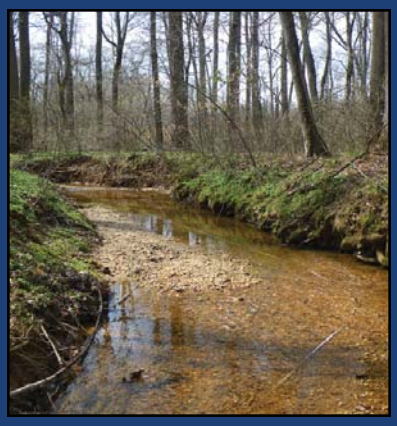

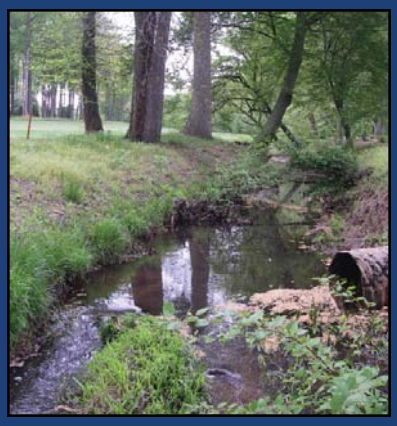

Targeted Biological Assessments of Streams in the Little Patuxent Watershed, Anne Arundel County, Maryland: 2011

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

ANNE ARUNDEL COUNTY MARYLAND

DPW

Targeted Biological Assessment of Streams in the Little Patuxent Watershed, Anne Arundel County, Maryland: 2011

August 2011 - DRAFT

Prepared for:

Anne Arundel County
Department of Public Works
Watershed, Ecosystem, and Restoration Services
Watershed Assessment and Planning Program

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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 Little Patuxent watershed during the Spring of 2011. The targeted assessment focuses on *in situ* water quality, 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 Little Patuxent watershed 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, 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. The Anne Arundel County portion of the Little Patuxent watershed (MDE 8-digit watershed 02131105, Little Patuxent River) encompasses 27,975 acres (43.7 square miles) and contains approximately 163 miles of streams based on the County's planimetric GIS stream data. The watershed covers one primary sampling unit (PSU) defined by the County-wide Monitoring and Assessment strategy, Little Patuxent (PSU-17), which was assessed by the County 2007 and 2009 during Rounds 1 and 2.

The Little Patuxent watershed was subdivided into 21 sub-basins by WAP for targeted site selection. Within these sub-basins, 40 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 29, 2001.

The Little Patuxent watershed is part of Maryland's Patuxent River basin. The Patuxent River basin drains approximately 900 square miles of land, including portions of Anne Arundel, Baltimore, Calvert, Charles, Howard, Prince George's, Montgomery, and St. Mary's Counties, along the Western Shore of the Chesapeake Bay. The basin originates in the Piedmont physiographic province, but the current study area is located in the central portion of the basin, within the Coastal Plain physiographic province. The Little Patuxent watershed study area is made up of numerous 1st order tributaries draining directly to the Little Patuxent River, as well as three large tributaries: Dorsey Run, which originates in Howard County, Rogue Harbor Branch, and Towsers Branch. Figure 1 – Vicinity Map shows the general location of the watershed as well as drainage areas to each sampling point.

1 Methods

The monitoring program includes chemical, physical and biological assessment conducted throughout the Little Patuxent watershed. The sampling methods used are consistent with the Anne

Arundel County Biological Monitoring and Assessment Program and detailed in the Quality Assurance Project Plan (QAPP; Anne Arundel County, 2011). A summary of these methods and the results of the 2011 monitoring are documented 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 in MBSS protocols prior to the 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. MBSS physical habitat assessment parameters were collected for the Little Patuxent watershed. Physical habitat was also assessed using the EPA's Rapid Bioassessment Protocol (RBP) (Barbour et al., 1999) habitat assessment for low-gradient streams.

1.1 Selection of Sampling Sites

The sampling design employed a targeted approach with a total of 40 sites distributed throughout the study area on each of the major stream reaches, covering 21 non-tidal subwatersheds, as shown in Figure 2. A complete list of targeted sites along with the corresponding subwatershed code is displayed in Table 1. The primary goal was to establish adequate spatial coverage of the watershed. Additionally, data from the County-wide random sampling program was used in the site selection process. The watershed was sampled for the County-wide program in 2007 and 2009. The targeted sites were generally selected in the downstream most reaches of the Little Patuxent's tributaries and placed to fill gaps not covered by the County-wide assessment. Where two sites could be placed in one subwatershed, the preference for the second site was in the central portion of the subwatershed. Of the 21 subwatersheds, 18 had two sites, one had three sites (LPH), and only two (LPK and LPB) had one site.

Table 1 – Sampling Sites and Corresponding Subwatersheds

	Site ID	Subwatershed Code
Dorsey Run	LPAX-37-2011	LPI
	LPAX-38-2011	LPI
	LPAX-39-2011	LPJ
	LPAX-40-2011	LPJ
	LPAX-41-2011	LPH
	LPAX-42-2011	LPH
	LPAX-43-2011	LPK
Little Patuxent	LPAX-07-2011	LP1
	LPAX-08-2011	LP1
	LPAX-11-2011	LP2
	LPAX-12-2011	LP2
	LPAX-13-2011	LP3
	LPAX-14-2011	LP3
	LPAX-23-2011	LP5
	LPAX-28-2011	LP5
	LPAX-35-2011	LP6
	LPAX-36-2011	LP6
	LPAX-46-2011	LP4

	Site ID	Subwatershed Code
Rogue Harbor	LPAX-19-2011	LPF
	LPAX-20-2011	LPF
	LPAX-31-2011	LPE
	LPAX-32-2011	LPE
	LPAX-33-2011	LPG
	LPAX-34-2011	LPG
Towsers Branch	LPAX-05-2011	LPD
	LPAX-06-2011	LPD
	LPAX-09-2011	LPC
	LPAX-17-2011	LPB
	LPAX-18-2011	LPB
Unnamed Tributary	LPAX-01-2011	LPA
	LPAX-02-2011	LPA
	LPAX-03-2011	LPM
	LPAX-04-2011	LPM
	LPAX-15-2011	LPL
	LPAX-16-2011	LPL
	LPAX-24-2011	LPO
	LPAX-25-2011	LPO
	LPAX-26-2011	LPO
	LPAX-29-2011	LPN
	LPAX-30-2011	LPN

Figure 1 – Study Area Vicinity Map

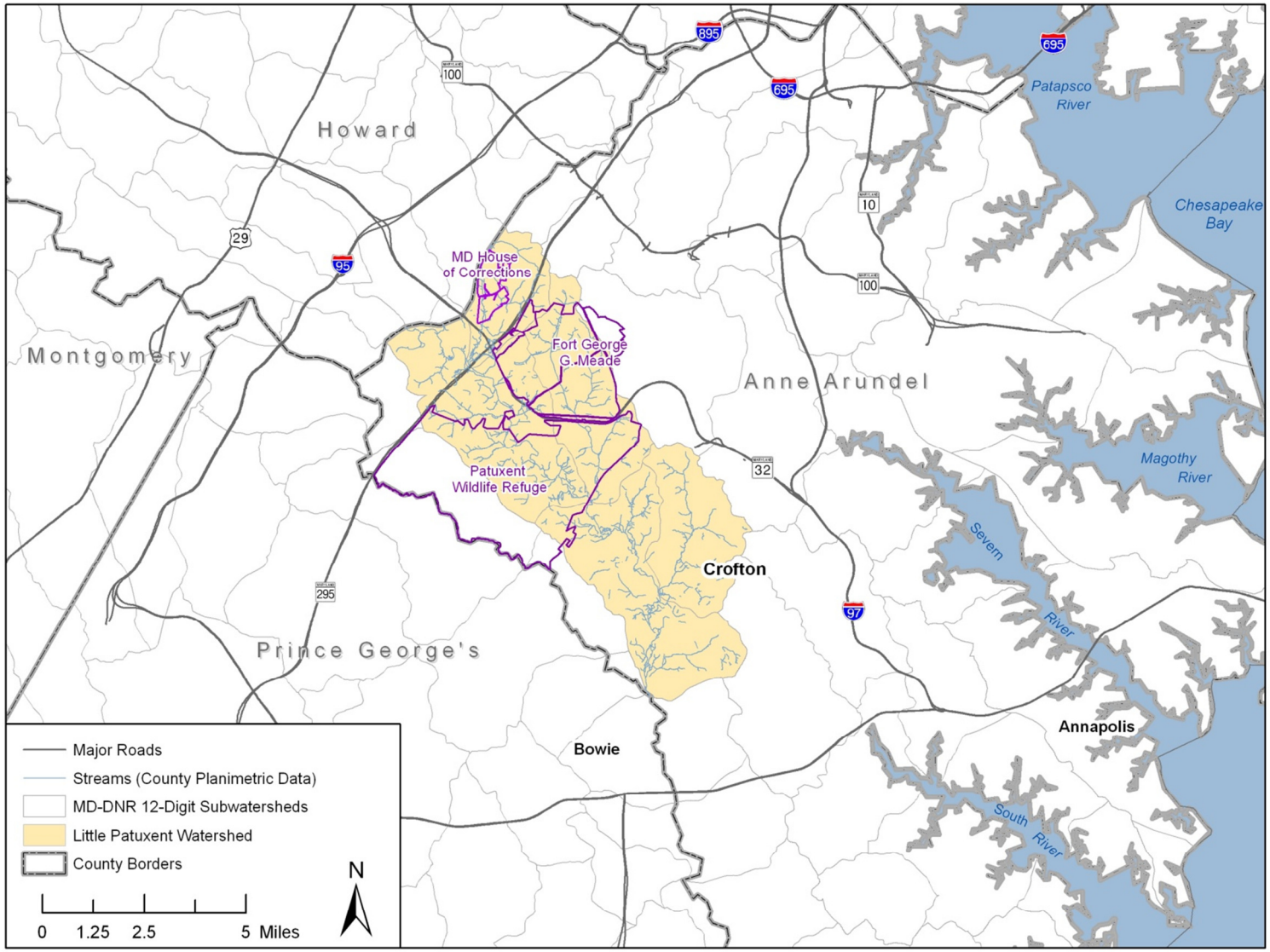
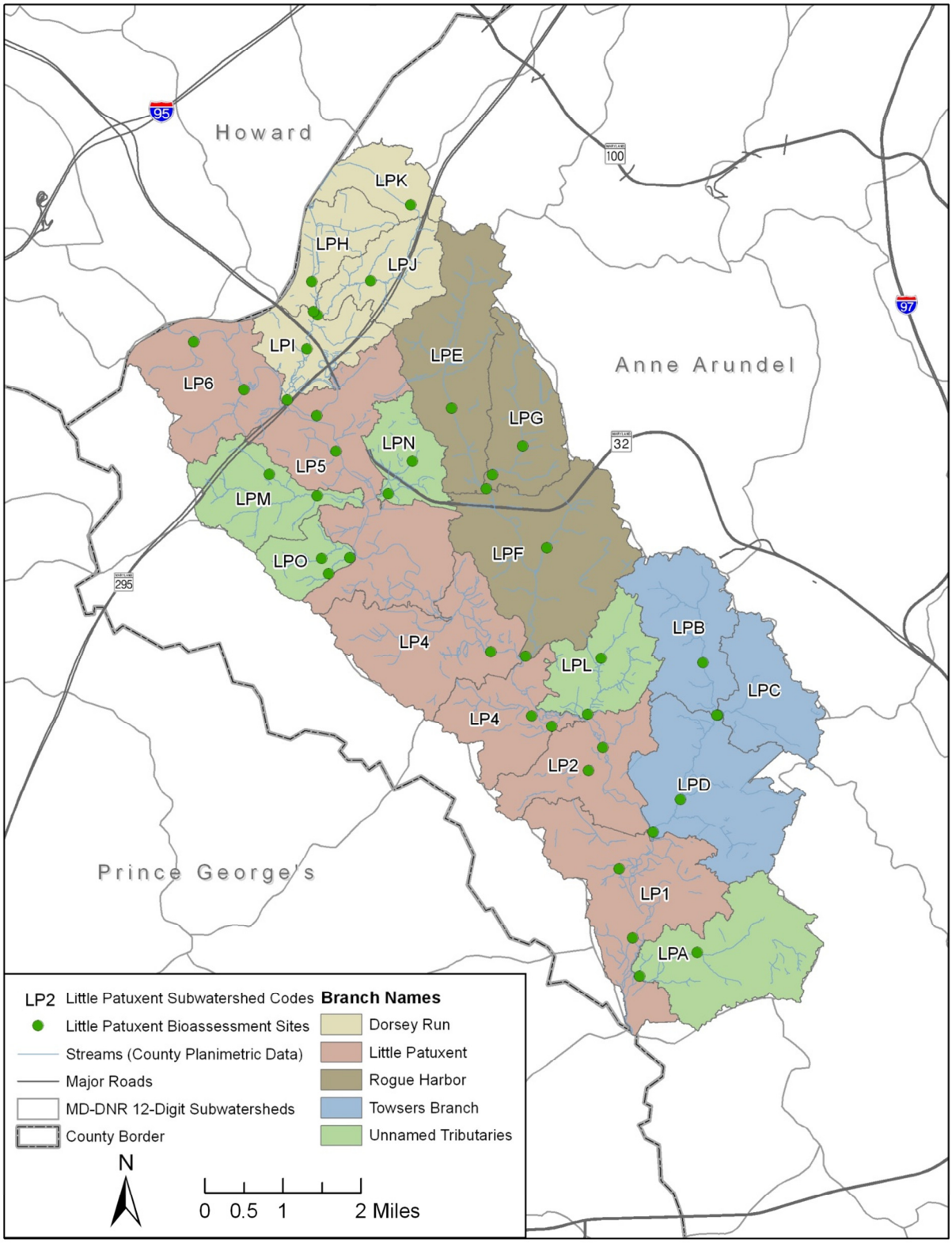


Figure 2 – Little Patuxent Subwatershed Map



If the stream channel at the selected site was found to be unfit for sampling during the field visit, the site was moved to another sampleable reach either on the same stream, or in an adjacent sub-basin, 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 resulted in several of the initially selected sites being shifted slightly to facilitate sampling. Once in the field, it was determined that several additional targeted sites were unable to be sampled, 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 (four 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 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 1-m satellite imagery during leaf-off conditions and 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. Four sampling locations (LPAX-37, 38, 41, and 42) include drainage areas that extend into Howard County. To calculate imperviousness for those four sampling locations, Howard County's vector polygon dataset of impervious land cover from 2006 was used in addition to the Anne Arundel County dataset.

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

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 QAPP (Anne Arundel County, 2011). Field measured water chemistry parameters include pH, specific conductivity, dissolved oxygen, 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 dissolved oxygen) were measured using a multiparameter sonde (YSI Professional Plus or YSI 650), 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 assess the physical habitat 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	Classification Scoring	Narrative Rating
≥151	≥151	Comparable to Reference
126-150	126-150	Supporting
101-125	101-125	Partially Supporting
≤100	0-100	Non Supporting

The PHI incorporates the results of a series of habitat parameters selected for Coastal Plain, Piedmont and Highlands regions. While all parameters are rated during the field assessment, the Coastal Plain parameters are used to develop the PHI score. In developing the PHI, MBSS identified six parameters that have the most discriminatory power for the coastal plain streams. These parameters are used in calculating the PHI (Table 4). 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 these scores yields the final 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 site. Benthic macroinvertebrate collection follows the QAPP which closely mirrors MBSS procedures (DNR, 2010). The monitoring sites consist of a 75-meter sampling reach, and benthic macroinvertebrate sampling is conducted during the spring index period (March 1st to May 1st). The sampling methods utilize systematic field collections of the benthic macroinvertebrate community. The multi-habitat D-frame net approach is used to sample a range of the most productive habitat types present within the reach. In this sampling approach, a total of twenty jabs 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. For sites with a final count of greater than 120 organisms identified, a post-processing subsampling procedure was conducted using an Excel spreadsheet application (Tetra Tech, 2006). This post-processing application is designed to randomly subsample all identified organisms within a given sample to a desired target number. Each taxon is subsampled based on its original proportion to the entire sample. In this case, the desired sample size selected was 110 individuals. This allows for a final sample size of approximately 110 individuals (±20 percent) but keeps the total number of individuals below the 120 maximum.

