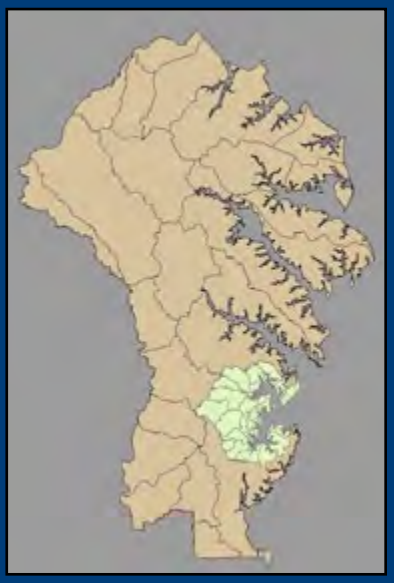

Targeted Biological Assessment of Streams in the West River and Rhode River Watersheds, Anne Arundel County, Maryland: 2012

Anne Arundel County, Maryland
Department of Public Works
Watershed, Ecosystem, and Restoration Services

Targeted Biological Assessment of Streams in the West River and Rhode River Watersheds, Anne Arundel County, Maryland: 2012

August 2012 - Final Report

Prepared for:

Anne Arundel County
Department of Public Works
Watershed, Ecosystem, and Restoration Services
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Background and Objectives

Anne Arundel County, in an effort to improve its surface water quality and streams, initiated systematic and comprehensive watershed assessments and management plans for restoration and protection across the County. Biological monitoring is a major component of the characterization and prioritization process. Anne Arundel County contracted KCI Technologies, Inc. to conduct a targeted assessment of the biological community and physical habitat in the West and Rhode Rivers Watersheds during the Spring of 2012. The targeted assessment focuses on *in situ* water quality measurements, sampling and analysis of the benthic macroinvertebrate community, and an assessment of instream and riparian physical habitat conditions.

The data collected and reported herein will be primarily utilized in the County's Watershed Management Tool (WMT), which is developed and maintained by the Department of Public Works, Watershed and Ecosystem Services and Restoration Division (WERS), Watershed Assessment and Planning Program (WAP). Within the WMT, relationships between biological condition, hydrology, water quality, and landuse are developed to support watershed and landuse planning and restoration goal setting. The West and Rhode Rivers watersheds targeted biological monitoring and assessment also fulfills part of the County's water quality assessment requirements under their National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit issued by the Maryland Department of the Environment (MDE), and assists the County in preparing TMDL implementation plans.

The biological data will also be beneficial for the ongoing County-wide Biological Monitoring and Assessment Program to further develop status, trends and problem identification for the portions of the County sampled. Collectively, the West and Rhode Rivers watersheds (MDE 8-digit watershed 02131004, West River) encompass 16,600 acres (25.9 square miles) and contain approximately 85 miles of streams based on the County's planimetric GIS stream data. Each watershed covers one primary sampling unit (PSU) defined by the County-wide Monitoring and Assessment strategy, West River (PSU-14), which was assessed by the County in 2008 and 2009 during Rounds 1 and 2, and Rhode River (PSU-13), which was assessed in and 2008 and 2012.

The West and Rhode Rivers watersheds were subdivided into 27 sub-basins, or subwatersheds, by WAP for targeted site selection, 14 in Rhode River and 13 in West River. Within these sub-basins, 50 targeted sites were selected, at which benthic macroinvertebrate samples were collected, *in situ* water quality was measured, and physical habitat was assessed between April 4 and April 27, 2012.

The West and Rhode Rivers watersheds are part of Maryland's Lower Western Shore basin. The watershed study area is made up of numerous unnamed 1st order tributaries draining directly to the West River and Rhode River as well as several larger 2nd order tributaries. Figure 1 – Vicinity Map shows the general location of the study area.

1 Methods

The monitoring program includes chemical, physical, and biological assessments conducted throughout the West and Rhode Rivers watersheds. The sampling methods used are consistent with the Anne Arundel County Biological Monitoring and Assessment Program and are detailed in the Quality Assurance Project Plan (QAPP; Anne Arundel County, 2011). A summary of these methods and the results of the 2012 monitoring are presented in this report.

Biological assessment methods within Anne Arundel County are designed to be consistent and comparable with the methods used by Maryland Department of Natural Resources (DNR) in their Maryland Biological Stream Survey (MBSS; DNR, 2010). All field crew leaders received recent training and/or certification in MBSS Spring Index Period sampling protocols prior to the commencement of sampling. The County has adopted the MBSS methodology to be consistent with statewide monitoring programs and programs adopted by other Maryland counties. The methods have been developed locally and are calibrated specifically to Maryland's physiographic regions and stream types.

1.1 Selection of Sampling Sites

The sampling design employed a targeted selection approach with a total of 50 sites distributed throughout the study area, covering 27 non-tidal subwatersheds (Figure 2). A complete list of targeted sites along with the corresponding subwatershed code is displayed in Table 1. The primary goals were to target each of the major stream reaches and to establish adequate spatial coverage throughout both watersheds. In addition, the location of sites sampled in the Rhode River watershed in March 2012 as part of the County-wide Monitoring and Assessment program, was also considered during the site selection process in an effort to avoid redundant sampling efforts while maintaining sufficient spatial coverage. In general, the targeted sites were selected in the downstream most reaches of the main tributaries located within each subwatershed, with additional sites placed to assess stream reaches not covered by the County-wide assessment. Where more than one site could be placed in a subwatershed, the preference for additional sites was in the central portion of the subwatershed or within parcels where landowner permission was granted. The site selection process was complicated by a large number of privately-owned parcels for which permission to access the stream channel was denied. Property owned by the Smithsonian Environmental Research Center (SERC) occupies a large percentage of both watersheds; with their cooperation, all sites located on these grounds were sampled. Of the 27 subwatersheds in the study area, four contained only one site, five contained two sites, four contained three sites, and three contained four sites. Only two subwatersheds contained more than four sites, RR8 which had five sites and RR5 which had seven. Additionally, there were nine subwatersheds that, upon field investigation, contained no assessment sites due to a lack of sampleable stream reaches. These were primarily smaller direct drainage subwatersheds in the eastern portions of the watersheds characterized by a predominance of dry ephemeral channels.

Table 1 – Sampling Sites and Corresponding Subwatersheds

Watershed	Subwatershed Name	Subwatershed Code	Site ID
West River	Johns Creek	WR1	WEST-16-2012
			WEST-17-2012
			WEST-19-2012
			WEST-22-2012
	Cheston Creek	WR2	WEST-53-2012
			WEST-55-2012
	Gales Creek	WR3	WEST-13-2012
			WEST-15-2012
	Popham Creek	WR4	WEST-50-2012
	Lerch Creek I	WR5	WEST-35-2012
			WEST-36-2012

Watershed	Subwatershed Name	Subwatershed Code	Site ID
	Lerch Creek II	WR6	WEST-39-2012
			WEST-43-2012
			WEST-42-2012
	Tenthouse Creek	WR7	WEST-46-2012
			WEST-48-2012
			WEST-49-2012
	Smith Creek I	WRB	WEST-23-2012
			WEST-25-2012
			WEST-27-2012
			WEST-28-2012
	Smith Creek II	WRC	WEST-30-2012
			WEST-31-2012
			WEST-32-2012
Rhode River	Forrest Branch	RR0	RHOD-10-2012
	Sellman Creek	RR2	RHOD-11-2012
			RHOD-13-2012
			RHOD-14-2012
	Many Fork Branch	RR3	RHOD-15-2012
			RHOD-16-2012
	South Fork Muddy Creek II	RR5	RHOD-30-2012
			RHOD-32-2012
			RHOD-33-2012
			RHOD-37-2012
			RHOD-39-2012
			RHOD-40-2012
			RHOD-41-2012
	Williamson Branch	RR7	RHOD-27-2012
			RHOD-28-2012
	North Fork Muddy Creek	RR8	RHOD-17-2012
			RHOD-18-2012
			RHOD-19-2012
			RHOD-20-2012
			RHOD-24-2012
	South Fork Muddy Creek I	RR9	RHOD-43-2012
			RHOD-45-2012
			RHOD-46-2012
			RHOD-48-2012
	Beverley Beach	RRB	RHOD-01-2012
	Boathouse Creek	RRE	RHOD-08-2012

Figure 1 – Study Area Vicinity Map

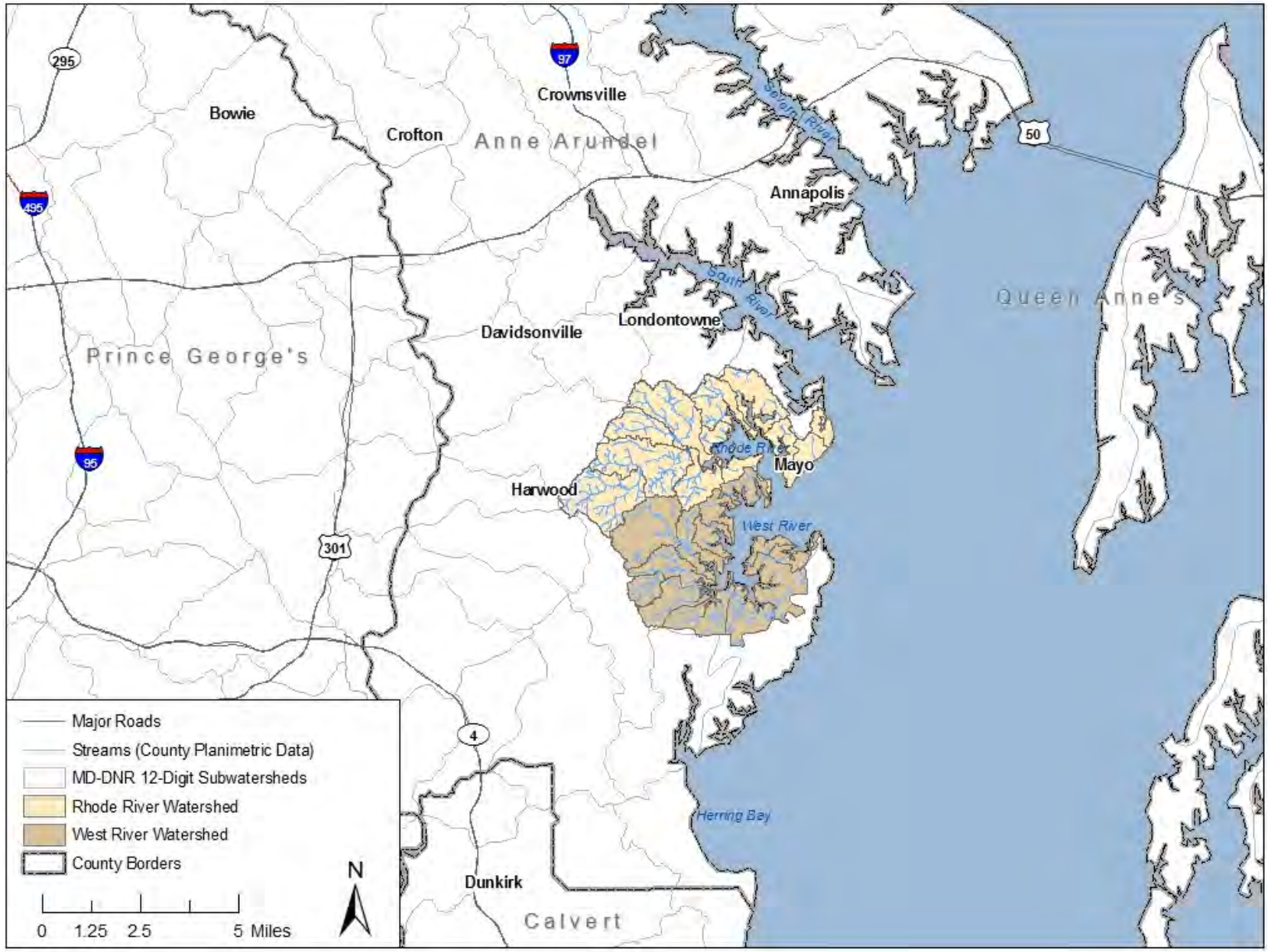
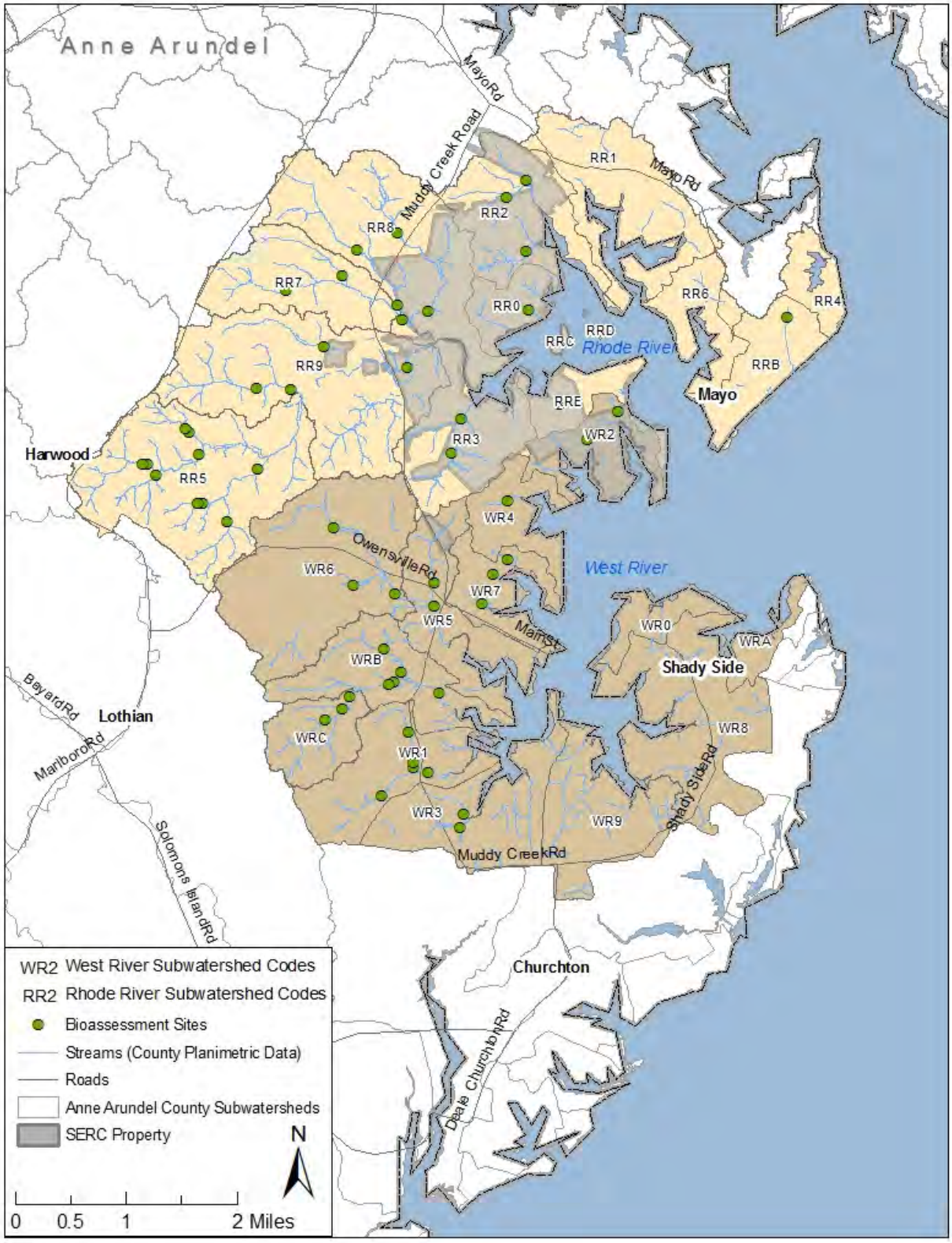


Figure 2 – West and Rhode Rivers Subwatershed Map



If the stream channel at the selected site was found to be unsampleable during the field visit, the site was moved to another sampleable reach either on the same stream, or in an adjacent subwatershed, pending approval by the Project Manager and the County. Conditions that would make a site unsampleable include predominant wetland or dry channel conditions, unsafe conditions, and lack of access due to property ownership issues. Desktop reconnaissance and coordination with landowners resulted in several of the initially selected sites being relocated to facilitate sampling. Once in the field, it was determined that several additional targeted sites were unsampleable, and they were relocated accordingly to adhere to the project's objectives.

Field crews used a Trimble® GPS unit and field maps with ortho-photography overlaid with the sites, streams and drainage areas to navigate to the proper site locations. Each sampling site is comprised of a 75-meter stream reach. The position of the reach mid-point was collected with the GPS unit, and the upstream and downstream ends were marked with flagging.

Duplicate biological samples as well as duplicate *in situ* water quality measurements and physical habitat data were collected at ten percent of sites (five total) to serve as Quality Assurance/Quality Control (QA/QC) samples. Each QA/QC sample was collected immediately upstream of the original site in an area where the habitat was very similar to the original sampling site based on visual inspection. Duplicate sites were selected in the field by the field crew at the time of the assessment. This method, as opposed to selecting the sites randomly or by desktop analysis, ensures that the stream type and habitat is similar, that no significant inputs of stormwater or confluences occur in the reach, and that the site is sampleable. A comparison of duplicate site data is included in the Quality Assurance and Quality Control section of this document (Appendix C).

1.2 Impervious Surface/GIS Analysis

Upon arrival at sampling locations, coordinates were recorded using a Trimble® Pathfinder ProXT or ProXH GPS unit coupled with a field computer at the midpoint of each reach to create a point layer showing sampling locations accurate to within one meter. These sampling points were then snapped to the stream layer on the Digital Elevation Model (DEM) for the watershed using the ArcHydro toolset to delineate drainage areas to each sampling location. The LIDAR derived DEM was generated by the Watershed Management Program based on the 2004 DNR DEM coverage with 1-meter resolution. Before drainage areas were delineated, the DEM was modified with inclusion of County and State Highway Administration stormdrain layers, and streams in areas with low relief. The DEM was reconditioned utilizing terrain preprocessing functionality within the ArcHydro extension toolset.

The impervious surface acreage and percent was calculated for the drainage area to each site using a 2007 vector polygon dataset of impervious land cover, maintained by the DPW, Bureau of Engineering, Watershed Assessment and Planning Program[1]. The GIS impervious layer was developed from 6-inch pixel resolution four band color infrared aerial ortho-photography resampled to one meter during leaf-off conditions, which represents the area of all impervious surfaces (roads, buildings, and parking lots). The results include all of the impervious surfaces and do not distinguish between connected versus disconnected surfaces.

1.3 Water Quality Sampling

Water quality conditions were measured *in situ* at all monitoring sites, including the duplicate sites, according to methods prescribed in the County's Biological Monitoring and Assessment Program

[1] Data custodian: Hala Flores, PWFLOR08@aacounty.org

QAPP (Anne Arundel County, 2011). Field measured water chemistry parameters include pH, specific conductivity, dissolved oxygen (DO), temperature, and turbidity. With the exception of turbidity, which was measured once at the upstream end of the site, all measurements were collected from three locations within each sampling reach (upstream end, mid-point, and downstream end) and results were averaged to minimize variability and better represent water quality conditions throughout the entire sampling reach. Most *in situ* parameters (i.e., temperature, pH, specific conductivity, and DO) were measured using a multiparameter sonde (YSI Professional Plus), while turbidity was measured with a Hach 2100 Turbidimeter. Water quality meters were regularly inspected, maintained, and calibrated to ensure proper usage and accuracy of the readings. Calibration logs were kept by field crew leaders and checked by the project manager regularly.

1.4 Physical Habitat Assessment

The biological monitoring sites, including the QC sites, were characterized based on visual observations of physical characteristics and various habitat parameters. The EPA's Rapid Bioassessment Protocol (RBP) habitat assessment for low gradient streams (Barbour et al., 1999) and the Maryland Biological Stream Survey's (MBSS) Physical Habitat Index (PHI; Paul et al., 2002) were used to qualitatively assess the physical habitat conditions at each site. Both assessment techniques rely on subjective scoring of selected habitat parameters. To reduce individual sampler bias, both assessments were completed as a team with discussion and agreement of the scoring for each parameter. In addition to the visual assessments, photographs were taken from three locations within each sampling reach (downstream end, mid-point, and upstream end) facing in the upstream and downstream direction, for a total of six (6) photographs per site.

The RBP habitat assessment consists of a review of ten biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health (Table 2). Each parameter is given a numerical score from 0-20 (20 = best, 0 = worst), or 0-10 for individual bank parameters (i.e., bank stability, vegetative protection, and riparian vegetative zone width), and a categorical rating of optimal, suboptimal, marginal or poor. Overall habitat quality typically increases as the total score for each site increases.

Table 2 – RBP Low Gradient Habitat Parameters

Low Gradient Stream Parameters	
Epifaunal substrate/available cover	Channel alteration
Pool substrate characterization	Channel sinuosity
Pool variability	Bank stability
Sediment deposition	Vegetative protection
Channel flow status	Riparian Vegetative Zone Width

The RBP habitat parameters for each reach are summed, with a total possible score of 200. The total score is then placed into one of four narrative categories (Table 3) based on the percent comparability to reference conditions. Since adequate reference condition scores do not currently exist for Anne Arundel County, the categories used in this report are based on reference conditions obtained from Prince George's County streams and watersheds (Stribling et al., 1999).

Table 3 – RBP Habitat Score and Ratings

Score	Percent of Reference	Narrative Rating
≥151	≥90%	Comparable to Reference
126-150	75% - 89%	Supporting
101-125	60% - 74%	Partially Supporting
≤100	≤60%	Non Supporting

The PHI incorporates the results of a series of habitat parameters selected for Coastal Plain, Piedmont and Highlands regions. In developing the PHI, MBSS identified six parameters that have the most discriminatory power for Coastal Plain streams (Table 4). While all parameters were rated during the field assessments, only the Coastal Plain parameters were used to calculate PHI scores. In addition, several of the parameters have been found to be drainage area dependent and are scaled accordingly. The drainage area to each point was calculated using GIS with County digital elevation model (DEM) topography as described in Section 2.2.

Table 4 – PHI Coastal Plain Parameters

Coastal Plain Stream Parameters	
Remoteness	Instream Habitat
Shading	Woody Debris and Rootwads
Epibenthic Substrate	Bank Stability

Each habitat parameter is given an assessment score ranging from 0-20, with the exception of shading (percentage) and woody debris and rootwads (total count). A prepared score and scaled score (0-100) are then calculated. The average of all individual parameter scores yields the overall PHI score. The final scores are then ranked according to the ranges shown in Table 5 and assigned corresponding narrative ratings, which allows for a score that can be compared to habitat assessments performed statewide.

Table 5 – PHI Score and Ratings

PHI Score	Narrative Rating
81.0 – 100.0	Minimally Degraded
66.0 – 80.9	Partially Degraded
51.0 – 65.9	Degraded
0.0 – 50.9	Severely Degraded

1.5 Benthic Macroinvertebrate Sampling

Biological assessment using benthic macroinvertebrate sampling and analysis was completed at all sites including the QC sites. Benthic macroinvertebrate sample collection was performed following the procedures described in the QAPP, which closely mirrors MBSS procedures (DNR, 2010). Benthic macroinvertebrate sampling is conducted during the spring index period (March 1st to May 1st) from a 75-meter sampling reach following methods that utilize systematic field collections of the benthic macroinvertebrate community. The multi-habitat collection approach uses a D-frame net to sample a range of the most productive habitat types present within the reach. In this sampling approach, a total of twenty jabs or kicks are distributed among all available productive habitats within the stream system and combined into a single composite sample. Potential habitats include submerged vegetation,

overhanging bank vegetation, leaf packs, stream bed substrate (i.e., cobbles, gravel, sand), and submerged organic matter (i.e., logs, stumps, snags, dead branches, and other debris).

1.5.1 Sample Processing and Laboratory Identification

Benthic macroinvertebrate samples were processed and subsampled according to the County QAPP and methods described by Caton (1991). Subsampling is conducted to standardize the sample size and reduce variation caused by samples of different size. In this method, the sample is spread evenly across a gridded tray (30 total grids), and a minimum of four grids are picked clean of organisms until count of 100 is reached. The 100 (plus 20 percent) organism target is used to allow for specimens that are missing parts or are not mature enough for proper identification.

Identification of the subsampled specimens was conducted by EcoAnalysts, Inc[2]. Taxa were identified to the genus level for most organisms. Groups including Oligochaeta and Nematomorpha were identified to the family level while Nematoda was left at phylum. Individuals of early instars or those that may be damaged were identified to the lowest possible level, which could be phylum or order, but in most cases was family. Chironomidae were further subsampled depending on the number of individuals in the sample and the numbers in each subfamily or tribe.

1.5.2 Biological Data Analysis

Benthic macroinvertebrate data were analyzed using methods developed by MBSS as outlined in the *New Biological Indicators to Better Assess the Condition of Maryland Streams* (Southerland et al., 2005a). The Benthic Index of Biotic Integrity (BIBI) approach involves statistical analysis using metrics that have a predictable response to water quality and/or habitat impairment. The metrics selected fall into five major groups including taxa richness, composition measures, tolerance to perturbation, trophic classification, and habit measures.

Raw values from each metric were given a score of 1, 3 or 5 based on ranges of values developed for each metric as shown in Table 6. The results were combined into a scaled BIBI score ranging from 1.0 to 5.0 and a corresponding narrative rating was assigned (Table 7). The following metrics and BIBI scoring were used for the analysis.

Coastal Plain BIBI Metrics *(Modified from Table 2-3 in Southerland et al., 2005a)*

Total Number of Taxa – Equals the richness of the community in terms of the total number of genera at the genus level or higher. A large variety of genera typically indicate better overall water quality, habitat diversity and/or suitability, and community health.

Number of EPT Taxa – Equals the richness of genera within the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). EPT taxa are generally considered pollution sensitive, thus higher levels of EPT taxa would be indicative of higher water quality.

Number of Ephemeroptera Taxa – Equals the total number Ephemeroptera Taxa in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

[2] Address: 1420 S. Blaine Suite 14, Moscow, Idaho

Percent Intolerant Urban – Percentage of sample considered intolerant to urbanization. Equals the percentage of individuals in the sample with a tolerance value of 0-3. As impairment increases the percent of intolerant taxa decreases.

Percent Ephemeroptera – Equals the percent of Ephemeroptera individuals in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

Number Scraper Taxa – Equals the number of scraper taxa in the sample, those taxa that scrape food from the substrate. As the levels of stressors or pollution rise there is an expected decrease in the numbers of Scraper taxa.

Percent Climbers – Equals the percentage of the total number of individuals who are adapted to living on stem type surfaces. Higher percentages of climbers typically represent a decrease in stressors and overall better water quality.

Information on trophic or functional feeding group and habit were based primarily on information compiled by DNR and from Merritt and Cummins (1996).

Table 6 - Biological Condition Scoring for the Coastal Plain Benthic Macroinvertebrates

Metric	Score		
	5	3	1
Total Number of Taxa	≥22	14-21	<14
Number of EPT Taxa	≥5	2-4	<2
Number of Ephemeroptera Taxa	≥2.0	1-1	<1.0
Percent Intolerant Urban Taxa	≥28	10-27	<10.0
Percent Ephemeroptera Taxa	≥11	0.8-10.9	<0.8
Number Scraper Taxa	≥2	1-1	<1.0
Percent Climber Taxa	≥8.0	0.9-7.9	<0.9

Table 7 – BIBI Scoring and Rating

BIBI Score	Narrative Rating
4.0 – 5.0	Good
3.0 – 3.9	Fair
2.0 – 2.9	Poor
1.0 – 1.9	Very Poor

1.6 Correlations

Correlations were performed to determine which environmental variables show strong associations with biological response indicators. Non-parametric correlation analysis using the Kendall rank correlation coefficient (Kendall, 1955), was performed on the data set using XLSTAT version 2010.3.07 (Addinsoft, 2010). The Kendall rank correlation coefficient, or Kendall's tau (τ), evaluates the degree of similarity between two sets of ranks given to a same set of objects and provides a set of binary values, which are then used to compute a correlation coefficient (Abdi, 2007). Values of the coefficient range from -1 to 1. Negative values indicate an inverse relationship between the two values (i.e., when one variable increases the other decreases), while positive values indicate a

positive relationship (i.e., both variables increase). The absolute value of the number indicates the strength of the association, with larger absolute values indicating stronger associations between the two variables. The significance level (also called the p-value) is a statement of probability regarding the likelihood that the differences in two variables after the application of a given statistical test are related to interactions between the variables themselves instead of being related to chance, with smaller values indicating a stronger likelihood of a non-random relationship. A significance level of 0.05 (i.e., 95% probability that the observed relationship is not due to chance) was used as a cutoff for significant correlations, and p-values of less than 0.01 (i.e., 99% probability) defined highly significant correlations.

2 Results

Biological monitoring was conducted at a total of 50 sites between April 4 and April 27, 2012. Additionally, five biological duplicate QC samples were collected immediately upstream of sites WEST-17, WEST-28, RHOD-33, RHOD-39, and RHOD-40. Presented below are the summary results for each assessment site. For site-specific bioassessment data and results, refer to Appendix A. Maps of the West and Rhode Rivers watersheds displaying the bioassessment results can be found in Figure 4 and Appendix B.

2.1 Impervious Surface Analysis

The results of the impervious surface analysis are listed below in Table 8 including general information about each sampling site. Drainage areas for West River ranged from 18.5 acres at site WEST-55, to 1,640.7 acres at site WEST-35, the most downstream site on Lerch Creek. The median drainage area size for the West River study area is 188.3 acres, with 83.3 percent of sites less than 500 acres. Rhode River drainage areas ranged from 23.7 acres at RHOD-01 to 661.0 acres at RHOD-24. The median drainage area size for the Rhode River study area is slightly larger than West River at 219.9 acres. All but two sites (92.3 percent) were less than 500 acres for the Rhode River study area.

Overall, imperviousness was low throughout both watersheds with the average imperviousness for the sites in West and Rhode at 2.6 percent and 4.0 percent, respectively. Imperviousness in West River ranged from a low of 0.0 percent at WEST-55, a headwater stream south of Cumberstone Road, to a high of 5.8 percent at WEST-53. Imperviousness in Rhode River ranged from a low of 1.0 percent at RHOD-11 to a high of 7.8 percent at RHOD-33 (Figure 3).

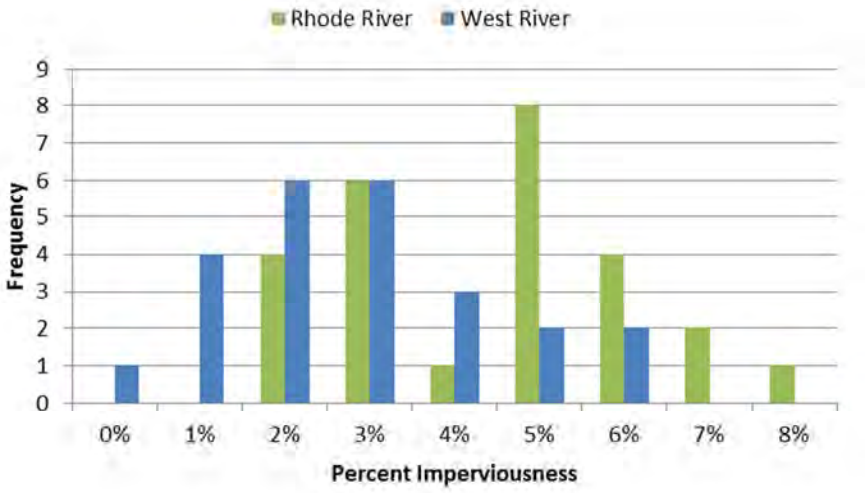


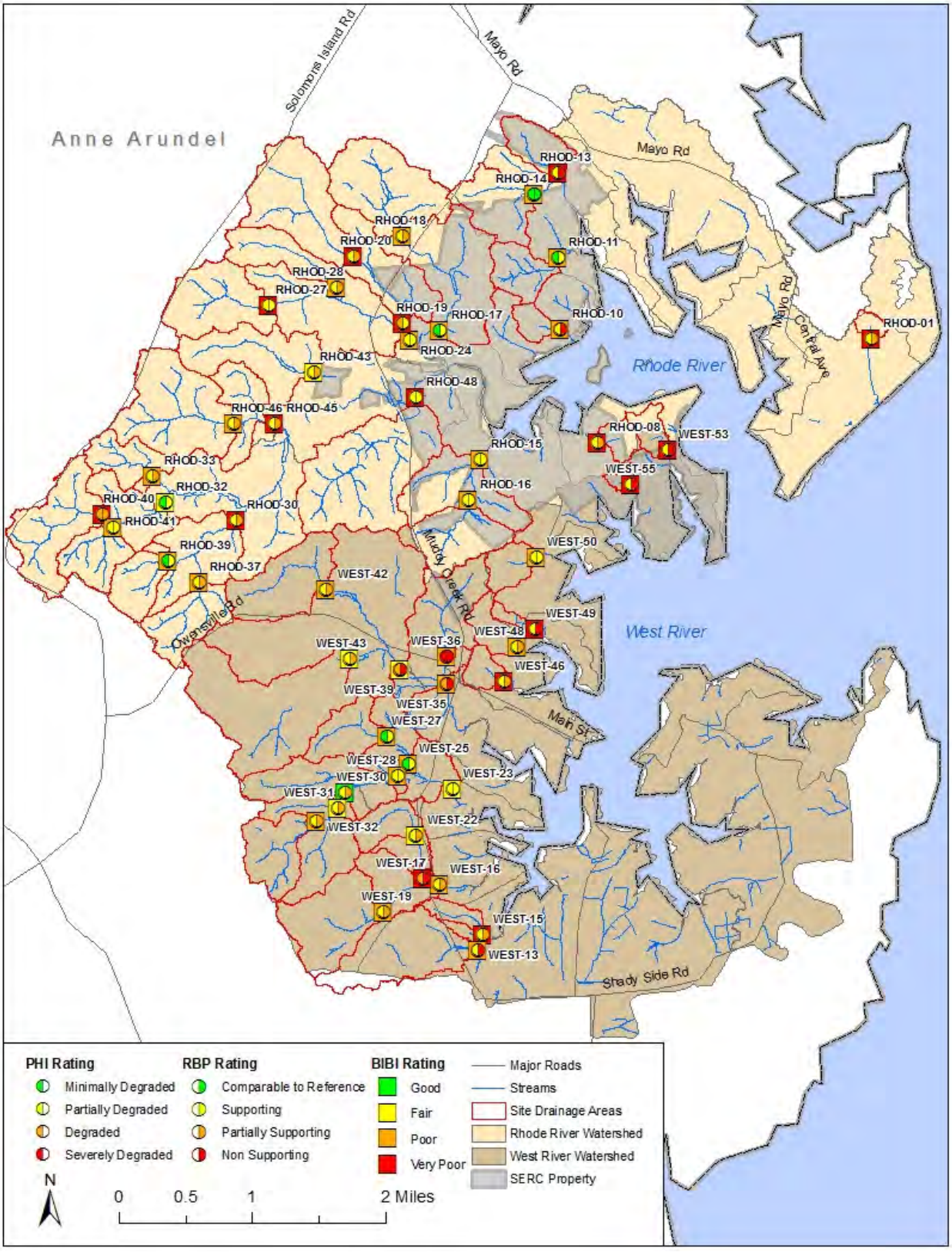
Figure 3 - Histogram showing the distribution of percent imperviousness for 26 targeted sites in the Rhode River watershed and 24 targeted sites in the West River watershed.

