Technical Memorandum CN 233.3

WESTFIELD RIVER WATERSHED
2006 BENTHIC MACROINVERTEBRATE BIOASSESSMENT

Division of Watershed Management
Watershed Planning Program
Worcester, MA

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Commonwealth of Massachusetts
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INTRODUCTION

Biological monitoring is a useful means of detecting anthropogenic impacts to the aquatic community. Resident biota (e.g., benthic macroinvertebrates, fish, periphyton) in a water body are natural monitors of environmental quality and can reveal the effects of episodic and cumulative pollution and habitat alteration (Plafkin et al. 1989, Barbour et al. 1995).

As part of the Massachusetts Department of Environmental Protection/Division of Watershed Management's (MassDEP/DWM) 2006 Westfield River Watershed assessments, aquatic benthic macroinvertebrate biomonitoring was conducted to evaluate the biological health of the Westfield River and selected tributaries and to determine their status with respect to the support of the *Aquatic Life* use, as designated in the *Massachusetts Surface Water Quality Standards* (SWQS) (MassDEP 2006a). These assessments form the basis for reporting and listing waters pursuant to sections 305(b) and 303(d) of the Clean Water Act (CWA). A total of eleven biomonitoring stations on eight named streams were sampled to investigate the effects of potential point and nonpoint sources of pollution—both historical and current—on the aquatic communities of the watershed. While sampling station locations may have varied from survey to survey, all of the streams had been previously assessed by MassDEP (Szal 1998; Fiorentino and Mitchell 2004; Dunn and Kennedy 2005). Table 1 presents the 2006 sampling locations, along with station identification numbers and sampling dates. Perceived issues and problems that were to be addressed during the 2006 Westfield River Watershed macroinvertebrate survey are presented in Table 2.

To provide information for making *Aquatic Life* use-support determinations, macroinvertebrate communities present at biomonitoring stations in the Westfield River Watershed were compared with communities occurring at regional reference stations most representative of "least disturbed" conditions in the watershed. Two watershed reference stations were established at sites unaffected by point sources of water pollution, and assumed [based on historical water quality data (Dunn and Kennedy 2005), topographic map examinations, and field reconnaissance] to be minimally impacted (relative to other portions of the Westfield Watershed) by nonpoint sources. Station YB01A on Yokum Brook was established as a reference site to be used for assessing small watersheds, and Station WB01 on the West Branch Westfield River served as the reference site for large watersheds. Impacts to the benthic community may be indicated by the absence of generally pollution-sensitive macroinvertebrate taxa such as Ephemeroptera, Plecoptera, and Trichoptera (EPT); dominance of a particular taxon, especially the pollution-tolerant Chironomidae and Oligochaeta taxa; low total taxa richness; or shifts in community composition relative to the reference station (Plafkin et al. 1989).

METHODS

Macroinvertebrate Sampling - RBPIII

Macroinvertebrate sampling activities employed for the 2006 Westfield River Watershed survey were conducted in accordance with the Sampling & Analysis Plan (SAP) for the Westfield River Watershed (MassDEP 2006b). The sampling procedures are described in the standard operating procedures *Water Quality Monitoring in Streams Using Aquatic Macroinvertebrates* (Nuzzo 2003), and are based on US EPA Rapid Bioassessment Protocols (RBPs) for wadeable streams and rivers (Plafkin et al. 1989). The macroinvertebrate collection procedure utilized kick-sampling, a method of sampling benthic organisms by kicking or disturbing bottom sediments and catching the dislodged organisms in a net as the current carries them downstream. Sampling was conducted by MassDEP/DWM biologists throughout a 100 m reach, in riffle/run areas with fast currents and rocky (cobble, pebble, and gravel) substrates—generally the most productive habitats, supporting the most diverse communities in the stream system. Ten kicks in squares approximately 0.46 m x 0.46 m were composited for a total sample area of about 2 m^2. Samples were labeled and preserved in the field with denatured 95% ethanol, then brought to the MassDEP/DWM lab for further processing.