Identification of the subsampled specimens is conducted by Environmental Services and Consulting, LLC[2]. Taxa are identified to the genus level for most organisms. Groups including Oligochaeta and Nematomorpha are identified to the family level while Nematoda is left at phylum. Individuals of early instars or those that may be damaged are identified to the lowest possible level, which could be phylum or order, but in most cases would be family. Chironomidae can be further subsampled depending on the number of individuals in the sample and the numbers in each subfamily or tribe. Most taxa are identified using a stereoscope. Temporary slide mounts are used to identify Oligochaeta to family with a compound scope. Chironomid sorting to subfamily and tribe is also conducted using temporary slide mounts. Permanent slide mounts are then used for final genus level identification. Results are logged on a bench sheet and entered into a spreadsheet for analysis.

1.5.2 Biological Data Analysis

Benthic macroinvertebrate data was 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 are given a score of 1, 3 or 5 based on ranges of values developed for each metric as shown in Table 6. The results are combined into a scaled BIBI score ranging from 1.0 to 5.0 and a corresponding narrative rating is assigned (Table 7). Three sets of metric calculations have been developed for Maryland streams based on broad physiographic regions. These include the coastal plain, piedmont and combined highlands regions, divided by the Fall Line. The current study area is located within the coastal plain region. The following metrics and BIBI scoring were used for the analysis.

[2] Address: 101 Professional Park Drive, STE 303, Blacksburg, VA

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.

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 heavily 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

2 Results

Biological monitoring was conducted at a total of 40 sites between April 4 and April 29, 2011. Additionally, four biological duplicate QC samples were collected immediately upstream of sites LPAX-05, LPAX-18, LPAX-24 and LPAX-36. Presented below are the summary results for each assessment site. For site-specific bioassessment data and results, refer to Appendix A. Maps of the Little Patuxent watershed 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 ranged from 89.3 acres at site LPAX-43, to 8053.5 acres at site LPAX-37, the most downstream site on Dorsey Run. The median watershed size for the study area is 736.7 acres, with 42.5 percent of sites less than 500 acres. Imperviousness ranged from a low of 0.2 percent at LPAX-46, located in the Patuxent Wildlife Refuge, to a high of 46.6 percent at LPAX-35. The average imperviousness for the 40 sites in the study area is 17.9 percent. The distribution of percent imperviousness among sampling sites shows the highest frequency in the ≤10 percent range; however, the frequency remains fairly consistent through 40 percent imperviousness before dropping off at >40 percent (Figure 3).

Table 8 – Drainage Area and Imperviousness

Site	Date Sampled	Drainage Area (acres)	Impervious Area (acres)	Impervious Percent
LPAX-01-2011	4/25/2011	1615.9	534.6	33.1
LPAX-02-2011	4/27/2011	1131.3	355.9	31.5
LPAX-03-2011	4/19/2011	985.2	103.2	10.5
LPAX-04-2011	4/19/2011	176.4	55.0	31.2
LPAX-05-2011	4/25/2011	4247.6	972.9	22.9
LPAX-06-2011	4/29/2011	3431.4	685.1	20.0
LPAX-07-2011	4/27/2011	105.1	1.6	1.5
LPAX-08-2011	4/27/2011	169.5	2.8	1.7
LPAX-09-2011	4/25/2011	1001.1	137.7	13.8
LPAX-11-2011	4/29/2011	365.7	6.5	1.8
LPAX-12-2011	4/29/2011	277.2	15.8	5.7
LPAX-13-2011	4/29/2011	798.2	25.2	3.2
LPAX-14-2011	4/29/2011	385.1	16.1	4.2
LPAX-15-2011	4/29/2011	701.0	208.3	29.7
LPAX-16-2011	4/29/2011	240.7	65.4	27.1
LPAX-17-2011	4/25/2011	1329.9	324.2	24.4
LPAX-18-2011	4/27/2011	969.7	244.3	25.2

Site	Date Sampled	Drainage Area (acres)	Impervious Area (acres)	Impervious Percent
LPAX-19-2011	4/22/2011	5387.6	1062.7	19.7
LPAX-20-2011	4/27/2011	772.7	130.2	16.8
LPAX-23-2011	4/19/2011	117.7	15.9	13.5
LPAX-24-2011	4/22/2011	146.3	2.5	1.7
LPAX-25-2011	4/22/2011	208.3	1.3	0.6
LPAX-26-2011	4/22/2011	101.4	1.4	1.4
LPAX-28-2011	4/19/2011	407.3	147.3	36.2
LPAX-29-2011	4/19/2011	124.2	46.5	37.5
LPAX-30-2011	4/18/2011	123.2	27.4	22.2
LPAX-31-2011	4/18/2011	1905.3	382.7	20.1
LPAX-32-2011	4/18/2011	1380.7	249.1	18.0
LPAX-33-2011	4/18/2011	1082.5	259.6	24.0
LPAX-34-2011	4/18/2011	789.6	173.3	21.9
LPAX-35-2011	4/29/2011	412.8	192.3	46.6
LPAX-36-2011	4/29/2011	374.7	7.4	2.0
LPAX-37-2011	4/27/2011	8053.5	2194.2	27.2
LPAX-38-2011	4/27/2011	7561.8	2136.3	28.3
LPAX-39-2011	4/4/2011	872.9	103.8	11.9
LPAX-40-2011	4/4/2011	535.0	58.7	11.0
LPAX-41-2011	4/4/2011	6320.6	1925.0	30.5
LPAX-42-2011	4/27/2011	5994.4	1811.2	30.2
LPAX-43-2011	4/4/2011	89.3	7.9	8.8
LPAX-46-2011	4/27/2011	595.5	1.0	0.2
Duplicate Sites for QC				
LPAX-05-2011QC	4/25/2011	4246.9	972.9	22.9
LPAX-18-2011QC	4/27/2011	946.3	235.7	24.9
LPAX-24-2011QC	4/22/2011	134.2	1.4	1.1
LPAX-36-2011QC	4/29/2011	372.3	7.4	2.0

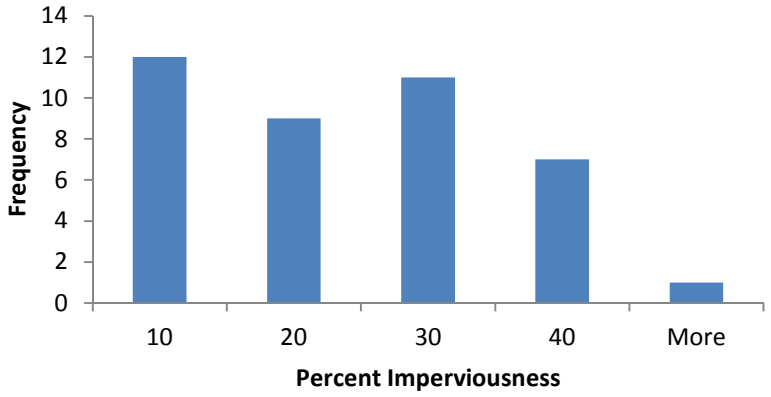
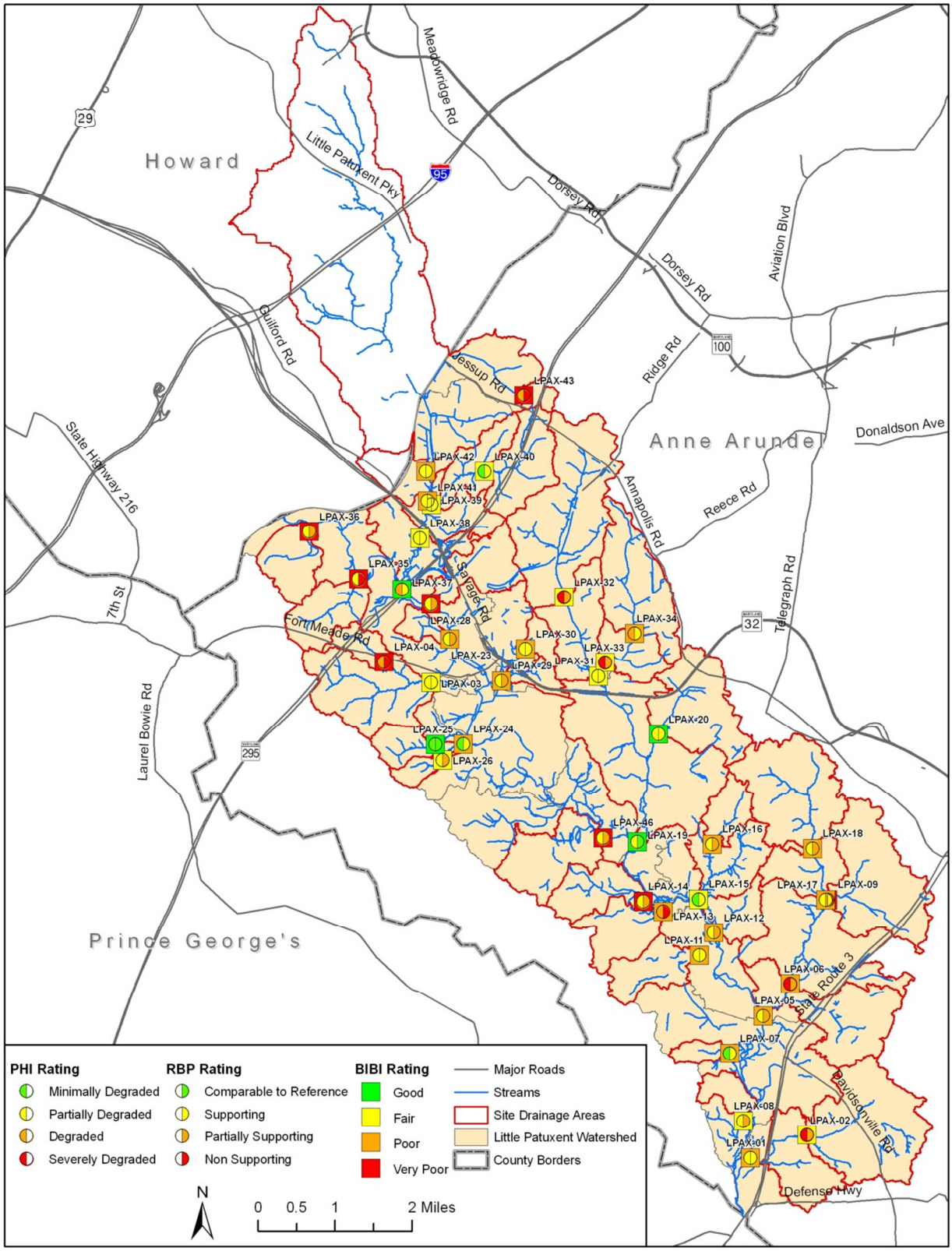


Figure 3 – Histogram showing the distribution of percent imperviousness for 40 targeted sites in the Little Patuxent watershed.

Figure 4 – Bioassessment Results Map



2.2 Water Quality

Instream water quality sampling was conducted in conjunction with macroinvertebrate sampling and occurred between April 4 and April 29, 2011. 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 Little Patuxent watershed is listed in *COMAR* in Sub-Basin 02-13-11: Patuxent River Area. The Little Patuxent River and all Tributaries above Old Forge Bridge (1 mile south of MD Route 198) are designated as Use I-P streams. Specific designated uses for Use I-P streams include water contact sports, fishing, the growth and propagation of fish, agricultural water supply, industrial water supply, and public water supply. The remaining portions of the Little Patuxent watershed 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 and I-P 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 Nephelometer 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 and I-P 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 17 sites with pH values recorded below the acceptable limit of 6.5. In addition, there were five sites with dissolved oxygen 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 µg/l for Maryland streams. A total of 24 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 (µS/cm)
LPAX-01-2011	6.43	19.17	9.70	7.38	249
LPAX-02-2011	5.40	19.11	6.88	6.97	306
LPAX-03-2011	6.89	12.47	9.97	8.66	190
LPAX-04-2011	7.00	13.40	8.23	19.10	438
LPAX-05-2011	6.12	20.47	9.62	25.50	320
LPAX-06-2011	6.15	14.83	8.76	6.92	297
LPAX-07-2011	6.29	18.60	7.78	6.77	106
LPAX-08-2011	6.65	18.38	0.99	12.30	231
LPAX-09-2011	5.67	24.50	8.33	34.80	174
LPAX-11-2011	5.72	15.02	1.32	9.65	72
LPAX-12-2011	6.18	15.36	9.40	28.70	122
LPAX-13-2011	6.46	16.57	4.69	21.20	142
LPAX-14-2011	6.69	16.87	5.12	12.40	120
LPAX-15-2011	6.64	15.35	8.66	2.76	301
LPAX-16-2011	6.23	15.17	8.94	3.17	394
LPAX-17-2011	5.76	19.42	9.51	11.30	179
LPAX-18-2011	5.77	19.38	6.84	8.04	243
LPAX-19-2011	7.03	12.30	10.50	7.40	425
LPAX-20-2011	7.14	21.37	7.22	8.87	620
LPAX-23-2011	6.68	13.63	5.18	25.00	357
LPAX-24-2011	4.89	10.00	8.93	3.89	50
LPAX-25-2011	5.82	10.07	10.73	3.96	52
LPAX-26-2011	5.20	10.40	4.85	4.52	41
LPAX-28-2011	7.90	14.33	11.03	9.10	614
LPAX-29-2011	6.55	11.57	7.09	7.72	709
LPAX-30-2011	6.44	12.97	8.75	3.84	236
LPAX-31-2011	6.93	11.30	10.06	16.40	335
LPAX-32-2011	6.71	12.90	10.09	13.60	305
LPAX-33-2011	7.15	15.00	8.27	28.90	430
LPAX-34-2011	6.80	12.87	7.81	28.00	322
LPAX-35-2011	7.15	14.97	6.67	4.54	700
LPAX-36-2011	6.68	15.57	2.43	36.00	169
LPAX-37-2011	7.36	20.80	10.31	4.69	540
LPAX-38-2011	7.34	21.10	10.77	6.32	550
LPAX-39-2011	7.16	11.33	10.33	14.60	428
LPAX-40-2011	7.15	13.87	10.69	4.87	363
LPAX-41-2011	7.63	12.93	12.86	4.38	651
LPAX-42-2011	7.39	21.50	10.34	6.97	603
LPAX-43-2011	7.26	8.47	10.21	7.79	758
LPAX-46-2011	5.96	21.00	5.09	9.09	54
Study Mean	*6.56*	*15.61*	*8.12*	*12.15*	*330*
Standard Deviation	*0.69*	*3.88*	*2.70*	*9.25*	*204*
Duplicate Sites for QC					
LPAX-05-2011QC	6.93	21.17	9.65	25.50	318
LPAX-18-2011QC	6.27	19.52	6.34	8.25	242

Site	pH	Temperature (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Conductivity (µS/cm)
LPAX-24-2011QC	4.97	10.05	7.56	4.33	49
LPAX-36-2011QC	6.62	15.77	1.51	45.60	164

2.3 Physical Habitat Assessment

The results of the RBP and PHI habitat assessments are presented in Table 10. The percent comparability to RBP reference scores ranged from 50 percent at site LPAX-43 to a high of 91.7 percent at site LPAX-25. Overall, two sites (5 percent) were classified as 'Comparable to Reference.' Seventeen sites (42.5 percent) were rated as 'Supporting' and sixteen (40 percent) were rated as 'Partially Supporting.' There were also five sites that received the lowest possible rating of 'Non Supporting'. The lowest PHI score of 44.32 was recorded at LPAX-02 while the highest score, 97.69 was recorded at LPAX-25 within the Patuxent Wildlife Refuge. Six sites were rated as 'Degraded' and 25 sites were rated as 'Partially Degraded.' There were five sites in the watershed that received the highest classification of 'Minimally Degraded', and four sites receiving the lowest classification of 'Severely Degraded'.