Table 8 – Drainage Area and Imperviousness

Site	Drainage Area (acres)	Impervious Area (acres)	Impervious Percent
RHOD-01-2012	23.7	0.86	3.62
RHOD-08-2012	41.5	1.04	2.51
RHOD-10-2012	42.3	1.85	4.38
RHOD-11-2012	96.8	0.99	1.02
RHOD-13-2012	91.0	1.19	1.31
RHOD-14-2012	152.8	1.97	1.29
RHOD-15-2012	372.7	10.79	2.90
RHOD-16-2012	173.9	4.01	2.31
RHOD-17-2012	604.1	29.83	4.94
RHOD-18-2012	278.7	17.47	6.27
RHOD-19-2012	479.3	23.53	4.91
RHOD-20-2012	289.2	15.90	5.50
RHOD-24-2012	661.0	32.38	4.90
RHOD-27-2012	219.9	13.00	5.91
RHOD-28-2012	128.9	7.03	5.45
RHOD-30-2012	454.0	13.62	3.00
RHOD-32-2012	481.3	28.69	5.96
RHOD-33-2012	111.6	8.68	7.78
RHOD-37-2012	145.4	6.09	4.19
RHOD-39-2012	109.7	4.63	4.22
RHOD-40-2012	238.1	15.97	6.71
RHOD-41-2012	113.8	4.84	4.25
RHOD-43-2012	233.1	10.38	4.45
RHOD-45-2012	444.5	10.75	2.42
RHOD-46-2012	323.0	8.73	2.70
RHOD-48-2012	442.1	8.45	1.91
WEST-13-2012	264.5	9.17	3.47

Site	Drainage Area (acres)	Impervious Area (acres)	Impervious Percent
WEST-15-2012	40.2	0.82	2.05
WEST-16-2012	486.4	10.78	2.22
WEST-17-2012	135.7	3.63	2.68
WEST-19-2012	234.4	4.06	1.73
WEST-22-2012	81.8	2.32	2.84
WEST-23-2012	864.7	15.59	1.80
WEST-25-2012	194.9	3.58	1.84
WEST-27-2012	112.6	1.84	1.64
WEST-28-2012	572.1	5.31	0.93
WEST-30-2012	349.3	2.79	0.80
WEST-31-2012	336.4	2.79	0.83
WEST-32-2012	145.2	2.41	1.66
WEST-35-2012	1640.7	50.74	3.09
WEST-36-2012	181.6	9.33	5.14
WEST-39-2012	1357.7	38.83	2.86
WEST-42-2012	212.6	10.51	4.94
WEST-43-2012	457.9	9.76	2.13
WEST-46-2012	46.9	0.43	0.91
WEST-48-2012	67.4	3.30	4.89
WEST-49-2012	19.9	0.76	3.80
WEST-50-2012	65.9	1.00	1.52
WEST-53-2012	47.8	2.75	5.76
WEST-55-2012	18.5	0.00	0.00
Duplicate Sites for QC			
RHOD-33-2012QC	103.0	8.21	7.98
RHOD-39-2012QC	99.5	4.05	4.07
RHOD-40-2012QC	236.0	15.97	6.77
WEST-17-2012 QC	128.5	3.63	2.83
WEST-28-2012 QC	546.6	5.13	0.94

Figure 4 – Bioassessment Results Map



2.2 Water Quality

Instream water quality measurements were collected in conjunction with macroinvertebrate sampling and occurred between April 4 and April 27, 2012. Water quality data are presented below in Table 9.

The Maryland Department of the Environment (MDE) has established acceptable standards for several of the sampled parameters for each designated Stream Use Classification. Currently, there are no standards available for specific conductivity; however, a threshold for biological impairment in Maryland streams has been established at 247 µS/cm (Morgan et al., 2007). Acceptable standards are listed in the *Code of Maryland Regulations (COMAR) 26.08.02.01-.03 - Water Quality*. The West River and Rhode River watersheds are listed in *COMAR* in Sub-Basin 02-13-10: West Chesapeake Bay Area. All non-tidal portions of these watersheds are designated as Use I streams, which includes uses for water contact sports, fishing, the growth and propagation of fish, agricultural water supply, and industrial water supply. The acceptable standards for Use I streams are as follows:

- pH - 6.5 to 8.5
- DO - may not be less than 5 mg/l at any time
- Turbidity - maximum of 150 Nephelometric Turbidity Units (NTU's) and maximum monthly average of 50 NTU
- Temperature - maximum of 90°F (32°C) or ambient temperature of the surface water, whichever is greater

Generally, *in situ* water quality parameters fell within COMAR limits for a Use I streams and are typical of streams in Maryland's coastal plain. All measurements for water temperature and turbidity were within COMAR standards. However, there were 34 sites with pH values recorded below the acceptable limit of 6.5. In addition, there were three sites with DO values recorded below the acceptable limit of 5 mg/l, all of which were noted as being primarily backwatered or having stagnant flow. Although MDE does not have a water quality standard for specific conductivity, Morgan et al. (2007) has reported a biological impairment threshold of 247 µS/cm for Maryland streams. A total of seven sites had specific conductivity values exceeding this threshold.

Table 9 – Instream Water Quality Results

Site	pH	Temperature (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Conductivity (S/cm)
RHOD-01-2012	5.92	17.2	3.69	10.1	413.4
RHOD-08-2012	5.47	13.5	8.43	10.3	175.1
RHOD-10-2012	6.12	10.1	10.85	8.14	195.5
RHOD-11-2012	6.10	13.5	10.05	18.7	122.2
RHOD-13-2012	5.84	12.8	8.66	16.1	102.9
RHOD-14-2012	5.52	15.9	9.43	10.8	103.5
RHOD-15-2012	6.37	9.6	9.50	15.1	182.4
RHOD-16-2012	5.86	11.1	9.44	14.5	158.9
RHOD-17-2012	6.22	12.1	8.43	15.3	181.4
RHOD-18-2012	6.57	11.3	10.69	9.44	162.8
RHOD-19-2012	6.57	15.0	11.77	6.59	202.3
RHOD-20-2012	6.41	17.2	10.12	8.75	175.1
RHOD-24-2012	6.78	11.0	10.91	8.33	212.3
RHOD-27-2012	6.43	9.8	9.28	20.2	308.5
RHOD-28-2012	6.33	15.4	9.51	7.68	164.4
RHOD-30-2012	6.83	17.6	9.31	8.11	164.0
RHOD-32-2012	6.92	17.8	9.83	8.93	247.8
RHOD-33-2012	6.89	16.0	12.60	2.88	211.6
RHOD-37-2012	6.72	12.8	10.09	12.6	269.0
RHOD-39-2012	6.71	11.8	9.83	17.1	191.7
RHOD-40-2012	6.81	12.7	9.37	10.5	315.1
RHOD-41-2012	6.71	12.6	9.82	24	209.2
RHOD-43-2012	6.48	21.0	4.88	21.2	146.7
RHOD-45-2012	6.58	12.9	10.44	7.39	134.4
RHOD-46-2012	6.29	9.1	12.10	18.7	152.2
RHOD-48-2012	5.82	11.1	7.63	15.7	137.6
WEST-13-2012	6.37	18.3	8.90	25.6	205.9
WEST-15-2012	5.86	13.3	4.45	48.9	404.6
WEST-16-2012	6.17	12.6	10.51	22.4	163.1
WEST-17-2012	5.89	13.9	9.22	21.6	184.7
WEST-19-2012	6.44	16.5	10.34	14.3	146.1
WEST-22-2012	6.48	13.1	9.42	10.9	140.9
WEST-23-2012	6.24	17.1	9.62	21.3	136.1
WEST-25-2012	6.30	12.5	10.93	20.4	113.9
WEST-27-2012	6.18	11.6	10.36	16.1	116.7
WEST-28-2012	6.15	12.6	9.49	13.5	127.9
WEST-30-2012	6.67	16.5	9.68	7.63	127.1
WEST-31-2012	6.60	17.0	9.55	6.83	128.6
WEST-32-2012	6.68	14.0	10.18	5.48	138.8
WEST-35-2012	6.38	16.3	9.46	48.4	166.5
WEST-36-2012	6.08	11.6	10.65	12.1	181.4

Site	pH	Temperature (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Conductivity (S/cm)
WEST-39-2012	6.56	16.2	8.58	11.3	167.6
WEST-42-2012	6.19	11.5	14.98	12.3	187.7
WEST-43-2012	6.33	11.9	10.12	16.8	140.0
WEST-46-2012	5.82	11.8	10.44	22.1	142.2
WEST-48-2012	5.82	12.6	8.83	22.7	168.0
WEST-49-2012	5.71	11.8	8.87	23	153.6
WEST-50-2012	5.91	12.0	8.69	64.1	158.8
WEST-53-2012	6.84	14.4	6.07	48.2	380.0
WEST-55-2012	6.11	15.1	7.55	24.8	125.2
Duplicate Sites for QC					
RHOD-33-2012-QC	6.84	16.3	11.07	3.63	210.0
RHOD-39-2012-QC	6.78	12.4	9.70	3.24	195.9
RHOD-40-2012-QC	7.05	12.9	10.02	14.4	306.9
WEST-17-2012-QC	5.70	14.0	9.07	18.6	189.1
WEST-28-2012-QC	6.11	13.8	9.85	13.8	127.9

Note: Shaded cells indicate values exceeding COMAR criteria or impairment thresholds

2.3 Physical Habitat Assessment

The results of the RBP and PHI habitat assessments are presented in Table 10. For Rhode River sites, the percent comparability to RBP reference scores ranged from 54 percent at site RHOD-10 to a high of 94.6 percent at site RHOD-14. West River sites had a slightly lower range for percent comparability to RBP reference scores, which ranged from 51 percent at site WEST-17 to a high of 84 percent at site WEST-25. The majority of sites in the Rhode River watershed were classified as either 'Partially Supporting' (46.2 percent) or 'Supporting' (42.3 percent; Figure 5). Only one site (3.8 percent) was classified as 'Comparable to Reference' and two sites (7.7 percent) were classified as 'Non Supporting.' Like sites in Rhode River, close to half of the sites in West River were classified as 'Partially Supporting' (45.8 percent; Figure 5) with the remaining sites classified as either 'Non Supporting' (33.3 percent) or 'Supporting' (20.8 percent).

The lowest PHI score for Rhode River of 56.61 was recorded at RHOD-40 while the highest score, 92.57 was recorded at RHOD-14. The majority of sites were rated as 'Partially Degraded' (19 sites) with five sites rated as 'Minimally Degraded' and two sites as 'Degraded' (Figure 6). Similar to Rhode River sites, the majority of West River sites were rated as 'Partially Degraded' (18 sites) with three sites rated as 'Degraded' (Figure 6). There were two sites in the watershed that received the highest classification of 'Minimally Degraded', and one site receiving the lowest classification of 'Severely Degraded.'

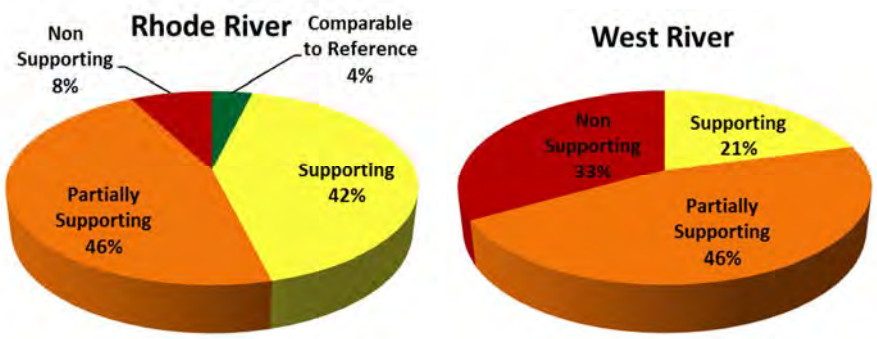


Figure 5 - RBP scores for 26 targeted sites in the Rhode River watershed and 24 targeted sites in the West River watershed

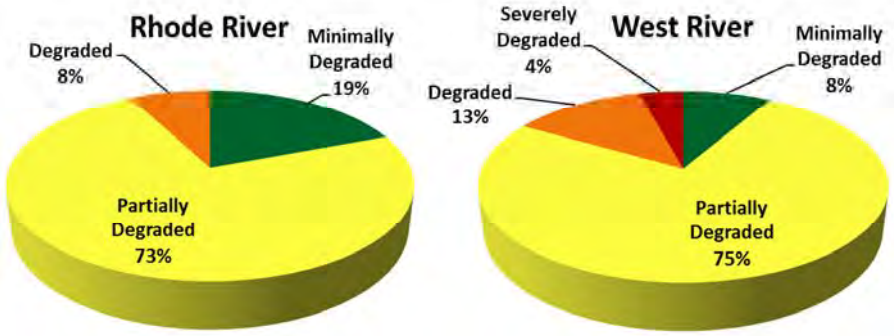


Figure 6 - PHI scores for 26 targeted sites in the Rhode River watershed and 24 targeted sites in the West River watershed

Distributions of selected RBP metric values were plotted and examined for normality (Figure 7 (*a* – *f*)). Four metrics, Epifaunal Substrate/Available Cover, Pool Variability, Pool Substrate Characterization, and Sediment Deposition showed a normal distribution with the majority of sites scoring in the 'Marginal' range (Figure 7 – *a*, *b*, *d*, and *f*, respectively). The remaining two metrics Riparian Vegetative Zone Width, and to a lesser extent Bank Vegetative Protection, had distributions that were skewed towards the 'Optimal' range (Figure 7 – *c* and *e*, respectively). For instance, all but one site in Rhode River (25 sites) and close to three-fourths of sites in West River (70.8 percent) received an 'Optimal' rating for Riparian Vegetative Zone Width.

Table 10 – Physical Habitat Assessment Results

Site	Total RBP	Percent Reference	RBP Classification	PHI Score	PHI Narrative Rating
RHOD-01-2012	108	64.29	Partially Supporting	70.85	Partially Degraded
RHOD-08-2012	104	61.90	Partially Supporting	78.78	Partially Degraded
RHOD-10-2012	91	54.17	Non Supporting	69.62	Partially Degraded
RHOD-11-2012	145	86.31	Supporting	89.29	Minimally Degraded
RHOD-13-2012	95	56.55	Non Supporting	80.04	Partially Degraded
RHOD-14-2012	159	94.64	Comparable to Reference	92.57	Minimally Degraded
RHOD-15-2012	139	82.74	Supporting	76.44	Partially Degraded
RHOD-16-2012	138	82.14	Supporting	77.71	Partially Degraded
RHOD-17-2012	149	88.69	Supporting	90.78	Minimally Degraded
RHOD-18-2012	120	71.43	Partially Supporting	77.43	Partially Degraded
RHOD-19-2012	139	82.74	Supporting	62.06	Degraded
RHOD-20-2012	125	74.40	Partially Supporting	79.27	Partially Degraded
RHOD-24-2012	126	75.00	Supporting	70.78	Partially Degraded
RHOD-27-2012	126	75.00	Supporting	71.64	Partially Degraded
RHOD-28-2012	109	64.88	Partially Supporting	75.22	Partially Degraded
RHOD-30-2012	115	68.45	Partially Supporting	68.43	Partially Degraded
RHOD-32-2012	141	83.93	Supporting	83.38	Minimally Degraded
RHOD-33-2012	121	72.02	Partially Supporting	79.18	Partially Degraded
RHOD-37-2012	123	73.21	Partially Supporting	73.30	Partially Degraded
RHOD-39-2012	148	88.10	Supporting	88.55	Minimally Degraded
RHOD-40-2012	124	73.81	Partially Supporting	56.61	Degraded
RHOD-41-2012	126	75.00	Supporting	73.55	Partially Degraded
RHOD-43-2012	117	69.64	Partially Supporting	74.81	Partially Degraded
RHOD-45-2012	114	67.86	Partially Supporting	79.86	Partially Degraded
RHOD-46-2012	113	67.26	Partially Supporting	69.96	Partially Degraded
RHOD-48-2012	149	88.69	Supporting	73.46	Partially Degraded
Rhode Mean	*126*	*74.7*	*Supporting*	*76.3*	*Partially Degraded*
Rhode Std. Dev.	*17*	*10.4*	--	*8.4*	--

Site	Total RBP	Percent Reference	RBP Classification	PHI Score	PHI Narrative Rating
WEST-13-2012	95	56.55	Non Supporting	67.89	Partially Degraded
WEST-15-2012	112	66.67	Partially Supporting	74.78	Partially Degraded
WEST-16-2012	123	73.21	Partially Supporting	68.21	Partially Degraded
WEST-17-2012	86	51.19	Non Supporting	64.35	Degraded
WEST-19-2012	122	72.62	Partially Supporting	75.55	Partially Degraded
WEST-22-2012	107	63.69	Partially Supporting	73.05	Partially Degraded
WEST-23-2012	136	80.95	Supporting	70.38	Partially Degraded
WEST-25-2012	141	83.93	Supporting	82.80	Minimally Degraded
WEST-27-2012	133	79.17	Supporting	84.08	Minimally Degraded
WEST-28-2012	136	80.95	Supporting	78.19	Partially Degraded
WEST-30-2012	123	73.21	Partially Supporting	75.82	Partially Degraded
WEST-31-2012	121	72.02	Partially Supporting	77.06	Partially Degraded
WEST-32-2012	118	70.24	Partially Supporting	80.00	Partially Degraded
WEST-35-2012	100	59.52	Non Supporting	56.83	Degraded
WEST-36-2012	90	53.57	Non Supporting	50.20	Severely Degraded
WEST-39-2012	88	52.38	Non Supporting	59.07	Degraded

Site	Total RBP	Percent Reference	RBP Classification	PHI Score	PHI Narrative Rating
WEST-42-2012	111	66.07	Partially Supporting	71.16	Partially Degraded
WEST-43-2012	106	63.10	Partially Supporting	71.41	Partially Degraded
WEST-46-2012	111	66.07	Partially Supporting	76.60	Partially Degraded
WEST-48-2012	125	74.40	Partially Supporting	80.17	Partially Degraded
WEST-49-2012	90	53.57	Non Supporting	73.16	Partially Degraded
WEST-50-2012	139	82.74	Supporting	79.70	Partially Degraded
WEST-53-2012	94	55.95	Non Supporting	72.15	Partially Degraded
WEST-55-2012	97	57.74	Non Supporting	75.75	Partially Degraded
West Mean	*113*	*67.1*	*Partially Supporting*	*72.4*	*Partially Degraded*
West Std. Dev.	*18*	*10.4*	*--*	*8.2*	*--*
Duplicate Sites for QC					
RHOD-33-2012 QC	123	73.21	Partially Supporting	81.77	Minimally Degraded
RHOD-39-2012 QC	149	88.69	Supporting	89.57	Minimally Degraded
RHOD-40-2012 QC	131	77.98	Supporting	58.54	Degraded
WEST-17-2012 QC	86	51.19	Non Supporting	68.80	Partially Degraded
WEST-28-2012 QC	128	76.19	Supporting	80.56	Partially Degraded

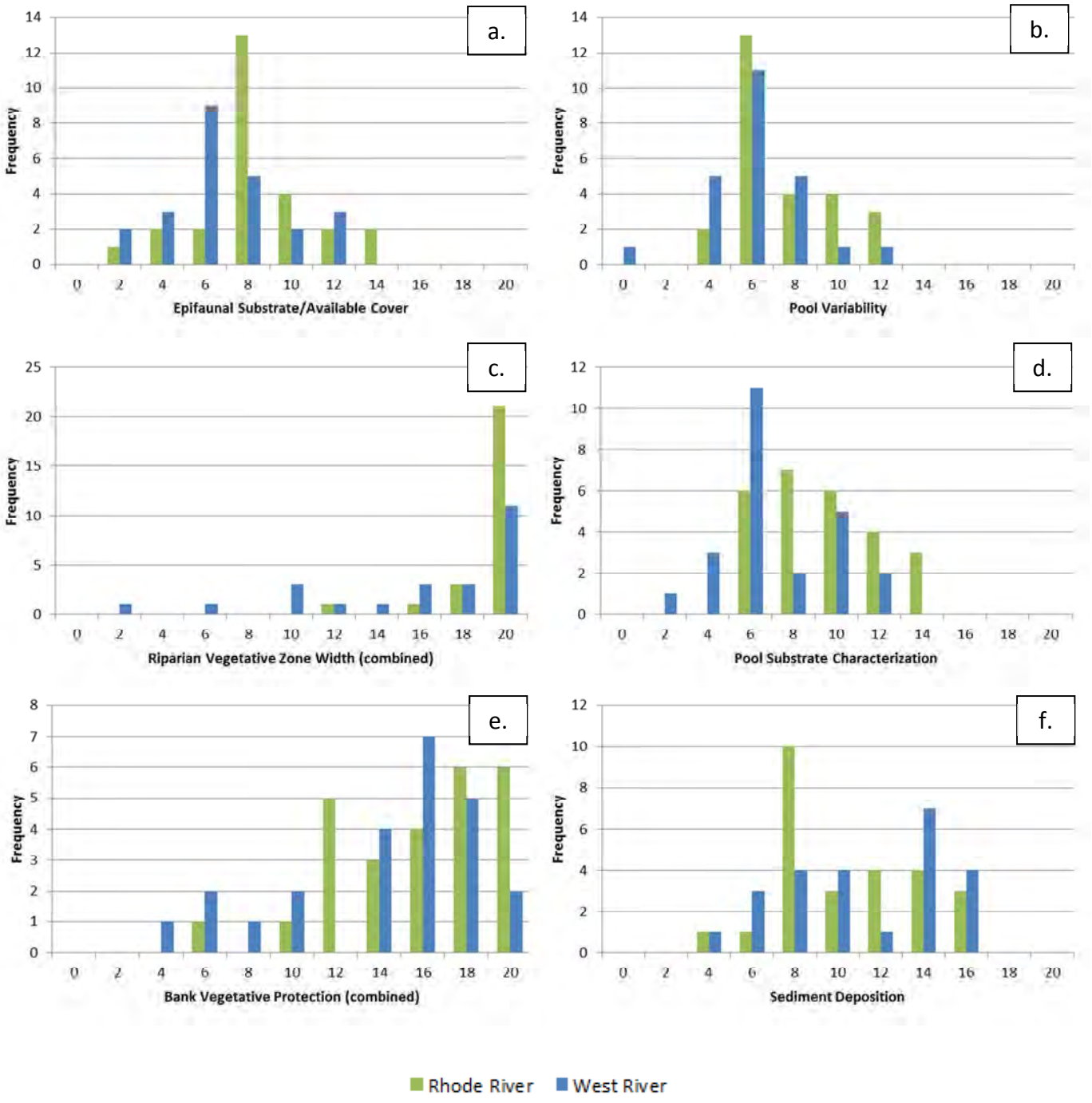


Figure 7 (a-f) – Histograms showing distributions of selected RBP metric values for 26 targeted sites in the Rhode River watershed and 24 targeted sites in the West River watershed.

2.4 Benthic Macroinvertebrates

The BIBI scores and corresponding narrative ratings for each site are presented in Table 11. Individual BIBI scores for Rhode River ranged from a low of 1.57 and narrative rating of 'Very Poor' at sites RHOD-08, RHOD-20, and RHOD-40 to a high of 3.29 and a rating of 'Fair' at site RHOD-43. The average BIBI score for the 26 targeted sites was 2.21 ('Poor'), with a standard deviation of 0.46. Overall, the majority of sites in Rhode River were rated as either 'Poor' (53.8 percent) or 'Very Poor' (38.5 percent; Figure 8). The remaining two sites (7.7 percent) were rated as 'Fair.'

BIBI scores were slightly better in West River when compared with Rhode River. The average BIBI score for the 24 sites was 2.46 ('Poor'), with a standard deviation of 0.71. Individual BIBI scores ranged from a low of 1.29 and a rating of 'Very Poor' at site WEST-15 to a high of 4.14 with a narrative rating of 'Good' at site WEST-30, which was the only site to receive a 'Good' rating in both watersheds. Half of the sites in West River were rated as 'Poor' while the majority of the remaining sites were rated as either 'Very Poor' (25.0 percent) or 'Fair' (20.8 percent; Figure 8). As previously mentioned, one site (4.2 percent) received a rating of 'Good.'

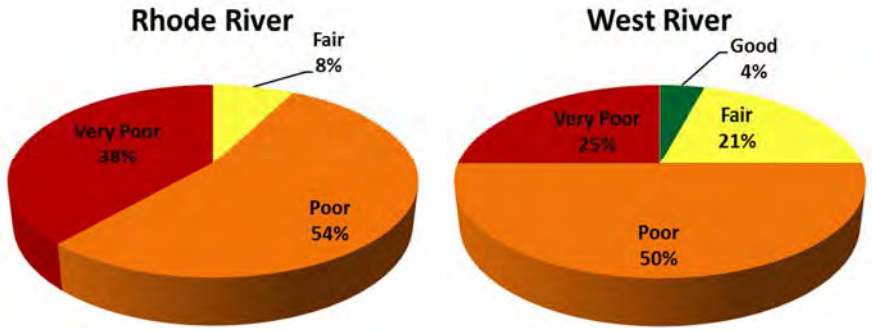


Figure 8 - BIBI scores for 26 targeted sites in the Rhode River watershed and 24 targeted sites in the West River watershed

Table 11 – Benthic Index of Biotic Integrity (BIBI) Summary Data

Site	BIBI Score	Narrative Rating
RHOD-01-2012	1.86	Very Poor
RHOD-08-2012	1.57	Very Poor
RHOD-10-2012	2.14	Poor
RHOD-11-2012	2.71	Poor
RHOD-13-2012	1.86	Very Poor
RHOD-14-2012	2.43	Poor
RHOD-15-2012	2.14	Poor
RHOD-16-2012	2.43	Poor
RHOD-17-2012	2.71	Poor
RHOD-18-2012	2.71	Poor
RHOD-19-2012	1.86	Very Poor
RHOD-20-2012	1.57	Very Poor
RHOD-24-2012	2.14	Poor
RHOD-27-2012	1.86	Very Poor
RHOD-28-2012	2.43	Poor
RHOD-30-2012	1.86	Very Poor
RHOD-32-2012	3.00	Fair

Site	BIBI Score	Narrative Rating
RHOD-33-2012	2.43	Poor
RHOD-37-2012	2.43	Poor
RHOD-39-2012	2.43	Poor
RHOD-40-2012	1.57	Very Poor
RHOD-41-2012	2.43	Poor
RHOD-43-2012	3.29	Fair
RHOD-45-2012	1.86	Very Poor
RHOD-46-2012	2.14	Poor
RHOD-48-2012	1.57	Very Poor
Rhode Mean	*2.21*	*Poor*
Rhode Std. Dev.	*0.46*	--

Site	BIBI Score	Narrative Rating
WEST-13-2012	2.43	Poor
WEST-15-2012	1.29	Very Poor
WEST-16-2012	2.71	Poor
WEST-17-2012	1.86	Very Poor
WEST-19-2012	2.14	Poor
WEST-22-2012	3.00	Fair
WEST-23-2012	3.00	Fair
WEST-25-2012	2.43	Poor
WEST-27-2012	2.43	Poor
WEST-28-2012	2.14	Poor
WEST-30-2012	4.14	Good
WEST-31-2012	3.29	Fair
WEST-32-2012	2.43	Poor
WEST-35-2012	2.71	Poor
WEST-36-2012	2.43	Poor
WEST-39-2012	3.86	Fair
WEST-42-2012	2.14	Poor
WEST-43-2012	3.29	Fair
WEST-46-2012	1.57	Very Poor
WEST-48-2012	2.43	Poor
WEST-49-2012	1.86	Very Poor
WEST-50-2012	2.43	Poor
WEST-53-2012	1.57	Very Poor
WEST-55-2012	1.57	Very Poor
West Mean	*2.46*	*Poor*
West Std. Dev.	*0.71*	--

Duplicate Sites for QC		
RHOD-33-2012 QC	2.43	Poor
RHOD-39-2012 QC	2.71	Poor
RHOD-40-2012 QC	2.14	Poor
WEST-17-2012 QC	2.14	Poor
WEST-28-2012 QC	3.00	Fair

Distributions of individual BIBI metric values were plotted and examined for normality (Figure 9 (*a* – *g*)). Two metrics, Number of Taxa and Number of EPT Taxa, approximated a normal distribution (Figure 9 – *a* and *b*, respectively). However, for sites in the West River, Number of Taxa approximated a bimodal distribution, with the highest frequencies occurring around 12 and 21 taxa. The remaining five metrics, Number of Ephemeroptera Taxa, Percent Ephemeroptera, Number of Scraper Taxa, Percent Climbers, and Percent Intolerant Urban, were generally skewed towards low values (Figure 9 – *c*, *d*, *e*, *f*, and *g*, respectively). As with the Number of Taxa metric, West River sites showed a bimodal distribution for Percent Intolerant Urban, with the highest frequencies occurring around 20% and 70%.

An analysis of the percent abundance and percent occurrence was completed, and the results of the top 30 taxa are shown in Table 12 and Table 13, respectively. *Polypedilum*, a tolerant midge, was the most commonly collected genus making up over 20 percent of the total collected individuals. Of the top 30 taxa by percent abundance, a total of 12 (40 percent) were in the family Chironomidae (midges).

Polypedilum and Tubificidae, a family of tolerant worms, were found at 47 sampling sites (94 percent). One intolerant isopod, *Caecidotea* (Tolerance value = 2.6) was found at 44 sites (88 percent). By percent occurrence, chironomids (midges) make up close to half (47 percent) of the top 30 taxa.

As shown in Table 12 and Table 13, members of the family Chironomidae were dominant throughout both watersheds. In general, the relative abundance of chironomids increases with increased perturbation. Table 14 lists all sites sampled and the percentage of identified individuals that were in the Chironomidae family. Site RHOD-20 contained the highest percentage of chironomids (94 percent) followed by RHOD-24 (92 percent), and RHOD-45 and RHOD-46 (both with 90 percent). The lowest percentage was found at WEST-53, with only 7 individuals (6 percent).

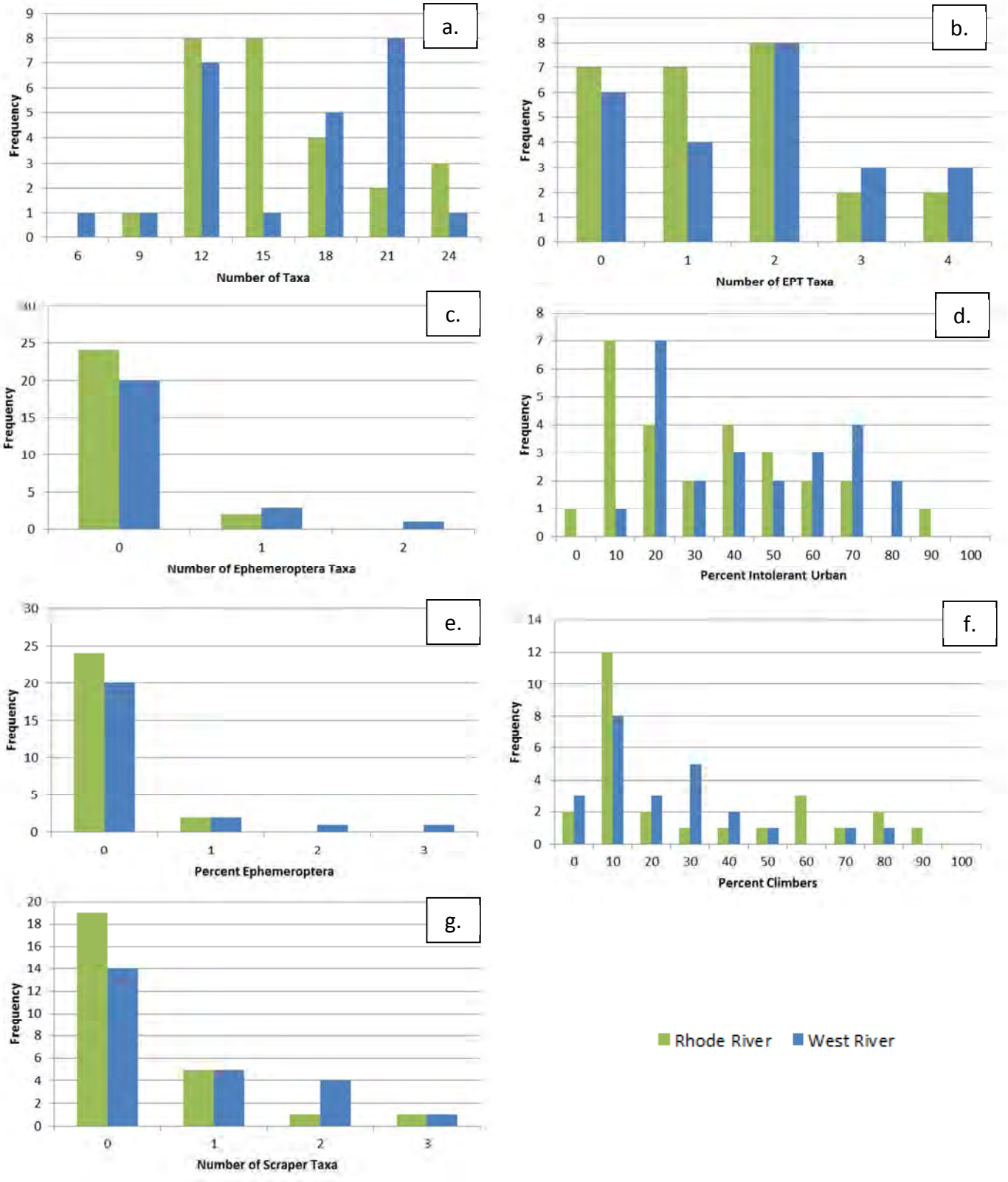


Figure 9 (a-g) – Histograms showing distributions of individual BIBI metric values for 26 targeted sites in the Rhode River watershed and 24 targeted sites in the West River watershed.

Table 12 – Percent Abundance (by top 30 taxa)

Final Identification	Order	Family	Functional Feeding Group	Habit[1]	Toler-ance Value	Total number of individuals	Percent of collected individuals
Polypedilum	Diptera	Chironomidae	Shredder	cb, cn	6.3	1366	20.8
Synurella	Amphipoda	Crangonyctidae	-	-	0.4	1030	15.7
Caecidotea	Isopoda	Asellidae	Collector	sp	2.6	850	13.0
Gammarus	Amphipoda	Gammaridae	Shredder	sp	6.7	585	8.9
Chironomus	Diptera	Chironomidae	Collector	bu	4.6	435	6.6
Tubificidae	Tubificida	Tubificidae	Collector	cn	8.4	406	6.2
Orthocladius	Diptera	Chironomidae	Collector	sp, bu	9.2	179	2.7
Parametriocnemus	Diptera	Chironomidae	Collector	sp	4.6	166	2.5
Amphinemura	Plecoptera	Nemouridae	Shredder	sp, cn	3.0	150	2.3
Pisidium	Veneroida	Pisidiidae	Filterer	bu	5.7	147	2.2
Rheocricotopus	Diptera	Chironomidae	Collector	sp	6.2	143	2.2
Zavrelimyia	Diptera	Chironomidae	Predator	sp	5.3	122	1.9
Thienemannimyia group	Diptera	Chironomidae	Predator	sp	8.2	77	1.2
Dicranota	Diptera	Tipulidae	Predator	sp, bu	1.1	75	1.1
Odontomesa	Diptera	Chironomidae	Collector	sp	6.6	64	1.0
Ironoquia	Trichoptera	Limnephilidae	Shredder	sp	4.9	63	1.0
Simulium	Diptera	Simuliidae	Filterer	cn	5.7	49	0.7
Cricotopus	Diptera	Chironomidae	Shredder	cn, bu	9.6	47	0.7
Physa	Basommatophora	Physidae	Scraper	cb	7.0	45	0.7
Crangonyctidae	Amphipoda	Crangonyctidae	Collector	sp	6.5	40	0.6
Crangonyx	Amphipoda	Crangonyctidae	Collector	sp	6.7	30	0.5
Bezzia	Diptera	Ceratopogonidae	Predator	bu	3.3	29	0.4
Turbellaria	not identified	not identified	Predator	sp	4.0	27	0.4
Dytiscidae	Coleoptera	Dytiscidae	Predator	sw, dv	5.4	23	0.4
Tanytarsus	Diptera	Chironomidae	Filterer	cb, cn	4.9	18	0.3
Chaetocladius	Diptera	Chironomidae	Collector	sp	7.0	17	0.3
Thienemanniella	Diptera	Chironomidae	Collector	sp	5.1	17	0.3
Stegopterna	Diptera	Simuliidae	Filterer	cn	2.4	16	0.2
Aedes	Diptera	Culicidae	Filterer	sw	8.0	15	0.2
Calopteryx	Odonata	Calopterygidae	Predator	cb	8.3	15	0.2
Oligostomis	Trichoptera	Phryganeidae	-	-	2.0	15	0.2

1 – Habit abbreviations: bu – burrower, cn – clinger, cb – climber, sp – sprawler, dv – diver, sk – skater.
QC sites were excluded from calculations.

