Aquatic Life Support Use Assessment of Bartlett Brook 2009

prepared by

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Biological Assessment Fact Sheet - Bartlett Brook

1. *Description of water body*

- The entire section of Bartlett Brook, located in South Burlington, from headwaters to the mouth in Lake Champlain, including tributaries, is designated as impaired due to non-support of aquatic life uses (*fair-poor* biological condition).

- Listed pollutants identified as contributing to the impaired condition are presently undefined and result from land development, erosion, and urban runoff in the watershed. The upper section of the watershed is characterized by agricultural use (UVM horticulture farm). Below this, the stream runs through a forested section before it crosses under Route 7 and out to the lake.

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

- Biological data was collected 1993-2008. Locations sampled were river mile (RM) 0.2 (fish-8 events, macroinvertebrates-5 events), RM 0.3 (fish-1 event), RM 0.4 (fish-6 events, macroinvertebrates-1 event) and RM 0.7 (fish-1event, macroinvertebrates-1event). Twenty-one of twenty-three sampling events were evaluated using DEC assessment protocols and best professional judgment.

- *Fish Community* – DEC has conducted 15 fish community samples from 4 sites during the period 1993-2008. RM 0.7 was not assessed due to small drainage size. Of the 15 fish community assessments: 3 rated *poor*, 5 rated f*air*, 5 rated *good*, and 2 rated *very good*.

- *Macroinvertebrate Community* – The DEC has conducted 7 macroinvertebrate assessments at 3 sites from 1993 to 2005. The site used for listing is RM 0.2, which has been assessed 5 times and rated as *fair-poor* 2 times and *poor* 3 times.

3. *Stressor Identification*: Assessment of the characteristics of the biological communities and physical habitat are inconclusive in regards to the identification of a single most significant stressor responsible for the impairment. The primary stressor(s) remains "undefined". It is certain that multiple factors related to watershed development, erosion and urban runoff resulting in alterations to the biological (e.g. nutrients), chemical (e.g. hydrocarbons) and physical (e.g. temperature, hydrology and sediment) characteristics of the stream are contributing to the impairment.

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

- Biological assessment data from Bartlett Brook provide the basis for impairment designation

- Available macroinvertebrate assessment data indicate severe to moderate biological impairment (*poor-fair* condition) in the lower section of the brook. The fish assemblage has met class standards since 2005. The upper section (RM 0.7) is too small for application of current biological criteria.

- As a result of biological assessments, the stream has been identified by the State of Vermont as impaired pursuant to the Clean Water Act, Section 303(d). The primary impairment is to aquatic life use support for Vermont Class B Water Quality Standards. Land development, erosion and urban runoff are listed as the most likely causes of impairment.

5. *Recommendations for assessment needs:* Fish and macroinvertebrate communities at RM 0.2 and 0.4 should be sampled 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.

Discussion of Biological Assessment Results

Description of Impaired Waterbody:

The entire stream and its tributaries are Class B waters. Bartlett Brook is a small moderate gradient stream located in Chittenden County in the Town of South Burlington (**Figure 1)**. The headwaters begin above, and to the east of, the UVM horticulture farm impoundment. Total drainage area of Bartlett Brook is 2.8km^2. Several small tributaries enter the main branch below the impoundment as the stream runs through a forested section of land. Below Route 7 a major tributary enters from the south near the Shearer Chevrolet dealership. A stream restoration project completed in 2002 involved construction of a new stream channel and on-and off-stream stormwater retention ponds at RM 0.3-0.4 below Shearer Chevrolet and Rt. 7. From this point down to the lake, the riparian zone is fully vegetated with a single street crossing and an apartment complex adjacent to the banks near the stream mouth.

Methods:

The fish and or macroinvertebrate communities were assessed at four locations (**Table 1, Figure 1)**.

The fish assemblage can be assessed using the Mixed Water Index of Biotic Integrity (MWIBI) only at sites that could naturally (potentially) support at least five native fish species. Corresponding areas on Bartlett Brook that meet the minimum requirements of the application of the MWIBI appear to be at RM 0.4 and downstream. Any further upstream the habitat volume becomes too small to support five or more species. Consequently RM 0.7 (drainage area approximately 1.0 km^2) could not be evaluated using accepted VTDEC protocols for fish community assessment.