Distributions of selected RBP metric values were plotted and examined for normality (Figure 5 (a – f)). Two metrics, Pool Variability and Sediment Deposition, Number of Taxa, showed a normal distribution with the majority of sites scoring in the 'Marginal' range (Figure 5 - b and f, respectively). Epifaunal Substrate/Available Cover and Pool Substrate Characterization metrics both have bimodal distributions with peaks in the 'Marginal' and 'Suboptimal' ranges (Figure 5 - a and d, 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 5 - c and e, respectively). For instance, nearly three-quarters all sites (29 sites) 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
LPAX-01-2011	135	80.36	Supporting	77.80	Partially Degraded
LPAX-02-2011	106	63.10	Partially Supporting	44.32	Severely Degraded
LPAX-03-2011	134	79.76	Supporting	78.84	Partially Degraded
LPAX-04-2011	92	54.76	Non Supporting	57.92	Degraded
LPAX-05-2011	118	70.24	Partially Supporting	66.41	Partially Degraded
LPAX-06-2011	111	66.07	Partially Supporting	47.46	Severely Degraded
LPAX-07-2011	141	83.93	Supporting	88.68	Minimally Degraded
LPAX-08-2011	114	67.86	Partially Supporting	75.05	Partially Degraded
LPAX-09-2011	97	57.74	Non Supporting	53.37	Degraded
LPAX-11-2011	141	83.93	Supporting	66.61	Partially Degraded
LPAX-12-2011	111	66.07	Partially Supporting	67.87	Partially Degraded
LPAX-13-2011	100	59.52	Non Supporting	62.98	Degraded
LPAX-14-2011	124	73.81	Partially Supporting	75.88	Partially Degraded
LPAX-15-2011	132	78.57	Supporting	82.71	Minimally Degraded
LPAX-16-2011	120	71.43	Partially Supporting	79.19	Partially Degraded
LPAX-17-2011	128	76.19	Supporting	67.01	Partially Degraded
LPAX-18-2011	118	70.24	Partially Supporting	77.42	Partially Degraded
LPAX-19-2011	151	89.88	Comparable to Reference	73.63	Partially Degraded
LPAX-20-2011	134	79.76	Supporting	73.57	Partially Degraded
LPAX-23-2011	117	69.64	Partially Supporting	78.12	Partially Degraded
LPAX-24-2011	144	85.71	Supporting	86.01	Minimally Degraded
LPAX-25-2011	154	91.67	Comparable to Reference	97.69	Minimally Degraded
LPAX-26-2011	120	71.43	Partially Supporting	71.92	Partially Degraded
LPAX-28-2011	114	67.86	Partially Supporting	76.59	Partially Degraded
LPAX-29-2011	125	74.40	Partially Supporting	77.96	Partially Degraded
LPAX-30-2011	127	75.60	Supporting	67.50	Partially Degraded
LPAX-31-2011	135	80.36	Supporting	69.29	Partially Degraded
LPAX-32-2011	103	61.31	Partially Supporting	46.98	Severely Degraded
LPAX-33-2011	122	72.62	Partially Supporting	49.74	Severely Degraded
LPAX-34-2011	131	77.98	Supporting	59.79	Degraded
LPAX-35-2011	94	55.95	Non Supporting	66.23	Partially Degraded
LPAX-36-2011	114	67.86	Partially Supporting	71.62	Partially Degraded
LPAX-37-2011	138	82.14	Supporting	64.28	Degraded
LPAX-38-2011	144	85.71	Supporting	68.96	Partially Degraded
LPAX-39-2011	128	76.19	Supporting	75.17	Partially Degraded
LPAX-40-2011	134	79.76	Supporting	81.70	Minimally Degraded
LPAX-41-2011	138	82.14	Supporting	71.97	Partially Degraded
LPAX-42-2011	141	83.93	Supporting	67.54	Partially Degraded
LPAX-43-2011	84	50.00	Non Supporting	59.05	Degraded
LPAX-46-2011	111	66.07	Partially Supporting	67.30	Partially Degraded
Study Mean	*123*	*73.3*	*Partially Supporting*	*69.8*	*Partially Degraded*
Standard Deviation	*17*	*10.0*	--	*11.5*	--
Duplicate Sites for QC					
LPAX-05-2011QC	118	70.24	Partially Supporting	65.32	Degraded
LPAX-18-2011QC	133	79.17	Supporting	79.97	Partially Degraded
LPAX-24-2011QC	138	82.14	Supporting	86.12	Minimally Degraded
LPAX-36-2011QC	123	73.21	Partially Supporting	73.02	Partially Degraded

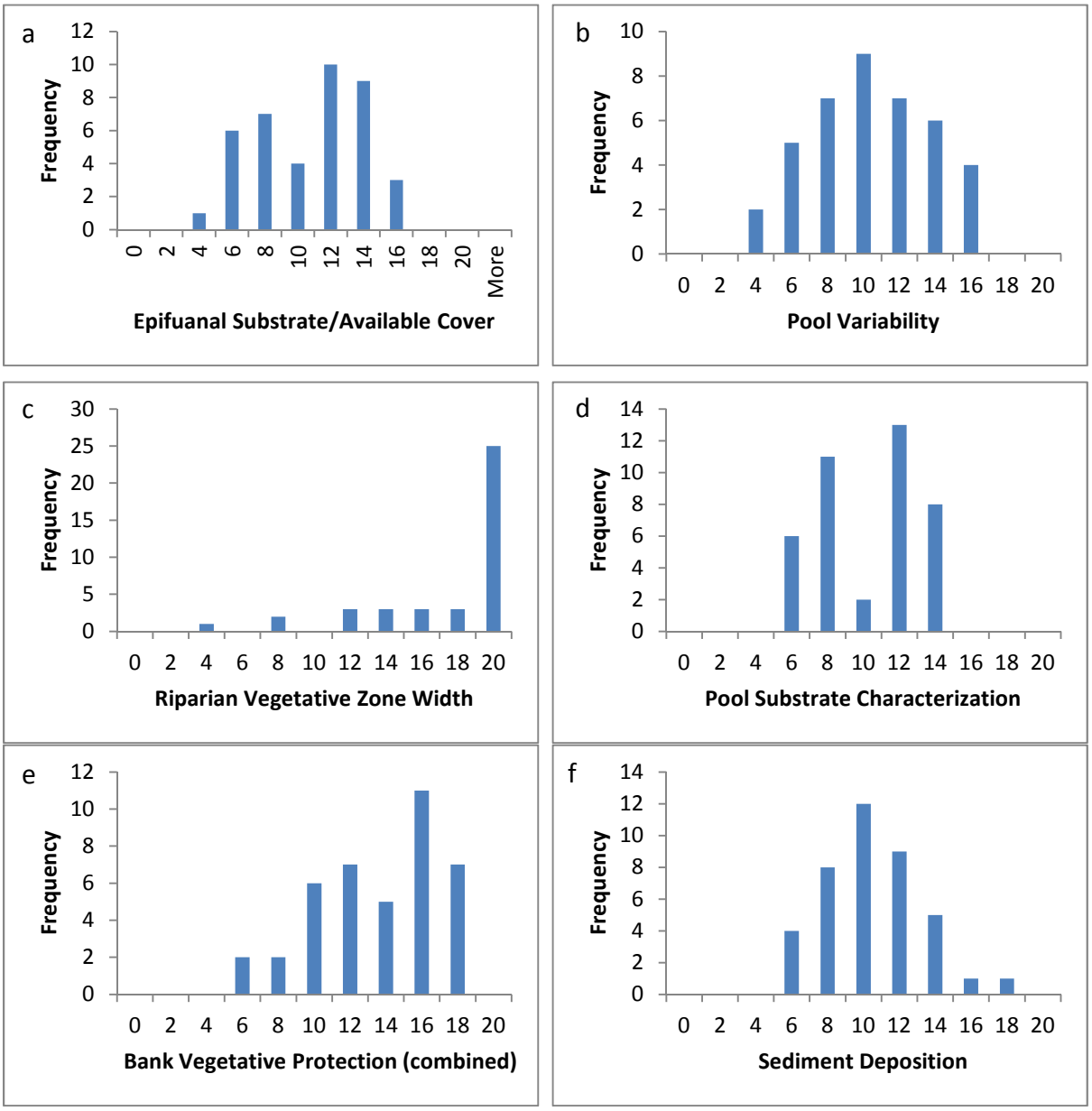


Figure 5 (a-f) – Histograms showing distributions of selected RBP metric values for 40 targeted sites in the Little Patuxent watershed.

2.4 Benthic Macroinvertebrates

The BIBI scores and corresponding narrative ratings for each site are presented in Table 11. Individual BIBI scores ranged from a low of 1.29 and narrative rating of 'Very Poor' at site LPAX-9 to a high of 4.43 and a rating of 'Good' at site LPAX-25. The average BIBI score for the 40 targeted sites was 2.74 ('Poor'), with a standard deviation of 0.77.

Overall, the majority of sites were rated as either 'Poor' (42.5 percent) or 'Fair' (27.5 percent). Additionally, there were eight sites (20 percent) rated as 'Very Poor,' and four sites (10 percent) rated as 'Good.'

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

Site	BIBI Score	Narrative Rating
LPAX-01-2011	2.71	Poor
LPAX-02-2011	3.29	Fair
LPAX-03-2011	3.00	Fair
LPAX-04-2011	1.57	Very Poor
LPAX-05-2011	2.43	Poor
LPAX-06-2011	2.43	Poor
LPAX-07-2011	2.71	Poor
LPAX-08-2011	3.29	Fair
LPAX-09-2011	1.29	Very Poor
LPAX-11-2011	2.14	Poor
LPAX-12-2011	2.14	Poor
LPAX-13-2011	2.71	Poor
LPAX-14-2011	1.86	Very Poor
LPAX-15-2011	3.29	Fair
LPAX-16-2011	2.71	Poor
LPAX-17-2011	2.71	Poor
LPAX-18-2011	2.71	Poor
LPAX-19-2011	4.14	Good
LPAX-20-2011	4.14	Good
LPAX-23-2011	2.71	Poor
LPAX-24-2011	2.43	Poor
LPAX-25-2011	4.43	Good
LPAX-26-2011	3.00	Fair
LPAX-28-2011	1.57	Very Poor
LPAX-29-2011	2.14	Poor
LPAX-30-2011	2.71	Poor
LPAX-31-2011	3.00	Fair
LPAX-32-2011	3.00	Fair
LPAX-33-2011	3.57	Fair
LPAX-34-2011	2.71	Poor
LPAX-35-2011	1.86	Very Poor
LPAX-36-2011	1.57	Very Poor
LPAX-37-2011	4.14	Good
LPAX-38-2011	3.86	Fair
LPAX-39-2011	3.00	Fair
LPAX-40-2011	3.57	Fair

Site	BIBI Score	Narrative Rating
LPAX-41-2011	2.43	Poor
LPAX-42-2011	2.71	Poor
LPAX-43-2011	1.86	Very Poor
LPAX-46-2011	1.86	Very Poor
Study Mean	2.74	*Poor*
Standard Deviation	0.77	--
Duplicate Sites for QC		
LPAX-05-2011QC	2.14	Poor
LPAX-18-2011QC	2.71	Poor
LPAX-24-2011QC	2.14	Poor
LPAX-36-2011QC	1.57	Very Poor

Distributions of individual BIBI metric values were plotted and examined for normality (Figure 6 (a – g)). Only one metric, Number of Taxa, approximated a normal distribution (Figure 6 (a)). The remaining six metrics had distributions that were skewed towards low values, especially metrics involving sensitive taxa such as Number of Ephemeroptera, Percent Ephemeroptera, and Percent Intolerant Urban (Figure 6 (c - e)).

An analysis of the percent abundance and percent occurrence was completed and the results of the top 30 taxa are shown in Tables Table 12 and Table 13, respectively. *Orthocladius*, a tolerant midge, was the most commonly collected genus making up over 15 percent of the total collected individuals. Of the top 30 taxa by percent abundance, 18 (60 percent) were in the family Chironomidae (midges).

The tolerant chironomids, *Orthocladius* and *Polypedilum* were found at 33 (82.5 percent) and 29 (72.5 percent) of sampling sites, respectively. One intolerant isopod, *Caecidotea* (Tolerance value = 2.6) was found at 13 sites (32.5 percent). By percent occurrence, chironomids (midges) make up over half (60 percent) of the top 30 taxa.

As shown in Table 12 and Table 13, members of the family Chironomidae were dominant throughout the watershed. 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 LPAX-28 contained the highest percentage of chironomids (92 percent) followed by LPAX-40 (89 percent) and LPAX-06 (88 percent). The lowest percentage was found at LPAX-11, with only 9 individuals (8 percent).

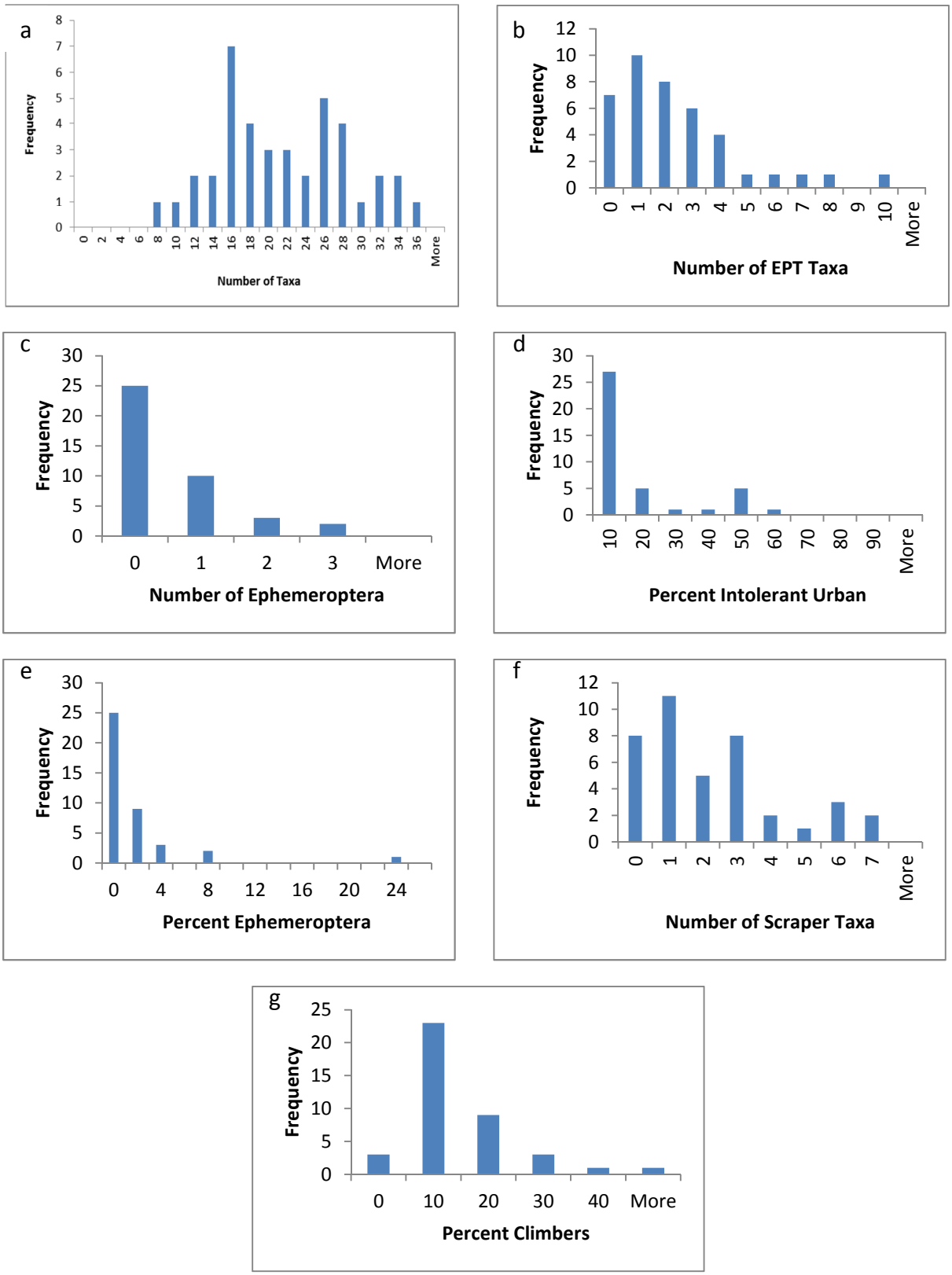


Figure 6 (a-g) – Histograms showing distributions of individual BIBI metric values for 40 targeted sites in the Little Patuxent watershed.