Table 13 – Percent Occurrence (by top 30 taxa)

Final Identification	Order	Family	Functional Feeding Group	Habit[1]	Toler-ance Value	Number of sites present	Percent of sites present
Polypedilum	Diptera	Chironomidae	Shredder	cb, cn	6.3	47	94
Tubificidae	Tubificida	Tubificidae	Collector	cn	8.4	47	94
Caecidotea	Isopoda	Asellidae	Collector	sp	2.6	44	88
Synurella	Amphipoda	Crangonyctidae	-	-	0.4	40	80
Parametriocnemus	Diptera	Chironomidae	Collector	sp	4.6	38	76
Rheocricotopus	Diptera	Chironomidae	Collector	sp	6.2	35	70
Zavrelimyia	Diptera	Chironomidae	Predator	sp	5.3	35	70
Orthocladius	Diptera	Chironomidae	Collector	sp, bu	9.2	34	68
Pisidium	Veneroida	Pisidiidae	Filterer	bu	5.7	30	60
Chironomus	Diptera	Chironomidae	Collector	bu	4.6	29	58
Ironoquia	Trichoptera	Limnephilidae	Shredder	sp	4.9	28	56
Amphinemura	Plecoptera	Nemouridae	Shredder	sp, cn	3.0	27	54
Thienemannimyia group	Diptera	Chironomidae	Predator	sp	8.2	23	46
Gammarus	Amphipoda	Gammaridae	Shredder	sp	6.7	22	44
Odontomesa	Diptera	Chironomidae	Collector	sp	6.6	17	34
Simulium	Diptera	Simuliidae	Filterer	cn	5.7	15	30
Dicranota	Diptera	Tipulidae	Predator	sp, bu	1.1	14	28
Dytiscidae	Coleoptera	Dytiscidae	Predator	sw, dv	5.4	13	26
Bezzia	Diptera	Ceratopogonidae	Predator	bu	3.3	12	24
Physa	Basommatophora	Physidae	Scraper	cb	7.0	12	24
Thienemanniella	Diptera	Chironomidae	Collector	sp	5.1	11	22
Calopteryx	Odonata	Calopterygidae	Predator	cb	8.3	10	20
Ceratopogonidae	Diptera	Ceratopogonidae	Predator	sp, bu	3.6	10	20
Limnophyes	Diptera	Chironomidae	Collector	sp	8.6	10	20
Tanytarsus	Diptera	Chironomidae	Filterer	cb, cn	4.9	10	20
Chaetocladius	Diptera	Chironomidae	Collector	sp	7.0	9	18
Chrysops	Diptera	Tabanidae	Predator	sp, bu	2.9	8	16
Lumbriculidae	Lumbriculida	Lumbriculidae	Collector	bu	6.6	8	16
Cricotopus	Diptera	Chironomidae	Shredder	cn, bu	9.6	7	14
Hydrobaenus	Diptera	Chironomidae	Scraper	sp	7.2	7	14
Parakiefferiella	Diptera	Chironomidae	Collector	sp	2.1	7	14
Potthastia	Diptera	Chironomidae	Collector	sp	0.0	7	14
Tipula	Diptera	Tipulidae	Shredder	bu	6.7	7	14
Turbellaria	not identified	not identified	Predator	sp	4.0	7	14

1 – Habit abbreviations: bu – burrower, cn – clinger, cb – climber, sp – sprawler, dv – diver, sk – skater.
QC sites were excluded from calculations.

Table 14 – Chironomidae Analysis

Site	Number of Chironomidae	Total Number of Individuals	Percent Chironomidae
RHOD-01-2012	36	120	30
RHOD-08-2012	17	118	14
RHOD-10-2012	9	121	7
RHOD-11-2012	24	118	20
RHOD-13-2012	95	121	79
RHOD-14-2012	30	117	26
RHOD-15-2012	17	117	15
RHOD-16-2012	33	118	28
RHOD-17-2012	78	118	66
RHOD-18-2012	55	123	45
RHOD-19-2012	107	125	86
RHOD-20-2012	115	122	94
RHOD-24-2012	109	118	92
RHOD-27-2012	38	120	32
RHOD-28-2012	40	114	35
RHOD-30-2012	79	121	65
RHOD-32-2012	43	115	37
RHOD-33-2012	68	118	58
RHOD-37-2012	11	116	9
RHOD-39-2012	26	118	22
RHOD-40-2012	21	123	17
RHOD-41-2012	21	121	17
RHOD-43-2012	77	118	65
RHOD-45-2012	109	121	90
RHOD-46-2012	105	117	90
RHOD-48-2012	81	117	69
WEST-13-2012	40	100	40
WEST-15-2012	104	123	85
WEST-16-2012	64	120	53
WEST-17-2012	31	122	25
WEST-19-2012	107	128	84
WEST-22-2012	10	115	9
WEST-23-2012	53	125	42
WEST-25-2012	64	123	52
WEST-27-2012	36	119	30
WEST-28-2012	63	119	53
WEST-30-2012	34	118	29
WEST-31-2012	29	129	22
WEST-32-2012	22	119	18
WEST-35-2012	85	121	70
WEST-36-2012	60	119	50
WEST-39-2012	93	116	80
WEST-42-2012	72	106	68
WEST-43-2012	9	125	7
WEST-46-2012	21	119	18
WEST-48-2012	18	114	16

Site	Number of Chironomidae	Total Number of Individuals	Percent Chironomidae
WEST-49-2012	9	124	7
WEST-50-2012	9	125	7
WEST-53-2012	7	118	6
WEST-55-2012	69	123	56

2.5 Quality Assurance/Quality Control

All applicable QA/QC measures were calculated and compared to quantitative measurement quality objectives (MQOs) as presented in Hill and Pieper, 2011a. No QA/QC problems were identified with the data collected and presented in this report. Detailed QA/QC results are presented in Appendix C.

3 Discussion

The targeted biological monitoring and assessments of streams in the West and Rhode Rivers watersheds provided valuable information regarding the biological, physical, and chemical conditions within the study area, in addition to current land use conditions. This section discusses the comprehensive results and findings of this study as well as some general conclusions regarding the condition of the West and Rhode Rivers watersheds.

3.1 Land Use and Impervious Surface

Land cover throughout both watersheds is predominately forested. The majority of sites sampled in Rhode River and West River were dominated by forested land cover (88.5 percent and 66.7 percent, respectively). One-fourth of sites in West River were dominated by agricultural land use (25.0 percent), while just two sites in Rhode River (7.7 percent) were dominated by agricultural use. Developed land is minimal throughout both watersheds; there are no major transportation corridors and developed land is mainly low density residential (1- or 2-acre) land use. Only one site in Rhode River and two sites in West River drained predominantly developed land use (3.8 and 8.3 percent, respectively).

Because developed land use is generally minimal throughout both watersheds, impervious surface coverage is also low with an average site-specific imperviousness of 2.6 percent for West River and 4.0 percent for Rhode River. The majority of sites had drainage areas with imperviousness below five percent (20 sites in West River and 11 sites in Rhode River), with all sites below 8.0 percent.

3.2 Water Chemistry

Water quality exceeded COMAR standards at over half of all sites sampled, primarily for low pH (<6.5). While the direct cause of low pH is uncertain, most instances appear to be on streams draining wetlands with tannic water or areas of acidic soils that could be expected to have naturally low pH levels given the landscape setting or streams with low flow conditions. A review of the natural soil groups as defined by the Maryland Department of Planning (MDP, 1973; Appendix D) show a predominance of potentially acidic soil types throughout both watersheds, including B1 (pH = 4.5-6.5), F3 (pH = 4.0-7.8), E2a (pH = 4.0-6.5), E3a (pH = 4.5-5.5), and G2 (pH = 4.0-7.3), with the majority of low pH sites occurring in conjunction with these soil types (Figure 10). This suggests that soil pH has a notable influence on pH of the surface waters throughout these watersheds, and low pH values are not likely attributed to anthropogenic disturbance.

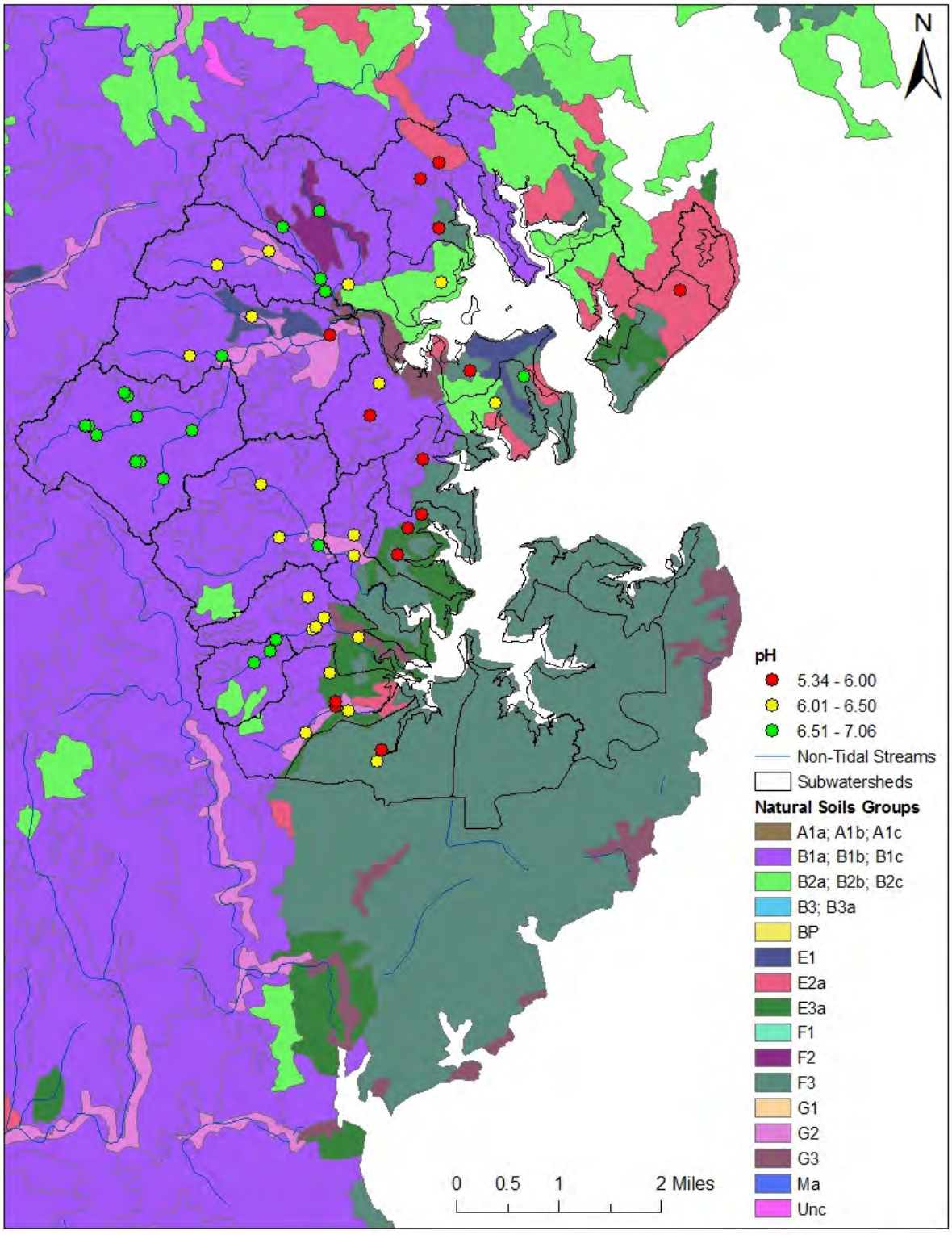


Figure 10 - Natural Soil Groups in Anne Arundel County

Three sites exceeded the standard for low dissolved oxygen (DO); however, it was noted that these streams exhibited stagnant flow, generally due to backwater conditions at the time of sampling or low water levels, and may not be typical of average flow conditions at these locations. Furthermore, one of the three sites with low DO had biological conditions that exceeded what the physical habitat condition would indicate, suggesting that the low DO conditions were atypical and not causing significant impairment to the benthic macroinvertebrate assemblages.

Seven sites (five in Rhode River and two in West River) exceeded the biological impairment threshold for conductivity of 247 µg/cm. Elevated conductivity levels (i.e., increased stream inorganic ion concentrations) are typically results from runoff over impervious surfaces, passage through pipes, and exposure to other infrastructure and are an indication of the effects from an urban environment (Cushman, 2006). However, because development is minimal and imperviousness is low in the West and Rhode Rivers watersheds, elevated conductivity seems to be a result of low flow conditions. Low water conditions impact conductivity measurements by producing a higher concentration of dissolved ions in solution. Four out of the seven sites with elevated conductivity were characterized by standing water with little flow at the time of sampling. In fact, two sites with observed low flow conditions not only had elevated conductivity but also low pH and DO measurements (RHOD-01 and WEST-15). While elevated conductivity may not directly affect stream biota, its constituents (e.g., chloride, metals, and nutrients) may be present at levels that can cause considerable biological impairment. Certainly, more detailed water quality sampling would be necessary to identify the nature and extent of chemical stressors throughout the watershed and would aid in locating, and ultimately, mitigating stressor sources impacting the biota.

It is also important to note that sites were sampled during an abnormally warm and dry spring. According to the National Climatic Data Center (NCDC), March and April 2012 recorded below average for precipitation and March recorded above average for temperature (Table 15).

Table 15 - Baltimore average monthly precipitation and temperature data

Year	Precipitation (inches)		Temperature (°F)	
	March	April	March	April
2012	1.76	1.99	53.7	55.3
Historical average (1871-2010)	3.90	3.19	43.6	53.7

3.3 Physical Habitat

Physical habitat scores for the RBP and PHI assessments both indicate varying habitat conditions throughout the watershed. The majority of sites assessed in West and Rhode Rivers were rated as either 'Partially Supporting' (45.8 and 46.2 percent, respectively) by the RBP or 'Partially Degraded' by the PHI (75.0 and 73.1 percent, respectively), which is indicative of moderate stream degradation.

Despite the predominantly forested land cover and generally low imperviousness in these watersheds, only one site (in Rhode River) was rated as 'Comparable to Reference' (RBP), and seven sites received a 'Minimally Degraded' (PHI) rating (two in West and five in Rhode). In contrast, 10 sites (eight in West and two in Rhode) were rated in the most impaired RBP category of 'Non

Supporting' (RBP) and one site (in West River) was rated in the most impaired 'Severely Degraded' category for the PHI. Habitat scores for the RBP and PHI assessments were significantly correlated to one another ($p < 0.0001$) with only a moderate goodness of fit ($R^2 = 0.3469$), and often the corresponding narrative categories did not match with respect to the overall level of degradation (Figure 11). For example, six sites were rated as 'Partially Degraded' by the PHI but rated as 'Non Supporting' by the RBP, which is a difference by two assessment categories. These differences are largely due to dissimilarities in scoring parameters between the two indices. For instance, PHI uses remoteness and shading as two of the five metrics used to calculate the habitat score while RBP uses riparian conditions (i.e. vegetative protection and riparian width) as four of the 13 metrics.

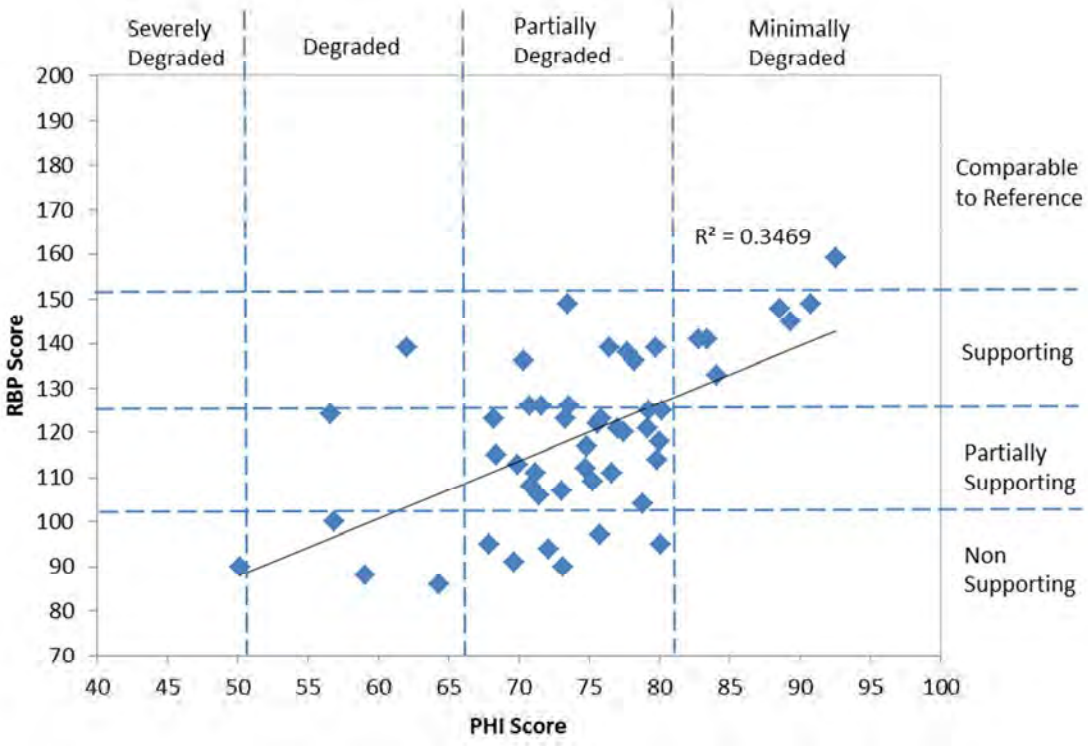


Figure 11 – Comparison of RBP and PHI habitat assessment scores for 50 targeted sites in the West and Rhode Rivers watersheds.

3.4 Biological Condition

While the targeted study design does not support assessment results at the overall watershed scale, general statements about the West and Rhode Rivers study area can be made based on site-specific results. The majority of sites assessed in both watersheds, 92.3 percent in Rhode and 75.0 percent in West, had impaired (i.e., 'Poor' or 'Very Poor') biological conditions, and only one site (from West River) was rated as 'Good.' The biological results indicate a median BIBI score of 2.21 and 2.46 for reaches assessed in the Rhode and West River watersheds, respectively, which is in the 'Poor' category. It should be noted, however, that these median scores do not represent the overall conditions of the Rhode and West River watersheds. Although these results are not overall

conditions, they are in line with Countywide Round One results in which West and Rhode Rivers were both characterized as impaired with 'Very Poor' biological conditions.

Three taxa, the tolerant midge *Polypedilum* (Tol. val. = 6.3), the intolerant amphipod *Synurella* (Tol. val. = 0.4), and intolerant isopod *Caecidotea* (Tol. val. = 2.6), dominated many of the samples and comprised 49.5 percent of collected individuals. Other prevalent taxa include Tubificidae (Tol. val. = 8.4) a family of tolerant worms and the midge *Parametriocnemus* (Tol. val. = 4.6). Additionally, the presence of sensitive Ephemeroptera taxa was minimal throughout both watersheds. Out of all 50 sites sampled, only one site (WEST-30) had two Ephemeroptera taxa identified in the benthic subsample and five sites had one Ephemeroptera taxa identified; all remaining sites did not have Ephemeroptera taxa present within the benthic subsample. There were, however, several Plecoptera and Trichoptera taxa (i.e., EPT taxa) present throughout both watersheds.

3.5 Integrated Assessment

Table 16 contains consolidated assessment results for each site to allow for easier comparisons of site specific conditions. Summary maps displaying biological and physical habitat results are shown in Appendix B.

Table 16 – Consolidated Assessment Results

Site	Sub-watershed Code	Drainage Area (acres)	Impervious Percent	BIBI Score	RBP Score	RBP Percent of Reference	PHI Score
RHOD-01-2012	RRB	23.7	3.6	1.86	108	64.3	70.85
RHOD-08-2012	RRE	41.5	2.5	1.57	104	61.9	78.78
RHOD-10-2012	RR0	42.3	4.4	2.14	91	54.2	69.62
RHOD-11-2012	RR2	96.8	1.0	2.71	145	86.3	89.29
RHOD-13-2012	RR2	91.1	1.3	1.86	95	56.5	80.04
RHOD-14-2012	RR2	152.8	1.3	2.43	159	94.6	92.57
RHOD-15-2012	RR3	372.7	2.9	2.14	139	82.7	76.44
RHOD-16-2012	RR3	173.9	2.3	2.43	138	82.1	77.71
RHOD-17-2012	RR8	604.1	4.9	2.71	149	88.7	90.78
RHOD-18-2012	RR8	278.7	6.3	2.71	120	71.4	77.43
RHOD-19-2012	RR8	479.3	4.9	1.86	139	82.7	62.06
RHOD-20-2012	RR8	289.2	5.5	1.57	125	74.4	79.27
RHOD-24-2012	RR8	661.0	4.9	2.14	126	75.0	70.78
RHOD-27-2012	RR7	219.9	5.9	1.86	126	75.0	71.64
RHOD-28-2012	RR7	128.9	5.5	2.43	109	64.9	75.22
RHOD-30-2012	RR5	454.0	3.0	1.86	115	68.5	68.43
RHOD-32-2012	RR5	481.3	6.0	3.00	141	83.9	83.38
RHOD-33-2012	RR5	111.7	7.8	2.43	121	72.0	79.18
RHOD-37-2012	RR5	145.4	4.2	2.43	123	73.2	73.30
RHOD-39-2012	RR5	109.7	4.2	2.43	148	88.1	88.55
RHOD-40-2012	RR5	238.1	6.7	1.57	124	73.8	56.61
RHOD-41-2012	RR5	113.8	4.3	2.43	126	75.0	73.55
RHOD-43-2012	RR9	233.1	4.5	3.29	117	69.6	74.81
RHOD-45-2012	RR9	444.5	2.4	1.86	114	67.9	79.86
RHOD-46-2012	RR9	323.0	2.7	2.14	113	67.3	69.96
RHOD-48-2012	RR9	442.1	1.9	1.57	149	88.7	73.46

Site	Sub-watershed Code	Drainage Area (acres)	Impervious Percent	BIBI Score	RBP Score	RBP Percent of Reference	PHI Score
WEST-13-2012	WR3	264.5	3.5	2.43	95	56.5	67.89
WEST-15-2012	WR3	40.2	2.1	1.29	112	66.7	74.78
WEST-16-2012	WR1	486.4	2.2	2.71	123	73.2	68.21
WEST-17-2012	WR1	135.7	2.7	1.86	86	51.2	64.35
WEST-19-2012	WR1	234.4	1.7	2.14	122	72.6	75.55
WEST-22-2012	WR1	81.8	2.8	3.00	107	63.7	73.05
WEST-23-2012	WRB	864.7	1.8	3.00	136	81.0	70.38
WEST-25-2012	WRB	194.9	1.8	2.43	141	83.9	82.80
WEST-27-2012	WRB	112.6	1.6	2.43	133	79.2	84.08
WEST-28-2012	WRB	572.1	0.9	2.14	136	81.0	78.19
WEST-30-2012	WRC	349.3	0.8	4.14	123	73.2	75.82
WEST-31-2012	WRC	336.4	0.8	3.29	121	72.0	77.06
WEST-32-2012	WRC	145.2	1.7	2.43	118	70.2	80.00
WEST-35-2012	WR5	1640.7	3.1	2.71	100	59.5	56.83
WEST-36-2012	WR5	181.6	5.1	2.43	90	53.6	50.20
WEST-39-2012	WR6	1357.7	2.9	3.86	88	52.4	59.07
WEST-42-2012	WR6	212.6	4.9	2.14	111	66.1	71.16
WEST-43-2012	WR6	457.9	2.1	3.29	106	63.1	71.41
WEST-46-2012	WR7	46.9	0.9	1.57	111	66.1	76.60
WEST-48-2012	WR7	67.4	4.9	2.43	125	74.4	80.17
WEST-49-2012	WR7	19.9	3.8	1.86	90	53.6	73.16
WEST-50-2012	WR4	65.9	1.5	2.43	139	82.7	79.70
WEST-53-2012	WR2	47.8	5.8	1.57	94	56.0	72.15
WEST-55-2012	WR2	18.5	0.0	1.57	97	57.7	75.75

Biological potential is limited by the quality of the physical habitat, which forms the template upon which biological communities develop (Southwood, 1977). To examine the biological condition in comparison to the site's biological potential as defined by the habitat ratings (both RBP and PHI), a matrix was developed by plotting each station by biological condition rating on one axis and habitat condition rating on the other in order axis to determine whether they exceed, match, or fall short of their expected biological potential. The biological potential matrix for both RBP and PHI habitat ratings is shown in Table 17.

Table 17 – Station Biological Potential Matrix

EPA RBP HABITAT RATING	BIOLOGICAL RATING			
	GOOD	FAIR	POOR	VERY POOR
Comparable			R14	
Supporting		R32, W23, W25, W30	R11, R15, R16, R17, R24, R39, R41, W27, W28, W53	**R19, R27, R48**

EPA RBP HABITAT RATING	BIOLOGICAL RATING			
	GOOD	FAIR	POOR	VERY POOR
Partially Supporting	**W31**	R43, W22, W32, W46	R18, R28, R33, R37, R46, W16, W19, W35, W43, W49	R01, R08, R20, R30, R40, R45, W15, W48
Non Supporting		**W42**	R10, W13, W36, W39	R13, W17, W50, W55

MBSS PHI HABITAT RATING	BIOLOGICAL RATING			
	GOOD	FAIR	POOR	VERY POOR
Minimally Degraded		R32	R11, R14, R17, R39, W27, W28	
Partially Degraded	W31	R43, W22, W23, W25, W30, W32, W46	R10, R15, R16, R18, R24, R28, R33, R37, R41, R46, W13, W16, W19, W35, W43, W49, W53	**R01, R08, R13, R20, R27, R30, R45, R48, W15, W48, W50, W55**
Degraded		W42	W36	R19, R40, W17
Severely Degraded			W39	

Green indicates stations where the biological community exceeded the habitat potential
Orange indicates stations where the biological community reached habitat potential
Pink indicates stations where the biological community did not reach the habitat potential
Bolded stations indicate biological conditions that differ by two categories from the corresponding habitat class

BIBI scores were not significantly correlated with either RBP scores ($p = 0.233$; Figure 12) or PHI scores ($p = 0.405$; Figure 13), suggesting that these indices are not adequate predictors of biological conditions in the West and Rhode Rivers watersheds. Nonetheless, it is likely that physical habitat conditions are limiting the potential of biological communities in numerous subwatersheds, especially at sites where the biological conditions match degraded physical habitat conditions. Furthermore, significant correlations were found between individual physical habitat parameters and the BIBI score. Two RBP physical habitat variables, Epifaunal Substrate/Available Cover ($p = 0.006$) and Channel Alteration ($p = 0.007$), as well as two PHI variables, Epibenthic Substrate ($p = 0.003$) and Instream Habitat ($p = 0.011$), were significantly positively correlated with the BIBI score (Appendix E). As epifaunal substrate and available cover improves to include substrate favorable for epifaunal colonization (i.e., mix of snags, submerged logs, cobble or other stable habitat) the BIBI score generally increases (Figure 14). While overall RBP and PHI scores were not significantly correlated with BIBI scores, these physical habitat parameters were determined to be better predictors of biological conditions than combined habitat indices.

While some sites show clear patterns of degraded physical habitat and correspondingly impaired biological communities, indicating physical habitat as the primary limiting factor, numerous sites show patterns more consistent with water quality impairment. For sites where the biological community did not reach RBP habitat potential, water quality may be a potential limiting or contributing factor (Table 18). These sites would be good candidates for further investigation of water quality impairment, especially sites with very low DO or excessively high conductivity. However, it should be noted that the water quality parameters measured in this study are very limited and are not intended to identify all potential water quality impairments. That said, further

investigations may be warranted to identify the nature and extent of water quality impairments, as well as potential sources.

It is also important to note that degraded physical habitat conditions were often observed in areas with little development and low imperviousness, suggesting that streams are still exhibiting impacts of legacy effects, which are the consequences of past disturbances (e.g., deforestation, channelization, intensive agriculture) that continue to influence environmental conditions long after the initial appearance of the disturbance (Allan, 2004). Historically, nearly all of Anne Arundel County has experienced deforestation, followed by intensive agriculture which significantly altered the landscape (Schneider, 1996). These drastic land use changes likely altered the structure and function of the stream ecosystems to a considerable extent, some of which have yet to fully recover. This notion is supported by Harding and others (1998), who found that that past land use activity, in particular agriculture, may result in long-term modifications to and reductions in aquatic diversity, regardless of reforestation of riparian zones.

Flow conditions may also be a substantial factor affecting biological communities as standing water and low flow was observed at multiple sites. Compared to other watersheds in Anne Arundel County, there may simply be a higher proportion of intermittent and/or ephemeral stream reaches in the West and Rhode watersheds, which may limit full benthic macroinvertebrate colonization potential. Or, as mentioned in section 3.2, the conditions observed throughout both watersheds may be the results of below average precipitation and above average temperatures.

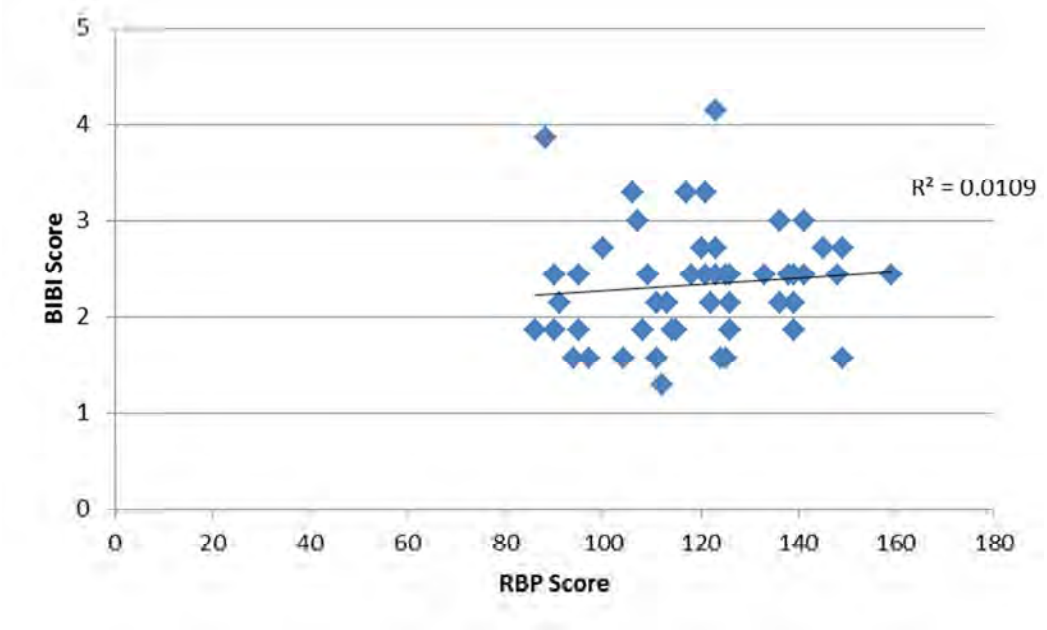


Figure 12 – Correlation between RBP habitat assessment score and BIBI score for 50 targeted sites in the West and Rhode Rivers watersheds.

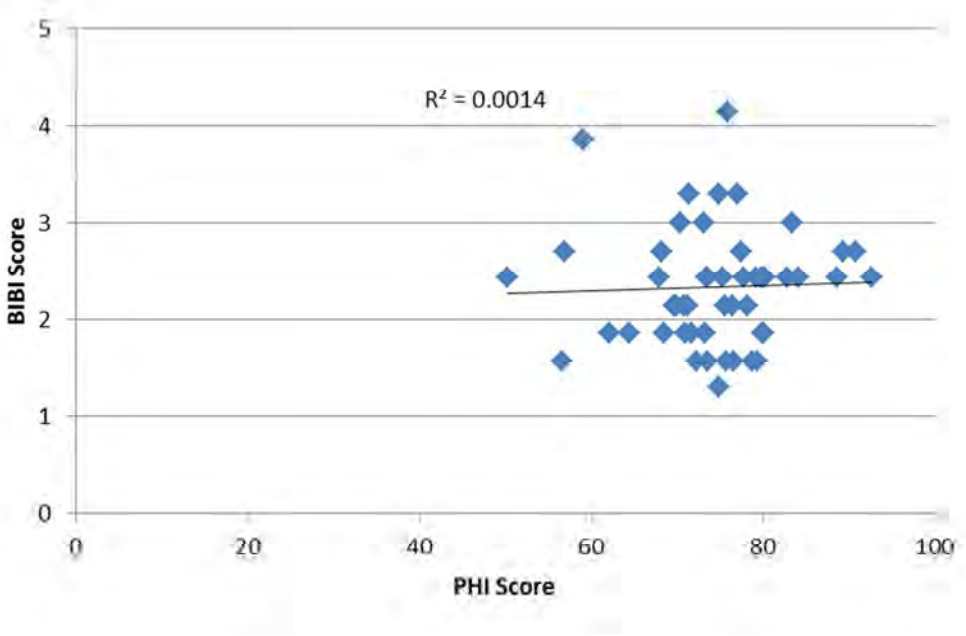


Figure 13 – Correlation between PHI habitat assessment score and BIBI score for 50 targeted sites in the West and Rhode Rivers watersheds.

It is also important to note the effect of drainage area size on biological communities and its influence on BIBI scoring. Drainage area was significantly positively correlated with the BIBI score ($p = 0.010$). In addition, drainage area was significantly correlated with six of the seven coastal plain metrics; Total Taxa ($p = 0.002$), Percent Intolerant Urban ($p = 0.001$), Percent Climbers ($p < 0.0001$), Percent Ephemeroptera ($p = 0.036$), Ephemeroptera Taxa ($p = 0.037$), and Scraper Taxa ($p = 0.045$). Percent Intolerant Urban was the only metric negatively correlated with drainage area, as would be expected. These results are consistent with those found by Hill and Pieper (2011b) where the BIBI score and five of the seven BIBI metrics were significantly positively correlated with drainage area, and Percent Intolerant was significantly negatively correlated to drainage area. These results suggest that drainage area, or perhaps stream size (width, depth) and discharge, influences coastal plain BIBI scores, since size and discharge typically increase with drainage area.

Drainage area was also significantly correlated with RBP habitat scores and several RBP and PHI metrics including channel flow status ($p < 0.0001$), pool variability ($p < 0.0001$), instream habitat ($p < 0.0001$), and epibenthic substrate ($p = 0.001$). Given that the instream habitat and epibenthic substrate metrics correlated very well with BIBI scores and individual metrics, we see a connection between drainage area, habitat adequacy and biological community. It is likely that instream physical habitat becomes more diverse and heterogeneous in larger stream systems, which provides an increased potential for full colonization by benthic macroinvertebrate communities.

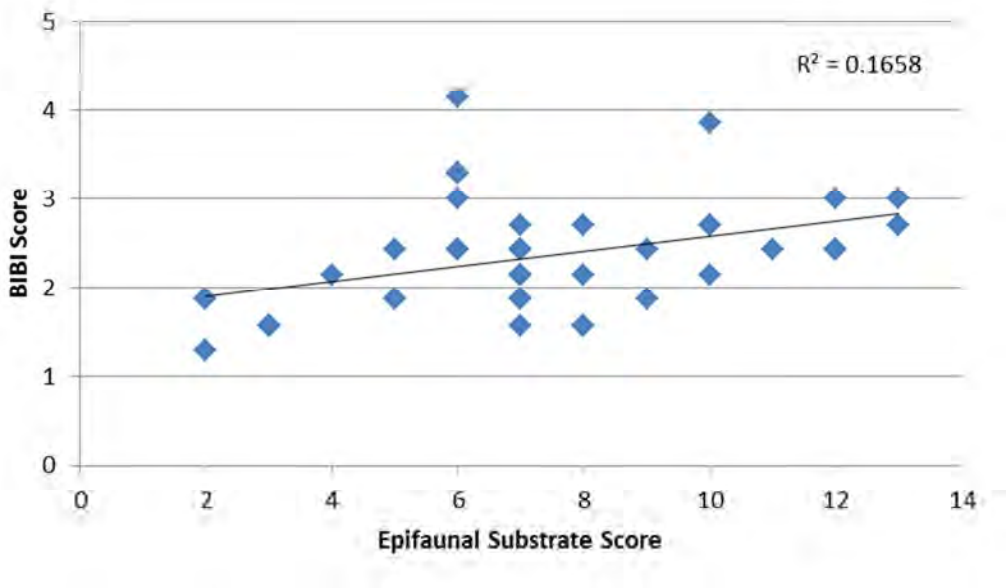


Figure 14 - Correlation of Epifaunal Substrate Score with BIBI Score for 50 targeted sites in the West and Rhode Rivers watersheds.