Table 1. List of biomonitoring stations sampled during the 2006 Westfield River watershed survey, including station and unique identification numbers, drainage areas, sampling site descriptions, and sampling dates.

Station ID	Unique ID	Drainage Area (mi^2)	Sampling Site Description	Sampling Date
MEDB01	B0578	4.16	Meadow Brook, ~75 meters upstream of the confluence with the Westfield River, Cummington, MA	6-Sept-2006
WRDS04	B0577	1.49	Wards Stream, upstream at Harvey Road, Worthington, MA	6-Sept-2006
YB01A	B0480	8.23	Yokum Brook, ~270 meters upstream from Route 8 crossing nearest to mouth, Becket, MA	6-Sept-2006
YB01B	B0479	8.31	Yokum Brook, upstream/South from Prentice Place, Becket, MA	6-Sept-2006
WBR01	B0579	2.54	West Branch Walker Brook, ~10 meters upstream from Bonny Rigg Hill Road, Becket, MA	6-Sept-2006
WBWR01	B0576	50.5	West Branch Westfield River, ~50 meters upstream from Middlefield Road, Chester, MA	6-Sept-2006
WB01	B0175	94.5	West Branch Westfield River, ~920 meters upstream/Northwest from Route 112, Huntington, MA	5-Sept-2006
WR02	B0177	321	Westfield River, ~590 meters downstream/South from confluence with West Branch Westfield River, adjacent to Roadside Park, Huntington, MA	5-Sept-2006
LR02C	B0475	54	Little River, ~275 meters downstream from Cook Brook, Westfield, MA	5-Sept-2006
PNDB00.1	B0575	8.77	Pond Brook, upstream at Union Street, Westfield, MA	5-Sept-2006
WR07	B0182	452	Westfield River, ~725 meters downstream/East of confluence with Little River, Westfield, MA	5-Sept-2006

Macroinvertebrate Sample Processing and Data Analysis

The macroinvertebrate sample processing and analysis procedures employed for the 2006 Westfield River watershed biomonitoring samples are described in the standard operating procedures (Nuzzo 2003). Macroinvertebrate sample processing entailed distributing whole samples in pans, randomly selecting grids within the pans, and sorting specimens from the other materials in the sample until approximately 100 organisms (±10%) were extracted. Specimens were identified to genus or species as allowed by available keys, specimen condition, and specimen maturity.

Based on the taxonomy, various community, population, and functional parameters, or "metrics", were calculated which allow measurement of important aspects of the biological integrity of the macroinvertebrate community. This integrated approach provides more assurance of a valid assessment because a variety of biological parameters are evaluated, and the deficiency of any one metric should not invalidate the entire approach (Plafkin et al. 1989). Taxonomic data were analyzed using a modification of Rapid Bioassessment Protocol III (RBP III) metrics and scores (Plafkin et al. 1989). The modifications were: substitution of "reference site affinity" (RSA) for the Community Loss Index and elimination of the shredder/total ratio (no separate leaf-pack material was collected). The reference site affinity metric is a modification of Percent Model Affinity (Novak and Bode 1992). Instead of using the model's percentages for Oligochaeta, Ephemeroptera, Plecoptera, Trichoptera, Coleoptera, Chironomidae, and "other," these percentages were taken from the reference site data. The RSA score is then calculated as:

$$100 - \Sigma (\delta \times 0.5)$$

Table 2. List of perceived problems addressed during the 2006 Westfield River Watershed biomonitoring survey. In addition to providing biological and habitat information to support *Aquatic Life Use* determinations for reporting under section 305(b) of the Clean Water Act, several sampling stations were positioned to provide data and information to evaluate suspected sources of pollution or other potential water quality-related problems. Issues to be investigated were identified in Fiorentino and Mitchell (2004) and in the Westfield River Watershed Sampling and Analysis Plan (MassDEP 2006b).