Table 12 – Percent Abundance (by top 30 taxa)

Final Identification	Order	Family	Functional Feeding Group	Habit[1]	Tolerance Value	Total Number of Individuals	Percent of collected individuals
Orthocladius	Diptera	Chironomidae	Collector	sp	9.2	656	15.5
Naididae	Haplotaxida	Naididae	Collector	bu	8.5	272	6.4
Polypedilum	Diptera	Chironomidae	Shredder	cb	6.3	199	4.7
Caecidotea	Isopoda	Asellidae	Collector	sp	2.6	193	4.6
Tubificidae	Haplotaxida	Tubificidae	Collector	cn	8.4	150	3.6
Parametriocnemus	Diptera	Chironomidae	Collector	sp	4.6	140	3.3
Stegopterna	Diptera	Simuliidae	Filterer	cn	2.4	128	3.0
Crangonyx	Amphipoda	Crangonyctidae	Collector	sp	6.7	127	3.0
Chironomus	Diptera	Chironomidae	Collector	bu	4.6	123	2.9
Stenelmis	Coleoptera	Elmidae	Scraper	cn	7.1	118	2.8
Musculium	Veneroida	Sphaeriidae	Filterer	na	5.5	99	2.3
Orthocladiinae	Diptera	Chironomidae	Collector	bu	7.6	98	2.3
Simulium	Diptera	Simuliidae	Filterer	cn	5.7	98	2.3
Cricotopus	Diptera	Chironomidae	Shredder	cn	9.6	87	2.1
Hydrobaenus	Diptera	Chironomidae	Scraper	sp	7.2	80	1.9
Tanytarsus	Diptera	Chironomidae	Filterer	cb	4.9	76	1.8
Tvetenia	Diptera	Chironomidae	Collector	sp	5.1	70	1.7
Rheotanytarsus	Diptera	Chironomidae	Filterer	cn	7.2	68	1.6
Chaetocladius	Diptera	Chironomidae	Collector	sp	7	55	1.3
Chironomini	Diptera	Chironomidae	Collector	bu	5.9	52	1.2
Thienemannimyia group	Diptera	Chironomidae	Predator	sp	8.2	51	1.2
Rheocricotopus	Diptera	Chironomidae	Collector	sp	6.2	48	1.1
Cheumatopsyche	Trichoptera	Hydropsychidae	Filterer	cn	6.5	46	1.1
Ancyronyx	Coleoptera	Elmidae	Scraper	cn	7.8	44	1.0
Amphinemura	Plecoptera	Nemouridae	Shredder	sp	3	41	1.0
Diplocladius	Diptera	Chironomidae	Collector	sp	5.9	38	0.9
Thienemanniella	Diptera	Chironomidae	Collector	sp	5.1	37	0.9
Brillia	Diptera	Chironomidae	Shredder	bu	7.4	36	0.9
Eukiefferiella	Diptera	Chironomidae	Collector	sp	6.1	33	0.8
Caenis	Ephemeroptera	Caenidae	Collector	sp	2.1	32	0.8

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]	Tolerance Value	Number of sites present	Percent of sites present
Orthocladius	Diptera	Chironomidae	Collector	sp	9.2	33	82.5
Polypedilum	Diptera	Chironomidae	Shredder	cb	6.3	29	72.5
Chironomini	Diptera	Chironomidae	Collector	bu	5.9	23	57.5
Tubificidae	Haplotaxida	Tubificidae	Collector	cn	8.4	23	57.5
Naididae	Haplotaxida	Naididae	Collector	bu	8.5	22	55.0
Cricotopus	Diptera	Chironomidae	Shredder	cn	9.6	20	50.0
Thienemanniella	Diptera	Chironomidae	Collector	sp	5.1	20	50.0
Chironomidae	Diptera	Chironomidae	Collector	na	6.6	19	47.5
Parametriocnemus	Diptera	Chironomidae	Collector	sp	4.6	19	47.5
Thienemannimyia group	Diptera	Chironomidae	Predator	sp	8.2	19	47.5
Hydrobaenus	Diptera	Chironomidae	Scraper	sp	7.2	18	45.0
Simulium	Diptera	Simuliidae	Filterer	cn	5.7	18	45.0
Tanytarsus	Diptera	Chironomidae	Filterer	cb	4.9	18	45.0
Tvetenia	Diptera	Chironomidae	Collector	sp	5.1	18	45.0
Stenelmis	Coleoptera	Elmidae	Scraper	cn	7.1	17	42.5
Chironomus	Diptera	Chironomidae	Collector	bu	4.6	16	40.0
Rheotanytarsus	Diptera	Chironomidae	Filterer	cn	7.2	16	40.0
Cheumatopsyche	Trichoptera	Hydropsychidae	Filterer	cn	6.5	15	37.5
Enchytraeidae	Haplotaxida	Enchytraeidae	Collector	bu	9.1	14	35.0
Bezzia/Palpomyia	Diptera	Ceratopogonidae	Predator	sp	3.6	13	32.5
Caecidotea	Isopoda	Asellidae	Collector	sp	2.6	13	32.5
Chaetocladius	Diptera	Chironomidae	Collector	sp	7.0	13	32.5
Eukiefferiella	Diptera	Chironomidae	Collector	sp	6.1	13	32.5
Brillia	Diptera	Chironomidae	Shredder	bu	7.4	12	30.0
Crangonyx	Amphipoda	Crangonyctidae	Collector	sp	6.7	11	27.5
Rheocricotopus	Diptera	Chironomidae	Collector	sp	6.2	11	27.5
Ancyronyx	Coleoptera	Elmidae	Scraper	cn	7.8	10	25.0
Calopteryx	Odonata	Calopterygidae	Predator	cb	8.3	10	25.0
Ironoquia	Trichoptera	Limnephilidae	Shredder	sp	4.9	10	25.0
Lumbricina	Haplotaxida	not identified	Collector	bu	10.0	10	25.0
Orthocladius	Diptera	Chironomidae	Collector	sp	9.2	33	82.5
Orthocladiinae	Diptera	Chironomidae	Collector	bu	7.6	32	80.0
Polypedilum	Diptera	Chironomidae	Shredder	cb	6.3	29	72.5

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
LPAX-01-2011	51	73	70
LPAX-02-2011	51	109	47
LPAX-03-2011	47	115	41
LPAX-04-2011	90	109	83
LPAX-05-2011	84	103	82
LPAX-06-2011	99	113	88
LPAX-07-2011	39	101	39
LPAX-08-2011	54	118	46
LPAX-09-2011	81	113	72
LPAX-11-2011	9	110	8
LPAX-12-2011	42	82	51
LPAX-13-2011	24	107	22
LPAX-14-2011	54	117	46
LPAX-15-2011	54	98	55
LPAX-16-2011	54	110	49
LPAX-17-2011	67	108	62
LPAX-18-2011	62	106	58
LPAX-19-2011	42	106	40
LPAX-20-2011	33	110	30
LPAX-23-2011	20	102	20
LPAX-24-2011	28	102	27
LPAX-25-2011	58	112	52
LPAX-26-2011	24	100	24
LPAX-28-2011	109	119	92
LPAX-29-2011	27	64	42
LPAX-30-2011	44	106	42
LPAX-31-2011	61	100	61
LPAX-32-2011	81	105	77
LPAX-33-2011	91	114	80
LPAX-34-2011	89	111	80
LPAX-35-2011	68	104	65
LPAX-36-2011	30	111	27
LPAX-37-2011	18	106	17
LPAX-38-2011	33	103	32
LPAX-39-2011	83	99	84
LPAX-40-2011	104	117	89
LPAX-41-2011	93	110	85
LPAX-42-2011	22	97	23
LPAX-43-2011	45	116	39
LPAX-46-2011	12	113	11

2.5 Quality Assurance/Quality Control

All applicable QA/QC measures were calculated and compared to quantitative measurement quality objectives as presented in Hill and Pieper 2011b. 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 Little Patuxent watershed 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 Little Patuxent watershed.

3.1 Land Use and Impervious Surface

Land use throughout the watershed is diverse, with subwatersheds to the north (Dorsey Run) dominated by industrial/commercial landuse, subwatersheds to the west (Patuxent Wildlife Refuge) dominated by forests, and subwatersheds to the east and south dominated by residential and mixed (commercial/industrial) land uses including the Fort Meade Military Reservation. In addition, the watershed contains several major transportation corridors including the Baltimore-Washington Parkway (I-295) and Maryland Route 32, Route 175 and Route 3 highway corridors, as well as the Maryland Area Rail Commuter (MARC) Penn line and Camden line railway corridors. Half of the sites sampled were dominated by developed land cover, while 17 sites were dominated by forested land cover. The remaining three sites were dominated by open or agricultural land cover.

Impervious surface coverage was relatively high throughout portions of the subwatershed with an average site-specific imperviousness of 17.9 percent. However, there were also several sites in the watershed, such as those located in the Patuxent Wildlife Refuge and Oxbow Natural Area, where imperviousness was very low (≤ 2 percent). Twelve sites had drainage areas with imperviousness below 10 percent, 15 sites ranged between 10 and 25 percent, and 13 sites had impervious drainages greater than 25 percent, which is a general threshold associated with moderate stream degradation (Scheuler, 2008). Not surprisingly, only four sites with greater that 25 percent imperviousness received a biological condition rating of 'Fair' or better.

3.2 Water Chemistry

Water quality exceeded COMAR standards at nearly half of all sites sampled, primarily for low pH (<6.5). While the direct cause of low pH is unclear, most instances appear to be on streams draining wetlands with tannic water that could be expected to have naturally low pH levels given the landscape setting. A map of pH and conductivity ranges for each site shows a pattern where sites with low conductivity, typical of minimal anthropogenic disturbance, had low pH values that were outside of COMAR standards; whereas sites with elevated conductivity, typical of increased anthropogenic disturbance, generally had pH values within COMAR standards (Figure 8 and Table 17). While several sites exceeded the standard for low dissolved oxygen, it was noted that these streams exhibited stagnant flow, generally due to backwater conditions at the time of sampling, and may not be typical of average flow conditions at these locations. Furthermore, three of the five 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.

Elevated conductivity levels were most prevalent in the more heavily developed, and hence more impervious, northern portion of the watershed. In fact, conductivity values were well correlated to imperviousness (r^2=0.4866; Figure 7), suggesting elevated conductivity levels in this watershed are influenced by runoff from impervious surfaces (i.e., roads, sidewalks, parking lots). This relationship between conductivity and imperviousness is consistent with patterns observed throughout Anne Arundel (Hill & Pieper, 2011). Increased stream inorganic ion concentrations (i.e., conductivity) in urban systems typically results from runoff over impervious surfaces, passage through pipes, and exposure to other anthropogenic infrastructure (Cushman, 2005). 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.

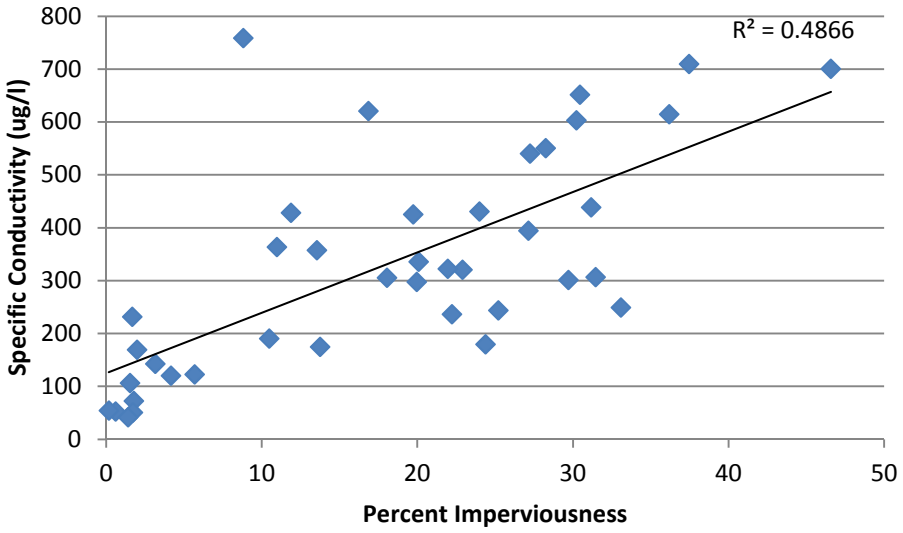
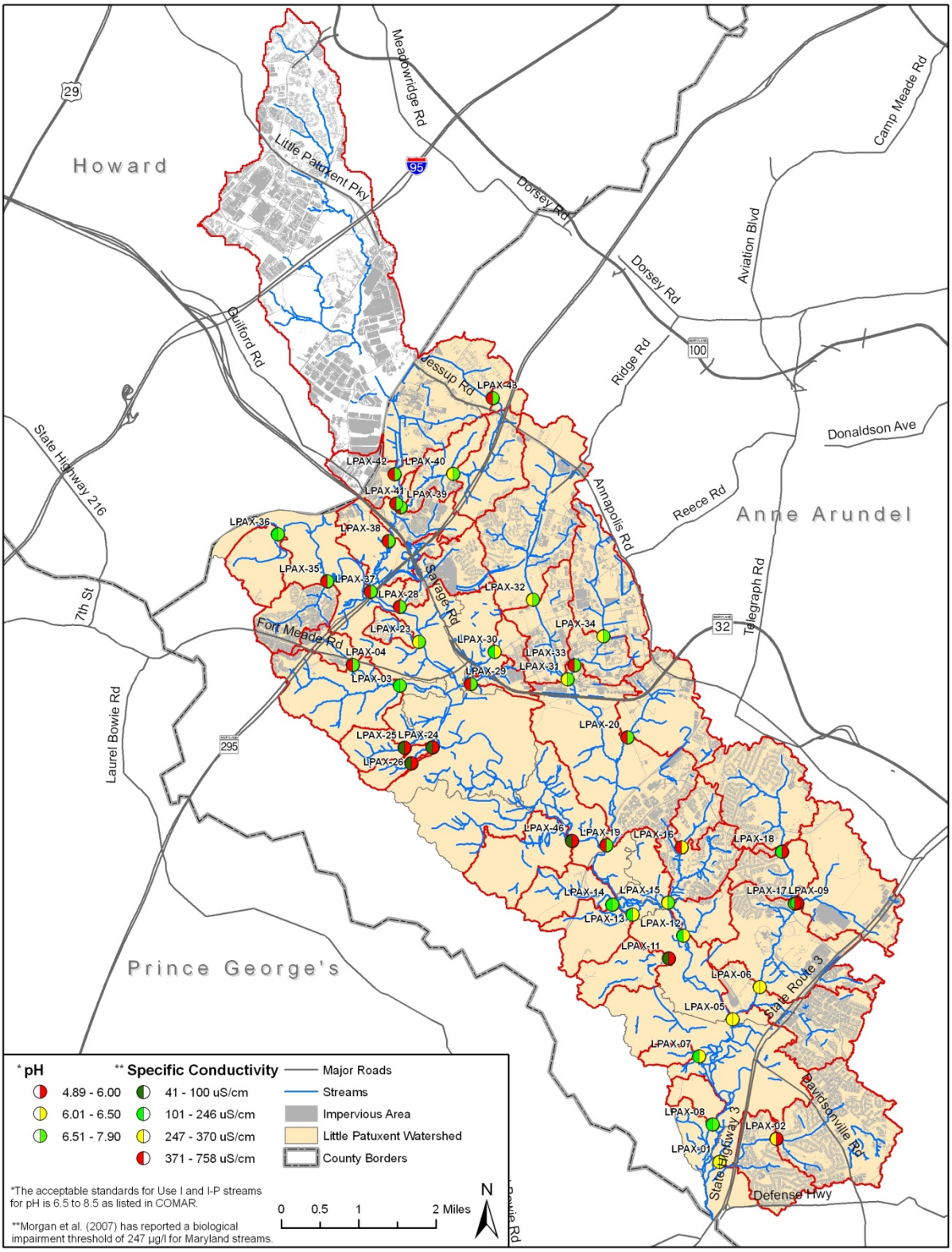


Figure 7 – Relationship between specific conductivity and percent imperviousness for 40 targeted sites in the Little Patuxent watershed.