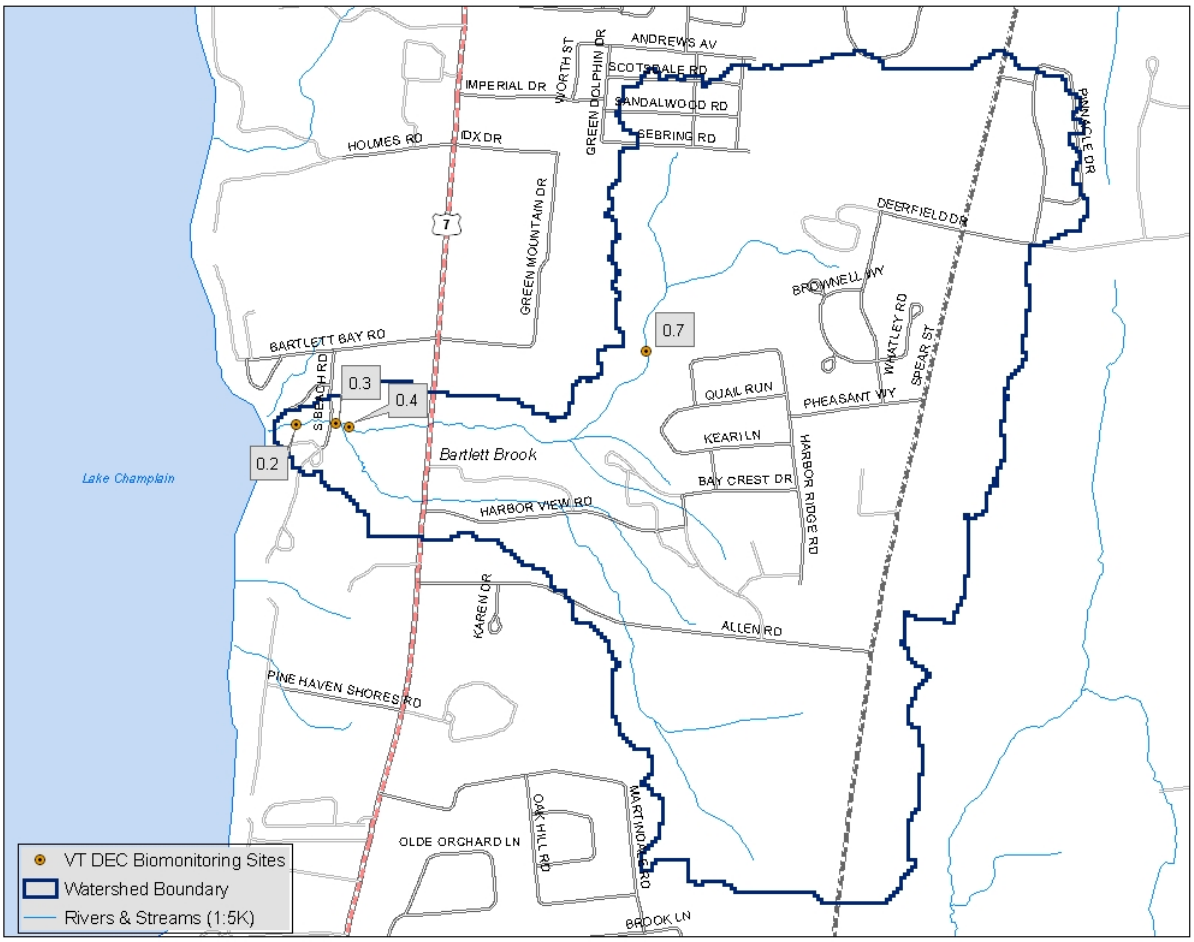
The macroinvertebrate assemblage was evaluated at RM 0.2 and 0.4. The lower site was used to assess the biological integrity of the macroinvertebrate assemblage for the watershed. The assessment was based on the Warmwater Medium Gradient (WWMG) biocriteria guidelines with best professional judgment interpretations due to the small size of the watershed. As with the fish community, the macroinvertebrate community could not be evaluated at RM 0.7 because of small size of the drainage at that point.

In addition to the above biological assessments, physical habitat measures and observations were collected at the time of biological assessments. Water quality was also sampled at the time of biological assessments and in 2005-6 numerous times under a wide range of flow conditions to better characterize the streams water quality.