Stream Name	Station ID	Issues/Problems
Meadow Brook	MEDB01	All uses not currently assessed. Expand spatial coverage of bioassessments.
Wards Stream	WRDS04	Investigate combined effects of Town of Worthington water withdrawals, NPDES sanitary discharge from "The Maples" and runoff from a junk yard.
Yokum Brook	YB01A	Reference condition for evaluation of dam removal and for sites with small drainage areas
Yokum Brook	YB01B	To document any changes in stream biota resulting from dam removal projects
West Branch Walker Brook	WBR01	To evaluate the potential effects of heavy shorefront development around Robin Hill Lake.
Little River	LR02C	To assess potential impacts to Little River from Cook Brook and the West Parish Filtration Plant filter backwash discharge
Pond Brook	PNDB00.1	All uses not currently assessed. Expand spatial coverage of bioassessments.
West Branch Westfield River	WBWR01	To verify "Alert Status" designation for Aquatic Life Use
West Branch Westfield River	WB01	Reference condition for sites with large drainage areas.
Westfield River	WR02	To continue to monitor combined effects of NPDES point discharges, FERC regulated hydropower projects and other potential pollution sources
Westfield River	WR07	To continue to monitor combined effects of NPDES point discharges, FERC regulated hydropower projects and other potential pollution sources

where δ is the difference between the reference percentage and the sample percentage for each taxonomic grouping. RSA percentages convert to RBP III scores as follows: 0 points for <35%; 2 points in the range from 35 to 49%; 4 points for 50 to 64%; and 6 points if ≥65%. The entire suite of metrics used for the analysis was:

- Richness—the total number of different species present in the subsample plus those detected from a "large/rare" search of the whole sample (those taxa missed in subsampling);
- HBI—Hilsenhoff Biotic Index (Hilsenhoff 1982), as modified in Nuzzo (2003); the HBI is the sum of the products of each taxon's abundance and its corresponding pollution tolerance value, divided by the total count in the subsample;
- EPT—sum of richness among the orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) as determined from the specimens in the subsample plus those detected in a "large/rare" search of the whole sample; these orders tend to be dominated by species generally considered to be pollution sensitive;
- $EPT_a/Chiro_a$—ratio of total abundance among EPT taxa to total abundance among Chironomidae taxa;

- SC/FC—ratio of the proportion of sample that is represented by individuals that predominantly feed by scraping to those that are primarily filter-feeders;

- % Dominant—most abundant taxon as a percent of the assemblage; >20% is generally considered hyperdominant and indicative of a stressor impact;

- RSA—reference site affinity (described above).

Metric values for each station were scored based on comparability to the reference station, and scores were totaled. The percent comparability of total metric scores for each study site to those for the selected "least-impacted" reference station yielded an impairment score for each site. RBP III analysis separates sites into four categories: "non-impaired", "slightly impaired", "moderately impaired", and "severely impaired". Each impairment category corresponds to a specific *Aquatic Life* use-support determination used in the CWA Section 305(b) water quality reporting process—non-impaired and slightly impaired benthic invertebrate communities are generally indicative of conditions supporting the *Aquatic Life* use, whereas water bodies exhibiting moderately or severely impaired communities are generally assessed as "non-support."

Habitat Assessment

Habitat qualities were scored for each sampling reach using the assessment procedure in Plafkin et al. (1989), as modified in Barbour et al. (1999). An evaluation of physical and biological habitat quality is critical to any assessment of ecological integrity (Karr et al. 1986; Plafkin et al. 1989). Habitat assessment supports understanding of the relationship between physical habitat quality and biological conditions, identifies obvious constraints on the attainable potential of a site, assists in the selection of appropriate sampling stations, and provides basic information for interpreting biosurvey results (US EPA 1995). The matrix used to assess habitat quality is based on key physical characteristics of the water body and the immediate riverfront area. Most parameters evaluated are instream physical attributes that are potential sources of limitation to the aquatic biota (Plafkin et al. 1989). The ten habitat parameters are as follows: instream cover, epifaunal substrate, embeddedness, sediment deposition, channel alteration, velocity/depth combinations, channel flow status, right and left (when facing downstream) bank vegetative protection, right and left bank stability, right and left bank riparian vegetative zone width. Habitat parameters are scored, totaled, and compared to the reference station to infer the extent to which the condition of the habitat, rather than water quality effects, may account for differences in macroinvertebrate community structure at the study sites.