3.1 Physical Habitat

Physical habitat scores for the RBP and PHI assessments both indicate varying habitat conditions throughout the watershed. The majority of sites assessed were rated as either 'Supporting' (42.5 percent) by the RBP or "Partially Degraded" by the PHI (62.5 percent), which is indicative of moderate stream degradation. On the high end of the scale only two sites were rated as 'Comparable to Reference' (RBP), and five sites received a 'Minimally Degraded' (PHI) rating. In contrast, five sites were rated in the most impaired RBP category of 'Non Supporting' (RBP) and four sites were rated in the most impaired 'Severely Degraded' category for the PHI. Habitat scores for the RBP and PHI assessments were only moderately correlated (r^2 = 0.3421), and often the corresponding narrative categories did not match with respect to the overall level of degradation (Figure 9). For example, four sites were rated as 'Severely Degraded' by the PHI but rated as 'Partially Supporting' by the RBP. However, it is important to note that only two sites (LPAX-19 and LPAX-35) differed by more than one assessment category.

Figure 8 - Conductivity and pH Results Map



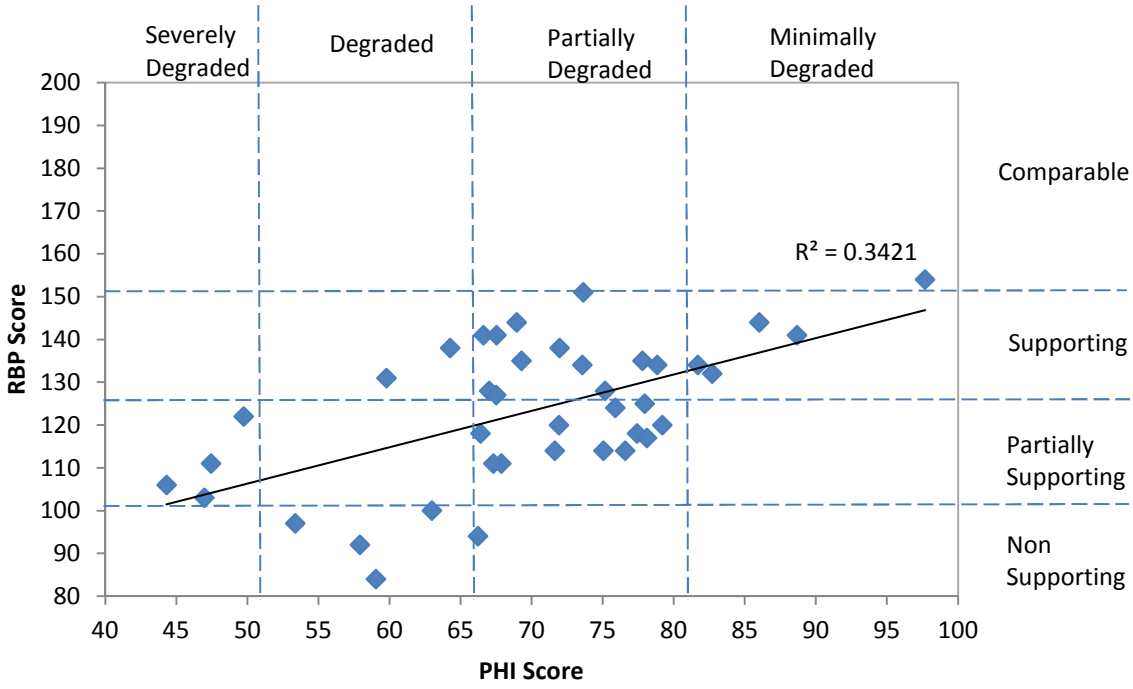


Figure 9 – Comparison of RBP and PHI habitat assessment scores for 40 sites in the Little Patuxent watershed.

3.2 Biological Condition

While the targeted study design does not support assessment results at the overall watershed scale, general statements about the Little Patuxent study area can be made based on site-specific results. Of the 40 sites assessed, 62.5 percent had impaired (i.e., 'Poor' or 'Very Poor') biological conditions and only 10 percent of sites were rated as 'Good'. The biological results indicate a median BIBI score of 2.71, which is in the 'Poor' category. Chironomidae taxa dominated many of the samples and comprised eight of the top ten taxa by percent occurrence. While some chironomid taxa are intolerant to stressors, the relevant abundance of chironomids tends to increase in urbanized drainages. Other prevalent taxa include Tubificidae (Tol. val. = 8.4) and Naididae (Tol. val. = 8.5) both families of tolerant worms. The three most abundant taxa found throughout the study area were either tolerant (i.e., Orthocladius [Tol. val. = 9.2], Naididae) or relatively tolerant (i.e., *Polypedilum* [Tol. val. = 6.3]) to urban stressors, which suggests that urban stressors are prevalent throughout the watershed and are likely influencing biological communities.

3.3 Integrated Assessment

Table 15 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 15 – Consolidated Assessment Results

Site	Sub-watershed Code	Drainage Area (acres)	Impervious Percent	BIBI Score	RBP Score	RBP Percent of Reference	PHI Score
LPAX-01-2011	LPA	1615.9	33.1	2.71	135	80.36	77.80
LPAX-02-2011	LPA	1131.3	31.5	3.29	106	63.10	44.32
LPAX-03-2011	LPM	985.2	10.5	3.00	134	79.76	78.84
LPAX-04-2011	LPM	176.4	31.2	1.57	92	54.76	57.92
LPAX-05-2011	LPD	4247.6	22.9	2.43	118	70.24	66.41
LPAX-06-2011	LPD	3431.4	20.0	2.43	111	66.07	47.46
LPAX-07-2011	LP1	105.1	1.5	2.71	141	83.93	88.68
LPAX-08-2011	LP1	169.5	1.7	3.29	114	67.86	75.05
LPAX-09-2011	LPC	1001.1	13.8	1.29	97	57.74	53.37
LPAX-11-2011	LP2	365.7	1.8	2.14	141	83.93	66.61
LPAX-12-2011	LP2	277.2	5.7	2.14	111	66.07	67.87
LPAX-13-2011	LP3	798.2	3.2	2.71	100	59.52	62.98
LPAX-14-2011	LP3	385.1	4.2	1.86	124	73.81	75.88
LPAX-15-2011	LPL	701.0	29.7	3.29	132	78.57	82.71
LPAX-16-2011	LPL	240.7	27.1	2.71	120	71.43	79.19
LPAX-17-2011	LPB	1329.9	24.4	2.71	128	76.19	67.01
LPAX-18-2011	LPB	969.7	25.2	2.71	118	70.24	77.42
LPAX-19-2011	LPF	5387.6	19.7	4.14	151	89.88	73.63
LPAX-20-2011	LPF	772.7	16.8	4.14	134	79.76	73.57
LPAX-23-2011	LP5	117.7	13.5	2.71	117	69.64	78.12
LPAX-24-2011	LPO	146.3	1.7	2.43	144	85.71	86.01
LPAX-25-2011	LPO	208.3	0.6	4.43	154	91.67	97.69
LPAX-26-2011	LPO	101.4	1.4	3.00	120	71.43	71.92
LPAX-28-2011	LP5	407.3	36.2	1.57	114	67.86	76.59
LPAX-29-2011	LPN	124.2	37.5	2.14	125	74.40	77.96
LPAX-30-2011	LPN	123.2	22.2	2.71	127	75.60	67.50
LPAX-31-2011	LPE	1905.3	20.1	3.00	135	80.36	69.29
LPAX-32-2011	LPE	1380.7	18.0	3.00	103	61.31	46.98
LPAX-33-2011	LPG	1082.5	24.0	3.57	122	72.62	49.74
LPAX-34-2011	LPG	789.6	21.9	2.71	131	77.98	59.79
LPAX-35-2011	LP6	412.8	46.6	1.86	94	55.95	66.23
LPAX-36-2011	LP6	374.7	2.0	1.57	114	67.86	71.62
LPAX-37-2011	LPI	8053.5	27.2	4.14	138	82.14	64.28
LPAX-38-2011	LPI	7561.8	28.3	3.86	144	85.71	68.96
LPAX-39-2011	LPJ	872.9	11.9	3.00	128	76.19	75.17
LPAX-40-2011	LPJ	535.0	11.0	3.57	134	79.76	81.70
LPAX-41-2011	LPH	6320.6	30.5	2.43	138	82.14	71.97
LPAX-42-2011	LPH	5994.4	30.2	2.71	141	83.93	67.54
LPAX-43-2011	LPK	89.3	8.8	1.86	84	50.00	59.05
LPAX-46-2011	LP4	595.5	0.2	1.86	111	66.07	67.30

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 16.

Table 16 – Station Biological Potential Matrix

EPA RBP HABITAT RATING	BIOLOGICAL RATING				MBSS PHI HABITAT RATING	BIOLOGICAL RATING			
	GOOD	FAIR	POOR	VERY POOR		GOOD	FAIR	POOR	VERY POOR
Comparable	19,25				Minimally Degraded	25	15,40	**07,24**	
Supporting	20,37	03,15, 31,38, 39,40	01,07,11, 17,24,30, 34,41,42		Partially Degraded	19,20,	03,08, 26,31, 38,39	01,05,11, 12,16,17, 18,23,29, 30,41,42	**14,28, 35,36, 46**
Partially Supporting		02,08, 26,32, 33	05,06,12, 16,18,23, 29	14,28, 36,46	Degraded	37		13,34	04,09, 43
Non Supporting			13	04,09, 35,43	Severely Degraded		**02,32, 33**	06	

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 fairly well correlated (r^2 = 0.3649) with RBP scores (Figure 10). PHI scores, on the other hand, were poorly correlated (r^2 = 0.0448) with BIBI scores (Figure 11), suggesting that the parameters included in this index are less predictive of biological conditions in the Little Patuxent watershed. These results are similar to those found throughout Anne Arundel County, which found a stronger correlation between the RBP and BIBI compared to the PHI (Hill and Pieper, 2011a). 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. It's also important to note that degraded habitat conditions were also observed in areas with little development and low imperviousness, suggesting that legacy effects of past land use changes (e.g., deforestation, channelization, mill dams) may continue to limit the biological potential in these streams.

While some sites show clear patterns of degraded physical habitat and correspondingly impaired biological communities, indicating physical habitat as the limiting factor, numerous sites show patterns more consistent with water quality impairment (

Table 17). For sites where the biological community did not reach RBP habitat potential, water quality may be a potential limiting or contributing factor. 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 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.

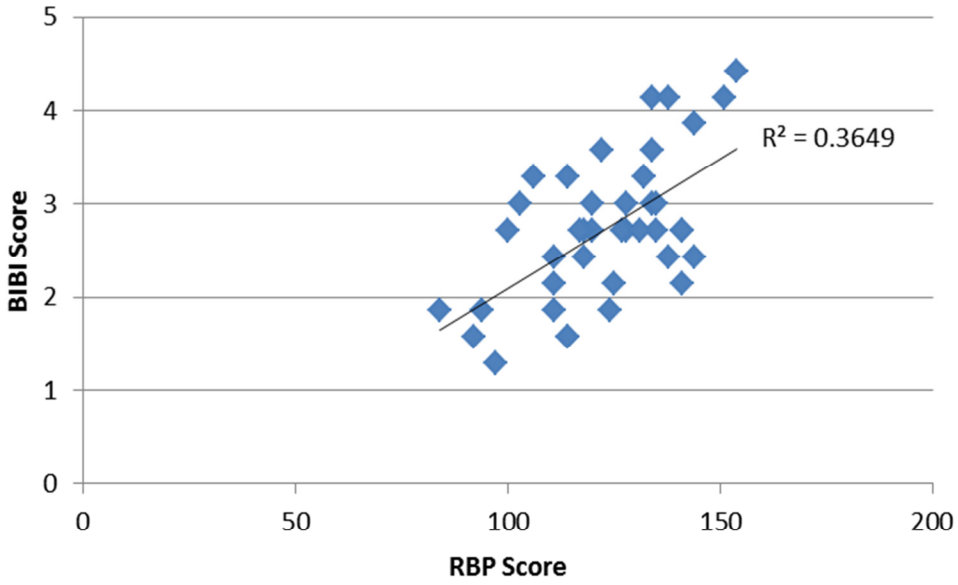


Figure 10 – Relationship between RBP habitat assessment score and BIBI score for 40 targeted sites in the Little Patuxent watershed.

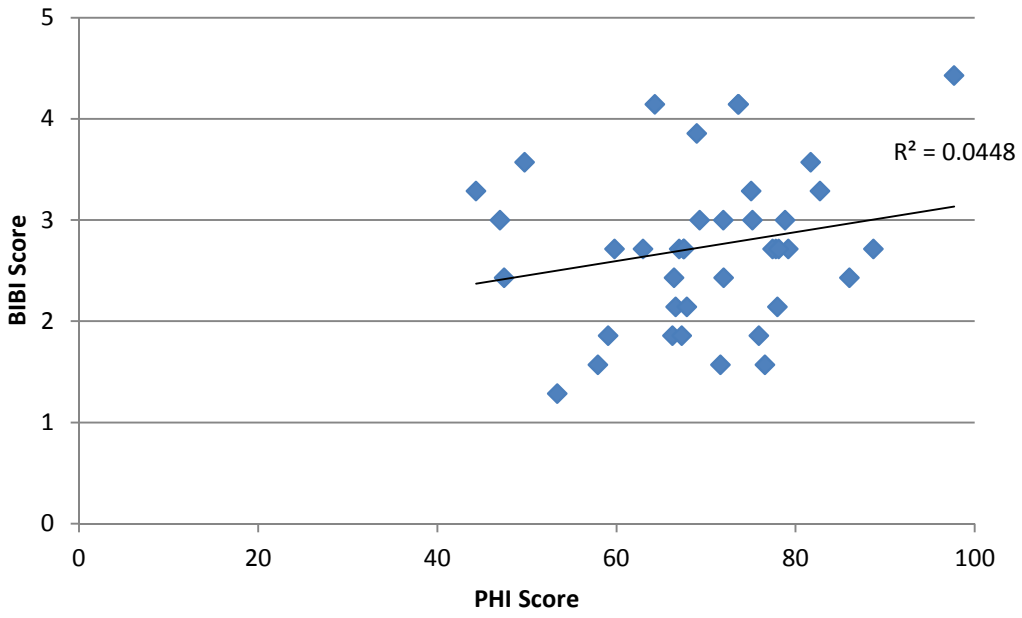


Figure 11 – Relationship between PHI habitat assessment score and BIBI score for 40 targeted sites in the Little Patuxent watershed.