Table 1. Biological sampling stations on Bartlett Brook, Burlington, VT. "M"– macroinvertebrate, "F"-fish, RM-river mile from stream mouth.

Site (RM)	Community	Description	Drainage Area km^2	Elevation ft	Latitude	Longitude
0.2	MF	Located 50m below Bingham Road.	2.7	120	44.426111	73.216111
0.3	F	Reach just below south tributary.	2.6	128	44.425833	73.214167
0.4	MF	Located 20 meters below Shearer Chevrolet parking lot sw outlet.	1.6	140	44.425833	73.213889
0.7	MF	Located below UVM Horticulture Farm.	1.13	210	44.427222	73.205556

Figure 1: Biomonitoring site locations on Bartlett Brook, VT. Site numbers indicate approximate River Mile from the stream mouth.



Discussion of Data:

The portion of Bartlett Brook between the mouth and RM 0.4 has been assessed 19 times from 1993-2004 for fish and or macroinvertebrates. Of the 19 assessments, 13 rated either the fish or macroinvertebrate assemblages as failing to meet Aquatic Life Support (ALS) for Class B waters.

Fish Community 1993-2008 - The fish assemblage at RM 0.2 scored *fair* or *poor* three of eight sampling events with the remainder scored *good*, and in 1997, *very good* (**Table 2**). There does not seem to be a trend over time in the data at this site. However the last two assessments were rated as *good.* Similar to RM 0.4, the results from RM 0.2 indicate considerable annual variation in species composition which resulted in variability in IBI scores. MWIBI scores were depressed due to excessive numbers of tolerant generalist feeders (primarily creek chub) and tolerant forms (creek chub and blacknose dace). Widely varying IBI scores at a site over time is often an indication of a degraded habitat.

The channel at RM 0.4 was moved and reconstructed in July of 2002. The sample taken two months after channel construction nearly met Class B ALS, scoring 31 on the MWIBI (*fair*). Five species had moved into the section. In 2003, low discharge rates from reduced rainfall may have caused the loss of three species and a very low density that triggered an MWIBI score of 9 (*poor*). In 2004 once again five species were recoded but the site was rated as *fair*. By 2005 however, the site, supporting seven species, recorded an MWIBI score of 39 (*very good*). An influx of banded killifish into the sediment-filled pool at the upper end of the sampled section accounted for much of the increase in IBI score. The most recent sample collected in 2008 rated the site as *good (IBI = 31).* As at site RM 0.2, the fish assemblage varied temporally.

The habitat restoration measures at RM 0.4 appear to have stabilized. An exception is the pool at the head of the section has filled in with sediment and is currently a straight shallow run that threads through cattails which have grown up at the site. Bank vegetation continues to develop and the lunkers along the south bank still provide resting habitat for fish. The channel appears to fairly stable. As long as water quality and sediment inputs upstream remain the same, the fish assemblage would be expected to exhibit consistent quality, scoring in the *good* range.

The fish community at the RM 0.2 site supports two benthic insectivores - mottled sculpin and longnose dace - and two intolerant species- mottled sculpin and rosyface shiner. The later two species are in low numbers and their occurrence in samples is sporadic. If these three species appear in sufficient densities in a sample then the site has the potential to score at least an MWIBI of 37 (*very good*). The potential for higher IBI scores at RM 0.3 and 0.4 sites may be limited because no mottled sculpin have been observed at these locations. This species is in low abundance in this stream and it is sedentary in nature. These two attributes reduce the potential of it moving into the restored section and becoming established. This is a key species in indicating fish assemblage health since it positively affects the score by increasing scoring in three metrics: number of benthic insectivore species, intolerant species, and % insectivores.

Macroinvertebrate Community 1993-2005

The extreme departure from the WWMG guidelines warrants the *poor-fair* biological condition of Bartlett Brook based on the five years of assessment data primarily from RM 0.2 (**Table 3**).