RESULTS AND DISCUSSION

Habitat quality was excellent at the biomonitoring sites draining large watersheds (i.e., >50 mi^2). The mean habitat score for the large streams was 170, with all stations scoring from 78% - 85% of the maximum attainable value of 200 (Table 3). By contrast, the mean habitat score was 148 for sites draining small watersheds (i.e., <10 mi^2). Nonetheless, all habitat scores at these sites equaled or exceeded 70% of the best value attainable and, key to this assessment, the habitat scores of all of the monitoring sites compared very favorably with those of their particular reference sites (WB01 and YB01A for large and small watersheds, respectively). Habitat quality at all four "test sites" on large streams was actually superior to the habitat offered by the reference station.

A taxonomic list of the macroinvertebrate organisms collected at each sampling station during the 2006 biomonitoring survey is attached as an Appendix. Included in the list are total organism counts, the functional feeding group designation (FG) for each macroinvertebrate taxon, and the tolerance value (TV) of each taxon. Table 4 presents a summary of the RBP III macroinvertebrate data analyses for sites draining small watersheds. Included are biological metric calculations, metric scores, and impairment designations. A similar assessment summary is presented for the large drainage sites in Table 5.

The benthic macroinvertebrate community at Station YB01A received a total metric score of 40 out of a possible 42, supporting its designation as the reference condition for the sites draining small watersheds

(Table 4). While this station lost points in the % Dominant Taxon metric (21%), the causal taxon, *Ephemerella* sp., is very intolerant of organic enrichment and is indicative of good water quality conditions. Furthermore, the Taxa Richness and Biotic Index metrics performed better at YB01A than at any sites to which it was compared in the RBP III analysis. The suitability of Station WB01 as the reference site for biomonitoring stations on large streams was, likewise, demonstrated by a maximum total metric score of 42 (Table 5). The benthic community at WB01 exhibited the best Taxa Richness, EPT Index and Biotic Index scores of all of the sites in large watersheds.

Table 3. Habitat assessment summary for biomonitoring stations sampled during the 2006 Westfield River Watershed survey. For within-reach parameters, scores ranging from 16-20 = optimal; 11-15 = suboptimal; 6-10 = marginal; 0-5 = poor. For riparian parameters, scores ranging from 9-10 = optimal; 6-8 = suboptimal; 3-5 = marginal; 0-2 = poor. Maximum habitat score for any site = 200. Refer to Table 1 for a listing and description of sampling stations.

STATION	MEDB01	WRDS04	YB01A[1]	YB01B	WBR01	WBWR01	WB01[2]	WR02	LR02C	PNDB00.1	WR07
WITHIN-REACH PARAMETERS (range is 0-20)	**SCORE**										
INSTREAM COVER	17	11	17	18	13	15	14	14	15	19	20
EPIFAUNAL SUBSTRATE	17	16	17	19	14	19	17	19	19	17	17
EMBEDDEDNESS	14	13	20	20	17	17	18	19	19	11	19
CHANNEL ALTERATION	15	19	19	19	19	19	15	19	20	14	19
SEDIMENT DEPOSITION	14	14	20	19	18	20	16	20	20	14	16
VELOCITY-DEPTH COMBINATIONS	10	10	17	19	10	10	10	13	10	14	17
CHANNEL FLOW STATUS	18	12	13	10	6	15	18	19	15	19	17
RIPARIAN PARAMETERS (range is 0-10 for each bank)	**SCORE**										
BANK VEGETATIVE PROTECTION left	10	8	2	7	10	10	9	10	9	8	9
BANK VEGETATIVE PROTECTION right	9	10	2	7	10	10	10	9	10	10	9
BANK STABILITY left	9	10	1	7	3	10	10	10	9	8	6
BANK STABILITY right	9	6	1	8	5	10	10	10	10	9	6
RIPARIAN VEGETATIVE ZONE WIDTH left	2	1	7	7	10	10	4	9	9	1	5
RIPARIAN VEGETATIVE ZONE WIDTH right	1	10	8	5	10	10	4	3	10	3	10
TOTAL SCORE	**145**	**140**	**144**	**165**	**145**	**175**	**155**	**174**	**175**	**147**	**170**