Table 17 - 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
LPAX-02-2011	X		X	
LPAX-13-2011	X	X		
LPAX-26-2011	X	X		
LPAX-08-2011		X		
LPAX-20-2011			X	
LPAX-33-2011			X	
LPAX-37-2011			X	
LPAX-32-2011			X	
LPAX-25-2011	X			
LPAX-09-2011	X			
LPAX-12-2011	X			
LPAX-18-2011	X			
LPAX-06-2011	X		X	
LPAX-05-2011	X		X	
LPAX-16-2011	X		X	
LPAX-19-2011			X	
LPAX-04-2011			X	
LPAX-23-2011			X	
LPAX-29-2011			X	
LPAX-38-2011			X	
LPAX-39-2011			X	
LPAX-40-2011			X	
LPAX-43-2011			X	
LPAX-35-2011			X	
LPAX-15-2011			X	
LPAX-31-2011			X	
LPAX-03-2011				X
LPAX-17-2011	X			
LPAX-07-2011	X			
LPAX-24-2011	X			
LPAX-46-2011	X			
LPAX-01-2011	X		X	
LPAX-30-2011	X			
LPAX-11-2011	X	X		
LPAX-36-2011		X		
LPAX-34-2011			X	
LPAX-28-2011			X	
LPAX-41-2011			X	
LPAX-42-2011			X	
LPAX-14-2011				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

LPAX-01-2011 LPA Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0004624677 **Longitude:** -76.7040719711

This site is located west of Crain Highway (Rt. 3) approximately 200 meters upstream of the confluence with the Little Patuxent River and is part of the LPA subwatershed. With over 60% as developed land, the drainage area to this site (1,616 acres) contains the entire Crofton Country Club property as well as multiple high density residential communities. This reach was within the floodplain of the Little Patuxent River and as a result was backwatered. Less than 80 organisms were identified in the entire benthic sample, which indicates a poor biological community. Water quality measured below COMAR standards for pH and elevated conductivity, which may impact the biologic community. Because habitat is supporting and biological condition is poor, there may be problems with water quality in this drainage system that cannot be measured through in situ analysis only.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- This sample only contained 73 organisms, the majority of which were midges (Orthocladius and Tvetenia) and worms (Naididae).
- Measured below COMAR standards for pH and conductivity elevated.
- Adequate habitat with high bank stability. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.7
Turbidity (NTU)	7.38
Temperature (°C)	19.17
pH (SU)	6.43
Specific Conductivity (µS/cm)	249.1

LPAX-01-2011 LPA Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	2
Ephemeroptera Taxa	1
Intolerant Urban %	4.1
Ephemeroptera %	1.4
Scraper Taxa	1
% Climbers	4.1

Calculated Metric Scores

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

Taxa	Count
Baetidae	1
Brillia	3
Chaetocladius	1
Chironomidae	1
Chironomini	1
Cricotopus	4
Eukiefferiella	3
Lepidoptera	3
Lumbricina	1
Naidinae	7
Orthocladiinae	2
Orthocladius	19
Parametriocnemus	3
Paratendipes	1
Plecoptera	2
Polypedilum	3
Simuliidae	3
Staphylinidae	2
Stenelmis	3
Thienemanniella	5
Tvetenia	5
TOTAL:	**73**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	10
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	12	Sediment Deposition	13
Channel Sinuosity	11	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	10		
EPA Habitat Score			**135**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Woody Debris/Rootwads	8	61.74
Shading	90	91.34	Instream Habitat	11	66.11
Epifaunal Substrate	11	71.99	Bank Stability	16	89.45
PHI Score					**77.8**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1615.85**
Cover	**Acres**	**%Area**
Developed Land	**981.64**	**60.75**
Commercial	75.04	4.64
Industrial	4.58	0.28
Residential 1/8-acre	337.39	20.88
Residential 1/4-acre	472.74	29.26
Residential 1/2-acre	0	0
Residential 1-Acre	5.64	0.35
Residential 2-Acre	18.89	1.17
Transportation	67.36	4.17
Utility	0	0
Forest Land	**459.3**	**28.42**
Forested Wetland	0	0
Residential Woods	163.32	10.11
Woods	295.98	18.32
Open Land	**152.46**	**9.44**
Open Space	147.62	9.14
Open Wetland	0	0
Water	4.85	0.3
Agricultural Land	**22.45**	**1.39**
Pasture/Hay	4.18	0.26
Row Crops	18.27	1.13
Impervious Surface	**Acres**	**% Area**
Impervious Land	534.6	33.09

LPAX-02-2011 LPA Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0047573123 **Longitude:** -76.6903728286

Located east of Crain Highway (State Route 3), this site is part of the LPA subwatershed. With close to 60% as developed land, the drainage area to this site (1,131 acres) contains half of the Crofton Country Club property as well as multiple high density residential communities. This site is located on the Crofton Country Club golf course where a golf cart road runs along the entire right bank of the sampling reach with little to no buffer due to mowed grass and few trees. Low pH and elevated conductivity may be attributed to multiple direct drainage inputs and lack of adequate vegetative protection/buffer. In spite of the partially supporting/severely degraded habitat, high taxa diversity (27 taxa present) including 3 EPT taxa and 2 Ephemeroptera taxa resulted in a biological community that is fair. Since the biological community exceeds the physical habitat potential, nutrient enrichment may be present, especially considering the surrounding golf course land use.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Severely Degraded"*
- Sample dominated by beetles (Stenelmis), midges (Orthocladius), and worms of the Naididae family.
- Measured below COMAR standards for pH and conductivity elevated.
- Bank stability scored high while instream habitat, epibenthic substrate, and woody debris scored low. Poor riparian width with marginal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	6.88
Turbidity (NTU)	6.97
Temperature (°C)	19.11
pH (SU)	5.4
Specific Conductivity (µS/cm)	306.1

LPAX-02-2011 LPA Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	27
EPT Taxa	3
Ephemeroptera Taxa	2
Intolerant Urban %	0.9
Ephemeroptera %	1.8
Scraper Taxa	1
% Climbers	2.8

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	1
Acentrella	1
Argia	1
Baetis	1
Ceratopogonidae	1
Chironomidae	1
Corynoneura	1
Dicrotendipes	4
Enallagma	1
Eukiefferiella	3
Ironoquia	1
Limnophyes	1
Microtendipes	4
Naidinae	14
Orthocladius	13
Parametriocnemus	1
Paratanytarsus	2
Pisidiidae	3
Polypedilum	2
Potthastia	1
Rheotanytarsus	6
Simuliidae	2
Simulium	5
Stenelmis	22
Tanypodinae	1
Thienemanniella	4
Thienemannimyia group	1
Tipula	1
Tubificinae	5
Tvetenia	5
TOTAL:	**109**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	9
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	2
Channel Alteration	12	Riparian Vegetative Zone Width- Right Bank	2
Channel Flow Status	18	Sediment Deposition	14
Channel Sinuosity	7	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	12		
EPA Habitat Score			**106**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	3	16.16	Woody Debris/Rootwads	1	45.07
Shading	10	8.55	Instream Habitat	9	58.67
Epifaunal Substrate	8	56.88	Bank Stability	13	80.63
PHI Score					**44.32**
PHI Narrative Rating					**Severely Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1131.34**
Cover	**Acres**	**%Area**
Developed Land	**671.07**	**59.32**
Commercial	48.44	4.28
Industrial	4.58	0.4
Residential 1/8-acre	300.31	26.54
Residential 1/4-acre	260.88	23.06
Residential 1/2-acre	0	0
Residential 1-Acre	3.75	0.33
Residential 2-Acre	13.27	1.17
Transportation	39.84	3.52
Utility	0	0
Forest Land	**337.28**	**29.81**
Forested Wetland	0	0
Residential Woods	95.26	8.42
Woods	242.02	21.39
Open Land	**100.54**	**8.89**
Open Space	95.69	8.46
Open Wetland	0	0
Water	4.85	0.43
Agricultural Land	**22.45**	**1.98**
Pasture/Hay	4.18	0.37
Row Crops	18.27	1.62
Impervious Surface	**Acres**	**% Area**
Impervious Land	355.9	31.46

LPAX-03-2011 LPM Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0900681069 **Longitude:** -76.7806637664

Located off of Welchs Court and Waters Road, behind a mobile home park, this site is part of the LPM subwatershed. Of the 985 acre drainage area to this site, over 75% is forested land with approximately 10% total impervious surface. All measured water quality parameters were within COMAR standards. The abundance of good quality cobble and large gravel riffles, good velocity and depth diversity, and overall supporting physical habitat quality resulted in a fair biological community with high taxa diversity (33) and numerous EPT taxa (6) and scraper taxa (4).

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Beetles (Stenelmis) and midges (Orthocladius) dominated the sample.
- Water quality values within COMAR standards.
- Instream habitat and epibenthic substrate scored high. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.97
Turbidity (NTU)	8.66
Temperature (°C)	12.47
pH (SU)	6.89
Specific Conductivity (µS/cm)	189.7

LPAX-03-2011 LPM Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	33
EPT Taxa	6
Ephemeroptera Taxa	0
Intolerant Urban %	5.2
Ephemeroptera %	0
Scraper Taxa	4
% Climbers	4.3

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	2
Ancyronyx	3
Calopteryx	1
Ceratopsyche	1
Chaetocladius	1
Cheumatopsyche	4
Chimarra	1
Chironomini	1
Corduliidae	1
Diplectrona	1
Dubiraphia	3
Hemerodromia	1
Hydrobaenus	1
Leuctra	1
Limnocharidae	1
Lumbricina	1
Nanocladius	1
Nigronia	1
Nilotanypus	1
Orthocladiinae	3
Orthocladius	2
Parametriocnemus	4
Paratendipes	1
Pisidiidae	2
Polycentropus	1
Rheocricotopus	3
Rheotanytarsus	18
Simuliidae	2
Simulium	7
Stegopterna	1
Stenelmis	32
Tanytarsus	4
Thienemannimyia group	2
Tipula	2
Tubificinae	1
Tvetenia	3
TOTAL:	**115**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	12
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	12	Sediment Deposition	8
Channel Sinuosity	9	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	11		
EPA Habitat Score			**134**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	4	55.51
Shading	95	99.94	Instream Habitat	14	87.82
Epifaunal Substrate	15	98.45	Bank Stability	12	77.46
PHI Score					**78.84**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**985.23**
Cover	**Acres**	**%Area**
Developed Land	**185.59**	**18.84**
Commercial	72.34	7.34
Industrial	5.84	0.59
Residential 1/8-acre	32.03	3.25
Residential 1/4-acre	0.1	0.01
Residential 1/2-acre	0.97	0.1
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	41.17	4.18
Utility	33.14	3.36
Forest Land	**744.74**	**75.59**
Forested Wetland	0	0
Residential Woods	0	0
Woods	744.74	75.59
Open Land	**54.89**	**5.57**
Open Space	49.35	5.01
Open Wetland	3.71	0.38
Water	1.83	0.19
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	103.2	10.48

LPAX-04-2011 LPM Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0939833047 **Longitude:** -76.7920067774

Located off of Fort Meade Road (Rt. 198), this site is part of the LPM subwatershed. This sampling reach runs adjacent to a parking lot with excessive dumping on the left bank and into the channel. The site is also located immediately downstream of culvert and rip-rap stabilization. As a result, the site has very poor habitat and the channel is deeply incised with areas of severe bank erosion and undercutting. Of the 176 acre drainage area to this site, close to half consists of developed land, 28% of which is commercial property including the Arundel Gateway Business Park as well as portions of Baltimore-Washington Parkway and Rt. 198. The remaining 46% of the drainage area is forested land. Water quality measurements indicated elevated conductivity, which may be attributed to the high percentage of impervious surface (31%) within the drainage area. The lack of EPT, intolerant, or scraper taxa in this sample are indicators of a very poor biological community.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Midges (Chaetocladius and Orthocladius) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Habitat variables scored poor to marginal. Very poor bank stability and refuse abundant. Poor riparian width on the right bank and marginal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.23
Turbidity (NTU)	19.1
Temperature (°C)	13.4
pH (SU)	7
Specific Conductivity (µS/cm)	438.3

LPAX-04-2011 LPM Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	1.8

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	1
Atrichopogon	1
Bezzia/Palpomyia	1
Ceratopogonidae	1
Chaetocladius	34
Cheumatopsyche	1
Chironomidae	1
Dasyhelea	1
Dicrotendipes	1
Diplocladius	9
Enchytraeidae	1
Lumbricina	1
Lumbriculidae	1
Orthocladiinae	3
Orthocladius	30
Polypedilum	1
Prostoma	2
Pseudorthocladius	1
Rheocricotopus	5
Stempellinella	1
Thienemannimyia group	3
Tipula	4
Tubificinae	5
TOTAL:	**109**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	3	Pool Variability	8
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	2
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	6
Channel Sinuosity	10	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	7		
EPA Habitat Score			**92**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	2	10.77	Woody Debris/Rootwads	5	77.94
Shading	85	84.56	Instream Habitat	6	61.04
Epifaunal Substrate	7	63.18	Bank Stability	5	50
PHI Score					**57.92**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**176.41**
Cover	**Acres**	**%Area**
Developed Land	**81.11**	**45.98**
Commercial	49.46	28.04
Industrial	1.09	0.62
Residential 1/8-acre	0.03	0.01
Residential 1/4-acre	0	0
Residential 1/2-acre	0.97	0.55
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	20.36	11.54
Utility	9.19	5.21
Forest Land	**82.6**	**46.82**
Forested Wetland	0	0
Residential Woods	0	0
Woods	82.6	46.82
Open Land	**12.7**	**7.2**
Open Space	12.7	7.2
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	55	31.17

LPAX-05-2011 LPD Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0272114027 **Longitude:** -76.7008364182

Located on the Towsers Branch mainstem approximately 150 meters upstream of the confluence with the Little Patuxent River and downstream of the crossing at Capitol Raceway Road, this site is part of the LPD subwatershed. Of the 4,248 acre drainage area, over half is developed land with 31% as high density residential. Approximately one-fourth of the drainage area is impervious, which may attribute to the elevated conductivity values measured at the site. This site also fell below COMAR standards for pH; however, this may be due to wetland drainage upstream. The channel is overwidened with actively eroding silt/clay banks indicating an unstable stream. The partially supporting habitat limits the benthic community, resulting in a poor biological rating. No EPT taxa were present in the benthic sample with only 2% intolerant urban taxa.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges (Orthocladius) and worms (Naididae) dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- Most habitat variables received sub-optimal scores. Good riparian width but marginal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.62
Turbidity (NTU)	25.5
Temperature (°C)	20.47
pH (SU)	6.12
Specific Conductivity (µS/cm)	320.4

LPAX-05-2011 LPD Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	8.7

Calculated Metric Scores

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

Taxa	Count
Brillia	3
Calopteryx	1
Chaetocladius	2
Chironomini	2
Chironomus	1
Cricotopus	3
Enchytraeidae	1
Hydrobaenus	7
Naidinae	14
Orthocladiinae	8
Orthocladius	47
Parametriocnemus	1
Polypedilum	8
Stenelmis	2
Thienemanniella	2
Tubificinae	1
TOTAL:	**103**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	13
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	11	Sediment Deposition	10
Channel Sinuosity	7	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	8		
EPA Habitat Score			**118**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Woody Debris/Rootwads	6	44.88
Shading	80	78.67	Instream Habitat	12	61.77
Epifaunal Substrate	11	65.69	Bank Stability	12	77.46
PHI Score					**66.41**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**4247.6**
Cover	**Acres**	**%Area**
Developed Land	**2236.5**	**52.65**
Commercial	197.22	4.64
Industrial	310.18	7.3
Residential 1/8-acre	629.02	14.81
Residential 1/4-acre	699.61	16.47
Residential 1/2-acre	2.52	0.06
Residential 1-Acre	25.25	0.59
Residential 2-Acre	115.84	2.73
Transportation	129.45	3.05
Utility	127.41	3
Forest Land	**888.84**	**20.93**
Forested Wetland	0	0
Residential Woods	0	0
Woods	888.84	20.93
Open Land	**445.3**	**10.48**
Open Space	429.86	10.12
Open Wetland	0	0
Water	15.44	0.36
Agricultural Land	**676.96**	**15.94**
Pasture/Hay	264	6.22
Row Crops	412.96	9.72
Impervious Surface	**Acres**	**% Area**
Impervious Land	972.9	22.9