In 1993, the community at RM 0.2 was assessed as *poor* based on the low density and EPT values as well as marginal richness and Bio Index values. In 1999 the EPT richness improved to a *fair* number of taxa however the overall richness decreased from *Good* to *Fair*. While the EPT taxa are considered as a group to be water quality sensitive, the dominant Trichoptera taxa present in Bartlett Brook are from the family Hydropsychidae, which are among the more tolerant taxa for the order. In all five years no taxa from the most sensitive order Ephemeroptera were present. The improvement noted in 1999 was due to the increase in the number and dominance by the Plecoptera, primarily the family Leuctridae. This was the only year the Plecoptera were present in any numbers. The high numbers of immature Leuctrids in 1999 is likely due to their rapid colonization of the stream after a high water event four weeks prior to sample collection in 1999. This family of Stonefly is known to tolerate very low water conditions and then rapidly colonize a stream after high flows

in the fall taking, advantage of the leaf litter inputs as a food source. **Table 4b** shows the increase in leaf shredders in the 1999 sample as a result of the rapid re-colonization of the stream by the *Leuctridae.* The 1993 sample is probably a better representation of a stable base flow community. The 2003 sample was collected after a draught year, in which the stream was nearly dry in late summer. In 2004, the stream was again rated as *poor*. Density was again very low, as was richness and EPT taxa present. The order Diptera dominated the stream as in 1993 (**Table 4a)**. In 2005, the community looked much as it did in 1999, with the Plecoptera *Capniidae* this time a significant component of the community.

The dominant taxa are an odd mixture of cool-cold water taxa considered intolerant of organic enrichment, but moderately tolerant of increased particulate organic matter, and warm water taxa considered moderately tolerant of enrichment and siltation. The cold water taxa include the Leuctridae, and *Diplectrona* sp.; the warm water taxa include *Stenelmis sp*, *Hydropsyche betteni* , and *Cheumatopsyche sp.*

RM 0.4 was only sampled once (one year after the channel reconstruction). Water quality sensitive EPT taxa richness has been consistently low in Bartlett Brook. Since Bartlett Brook is impaired near its confluence with Lake Champlain, only very limited upstream recolonization can occur from within the brook itself. Recolonization may be limited to the smaller up stream areas and from adjacent streams. The few Trichoptera and Ephemeroptera species that can occur in the lake-washed shoreline environment could serve as a recolonization source for upstream. In the case of Bartlett Brook, streams with a full complement of species are 3-4 miles away. As a result, recolonization may take a number of years.

Watershed management should focus on reducing silt and sand inputs to the stream as well as restoring stable hydrologic conditions, including base flows. The present level of sand within the stream substrate may take a number of years to be flushed out once hydrologic instability and sediment loading are reduced. Until this occurs, recolonization of the stream will be limited. The presence of both cold and warm water macroinvertebrate species indicates that temperature increases may result in the loss of a percentage of coldwater taxa. It is therefore important to maintain a fully canopied stream, and discourage the presence of on-stream impoundments.

Physical and Chemical data

The physical habitat data is presented in **Table 5** and shows the stream substrate composition is boulder to gravel dominated, but with an elevated amount of sand present (generally near 20%) especially in 1993 and 2005 (low flow years). The high level of sand observed in 1993 and 2005 also resulted in a high level of cobble embeddedness (5-75%). In four out of five years the stream was given a very high silt rating of 4 on a 0-5 scale. These habitat features are likely in part responsible for the low macroinvertebrate density in 1993, and 2004 the low overall richness values, and the absence of the sensitive order Ephemeroptera.

Water quality measures are presented in **Table 6**. Stream pH measures were all above 8.0 and the alkalinity was high ranging from 157-198 mg/l. The stream also has elevated levels of chloride. Mean concentrations of 151.7 mg/l were observed during the summer and fall of 2005. However, no values in exceedence of the EPA chronic value 230 mg/l were observed. These elevated chloride levels are indicative of the of de-icing salts used within the watershed. The metals (iron and manganese), were both elevated and tend to indicate the influence of high levels of soil disturbance within the watershed. Nutrient values also show increases from an undisturbed watershed. Elevated levels of hydrocarbons have been observed in sediments in the lower reaches of Bartlett Brook. The above physical chemical measures and biological condition support the conclusion that the potential stressors likely include (but may not be limited to): hydrology, sediment, in-stream habitat, nutrients, hydrocarbons, and chloride.