Table 18 - Water quality exceedences by site. Colors correspond with the biological potential matrix in Table 14 using the RBP rating.

Site	Low pH (<6.5)	Low DO (<5.0 mg/l)	Elevated Conductivity (>247 ug/cm)	No Threshold Exceedences
RHOD-43	X	X		
RHOD-10	X			
WEST-13	X			
WEST-22	X			
WEST-36	X			
WEST-42	X			
WEST-46	X			
WEST-31				X
WEST-32				X
WEST-39				X
RHOD-13	X			
RHOD-28	X			
RHOD-46	X			
WEST-16	X			
WEST-17	X			
WEST-19	X			
WEST-23	X			
WEST-25	X			
WEST-35	X			
WEST-43	X			
WEST-49	X			
WEST-50	X			
WEST-55	X			
RHOD-32			X	
RHOD-37			X	
RHOD-18				X
RHOD-33				X
WEST-30				X
RHOD-01	X	X	X	
WEST-15	X	X	X	
RHOD-27	X		X	
RHOD-08	X			
RHOD-11	X			
RHOD-14	X			
RHOD-15	X			
RHOD-16	X			
RHOD-17	X			
RHOD-20	X			
RHOD-48	X			
WEST-27	X			
WEST-28	X			
WEST-48	X			
RHOD-40			X	
WEST-53			X	
RHOD-19				X

Site	Low pH (<6.5)	Low DO (<5.0 mg/l)	Elevated Conductivity (>247 ug/cm)	No Threshold Exceedences
RHOD-24				X
RHOD-30				X
RHOD-39				X
RHOD-41				X
RHOD-45				X

Green indicates stations where the biological community exceeded the RBP habitat potential
Orange indicates stations where the biological community reached RBP habitat potential
Pink indicates stations where the biological community did not reach RBP habitat potential

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Appendix A: Individual Site Summaries

RHOD-01-2012 RRB Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8866484738 **Longitude:** -76.4993868618

This site is located south of Triton Beach Road and upstream of Deep Pond in Beverly Beach, which is part of the RRB subwatershed. With the smallest drainage area of all sites sampled in Rhode River (24 acres) this stream had only standing water in shallow pools with no visible flow. Forested land accounted for 93% of the area draining to the site with only 4% imperviousness. The stream is also tannic due to heavy leaf litter which has accumulated in this highly forested drainage area. Although over half of macroinvertebrates in the benthic sample were intolerant to urban stresses, the biological condition remains poor. This site measured below COMAR standards for pH and dissolved oxygen with elevated conductivity, which may impact the biologic community. Low flow conditions observed at this site may be affecting water quality and the biological condition.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea) and midges (Chironomus) dominated the sample.
- Measured below COMAR standards for pH and dissolved oxygen. Conductivity also elevated.
- Intermittent stream with only standing water in shallow pools. Poor benthic substrate due to lack of flow. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	3.69
Turbidity (NTU)	10.1
Temperature (°C)	17.2
pH (SU)	5.92
Specific Conductivity (µS/cm)	413.4

RHOD-01-2012 RRB Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	55
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	0

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	1
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Aedes	15
Caecidotea	64
Chironomus	29
Crangonyx	1
Dytiscidae	1
Hydrobaenus	1
Rheocricotopus	4
Synurella	2
Tubificidae	1
Zavrelimyia	2
TOTAL:	**120**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	5
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	3	Sediment Deposition	10
Channel Sinuosity	9	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	2	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	5		
EPA Habitat Score			**108**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Woody Debris/Rootwads	7	100
Shading	90	91.34	Instream Habitat	2	59.39
Epifaunal Substrate	2	47.21	Bank Stability	18	94.87
PHI Score					**70.85**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**23.66**
Cover	**Acres**	**%Area**
Developed Land	**1.63**	**6.89**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	1.63	6.89
Utility	0	0
Forest Land	**22.03**	**93.11**
Forested Wetland	0	0
Residential Woods	0	0
Woods	22.03	93.11
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	0.86	3.62

RHOD-08-2012 RRE Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8754426538 **Longitude:** -76.5376366389

This site is located on Smithsonian Environmental Research Center (SERC) property and is located in the subwatershed RRE which drains to Boathouse Creek. Over half of the 42 acre drainage area consists of pasture (56%) with approximately one-third as forested land (35%) with only 3% imperviousness. Very little flow was observed at this site and water quality measured below COMAR standards for pH. In spite of the partially supporting/partially degraded habitat and high percentage of taxa intolerant to urban stressors (39%), a low taxa count (8 taxa) with no Ephemeroptera, scraper, or climber taxa resulted in a biological community that is very poor. Low flow conditions observed at this site may be affecting water quality and the biological condition.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea) and worms (Tubificidae) dominated the sample.
- Measured below COMAR standards for pH.
- Intermittent or ephemeral stream with very little observable flow. Poor benthic habitat. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.43
Turbidity (NTU)	10.3
Temperature (°C)	13.5
pH (SU)	5.47
Specific Conductivity (µS/cm)	175.1

RHOD-08-2012 RRE Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	8
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	38.98
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	0

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	42
Chironomus	16
Ironoquia	1
Ostracoda	1
Parametriocnemus	1
Synurella	4
Tubificidae	52
Turbellaria	1
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	3
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	4	Sediment Deposition	4
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	3	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	5		
EPA Habitat Score			**104**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Woody Debris/Rootwads	5	94.33
Shading	95	99.94	Instream Habitat	2	53.66
Epifaunal Substrate	3	49.37	Bank Stability	20	100
PHI Score					**78.78**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**41.46**
Cover	**Acres**	**%Area**
Developed Land	**1.57**	**3.78**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0.79	1.9
Residential 2-Acre	0	0
Transportation	0.78	1.88
Utility	0	0
Forest Land	**14.47**	**34.9**
Forested Wetland	0	0
Residential Woods	0	0
Woods	14.47	34.9
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**25.42**	**61.32**
Pasture/Hay	23.36	56.35
Row Crops	2.06	4.98
Impervious Surface	**Acres**	**% Area**
Impervious Land	1.04	2.51

RHOD-10-2012 RR0 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8878602315

Longitude: -76.5426684328

Located between Dock Road and Contees Wharf Road, this site is in the Forrest Branch (RR0) subwatershed. Two-thirds of the 42 acre drainage area consists of forested land (65%) with just 4% impervious surface. Macroinvertebrates intolerant to urban stressors accounted for over two-thirds of the sample; however, only 12 taxa were present including only two EPT, one scraper, and no Ephemeroptera. Very little flow was observed at this site resulting in minimal habitat available for benthos and a poor biological community. Water quality also measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea) and amphipods (Gammarus and Synurella) dominated the sample.
- Measured below COMAR standards for pH.
- Incised, silt/clay bottom channel with very little flow and minimal habitat. Moderately unstable banks but good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.85
Turbidity (NTU)	8.14
Temperature (°C)	10.1
pH (SU)	6.12
Specific Conductivity (µS/cm)	195.5

RHOD-10-2012 RR0 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	69.42
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	0.83

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	1
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	9
Caecidotea	56
Gammarus	21
Hydrobaenus	1
Ironoquia	3
Parametriocnemus	1
Polypedilum	1
Rheocricotopus	3
Stegopterna	7
Synurella	12
Tubificidae	4
Zavrelimyia	3
TOTAL:	**121**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	4
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	7	Sediment Deposition	8
Channel Sinuosity	8	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	5		
EPA Habitat Score			**91**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	9	48.47	Woody Debris/Rootwads	3	88.19
Shading	95	99.94	Instream Habitat	3	59.01
Epifaunal Substrate	4	55.05	Bank Stability	9	67.08
PHI Score					**69.62**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 42.3

Cover	Acres	%Area
Developed Land	**9.96**	**21.69**
Commercial	0.03	0.07
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	6.61	15.62
Transportation	2.54	6.01
Utility	0	0
Forest Land	**27.48**	**64.96**
Forested Wetland	0	0
Residential Woods	0	0
Woods	27.48	64.96
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**5.64**	**13.35**
Pasture/Hay	2.04	4.82
Row Crops	3.6	8.52

Impervious Surface	Acres	% Area
Impervious Land	1.85	4.38

RHOD-11-2012 RR2 Subwatershed

Upstream View:

Latitude: 38.8955793307

Downstream View:

Longitude: -76.5430327641

This site is located on Sellman Creek, which is part of the RR2 subwatershed and on Smithsonian Environmental Research Center (SERC) property. Of the 97 acre drainage area, 59% consists of forested land and 35% pasture. Only 1% of the drainage area is impervious surface. Approximately half of the benthic sample consisted of individuals intolerant to urban stressors (49%); however, a lack of EPT taxa and Ephemeroptera taxa as well as low occurrences of scraper and climber taxa resulted in a poor biological community. Water quality measured below COMAR standards for pH, which may be a result of the bald cypress wetland located upstream of the site.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Amphipods (Synurella), worms (Tubificidae), and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Good sinuosity. Large woody debris and roots provide majority of habitat. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.05
Turbidity (NTU)	18.7
Temperature (°C)	13.5
pH (SU)	6.1
Specific Conductivity (µS/cm)	122.2

RHOD-11-2012 RR2 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	49.15
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	5.93

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	10
Bezzia	2
Caecidotea	19
Chironomus	4
Chrysops	1
Cordulegaster	1
Ironoquia	2
Lype	1
Microvelia	1
Oligostomis	1
Parametriocnemus	2
Pisidium	4
Polypedilum	7
Rheocricotopus	5
Simulium	1
Synurella	26
Thienemannimyia group	2
Tipulidae	1
Tubificidae	24
Zavrelimyia	4
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	9
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	8
Channel Sinuosity	14	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	13		
EPA Habitat Score			**145**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	18	96.93	Woody Debris/Rootwads	9	96.57
Shading	85	84.56	Instream Habitat	8	78.28
Epifaunal Substrate	10	84.52	Bank Stability	18	94.87
PHI Score					**89.29**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 96.76

Cover	Acres	%Area
Developed Land	**11.42**	**4.97**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	3.88	4.01
Residential 2-Acre	0	0
Transportation	0.93	0.96
Utility	0	0
Forest Land	**56.57**	**58.46**
Forested Wetland	0	0
Residential Woods	0	0
Woods	56.57	58.46
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**35.38**	**36.56**
Pasture/Hay	33.25	34.37
Row Crops	2.12	2.19

Impervious Surface	Acres	% Area
Impervious Land	0.99	1.02

RHOD-13-2012 RR2 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.9048278334 **Longitude:** -76.5429586357

This site is located in the Sellman Creek (RR2) watershed and is on Smithsonian Environmental Research Center (SERC) property. The dominant land cover of the 9 acre drainage area consists of forested land (79%) with only 1% imperviousness. However, the incised channel had little flow and severely undercutting banks with little benthic habitat. As a result, the biological community was very poor and dominated by tolerant midges with no EPT or Ephemeroptera taxa present. Water quality measured below COMAR standards for pH. Low flow conditions observed at this site may be affecting water quality and the biological condition.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Various midges including Chironomus, Odontomesa, and Zavrelimyia dominated the sample.
- Measured below COMAR standards for pH.
- Incised, clay bottom channel with little flow and benthic habitat. Some severe undercutting on banks with a headcut present at upstream end of reach. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.66
Turbidity (NTU)	16.1
Temperature (°C)	12.8
pH (SU)	5.84
Specific Conductivity (µS/cm)	102.9

RHOD-13-2012 RR2 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	7.44
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	1.65

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Bezzia	2
Caecidotea	6
Ceratopogonidae	3
Chaetocladius	7
Chironomus	57
Diplocladius	1
Dytiscidae	3
Ephydridae	1
Hydrobaenus	5
Odontomesa	9
Orthocladius	1
Parametriocnemus	3
Polypedilum	1
Rheocricotopus	2
Simulium	1
Synurella	3
Tanytarsus	1
Tubificidae	7
Zavrelimyia	8
TOTAL:	**121**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	6
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	7	Sediment Deposition	5
Channel Sinuosity	8	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	5		
EPA Habitat Score			**95**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	17	91.55	Woody Debris/Rootwads	7	91.35
Shading	90	91.34	Instream Habitat	6	67.82
Epifaunal Substrate	7	67.49	Bank Stability	10	70.71
PHI Score					**80.04**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**91.05**
Cover	**Acres**	**%Area**
Developed Land	**7.14**	**3.58**
Commercial	1.21	1.33
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.7	1.87
Residential 2-Acre	0.35	0.38
Transportation	0	0
Utility	0	0
Forest Land	**71.63**	**78.68**
Forested Wetland	0	0
Residential Woods	0	0
Woods	71.63	78.68
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**16.15**	**17.74**
Pasture/Hay	0	0
Row Crops	16.15	17.74
Impervious Surface	**Acres**	**% Area**
Impervious Land	1.19	1.31

RHOD-14-2012 RR2 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.9025418461 **Longitude:** -76.5463527597

This site is located to the east of Muddy Creek Road and Contees Wharf Road on Alexander Branch, which is part of the RR2 (Sellman Creek) watershed. Located on Smithsonian Environmental Research Center (SERC) property, two-thirds of the 153 acre drainage area consists of forested land (67%) with 21% of land as row crops. Only 1% of the drainage area is impervious surface. This stream runs through wetland and has stable, well vegetated banks with roots providing stable benthic habitat. Water quality measured below COMAR standards for pH, which may be attributed to wetland conditions. Although approximately one-third of the benthic sample consisted of individuals intolerant to urban stressors (32%), few EPT taxa and no Ephemeroptera or scraper taxa attributed to a poor biological community.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Amphipods (Crangonyctidae) and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Stable well vegetated banks and good sinuosity. Roots provide much of stable benthic habitat. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.43
Turbidity (NTU)	10.8
Temperature (°C)	15.9
pH (SU)	5.52
Specific Conductivity (µS/cm)	103.5

RHOD-14-2012 RR2 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	32.48
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	6.84

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	3
Apsectrotanypus	1
Caecidotea	24
Ceratopogonidae	1
Crangonyctidae	40
Dicranota	1
Heterotrissocladius	2
Ironoquia	1
Limnophila	1
Oligostomis	7
Ostracoda	1
Parametriocnemus	9
Pisidium	1
Polypedilum	3
Rheocricotopus	10
Tanytarsus	5
Tubificidae	6
Wormaldia	1
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	7
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	18	Sediment Deposition	15
Channel Sinuosity	14	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	14		
EPA Habitat Score			**159**
EPA Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	19	100	Woody Debris/Rootwads	13	100
Shading	100	100	Instream Habitat	7	68.06
Epifaunal Substrate	11	87.35	Bank Stability	20	100
PHI Score					**92.57**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**152.79**
Cover	**Acres**	**%Area**
Developed Land	**16.28**	**9.32**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	12.72	8.32
Transportation	1.52	0.99
Utility	0	0
Forest Land	**102.36**	**67**
Forested Wetland	0	0
Residential Woods	0	0
Woods	102.36	67
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**36.19**	**23.68**
Pasture/Hay	3.41	2.23
Row Crops	32.78	21.45
Impervious Surface	**Acres**	**% Area**
Impervious Land	1.97	1.29

RHOD-15-2012 RR3 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8736072666 **Longitude:** -76.554069803

Located east of Muddy Creek Road, this site is located on All Hardwood Branch, which is part of the Many Fork Branch (RR3) watershed and drains directly into Muddy Creek. The stream runs through an old mill pond valley that turned into a wetland and is partially backwatered due to a large woody debris jam and beaver dam. Eighty percent of the benthic sample consisted of individuals intolerant to urban stressors; however, low taxa diversity with no Ephemeroptera or scraper taxa present resulted in a poor biological score. Over half of the 373 acre drainage area consists of forested land (57%) while one-fourth of the area is row crops (25%). Only 3% of the drainage area is impervious surface. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella) and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Woody debris and roots provide some stable substrate. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.5
Turbidity (NTU)	15.1
Temperature (°C)	9.6
pH (SU)	6.37
Specific Conductivity (µS/cm)	182.4

RHOD-15-2012 RR3 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	80.34
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	5.13

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	2
Caecidotea	26
Ephydridae	1
Ironoquia	1
Orthocladius	1
Parametriocnemus	2
Pisidium	1
Polypedilum	6
Synurella	66
Thienemannimyia group	4
Tubificidae	3
Zavrelimyia	4
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	11
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	8
Channel Sinuosity	12	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	12		
EPA Habitat Score			**139**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Woody Debris/Rootwads	12	90.18
Shading	80	78.67	Instream Habitat	5	47.84
Epifaunal Substrate	7	58.31	Bank Stability	19	97.47
PHI Score					**76.44**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**372.67**
Cover	**Acres**	**%Area**
Developed Land	**59.64**	**12.59**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	10.86	2.91
Residential 2-Acre	27.46	7.37
Transportation	8.61	2.31
Utility	0	0
Forest Land	**210.64**	**56.52**
Forested Wetland	0	0
Residential Woods	0	0
Woods	210.64	56.52
Open Land	**23.19**	**6.22**
Open Space	23.19	6.22
Open Wetland	0	0
Water	0	0
Agricultural Land	**91.91**	**24.66**
Pasture/Hay	0.12	0.03
Row Crops	91.79	24.63
Impervious Surface	**Acres**	**% Area**
Impervious Land	10.79	2.9

RHOD-16-2012 RR3 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8691727226 **Longitude:** -76.5556562253

This site is located on All Hardwood Branch, which is part of the Many Fork Branch (RR3) watershed. Located on Smithsonian Environmental Research Center (SERC) property, the 174 acre drainage area to this site is largely forested land (57%) or row crops (34%) with minimal imperviousness (2%). This stream runs through wetland and has multiple threads just upstream of the sampling site. Wetland conditions may be contributing to a depressed pH, which measured below COMAR standards. Although over half of the benthic sample consisted of individuals intolerant to urban stressors, the lack of Ephemeroptera and scraper taxa resulted in a biological community with a poor score.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella), midges (Thienemannimyia group), and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Marginal habitat diversity but good riparian width and vegetative protection. Banks are stable.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.44
Turbidity (NTU)	14.5
Temperature (°C)	11.1
pH (SU)	5.86
Specific Conductivity (µS/cm)	158.9

RHOD-16-2012 RR3 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	67.8
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	5.08

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	1
Caecidotea	11
Chironomus	4
Ironoquia	1
Lumbriculidae	1
Orthocladius	1
Parametriocnemus	2
Pisidium	2
Polypedilum	3
Synurella	68
Tanytarsus	3
Thienemannimyia group	16
Tubificidae	1
Zavrelimyia	4
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	7
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	7
Channel Sinuosity	12	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	12		
EPA Habitat Score			**138**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	3	72.19
Shading	90	91.34	Instream Habitat	6	61.19
Epifaunal Substrate	7	63.27	Bank Stability	19	97.47
PHI Score					**77.71**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**173.86**
Cover	**Acres**	**%Area**
Developed Land	**51.4**	**7.53**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	5.18	2.98
Residential 2-Acre	3.7	2.13
Transportation	4.21	2.42
Utility	0	0
Forest Land	**99.44**	**57.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	99.44	57.2
Open Land	**2.86**	**1.65**
Open Space	2.86	1.65
Open Wetland	0	0
Water	0	0
Agricultural Land	**58.47**	**33.63**
Pasture/Hay	0.12	0.07
Row Crops	58.35	33.56
Impervious Surface	**Acres**	**% Area**
Impervious Land	4.01	2.31

RHOD-17-2012 RR8 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8877188865 **Longitude:** -76.5595807306

This site is located on North Fork Muddy Creek, which is part of the RR8 watershed (North Fork Muddy Creek). Two-thirds of the 604 acre drainage area is forested (66%) with 14% as 2-acre residential. Only 5% of the drainage area to this site consists of impervious surface. The stream is adjacent to and draining wetlands with an abundance of large woody debris and root habitat for benthos. Although taxa diversity (23 taxa) and percent climbers (9%) received high scores, a lack of Ephemeroptera and scraper taxa contributed to a biological community with an overall poor score. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Midges, including Thienemannimyia group, Parametriocnemus, and Chironomus dominated the sample.
- Measured below COMAR standards for pH.
- Abundance of large woody debris and root habitat. Banks stable and well vegetated. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.43
Turbidity (NTU)	15.3
Temperature (°C)	12.1
pH (SU)	6.22
Specific Conductivity (µS/cm)	181.4

RHOD-17-2012 RR8 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	19.49
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	8.47

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Bezzia	2
Caecidotea	9
Chironomus	11
Coenagrionidae	1
Dicrotendipes	3
Dytiscidae	1
Endochironomus	1
Hydropsychidae	1
Ironoquia	1
Microtendipes	7
Orthocladius	2
Parametriocnemus	17
Paratanytarsus	4
Phaenopsectra	1
Pisidium	1
Polypedilum	8
Potthastia	1
Simulium	7
Synurella	14
Tanypodinae	1
Tanytarsus	1
Thienemannimyia group	22
Tubificidae	2
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	11
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	19	Sediment Deposition	9
Channel Sinuosity	11	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	10		
EPA Habitat Score			**149**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	19	100
Shading	95	99.94	Instream Habitat	12	81.73
Epifaunal Substrate	13	90.02	Bank Stability	17	92.2
PHI Score					**90.78**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**604.13**
Cover	**Acres**	**%Area**
Developed Land	**134.57**	**20.81**
Commercial	6.26	1.04
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	9.59	1.59
Residential 1-Acre	10.48	1.73
Residential 2-Acre	85.18	14.1
Transportation	14.19	2.35
Utility	0	0
Forest Land	**398.69**	**65.99**
Forested Wetland	0	0
Residential Woods	0	0
Woods	398.69	65.99
Open Land	**66.27**	**10.97**
Open Space	62.84	10.4
Open Wetland	0	0
Water	3.43	0.57
Agricultural Land	**13.47**	**2.23**
Pasture/Hay	13.46	2.23
Row Crops	0.02	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	29.83	4.94

RHOD-18-2012 RR8 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8980793909 **Longitude:** -76.5646799983

This site is located approximately 150 meters upstream of Muddy Creek Road on North Fork Muddy Creek, which is part of the RR8 watershed (North Fork Muddy Creek). Of the 279 acres draining to the site, 43% is forested while 27% is 2-acre residential. Impervious surface accounts for 6% of the drainage area. Although the percentage of benthic individuals intolerant to urban stressors (42%) and percent climbers (18%) both received high scores, a complete lack of Ephemeroptera and scraper taxa contributed to an overall poor score for the biological community.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Isopods (Synurella) and midges (Parametriocnemus and Polypedilum) dominated the sample.
- Water quality values within COMAR standards.
- Small, shallow sandy bottom channel with few pools but good woody debris habitat. Banks are moderately unstable but good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.69
Turbidity (NTU)	9.44
Temperature (°C)	11.3
pH (SU)	6.57
Specific Conductivity (µS/cm)	162.8

RHOD-18-2012 RR8 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	22
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	42.28
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	17.89

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	8
Caecidotea	13
Calopteryx	1
Chaetocladius	1
Cheumatopsyche	3
Chrysops	1
Corynoneura	1
Ironoquia	2
Naididae	1
Neoporus	2
Orthocladius	1
Parametriocnemus	25
Pisidium	3
Polypedilum	21
Rheocricotopus	4
Simulium	3
Somatochlora	1
Stegopterna	4
Synurella	25
Thienemanniella	1
Thienemannimyia group	1
Tubificidae	1
TOTAL:	**123**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	6
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	14
Channel Sinuosity	8	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	9		
EPA Habitat Score			**120**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	15	100
Shading	80	78.67	Instream Habitat	8	67.46
Epifaunal Substrate	7	60.2	Bank Stability	12	77.46
PHI Score					**77.43**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**278.74**
Cover	**Acres**	**%Area**
Developed Land	**202.5**	**34.89**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	9.59	3.44
Residential 1-Acre	4.23	1.52
Residential 2-Acre	76.59	27.48
Transportation	6.85	2.46
Utility	0	0
Forest Land	**119.28**	**42.79**
Forested Wetland	0	0
Residential Woods	0	0
Woods	119.28	42.79
Open Land	**49.32**	**17.69**
Open Space	48.21	17.3
Open Wetland	0	0
Water	1.11	0.4
Agricultural Land	**12.88**	**4.62**
Pasture/Hay	12.87	4.62
Row Crops	0.02	0.01
Impervious Surface	**Acres**	**% Area**
Impervious Land	17.47	6.27

RHOD-19-2012 RR8 Subwatershed

Upstream View:

Latitude: 38.8885671237

Downstream View:

Longitude: -76.5646494132

This site is located between Collins Road and Old Muddy Creek Road on Bluejay Branch, which is part of the North Fork Muddy Creek watershed (RR8). Approximately half of the 479 acre drainage area is forested (53%) with 27% consisting of 2-acre residential land use. Only 5% of the drainage area is impervious surface. This shallow, slow flowing stream runs through vegetated wetland with an abundance of attached algae throughout. All in situ water quality measurements were within COMAR standards. Poor taxa diversity (11 taxa) with no EPT or Ephemeroptera taxa and very few individuals intolerant to urban stressors contributed to a very poor biological community. A lack of habitat complexity for benthos was observed at this site.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Polypedilum (midge) dominated the sample.
- Water quality values within COMAR standards.
- Poor velocity/depth diversity with poor habitat complexity. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	11.77
Turbidity (NTU)	6.59
Temperature (°C)	15
pH (SU)	6.57
Specific Conductivity (µS/cm)	202.3

RHOD-19-2012 RR8 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	11
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	8.8
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	74.4

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	10
Hydrobaenus	1
Orthocladius	9
Parametriocnemus	1
Phaenopsectra	1
Pisidium	5
Polypedilum	93
Synurella	1
Thienemannimyia group	1
Tubificidae	2
Zavrelimyia	1
TOTAL:	**125**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	6
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	15
Channel Sinuosity	7	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	10		
EPA Habitat Score			**139**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	10	81.42
Shading	40	40.96	Instream Habitat	5	45.26
Epifaunal Substrate	6	50.86	Bank Stability	20	100
PHI Score					**62.06**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**479.31**
Cover	**Acres**	**%Area**
Developed Land	**231.88**	**29.52**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.8	0.17
Residential 1-Acre	5.31	1.11
Residential 2-Acre	127.49	26.6
Transportation	7.88	1.64
Utility	0	0
Forest Land	**252.92**	**52.77**
Forested Wetland	0	0
Residential Woods	0	0
Woods	252.92	52.77
Open Land	**49.11**	**10.25**
Open Space	47.86	9.99
Open Wetland	0	0
Water	1.25	0.26
Agricultural Land	**35.81**	**7.47**
Pasture/Hay	1.95	0.41
Row Crops	33.86	7.07
Impervious Surface	**Acres**	**% Area**
Impervious Land	23.53	4.91

RHOD-20-2012 RR8 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8958527914 **Longitude:** -76.5714543514

This site is located north of Fiddlers Hill Road and to the west of Muddy Creek Road on Bluejay Branch, which is part of the North Fork Muddy Creek watershed (RR8). One-third of the 289 acre drainage area consists of forested land (35%) with another one-third consisting of 2-acre residential land use (38%). Imperviousness accounts for only 6% of the drainage area. This shallow, sandy bottom channel has minimal bed feature diversity with mostly run features. Woody debris and some roots provide the only stable habitat for benthos. This site received a very poor biological condition score due to poor taxa diversity (10 taxa) with no EPT, Ephemeroptera, scraper, or taxa intolerant to urban stressors.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) dominated the sample.
- Measured below COMAR standards for pH.
- Some woody debris and roots providing stable benthic habitat. Moderately stable banks with good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.12
Turbidity (NTU)	8.75
Temperature (°C)	17.2
pH (SU)	6.41
Specific Conductivity (µS/cm)	175.1

RHOD-20-2012 RR8 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	68.03

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Chaetocladius	1
Chironomus	4
Limnophyes	1
Orthocladius	9
Polypedilum	83
Potthastia	1
Rheocricotopus	13
Simuliidae	1
Tubificidae	6
Zavrelimyia	3
TOTAL:	**122**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	5
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	14
Channel Sinuosity	10	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	5		
EPA Habitat Score			**125**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	9	84.18
Shading	95	99.94	Instream Habitat	8	67.08
Epifaunal Substrate	7	59.96	Bank Stability	14	83.67
PHI Score					**79.27**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**289.22**
Cover	**Acres**	**%Area**
Developed Land	**247.63**	**39.43**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	109.8	37.96
Transportation	4.23	1.46
Utility	0	0
Forest Land	**100.35**	**34.7**
Forested Wetland	0	0
Residential Woods	0	0
Woods	100.35	34.7
Open Land	**40.77**	**14.1**
Open Space	39.53	13.67
Open Wetland	0	0
Water	1.25	0.43
Agricultural Land	**34.06**	**11.78**
Pasture/Hay	0.67	0.23
Row Crops	33.4	11.55
Impervious Surface	**Acres**	**% Area**
Impervious Land	15.9	5.5

RHOD-24-2012 RR8 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8867057388 **Longitude:** -76.5637916663

This site is located approximately 150 meters downstream of Old Muddy Creek Road and Collins Road on Williamson Branch, which is part of the North Fork Muddy Branch (RR8) watershed. An earthen berm impoundment near the site's midpoint is creating backwatering conditions in the upstream portion of the reach. The stream has formed new channels around the impoundment and onto the floodplain. Water quality measured within COMAR standards; however, abundant algae was observed. The drainage area to this site (661 acres) is largely forested (61%) with 19% as 2-acre residential land use. Imperviousness accounts for only 5% of the drainage area. Over half of the benthic sample consisted of climber taxa (58%); however, low taxa diversity (15 taxa) with few EPT taxa and no Ephemeroptera or scraper taxa contributed to an overall pool biological community.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) dominated the sample.
- Water quality values within COMAR standards.
- Marginal habitat complexity but banks are stable with good riparian width. Refuse present in moderate amounts

Water Chemistry:

Dissolved Oxygen (mg/L)	10.91
Turbidity (NTU)	8.33
Temperature (°C)	11
pH (SU)	6.78
Specific Conductivity (µS/cm)	212.3

RHOD-24-2012 RR8 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	0.85
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	57.63

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Ceratopogonidae	1
Chironomus	11
Dytiscidae	1
Empididae	1
Ironoquia	1
Limnophyes	1
Orthocladius	14
Parametriocnemus	1
Perlodidae	1
Polypedilum	68
Rheocricotopus	11
Simulium	4
Thienemanniella	1
Thienemannimyia group	1
Zavrelimyia	1
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	8
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	11	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	16	Sediment Deposition	12
Channel Sinuosity	13	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	7		
EPA Habitat Score			**126**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	14	89.61
Shading	75	73.32	Instream Habitat	7	53.07
Epifaunal Substrate	7	54.57	Bank Stability	18	94.87
PHI Score					**70.78**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**661.04**
Cover	**Acres**	**%Area**
Developed Land	**292.31**	**27.61**
Commercial	3.02	0.46
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	9.7	1.47
Residential 1-Acre	24.8	3.75
Residential 2-Acre	125.43	18.97
Transportation	19.56	2.96
Utility	0	0
Forest Land	**405.91**	**61.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	405.91	61.4
Open Land	**49.04**	**7.42**
Open Space	48.12	7.28
Open Wetland	0	0
Water	0.92	0.14
Agricultural Land	**23.59**	**3.57**
Pasture/Hay	19.8	3
Row Crops	3.78	0.57
Impervious Surface	**Acres**	**% Area**
Impervious Land	32.38	4.9

RHOD-27-2012 RR7 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8905355218 **Longitude:** -76.5833352137

This site is located east of Solomons Island Road on the headwater portion of Williamson Branch, which is part of the Williamson Branch (RR7) watershed. The drainage area to this site (289 acres) is largely forested (63%) with little impervious surface (6%). The stream drains a wetland valley with multiple overflow channels. A horse trail and footbridge are located just upstream of the site. Even though half of the benthic sample consisted of individuals intolerant to urban stressors, the complete lack of EPT, Ephemeroptera, and scraper taxa contributed to a very poor benthic community rating. Water quality measured below COMAR standards for pH with elevated levels of conductivity.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella and Gammarus) dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- Minimal stable habitat for benthos. Moderately stable banks with suboptimal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.28
Turbidity (NTU)	20.2
Temperature (°C)	9.8
pH (SU)	6.43
Specific Conductivity (µS/cm)	308.5

RHOD-27-2012 RR7 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	50
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	5.83

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	11
Calopteryx	1
Dytiscidae	8
Gammarus	12
Orthocladius	5
Parametriocnemus	5
Polypedilum	6
Rheocricotopus	6
Synurella	49
Thienemannimyia group	3
Tubificidae	1
Zavrelimyia	13
TOTAL:	**120**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	6
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	19	Sediment Deposition	14
Channel Sinuosity	11	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	7		
EPA Habitat Score			**126**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	4	72.49
Shading	95	99.94	Instream Habitat	7	64.33
Epifaunal Substrate	7	61.74	Bank Stability	12	77.46
PHI Score					**71.64**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 219.92

Cover	Acres	%Area
Developed Land	**223.55**	**28.93**
Commercial	0.42	0.19
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	2.2	1
Residential 1-Acre	11.64	5.29
Residential 2-Acre	43.11	19.6
Transportation	6.24	2.84
Utility	0	0
Forest Land	**137.64**	**62.59**
Forested Wetland	0	0
Residential Woods	0	0
Woods	137.64	62.59
Open Land	**17.37**	**7.9**
Open Space	16.45	7.48
Open Wetland	0	0
Water	0.92	0.42
Agricultural Land	**1.3**	**0.59**
Pasture/Hay	1.02	0.46
Row Crops	0.28	0.13

Impervious Surface	Acres	% Area
Impervious Land	13	5.91

RHOD-28-2012 RR7 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8924927279 **Longitude:** -76.5738226089

This site is located on Jessica Brook, a part of the Williamson Branch watershed (RR7) , approximately 150 meters upstream of the confluence with Williamson Branch. Of the 129 acre drainage area, 47% is forested while 30% is 2-acre residential. Impervious surface accounts for only 6% of the drainage area. The channel appears to have been straightened in the past and there is erosion along both banks. Although over half of the benthic sample consisted of individuals intolerant to urban stressors and 22% climbers, suboptimal taxa diversity, only one EPT taxa and no Ephemeroptera or scraper taxa contributed to an overall poor biological community. Water quality measured below COMAR standards for pH. Impacts from historical land use (e.g. channelization) may continue to limit the stream's ability to support a healthy biota.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea), midges (Polypedilum), and amphipods (Synurella) dominated the sample.
- Measured below COMAR standards for pH.
- Erosion on both banks with suboptimal vegetative protection. Some good riffles, but only marginal quality providing marginal habitat. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.51
Turbidity (NTU)	7.68
Temperature (°C)	15.4
pH (SU)	6.33
Specific Conductivity (µS/cm)	164.4

RHOD-28-2012 RR7 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	57.89
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	21.93

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	17
Caecidotea	25
Chironomus	10
Culicidae	1
Dicranota	1
Nanocladius	1
Orthocladius	1
Pisidium	3
Polypedilum	25
Simulium	2
Synurella	23
Thienemanniella	1
Thienemannimyia group	1
Tubificidae	2
Zavrelimyia	1
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	6
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	11
Channel Sinuosity	4	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	9		
EPA Habitat Score			**109**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	2	72.62
Shading	95	99.94	Instream Habitat	7	69.8
Epifaunal Substrate	10	82.65	Bank Stability	9	67.08
PHI Score					**75.22**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**128.87**
Cover	**Acres**	**%Area**
Developed Land	**106.44**	**38.4**
Commercial	2.6	2.02
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.44	1.9
Residential 2-Acre	39.17	30.4
Transportation	5.27	4.09
Utility	0	0
Forest Land	**60.54**	**46.98**
Forested Wetland	0	0
Residential Woods	0	0
Woods	60.54	46.98
Open Land	**15.33**	**11.9**
Open Space	15.33	11.9
Open Wetland	0	0
Water	0	0
Agricultural Land	**3.51**	**2.72**
Pasture/Hay	0	0
Row Crops	3.51	2.72
Impervious Surface	**Acres**	**% Area**
Impervious Land	7.03	5.45