[1] Reference site for small drainage areas; [2] Reference site for large drainage areas

The macroinvertebrate communities present at all of the small watershed sampling sites (Table 4) were at least 80% comparable to the reference community, resulting in assessments of either “non-impaired” (YB01B, WBR01) or “slightly/non-impaired” (MEDB01, WRDS04, PNDB00.1). Although Meadow and

Pond brooks and Wards Stream exhibited slight deviations from the reference condition, all of the sites draining small watersheds were considered to be in support of the designated *Aquatic Life Use.* Meadow and Pond brooks were chosen for study in 2006 primarily to expand the spatial coverage of assessed waters within the Westfield River Watershed. Wards Stream, the West Branch Walker Brook and the downstream station on Yokum Brook (YB01B) were not only targeted for general assessment purposes (i.e., §305b reporting), but were selected in order to evaluate the potential effects of particular activities within their watersheds (see Table 2). Nevertheless, results of the RBP III analysis provided little or no evidence of any deleterious impacts from activities such as dam removal on Yokum Brook, development in the Walker Brook Watershed or water withdrawals and wastewater discharges in the catchment area of Wards Stream.

Table 4. Summary of RBP III analysis of macroinvertebrate communities sampled during the Westfield River Watershed survey between 5 and 6 September 2006. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station for small watersheds (YB01A), and the corresponding assessment designation for each biomonitoring station. Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	**YB01A**		**YB01B**		**MEDB01**		**WRDS04**		**WBR01**		**PNDB00.1**	
STREAM	Yokum Brook		Yokum Brook		Meadow Brook		Wards Stream		West Br. Walker Brook		Pond Brook	
HABITAT SCORE	144		165		145		140		145		147	
TAXA RICHNESS	30	*6*	25	*6*	28	*6*	20	*4*	30	*6*	29	*6*
BIOTIC INDEX	2.41	*6*	2.76	*6*	3.54	*2*	3.07	*4*	2.90	*4*	4.75	*2*
EPT INDEX	14	*6*	15	*6*	11	*2*	10	*2*	12	*4*	14	*6*
EPT/CHIRONOMIDAE	3.41	*6*	8.09	*6*	1.94	*4*	10.88	*6*	3.47	*6*	4.63	*6*
SCRAPER/FILTERER	0.25	*6*	0.18	*6*	0.68	*6*	0.42	*6*	1.05	*6*	0.10	*4*
REFERENCE AFFINITY	100%	*6*	88%	*6*	88%	*6*	81%	*6*	70%	*6*	59%	*4*
% DOMINANT TAXON	21%	*4*	18%	*6*	19%	*6*	29%	*4*	15%	*6*	23%	*4*
TOTAL METRIC SCORE	*40*		*42*		*32*		*32*		*38*		*32*	
% COMPARABILITY TO REFERENCE	--		105%		80%		80%		95%		80%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	**REFERENCE**		**NON-IMPAIRED**		**SLIGHTLY/ NON-IMPAIRED**		**SLIGHTLY/ NON-IMPAIRED**		**NON-IMPAIRED**		**SLIGHTLY/ NON-IMPAIRED**	

Results of the RBP III analyses of sites draining large watershed areas (Table 5) ranged from "non-impaired" at Station WR02 on the Westfield River to "moderately impaired" at the sampling station on the Little River (LR02C). Stations WBWR01 on the West Branch Westfield River ("slightly/non-impaired") and WR07 on the Westfield River ("slightly impaired") exhibited slight deviations from the reference condition, but were still judged to be in support of the designated *Aquatic Life Use.* The bioassessment of the Little

River, however, led to the determination that the *Aquatic Life Use* was not supported by this water body. Despite the availability of excellent habitat (Habitat Score = 175), the benthic macroinvertebrate community at Station at LR02C was only 48% comparable to that of the reference station. While the EPT Index and Scraper/Filterer metrics compromised the total metric score the most, the EPT/Chironomidae and Reference Affinity metrics also scored poorly. This site was chosen for study, in part, to evaluate the influence on receiving water quality of the filter backwash discharge from the West Parish Filters Water Treatment Plant which enters the Little River via Cook Brook less than 300 meters upstream from the sampling location.