Stressor Identification

Assessment of the characteristics of the biological communities and physical habitat are inconclusive in regards to the identification of a single most significant stressor responsible for the impairment. Data and site observations imply that sedimentation, habitat alteration, hydrological variation and organic contaminants constitute a primary list of potential impairment contributors. The primary stressor(s) remains "undefined". It is certain that multiple factors related to watershed development are significant sources. Sediment characterization surveys conducted by DEC imply that hydrocarbon contaminants are more likely to be of concern in Bartlett Brook than are metals.

5. *Confidence in the implications of the data*

Because the Bartlett Brook drainage size is below the range of streams used to determine the reference condition for the biological criteria applied, significant best professional judgment has been used by DEC staff. However, the DEC does have a high level of confidence in the application of biological assessments to Bartlett Brook and in the conclusions drawn from those assessments.

6. Summary Statement Overall Weight of Evidence:

Biological assessment data from Bartlett Brook provide the basis for impairment designation. Available assessment data indicate severe to moderate biological impairment (*poor-fair* condition) in the lower section of the brook from 1993 to 2005. The upper section is too small for application of current biological criteria.

7. Recommended monitoring- Fish and macroinvertebrate communities at RM 0.2 and 0.4 should be sampled 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 2. Mixed Water Index of Biotic Integrity (MWIBI) metrics for fish from Bartlett Brook sites 1993-2005.

Site (RM)	Date	**MWIBI**[2]	Species Rich	No. of Intolerant Species	No. of Benthic Insectivore Species	% White Sucker and Creek Chub	% Generalist Feeders	% Insectivores	% Top Carnivores	% Anomalies	Density (#/100m^2)
0.2	9/13/1993	**35 (Good)**	7	1	2	62	68	32	0	0.0	168
	8/29/1994	**29 (Fair)**	7	1	2	58	79	21	0	1.2	145
	8/14/1995	**33 (Good)**	8	0	1	38	52	48	0	2.4	146
	9/22/1997	**37 (Very Good)**	7	1	2	38	48	52	0	0.0	118
	9/20/2001	**27 (Fair)**	5	1	2	70	70	30	0	0.8	114
	9/20/2003	**21 (Poor)**	4	0	0	74	77	23	0	4.7	39
	10/8/2004	**31 (Good)**	5	1	1	59	59	40	1	1.5	53
	10/7/2008	**37 (Good)**	4	0	1	4	4	94	2	0	21
0.3	9/30/2002	**29 (Fair)**	4	0	1	53	59	41	0	0.0	13
0.4	10/12/1995	**19 (Poor)**[1]	3	0	0	85	86	14	0	4.1	150
	9/30/2002	**31 (Fair)**	5	0	1	18	54	41	0	0	20
	10/09/2003	**9 (Poor)**	2	0	0	86	100	0	0	0	6
	10/8/2004	**29 (Fair)**	5	0	1	66	77	23	0	0	50
	10/5/2005	**39 (Very Good)**	7	0	1	15	21	79	0	0	37
	10/6/2008	**31 (Good)**	5	0	1	24	50	50	0	3.0	36
0.7	8/21994	-	2	0	0	69	69	31	0	0	62

1.This site had been recently restructured and lined with white colored cobble. Since that time the channel has been redesigned into its current configuration.
2. MWIBI Range: 9-25 (Poor), 27-29 (Fair), 33-35 (Good), 37 (Very Good), 41-45 (Excellent).

Table 3. Macroinvertebrate community assessments and biometric values from samples collected from 1993-2003 from Bartlett Brook.

Site (RM)	Date	Community Assessment	Density	Richness	EPT	PMA-O1	BI (0-10)	Oligochaeta %	Ept/ Ept&Chiro	PPCS-F1
0.2	9/30/1993	**Poor**	263	27.0	3.5	50.2	5.28	2.3	0.50	0.65
	10/12/1999	**F-Poor**	720	22.0	7.0	49.7	4.12	1.3	0.68	0.42
	10/09/2003	**Poor**	1112	16.0	6.0	55.9	5.75	0.0	0.89	0.56
	10/8/2004	**Poor**	293	27	6	49.8	6.07	1.4	0.58	0.47
	10/21/2005	**F-Poor**	536	22	5	55.6	4.96	0.4	0.74	0.44
0.4	10/09/2003	**Poor**	2075	32	4.0	51.8	5.98	0.8	0.88	0.48
0.7	10/13/1994	-	1392	28.0	6.0	58.3	5.29	0.3	0.64	0.59

Table 4a. The Percent composition of the major orders and functional feeding groups of the macroinvertebrate community from Bartlett Brook sites.