RHOD-30-2012 RR5 Subwatershed

Upstream View:

Latitude: 38.8671146185

Downstream View:

Longitude: -76.5880713495

This site is located on an unnamed tributary that runs between Three Rivers Road and Chews Chapel Road and is 230 meters upstream of the confluence with Muddy Creek. A part of the South Fork Muddy Creek II watershed (RR5), the drainage area to this site (454 acres) is largely forested (65%) with little impervious surface (3%). This reach is just downstream of a beaver dam and is deeply incised with some areas of severely eroded and undercut banks. Heavy sediment deposition and little diversity of bed features along with some large woody debris and roots provide partially supporting habitat for the biological community. Over half of the benthic sample consisted of climbers; however, suboptimal taxa diversity including only one EPT taxa, few intolerant taxa, and no Ephemeroptera or scraper taxa contributed to a very poor biological condition score.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) and Gammarus (amphipod) dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised channel with some areas of severely eroded and undercut banks. Heavy sediment deposition with some woody debris and roots providing stable benthic habitat. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.31
Turbidity (NTU)	8.11
Temperature (°C)	17.6
pH (SU)	6.83
Specific Conductivity (µS/cm)	164

RHOD-30-2012 RR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	7.44
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	59.5

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Amphinemura	1
Ceratopogonidae	1
Chrysops	1
Dicranota	5
Gammarus	26
Hydrobius	2
Lumbricina	1
Parametriocnemus	3
Polypedilum	70
Rheocricotopus	3
Simulium	1
Stegopterna	2
Tipula	1
Tubificidae	1
Zavrelimyia	3
TOTAL:	**121**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	6
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	7
Channel Sinuosity	12	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	7		
EPA Habitat Score			**115**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Woody Debris/Rootwads	8	76.11
Shading	95	99.94	Instream Habitat	5	45.82
Epifaunal Substrate	7	57.02	Bank Stability	9	67.08
PHI Score					**68.43**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 453.96

Cover	Acres	%Area
Developed Land	**152.38**	**24.4**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	19.52	4.3
Residential 2-Acre	57.77	12.73
Transportation	10.14	2.23
Utility	23.34	5.14
Forest Land	**296.04**	**65.21**
Forested Wetland	0	0
Residential Woods	0	0
Woods	296.04	65.21
Open Land	**29**	**6.39**
Open Space	29	6.39
Open Wetland	0	0
Water	0	0
Agricultural Land	**18.16**	**4**
Pasture/Hay	9.22	2.03
Row Crops	8.93	1.97

Impervious Surface	Acres	% Area
Impervious Land	13.62	3

RHOD-32-2012 RR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8691684612 **Longitude:** -76.5979000839

This site is located along the headwater portion of Muddy Creek, which is part of the South Fork Muddy Creek II watershed (RR5). Of the 481 acre drainage area, approximately half is forested land (53%) and one-fourth (25%) is 2-acre residential land use with only 6% impervious surface. The channel has good sinuosity; however, it is also incised with banks severely eroded along the outer meanders. A good mix of habitats and velocities provides a supporting habitat to a fair benthic community. Close to half of the benthic sample consisted of climber taxa; in addition, two scraper taxa and three EPT taxa were also present in the sample. Water quality values were within COMAR standards but conductivity was elevated.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Amphipods (Gammarus), midges (Polypedilum), and snails (Physa) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Channel incised but with good sinuosity. Banks severely eroded on outer meanders. Good mix of habitats and velocities. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.83
Turbidity (NTU)	8.93
Temperature (°C)	17.8
pH (SU)	6.92
Specific Conductivity (µS/cm)	247.8

RHOD-32-2012 RR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	10.43
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	42.61

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	8
Antocha	1
Calopteryx	3
Cheumatopsyche	1
Dicranota	1
Gammarus	31
Naididae	1
Neophylax	3
Orthocladius	1
Parametriocnemus	4
Physa	17
Polypedilum	29
Potthastia	1
Thienemannimyia group	2
Tipula	1
Tubificidae	5
Zavrelimyia	6
TOTAL:	**115**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	11
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	11
Channel Sinuosity	15	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	11		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	5	66.58
Shading	95	99.94	Instream Habitat	12	84.06
Epifaunal Substrate	13	91.5	Bank Stability	12	77.46
PHI Score					**83.38**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 481.34

Cover	Acres	%Area
Developed Land	**254.34**	**36.78**
Commercial	5.24	1.09
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.43	0.09
Residential 1-Acre	6.9	1.43
Residential 2-Acre	119.71	24.87
Transportation	10.2	2.12
Utility	34.59	7.19
Forest Land	**254.88**	**52.95**
Forested Wetland	0	0
Residential Woods	0	0
Woods	254.88	52.95
Open Land	**48.84**	**10.15**
Open Space	48.84	10.15
Open Wetland	0	0
Water	0	0
Agricultural Land	**0.57**	**0.12**
Pasture/Hay	0	0
Row Crops	0.57	0.12

Impervious Surface	Acres	% Area
Impervious Land	28.69	5.96

RHOD-33-2012 RR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8720517655 **Longitude:** -76.5996626912

Located on an unnamed tributary to Muddy Creek, this site is part of the South Fork Muddy Creek II watershed (RR5). Large point bars were observed in this shallow channel which suggests heavy sedimentation. Partially supporting habitat, consisting mainly of riffles and runs with few pools, is available to the biological community. The benthic sample for this site had high taxa diversity (24 taxa) and a high percentage of climbers (32%); however, low scores for EPT taxa, Ephemeroptera, and scraper taxa resulted in a poor biological community. Of the 112 acre drainage area, 57% is forested with 33% as 2-acre residential land use. Impervious surface accounts for 8% of the drainage area, which is the highest percentage of imperviousness for all sites sampled in Rhode River.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges (Polypedilum) and amphipods (Gammarus) dominated the sample.
- Water quality values within COMAR standards.
- Shallow channel with large point bars suggesting heavy sedimentation. Marginal habitat for benthos. Moderately stable banks with good vegetative protection and good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	12.6
Turbidity (NTU)	2.88
Temperature (°C)	16
pH (SU)	6.89
Specific Conductivity (µS/cm)	211.6

RHOD-33-2012 RR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	11.86
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	32.2

Calculated Metric Scores

Total Taxa	5
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	6
Caecidotea	3
Calopteryx	1
Chaetocladius	3
Chironomus	5
Gammarus	33
Limnophyes	1
Nemata	1
Odontomesa	2
Orthocladius	6
Parakiefferiella	1
Parametriocnemus	3
Phaenopsectra	1
Polypedilum	37
Potthastia	1
Pseudolimnophila	2
Rheocricotopus	1
Simulium	1
Stegopterna	1
Synurella	1
Thienemanniella	1
Thienemannimyia group	2
Tubificidae	1
Zavrelimyia	4
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	6
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	7
Channel Sinuosity	9	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	8		
EPA Habitat Score			**121**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Woody Debris/Rootwads	8	92
Shading	90	91.34	Instream Habitat	6	65.73
Epifaunal Substrate	8	71.97	Bank Stability	16	89.45
PHI Score					**79.18**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**111.65**
Cover	**Acres**	**%Area**
Developed Land	**165.95**	**34.85**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0.72	0.64
Residential 2-Acre	37.33	33.44
Transportation	0.86	0.77
Utility	0	0
Forest Land	**63.57**	**56.94**
Forested Wetland	0	0
Residential Woods	0	0
Woods	63.57	56.94
Open Land	**5.09**	**4.56**
Open Space	5.09	4.56
Open Wetland	0	0
Water	0	0
Agricultural Land	**4.07**	**3.65**
Pasture/Hay	0	0
Row Crops	4.07	3.65
Impervious Surface	**Acres**	**% Area**
Impervious Land	8.68	7.78

RHOD-37-2012 RR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8603588396 **Longitude:** -76.5932847332

Located behind Fibich Lane on an unnamed tributary to Muddy Creek, this site is part of the South Fork Muddy Creek II watershed (RR5). This channel is incised with a shallow, sandy bottom and little bed feature diversity. Minimal woody debris and leaf packs provide partially supporting habitat for benthos. Although over one third of the benthic sample consisted of individuals intolerant to urban stressors (36%) low taxa diversity with few EPT taxa and no Ephemeroptera or scraper taxa contributed to a poor biological community. The majority of the 145 acre drainage area is forested (68%) with minimal impervious surface (4%). Water quality values were within COMAR standards but conductivity was elevated.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Gammarus (amphipod) and Amphinemura (stonefly) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Channel incised with minimal wood/leaf pack habitat for benthos. Moderately stable banks with suboptimal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.09
Turbidity (NTU)	12.6
Temperature (°C)	12.8
pH (SU)	6.72
Specific Conductivity (µS/cm)	269

RHOD-37-2012 RR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	36.21
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	1.72

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	27
Caecidotea	3
Chrysops	1
Dicranota	8
Dytiscidae	1
Gammarus	52
Ironoquia	2
Odontomesa	6
Polypedilum	2
Prodiamesa	2
Synurella	3
Tipula	1
Tubificidae	7
Zavrelimyia	1
TOTAL:	**116**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	6
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	13	Sediment Deposition	7
Channel Sinuosity	13	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	8		
EPA Habitat Score			**123**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Woody Debris/Rootwads	5	80.13
Shading	95	99.94	Instream Habitat	7	68.57
Epifaunal Substrate	7	64.44	Bank Stability	14	83.67
PHI Score					**73.3**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**145.44**
Cover	**Acres**	**%Area**
Developed Land	**73.46**	**26.36**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	11.91	8.19
Residential 2-Acre	23.03	15.83
Transportation	3.4	2.34
Utility	0	0
Forest Land	**98.18**	**67.51**
Forested Wetland	0	0
Residential Woods	0	0
Woods	98.18	67.51
Open Land	**7.25**	**4.99**
Open Space	7.25	4.99
Open Wetland	0	0
Water	0	0
Agricultural Land	**1.66**	**1.14**
Pasture/Hay	0	0
Row Crops	1.66	1.14
Impervious Surface	**Acres**	**% Area**
Impervious Land	6.09	4.19

RHOD-39-2012 RR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.86269179 **Longitude:** -76.597487047

Southeast of Three Rivers Road, this site is located on an unnamed tributary to Muddy Creek, which is part of the South Fork Muddy Creek II watershed (RR5). This is a shallow stream with mostly riffle/run features but lacks deep pools. A good mix of shallow gravel riffles with large woody debris, rootwads, and leaf packs provides supporting habitat for benthos. The absence of Ephemeroptera and scraper taxa contributes to a poor biological score. Of the 110 acre drainage area, 64% is forested with 21% developed land. Impervious surface accounts for only 4% of the drainage area.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Polypedilum (midge) and Gammarus (amphipod) dominated the sample.
- Water quality values within COMAR standards.
- Good mix of benthic habitat types including shallow gravel riffles, large woody debris, root and leaf packs. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.83
Turbidity (NTU)	17.1
Temperature (°C)	11.8
pH (SU)	6.71
Specific Conductivity (µS/cm)	191.7

RHOD-39-2012 RR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	11.86
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	16.95

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	2
Bezzia	1
Cheumatopsyche	1
Dicranota	11
Dytiscidae	1
Gammarus	73
Odontomesa	1
Phaenopsectra	1
Polypedilum	20
Rheocricotopus	1
Synurella	1
Thienemanniella	2
Tipula	1
Tubificidae	1
Zavrelimyia	1
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	9
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	12
Channel Sinuosity	13	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	11		
EPA Habitat Score			**148**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	5	83.32
Shading	100	100	Instream Habitat	8	77
Epifaunal Substrate	12	95.32	Bank Stability	18	94.87
PHI Score					**88.55**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**109.66**
Cover	**Acres**	**%Area**
Developed Land	**58.3**	**21.3**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	6.74	6.15
Residential 2-Acre	11.31	10.31
Transportation	5.31	4.84
Utility	0	0
Forest Land	**69.88**	**63.72**
Forested Wetland	0	0
Residential Woods	0	0
Woods	69.88	63.72
Open Land	**16.42**	**14.97**
Open Space	16.42	14.97
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	4.63	4.22

RHOD-40-2012 RR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8678713628 **Longitude:** -76.6066413961

This site is located on the mainstem of Muddy Creek and is part of the South Fork Muddy Creek II watershed (RR5). Of the 238 acre drainage area, 53% is forested with 21% as 2-acre residential and 17% as agriculture. Seven percent of the drainage area is impervious surface. This channel runs through a powerline corridor with no canopy cover and is adjacent to pasture. Although this stream exhibits good sinuosity, little flow/depth variation and extensive attached algae provides degraded habitat to a very poor biological community. The benthic sample for this site had poor taxa diversity (12 taxa) with very few intolerant individuals (2%) and no EPT, Ephemeroptera, or scraper taxa. Water quality values were within COMAR standards but conductivity was elevated.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Gammarus (amphipod) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Channel runs through powerline corridor with no canopy cover and is adjacent to pasture - resulting in suboptimal riparian width and marginal vegetative protection. Good sinuosity, but little flow/depth variation.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.37
Turbidity (NTU)	10.5
Temperature (°C)	12.7
pH (SU)	6.81
Specific Conductivity (µS/cm)	315.1

RHOD-40-2012 RR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	2.44
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	8.94

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Bezzia	2
Chrysops	1
Dicranota	1
Gammarus	86
Orthocladius	5
Parametriocnemus	2
Pisidium	7
Polypedilum	11
Synurella	1
Thienemannimyia group	1
Tubificidae	4
Zavrelimyia	2
TOTAL:	**123**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	8
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	4
Channel Flow Status	18	Sediment Deposition	13
Channel Sinuosity	14	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	10		
EPA Habitat Score			**124**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	9	48.47	Woody Debris/Rootwads	2	65.67
Shading	5	0	Instream Habitat	8	69.07
Epifaunal Substrate	8	67.03	Bank Stability	16	89.45
PHI Score					**56.61**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**238.09**
Cover	**Acres**	**%Area**
Developed Land	**97.56**	**34.47**
Commercial	5.24	2.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.43	0.18
Residential 1-Acre	2.72	1.14
Residential 2-Acre	49.31	20.71
Transportation	6.46	2.72
Utility	17.9	7.52
Forest Land	**128.43**	**53.94**
Forested Wetland	0	0
Residential Woods	0	0
Woods	128.43	53.94
Open Land	**27.03**	**11.35**
Open Space	27.03	11.35
Open Wetland	0	0
Water	0	0
Agricultural Land	**0.57**	**0.24**
Pasture/Hay	0	0
Row Crops	0.57	0.24
Impervious Surface	**Acres**	**% Area**
Impervious Land	15.97	6.71

RHOD-41-2012 RR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8664718164 **Longitude:** -76.6051764335

Northwest of Three Rivers Road, this site is located on an unnamed tributary to Muddy Creek and is part of the South Fork Muddy Creek II watershed (RR5). This channel is shallow with a sandy bottom and little flow/depth diversity, likely due to heavy sedimentation and lacks habitat complexity with wood and leaf packs providing most of the benthic substrate. Although 32% of the benthic sample consisted of individuals intolerant to urban stressors, marginal taxa diversity (14 taxa) with few EPT taxa and no Ephemeroptera or scraper taxa resulted in an overall poor biologic score. Of the 114 acre drainage area, 59% is forested with 34% as 2-acre residential land use. Only 4% of the drainage area is impervious.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Amphipods (Gammarus) and isopods (Caecidotea) dominated the sample.
- Water quality values within COMAR standards.
- Shallow, sandy bottom channel with little flow/depth diversity, likely due to heavy sedimentation. Stream lacking habitat complexity. Wood and leaf packs provide most of benthic substrate.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.82
Turbidity (NTU)	24
Temperature (°C)	12.6
pH (SU)	6.71
Specific Conductivity (µS/cm)	209.2

RHOD-41-2012 RR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	32.23
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	6.61

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	1
Caecidotea	21
Dicranota	11
Gammarus	46
Ironoquia	2
Odontomesa	3
Parakiefferiella	1
Parametriocnemus	5
Polypedilum	8
Rheocricotopus	3
Synurella	5
Thienemanniella	1
Tipula	4
Tubificidae	10
TOTAL:	**121**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	5
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	6
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	8
Channel Sinuosity	10	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	7		
EPA Habitat Score			**126**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Woody Debris/Rootwads	4	79.95
Shading	98	100	Instream Habitat	6	65.53
Epifaunal Substrate	7	66.03	Bank Stability	19	97.47
PHI Score					**73.55**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**113.83**
Cover	**Acres**	**%Area**
Developed Land	**92.2**	**34.91**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	38.42	33.75
Transportation	1.32	1.16
Utility	0	0
Forest Land	**66.98**	**58.85**
Forested Wetland	0	0
Residential Woods	0	0
Woods	66.98	58.85
Open Land	**7.11**	**6.24**
Open Space	7.11	6.24
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	4.84	4.25

RHOD-43-2012 RR9 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8831943628 **Longitude:** -76.5770618982

This site is located on Mill Swamp Branch, which is part of the South Fork Muddy Creek I watershed (RR9). Of the 233 acre drainage area, 46% is agriculture, 27% forested, and 21% developed. Only 4%of the drainage area consists of impervious surface. This is a slow moving, sediment filled stream with a debris jam causing some backwatering. Woody debris and roots along the bank provide the majority of benthic habitat. Over half of the benthic sample consisted of climber taxa (55%) and intolerant individuals accounted for 20% of the sample. In addition, the inclusion of three scraper taxa and three Ephemeroptera taxa resulted in a fair biological score. Water quality measured below COMAR standards for pH and dissolved oxygen, which may be a result of poor flow conditions.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) dominated the sample.
- Measured below COMAR standards for pH and dissolved oxygen.
- Slow moving sediment filled stream with roots along bank and woody debris as majority of benthic habitat. Banks are moderately stable with suboptimal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	4.88
Turbidity (NTU)	21.2
Temperature (°C)	21
pH (SU)	6.48
Specific Conductivity (µS/cm)	146.7

RHOD-43-2012 RR9 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	20.34
Ephemeroptera %	0.85
Scraper Taxa	3
% Climbers	55.08

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	3
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Caecidotea	8
Calopteryx	1
Chironomus	3
Dytiscidae	1
Gammarus	4
Gyraulus	1
Heptageniidae	1
Lumbriculidae	1
Nigronia	1
Orthocladius	2
Parametriocnemus	2
Phaenopsectra	1
Physa	2
Pisidium	7
Polypedilum	60
Psectrotanypus	2
Stenochironomus	1
Synurella	14
Zavrelimyia	6
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	5
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	7
Channel Sinuosity	8	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	5		
EPA Habitat Score			**117**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	7	80.7
Shading	95	99.94	Instream Habitat	6	58.19
Epifaunal Substrate	7	61.36	Bank Stability	16	89.45
PHI Score					**74.81**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**233.1**
Cover	**Acres**	**%Area**
Developed Land	**87.25**	**20.95**
Commercial	1.18	0.51
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	7.23	3.1
Residential 1-Acre	22.5	9.65
Residential 2-Acre	12	5.15
Transportation	5.92	2.54
Utility	0	0
Forest Land	**62.22**	**26.69**
Forested Wetland	0	0
Residential Woods	0	0
Woods	62.22	26.69
Open Land	**14.99**	**6.43**
Open Space	14.99	6.43
Open Wetland	0	0
Water	0	0
Agricultural Land	**107.07**	**45.93**
Pasture/Hay	102.68	44.05
Row Crops	4.39	1.88
Impervious Surface	**Acres**	**% Area**
Impervious Land	10.38	4.45

RHOD-45-2012 RR9 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8776385193 **Longitude:** -76.5826176661

Located on Big Hob Run, this site is part of the South Fork Muddy Creek I watershed (RR9). Over half of the 444 acre drainage area is forested (53%) with 21% consisting of agricultural land. Impervious surface accounts for only 2% of the drainage area. This channel is incised and overwidened with a shallow, sandy bottom that lacks bed feature complexity. Some large woody debris and gravel riffles provide partially supporting habitat for the benthic community. The benthic sample scored high for climber taxa because Polypedilum (a tolerant midge) dominated the benthic sample. However, few EPT and intolerant taxa in addition to no Ephemeroptera or scraper taxa resulted in a very poor biological score.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) dominated the sample.
- Water quality values within COMAR standards.
- Incised, overwidened channel with shallow sandy bottom and lack of bed feature complexity. Some woody debris and gravel riffles provide benthic habitat. Banks are moderately stable with suboptimal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.44
Turbidity (NTU)	7.39
Temperature (°C)	12.9
pH (SU)	6.58
Specific Conductivity (µS/cm)	134.4

RHOD-45-2012 RR9 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	4.13
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	78.51

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Brillia	1
Calopteryx	1
Chaetocladius	1
Chironomus	4
Dicranota	5
Empididae	1
Gammarus	4
Ironoquia	1
Odontomesa	2
Orthocladius	1
Parametriocnemus	2
Polypedilum	94
Rheocricotopus	1
Stenochironomus	1
Thienemannimyia group	1
Zavrelimyia	1
TOTAL:	**121**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	6
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	7
Channel Sinuosity	9	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	7		
EPA Habitat Score			**114**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	18	96.93	Woody Debris/Rootwads	7	73.4
Shading	95	99.94	Instream Habitat	8	62.68
Epifaunal Substrate	9	68.78	Bank Stability	12	77.46
PHI Score					**79.86**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**444.47**
Cover	**Acres**	**%Area**
Developed Land	**103.98**	**14.01**
Commercial	5.69	1.28
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	2.3	0.52
Residential 1-Acre	34.85	7.84
Residential 2-Acre	17.06	3.84
Transportation	2.35	0.53
Utility	0	0
Forest Land	**237.27**	**53.38**
Forested Wetland	0	0
Residential Woods	0	0
Woods	237.27	53.38
Open Land	**52.07**	**11.72**
Open Space	52.07	11.72
Open Wetland	0	0
Water	0	0
Agricultural Land	**92.88**	**20.9**
Pasture/Hay	66.3	14.92
Row Crops	26.58	5.98
Impervious Surface	**Acres**	**% Area**
Impervious Land	10.75	2.42

RHOD-46-2012 RR9 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8776915435 **Longitude:** -76.5882891163

Located on Big Hob Run, this site is part of the South Fork Muddy Creek I watershed (RR9). The dominant land cover of the 323 acre drainage area consists of forested land (53%) with the remaining land cover consisting of 17% as agriculture and 30% split equally between developed land and open space. Impervious surface accounts for only 3% of the drainage area. This channel is deeply incised with heavily eroded banks. Numerous gravel riffles provide stable habitat for a poor benthic community consisting of poor taxa diversity (12 taxa) with few EPT, Ephemeroptera, and intolerant taxa. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) dominated the sample.
- Measured below COMAR standards for pH.
- Deeply incised channel with heavily eroded banks and poor vegetative protection. Numerous gravel riffles provide stable habitat, but woody debris lacking. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	12.1
Turbidity (NTU)	18.7
Temperature (°C)	9.1
pH (SU)	6.29
Specific Conductivity (µS/cm)	152.2

RHOD-46-2012 RR9 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3.42
Ephemeroptera %	0.85
Scraper Taxa	0
% Climbers	82.05

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	3
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Chaetocladius	1
Dicranota	3
Erioptera	1
Gammarus	6
Leptophlebiidae	1
Orthocladius	3
Paratanytarsus	1
Polypedilum	96
Potthastia	2
Rheocricotopus	1
Thienemanniella	1
Tipula	1
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	2	Pool Variability	10
Bank Stability- Right Bank	1	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	10
Channel Sinuosity	14	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	2
Pool Substrate Characterization	10		
EPA Habitat Score			**113**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	4	68.14
Shading	95	99.94	Instream Habitat	10	77.04
Epifaunal Substrate	10	76.67	Bank Stability	3	38.73
PHI Score					**69.96**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**323.03**
Cover	**Acres**	**%Area**
Developed Land	**101.71**	**14.7**
Commercial	5.69	1.76
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	2.3	0.71
Residential 1-Acre	20.09	6.22
Residential 2-Acre	17.06	5.28
Transportation	2.35	0.73
Utility	0	0
Forest Land	**172.67**	**53.45**
Forested Wetland	0	0
Residential Woods	0	0
Woods	172.67	53.45
Open Land	**47.5**	**14.7**
Open Space	47.5	14.7
Open Wetland	0	0
Water	0	0
Agricultural Land	**55.37**	**17.14**
Pasture/Hay	38.92	12.05
Row Crops	16.45	5.09
Impervious Surface	**Acres**	**% Area**
Impervious Land	8.73	2.7

RHOD-48-2012 RR9 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8804520284 **Longitude:** -76.5629929868

Located 200 meters downstream of the confluence of South Fork Muddy Creek and Rainy Day Branch, this site is part of the South Fork Muddy Creek I watershed (RR9). This site is located on Smithsonian Environmental Research Center (SERC) property and is immediately downstream of a beaver dam, draining a large wetland. Emergent vegetation and attached algae is present in the channel with some large woody debris providing stable benthic habitat. Poor taxa diversity (13 taxa) with no EPT, Ephemeroptera, or scraper taxa contributed to a very poor biologic community score. Water quality measured below COMAR standards for pH, which may be an effect of wetland conditions upstream. The dominant land cover of the 442 acre drainage area consists of forested land (64%) with minimal impervious surface (3%).

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea) and midges (Orthocladius, Cricotopus, and Chironomus) dominated the sample.
- Measured below COMAR standards for pH.
- Immediately downstream of beaver dam, draining large wetland. Some woody debris providing stable benthic substrate. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	7.63
Turbidity (NTU)	15.7
Temperature (°C)	11.1
pH (SU)	5.82
Specific Conductivity (µS/cm)	137.6

RHOD-48-2012 RR9 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	13
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	24.79
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	2.56

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	29
Ceratopogonidae	1
Chironomus	13
Corynoneura	1
Cricotopus	23
Dytiscidae	1
Limnophyes	2
Naididae	1
Orthocladius	36
Polypedilum	3
Simulium	3
Thienemanniella	3
Turbellaria	1
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	10
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	16	Sediment Deposition	15
Channel Sinuosity	10	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	14		
EPA Habitat Score			**149**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	10	82.33
Shading	75	73.32	Instream Habitat	9	68.28
Epifaunal Substrate	8	63	Bank Stability	20	100
PHI Score					**73.46**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 442.14

Cover	Acres	%Area
Developed Land	**93.53**	**12.23**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	9.16	2.07
Residential 2-Acre	38.88	8.79
Transportation	6.05	1.37
Utility	0	0
Forest Land	**281.27**	**63.62**
Forested Wetland	0	0
Residential Woods	0	0
Woods	281.27	63.62
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**106.78**	**24.15**
Pasture/Hay	0	0
Row Crops	106.78	24.15

Impervious Surface	Acres	% Area
Impervious Land	8.45	1.91

WEST-13-2012 WR3 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8201080322 **Longitude:** -76.5546884288

Located 300 meters downstream of Muddy Creek Road, this site is part of the Gales Creek watershed (WR3). Minimal flow was observed at this site as well as poor stable habitat for benthics consisting of woody debris and poor rootwads. Water quality measured below COMAR standards for pH. Although three scraper taxa were identified in the benthic sample, few climber and intolerant taxa and a complete lack of EPT and Ephemeroptera taxa contributed to a poor biological community score. Half of the 264 acre drainage area consisted of agricultural land (50%) with 25% as developed. Impervious surface accounted for only 3% of the drainage area.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Midges (Orthocladius), isopods (Caecidotea), and amphipods (Crangonyx) dominated the sample.
- Measured below COMAR standards for pH.
- Minimal flow with poor stable habitat in form of woody debris and poor rootwads. Moderately unstable banks with marginal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.9
Turbidity (NTU)	25.6
Temperature (°C)	18.3
pH (SU)	6.37
Specific Conductivity (µS/cm)	205.9

WEST-13-2012 WR3 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	15
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	2

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Acari	1
Caecidotea	14
Chironomus	4
Crangonyx	15
Cricotopus	2
Hydrobaenus	2
Limnophyes	2
Menetus	1
Nanocladius	4
Orthocladius	21
Parakiefferiella	1
Parametriocnemus	2
Physa	1
Prostoma	4
Rheocricotopus	1
Smittia	1
Sphaeriidae	3
Tipulidae	1
Tubificidae	8
Turbellaria	12
TOTAL:	**100**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	5
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	6	Sediment Deposition	14
Channel Sinuosity	7	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	5		
EPA Habitat Score			**95**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Woody Debris/Rootwads	7	79.27
Shading	95	99.94	Instream Habitat	5	51.35
Epifaunal Substrate	5	48.92	Bank Stability	8	63.25
PHI Score					**67.89**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**264.49**
Cover	**Acres**	**%Area**
Developed Land	**113.01**	**24.57**
Commercial	1.08	0.41
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	10.41	3.94
Residential 1-Acre	6.08	2.3
Residential 2-Acre	37.17	14.05
Transportation	10.24	3.87
Utility	0	0
Forest Land	**36.84**	**13.93**
Forested Wetland	0	0
Residential Woods	0	0
Woods	36.84	13.93
Open Land	**29.87**	**11.29**
Open Space	29.87	11.29
Open Wetland	0	0
Water	0	0
Agricultural Land	**132.8**	**50.21**
Pasture/Hay	78.44	29.66
Row Crops	54.36	20.55
Impervious Surface	**Acres**	**% Area**
Impervious Land	9.17	3.47

WEST-15-2012 WR3 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.82182445 **Longitude:** -76.5539658245

Located 250 meters west of Plantation Boulevard, this site is part of the Gales Creek watershed (WR3). Likely an ephemeral or intermittent channel, virtually no flow was observed at this site with water mostly present as standing pools. Some submerged vegetation provides habitat, but benthic habitat is severely lacking. Only 6 taxa were identified in the benthic sample, which was largely dominated by the tolerant midge, Chironomus. Because of the poor taxa diversity in addition to the complete lack of EPT, Ephemeroptera, scraper, and climber taxa this site received a very poor biological community score. Forested land accounted for 76% of the 40 acre drainage area with little impervious surface (2%). Water quality measured below COMAR standards for pH and dissolved oxygen. In addition, conductivity values were elevated. Depressed water quality measurements at this site may be an effect of low flow conditions.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Chironomus (midge) dominated the sample.
- Measured below COMAR standards for pH and dissolved oxygen. Conductivity also elevated.
- Likely ephemeral or intermittent channel with virtually no flow and water present mostly as standing pools. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	4.45
Turbidity (NTU)	48.9
Temperature (°C)	13.3
pH (SU)	5.86
Specific Conductivity (µS/cm)	404.6

WEST-15-2012 WR3 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	6
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	10.57
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	0

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.29**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	11
Chironomus	102
Pisidium	2
Psectrotanypus	2
Synurella	2
Tubificidae	4
TOTAL:	**123**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	8
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	2	Sediment Deposition	8
Channel Sinuosity	9	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	2	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	11		
EPA Habitat Score			**112**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Woody Debris/Rootwads	3	88.78
Shading	95	99.94	Instream Habitat	2	53.99
Epifaunal Substrate	2	43.77	Bank Stability	17	92.2
PHI Score					**74.78**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**40.16**
Cover	**Acres**	**%Area**
Developed Land	**57.77**	**10.25**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	3.07	7.65
Transportation	1.04	2.6
Utility	0	0
Forest Land	**3.87**	**9.63**
Forested Wetland	0	0
Residential Woods	0	0
Woods	3.87	9.63
Open Land	**1.66**	**4.13**
Open Space	1.66	4.13
Open Wetland	0	0
Water	0	0
Agricultural Land	**30.52**	**75.99**
Pasture/Hay	0	0
Row Crops	30.52	75.99
Impervious Surface	**Acres**	**% Area**
Impervious Land	0.82	2.05

WEST-16-2012 WR1 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8272787593 **Longitude:** -76.5599417916

This site is located 120 meters downstream of Muddy Creek Road and is part of the Johns Creek watershed (WR1). Some riffles and woody debris provide habitat for a poor biologic community consisting of few EPT, Ephemeroptera, and scraper taxa. Water quality measured below COMAR standards for pH. Of the 486 acre drainage area, 45% is forested and 33% is row crops. Only 2% of the drainage area consists of impervious surface.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) and Synurella (amphipod) dominated the sample.
- Measured below COMAR standards for pH.
- Some riffles and good woody debris. Poor riparian because of adjacent mowed lawns with minimal buffer, although roots are helping eroded banks.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.51
Turbidity (NTU)	22.4
Temperature (°C)	12.6
pH (SU)	6.17
Specific Conductivity (µS/cm)	163.1

WEST-16-2012 WR1 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	37.5
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	25

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	6
Caecidotea	13
Chironomus	3
Cordulegaster	1
Cricotopus	2
Eukiefferiella	3
Hydrobaenus	1
Orthocladius	9
Parakiefferiella	1
Parametriocnemus	4
Pisidium	1
Polypedilum	30
Potthastia	1
Rheocricotopus	5
Saetheria	1
Simulium	2
Synurella	24
Tubificidae	9
Tvetenia	1
Zavrelimyia	3
TOTAL:	**120**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	8
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	13	Sediment Deposition	15
Channel Sinuosity	8	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	9		
EPA Habitat Score			**123**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Woody Debris/Rootwads	7	72.38
Shading	90	91.34	Instream Habitat	8	61.76
Epifaunal Substrate	10	74	Bank Stability	12	77.46
PHI Score					**68.21**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**486.38**
Cover	**Acres**	**%Area**
Developed Land	**92.72**	**18.43**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.13	0.03
Residential 1-Acre	3.66	0.75
Residential 2-Acre	74.45	15.31
Transportation	11.4	2.34
Utility	0	0
Forest Land	**218.88**	**45**
Forested Wetland	0	0
Residential Woods	0	0
Woods	218.88	45
Open Land	**15.25**	**3.14**
Open Space	15.25	3.14
Open Wetland	0	0
Water	0	0
Agricultural Land	**162.61**	**33.43**
Pasture/Hay	3.29	0.68
Row Crops	159.32	32.76
Impervious Surface	**Acres**	**% Area**
Impervious Land	10.78	2.22

WEST-17-2012 WR1 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.828019272 **Longitude:** -76.5622561892

This site is located in the Johns Creek watershed (WR1) and runs parallel to Muddy Creek Road. The channel is adjacent to row crops and may have been straightened in the past. Poor habitat for benthos, consisting of minimal woody debris and rootwads was observed at the site. Although over half of the benthic sample consisted of individuals intolerant to urban stressors (56%), poor taxa diversity (12 taxa) with few EPT and climber taxa and no Ephemeroptera or scraper taxa resulted in an overall biological score of very poor. Water quality measured below COMAR standards for pH, which may be attributed to low flow conditions. Over two-thirds of the 136 acre drainage area consists of row crops (65%) with 18% as 2-acre residential land use. Imperviousness accounts for 3% of the drainage area.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Amphipods (Synurella) dominated the sample.
- Measured below COMAR standards for pH.
- Low flow, silty bottomed stream with poor habitat and poor velocity/depth diversity. Moderately unstable banks with marginal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.22
Turbidity (NTU)	21.6
Temperature (°C)	13.9
pH (SU)	5.89
Specific Conductivity (µS/cm)	184.7

WEST-17-2012 WR1 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	55.74
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	5.74

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Bezzia	1
Caecidotea	14
Cryptochironomus	1
Ironoquia	11
Orthocladius	1
Parametriocnemus	4
Polypedilum	7
Rheocricotopus	17
Sphaeriidae	1
Synurella	54
Thienemannimyia group	1
Tubificidae	10
TOTAL:	**122**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	3
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	5	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	9	Sediment Deposition	15
Channel Sinuosity	6	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	4		
EPA Habitat Score			**86**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	3	75
Shading	75	73.32	Instream Habitat	5	58.18
Epifaunal Substrate	5	53.27	Bank Stability	9	67.08
PHI Score					**64.35**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**135.66**
Cover	**Acres**	**%Area**
Developed Land	**105.85**	**20.36**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	24.31	17.92
Transportation	3.3	2.43
Utility	0	0
Forest Land	**16.76**	**12.36**
Forested Wetland	0	0
Residential Woods	0	0
Woods	16.76	12.36
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**91.28**	**67.29**
Pasture/Hay	3.29	2.43
Row Crops	87.99	64.86
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.63	2.68

WEST-19-2012 WR1 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8243038532 **Longitude:** -76.5677319167