Table 5. Summary of RBP III analysis of macroinvertebrate communities sampled during the Westfield River Watershed survey between 5 and 6 September 2006. Shown are the calculated metric values, metric scores (in italics) based on comparability to the reference station for large watersheds (WB01), and the corresponding assessment designation for each biomonitoring station. Refer to Table 1 for a listing and description of sampling stations.

SAMPLING STATION	**WB01**		**WBWR01**		**WR02**		**WR07**		**LR02C**	
STREAM	West Br. Westfield River		West Br. Westfield River		Westfield River		Westfield River		Little River	
HABITAT SCORE	155		175		174		170		175	
TAXA RICHNESS	36	*6*	29	*6*	32	*6*	27	*4*	32	*6*
BIOTIC INDEX	3.68	*6*	3.90	*6*	4.49	*4*	4.55	*4*	4.74	*4*
EPT INDEX	17	*6*	14	*4*	16	*6*	12	*2*	10	*0*
EPT/CHIRONOMIDAE	2.50	*6*	2.21	*6*	2.50	*6*	2.94	*6*	1.15	*2*
SCRAPER/FILTERER	0.69	*6*	0.19	*2*	0.44	*6*	1.45	*6*	0.13	*0*
REFERENCE AFFINITY	100%	*6*	65%	*4*	73%	*6*	59%	*4*	41%	*2*
% DOMINANT TAXON	17%	*6*	13%	*6*	14%	*6*	17%	*6*	11%	*6*
TOTAL METRIC SCORE	*42*		*34*		*40*		*32*		*20*	
% COMPARABILITY TO REFERENCE	--		81%		95%		76%		48%	
BIOLOGICAL CONDITION -DEGREE IMPACTED	**REFERENCE**		**SLIGHTLY/ NON-IMPAIRED**		**NON-IMPAIRED**		**SLIGHTLY IMPAIRED**		**MODERATELY IMPAIRED**	

Five years earlier, Fiorentino and Mitchell (2004) found the benthic macroinvertebrate community at Station LR02C to be “slightly” or “moderately” impaired depending on which of their reference sites was used in the analysis. They attributed the impairment to the Cook Brook discharge; and this was further supported by the condition of the habitat. At that time, habitat parameters most closely associated with instream sedimentation – sediment deposition and embeddedness – were greatly reduced from the reference condition, and a large buildup of fine sediments was observed at the mouth of Cook Brook. In

2006, however, habitat quality was rated much higher, and there was little evidence of the sedimentation that was documented earlier at this site. Unlike in 2001, no reference site was established on the Little River immediately upstream from the confluence with Cook Brook. Nonetheless, the condition of the benthic macroinvertebrate community downstream from the confluence continues to implicate the water treatment facility with water quality problems in Cook Brook and the Little River. Sediments may be settling on the stream bottom at times of low flow and washing away during higher flow events. Repeated settling and scouring of the substrates in this manner may be hindering the establishment of a diverse and well-functioning macroinvertebrate community in the lower portion of the Little River.

SUMMARY AND RECOMMENDATIONS

Sampling of the benthic macroinvertebrate community was carried out in September, 2006 at eleven sites in the Westfield River Watershed to evaluate the biological health of selected streams and to determine their status with respect to the support of the *Aquatic Life* use. Results of these assessments form the basis for reporting and listing waters under sections 305(b) and 303(d) of the Clean Water Act. In addition, some sites were chosen to evaluate the potential effects of particular activities within their watersheds. Field and laboratory methods and data analysis were based on the USEPA's Rapid Biomonitoring Protocols. Station YB01A on Yokum Brook, served as the reference site for streams draining small watersheds (<10 mi^2), and Station WB01 on the West Branch Westfield River defined the reference condition for sites draining large watershed areas (>50 mi^2). With one exception, the water bodies ranged between "non-impaired" and "slightly impaired" and these waters were considered to be supporting the *Aquatic Life Use.* Only in the Little River ("moderately impaired") was the benthic macroinvertebrate community degraded to the point where the *Aquatic Life Use* was not supported. The Little River was investigated at a location immediately downstream from its confluence with Cook Brook, a tributary that receives the intermittent discharge of filter backwash from the City of Springfield's West Parish Filters Water Treatment Plant.