Site (RM)	Date	Gatherer	Filterer	Predator	Shrd Detritus	Shrd Herbivour	Scraper
0.2	9/30/1993	41.0	36.2	9.1	4.2	5.3	3.6
	10/12/1999	14.0	20.3	14.0	32.3	12.0	7.0
	10/09/2003	15.5	64.0	5.0	1.4	0.0	14.0
	10/8/2004	37.5	53.6	2.7	1.4	1.7	3.1
	10/21/2005	22.0	44.8	11.2	19.4	0.0	2.2
0.4	10/09/2003	9.5	73.2	7.9	0.4	3.1	5.8
0.7	10/13/1994	20.5	40.9	17.3	3.7	0.0	17.4

Table 4b. The Percent composition of the major orders and functional feeding groups of the macroinvertebrate community from Bartlett Brook sites.

Site (RM)	Date	Coleoptera	Diptera	Ephemeroptera	Plecoptera	Trichoptera	Oligochaeta	Other (Amphipods/Isopods/ Gastropds)
0.2	9/30/1993	4.0	43.5	0.0	0.2	31.6	2.3	18.4
	10/12/1999	6.3	27.3	0.0	32.3	20.3	1.3	12.3
	10/09/2003	14.0	11.5	0.0	0.4	64.0	0.0	10.1
	10/8/2004	3.4	43.0	0.0	0.3	45.1	1.4	6.8
	10/21/2005	2.2	29.1	0.0	14.9	44.8	0.4	8.6
0.4	10/09/2003	6.0	14.5	0.0	0.0	72.4	0.8	6.4
0.7	10/13/1994	17.7	32.5	0.0	1.0	41.3	0.3	7.2

Table 5. Physical-chemical measures and habitat observations, taken at time of macroinvertebrate sampling, from Bartlett Brook sites 1993-2003.

Site (RM)	Date	% Boulder	% Cobble	% Coarse Gravel	% Gravel	% Sand	Silt rating 0-5	% Embed	% Canopy	% Filament	% Bl.Gr.	% Moss
0.2	9/30/1993	10	25	20	25	25	3	25-50	100	0	10	0
	10/12/1999	25	20	20	20	15	4	50-75	100	20	0	0
	10/09/2003[1]	10	27	31	13	18	4	50-75	90	0	0	0
	10/8/2004[1]	28	30	19	6	17	4	50-75	90	0	0	0
	10/21/2005[1]	18	21	13	20	28	4	50-75	95	0	20	0
0.4	10/09/2003	1	25	55	25	5	2	25-50	50	0	5	0
0.7	10/13/1994	0	25	55	10	10	2	5-25	100	0	0	0

[1] Pebble Count used to estimate substrate composition at this site since 2003.

Table 6: Water chemistry parameters for Bartlett Brook sampling sites. RM = river mile. See end of table for parameter abbreviations.

Site (RM)	Date	Color Pt Co units	Time	Water Temperature ^{0} C	Dissolved Oxygen mg/l	Dissolved Oxygen % Saturation
0.2	10/8/2004	17.5	1230	13.59	11.19	107.8
	6/14/2005		1015	20.5	7.81	77.3
	6/29/2005		900	20.8	6.67	91.8
	7/6/2005		1430	20	7.83	86.8
	7/27/2005		1311	21.2	7.68	83.6
	8/9/2005		1100	22.2	8.4	98.1
	8/26/2005		950	16.5	9.52	96
	9/19/2005		1330	18.1	9.08	96.4
	9/27/2005		925	15.5	8.81	88.2
	10/11/2005		1000	13.1	8.3	78.5
	10/21/2005		940	8.6	**6.96**	**60.1**
	11/7/2005		1000	9.6	9.73	86.1
	11/14/2005		934	7.8	10.51	8.85
	3/10/2006		1230	0.8	13.87	98

Table 6 continued Ph, Alkalinity, Conductivity (those in italics lab cond). Anions and Cations, Total Hardness (calculated)