LPAX-06-2011 LPD Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0332228582 **Longitude:** -76.6943194916

This site is located on Towsers Branch mainstem immediately downstream of the crossing at Evergreen Road off of Crain Highway and is part of the LPD subwatershed. Abundant woody debris with some riffle habitat and very deep pools are present throughout the stream. Of the 3,431 acre drainage area to this site, half consists of developed land with the remaining 21% as forested, 20% as agriculture, and 10% as open space. Several holding ponds from the adjacent quarry operation appear to drain into the stream just upstream of the sampling reach. A powerline corridor runs the entire length of the left bank of the site which results in poor vegetative protection and riparian buffer. The channel is also incised with actively eroded stream banks indicating an unstable stream type. Insufficient physical habitat and potential water quality impairment, including low pH and elevated conductivity, likely contribute to a poor biological community. Only 4% of the benthic sample consisted of intolerant urban taxa with only one EPT taxa present.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Severely Degraded"*
- Sample dominated by midges (Orthocladius).
- Measured below COMAR standards for pH and conductivity elevated.
- Extremely low percent shading (5%). Instream habitat, epibenthic substrate and bank stability received sub-optimal scores. Marginal riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.76
Turbidity (NTU)	6.92
Temperature (°C)	14.83
pH (SU)	6.15
Specific Conductivity (µS/cm)	297

LPAX-06-2011 LPD Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3.5
Ephemeroptera %	2.7
Scraper Taxa	2
% Climbers	0.9

Calculated Metric Scores

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

Taxa	Count
Acentrella	1
Baetidae	2
Boyeria	1
Brillia	2
Chaetocladius	1
Chironomidae	2
Chironomini	3
Chironomus	1
Cricotopus	7
Macronychus	1
Naidinae	8
Orthocladiinae	2
Orthocladius	75
Parakiefferiella	1
Potthastia	1
Stenelmis	1
Thienemanniella	1
Thienemannimyia group	1
Tvetenia	2
TOTAL:	**113**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	14
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	4
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	4
Channel Flow Status	14	Sediment Deposition	9
Channel Sinuosity	9	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	8		
EPA Habitat Score			**111**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	1	5.39	Woody Debris/Rootwads	10	59.13
Shading	5	0	Instream Habitat	13	69.5
Epifaunal Substrate	11	67.08	Bank Stability	14	83.67
PHI Score					**47.46**
PHI Narrative Rating					**Severely Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**3431.37**
Cover	**Acres**	**%Area**
Developed Land	**1712.36**	**49.9**
Commercial	160.04	4.66
Industrial	309.52	9.02
Residential 1/8-acre	345.77	10.08
Residential 1/4-acre	608.04	17.72
Residential 1/2-acre	2.52	0.07
Residential 1-Acre	24.65	0.72
Residential 2-Acre	71.15	2.07
Transportation	91.72	2.67
Utility	98.94	2.88
Forest Land	**702.35**	**20.47**
Forested Wetland	0	0
Residential Woods	0	0
Woods	702.35	20.47
Open Land	**351.73**	**10.25**
Open Space	344.89	10.05
Open Wetland	0	0
Water	6.84	0.2
Agricultural Land	**664.94**	**19.38**
Pasture/Hay	251.97	7.34
Row Crops	412.96	12.03

Impervious Surface	**Acres**	**% Area**
Impervious Land	685.1	19.97

LPAX-07-2011 LP1 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0202432886 **Longitude:** -76.708931343

Located behind houses along Meyers Station Road, this site is part of the LP1 subwatershed and drains to the Little Patuxent River. The drainage area to this site (105 acres) is largely forested land (87%) with only 1.5% impervious surface. This site is on a small channel that runs through a wetland and has full floodplain access on both banks. Riffle habitat and woody debris support high scores for physical habitat; however, the lack of Ephemeroptera and scraper taxa in the subsample resulted in a poor biological score. Because habitat is supporting and biological condition is poor, there may be problems with water quality in this drainage area that cannot be measured through in situ analysis only. Measured pH values fell below COMAR standards, but this is likely to be influenced by the surrounding wetland system that drains to the site.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Plecoptera (Amphinemura) and midges (Dicranota, Thienemannimyia group, and Corynoneura) dominated the sample.
- Measured below COMAR standards for pH.
- Bank stability scored high while instream habitat and epibenthic substrate received marginal to sub-optimal scores. Good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	7.78
Turbidity (NTU)	6.77
Temperature (°C)	18.6
pH (SU)	6.29
Specific Conductivity (µS/cm)	106

LPAX-07-2011 LP1 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	47.5
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	6.9

Calculated Metric Scores

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

Taxa	Count
Amphinemura	35
Anchytarsus	2
Bezzia/Palpomyia	5
Caecidotea	1
Chironomidae	1
Conchapelopia	1
Corynoneura	6
Crangonyctidae	1
Cricotopus	1
Diamesa	1
Dicranota	10
Diplectrona	1
Eukiefferiella	1
Naidinae	1
Natarsia	2
Orthocladiinae	2
Orthocladius	1
Parametriocnemus	1
Plecoptera	1
Polypedilum	3
Rheotanytarsus	1
Simulium	4
Stempellina	1
Tanytarsus	3
Thienemanniella	2
Thienemannimyia group	8
Tubificinae	1
Tvetenia	4
TOTAL:	**101**

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	15	Sediment Deposition	11
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	7		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Woody Debris/Rootwads	5	83.81
Shading	95	99.94	Instream Habitat	10	88.54
Epifaunal Substrate	11	89.79	Bank Stability	20	100
PHI Score					**88.68**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**105.1**
Cover	**Acres**	**%Area**
Developed Land	**5.93**	**5.65**
Commercial	0.54	0.51
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.52	1.44
Residential 2-Acre	2.01	1.91
Transportation	1.87	1.78
Utility	0	0
Forest Land	**91.15**	**86.73**
Forested Wetland	0	0
Residential Woods	0	0
Woods	91.15	86.73
Open Land	**1.32**	**1.25**
Open Space	1.32	1.25
Open Wetland	0	0
Water	0	0
Agricultural Land	**6.69**	**6.37**
Pasture/Hay	6.69	6.37
Row Crops	0	0

Impervious Surface	**Acres**	**% Area**
Impervious Land	1.6	1.53

LPAX-08-2011 LP1 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0074618777 **Longitude:** -76.7057105108

Located on the Little Patuxent River floodplain between Grays Ford Road and Crain Highway (State Route 3), this site is part of the LP1 subwatershed. Because this site is located approximately 100 meters upstream of the confluence with the Little Patuxent River, the sampling reach was backwatered pool habitat with little observable flow. Low dissolved oxygen levels measured at this site are largely attributed to the stream being backwatered with little mixing occurring in the water column. Few woody debris and fibrous roots along the banks provided only minimal stable habitat for the benthic community. In spite of the partially supporting habitat, 21 taxa were present in the benthic sample with one Ephemeroptera taxa and one scraper taxa present. Of the 169 acre drainage area, 46% is forested land and 30% is developed land with only 1.7% impervious surface. However, it should be noted that the one large developed parcel (classified as industrial land use), appears to never have been fully developed and is more characteristic of open land, hence the low imperviousness in this drainage area.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Crangonyx) and midges dominated the sample.
- Measured below COMAR standards for dissolved oxygen.
- Poor habitat diversity but banks are stable. Good riparian width but marginal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	0.99
Turbidity (NTU)	12.3
Temperature (°C)	18.38
pH (SU)	6.65
Specific Conductivity (µS/cm)	231.4

LPAX-08-2011 LP1 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	2
Ephemeroptera Taxa	1
Intolerant Urban %	11.9
Ephemeroptera %	1.7
Scraper Taxa	1
% Climbers	11.9

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
Ablabesmyia	1
Bezzia/Palpomyia	1
Caecidotea	11
Caenis	2
Chironomini	6
Chironomus	21
Crangonyx	25
Cryptotendipes	5
Dubiraphia	3
Gammarus	6
Lumbricina	1
Mallochohelea	3
Microtendipes	1
Neoporus	8
Orthocladiinae	1
Paratendipes	2
Phaenopsectra	1
Polycentropus	1
Polypedilum	7
Tanytarsini	1
Tanytarsus	7
Thienemannimyia group	1
Tubificinae	3
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	5
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	20	Sediment Deposition	7
Channel Sinuosity	4	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	6		
EPA Habitat Score			**114**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	4	75.44
Shading	90	91.34	Instream Habitat	6	61.45
Epifaunal Substrate	5	51.82	Bank Stability	16	89.45
PHI Score					**75.05**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**169.47**
Cover	**Acres**	**%Area**
Developed Land	**50.98**	**30.08**
Commercial	0	0
Industrial	42.55	25.11
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	6.01	3.55
Transportation	2.42	1.43
Utility	0	0
Forest Land	**78.33**	**46.22**
Forested Wetland	0	0
Residential Woods	0	0
Woods	78.33	46.22
Open Land	**10.52**	**6.21**
Open Space	10.52	6.21
Open Wetland	0	0
Water	0	0
Agricultural Land	**29.64**	**17.49**
Pasture/Hay	24.86	14.67
Row Crops	4.77	2.82
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.8	1.68

LPAX-09-2011 LPC Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0490031808 **Longitude:** -76.6852101906

Located at the end of Springhill Court, this site is part of the LPC subwatershed and drains to Towsers Branch. Of the 1,001 acre drainage area to the site, over half consists of agricultural land--the majority of which is the US Naval Academy Dairy Farm, with developed land accounting for 23% of the drainage area. This channel is deeply incised with a severely eroded stream banks, indicating an unstable stream reach. Poor quality riffles and an overall lack of stable substrate resulted in non-supporting physical habitat. No EPT or scraper taxa were present in the benthic sample and only 1% of the sample consisted of intolerant urban taxa. Measured pH values fell below COMAR standards, but this may be due to naturally occurring acidic conditions.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Midges (Orthocladius) and worms (Naididae) dominated the sample.
- Measured below COMAR standards for pH.
- Very low woody debris score and marginal habitat diversity. Poor vegetative protection on the right bank and marginal riparian width on the left bank.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.33
Turbidity (NTU)	34.8
Temperature (°C)	24.5
pH (SU)	5.67
Specific Conductivity (µS/cm)	173.6

LPAX-09-2011 LPC Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	0.9
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	1.8

Calculated Metric Scores

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

Taxa	Count
Chaetocladius	1
Chironomidae	1
Chironomus	2
Cricotopus	2
Enchytraeidae	1
Lumbricina	2
Lumbriculidae	1
Micropsectra	1
Naidinae	24
Orthocladiinae	1
Orthocladius	67
Peltodytes	1
Rheocricotopus	6
Tubificinae	3
TOTAL:	**113**

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	5
Channel Flow Status	13	Sediment Deposition	10
Channel Sinuosity	8	Vegetative Protection - Left Bank	2
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	6		
EPA Habitat Score			**97**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	0	43.5
Shading	60	58.94	Instream Habitat	7	48.82
Epifaunal Substrate	7	51.87	Bank Stability	8	63.25
PHI Score					**53.37**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1001.12**
Cover	**Acres**	**%Area**
Developed Land	**228.44**	**22.82**
Commercial	50.26	5.02
Industrial	85.33	8.52
Residential 1/8-acre	11.52	1.15
Residential 1/4-acre	8.86	0.89
Residential 1/2-acre	2.52	0.25
Residential 1-Acre	8.68	0.87
Residential 2-Acre	19.28	1.93
Transportation	27.2	2.72
Utility	14.78	1.48
Forest Land	**101.63**	**10.15**
Forested Wetland	0	0
Residential Woods	0	0
Woods	101.63	10.15
Open Land	**132.36**	**13.22**
Open Space	130.12	13
Open Wetland	0	0
Water	2.24	0.22
Agricultural Land	**538.7**	**53.81**
Pasture/Hay	149.52	14.93
Row Crops	389.19	38.88
Impervious Surface	**Acres**	**% Area**
Impervious Land	137.7	13.75

LPAX-11-2011 LP2 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0386751783 **Longitude:** -76.7161438723

Located immediately downstream of Patuxent Road, this site is part of the LP2 subwatershed. This site drains a large wetland system upstream of the road crossing and into a large wetland downstream, and as a result the site was slightly backwatered. Low dissolved oxygen and pH values measured at this site are largely attributed to the wetland drainage and subsequent backwatering with little mixing occurring in the water column. Forested land accounts for 73% of the drainage area to this site with developed land accounting for 17%. Of the 366 acre drainage area, only 1.8% is impervious. However, a complete lack of EPT, Ephemeroptera, and scraper taxa resulted in a poor biological community.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea) and worms (Tubificidae and Naididae) dominated the sample.
- Measured below COMAR standards for pH and dissolved oxygen.
- Bank stability scored high but very little woody debris present. Refuse present in moderate amounts. Good vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	1.32
Turbidity (NTU)	9.65
Temperature (°C)	15.02
pH (SU)	5.72
Specific Conductivity (µS/cm)	72.5

LPAX-11-2011 LP2 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	47.3
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	2.7

Calculated Metric Scores

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

Taxa	Count
Bivalvia	1
Caecidotea	52
Ceratopogonidae	1
Chironomini	4
Chironomus	2
Corethrella	1
Culicoides	1
Curculionidae	1
Larsia	1
Lumbricina	1
Lumbriculidae	3
Naidinae	13
Peltodytes	2
Pisidium	3
Polypedilum	1
Serromyia	1
Synurella	4
Thienemanniella	1
Tubificinae	17
TOTAL:	**110**

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	8
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	6
Channel Flow Status	20	Sediment Deposition	18
Channel Sinuosity	8	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	12		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	2	10.77	Woody Debris/Rootwads	1	57.85
Shading	70	68.32	Instream Habitat	12	86.87
Epifaunal Substrate	10	75.86	Bank Stability	20	100
PHI Score					**66.61**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**365.72**
Cover	**Acres**	**%Area**
Developed Land	**62.96**	**17.22**
Commercial	0.18	0.05
Industrial	0.16	0.04
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.56	0.7
Residential 2-Acre	36.68	10.03
Transportation	8.01	2.19
Utility	15.36	4.2
Forest Land	**269.16**	**73.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	269.16	73.6
Open Land	**31.92**	**8.73**
Open Space	20.94	5.72
Open Wetland	3.25	0.89
Water	7.73	2.11
Agricultural Land	**1.68**	**0.46**
Pasture/Hay	1.68	0.46
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	6.5	1.77

LPAX-12-2011 LP2 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.042914223 **Longitude:** -76.7126820998

Located approximately 0.4 miles northeast of the intersection of Patuxent Road and Bragers Road, this site is part of the LP2 subwatershed. This site is located approximately 50 meters upstream of the confluence with the Little Patuxent River, and consequently the downstream end of the reach was backwatered. Poor quality riffles in a silt/clay substrate and minimal woody debris provide inadequate epifaunal substrate, resulting in a poor biological community. Because the sampling reach is located on the active floodplain of the Little Patuxent River, the local physical habitat is being influenced by backwatering and fine sediment deposition. Of the 277 acre drainage area to the site, only 6% is impervious surface. Half of the drainage area consists of forested land with the remaining 39% as open and 11% as developed land; however, it should be noted that the majority of the land classified as open is an active quarry operation.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Sample dominated by various midges and worms of the family Naididae.
- Measured below COMAR standards for pH.
- Poor bank stability and marginal habitat diversity. Very little woody debris. Good riparian width but marginal vegetative protection on the left bank.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.4
Turbidity (NTU)	28.7
Temperature (°C)	15.36
pH (SU)	6.18
Specific Conductivity (µS/cm)	122.3

