/2005		180.0			623	319.0	5.39	41.6	94.8	27.3	
	7/27/2005	7.81	98.1	763		172	91.3	2.83	18.5	33.2	8.8	
	8/9/2005	7.70	160.0	1789		449	231.0	4.55	28.1	72.0	20.0	
	8/26/2005	7.56	182.0	2141		556	299.0	5.13	27.6	89.2	26.1	330
	8/29/2005	7.68		2302								
	9/19/2005	7.61	128.0	1173		270	155.0	3.89	20.9	56.1	15.6	204
	9/27/2005	7.43	95.9	884		197	106.0	3.52	19.9	42.4	11.9	155
	10/11/2005	7.48	127.0	1140		262	134.0	3.39	27.2	50.6	14.9	188
	10/21/2005	7.46	164.0	1552		366	197.0	4.06	35.3	66.9	19.9	249
	11/7/2005	7.87	113.0	1113	1180	280	147.0	3.52	25.1	49.9	14.9	186
	11/7/2005		114.0		1180	277	144.0	3.47	25.4	47.4	14.8	179
	11/14/2005	7.93	158.0	1495	1640	392	217.0	4.05	31.0	65.8	21.8	254
	11/23/2005	7.30		1704	1730	432	259.0	3.69	28.9	63.0	17.7	230
	12/12/2005	7.28		2503	2540	656	400.0	4.00	34.6	82.0	22.7	298
	1/11/2006	7.28	152.0	3431	3470	1040						
	1/12/2006	7.20	114.0	2547	2590	776	414.0	4.92	32.2	61.6	17.5	225
2/8/2006	7.15	151.0	2455	2450	697							
2/16/2006	7.29	155.0	2215	2210	599							
3/10/2006	7.82	132.0	2965	2920	934	515.0	6.03	34.1	72.1	26.4	289	
4/5/2006	7.80	104.0	1396	1420	367	194.0	3.07	24.8	49.6	15.1	186	
0.2	10/7/2004	7.98	108.0		1830	451	257.0	4.79	27.7	81.9	23.5	301
0.5	8/31/1994			1391								
1.2	8/29/1994			640								
	10/13/1994	7.57	82.0	660								

Table 7 continued.

Site (RM)	Sample Date	Flow Level	Flow Type	Turb NTU	TSS mg/l	TP ug/l	TDP ug/l	TN mg/l	TNOX mg/l
0.1	10/13/2003	Low	Base	2.0		29.0		0.43	0.09
	6/16/2005	High	Freshet	8.5	85.0	179.0	28.0	0.96	0.26
	6/29/2005	Moderate	Base	6.7	9.7	53.3	23.3	0.73	0.25
	7/7/2005	Moderate	Freshet	10.3	15.6	59.6	23.0	0.92	0.34
	7/19/2005	Moderate	Base	4.4	4.2	44.9	19.6	0.69	0.28
	7/27/2005	High	Freshet	185.0	165.0	216.0	45.7	0.89	0.30
	8/9/2005	Moderate	Base	4.2	3.2	40.7	17.7	0.68	0.32
	8/26/2005	Moderate	Base	6.0	4.8	56.1	19.4	0.58	0.16
	9/19/2005	Moderate	Base	12.1	24.4	63.3	20.5	0.66	0.29
	9/27/2005	Moderate	Freshet	38.7	49.0	120.0	27.7	0.75	0.41
	10/11/2005	Moderate	Base	5.9	5.5	48.4	24.3	0.92	0.56
	10/21/2005	Moderate	Base	4.9	5.1	43.1	11.3	1.19	0.89
	11/7/2005	Moderate	Freshet	31.9	33.6	99.1	24.9	0.89	0.56
	11/7/2005	Moderate	Freshet	29.7	28.7	106.0	26.3	0.89	0.56
	11/14/2005	Low	Base	5.6	5.2	38.0	11.5	0.87	0.70
	11/23/2005	Moderate	Freshet	7.5	25.7	68.2	17.6	1.19	0.84
	12/12/2005	Moderate	Base	6.2	10.9	38.6	11.2	1.26	1.26
	1/11/2006	Moderate	Freshet	5.4	5.6	29.1		2.23	1.05
	1/12/2006	High	Freshet	31.4	35.9	82.7	19.5	1.49	0.88
	2/8/2006	Moderate	Base	5.0		25.4		2.72	1.37
2/16/2006	Moderate	Base	4.0		24.0		1.71	1.40	
3/10/2006	Moderate	Freshet	199.0		212.0	25.9	2.90	1.06	
4/5/2006	Moderate	Freshet	22.6		84.6	14.6	1.15	0.72	

**Table 7** continued, < sign indicates lower limit of test.

Site (RM)	Date	Fe ug/l	Mn ug/l	Ni ug/l	Cd 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
0.1	10/13/2003	478	62.3	<10		<5	<10	25		5	<1	<1	5	<10	<5
	6/16/2005	294	395	<5	<1	<5	<10	<10		1.48	<1	<1	5	<10	<1
	6/29/2005	50	486	<5	<1	<5	<10	<10		1.64	<1	<1	5	<10	<1
	7/7/2005	158	372	<5	<1	<5	<10	<10		1.54	<1	<1	5	<10	<1
	7/19/2005	50	227	<5	<1	<5	<10	<10		1.56	<1	<1	5	<10	<1
	7/27/2005	133	209	<5	<1	<5	<10	<10		1.47	<1	<1	5	<10	<1
	8/9/2005	50	265	<5	<1	10	<10	<10		1.44	<1	<1	5	<10	<1
	8/26/2005	50	205	12.5		5	<10	<10		1.31					
	9/19/2005	50	234	<5	<1	<5		<10		1.29					
	9/27/2005	83.2	317	<5	<1	<5	<10	<10	13.6	1.35					
	10/11/2005	614	292	<5	<1	<5	<10	<10		1.28					
	10/21/2005	50	350	<5	<1	<5	<10	<10		<1					
	11/7/2005	65	181	<5	<1	<5	<10	<10		<1					
	11/7/2005	71.2	191	<5	<1	<5	<10	<10		<1					
	11/14/2005	50	277	<5	<1	<5	<10	<10		<1					
	11/23/2005	50	312	<5	<1	<5	<10	<10		<1					
	12/12/2005	50	509	<5	<1	<5	<10	<10		<1					
1/12/2006	90.2	296	<5	<1	<5	<10	<10		<1						
3/10/2006	66.6	516	<5	<1	<5	<10	<10	12.8		<1					
4/5/2006	106	282	<5	<1	<5	<10	<10			<1					
0.2	10/7/2004	50	365		<1	<5	<10	<10	<10	<1					

Alk - Alkalinity  
 Cond- Specific conductance  
 Cl - Chloride  
 Na - Sodium  
 K - Potassium  
 TSO4 - Total sulfates  
 Ca - Calcium  
 Mg- Manganese  
 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  
 Cd - Cadmium

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