Site (RM)	SampleDate	pH std.units	Alk mg/l	Cond (field) µmhos/cm	Cl mg/l	Na mg/l	K mg/l	TSO4 mg/l	Ca mg/l	Mg mg/l	THC mg/l
	9/13/1993			777							
	9/30/1993	8.22	180	730							
	8/29/1994			755							
	9/22/1997	8.03	187	742							
	10/12/1999	8.15	196	907							
	9/20/2001	8.17		907							
	10/9/2003		198	*904*	166	91.6	4.48	23.2	72.2	18.7	
	10/8/2004	8.38	210	838	126	74.3	4.69	23.8	70.3	19.8	257
	6/14/2005	8	205	1047	191	114	4.64	23.7	75.6	22.6	
	6/29/2005	7.98	233	1190	219	126	5.05	36.4	88.2	24.2	
	6/29/2005		222		218	122	5.12	35.7	84.9	23.3	
	7/6/2005	8.06	164	897.6	156	92.8	4.21	32.6	61.4	19.8	
	7/19/2005		233	715	202	109	5.39	47.9	88.2	22.6	
	7/27/2005	7.77	85.9	348	53	25.4	2.03	14.4	23.4	6.01	
	8/9/2005	7.87	241	1105	184	5.09	102	42.4	84.6	21.6	
0.2	8/26/2005	7.6	261	1269	228	5.74	131	45.3	97.5	26.6	
	9/19/2005	7.75	194	941	180	102	4.38		74.5	21.1	273
	9/27/2005	7.47	163	936	120	70.2	3.93	38.5	57.5	16.8	213
	10/11/2005	7.37	193	876	123	73.4	4	45.5	64.9	17.9	236
	10/21/2005	7.44	212	961	114	72.2	4.16	37.2	70.6	19.9	260
	11/7/2005	7.98	175	788.4	100	57.3	4.09	33.7	59.8	19.2	228
	11/14/2005	7.79	202	822.2	113	64.1	3.92	33.6	66.4	19.5	245
	11/23/2005	7.52	166	926	150	98.3	3.41	23.6	67.9	20.9	256
	12/12/2005	7.53		827	116	68.8	3.06	27.1	64.2	19.2	240
	12/12/2005			*841*	118	73.5	3.04	33.2	66.6	19.5	247
	1/11/2006	7.56	176	825	141						
	1/12/2006	7.47	146	814	148	83.9	2.84	18.2	48.5	14.7	182
	2/8/2006	7.52	170	758	124						
	2/16/2006	7.49	177	866	149						
	3/10/2006	7.96	116	870	177	105	3.47	18.6	47.8	13.8	176
	3/10/2006		117		176	103	3037	18.7	45.9	80	167
	2/16/2006		180	*870*	143						
0.4	4/5/2006	8.07	134	690	108	59.3	2.78	17.3	47.6	13.6	175
	10/06/2008			895	137	86.2	4.07	24.3	69.4	19.8	255
0.7	8/29/1994			620							
	10/13/1994	8.05	157	722							

Table 6 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
0.2	10/9/2003	Low	Base	11.9		30		0.87	0.64
	10/8/2004	Low	Base	2.36	7.4	19	11	1.16	0.88
	6/14/2005	Moderate	Freshet	9.72	11.9	40.9	13.5	0.87	0.56
	6/29/2005			4.11	6.24	27.8	14.9	1.07	0.8
	6/29/2005			4.83	4.66	30	13.3	1.09	0.81
	7/6/2005	Moderate	Freshet	18.8	21.1	58.2	23.4	0.97	0.57
	7/19/2005	Moderate	Base	2.69	3.08	25.6	14.3	1.02	0.82
	7/27/2005	Moderate	Freshet	204	192	357	79.1	0.9	0.23
	8/9/2005	Low	Base	2.16	4.56	20.4	12.1	1.08	0.88
	8/26/2005	Low	Base	3.93	7.08	20.6	9.17	0.81	0.54
	9/19/2005	Moderate	Base	8.21	5.38	31.2	13.8	0.99	0.71
	9/27/2005	Moderate	Freshet	6.88	5.43	38	15.6	0.75	0.4
	10/11/2005	Moderate	Freshet	2.99	3.06	26.6	16.8	1.12	0.83
	10/21/2005	Moderate	Base	1.64	1	25.2	14.5	1.61	1.34
	11/7/2005	Moderate	Freshet	5.1	5.24	38.7	22	1.49	1.14
	11/14/2005	Low	Base	1.85	1	23.9	16.6	1.41	1.36
	11/23/2005	Moderate	Freshet	1.98	2.41	27.4	14.3	1.11	0.83
	12/12/2005	Low	Base	1.89	1	17.2	10.4	1.9	1.57
	12/12/2005	Low	Base	1.79	1.25	16.9	11.3	2.15	1.97
	1/11/2006	Moderate	Freshet	3.91	4.02	26.2		2.21	1.96
	1/12/2006	High	Freshet	17.6	17.3	58.3	23.3	1.15	0.92
	2/8/2006	Moderate	Base	6.27		23.9		2.36	2.14
	2/16/2006	Low	Base	3.01		14.5		1.99	1.83
	3/10/2006	High		287		236	26	1.72	1.07
	3/10/2006	High		331		244	29.8	1.76	0.93
0.4	2/16/2006			2.61		14.2		1.5	1.26
	4/5/2006	Moderate	Freshet	19.8		55.6	16.5	1.17	0.84
	10/6/2008	Moderate		3.18		20.4	11.8	0.7	0.51