This site is located 80 meters west of Old Sudley Road and is part of the Johns Creek watershed (WR1). The channel is behind an old crop field with horse trails evident, although they do not appear to be severely affecting the site. Of the 234 acre drainage area, 65% is forested with little impervious surface (2%). Of the 20 taxa identified in the benthic sample, 2 were EPT taxa and 30% consisted of climber taxa. However, few intolerant taxa in addition to a complete lack of Ephemeroptera and scraper taxa contributed to an overall poor biological community score. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges (Polypedilum, Orthocladius, Parametriocnemus, Odontomes, and Rheocricotopus) dominated the sample.
- Measured below COMAR standards for pH.
- Debris jam at 0 meters blocking some flow and creating some stagnant areas. Marginal habitat for benthos. Moderately stable banks with suboptimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.34
Turbidity (NTU)	14.3
Temperature (°C)	16.5
pH (SU)	6.44
Specific Conductivity (µS/cm)	146.1

WEST-19-2012 WR1 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	5.47
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	29.69

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphipoda	1
Caecidotea	2
Chironomus	6
Cricotopus	1
Ephydridae	2
Haplotaxidae	1
Ironoquia	3
Isoperla	1
Limnophyes	2
Lumbriculidae	1
Odontomesa	12
Orthocladius	14
Parakiefferiella	4
Parametriocnemus	13
Pisidium	4
Polypedilum	38
Rheocricotopus	11
Thienemannimyia group	5
Tubificidae	6
Zavrelimyia	1
TOTAL:	**128**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	6
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	6
Channel Flow Status	13	Sediment Deposition	13
Channel Sinuosity	14	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	6		
EPA Habitat Score			**122**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	8	83.6
Shading	90	91.34	Instream Habitat	5	52.58
Epifaunal Substrate	7	61.33	Bank Stability	14	83.67
PHI Score					**75.55**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**234.37**
Cover	**Acres**	**%Area**
Developed Land	**61.4**	**15.82**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.13	0.06
Residential 1-Acre	3.66	1.56
Residential 2-Acre	29.84	12.73
Transportation	3.46	1.47
Utility	0	0
Forest Land	**151.55**	**64.66**
Forested Wetland	0	0
Residential Woods	0	0
Woods	151.55	64.66
Open Land	**12.17**	**5.19**
Open Space	12.17	5.19
Open Wetland	0	0
Water	0	0
Agricultural Land	**33.56**	**14.32**
Pasture/Hay	0	0
Row Crops	33.56	14.32
Impervious Surface	**Acres**	**% Area**
Impervious Land	4.06	1.73

WEST-22-2012 WR1 Subwatershed

Upstream View:

Latitude: 38.8326254846

Downstream View:

Longitude: -76.5631617593

This site is located in the Johns Creek watershed (WR1) and runs parallel to Muddy Creek Road and is adjacent to cropland with limited riparian buffer. The channel consists of mostly run/glide features with little benthic habitat and no pools. Individuals intolerant to urban stressors accounted for over half of the benthic sample (57%) with 14% of the sample consisting of climber taxa. However, marginal taxa diversity (16 taxa) with few EPT and scraper taxa and no Ephemeroptera contributed to an overall fair biologic score. Of the 82 acre drainage area, 57% is row crops with 30% as 2-acre residential. Three percent of the drainage area is impervious surface. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella) and bivalves (Pisidium) dominated the sample.
- Measured below COMAR standards for pH.
- Shallow channel with little benthic habitat and poor velocity/depth diversity. Limited riparian buffer between crop fields. Banks are stable but with suboptimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.42
Turbidity (NTU)	10.9
Temperature (°C)	13.1
pH (SU)	6.48
Specific Conductivity (µS/cm)	140.9

WEST-22-2012 WR1 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	57.39
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	13.91

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	1
Bezzia	1
Caecidotea	8
Calopteryx	3
Dicranota	1
Diplectrona	1
Ironoquia	1
Parametriocnemus	3
Physa	10
Pisidium	19
Polypedilum	3
Simulium	2
Synurella	55
Thienemannimyia	3
Tubificidae	3
Zavrelimyia	1
TOTAL:	**115**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	4
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	10	Sediment Deposition	7
Channel Sinuosity	9	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	9		
EPA Habitat Score			**107**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Woody Debris/Rootwads	4	83.69
Shading	90	91.34	Instream Habitat	4	57.81
Epifaunal Substrate	6	62.38	Bank Stability	20	100
PHI Score					**73.05**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**81.77**
Cover	**Acres**	**%Area**
Developed Land	**59.39**	**31.5**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	24.28	29.69
Transportation	1.48	1.81
Utility	0	0
Forest Land	**9.08**	**11.11**
Forested Wetland	0	0
Residential Woods	0	0
Woods	9.08	11.11
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**46.93**	**57.39**
Pasture/Hay	0	0
Row Crops	46.93	57.39
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.32	2.84

WEST-23-2012 WRB Subwatershed

Upstream View:

Latitude: 38.8377136481

Downstream View:

Longitude: -76.5580725711

This site is located on the mainstem of Smith Creek and is part of the Smith Creek I watershed (WRB). The site is 300 meters upstream of the tidal portion of Smith Creek with lots of woody debris and good velocity diversity. Forested land is the dominant land cover of the 865 acre drainage area (70%) with minimal impervious surface (2%). Of the 20 taxa identified in the benthic sample, 22% were climber taxa, 2 were EPT taxa, and 2 were scraper taxa resulting in an overall fair biological score. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Amphipods (Gammarus) and midges (Polypedilum) dominated the sample.
- Measured below COMAR standards for pH.
- Lots of woody debris and good velocity diversity. Suboptimal habitat diversity. Moderately unstable banks with suboptimal vegetative protection. Riparian width is also suboptimal.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.62
Turbidity (NTU)	21.3
Temperature (°C)	17.1
pH (SU)	6.24
Specific Conductivity (µS/cm)	136.1

WEST-23-2012 WRB Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	13.6
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	21.6

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	2
Caecidotea	15
Chironomus	4
Crangonyx	6
Cricotopus	9
Dicrotendipes	2
Gammarus	37
Glyptotendipes	3
Ironoquia	1
Menetus	1
Nemata	1
Orthocladius	2
Physa	2
Pisidium	1
Polypedilum	21
Psectrotanypus	1
Tanytarsus	3
Thienemannimyia group	3
Tubificidae	6
Zavrelimyia	5
TOTAL:	**125**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	9
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	13
Channel Sinuosity	15	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	11		
EPA Habitat Score			**136**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Woody Debris/Rootwads	17	95.44
Shading	60	58.94	Instream Habitat	12	78.06
Epifaunal Substrate	11	76.06	Bank Stability	10	70.71
PHI Score					**70.38**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**864.72**
Cover	**Acres**	**%Area**
Developed Land	**121.5**	**11.24**
Commercial	9.21	1.06
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.56	0.18
Residential 2-Acre	76.23	8.82
Transportation	10.22	1.18
Utility	0	0
Forest Land	**604.09**	**69.86**
Forested Wetland	0	0
Residential Woods	0	0
Woods	604.09	69.86
Open Land	**26.85**	**3.1**
Open Space	23.88	2.76
Open Wetland	0	0
Water	2.97	0.34
Agricultural Land	**136.56**	**15.79**
Pasture/Hay	46.25	5.35
Row Crops	90.31	10.44
Impervious Surface	**Acres**	**% Area**
Impervious Land	15.59	1.8

WEST-25-2012 WRB Subwatershed

Upstream View:

Latitude: 38.8404211391

Downstream View:

Longitude: -76.5642741206

This site is 250 meters south of Westbury Farm Lane and 250 meters west of Muddy Creek Road and is located on an unnamed tributary to Smith Creek, which is part of the Smith Creek I watershed (WRB). The channel has shallow water depth but has good sinuosity and a good mix of velocities. Woody debris, rootwads, and vegetation provide stable habitat for the benthic community. Although 47% of the benthic sample consisted of climbers and intolerant organisms accounted for 44% of the sample, poor taxa diversity (12 taxa) with few EPT taxa and no Ephemeroptera or scraper taxa resulted in a poor biologic score. Over half of the 195 acre drainage area is forested (53%) with pasture land cover accounting for 20%. Two percent of the drainage area is impervious surface. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Polypedilum (midge) and Synurella (amphipod) dominated the sample.
- Measured below COMAR standards for pH.
- Good sinuosity and good mix of habitat in form of woody debris/rootwads and vegetation. Good mix of velocity but only shallow depth. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.93
Turbidity (NTU)	20.4
Temperature (°C)	12.5
pH (SU)	6.3
Specific Conductivity (µS/cm)	113.9

WEST-25-2012 WRB Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	43.9
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	47.15

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	1
Caecidotea	9
Ironoquia	2
Oligostomis	2
Orthocladiinae	1
Parametriocnemus	1
Pisidium	3
Polypedilum	58
Rheocricotopus	3
Synurella	41
Tabanus	1
Thienemannimyia group	1
TOTAL:	**123**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	6
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	16	Sediment Deposition	14
Channel Sinuosity	15	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	6		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	9	88.65
Shading	90	91.34	Instream Habitat	8	71.12
Epifaunal Substrate	12	91.58	Bank Stability	18	94.87
PHI Score					**82.8**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**194.91**
Cover	**Acres**	**%Area**
Developed Land	**96.9**	**9.8**
Commercial	3.08	1.58
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0.22	0.11
Residential 2-Acre	14.43	7.41
Transportation	1.37	0.7
Utility	0	0
Forest Land	**103.17**	**52.93**
Forested Wetland	0	0
Residential Woods	0	0
Woods	103.17	52.93
Open Land	**12.25**	**6.29**
Open Space	12.07	6.19
Open Wetland	0	0
Water	0.18	0.09
Agricultural Land	**60.38**	**30.98**
Pasture/Hay	38	19.5
Row Crops	22.38	11.48
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.58	1.84

WEST-27-2012 WRB Subwatershed

Upstream View:

Downstream View:

Latitude: 38.843490395 **Longitude:** -76.5671568907

This site is adjacent to Westbury Farm Lane and is located on an unnamed tributary to Smith Creek, which is part of the Smith Creek I watershed (WRB). Of the 113 acre drainage area, 64% of land cover is forested and 25% is agriculture with only 2% imperviousness. Very good rootwads are keeping banks stable with woody debris accounting for the majority of stable benthic habitat. Although 60% of the benthic sample consisted of intolerant organisms and 29% climbers, poor taxa diversity (10 taxa), few EPT taxa and a lack of Ephemeroptera and scraper taxa resulted in an overall poor biological score. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Synurella (amphipod) and Polypedilum (midge) dominated the sample.
- Measured below COMAR standards for pH.
- Suboptimal riparian width because of powerline easement parallel to stream along left bank. Very good rootwads keeping banks stable and a lot of woody debris for bethos.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.36
Turbidity (NTU)	16.1
Temperature (°C)	11.6
pH (SU)	6.18
Specific Conductivity (µS/cm)	116.7

WEST-27-2012 WRB Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	59.66
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	29.41

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Bezzia	8
Caecidotea	3
Ceratopogonidae	2
Lepidoptera	1
Metriocnemus	1
Oligostomis	2
Perlodidae	1
Polypedilum	35
Synurella	65
Tubificidae	1
TOTAL:	**119**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	6
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	16	Sediment Deposition	11
Channel Sinuosity	13	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	7		
EPA Habitat Score			**133**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	17	100
Shading	85	84.56	Instream Habitat	7	71.18
Epifaunal Substrate	13	100	Bank Stability	18	94.87
PHI Score					**84.08**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**112.6**
Cover	**Acres**	**%Area**
Developed Land	**22.47**	**6.94**
Commercial	0.62	0.55
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0.22	0.2
Residential 2-Acre	6.42	5.7
Transportation	0.56	0.5
Utility	0	0
Forest Land	**71.75**	**63.72**
Forested Wetland	0	0
Residential Woods	0	0
Woods	71.75	63.72
Open Land	**4.88**	**4.33**
Open Space	4.88	4.33
Open Wetland	0	0
Water	0	0
Agricultural Land	**28.16**	**25.01**
Pasture/Hay	9.41	8.35
Row Crops	18.75	16.65
Impervious Surface	**Acres**	**% Area**
Impervious Land	1.84	1.64

WEST-28-2012 WRB Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8391542674 **Longitude:** -76.5656274514

This site is located on the mainstem of Smith Creek and is part of the Smith Creek I watershed (WRB). Mostly slow, shallow flow was observed at this site with the lower half of the site slightly backwatered due to the wetland complex downstream. Poor benthic habitat consisting of mainly woody debris supports a poor benthic community consisting of few EPT taxa and Ephemeroptera or scraper taxa. The majority of the 572 acre drainage area is forested (82%) with minimal imperviousness (1%). Water quality measured below COMAR standards for pH, which may be the effects of wetland conditions.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Midges (Polypedilum) and worms (Tubificidae) dominated the sample.
- Measured below COMAR standards for pH.
- Mostly slow shallow flow with poor habitat consisting of woody debris. Banks are stable with good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.49
Turbidity (NTU)	13.5
Temperature (°C)	12.6
pH (SU)	6.15
Specific Conductivity (µS/cm)	127.9

WEST-28-2012 WRB Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	15.97
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	37.82

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Bezzia	4
Calopteryx	1
Cambarus	1
Chironomus	4
Ironoquia	3
Lumbriculidae	1
Odontomesa	7
Orthocladius	2
Parakiefferiella	1
Parametriocnemus	1
Pisidium	3
Polypedilum	44
Rheocricotopus	2
Synurella	17
Thienemannimyia group	2
Tubificidae	25
Turbellaria	1
TOTAL:	**119**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	8
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	14
Channel Sinuosity	11	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	6		
EPA Habitat Score			**136**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	18	96.93	Woody Debris/Rootwads	6	67.58
Shading	95	99.94	Instream Habitat	8	60.1
Epifaunal Substrate	6	49.7	Bank Stability	18	94.87
PHI Score					**78.19**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**572.12**
Cover	**Acres**	**%Area**
Developed Land	**43.43**	**6.43**
Commercial	1	0.18
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.19	0.21
Residential 2-Acre	30.88	5.4
Transportation	3.71	0.65
Utility	0	0
Forest Land	**470.2**	**82.19**
Forested Wetland	0	0
Residential Woods	0	0
Woods	470.2	82.19
Open Land	**6.67**	**1.17**
Open Space	6.67	1.17
Open Wetland	0	0
Water	0	0
Agricultural Land	**58.46**	**10.22**
Pasture/Hay	4.34	0.76
Row Crops	54.12	9.46
Impervious Surface	**Acres**	**% Area**
Impervious Land	5.31	0.93

WEST-30-2012 WRC Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8373879591 **Longitude:** -76.5730311982

This site is located on the mainstem of Smith Creek and is part of the Smith Creek II watershed (WRC). This channel is incised with shallow water depth and mostly run/glide features. Despite lacking habitat diversity, this benthic sample received a good overall rating. Of the 20 taxa identified in the benthic sample, 2 were scraper taxa and 4 were EPT taxa, 2 of which were Ephemeroptera taxa. The majority of the 349 acre drainage area is forested (83%) with minimal imperviousness (1%).

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella), worms (Tubificidae), and midges (Polypedilum) dominated the sample.
- Water quality values within COMAR standards.
- Shallow, incised channel with excellent sinuosity. Raw eroded banks on outer meanders with habitat diversity lacking. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.68
Turbidity (NTU)	7.63
Temperature (°C)	16.5
pH (SU)	6.67
Specific Conductivity (µS/cm)	127.1

WEST-30-2012 WRC Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	4
Ephemeroptera Taxa	2
Intolerant Urban %	33.05
Ephemeroptera %	2.54
Scraper Taxa	2
% Climbers	16.95

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	5
Intolerant Urban %	5
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**4.14**
BIBI Narrative Rating	**Good**

Taxa	Count
Acentrella	2
Chironomus	2
Corynoneura	1
Dytiscidae	2
Enchytraeidae	1
Heptageniidae	1
Ironoquia	5
Isoperla	1
Lumbriculidae	1
Naididae	1
Odontomesa	2
Parametriocnemus	4
Physa	1
Pilaria	1
Pisidium	2
Polypedilum	19
Rheocricotopus	3
Synurella	37
Tubificidae	29
Zavrelimyia	3
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	5
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	7
Channel Sinuosity	18	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	5		
EPA Habitat Score			**123**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	19	100	Woody Debris/Rootwads	7	76.12
Shading	95	99.94	Instream Habitat	5	48.5
Epifaunal Substrate	6	52.92	Bank Stability	12	77.46
PHI Score					**75.82**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**349.31**
Cover	**Acres**	**%Area**
Developed Land	**56.86**	**7.1**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.19	0.34
Residential 2-Acre	20.96	6
Transportation	2.64	0.75
Utility	0	0
Forest Land	**289.98**	**83.02**
Forested Wetland	0	0
Residential Woods	0	0
Woods	289.98	83.02
Open Land	**4.98**	**1.43**
Open Space	4.98	1.43
Open Wetland	0	0
Water	0	0
Agricultural Land	**29.56**	**8.46**
Pasture/Hay	0	0
Row Crops	29.56	8.46
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.79	0.8

WEST-31-2012 WRC Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8357460622 **Longitude:** -76.5741105351

This site is located on the mainstem of Smith Creek and is part of the Smith Creek II watershed (WRC). The channel is incised with poor velocity/depth diversity and nearly all run/riffle features. Of the 20 taxa identified in the benthic sample, 21% were climber taxa and 27% were intolerant taxa. Four EPT taxa were identified in the sample, including one Ephemeroptera, resulting in a fair biological community score. The majority of the 336 acre drainage area is forested (84%) with minimal imperviousness (1%).

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Bivalves (Pisidium), amphipods (Synurella), and midges (Polypedilum) dominated the sample.
- Water quality values within COMAR standards.
- Shallow, incised channel with good sinuosity. Poor velocity/depth diversity with habitat diversity also lacking. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.55
Turbidity (NTU)	6.83
Temperature (°C)	17
pH (SU)	6.6
Specific Conductivity (µS/cm)	128.6

WEST-31-2012 WRC Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	4
Ephemeroptera Taxa	1
Intolerant Urban %	27.13
Ephemeroptera %	1.55
Scraper Taxa	1
% Climbers	20.93

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	3
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	3
% Climbers	5
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Acentrella	2
Amphinemura	2
Caecidotea	3
Copelatus	1
Haplotaxidae	1
Ironoquia	4
Isoperla	1
Limnophyes	1
Lumbricina	1
Lumbriculidae	1
Neoporus	1
Orthocladius	1
Physa	2
Pisidium	39
Polypedilum	25
Rheocricotopus	1
Synurella	28
Tabanidae	1
Thienemannimyia group	1
Tubificidae	13
TOTAL:	**129**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	5
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	5
Channel Sinuosity	15	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	5		
EPA Habitat Score			**121**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	18	96.93	Woody Debris/Rootwads	11	88.38
Shading	90	91.34	Instream Habitat	5	48.89
Epifaunal Substrate	6	53.16	Bank Stability	14	83.67
PHI Score					**77.06**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**336.38**
Cover	**Acres**	**%Area**
Developed Land	**46.94**	**7.37**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.19	0.35
Residential 2-Acre	20.96	6.23
Transportation	2.64	0.78
Utility	0	0
Forest Land	**282.15**	**83.88**
Forested Wetland	0	0
Residential Woods	0	0
Woods	282.15	83.88
Open Land	**4.98**	**1.48**
Open Space	4.98	1.48
Open Wetland	0	0
Water	0	0
Agricultural Land	**24.46**	**7.27**
Pasture/Hay	0	0
Row Crops	24.46	7.27
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.79	0.83

WEST-32-2012 WRC Subwatershed

Upstream View:

Latitude: 38.8342704654

Downstream View:

Longitude: -76.5769949563

This site is located on the mainstem of Smith Creek and is part of the Smith Creek II watershed (WRC). The channel is incised with mostly run/riffle features and lacking habitat diversity. Although over half of the benthic sample consisted of intolerant taxa (62%), poor taxa diversity (13 taxa) in addition to few EPT taxa and no Ephemeroptera or scraper taxa contributed to a poor biological score. The majority of the 145 acre drainage area is forested (87%) with minimal imperviousness (2%).

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella) dominated the sample.
- Water quality values within COMAR standards.
- Shallow, incised channel with banks mostly healed over and stabilized. Habitat diversity lacking. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.18
Turbidity (NTU)	5.48
Temperature (°C)	14
pH (SU)	6.68
Specific Conductivity (µS/cm)	138.8

WEST-32-2012 WRC Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	13
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	62.18
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	12.61

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	9
Caecidotea	10
Cordulegaster	1
Ironoquia	1
Odontomesa	1
Orthocladius	1
Parametriocnemus	3
Pisidium	11
Polypedilum	15
Rheocricotopus	2
Synurella	54
Tipulidae	1
Tubificidae	10
TOTAL:	**119**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	5
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	7
Channel Sinuosity	9	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	5		
EPA Habitat Score			**118**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	20	100	Woody Debris/Rootwads	6	83.1
Shading	90	91.34	Instream Habitat	5	57.49
Epifaunal Substrate	6	58.64	Bank Stability	16	89.45
PHI Score					**80**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**145.2**
Cover	**Acres**	**%Area**
Developed Land	**39.99**	**12.29**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.19	0.82
Residential 2-Acre	14.01	9.65
Transportation	2.64	1.82
Utility	0	0
Forest Land	**126.69**	**87.26**
Forested Wetland	0	0
Residential Woods	0	0
Woods	126.69	87.26
Open Land	**0.66**	**0.46**
Open Space	0.66	0.46
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.41	1.66

WEST-35-2012 WR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8491869001 **Longitude:** -76.5588364828

Located in the Lerch Creek I watershed (WR5), this site is in the middle of a cow pasture located behind the Citgo gas station at the intersection of Galesville Road and Muddy Creek Road. Of the 1,641 acre drainage area, which is the largest drainage area of sites sampled in West River, 48% is forested, 28% is agricultural land, and 20% is developed. Three percent of the drainage area consists of impervious surface. Good rootwads and instream vegetation provide stable habitat for benthos. Climber taxa accounted for 71% of the benthic sample; however, the complete lack of EPT and Ephemeroptera taxa resulted in a poor score for the biological community. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Polypedilum (midge) dominated the sample.
- Measured below COMAR standards for pH.
- Poor riparian width on right bank because of pasture. Bank slumping because of multiple cattle crossings. Marginal habitat for benthos consisting of rootwads and instream vegetation.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.46
Turbidity (NTU)	48.4
Temperature (°C)	16.3
pH (SU)	6.38
Specific Conductivity (µS/cm)	166.5

WEST-35-2012 WR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	13.22
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	71.07

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Agabus	1
Bezzia	2
Caecidotea	13
Calopteryx	2
Cricotopus	7
Gammarus	2
Ischnura	2
Limnophyes	1
Menetus	3
Neoporus	2
Physa	3
Pisidium	1
Polypedilum	75
Simulium	2
Synurella	3
Tanytarsus	1
Thienemannimyia group	1
TOTAL:	**121**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	3	Pool Variability	7
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	2
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	18	Sediment Deposition	9
Channel Sinuosity	9	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	6		
EPA Habitat Score			**100**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	4	49.74
Shading	75	73.32	Instream Habitat	9	54.86
Epifaunal Substrate	8	54.46	Bank Stability	6	54.77
PHI Score					**56.83**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1640.71**
Cover	**Acres**	**%Area**
Developed Land	**345**	**20.1**
Commercial	4.1	0.25
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	4.64	0.28
Residential 1-Acre	58.7	3.58
Residential 2-Acre	188.38	11.48
Transportation	33.37	2.03
Utility	40.61	2.48
Forest Land	**784.1**	**47.79**
Forested Wetland	0	0
Residential Woods	0	0
Woods	784.1	47.79
Open Land	**63.14**	**3.85**
Open Space	62.62	3.82
Open Wetland	0	0
Water	0.51	0.03
Agricultural Land	**463.68**	**28.26**
Pasture/Hay	172.04	10.49
Row Crops	291.64	17.78
Impervious Surface	**Acres**	**% Area**
Impervious Land	50.74	3.09

WEST-36-2012 WR5 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8521833085 **Longitude:** -76.5588163639

Located 300 meters northwest of the intersection of Galesville Road and Muddy Creek Road, this site is a part of the Lerch Creek I watershed (WR5). Of the 182 acre drainage area, 35% is row crops, 30% is forested, and 28% is developed. Impervious surface accounts for 5% of the drainage area. The site is located in the middle of a cow pasture with minimal riparian zone width, if any. Of the 21 taxa identified in the benthic sample, 30% were climbers; however, only one scraper taxa was identified and no EPT taxa were present resulting in a poor biological score. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Severely Degraded"*
- Midges (Polypedilum), black flies (Simulium), and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Reach is in the middle of a cow pasture resulting in a marginal riparian zone and poor habitat quality for benthos. Banks are moderately unstable with poor vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.65
Turbidity (NTU)	12.1
Temperature (°C)	11.6
pH (SU)	6.08
Specific Conductivity (µS/cm)	181.4

WEST-36-2012 WR5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	22.69
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	30.25

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Agabus	1
Caecidotea	16
Calopteryx	1
Chrysops	1
Cryptochironomus	1
Gammarus	7
Hydrobaenus	1
Limnophyes	1
Odontomesa	1
Orthocladius	10
Parakiefferiella	1
Parametriocnemus	4
Pisidium	1
Polypedilum	34
Rheocricotopus	3
Simulium	17
Synurella	9
Tanytarsus	1
Thienemannimyia group	2
Tubificidae	6
Zavrelimyia	1
TOTAL:	**119**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	5
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	3
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	3
Channel Flow Status	17	Sediment Deposition	16
Channel Sinuosity	4	Vegetative Protection - Left Bank	2
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	2
Pool Substrate Characterization	6		
EPA Habitat Score			**90**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	4	21.54	Woody Debris/Rootwads	3	71.69
Shading	20	21.22	Instream Habitat	7	66.29
Epifaunal Substrate	6	57.18	Bank Stability	8	63.25
PHI Score					**50.2**
PHI Narrative Rating					**Severely Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**181.63**
Cover	**Acres**	**%Area**
Developed Land	**301.95**	**27.66**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	20.15	11.1
Residential 2-Acre	22.27	12.26
Transportation	7.81	4.3
Utility	0	0
Forest Land	**54.24**	**29.86**
Forested Wetland	0	0
Residential Woods	0	0
Woods	54.24	29.86
Open Land	**4.26**	**2.35**
Open Space	4.26	2.35
Open Wetland	0	0
Water	0	0
Agricultural Land	**72.9**	**40.14**
Pasture/Hay	10.21	5.62
Row Crops	62.69	34.51
Impervious Surface	**Acres**	**% Area**
Impervious Land	9.33	5.14

WEST-39-2012 WR6 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8507363627 **Longitude:** -76.565233897

This site is part of the Lerch Creek II watershed (WR6) and is located 300 meters downstream of Owensville Road. Half of the 1,358 acre drainage area is forested (51%) with 26% as agricultural land and 19% developed. Impervious surface accounts for 3% of the drainage area. The channel runs through pasture with little riparian vegetation and few mature trees. The benthic sample received a fair score due to good taxa diversity (24 taxa) and the presence of four EPT taxa, one of which was a sensitive Ephemeroptera taxa, as well as two scraper taxa.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Chironomus (midge) dominated the sample.
- Water quality values within COMAR standards.
- Stream runs through pasture with minimal riparian width. Marginal habitat complexity for benthos. Cattle access stream and banks are somewhat trampled resulting in a poor bank stability score.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.58
Turbidity (NTU)	11.3
Temperature (°C)	16.2
pH (SU)	6.56
Specific Conductivity (µS/cm)	167.6

WEST-39-2012 WR6 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	4
Ephemeroptera Taxa	1
Intolerant Urban %	11.21
Ephemeroptera %	0.86
Scraper Taxa	2
% Climbers	9.48

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	3
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.86**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	1
Amphipoda	1
Bezzia	3
Caecidotea	1
Caenis	1
Chironomus	66
Cricotopus	3
Isoperla	1
Libellulidae	1
Menetus	1
Microtendipes	1
Neoporus	5
Paratanytarsus	1
Perlesta	1
Physa	1
Polypedilum	8
Procladius	8
Simulium	1
Sphaeriidae	1
Tanytarsus	1
Thienemannimyia group	3
Tipulidae	2
Tubificidae	2
Zavrelimyia	2
TOTAL:	**116**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	2	Pool Variability	11
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	1
Channel Alteration	12	Riparian Vegetative Zone Width- Right Bank	1
Channel Flow Status	20	Sediment Deposition	9
Channel Sinuosity	5	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	9		
EPA Habitat Score			**88**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	9	48.47	Woody Debris/Rootwads	25	100
Shading	30	31.57	Instream Habitat	10	62.35
Epifaunal Substrate	10	67.31	Bank Stability	4	44.72
PHI Score					**59.07**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1357.71**
Cover	**Acres**	**%Area**
Developed Land	**301.4**	**19.07**
Commercial	3.79	0.28
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	4.64	0.34
Residential 1-Acre	35.1	2.59
Residential 2-Acre	152.9	11.26
Transportation	21.95	1.62
Utility	40.61	2.99
Forest Land	**689.06**	**50.75**
Forested Wetland	0	0
Residential Woods	0	0
Woods	689.06	50.75
Open Land	**57.24**	**4.22**
Open Space	56.72	4.18
Open Wetland	0	0
Water	0.51	0.04
Agricultural Land	**352.43**	**25.96**
Pasture/Hay	131.71	9.7
Row Crops	220.72	16.26
Impervious Surface	**Acres**	**% Area**
Impervious Land	38.83	2.86

WEST-42-2012 WR6 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8594856482 **Longitude:** -76.5755013737

This site is located behind Owensbrooke Court and is part of the Lerch Creek II watershed (WR6). The channel runs parallel to Charlesgift Court and Rousby Run with woody debris providing stable habitat for benthos. Although over half of the benthic sample consisted of climber taxa (64%), poor taxa diversity (11 taxa) and a complete lack of Ephemeroptera or scraper taxa in the sample resulted in an overall poor biological community. Of the 213 acre drainage area, 35% is developed (mainly 2-acre residential), 34% is forested, and 24% consists of row crops. Imperviousness accounts for 5% of the drainage area. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) dominated the sample.
- Measured below COMAR standards for pH.
- Raw banks with woody debris as marginal habitat for benthos. Moderately unstable banks with marginal vegetative protection. Suboptimal riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	14.98
Turbidity (NTU)	12.3
Temperature (°C)	11.5
pH (SU)	6.19
Specific Conductivity (µS/cm)	187.7

WEST-42-2012 WR6 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	11
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	16.98
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	64.15

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	1
Caecidotea	7
Dicranota	7
Gammarus	13
Ironoquia	1
Orthocladius	2
Polypedilum	68
Rheocricotopus	2
Simulium	2
Stegopterna	1
Synurella	2
TOTAL:	**106**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	6
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	12	Sediment Deposition	14
Channel Sinuosity	12	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	7		
EPA Habitat Score			**111**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Woody Debris/Rootwads	9	87.66
Shading	95	99.94	Instream Habitat	8	70.23
Epifaunal Substrate	9	73.58	Bank Stability	8	63.25
PHI Score					**71.16**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**212.61**
Cover	**Acres**	**%Area**
Developed Land	**267.65**	**35.28**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	3.92	1.84
Residential 2-Acre	57.55	27.07
Transportation	3.04	1.43
Utility	10.51	4.94
Forest Land	**72.46**	**34.08**
Forested Wetland	0	0
Residential Woods	0	0
Woods	72.46	34.08
Open Land	**11.97**	**5.63**
Open Space	11.83	5.56
Open Wetland	0	0
Water	0.14	0.06
Agricultural Land	**53.17**	**25.01**
Pasture/Hay	2.94	1.38
Row Crops	50.23	23.63
Impervious Surface	**Acres**	**% Area**
Impervious Land	10.51	4.94

WEST-43-2012 WR6 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.851924742 **Longitude:** -76.5723446469

Located 350 meters south of Owensville Road, this site is a part ofthe Lerch Creek II watershed (WR6). Habitat complexity is lacking in this shallow stream with heavy siltation. Anaerobic decomposition was also observed in pools and stagnant areas. Water quality measured below COMAR standards for pH. Intolerant organisms accounted for over half of the benthic sample (62%). Of the 18 taxa identified in the sample, one scraper taxa was present as well as two EPT taxa, including one Ephemeroptera, resulting in an overall score of fair for the biological community. Of the 458 acre drainage area, forested land is the dominant land use (64%) with 30% split equally between agriculture and developed land. Two percent of the drainage area is impervious surface.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella), isopods (Caecidotea), and worms (Tubificidae) dominated the sample.
- Measured below COMAR standards for pH.
- Shallow stream with heavy siltation. Habitat complexity lacking. Moderately stable banks with suboptimal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.12
Turbidity (NTU)	16.8
Temperature (°C)	11.9
pH (SU)	6.33
Specific Conductivity (µS/cm)	140

WEST-43-2012 WR6 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	2
Ephemeroptera Taxa	1
Intolerant Urban %	62.4
Ephemeroptera %	0.8
Scraper Taxa	1
% Climbers	2.4

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	3
Intolerant Urban %	5
Ephemeroptera %	3
Scraper Taxa	3
% Climbers	3
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	6
Caecidotea	20
Ceratopogonidae	1
Crangonyx	1
Cryptochironomus	1
Gammarus	7
Helichus	1
Leptophlebiidae	1
Lumbriculidae	1
Neoporus	1
Orthocladius	2
Pisidium	6
Polypedilum	3
Rheocricotopus	1
Synurella	51
Tipula	1
Tubificidae	19
Zavrelimyia	2
TOTAL:	**125**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	6
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	3
Channel Sinuosity	9	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	5		
EPA Habitat Score			**106**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	9	78.98
Shading	95	99.94	Instream Habitat	4	40.18
Epifaunal Substrate	6	51.15	Bank Stability	12	77.46
PHI Score					**71.41**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 457.92

Cover	Acres	%Area
Developed Land	**134.3**	**15.9**
Commercial	0.95	0.21
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	4.64	1.01
Residential 1-Acre	4.18	0.91
Residential 2-Acre	40.55	8.85
Transportation	6.14	1.34
Utility	16.38	3.58
Forest Land	**294.1**	**64.22**
Forested Wetland	0	0
Residential Woods	0	0
Woods	294.1	64.22
Open Land	**20.12**	**4.39**
Open Space	20.12	4.39
Open Wetland	0	0
Water	0	0
Agricultural Land	**70.88**	**15.48**
Pasture/Hay	33.74	7.37
Row Crops	37.14	8.11

Impervious Surface	Acres	% Area
Impervious Land	9.76	2.13

WEST-46-2012 WR7 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8494006016 **Longitude:** -76.5508200856

Located in the Tenthouse Creek watershed (WR7), this site is on a small tributary 230 meters north of Galesville Road and 130 meters upstream of tidal conditions. Very low water level was observed at this site with minimal stable habitat for benthos. The majority of the benthic sample consisted of taxa intolerant to urban stressors; however, poor taxa diversity (12 taxa) with only one EPT taxa and no Ephemeroptera, scraper, or climber taxa contributed to an overall biological score of very poor. The majority of the 47 acre drainage area is forested (61%) with minimal impervious surface (1%). Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Caecidotea (isopod) dominated the sample.
- Measured below COMAR standards for pH.
- Very low water level, minimal stable habitat in woody debris for bethos. Banks are stable with suboptimal vegetative protection. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.44
Turbidity (NTU)	22.1
Temperature (°C)	11.8
pH (SU)	5.82
Specific Conductivity (µS/cm)	142.2

WEST-46-2012 WR7 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	73.11
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	0

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Agabus	2
Caecidotea	69
Chironomus	7
Ironoquia	3
Odontomesa	1
Orthocladius	1
Parametriocnemus	2
Pisidium	3
Rheocricotopus	7
Synurella	18
Tubificidae	3
Zavrelimyia	3
TOTAL:	**119**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	3
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	7	Sediment Deposition	15
Channel Sinuosity	7	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	3	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	4		
EPA Habitat Score			**111**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	6	95.89
Shading	95	99.94	Instream Habitat	3	57.95
Epifaunal Substrate	4	54.38	Bank Stability	17	92.2
PHI Score					**76.6**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 46.92