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APPENDIX

Species-level taxa list and counts, functional feeding groups (FG), and tolerance values (TV) for macroinvertebrates collected from stream sites during the 2006 Westfield River Watershed survey on 5 and 6 September 2006. Refer to Table 1 for a listing and description of sampling stations.

TAXON	FFG[1]	TV[2]	Sampling Stations										
			MEDB01	WRDS04	YB01A[3]	YB01B	WBR01	WBWR01	WB01[4]	WR02	LR02C	PNDB00.1	WR07
Nais communis	GC	8							1				
Lumbriculidae	GC	7							2				
Hydrachnidia	PR	6					1				1		
Lebertia sp.	PR	6							1				
Sperchonidae	PR	6				1		1	2	1			4
Baetidae	GC	4								1			1
Acentrella turbida	SC	4	13		1	1			1	1			1
Baetis sp.	GC	6										6	
Baetis flavistriga	GC	4		3				2	1	6		2	2
Baetis intercalaris	GC	6	2				5	2	1			2	5
Baetis tricaudatus	GC	6		29	3	12		1				1	
Plauditus sp.	GC	4							3	8			
Ephemerella sp.	GC	1	2	16	22		3	4		2			2
Ephemerella subvaria	GC	1	2	4	8	18			9		1		
Eurylophella sp.	GC	2								1			
Serratella sp.	GC	2			1			1	1	1		1	
Heptageniidae	SC	4	2						1	1			
Epeorus vitreus	SC	0							2				
Maccaffertium sp.	SC	3		3	1		3	4	6	8			
Maccaffertium modestum	SC	1											10
Maccaffertium vicarium	SC	2				2							
I*sonychia* sp.	FC	2	1		4			5	5	2			1
Paraleptophlebia sp.	GC	1	19	9	8	19	16	11	5				
Boyeria grafiana	PR	2				1							
Boyeria vinosa	PR	2										1	
Ophiogomphus sp.	PR	1							1				
Plecoptera	GC	3					1						
Sweltsa sp.	PR	0					3		1				
Leuctra sp.	SH	0					1						
Tallaperla maria	SH	0				1							
Acroneuria abnormis	PR	0					3			1		2	
Paragnetina sp.	PR	1	1			1		2					
Paragnetina immarginata	PR	1					3		3	1	2		
Paragnetina media	PR	5										7	
Perlodidae	PR	2			1								
Pteronarcys biloba	SH	0										1	
Corydalus cornutus	PR	4							3	1			1
Nigronia serricornis	PR	0					2						
Apatania sp.	SC	3						1					1
Brachycentrus appalachia	FC	0						1					
Micrasema sp.	SH	2										1	
Glossosoma sp.	SC	0		2	3	2	4						