Table 6 continued – Metals. All metals except Iron (Fe) and Manganese (Mn) were below detection limits of test, either 1,5,10 ug/l

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
0.2	10/9/2003	420	77.2	<10		<5	<10	<25		<5	<1	<1	<5	<10	<5
	10/8/2004	50	46.1		<1	<5	<5	<10	<10	<1					
	6/14/2005	50	78.2	<5	<1	<5	<10	<10		<1	<1	<1	<5	<10	<1
	6/29/2005	50	73.6	<5	<1	<5	<10	<10		<1	<1	<1	<5	<10	<1
	6/29/2005	50	74.6	<5	<1	<5	<10	<10		<1	<1	<1	<5	<10	<1
	7/6/2005	50	54.9	<5	<1	<5	<10	<10		<1	<1	<1	<5	<10	<1
	7/19/2005	50	76	<5	<1	<5	<10	<10		<1	<1	<1	<5	<10	<1
	7/27/2005	598	41.7	<5	<1	<5	<10	<10		<1	<1	<1	<5	<10	<1
	8/9/2005	50	67.5	<5	<1	<5	<10	<10		<1	<1	<1	<5	<10	<1
	8/26/2005	50	94.6	<5	<1	<5	<10	<10		<1					
	9/19/2005	50	57	<5	<1	<5	<10	<10		<1					
	9/27/2005	50	40.1	<5	<1	<5	<10	<10	<10	<1					
	10/11/2005	50	49.1	<5	<1	<5	<10	<10		<1					
	10/21/2005	50	52	<5	<1	<5	<10	<10		<1					
	11/7/2005	84.7	55.7	<5	<1	<5	<10	<10		<1					
	11/14/2005	84.2	52.3	<5	<1	<5	<10	<10		<1					
	11/23/2005	50	50	<5	<1	<5	<10	<10		<1					
	12/12/2005	50	67.9	<5	<1	<5	<10	<10		<1					
	12/12/2005	50	74.9	<5	<1	<5	<10	<10		<1					
	1/12/2006	50	51.5	<5	<1	<5	<10	<10		<1					
	3/10/2006	207	79.4	<5	<1	<5	<10	<10		<1					
	3/10/2006	144	80	<5	<1	<5	<10	<10		<1					
0.4	4/5/2006	99.2	33.8	<5	<1	<5	<10	<10		<1					
	10/6/2008	<50	56.9	<5	<1	<5	<10	<50	<10	<1	<1	<1	<5	<10	<1

Alk - Alkalinity	TSS - Total suspended solids	Cu - Copper
Cond- Specific conductance	TP - Total phosphorus	Zn - Zinc
Cl - Chloride	TDP - Total dissolved phosphorus	Al - Aluminum
Na - Sodium	TN - Total nitrogen	As - Arsenic
K - Potassium	TNOX - Total nitrates-nitrites	Ag - Silver
TSO4 - Total sulfates	Fe- Iron	Be - Beryllium
Ca - Calcium	Mn - manganese	Se - Selenium
Mg- Mangnesium	Ni - Nickel	Sb - Antimony
THC- Total hardness	Cr - Chromium	Ti - Titanium
Turb - Turbidity	Cd - Cadmium	