Cover	Acres	%Area
Developed Land	**58.15**	**18.72**
Commercial	0.01	0.01
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0.97	2.07
Residential 2-Acre	7.77	16.56
Transportation	0.04	0.08
Utility	0	0
Forest Land	**28.43**	**60.59**
Forested Wetland	0	0
Residential Woods	0	0
Woods	28.43	60.59
Open Land	**1.36**	**2.89**
Open Space	1.36	2.89
Open Wetland	0	0
Water	0	0
Agricultural Land	**8.35**	**17.8**
Pasture/Hay	6.97	14.86
Row Crops	1.38	2.95

Impervious Surface	Acres	% Area
Impervious Land	0.43	0.91

WEST-48-2012 WR7 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8532098915 **Longitude:** -76.5489141651

Located in the Tenthouse Creek watershed (WR7), this site is 150 meters upstream of the tidal portion of Cox Creek. This channel is shallow and runs through a narrow wetland. Woody debris and roots provide the only habitat for benthos. Over half of the benthic sample consisted of taxa intolerant to urban stressors (67%); however, a complete lack of Ephemeroptera and scraper taxa contributed to an overall poor biological community score. Of the 67 acre drainage area, 35% is agricultural land, 33% is developed , and 32% is forested. Impervious surface accounts for 5% of the drainage area. Water quality measured below COMAR standards for pH.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella) and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Shallow intermittent stream with woody debris/rootwads providing only marginal benthic habitat. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.83
Turbidity (NTU)	22.7
Temperature (°C)	12.6
pH (SU)	5.82
Specific Conductivity (µS/cm)	168

WEST-48-2012 WR7 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	66.67
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	2.63

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Agabus	1
Amphinemura	1
Caecidotea	16
Ceratopogonidae	1
Chaetocladius	1
Chironomus	1
Chrysops	1
Dixa	1
Ironoquia	3
Odontomesa	3
Oligostomis	3
Orthocladius	1
Parametriocnemus	6
Pisidium	3
Polypedilum	2
Rheocricotopus	2
Synurella	55
Tipulidae	1
Trichoptera	1
Tubificidae	7
Turbellaria	2
Zavrelimyia	2
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	6
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	9	Sediment Deposition	9
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	10		
EPA Habitat Score			**125**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	8	97.71
Shading	80	78.67	Instream Habitat	5	65.34
Epifaunal Substrate	6	63.64	Bank Stability	18	94.87
PHI Score					**80.17**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**67.4**
Cover	**Acres**	**%Area**
Developed Land	**31.06**	**33.12**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	18.98	28.16
Residential 2-Acre	1.88	2.79
Transportation	1.46	2.17
Utility	0	0
Forest Land	**21.6**	**32.05**
Forested Wetland	0	0
Residential Woods	0	0
Woods	21.6	32.05
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**23.48**	**34.84**
Pasture/Hay	1.58	2.34
Row Crops	21.9	32.49
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.3	4.89

WEST-49-2012 WR7 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8551323435 **Longitude:** -76.5464619545

Located in the Tenthouse Creek watershed (WR7), this site is 300 meters downstream of Bayfields Road and 130 meters upstream of the tidal portion of Cox Creek. Of the 20 acre drainage area, 38% is developed, 37% is agriculture (row crops), and 25% is forested. Four percent of the drainage area is impervious surface. Water quality measured below COMAR standards for pH. Poor taxa diversity (12 taxa) with few EPT and climber taxa and no Ephemeroptera or scraper taxa resulted in a very poor biological score.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Worms (Tubificidae) and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Little buffer due to residential property on right bank and cropland on left bank. Very little flow with very poor habitat. Multiple rootwads throughout. Refuse present in moderate amounts.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.87
Turbidity (NTU)	23
Temperature (°C)	11.8
pH (SU)	5.71
Specific Conductivity (µS/cm)	153.6

WEST-49-2012 WR7 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	33.87
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	0.81

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	40
Chironomus	1
Crangonyx	7
Ironoquia	1
Nemata	1
Parametriocnemus	7
Pisidium	5
Polycentropus	1
Stegopterna	1
Tanytarsus	1
Tubificidae	52
Turbellaria	7
TOTAL:	**124**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	0
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	6
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	4
Channel Flow Status	4	Sediment Deposition	13
Channel Sinuosity	8	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	2	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	1		
EPA Habitat Score			**90**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Woody Debris/Rootwads	8	100
Shading	90	91.34	Instream Habitat	2	61.18
Epifaunal Substrate	3	54.15	Bank Stability	20	100
PHI Score					**73.16**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**19.91**
Cover	**Acres**	**%Area**
Developed Land	**28.36**	**37.68**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.46	12.35
Residential 2-Acre	4	20.1
Transportation	1.04	5.23
Utility	0	0
Forest Land	**4.98**	**25.03**
Forested Wetland	0	0
Residential Woods	0	0
Woods	4.98	25.03
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**7.42**	**37.28**
Pasture/Hay	0	0
Row Crops	7.42	37.28
Impervious Surface	**Acres**	**% Area**
Impervious Land	0.76	3.8

WEST-50-2012 WR4 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8629309805 **Longitude:** -76.5462843586

Located in the Popham Creek watershed (WR4), this site is behind Annandale Road and 200 meters upstream of the tidal portion of Popham Creek. The majority of the 66 acre drainage area is forested (72%) with minimal impervious surface (2%). The stream runs through a broad wetland valley with an abundance of fine particulate organic matter, leaves, and some woody debris. Taxa intolerant to urban stressors accounted for 78% of the benthic sample. However, few EPT and climber taxa as well as a complete lack of Ephemeroptera and scraper taxa contributed to an overall score of poor for the biological community. Water quality measured below COMAR standards for pH, which may be an effect of wetland conditions.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Amphipods (Synurella) and isopods (Caecidotea) dominated the sample.
- Measured below COMAR standards for pH.
- Abundance of leaves and some woody debris providing marginal habitat for benthos. Banks are stable with good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.69
Turbidity (NTU)	64.1
Temperature (°C)	12
pH (SU)	5.91
Specific Conductivity (µS/cm)	158.8

WEST-50-2012 WR4 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	78.4
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	1.6

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	2
Caecidotea	32
Chironomus	1
Corynoneura	1
Diptera	1
Dytiscidae	1
Gammarus	1
Odontomesa	1
Parametriocnemus	1
Pisidium	1
Polypedilum	2
Rheocricotopus	2
Synurella	63
Tubificidae	11
Turbellaria	3
Wormaldia	1
Zavrelimyia	1
TOTAL:	**125**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	7
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	12	Sediment Deposition	9
Channel Sinuosity	14	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	10		
EPA Habitat Score			**139**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Woody Debris/Rootwads	8	97.96
Shading	60	58.94	Instream Habitat	5	65.57
Epifaunal Substrate	7	69.59	Bank Stability	20	100
PHI Score					**79.7**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**65.91**
Cover	**Acres**	**%Area**
Developed Land	**15.03**	**13.01**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0.56	0.85
Residential 2-Acre	6.68	10.13
Transportation	1.33	2.02
Utility	0	0
Forest Land	**47.52**	**72.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	47.52	72.1
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**9.82**	**14.9**
Pasture/Hay	0	0
Row Crops	9.82	14.9
Impervious Surface	**Acres**	**% Area**
Impervious Land	1	1.52

WEST-53-2012 WR2 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8745395731 **Longitude:** -76.5278856132

This site is located approximately 200 meters upstream of the tidal portion of Cheston Creek, which is part of the Cheston Creek watershed (WR2). Located on Smithsonian Environmental Research Center (SERC) property, 40% of the 48 acre drainage area is forested with 36% as agricultural land. Six percent of the drainage area is impervious surface. Although water quality values were within COMAR standards, conductivity values were elevated. This stream was shallow with virtually no flow and poor habitat for benthos. Taxa intolerant to urban stressors accounted for 69% of the benthic sample; however, poor taxa diversity (10 taxa) and a complete lack of EPT, Ephemeroptera, scraper, and climber taxa resulted in a very poor score for the biological community.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Caecidotea (isopod) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Shallow stream with virtually no flow, likely ephemeral or intermittent. Poor habitat, but numerous rootwads provide bank protection and limited habitat for benthos. Good riparian.

Water Chemistry:

Dissolved Oxygen (mg/L)	6.07
Turbidity (NTU)	48.2
Temperature (°C)	14.4
pH (SU)	6.84
Specific Conductivity (µS/cm)	380

WEST-53-2012 WR2 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	68.64
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	0

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	80
Chironomus	4
Dolichopodidae	1
Enchytraeidae	1
Gammarus	17
Limnophyes	1
Naididae	1
Procladius	1
Psectrotanypus	1
Tubificidae	11
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	4
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	2	Sediment Deposition	5
Channel Sinuosity	5	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	3	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	4		
EPA Habitat Score			**94**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Woody Debris/Rootwads	15	100
Shading	95	99.94	Instream Habitat	2	52.21
Epifaunal Substrate	3	48.45	Bank Stability	20	100
PHI Score					**72.15**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 47.79

Cover	Acres	%Area
Developed Land	**16.03**	**18.4**
Commercial	0.67	1.41
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.44	5.1
Residential 2-Acre	2.26	4.72
Transportation	3.43	7.17
Utility	0	0
Forest Land	**19.33**	**40.46**
Forested Wetland	0	0
Residential Woods	0	0
Woods	19.33	40.46
Open Land	**2.37**	**4.95**
Open Space	2.37	4.95
Open Wetland	0	0
Water	0	0
Agricultural Land	**17.3**	**36.2**
Pasture/Hay	11.98	25.07
Row Crops	5.32	11.13

Impervious Surface	Acres	% Area
Impervious Land	2.75	5.76

WEST-55-2012 WR2 Subwatershed

Upstream View:

Downstream View:

Latitude: 38.8707806647 **Longitude:** -76.5330420029

This site is located on Smithsonian Environmental Research Center (SERC) property and is 150 meters upstream of the tidal portions of Scaffold Creek, which is part of the Cheston Creek watershed (WR2). At 18 acres, this site has the smallest drainage area of sites sampled in West River and is 56% forested and 44% agricultural land with no impervious surface. This stream was shallow with minimal habitat complexity and virtually no flow. Water quality measured below COMAR standards for pH. Although 41% of the benthic sample consisted of taxa intolerant to urban stressors, poor taxa diversity (8 taxa) with one climber taxa and no EPT, Ephemeroptera, or scraper taxa resulted in a biological community that is very poor.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Chironomus (midge) and Caecidotea (isopod) dominated the sample.
- Measured below COMAR standards for pH.
- Shallow channel with minimal habitat complexity. Upstream half of reach deeply incised with raw eroding banks. Virtually no observable flow, likely ephemeral or intermittent. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	7.55
Turbidity (NTU)	24.8
Temperature (°C)	15.1
pH (SU)	6.11
Specific Conductivity (µS/cm)	125.2

WEST-55-2012 WR2 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	8
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	41.46
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	0.81

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	42
Ceratopogonidae	1
Chaetocladius	1
Chironomus	56
Micropsectra	1
Synurella	8
Tubificidae	3
Zavrelimyia	11
TOTAL:	**123**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	4
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	3	Sediment Deposition	5
Channel Sinuosity	11	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	3	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	5		
EPA Habitat Score			**97**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	2	94.62
Shading	75	73.32	Instream Habitat	3	67.49
Epifaunal Substrate	3	54.64	Bank Stability	14	83.67
PHI Score					**75.75**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 18.47

Cover	Acres	%Area
Developed Land	**0**	**0**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	0	0
Utility	0	0
Forest Land	**10.43**	**56.46**
Forested Wetland	0	0
Residential Woods	0	0
Woods	10.43	56.46
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**8.04**	**43.54**
Pasture/Hay	8.04	43.54
Row Crops	0	0

Impervious Surface	Acres	% Area
Impervious Land	0	0

Appendix B: Bioassessment Results Maps

Appendix C: QA/QC Procedures and Results

Appendix C: Quality Assurance/Quality Control Procedures and Results

A quality assurance and quality control analysis was completed for the data collected for the West and Rhode Rivers Watersheds Targeted Biological Assessment following the methods described by Hill and Pieper (2011). This analysis included performance characteristics of precision, accuracy, bias, sensitivity, and completeness, with comparisons to MQOs. Performance measures include:

- Precision (consistency) of field sampling and overall site assessments using intra-team site duplication
  - median relative percent difference (mRPD)
  - root mean square error (RMSE)
  - coefficient of variability (CV)
- Sensitivity of overall site assessments
  - 90% confidence interval (CI)
- Bias of sample sorting and subsampling
  - percent sorting efficiency (PSE)
- Precision of taxonomic identification and enumeration
  - percent taxonomic disagreement (PTD)
  - percent difference in enumeration (PDE)

Data that do not meet performance or acceptable criteria are re-evaluated to correct any problems or investigated further to determine the reason behind the results.

Field Sampling

All field crew leaders were recently trained in MBSS Spring Sampling protocols prior to the start of field sampling. In addition, benthic macroinvertebrate sampling was conducted by KCI staff with *2012 MBSS Benthic Macroinvertebrate Sampling Certification*. All subjective scoring of physical habitat parameters was completed with the input of all team members at the sampling site to reduce individual sampler bias.

Field water quality measurements were collected *in situ* at all monitoring sites according to methods in the County QAPP. With the exception of turbidity, *in situ* parameters were measured with a multi-parameter sonde (YSI Professional Plus series or YSI 560 series). Turbidity was measured using a Hach 2100 Turbidimeter. All water quality equipment was regularly inspected, maintained, and calibrated to ensure proper usage and accuracy of the readings. Calibration logs were kept by field crew leaders and checked by the project manager regularly.

Benthic macroinvertebrate sample buckets were labeled using both internal and external labels, and all samples were logged onto a chain-of-custody form while in the field. All chain-of-custody procedures were followed for transfer of the samples between the field and the laboratory performing sorting and taxonomic identifications.

Replicate (duplicate) samples were taken at ten percent of the overall sites (five sites). QC samples were collected just upstream of the original sampling location to determine the consistency and repeatability of the sampling procedures and the intra-team adherence to those protocols. The QC site was selected in the field to ensure that the QC sites maintained similar habitat conditions to the original site, and no additional stressors or unusual conditions were

present that may affect the biota. Duplicate samples included collection and analysis of the benthic macroinvertebrate community, completion of the RBP and the PHI habitat assessments, and measurement of *in situ* water chemistry. Photographs were also taken at duplicate sites. After sampling was completed, a review of physical habitat scores and water quality parameters between the targeted and QC reaches revealed similar physical habitat and water chemistry conditions. Consequently, it is expected that targeted and QC reaches would support similar benthic macroinvertebrate communities, and random variability between duplicate sample pairs would be minimized.

Precision

Performance characteristics calculated for the consistency of field sampling and overall site assessments using intra-team site duplication were:

- Relative Percent Difference (RPD)
- Root Mean Square Error (RMSE)
- Coefficient of Variability (CV)

Acceptable measurement quality objectives are listed in Table 1. DNR's MBSS protocols were used for the collection and analysis of macroinvertebrate data.

Table 1 – Measurement quality objectives for metric and index scores

Attribute	MQO[1]		
	Median RPD	RMSE	CV
Total Number of Taxa	20	4.3	20
Number of EPT Taxa	30	1.7	50
Number of Ephemeroptera Taxa	30	2.8	100
Percent Intolerant Urban	80	15.9	80
Percent Ephemeroptera	30	0.5	100
Number of Scraper Taxa	30	0.9	100
Percent Climber	30	6.9	70
B-IBI	20	0.6	22

[1]Values derived from Hill and Pieper, 2011

Results of performance characteristics using individual metric values are presented in Table 2. Results are shown for sites where a duplicate sample (i.e., sample pair) was collected and analyzed.

Table 2 – Individual Metric Values and Related Measures of Precision. Bold values exceed MQOs.

Site	Total Taxa	EPT Taxa	% Ephem	Ephem Taxa	% Intol Urban	Scraper Taxa	% Climber	BIBI	Rating
RHOD-33	24	1	0.0	0	11.9	0	32.2	2.43	Poor
RHOD-33 QC	21	1	0.0	0	29.2	0	20.8	2.43	Poor
RHOD-39	15	2	0.0	0	11.9	0	17.0	2.43	Poor
RHOD-39 QC	17	3	0.0	0	20.9	1	27.8	2.71	Poor
RHOD-40	12	0	0.0	0	2.4	0	8.9	1.57	VeryPoor
RHOD-40 QC	16	0	0.0	0	0.8	1	30.3	2.14	Poor
WEST-17	12	1	0.0	0	55.7	0	5.7	1.86	Very Poor
WEST-17 QC	10	1	0.0	0	81.7	1	5.0	2.14	Poor
WEST-28	17	1	0.0	0	16.0	0	37.8	2.14	Poor
WEST-28 QC	17	3	0.0	0	42.0	1	28.6	3.00	Fair
Median RPD	12.9	20.0	0.0	0.0	**87.1**	**200.0**	**45.7**	**20.8**	-
RMSE	3.3	0.5	0.0	0.0	**19.5**	0.0	**15.0**	0.3	-
CV	19.0	36.4	0.0	0.0	**115.6**	0.0	**59.0**	14.4	-

Both metric values and index scores were compared to MQOs to determine exceedances. Three metrics, Percent Intolerant Urban, Scraper Taxa, and Percent Climbers in addition to overall BIBI score exceeded the MQO for mRPD. Scraper Taxa and BIBI did not exceed the MQO for RMSE or CV. The high mRPD value for Scraper Taxa and BIBI was due to relatively few scraper taxa and low BIBI scores in all samples, which tends to skew RPD values upward when comparing small values as compared to large values. In addition to exceeding the MQO for mRPD, Percent Intolerant Urban and Percent Climbers also exceeded the MQO for RMSE and CV. The high RMSE and CV were likely due to the variability within both metrics between the sites sampled. For example, Percent Intolerant Urban values range from 0.8 percent to 81.7 percent for the sites analyzed for QC. All other values were within acceptable ranges.

Laboratory Sorting and Subsampling

Bias

All sorting was completed following the SOPs described in the QAPP. All samples (50 samples in addition to five QC samples) underwent quality control procedures for sorting, above the ten percent requirement. Average percent sorting efficiency was 100% (n= 55). All samples sorted by laboratory personnel in training (i.e., not consistently achieving >90% sorting efficiency) were checked and all samples sorted by experienced laboratory personnel were also checked, which exceeded the ten percent requirement. This procedure ensures that all sorted samples either initially exceed the MQO of >90% for PSE, or will exceed the MQO following QC checks by experienced sorters.

Taxonomic Identification and Enumeration

Five samples (WEST-36-3012, WEST-46-2012, RHOD-15-2012, RHOD-39-2012, and RHOD-40-2012) were randomly selected for QC identification and enumeration by an independent lab. Original identification was completed by EcoAnalysts, Inc[1]. Re-identification of the randomly selected sites was done by Aquatic Resources Center[2]. Each sample was identified to the genus level where possible. Individuals that were not able to be identified to genus level were identified to the lowest possible level, usually family, but in some cases order. For Chironomidae, individuals not identifiable to genus may have been identified to subfamily or tribe level.

Precision

Measures of precision were calculated for the identification consistency between the two randomly selected samples. These include percent difference in enumeration (PDE) and percent taxonomic disagreement (PTD).

The PDE compares the final specimen counts between the two taxonomy labs, whereas PTD compares the number of agreements in final specimen identifications between the two taxonomy labs. To meet required MQOs set by the QAPP, the PDE for each sample must be equal to or less than 5%, and the PTD must be equal to or less than 15%. Results for the taxonomic comparison and resulting values for PDE and PTD for all five samples are found in Tables 4 through 8. It should be noted that hierarchical agreements are counted if the target level was reached by one taxonomist and exceeded by another taxonomist. For example, if the primary taxonomist identifies a worm with a family level target as Tubficidae, but the secondary taxonomist takes it further to genus level it would be counted as an agreement. In addition, if the secondary taxonomist cannot reach the target level due to a damaged specimen and there was no indication by the primary taxonomist that the specimen was damaged, it can still be counted as an agreement if the primary taxonomist was able to reach the target, since it was likely damaged following initial identification.

Results of the taxonomic re-identification and enumeration yielded a PDE below the MQO value of 5% for all verification samples. Similarly, the PTD was below the stated MQO of 15% for all verification samples.

[1] Address: 1420 S. Blaine Suite 14, Moscow, ID
[2] Address: 545 Cathy Jo Circle, Nashville, TN

Summary

A summary of QC results for this sampling period, as compared to established MQOs, for each activity in the biological sampling process is displayed below in Table 3. Results indicate that all MQOs were met for this project, and subsequently, all data are of acceptable quality as specified by the QAPP.

Table 3. Summary comparison of QC results and measurement quality objectives[1].

Activity	Performance Indicator	Measure	MQO	2012 Results
Field Sampling	Precision	mRPD (BIBI)	<20	20.8
		RMSE (BIBI)	<0.6	0.3
Laboratory Sorting/Subsampling	Bias	PSE	>90	100.0
Taxonomic Identification	Precision	PDE	<5	0.4
		PTD	<15	2.5
Site Assessment	Sensitivity	90% CI (BIBI)	≤0.96	0.56

[1] MQOs are derived from Hill and Pieper, 2011

Table 4 - Taxonomic Identification and Enumeration Results: WEST-36-2012

Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Chironomidae	-	Chaetocladius	0	1	0
	Chironomidae	-	Cricotopus/Orthocladius	-	11	10
	Chironomidae	-	Orthocladius	10	0	0
	Chironomidae	Chironomini	Cryptochironomus	1	1	1
	Chironomidae	-	Hydrobaenus	1	1	1
	Chironomidae	-	Limnophyes	1	1	1
	Chironomidae	-	Odontomesa	1	1	1
	Chironomidae	-	Parakiefferiella	1	1	1
	Chironomidae	-	Parametriocnemus	4	4	4
	Chironomidae	Chironomini	Polypedilum	34	32	32
	Chironomidae	-	Rheocricotopus	3	3	3
	Chironomidae	Tanytarsini	Tanytarsus	1	1	1
	Chironomidae	-	Thienemannimyia group	2	2	2
	Chironomidae	-	Tanypodinae	0	1	0
	Chironomidae	Pentaneurini	Zavrelimyia	1	0	1
	Simuliidae	Simuliini	Simulium	17	17	17
	Tabanidae	-	Chrysops	1	1	1
Amphipoda	Crangonyctidae	-	Synurella	9	9	9
	Gammaridae	-	Gammarus	7	7	7
Coleoptera	Dytiscidae	-	Agabus	1	1	1
Haplotaxida	Tubificidae	-	Tubificidae	6	-	6
	Tubificidae	-	Tubificinae	0	2	0
	Tubificidae	-	Aulodrilus	0	1	0
	Tubificidae	-	Limnodrilus	0	2	0
	Tubificidae	-	Rhyacodrilus	0	2	0
Isopoda	Asellidae	-	Caecidotea	16	16	16
Odonata	Calopterygidae	-	Calopteryx	1	1	1
Veneroida	Pisidiidae	-	Pisidium	1	1	1
			Total	119	120	117
			PDE			0.42
			PTD			2.50

Table 5 - Taxonomic Identification and Enumeration Results: WEST-46-2012

Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Chironomidae	Chironomini	Chironomus	7	7	7
	Chironomidae	-	Cricotopus/Orthocladius	-	1	1
	Chironomidae	-	Orthocladius	1	0	0
	Chironomidae	-	Odontomesa	1	1	1
	Chironomidae	-	Parametriocnemus	2	2	2
	Chironomidae	-	Rheocricotopus	7	7	7
	Chironomidae	Pentaneurini	Zavrelimyia	3	3	3
Amphipoda	Crangonyctidae	-	Synurella	18	18	18
Coleoptera	Dytiscidae	-	Agabus	2	2	2
Haplotaxida	Tubificidae	-	Tubificidae	3	-	3
	Tubificidae	-	Tubificinae	0	1	0
	Tubificidae	-	Limnodrilus	0	2	0
Isopoda	Asellidae	-	Caecidotea	69	69	69
Trichoptera	Limnephilidae	-	Ironoquia	3	3	3
Veneroida	Pisidiidae	-	Pisidium	3	3	3
			Total	119	119	119
			PDE			0.00
			PTD			0.00

Table 6 - Taxonomic Identification and Enumeration Results: RHOD-15-2012

Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Chironomidae	-	Cricotopus	0	1	0
	Chironomidae	-	Orthocladius	1	0	0
	Chironomidae	-	Parametriocnemus	2	2	2
	Chironomidae	Chironomini	Polypedilum	6	6	6
	Chironomidae	-	Thienemannimyia group	4	5	4
	Chironomidae	Pentaneurini	Zavrelimyia	4	4	4
	Ephydridae	-	Ephydridae	1	1	1

Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Amphipoda	Crangonyctidae	-	Synurella	66	67	66
Haplotaxida	Tubificidae	-	Tubificidae	3	-	3
	Tubificidae	-	Aulodrilus	0	1	0
	Tubificidae	-	Rhyacodrilus	0	1	0
	Tubificidae	-	Spirosperma	0	1	0
Isopoda	Asellidae	-	Caecidotea	26	27	26
Plecoptera	Nemouridae	-	Amphinemura	2	2	2
Trichoptera	Limnephilidae	-	Ironoquia	1	1	1
Veneroida	Pisidiidae	-	Pisidium	1	1	1
			Total	117	120	116
			PDE			1.27
			PTD			3.33

Table 7 - Taxonomic Identification and Enumeration Results: RHOD-39-2012

Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Ceratopogonidae	-	Bezzia/Palpomyia	1	1	1
	Chironomidae	-	Odontomesa	1	1	1
	Chironomidae	Chironomini	Phaenopsectra	1	0	0
	Chironomidae	Chironomini	Polypedilum	20	21	20
	Chironomidae	-	Rheocricotopus	1	1	1
	Chironomidae	-	Thienemanniella	2	2	2
	Chironomidae	Pentaneurini	Zavrelimyia	1	1	1
	Tipulidae	-	Dicranota	11	11	11
	Tipulidae	-	Tipula	1	1	1
Amphipoda	not identified	-	Amphipoda	0	6	0
	Gammaridae	-	Gammarus	73	66	72
	Crangonyctidae	-	Synurella	1	2	1
Coleoptera	Dytiscidae	-	Dytiscidae	1	0	0
	Dytiscidae	-	Neoporus	0	1	0
Haplotaxida	Tubificidae	-	Tubificidae	1	-	1

Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
	Tubificidae	-	Limnodrilus	0	1	0
Plecoptera	Nemouridae	-	Amphinemura	2	2	2
Trichoptera	Hydropsychidae	-	Cheumatopsyche	1	1	1
			Total	118	118	115
			PDE			0.00
			PTD			2.54

Table 8 - Taxonomic Identification and Enumeration Results: RHOD-40-2012

Order	Family	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Ceratopogonidae	-	Bezzia/Palpomyia	2	1	1
	Ceratopogonidae	-	Mallochohelea	0	1	0
	Chironomidae	-	Cricotopus/Orthocladius	-	1	1
	Chironomidae	-	Orthocladius	5	0	1
	Chironomidae	-	Cricotopus	0	4	0
	Chironomidae	-	Parametriocnemus	2	2	2
	Chironomidae	Chironomini	Polypedilum	11	11	11
	Chironomidae	-	Thienemannimyia group	1	1	1
	Chironomidae	Pentaneurini	Zavrelimyia	2	2	2
	Tabanidae	-	Chrysops	1	1	1
	Tipulidae	-	Dicranota	1	1	1
Amphipoda	not identified	-	Amphipoda	0	15	0
	Gammaridae	-	Gammarus	86	72	86
	Crangonyctidae	-	Synurella	1	1	1
Haplotaxida	Tubificidae	-	Tubificidae	4	-	4
	Tubificidae	-	Tubificinae	0	3	0
	Tubificidae	-	Isochaetides	0	1	0
Veneroida	Pisidiidae	-	Pisidium	7	7	7
			Total	123	124	119
			PDE			0.40
			PTD			4.03

References

Hill, C.R., and M. J. Pieper. 2011. Documentation of Method Performance Characteristics for the Anne Arundel County Biological Monitoring Program. Revised, June 2010. Prepared by KCI Technologies, Sparks, MD for Anne Arundel County, Department of Public Works, Watershed, Ecosystem, and Restoration Services. Annapolis, MD.

Appendix D: Natural Soils Groups of Maryland

Estimated physical and chemical properties of Natural Soils Groups of Maryland (Maryland Department of Planning)

SOIL	DEPBED	DEPWAT	DEPSOL	TEXTUR	EROK	HYDGRP	IRRMAX	PERMAX	PERC	AWC	PH
A1,A1a,A1b,A1c	72+	4+	0-60	loamy sand; sand, sandy loam	0.17	A	1.00	>6.0	<45	0.2-0.6	4.0-5.0
A2	72+	1-10	0-60	sand	0.17	A	N/A	>6.0	<45	<0.06	5.0-8.0
B1,B1a,B1b,B1c	72+	3+	0-60	silt loam,loam, fine sandy loam, sandy loam, silty clay loam, clay loam,silty clay, clay	0.32	B	0.4-0.6	0.6-2.0	45-60	0.12-0.24	4.5-6.5
B2,B2a,B2b, B2c	72+	4+	0-60	silt loam, loam, gravelly loam, clay loam,silty clay loam	0.43	C	0.3-0.4	0.2-0.6	>60	0.12-0.24	4.5-7.3
B3	72+	5+	0-60	clay, silty clay, silt loam, loam,loamy sand	0.37	C	0.3	<0.6	>60	0.06-0.24	4.0-5.0
C1,C1a,C1b,C1c	20-40	In bed-rock	0-40	silt loam, loam, shaly silty loam, shaly loam, channery loam, channery silt loam, sandy loam	0.22	C	0.3	0.6-6.0	>60	0.12-0.24	4.-7.3
C2	20-40	3+	0-40	silty clay loam, silty clay, clay	0.37	C	0.3	<0.6	>60	0.12-0.24	5.0-7.5
D1,D1a,D1b, D1c	<20	In bed-rock	0-20	shaly silt loam, shaly loam, silty clay loam, silty clay	0.28	C-D	0.3	0.6-6.0	45-60	0.18-0.24	4.0-7.3
E1, E1a,E1b	72+	1.5-2.5	0-60	sandy loam, sandy clay, loam, loamy	0.28	C	0.4-0.6	0.6-6.0	<60	0.12-0.24	4.0-5.0

				sand, sand							
E2,E2a,E2b	72+	1-3	0-60	silt loam, loam, silty clay loam, fine sandy loam, sandy clay loam	0.43	C	0.3-0.4	<0.6	>60	0.12-0.24	4.0-6.5
E3, E3a, E3b	72+	1.5-2.5	0-60	silt loam, loam, silty clay loam	0.37	C	0.4	0.2-0.6	>60	0.18-0.24	4.5-5.5
F1	72+	0-1	0-60	loamy sand, sand	N/A	D	1.0	>60	<45	<0.06	3.5-5.0
F2	72+	0-1	0-60	sandy loam, fine sandy loam, sandy clay loam, loam, loamy sand	0.28	D	0.4-0.6	0.6-2.0	<60	0.12-0.24	4.0-5.0
F3	72+	0-1	0-60	silty clay loam, silty clay, clay, loam, silt loam	0.43	D	0.3	<0.6	>60	0.18-0.24	4.0-7.8
G1,G1a	72+	3+	0-60	silt loam, loam, fine sandy loam, sandy loam, silty clay loam	N/A	B-C	0.5-0.7	0.2-2.0	45-60	0.12-0.24	4.0-7.3
G2	72+	0-1	0-60	silt loam, silty clay loam, silty clay, fine sandy loam, sandy loam, loam, muck	N/A	D	0.5	0.6-6.0	45-60	0.18-0.24	4.0-7.3
G3	72+	0	0-60	variable	N/A	N/A	N/A	Var.	Var.	Var.	3.5-9.0
H1,H1a,H1b,H1c	Too variable to rate. Determine the specific soil series name from detailed soil map and use the information for the group that the series is in.										
H2,H2a,H2b,H2c	Too variable to rate. Determine the specific soil series name from detailed soil map and use the information for the group that the series is in.										

EXPLANATION

DEPBED = Depth to bedrock (in.) -- distance from the surface of the soil downward to the surface of the rock layers. Soils were observed only to a depth of 6 feet: greater depths are specified at 72+ in.

DEPWAT = Depth to water table (ft) -- distance from the surface of the soil downward to the highest level reached In most years by ground water.

DEPSOL = Soil depth (in.) -- this does not imply that the soils are only 60 in. deep, but rather that the estimates In the table are for the 0-60 in. depth and not below.

TEXTUR = Dominant texture -- relative percentages of sand, silt, and clay in a soil sample. If the soil contains gravel or other particles coarser than sand, then an appropriate modifier Is added.

EROK = Erodibility (K factor) -- a measure of the susceptibility of bare soil to erosion and the same K factor as that used in the Universal Soil Loss Equation (Wischmeier and Smith, 1965).

HYDGRP = Hydrologic Soil Group -- a measure of the runoff potential of soils, when fully saturated. Group A soils have the lowest potential and D soils the highest.

IRRZMAX = maximum irrigation rate (in/hr)-- maximum rate of irrigation water applied by sprinklers.

PERMAX = Permeability (in/hr) -- rate at which soil transmits water while saturated. Permeability rates shown are based on the least permeable section of the soil.

PERC = Percolation (min/in) -- rate at which water can move through a soil with moisture at field capacity.

AWC = Available Water Capacity (in/in) -- the difference between the amount of water in the soil at field capacity and the amount in the soil at the wilting point of most crops.

PH = Reaction (pH) -- the degree of acidity or alkalinity of a Soil group, expressed in pH units.