Protoptila sp.	SC	1											1
Cheumatopsyche sp.	FC	5	2			1		12	1	14	6	8	15
Diplectrona modesta	FC	0			2							1	
Hydropsyche sp.	FC	4			6	6	7		2		8	4	
Hydropsyche alhedra	FC	5			1	1							
Hydropsyche betteni	FC	7										10	
Hydropsyche morosa gr.	FC	6	11			1		13		4	4	2	8
Hydropsyche slossonae	FC	4	2		7	14					8		
Hydropsyche sparna	FC	6		2		1				2	11		
Hydroptilidae	GC	4											1
Hydroptila sp.	GC	6								2	1	2	
Lepidostoma sp.	SH	1	1	2	1								
Setodes sp.	GC	2							1				
Chimarra sp.	FC	4									1		
Chimarra aterrima	FC	4					4		2			24	2
Chimarra socia	FC	2								5			
Dolophilodes distinctus	FC	0	4	16	6	8	6	3			3		
Rhyacophila minor	PR	1		1		1					1		
Elmidae	SC	4											2
Optioservus sp.	SC	4							1				11
Oulimnius latiusculus	SC	4		2		1	5				2	5	1
Promoresia tardella	SC	2			1						3	1	
Stenelmis sp.	SC	5						1		4			
Stenelmis crenata	SC	5					5		9				18
Ectopria nervosa	SC	5									1		
Psephenus herricki	SC	4		1	1		5	1		1			
Atherix sp.	PR	4		1				1					
Ceratopogonidae	PR	6						1					
Cryptochironomus sp.	PR	8						2					
Microtendipes pedellus gr.	FC	6						1		1			
Polypedilum aviceps	SH	4	2		2	3	1	6	5		1	1	
Polypedilum flavum	SH	6							1				2
Polypedilum illinoense gr.	SH	6											1
Micropsectra sp.	GC	7	2	1	1		1						
Neozavrelia sp.	GC	5									1		
Rheotanytarsus exiguus gr.	FC	6	1									2	4
Rheotanytarsus pellucidus	FC	5		1					1				
Stempellina sp.	GC	2	1										
Stempellinella sp.	GC	2	2		2						1		
Tanytarsus sp.	FC	6			1		3		1				1
Diamesa sp.	GC	5	3	2	6		1					6	
Pagastia sp.	GC	1			3								
Potthastia gaedii gr.	GC	2							1	2			
Potthastia longimana gr.	GC	2								1	1		
Orthocladiinae	GC	5			1						1		
Cardiocladius obscurus	PR	5								2			
Chaetocladius sp.	GC	6		1									
Cricotopus bicinctus	GC	7			1				1	6	7	1	2
Cricotopus tremulus gr.	SH	7									3		
Cricotopus trifascia	SH	6										1	
Cricotopus/Orthocladius sp.	GC	7									2		
Diplocladius sp.	GC	8		1			1						
Eukiefferiella sp.	GC	6	1				1						
Eukiefferiella devonica gr.	GC	4									1		

Eukiefferiella gracei gr.	GC	4	3										
Heleniella sp.	GC	5									1		
Lopescladius sp.	GC	4			2			8	5				
Nanocladius sp.	GC	7								2	1		
Orthocladius sp.	GC	6	1			1		2	2	3	1	1	
Orthocladius carlatus	GC	6									2	1	1
Orthocladius dentifer	GC	6											2
Parachaetocladius sp.	GC	2	1			1	3						
Parametriocnemus sp.	GC	5	5				5	1	1		9	1	
Synorthocladius sp.	GC	6								4			2
Thienemanniella sp.	GC	6	1		1					1			
Tvetenia paucunca	GC	5	9	2	2	5					6	2	
Tvetenia vitracies	GC	5						7		2	1		2
Tanypodinae	PR	7					1						
Thienemannimyia gr.	PR	6				1		1			1		
Clinocera sp.	PR	6										1	
Hemerodromia sp.	PR	6			1		2			3		1	
Simulium sp.	FC	5	1		1	1	1	2	17	6	5	7	
Tipulidae	SH	5					1						
Antocha sp.	GC	3	1		1								1
Dicranota sp.	PR	3	1				4						
Hexatoma sp.	PR	2	1		2	2	3		1		2		
Limnophila sp.	SH	3						1					
Tipula sp.	SH	6		1									
TOTAL			**98**	**100**	**104**	**106**	**105**	**98**	**101**	**100**	**100**	**106**	**105**

[1]Functional Feeding Group (FG) lists the primary feeding habit of each species and follows the abbreviations: SH-Shredder; GC-Gathering Collector; FC-Filtering Collector; SC-Scraper; PR-Predator.

[2]Tolerance Value (TV) is an assigned value used in the calculation of the Biotic Index. Tolerance values range from 0 for organisms very intolerant of organic wastes to 10 for very tolerant organisms.

[3] Reference station for small watersheds

[4] Reference station for large watersheds