Appendix E: Kendall Correlation Matrices

Kendall Correlation Matrix:

Variables	BIBI Score	Total Taxa	EPT Taxa	% Ephemeroptera	Ephemeroptera Taxa	% Intolerant Urban	Scraper Taxa	% Climber	Drainage Area	Bank Stability, Left	Bank Stability, Right	Vegetative Protection, Left	Vegetative Protection, Right	Channel Flow Status	Channel Alteration	Channel Sinuosity	Pool Substrate Characterization	Pool Variability	Riparian Zone Width, Left	Riparian Zone Width, Right	Sediment Deposition	Epi. Substrate/Avail. Cover	RBP Score	Instream Habitat	Epibenthic Substrate	Bank Stability	% Shading	Remoteness	# Woody Debris/Rootwads	PHI Score	Conductivity	DO	PH	Turbidity	Temperature	% Impervious	% Developed	% Forested	% Open	% Agriculture
BIBI Score	**1**	**0.587**	**0.570**	**0.409**	**0.412**	0.072	**0.475**	0.200	**0.268**	-0.191	-0.153	-0.050	-0.004	0.189	**0.306**	0.157	0.166	0.194	-0.143	-0.023	-0.125	**0.301**	0.125	0.278	**0.321**	-0.174	-0.025	0.097	0.176	0.086	-0.195	0.124	0.201	-0.065	0.143	-0.050	0.023	0.094	0.018	-0.055
Total Taxa	**0.587**	**1**	**0.333**	0.242	0.237	-0.104	**0.344**	0.180	**0.307**	-0.200	-0.209	-0.105	-0.107	0.171	0.219	0.026	0.141	0.219	-0.078	-0.029	-0.011	0.251	0.076	**0.278**	0.249	-0.204	-0.097	0.191	0.218	0.079	-0.174	0.065	0.117	-0.080	0.154	-0.017	0.058	0.115	0.032	-0.059
EPT Taxa	**0.570**	**0.333**	**1**	0.253	0.249	0.171	0.060	0.045	0.074	0.086	0.116	0.151	0.215	0.106	0.156	**0.386**	0.208	0.135	0.083	-0.070	-0.106	0.278	0.266	0.109	0.247	0.108	0.037	0.246	**0.287**	**0.322**	-0.261	0.172	0.076	-0.150	-0.050	-0.170	-0.033	0.167	-0.098	-0.070
% Ephemeroptera	**0.409**	0.242	0.253	**1**	**0.984**	-0.072	**0.396**	0.126	0.243	-0.273	-0.245	-0.201	-0.183	0.086	0.044	0.084	-0.147	0.013	-0.057	0.071	-0.271	-0.031	-0.136	0.020	-0.004	-0.248	0.079	0.124	0.119	-0.117	-0.206	-0.015	0.169	-0.091	0.133	-0.171	-0.144	0.086	0.043	0.014
Ephemeroptera Taxa	**0.412**	0.237	0.249	**0.984**	**1**	-0.071	**0.402**	0.126	0.246	-0.277	-0.251	-0.206	-0.190	0.076	0.043	0.084	-0.150	0.013	-0.053	0.077	-0.277	-0.033	-0.144	0.017	-0.006	-0.254	0.090	0.128	0.115	-0.120	-0.211	-0.014	0.159	-0.084	0.130	-0.173	-0.141	0.085	0.052	0.016
% Intolerant Urban	0.072	-0.104	0.171	-0.072	-0.071	**1**	-0.086	**-0.420**	**-0.333**	0.227	0.218	0.265	0.230	-0.233	-0.027	-0.104	-0.098	-0.240	0.047	0.070	-0.103	-0.198	-0.039	**-0.331**	-0.206	0.219	-0.024	-0.009	-0.042	0.107	-0.084	-0.092	-0.248	0.153	-0.212	-0.129	-0.122	0.041	**-0.337**	0.120
Scraper Taxa	**0.475**	**0.344**	0.060	**0.396**	**0.402**	-0.086	**1**	0.082	0.227	**-0.333**	-0.271	-0.280	-0.207	-0.005	0.138	-0.132	-0.096	-0.005	-0.266	0.009	-0.071	-0.066	-0.190	0.052	-0.024	-0.299	-0.128	-0.092	0.033	-0.265	-0.056	-0.053	0.083	-0.021	**0.374**	-0.055	-0.051	-0.017	-0.099	0.118
% Climber	0.200	0.180	0.045	0.126	0.126	**-0.420**	0.082	**1**	**0.464**	**-0.272**	-0.224	-0.224	-0.149	**0.445**	0.087	0.131	0.098	0.215	-0.051	-0.096	0.177	**0.394**	0.127	**0.474**	**0.424**	-0.253	-0.020	0.026	0.115	-0.040	-0.088	**0.448**	**0.316**	**-0.293**	0.097	0.141	0.193	-0.061	**0.404**	-0.133
Drainage Area	**0.268**	**0.307**	0.074	0.243	0.246	**-0.333**	0.227	**0.464**	**1**	**-0.306**	-0.241	-0.190	-0.125	**0.524**	0.130	0.111	0.170	**0.419**	-0.073	-0.052	0.147	**0.375**	0.207	**0.501**	**0.355**	**-0.272**	-0.094	0.059	**0.260**	-0.158	-0.051	0.177	**0.265**	-0.172	0.054	0.064	0.084	0.070	**0.323**	-0.162
Bank Stability, Left	-0.191	-0.200	0.086	-0.273	-0.277	0.227	**-0.333**	**-0.272**	**-0.306**	**1**	**0.842**	**0.746**	**0.655**	-0.062	0.022	0.099	0.149	-0.036	0.150	-0.037	-0.015	-0.127	**0.340**	-0.245	-0.140	**0.930**	-0.053	0.060	0.180	**0.317**	-0.047	-0.173	-0.176	0.089	-0.165	-0.082	-0.139	0.027	-0.225	0.059
Bank Stability, Right	-0.153	-0.209	0.116	-0.245	-0.251	0.218	-0.271	-0.224	-0.241	**0.842**	**1**	**0.684**	**0.772**	-0.030	0.103	0.158	0.154	-0.020	0.114	0.000	-0.036	-0.111	**0.386**	-0.239	-0.105	**0.941**	0.008	0.066	0.133	**0.307**	-0.009	-0.161	-0.084	0.054	-0.111	-0.074	-0.108	0.052	-0.196	-0.011
Vegetative Protection, Left	-0.050	-0.105	0.151	-0.201	-0.206	0.265	-0.280	-0.224	-0.190	**0.746**	**0.684**	**1**	**0.873**	-0.021	0.147	0.166	0.219	0.066	0.245	0.209	-0.119	-0.019	**0.450**	-0.167	-0.024	**0.727**	0.016	0.184	0.255	**0.440**	-0.066	-0.098	-0.088	0.048	-0.079	-0.122	-0.211	0.174	-0.142	-0.043
Vegetative Protection, Right	-0.004	-0.107	0.215	-0.183	-0.190	0.230	-0.207	-0.149	-0.125	**0.655**	**0.772**	**0.873**	**1**	0.019	0.215	0.254	0.235	0.097	0.245	0.195	-0.117	0.030	**0.508**	-0.124	0.040	**0.727**	0.077	0.187	0.232	**0.446**	-0.028	-0.078	0.004	-0.019	0.007	-0.080	-0.152	0.178	-0.124	-0.115
Channel Flow Status	0.189	0.171	0.106	0.086	0.076	-0.233	-0.005	**0.445**	**0.524**	-0.062	-0.030	-0.021	0.019	**1**	0.102	0.169	**0.331**	**0.426**	-0.085	-0.105	0.269	**0.494**	**0.390**	**0.540**	**0.494**	-0.049	-0.155	0.026	0.216	0.000	-0.087	0.150	0.201	-0.207	-0.098	0.101	0.068	0.128	**0.300**	-0.240
Channel Alteration	**0.306**	0.219	0.156	0.044	0.043	-0.027	0.138	0.087	0.130	0.022	0.103	0.147	0.215	0.102	**1**	**0.362**	0.175	0.198	-0.003	0.123	0.082	0.226	**0.402**	0.219	0.242	0.063	0.188	0.143	0.096	0.246	-0.217	-0.007	-0.060	0.150	0.143	-0.245	-0.137	0.250	-0.043	-0.069
Channel Sinuosity	0.157	0.026	**0.386**	0.084	0.084	-0.104	-0.132	0.131	0.111	0.099	0.158	0.166	0.254	0.169	**0.362**	**1**	**0.291**	**0.305**	0.200	0.027	-0.068	**0.337**	**0.475**	0.210	**0.301**	0.136	0.047	**0.276**	0.121	**0.289**	-0.169	0.092	0.086	-0.055	-0.016	-0.219	-0.203	**0.319**	0.016	-0.186
Pool Substrate Characterization	0.166	0.141	0.208	-0.147	-0.150	-0.098	-0.096	0.098	0.170	0.149	0.154	0.219	0.235	**0.331**	0.175	**0.291**	**1**	**0.682**	0.060	-0.001	0.131	**0.523**	**0.518**	**0.414**	**0.495**	0.149	-0.113	0.097	0.095	0.138	0.040	0.044	0.017	-0.029	-0.156	0.057	0.027	0.038	0.146	-0.106
Pool Variability	0.194	0.219	0.135	0.013	0.013	-0.240	-0.005	0.215	**0.419**	-0.036	-0.020	0.066	0.097	**0.426**	0.198	**0.305**	**0.682**	**1**	0.033	-0.024	0.130	**0.627**	**0.481**	**0.606**	**0.589**	-0.035	-0.124	0.132	0.212	0.098	0.013	0.047	0.066	0.012	-0.139	0.019	-0.056	0.143	0.216	-0.161
Riparian Zone Width, Left	-0.143	-0.078	0.083	-0.057	-0.053	0.047	-0.266	-0.051	-0.073	0.150	0.114	0.245	0.245	-0.085	-0.003	0.200	0.060	0.033	**1**	**0.466**	-0.154	-0.044	0.257	-0.119	-0.067	0.134	0.209	**0.500**	0.033	**0.383**	-0.020	-0.025	-0.008	-0.272	0.027	-0.033	-0.125	0.228	-0.001	-0.204
Riparian Zone Width, Right	-0.023	-0.029	-0.070	0.071	0.077	0.070	0.009	-0.096	-0.052	-0.037	0.000	0.209	0.195	-0.105	0.123	0.027	-0.001	-0.024	**0.466**	**1**	-0.208	-0.092	0.133	-0.124	-0.111	-0.022	**0.346**	**0.453**	-0.102	0.258	-0.035	-0.067	-0.017	-0.080	0.153	-0.120	-0.191	0.248	0.061	-0.208
Sediment Deposition	-0.125	-0.011	-0.106	-0.271	-0.277	-0.103	-0.071	0.177	0.147	-0.015	-0.036	-0.119	-0.117	0.269	0.082	-0.068	0.131	0.130	-0.154	-0.208	**1**	0.198	0.179	0.275	0.173	-0.039	-0.141	-0.215	0.060	-0.137	0.058	0.192	-0.169	0.077	-0.137	0.136	0.217	-0.148	0.131	-0.008
Epi. Substrate/Avail. Cover	**0.301**	0.251	0.278	-0.031	-0.033	-0.198	-0.066	**0.394**	**0.375**	-0.127	-0.111	-0.019	0.030	**0.494**	0.226	**0.337**	**0.523**	**0.627**	-0.044	-0.092	0.198	**1**	**0.440**	**0.772**	**0.942**	-0.126	0.010	0.087	0.236	0.223	-0.162	0.232	0.140	-0.072	-0.092	0.044	0.049	0.127	**0.317**	-0.221
RBP Score	0.125	0.076	0.266	-0.136	-0.144	-0.039	-0.190	0.127	0.207	**0.340**	**0.386**	**0.450**	**0.508**	**0.390**	**0.402**	**0.475**	**0.518**	**0.481**	0.257	0.133	0.179	**0.440**	**1**	**0.344**	**0.407**	**0.364**	0.022	0.246	0.245	**0.386**	-0.095	0.089	0.070	-0.051	-0.118	-0.045	-0.067	**0.261**	0.148	**-0.255**
Instream Habitat	0.278	**0.278**	0.109	0.020	0.017	**-0.331**	0.052	**0.474**	**0.501**	-0.245	-0.239	-0.167	-0.124	**0.540**	0.219	0.210	**0.414**	**0.606**	-0.119	-0.124	0.275	**0.772**	**0.344**	**1**	**0.745**	-0.252	-0.076	-0.005	0.149	0.076	-0.062	0.221	0.150	-0.065	-0.066	0.134	0.116	0.040	**0.339**	-0.199
Epibenthic Substrate	**0.321**	0.249	0.247	-0.004	-0.006	-0.206	-0.024	**0.424**	**0.355**	-0.140	-0.105	-0.024	0.040	**0.494**	0.242	**0.301**	**0.495**	**0.589**	-0.067	-0.111	0.173	**0.942**	**0.407**	**0.745**	**1**	-0.124	0.003	0.040	0.226	0.200	-0.137	0.239	0.153	-0.067	-0.059	0.077	0.075	0.086	**0.319**	-0.200
Bank Stability	-0.174	-0.204	0.108	-0.248	-0.254	0.219	-0.299	-0.253	**-0.272**	**0.930**	**0.941**	**0.727**	**0.727**	-0.049	0.063	0.136	0.149	-0.035	0.134	-0.022	-0.039	-0.126	**0.364**	-0.252	-0.124	**1**	-0.024	0.070	0.154	**0.303**	-0.038	-0.173	-0.126	0.063	-0.134	-0.083	-0.128	0.046	-0.217	0.022
% Shading	-0.025	-0.097	0.037	0.079	0.090	-0.024	-0.128	-0.020	-0.094	-0.053	0.008	0.016	0.077	-0.155	0.188	0.047	-0.113	-0.124	0.209	**0.346**	-0.141	0.010	0.022	-0.076	0.003	-0.024	**1**	0.139	-0.156	0.223	0.054	0.012	0.081	-0.033	0.056	0.041	0.061	0.069	0.211	-0.144
Remoteness	0.097	0.191	0.246	0.124	0.128	-0.009	-0.092	0.026	0.059	0.060	0.066	0.184	0.187	0.026	0.143	**0.276**	0.097	0.132	**0.500**	**0.453**	-0.215	0.087	0.246	-0.005	0.040	0.070	0.139	**1**	0.082	**0.495**	**-0.335**	-0.021	-0.005	-0.158	0.102	**-0.320**	**-0.293**	**0.272**	-0.022	-0.073
# Woody Debris/Rootwads	0.176	0.218	**0.287**	0.119	0.115	-0.042	0.033	0.115	**0.260**	0.180	0.133	0.255	0.232	0.216	0.096	0.121	0.095	0.212	0.033	-0.102	0.060	0.236	0.245	0.149	0.226	0.154	-0.156	0.082	**1**	0.160	-0.161	0.064	0.054	-0.074	0.014	-0.041	-0.069	0.136	0.057	-0.038
PHI Score	0.086	0.079	**0.322**	-0.117	-0.120	0.107	-0.265	-0.040	-0.158	**0.317**	**0.307**	**0.440**	**0.446**	0.000	0.246	**0.289**	0.138	0.098	**0.383**	0.258	-0.137	0.223	**0.386**	0.076	0.200	**0.303**	0.223	**0.495**	0.160	**1**	**-0.285**	0.002	-0.085	-0.051	-0.008	-0.183	-0.208	0.185	-0.063	-0.080
Conductivity	-0.195	-0.174	-0.261	-0.206	-0.211	-0.084	-0.056	-0.088	-0.051	-0.047	-0.009	-0.066	-0.028	-0.087	-0.217	-0.169	0.040	0.013	-0.020	-0.035	0.058	-0.162	-0.095	-0.062	-0.137	-0.038	0.054	**-0.335**	-0.161	**-0.285**	**1**	-0.047	0.231	0.006	-0.015	**0.554**	**0.429**	-0.195	0.246	-0.180
DO	0.124	0.065	0.172	-0.015	-0.014	-0.092	-0.053	**0.448**	0.177	-0.173	-0.161	-0.098	-0.078	0.150	-0.007	0.092	0.044	0.047	-0.025	-0.067	0.192	0.232	0.089	0.221	0.239	-0.173	0.012	-0.021	0.064	0.002	-0.047	**1**	0.190	**-0.274**	-0.214	0.077	0.189	0.021	**0.261**	-0.192
PH	0.201	0.117	0.076	0.169	0.159	-0.248	0.083	**0.316**	**0.265**	-0.176	-0.084	-0.088	0.004	0.201	-0.060	0.086	0.017	0.066	-0.008	-0.017	-0.169	0.140	0.070	0.150	0.153	-0.126	0.081	-0.005	0.054	-0.085	0.231	0.190	**1**	**-0.284**	0.176	**0.309**	**0.292**	0.058	**0.448**	**-0.399**
Turbidity	-0.065	-0.080	-0.150	-0.091	-0.084	0.153	-0.021	**-0.293**	-0.172	0.089	0.054	0.048	-0.019	-0.207	0.150	-0.055	-0.029	0.012	-0.272	-0.080	0.077	-0.072	-0.051	-0.065	-0.067	0.063	-0.033	-0.158	-0.074	-0.051	0.006	**-0.274**	**-0.284**	**1**	-0.097	-0.139	-0.102	-0.216	-0.114	**0.347**
Temperature	0.143	0.154	-0.050	0.133	0.130	-0.212	**0.374**	0.097	0.054	-0.165	-0.111	-0.079	0.007	-0.098	0.143	-0.016	-0.156	-0.139	0.027	0.153	-0.137	-0.092	-0.118	-0.066	-0.059	-0.134	0.056	0.102	0.014	-0.008	-0.015	-0.214	0.176	-0.097	**1**	-0.044	-0.039	0.004	-0.006	0.004
% Impervious	-0.050	-0.017	-0.170	-0.171	-0.173	-0.129	-0.055	0.141	0.064	-0.082	-0.074	-0.122	-0.080	0.101	-0.245	-0.219	0.057	0.019	-0.033	-0.120	0.136	0.044	-0.045	0.134	0.077	-0.083	0.041	**-0.320**	-0.041	-0.183	**0.554**	0.077	**0.309**	-0.139	-0.044	**1**	**0.629**	**-0.277**	**0.403**	-0.161
% Developed	0.023	0.058	-0.033	-0.144	-0.141	-0.122	-0.051	0.193	0.084	-0.139	-0.108	-0.211	-0.152	0.068	-0.137	-0.203	0.027	-0.056	-0.125	-0.191	0.217	0.049	-0.067	0.116	0.075	-0.128	0.061	**-0.293**	-0.069	-0.208	**0.429**	0.189	**0.292**	-0.102	-0.039	**0.629**	**1**	**-0.322**	**0.382**	-0.177
% Forested	0.094	0.115	0.167	0.086	0.085	0.041	-0.017	-0.061	0.070	0.027	0.052	0.174	0.178	0.128	0.250	**0.319**	0.038	0.143	0.228	0.248	-0.148	0.127	**0.261**	0.040	0.086	0.046	0.069	**0.272**	0.136	0.185	-0.195	0.021	0.058	-0.216	0.004	**-0.277**	**-0.322**	**1**	-0.135	**-0.487**
% Open	0.018	0.032	-0.098	0.043	0.052	**-0.337**	-0.099	**0.404**	**0.323**	-0.225	-0.196	-0.142	-0.124	**0.300**	-0.043	0.016	0.146	0.216	-0.001	0.061	0.131	**0.317**	0.148	**0.339**	**0.319**	-0.217	0.211	-0.022	0.057	-0.063	0.246	**0.261**	**0.448**	-0.114	-0.006	**0.403**	**0.382**	-0.135	**1**	**-0.296**
% Agriculture	-0.055	-0.059	-0.070	0.014	0.016	0.120	0.118	-0.133	-0.162	0.059	-0.011	-0.043	-0.115	-0.240	-0.069	-0.186	-0.106	-0.161	-0.204	-0.208	-0.008	-0.221	**-0.255**	-0.199	-0.200	0.022	-0.144	-0.073	-0.038	-0.080	-0.180	-0.192	**-0.399**	**0.347**	0.004	-0.161	-0.177	**-0.487**	**-0.296**	**1**

Values in bold are different from 0 with a significance level alpha=0.01

Kendall Correlation p-values:

Variables	BIBI Score	Total Taxa	EPT Taxa	% Ephemeroptera	Ephemeroptera Taxa	% Intolerant Urban	Scraper Taxa	% Climber	Drainage Area	Bank Stability, Left	Bank Stability, Right	Vegetative Protection, Left	Vegetative Protection, Right	Channel Flow Status	Channel Alteration	Channel Sinuosity	Pool Substrate Characterization	Pool Variability	Riparian Zone Width, Left	Riparian Zone Width, Right	Sediment Deposition	Epi. Substrate/Avail. Cover	RBP Score	Instream Habitat	Epibenthic Substrate	Bank Stability	% Shading	Remoteness	# Woody Debris/Rootwads	PHI Score	Conductivity	DO	PH	Turbidity	Temperature	% Impervious	% Developed	% Forested	% Open	% Agriculture
BIBI Score	**0**	**< 0.0001**	**< 0.0001**	**0.001**	**0.001**	0.490	**< 0.0001**	0.056	**0.010**	0.084	0.165	0.658	0.979	0.079	**0.007**	0.145	0.127	0.079	0.231	0.853	0.250	**0.006**	0.233	0.011	**0.003**	0.109	0.831	0.372	0.100	0.405	0.061	0.236	0.054	0.534	0.173	0.633	0.831	0.371	0.870	0.603
Total Taxa	**< 0.0001**	**0**	**0.003**	0.043	0.051	0.305	**0.003**	0.076	**0.002**	0.061	0.050	0.332	0.321	0.102	0.046	0.806	0.184	0.041	0.502	0.807	0.926	0.018	0.459	**0.009**	0.019	0.052	0.376	0.069	0.036	0.435	0.086	0.522	0.249	0.429	0.130	0.873	0.567	0.256	0.760	0.561
EPT Taxa	**< 0.0001**	**0.003**	**0**	0.047	0.054	0.113	0.634	0.684	0.494	0.455	0.309	0.189	0.060	0.342	0.182	**0.001**	0.065	0.237	0.504	0.571	0.346	0.014	0.014	0.339	0.029	0.337	0.759	0.027	**0.009**	**0.002**	0.015	0.111	0.483	0.163	0.646	0.113	0.762	0.121	0.377	0.521
% Ephemeroptera	**0.001**	0.043	0.047	**0 < 0.0001**		0.542	**0.003**	0.284	0.036	0.026	0.045	0.105	0.139	0.481	0.734	0.491	0.229	0.928	0.679	0.602	0.025	0.809	0.245	0.880	0.988	0.040	0.536	0.308	0.324	0.315	0.077	0.905	0.149	0.439	0.258	0.141	0.217	0.466	0.730	0.917
Ephemeroptera Taxa	**0.001**	0.051	0.054	**< 0.0001**	**0**	0.551	**0.003**	0.290	0.037	0.026	0.043	0.101	0.130	0.538	0.745	0.500	0.228	0.927	0.706	0.576	0.023	0.797	0.227	0.904	0.976	0.038	0.485	0.300	0.346	0.307	0.074	0.917	0.180	0.483	0.276	0.144	0.233	0.474	0.674	0.905
% Intolerant Urban	0.490	0.305	0.113	0.542	0.551	**0**	0.453	**< 0.0001**	**0.001**	0.028	0.035	0.011	0.027	0.021	0.807	0.308	0.343	0.021	0.679	0.536	0.316	0.055	0.694	**0.001**	0.045	0.032	0.827	0.933	0.680	0.273	0.393	0.349	0.012	0.120	0.031	0.189	0.216	0.682	**0.001**	0.225
Scraper Taxa	**< 0.0001**	**0.003**	0.634	**0.003**	**0.003**	0.453	**0**	0.477	0.045	**0.005**	0.023	0.021	0.086	0.976	0.266	0.264	0.424	0.976	0.040	0.952	0.552	0.583	0.096	0.670	0.847	0.011	0.298	0.438	0.786	0.018	0.624	0.645	0.471	0.857	**0.001**	0.631	0.660	0.889	0.396	0.302
% Climber	0.056	0.076	0.684	0.284	0.290	**< 0.0001**	0.477	**0 < 0.0001**	**0.009**	0.031	0.033	0.155	**< 0.0001**	0.418	0.200	0.343	0.040	0.656	0.394	0.084	**0.000**	0.200	**< 0.0001**	**< 0.0001**	0.013	0.855	0.807	0.256	0.685	0.375	**< 0.0001**	**0.001**	**0.003**	0.327	0.152	0.050	0.541	**< 0.0001**	0.178
Drainage Area	**0.010**	**0.002**	0.494	0.036	0.037	**0.001**	0.045	**< 0.0001**	**0**	**0.003**	0.020	0.069	0.230	**< 0.0001**	0.222	0.277	0.097	**< 0.0001**	0.517	0.648	0.149	**0.000**	0.036	**< 0.0001**	**0.001**	**0.007**	0.378	0.566	**0.010**	0.105	0.604	0.071	**0.007**	0.079	0.586	0.519	0.393	0.477	**0.001**	0.099
Bank Stability, Left	0.084	0.061	0.455	0.026	0.026	0.028	**0.005**	**0.009**	**0.003**	**0 < 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	0.566	0.853	0.360	0.172	0.749	0.208	0.758	0.898	0.244	**0.001**	0.025	0.199	**< 0.0001**	0.639	0.584	0.093	**0.002**	0.659	0.096	0.091	0.396	0.114	0.429	0.179	0.799	0.034	0.575
Bank Stability, Right	0.165	0.050	0.309	0.045	0.043	0.035	0.023	0.031	0.020	**< 0.0001**	**0 < 0.0001**	**< 0.0001**	**< 0.0001**	0.785	0.359	0.140	0.155	0.863	0.339	1.000	0.746	0.310	**0.000**	0.028	0.336	**< 0.0001**	0.951	0.544	0.214	**0.003**	0.939	0.121	0.420	0.605	0.289	0.476	0.297	0.617	0.065	0.926
Vegetative Protection, Left	0.658	0.332	0.189	0.105	0.101	0.011	0.021	0.033	0.069	**< 0.0001**	**< 0.0001**	**0 < 0.0001**	0.850	0.195	0.125	0.045	0.555	0.040	0.077	0.275	0.869	**< 0.0001**	0.131	0.836	**< 0.0001**	0.894	0.090	0.018	**< 0.0001**	0.534	0.353	0.403	0.651	0.453	0.246	0.043	0.096	0.185	0.688
Vegetative Protection, Right	0.979	0.321	0.060	0.139	0.130	0.027	0.086	0.155	0.230	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0**	0.864	0.057	0.019	0.031	0.381	0.040	0.099	0.280	0.789	**< 0.0001**	0.259	0.717	**< 0.0001**	0.501	0.083	0.031	**< 0.0001**	0.792	0.459	0.973	0.858	0.952	0.444	0.146	0.087	0.246	0.272
Channel Flow Status	0.079	0.102	0.342	0.481	0.538	0.021	0.976	**< 0.0001**	**< 0.0001**	0.566	0.785	0.850	0.864	**0**	0.357	0.107	**0.002**	**< 0.0001**	0.468	0.363	0.011	**< 0.0001**	**0.000**	**< 0.0001**	**< 0.0001**	0.647	0.157	0.812	0.038	1.000	0.395	0.140	0.048	0.041	0.336	0.320	0.506	0.206	**0.004**	0.018
Channel Alteration	**0.007**	0.046	0.182	0.734	0.745	0.807	0.266	0.418	0.222	0.853	0.359	0.195	0.057	0.357	**0**	**0.001**	0.117	0.079	0.991	0.311	0.461	0.043	**0.000**	0.050	0.030	0.574	0.102	0.197	0.381	0.020	0.041	0.951	0.577	0.158	0.182	0.021	0.197	0.019	0.699	0.519
Channel Sinuosity	0.145	0.806	**0.001**	0.491	0.500	0.308	0.264	0.200	0.277	0.360	0.140	0.125	0.019	0.107	**0.001**	**0**	**0.006**	**0.005**	0.086	0.822	0.525	**0.002**	**< 0.0001**	0.050	**0.005**	0.197	0.674	**0.009**	0.250	**0.004**	0.097	0.368	0.400	0.590	0.879	0.031	0.046	**0.002**	0.885	0.068
Pool Substrate Characterization	0.127	0.184	0.065	0.229	0.228	0.343	0.424	0.343	0.097	0.172	0.155	0.045	0.031	**0.002**	0.117	**0.006**	**0 < 0.0001**		0.614	1.000	0.223	**< 0.0001**	**< 0.0001**	**0.000**	**< 0.0001**	0.165	0.311	0.366	0.372	0.178	0.703	0.672	0.872	0.786	0.132	0.582	0.800	0.716	0.166	0.306
Pool Variability	0.079	0.041	0.237	0.928	0.927	0.021	0.976	0.040	**< 0.0001**	0.749	0.863	0.555	0.381	**< 0.0001**	0.079	**0.005**	**< 0.0001**	**0**	0.787	0.844	0.229	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	0.750	0.271	0.222	0.048	0.344	0.905	0.657	0.533	0.912	0.183	0.858	0.597	0.170	0.042	0.122
Riparian Zone Width, Left	0.231	0.502	0.504	0.679	0.706	0.679	0.040	0.656	0.517	0.208	0.339	0.040	0.040	0.468	0.991	0.086	0.614	0.787	**0**	**0.000**	0.189	0.714	0.022	0.318	0.576	0.253	0.085	**< 0.0001**	0.782	**0.001**	0.865	0.832	0.949	0.015	0.815	0.775	0.265	0.042	1.000	0.070
Riparian Zone Width, Right	0.853	0.807	0.571	0.602	0.576	0.536	0.952	0.394	0.648	0.758	1.000	0.077	0.099	0.363	0.311	0.822	1.000	0.844	**0.000**	**0**	0.072	0.434	0.235	0.290	0.344	0.854	**0.004**	**< 0.0001**	0.375	0.019	0.761	0.550	0.887	0.478	0.171	0.282	0.086	0.026	0.595	0.062
Sediment Deposition	0.250	0.926	0.346	0.025	0.023	0.316	0.552	0.084	0.149	0.898	0.746	0.275	0.280	0.011	0.461	0.525	0.223	0.229	0.189	0.072	**0**	0.064	0.081	0.010	0.106	0.715	0.203	0.042	0.570	0.177	0.572	0.060	0.098	0.453	0.183	0.183	0.033	0.147	0.211	0.946
Epi. Substrate/Avail. Cover	**0.006**	0.018	0.014	0.809	0.797	0.055	0.583	**0.000**	**0.000**	0.244	0.310	0.869	0.789	**< 0.0001**	0.043	**0.002**	**< 0.0001**	**< 0.0001**	0.714	0.434	0.064	**0 < 0.0001**	**< 0.0001**	**< 0.0001**	0.241	0.937	0.421	0.026	0.029	0.116	0.024	0.177	0.486	0.377	0.671	0.640	0.218	**0.003**	0.032
RBP Score	0.233	0.459	0.014	0.245	0.227	0.694	0.096	0.200	0.036	**0.001**	**0.000**	**< 0.0001**	**< 0.0001**	**0.000**	**0.000**	**< 0.0001**	**< 0.0001**	**< 0.0001**	0.022	0.235	0.081	**< 0.0001**	**0**	**0.001**	**< 0.0001**	**0.000**	0.841	0.016	0.016	**< 0.0001**	0.336	0.370	0.482	0.610	0.234	0.651	0.498	**0.008**	0.144	**0.010**
Instream Habitat	0.011	**0.009**	0.339	0.880	0.904	**0.001**	0.670	**< 0.0001**	**< 0.0001**	0.025	0.028	0.131	0.259	**< 0.0001**	0.050	0.050	**0.000**	**< 0.0001**	0.318	0.290	0.010	**< 0.0001**	**0.001**	**0 < 0.0001**	0.019	0.502	0.966	0.162	0.462	0.553	0.033	0.149	0.530	0.530	0.195	0.263	0.703	**0.001**	0.054
Epibenthic Substrate	**0.003**	0.019	0.029	0.988	0.976	0.045	0.847	**< 0.0001**	**0.001**	0.199	0.336	0.836	0.717	**< 0.0001**	0.030	**0.005**	**< 0.0001**	**< 0.0001**	0.576	0.344	0.106	**< 0.0001**	**< 0.0001**	**< 0.0001**	**0**	0.248	0.986	0.713	0.033	0.050	0.183	0.021	0.140	0.519	0.575	0.455	0.471	0.406	**0.002**	0.053
Bank Stability	0.109	0.052	0.337	0.040	0.038	0.032	0.011	0.013	**0.007**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	0.647	0.574	0.197	0.165	0.750	0.253	0.854	0.715	0.241	**0.000**	0.019	0.248	**0**	0.833	0.513	0.143	**0.003**	0.717	0.090	0.218	0.538	0.191	0.418	0.209	0.655	0.038	0.833
% Shading	0.831	0.376	0.759	0.536	0.485	0.827	0.298	0.855	0.378	0.639	0.951	0.894	0.501	0.157	0.102	0.674	0.311	0.271	0.085	**0.004**	0.203	0.937	0.841	0.502	0.986	0.833	**0**	0.209	0.153	0.034	0.613	0.917	0.448	0.760	0.601	0.708	0.571	0.519	0.052	0.176
Remoteness	0.372	0.069	0.027	0.308	0.300	0.933	0.438	0.807	0.566	0.584	0.544	0.090	0.083	0.812	0.197	**0.009**	0.366	0.222	**< 0.0001**	**< 0.0001**	0.042	0.421	0.016	0.966	0.713	0.513	0.209	**0**	0.436	**< 0.0001**	**0.001**	0.840	0.966	0.121	0.319	**0.002**	**0.004**	**0.007**	0.838	0.478
# Woody Debris/Rootwads	0.100	0.036	**0.009**	0.324	0.346	0.680	0.786	0.256	**0.010**	0.093	0.214	0.018	0.031	0.038	0.381	0.250	0.372	0.048	0.782	0.375	0.570	0.026	0.016	0.162	0.033	0.143	0.153	0.436	**0**	0.109	0.112	0.528	0.596	0.465	0.893	0.687	0.496	0.179	0.587	0.711
PHI Score	0.405	0.435	**0.002**	0.315	0.307	0.273	0.018	0.685	0.105	**0.002**	**0.003**	**< 0.0001**	**< 0.0001**	1.000	0.020	**0.004**	0.178	0.344	**0.001**	0.019	0.177	0.029	**< 0.0001**	0.462	0.050	**0.003**	0.034	**< 0.0001**	0.109	**0**	**0.003**	0.987	0.385	0.601	0.939	0.060	0.032	0.058	0.529	0.413
Conductivity	0.061	0.086	0.015	0.077	0.074	0.393	0.624	0.375	0.604	0.659	0.939	0.534	0.792	0.395	0.041	0.097	0.703	0.905	0.865	0.761	0.572	0.116	0.336	0.553	0.183	0.717	0.613	**0.001**	0.112	**0.003**	**0**	0.639	0.019	0.960	0.887	**< 0.0001**	**< 0.0001**	0.047	0.014	0.067
DO	0.236	0.522	0.111	0.905	0.917	0.349	0.645	**< 0.0001**	0.071	0.096	0.121	0.353	0.459	0.140	0.951	0.368	0.672	0.657	0.832	0.550	0.060	0.024	0.370	0.033	0.021	0.090	0.917	0.840	0.528	0.987	0.639	**0**	0.053	**0.005**	0.030	0.437	0.054	0.834	**0.009**	0.051
PH	0.054	0.249	0.483	0.149	0.180	0.012	0.471	**0.001**	**0.007**	0.091	0.420	0.403	0.973	0.048	0.577	0.400	0.872	0.533	0.949	0.887	0.098	0.177	0.482	0.149	0.140	0.218	0.448	0.966	0.596	0.385	0.019	0.053	**0**	**0.004**	0.076	**0.002**	**0.003**	0.558	**< 0.0001**	**< 0.0001**
Turbidity	0.534	0.429	0.163	0.439	0.483	0.120	0.857	**0.003**	0.079	0.396	0.605	0.651	0.858	0.041	0.158	0.590	0.786	0.912	0.015	0.478	0.453	0.486	0.610	0.530	0.519	0.538	0.760	0.121	0.465	0.601	0.960	**0.005**	**0.004**	**0**	0.327	0.157	0.300	0.028	0.258	**0.000**
Temperature	0.173	0.130	0.646	0.258	0.276	0.031	**0.001**	0.327	0.586	0.114	0.289	0.453	0.952	0.336	0.182	0.879	0.132	0.183	0.815	0.171	0.183	0.377	0.234	0.530	0.575	0.191	0.601	0.319	0.893	0.939	0.887	0.030	0.076	0.327	**0**	0.663	0.694	0.973	0.960	0.973
% Impervious	0.633	0.873	0.113	0.141	0.144	0.189	0.631	0.152	0.519	0.429	0.476	0.246	0.444	0.320	0.021	0.031	0.582	0.858	0.775	0.282	0.183	0.671	0.651	0.195	0.455	0.418	0.708	**0.002**	0.687	0.060	**< 0.0001**	0.437	**0.002**	0.157	0.663	**0 < 0.0001**		**0.005**	**< 0.0001**	0.101
% Developed	0.831	0.567	0.762	0.217	0.233	0.216	0.660	0.050	0.393	0.179	0.297	0.043	0.146	0.506	0.197	0.046	0.800	0.597	0.265	0.086	0.033	0.640	0.498	0.263	0.471	0.209	0.571	**0.004**	0.496	0.032	**< 0.0001**	0.054	**0.003**	0.300	0.694	**< 0.0001**	**0**	**0.001**	**0.000**	0.072
% Forested	0.371	0.256	0.121	0.466	0.474	0.682	0.889	0.541	0.477	0.799	0.617	0.096	0.087	0.206	0.019	**0.002**	0.716	0.170	0.042	0.026	0.147	0.218	**0.008**	0.703	0.406	0.655	0.519	**0.007**	0.179	0.058	0.047	0.834	0.558	0.028	0.973	**0.005**	**0.001**	**0**	0.179	**< 0.0001**
% Open	0.870	0.760	0.377	0.730	0.674	**0.001**	0.396	**< 0.0001**	**0.001**	0.034	0.065	0.185	0.246	**0.004**	0.699	0.885	0.166	0.042	1.000	0.595	0.211	**0.003**	0.144	**0.001**	**0.002**	0.038	0.052	0.838	0.587	0.529	0.014	**0.009**	**< 0.0001**	0.258	0.960	**< 0.0001**	**0.000**	0.179	**0**	**0.003**
% Agriculture	0.603	0.561	0.521	0.917	0.905	0.225	0.302	0.178	0.099	0.575	0.926	0.688	0.272	0.018	0.519	0.068	0.306	0.122	0.070	0.062	0.946	0.032	**0.010**	0.054	0.053	0.833	0.176	0.478	0.711	0.413	0.067	0.051	**< 0.0001**	**0.000**	0.973	0.101	0.072	**< 0.0001**	**0.003**	**0**

Values in bold are different from 0 with a significance level alpha=0.01