LPAX-12-2011 LP2 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	27
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	4.9
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	11

Calculated Metric Scores

Total Taxa	5
EPT Taxa	1
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
Bezzia/Palpomyia	3
Brillia	4
Chironomini	3
Chironomus	1
Coenagrionidae	1
Crangonyx	2
Cricotopus	1
Dicranota	2
Diplectrona	1
Diptera	9
Enchytraeidae	1
Eukiefferiella	1
Lumbricina	2
Naidinae	10
Nemata	1
Orthocladiinae	5
Orthocladius	2
Parakiefferiella	1
Parametriocnemus	2
Peltodytes	1
Polypedilum	6
Rheocricotopus	8
Rheotanytarsus	2
Simulium	2
Staphylinidae	1
Tanytarsus	1
Thienemanniella	1
Thienemannimyia group	4
Tipula	1
Tubificinae	2
TOTAL:	**82**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	5
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	8
Channel Sinuosity	14	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	7		
EPA Habitat Score			**111**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	17	91.55	Woody Debris/Rootwads	1	60.99
Shading	80	78.67	Instream Habitat	5	50.87
Epifaunal Substrate	6	54.43	Bank Stability	10	70.71
PHI Score					**67.87**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**277.18**
Cover	**Acres**	**%Area**
Developed Land	**29.07**	**10.49**
Commercial	4.19	1.51
Industrial	21.96	7.92
Residential 1/8-acre	0	0
Residential 1/4-acre	2.82	1.02
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	0.1	0.04
Utility	0	0
Forest Land	**139.56**	**50.35**
Forested Wetland	0	0
Residential Woods	0	0
Woods	139.56	50.35
Open Land	**108.55**	**39.16**
Open Space	107.26	38.7
Open Wetland	0	0
Water	1.29	0.47
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	15.8	5.69

LPAX-13-2011 LP3 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0469569916 **Longitude:** -76.7248178859

This site is located approximately 200 meters northeast of Patuxent Road and is part of the LP3 subwatershed. The drainage area to this site (798 acres) is largely forested land (85%) with only 3% impervious surface. However, because the stream is located approximately 200 meters upstream of the confluence with the Little Patuxent River, this site was predominantly backwatered with virtually no visible flow. Low dissolved oxygen levels measured at this site are largely attributed to the stream being backwatered with little mixing occurring in the water column. Poor physical habitat consisted of mostly deep pools with anaerobic silt/muck bottom, insufficient for supporting a robust biological community. Measured pH values fell below COMAR standards, which is likely due to wetland drainage as evidenced by the tannic color of the water.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Sample dominated by midges (Serromyia and Chironomus) and worms (Tubificidae).
- Measured below COMAR standards for pH and dissolved oxygen.
- Marginal habitat diversity but good riparian vegetation. Banks are moderately unstable. Good riparian width but marginal vegetative protection on the left bank.

Water Chemistry:

Dissolved Oxygen (mg/L)	4.69
Turbidity (NTU)	21.2
Temperature (°C)	16.57
pH (SU)	6.46
Specific Conductivity (µS/cm)	142.4

LPAX-13-2011 LP3 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	13.1
Ephemeroptera %	0.9
Scraper Taxa	1
% Climbers	0.9

Calculated Metric Scores

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

Taxa	Count
Caecidotea	11
Caenis	1
Chironomus	17
Crangonyx	3
Culicoides	1
Ephydridae	1
Gomphidae	1
Hydrobaenus	1
Musculium	2
Orthocladiinae	1
Orthocladius	1
Pisidiidae	1
Pisidium	3
Polypedilum	1
Procladius	1
Rheotanytarsus	1
Serromyia	22
Tubificinae	37
Zavrelimyia	1
TOTAL:	**107**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	6
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	6
Channel Sinuosity	8	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	5		
EPA Habitat Score			**100**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Woody Debris/Rootwads	7	66.77
Shading	100	100	Instream Habitat	6	45.59
Epifaunal Substrate	5	41.73	Bank Stability	7	59.16
PHI Score					**62.98**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**798.2**
Cover	**Acres**	**%Area**
Developed Land	**84.25**	**10.56**
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	6.66	0.83
Residential 2-Acre	43.37	5.43
Transportation	34.22	4.29
Utility	0	0
Forest Land	**677.45**	**84.87**
Forested Wetland	0	0
Residential Woods	0	0
Woods	677.45	84.87
Open Land	**36.5**	**4.57**
Open Space	36.5	4.57
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	25.2	3.16

LPAX-14-2011 LP3 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0488016996 **Longitude:** -76.7296755061

Located approximately 300 meters east of Patuxent Road, this site is part of the LP3 subwatershed. The drainage area to this site (385 acres) is predominantly forested land (83%), which includes property on the Patuxent Research Refuge. Located on the floodplain of the Little Patuxent River, this site drains an extensive wetland area. With very little flow, the site is an entrenched channel with a silt/sand bottom and an abundance of detrital material. Although the site received a partially supporting habitat score, epifaunal substrate was only marginal, resulting in a poor biological community which contained only one EPT taxa, lacked Ephemeroptera taxa, and consisted of just 6% intolerant taxa in the benthic sample. All measured water quality parameters fell within COMAR standards. Impacts from historical land use (deforestation, channelization, etc.) may continue to limit the stream's ability to support a healthy biota.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Crangonyx) and midges dominated the sample.
- Water quality values within COMAR standards.
- Moderately stable banks with marginal habitat diversity. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	5.12
Turbidity (NTU)	12.4
Temperature (°C)	16.87
pH (SU)	6.69
Specific Conductivity (µS/cm)	119.5

LPAX-14-2011 LP3 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	6
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	3.4

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
Amphipoda	12
Brillia	1
Caecidotea	2
Chironomini	2
Chironomus	15
Cladotanytarsus	1
Corynoneura	5
Crangonyx	37
Cricotopus	2
Elmidae	1
Hydrobaenus	1
Micropsectra	3
Microtendipes	4
Musculium	5
Oecetis	1
Orthocladiinae	1
Orthocladius	1
Parametriocnemus	2
Polypedilum	1
Potthastia	2
Rheotanytarsus	11
Simuliidae	1
Thienemanniella	2
Trichoptera	1
Tubificinae	3
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	8
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	13	Sediment Deposition	9
Channel Sinuosity	10	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	7		
EPA Habitat Score			**124**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	18	96.93	Woody Debris/Rootwads	5	69.1
Shading	100	100	Instream Habitat	5	47.5
Epifaunal Substrate	7	58.09	Bank Stability	14	83.67
PHI Score					**75.88**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**385.12**
Cover	**Acres**	**%Area**
Developed Land	**48.64**	**12.63**
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	6.66	1.73
Residential 2-Acre	19.68	5.11
Transportation	22.3	5.79
Utility	0	0
Forest Land	**321.21**	**83.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	321.21	83.4
Open Land	**15.28**	**3.97**
Open Space	15.28	3.97
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	16.1	4.17

LPAX-15-2011 LPL Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0491529775 **Longitude:** -76.7163012177

Located just off of a hike and bike trail near Strawberry Lake Way, this site is part of the LPL subwatershed. Of the 798 acre drainage area to this site, 30% consists of impervious surface and largely drains high density residential communities (68%). Conductivity values were elevated, likely due to the high imperviousness in the drainage area. Numerous good quality riffles and woody debris/rootwads support a fair biological community with high taxa diversity. Multiple sand and gravel bars throughout the stream indicate a system that is overwidened and actively aggrading.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Worms (Naididae), midges (Orthocladius) and black flies (Simulium) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Scored high for instream habitat, epibenthic substrate, and woody debris.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.66
Turbidity (NTU)	2.76
Temperature (°C)	15.35
pH (SU)	6.64
Specific Conductivity (µS/cm)	301.2

LPAX-15-2011 LPL Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	27
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	2
% Climbers	5.1

Calculated Metric Scores

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

Taxa	Count
Acentrella	1
Boyeria	1
Brillia	3
Chaetocladius	1
Chironomidae	1
Corynoneura	1
Cricotopus	1
Hydrobaenus	2
Hydropsyche	2
Limnophyes	1
Naidinae	15
Nemata	1
Orthocladiinae	1
Orthocladius	19
Parakiefferiella	1
Parametriocnemus	3
Paratanytarsus	2
Paratendipes	1
Physa	1
Polypedilum	1
Rheotanytarsus	5
Simulium	11
Stenochironomus	1
Taeniopteryx	8
Tanytarsini	1
Tanytarsus	2
Thienemanniella	6
Tipula	3
Tubificinae	1
Tvetenia	1
TOTAL:	**98**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	10
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	6
Channel Sinuosity	12	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	11		
EPA Habitat Score			**132**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Woody Debris/Rootwads	11	80.07
Shading	95	99.94	Instream Habitat	15	96.86
Epifaunal Substrate	14	94.86	Bank Stability	17	92.2
PHI Score					**82.71**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**700.96**
Cover	**Acres**	**%Area**
Developed Land	**479.58**	**68.42**
Commercial	4.53	0.65
Industrial	11.43	1.63
Residential 1/8-acre	248.55	35.46
Residential 1/4-acre	177.9	25.38
Residential 1/2-acre	0	0
Residential 1-Acre	0.73	0.1
Residential 2-Acre	4.1	0.59
Transportation	32.33	4.61
Utility	0	0
Forest Land	**190.51**	**27.18**
Forested Wetland	0	0
Residential Woods	0	0
Woods	190.51	27.18
Open Land	**30.87**	**4.4**
Open Space	29.62	4.23
Open Wetland	0	0
Water	1.25	0.18
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	208.3	29.72

LPAX-16-2011 LPL Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0595530917 **Longitude:** -76.7129874179

Located behind a retention pond to the east of Streamview Drive, this site is part of the LPL subwatershed. Of the 241 acre drainage area to this site, 27% consists impervious surface and largely drains high density residential communities (64%). Low pH and elevated conductivity values measured at this site may be attributed to an outfall from the retention pond that flows directly into the sampling reach. A mix of riffle and woody debris habitat is only partially supporting of a healthy biological community. Only 2% of the benthic sample accounted for taxa intolerant to urban stressors, and the overall benthic community was rated poor.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Worms of the Naididae family and various midges dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- Most habitat variables received sub-optimal scores. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.94
Turbidity (NTU)	3.17
Temperature (°C)	15.17
pH (SU)	6.23
Specific Conductivity (µS/cm)	393.5

LPAX-16-2011 LPL Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1.8
Ephemeroptera %	0.9
Scraper Taxa	1
% Climbers	4.5

Calculated Metric Scores

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

Taxa	Count
Cheumatopsyche	3
Chironomidae	1
Chironomini	1
Diplocladius	2
Eukiefferiella	4
Ironoquia	3
Libellulidae	1
Musculium	1
Naidinae	44
Orthocladiinae	16
Orthocladius	7
Parametriocnemus	10
Physa	1
Plauditus	1
Polypedilum	4
Potthastia	1
Rheotanytarsus	1
Thienemanniella	1
Tubificinae	2
Tvetenia	6
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	10
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	11	Sediment Deposition	9
Channel Sinuosity	14	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	8		
EPA Habitat Score			**120**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	9	48.47	Woody Debris/Rootwads	4	71.46
Shading	95	99.94	Instream Habitat	13	96.7
Epifaunal Substrate	11	84.39	Bank Stability	11	74.16
PHI Score					**79.19**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**240.74**
Cover	**Acres**	**%Area**
Developed Land	**153.79**	**63.88**
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	83.23	34.57
Residential 1/4-acre	54.35	22.58
Residential 1/2-acre	0	0
Residential 1-Acre	0.73	0.3
Residential 2-Acre	4.1	1.7
Transportation	11.37	4.72
Utility	0	0
Forest Land	**84.26**	**35**
Forested Wetland	0	0
Residential Woods	0	0
Woods	84.26	35
Open Land	**2.7**	**1.12**
Open Space	2.31	0.96
Open Wetland	0	0
Water	0.39	0.16
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	65.4	27.15

LPAX-17-2011 LPB Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0489726492 **Longitude:** -76.6857378423

Located east of a powerline corridor that runs behind Springhill Court, this site is part of the LPB subwatershed. Of the 1,330 acre drainage area to this site, 64% consists of developed land and 20% as forested land. Impervious surface accounts for 24% of the drainage area. The channel is incised with severe bank erosion indicating an unstable stream type, likely resulting from the high imperviousness upstream. The riparian buffer width was limited due to the powerline corridor along the left bank and pasture along the right bank (US Naval Academy Dairy Farm). Water quality measured below COMAR standards for pH, which is likely due to wetland drainage upstream. Because habitat is supporting and biological condition is poor, there may be problems with water quality in this drainage system that cannot be measured through in situ analysis only. However, the unstable stream type may also be impacting the biota.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by midges (Orthocladius, Polypedilum,and Tvetenia).
- Measured below COMAR standards for pH.
- Marginal bank stability. Instream habitat and epibenthic substrate received sub-optimal scores. Refuse present in moderate amounts.

Water Chemistry:

Dissolved Oxygen (mg/L)	9.51
Turbidity (NTU)	11.3
Temperature (°C)	19.42
pH (SU)	5.76
Specific Conductivity (µS/cm)	178.7

LPAX-17-2011 LPB Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	22.2

Calculated Metric Scores

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

Taxa	Count
Amphipoda	1
Ancyronyx	9
Calopteryx	3
Cheumatopsyche	8
Chironomidae	1
Chironomini	2
Crangonyx	1
Dicrotendipes	4
Hydropsyche	6
Macronychus	4
Naidinae	4
Orthocladiinae	1
Orthocladius	20
Parametriocnemus	1
Polypedilum	21
Stenelmis	3
Thienemanniella	2
Thienemannimyia group	1
Tubificinae	2
Tvetenia	14
TOTAL:	**108**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	13
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	7
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	13	Sediment Deposition	12
Channel Sinuosity	9	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	11		
EPA Habitat Score			**128**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	4	52.11
Shading	50	49.95	Instream Habitat	14	84.75
Epifaunal Substrate	14	90.69	Bank Stability	10	70.71
PHI Score					**67.01**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1329.86**
Cover	**Acres**	**%Area**
Developed Land	**848.6**	**63.81**
Commercial	36.84	2.77
Industrial	0.37	0.03
Residential 1/8-acre	212.12	15.95
Residential 1/4-acre	503.83	37.89
Residential 1/2-acre	0	0
Residential 1-Acre	13.9	1.05
Residential 2-Acre	21.95	1.65
Transportation	22.66	1.7
Utility	36.93	2.78
Forest Land	**260.23**	**19.57**
Forested Wetland	0	0
Residential Woods	0	0
Woods	260.23	19.57
Open Land	**98.68**	**7.42**
Open Space	98.5	7.41
Open Wetland	0	0
Water	0.18	0.01
Agricultural Land	**122.36**	**9.2**
Pasture/Hay	98.61	7.41
Row Crops	23.75	1.79
Impervious Surface	**Acres**	**% Area**
Impervious Land	324.2	24.38

LPAX-18-2011 LPB Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0586884382 **Longitude:** -76.6888042091

Located behind the end of Autumn Valley Lane and Four Season Drive, this site is part of the LPB subwatershed and drains to Towsers Branch. A quarter of the drainage area to this site is impervious surface as the dominant land cover is developed (68%), followed by forested land (25%). This site has a limited forested riparian buffer due to the powerline corridor along the left bank and pasture along the right bank (US Naval Academy Dairy Farm). Wetlands surround and drain to this reach, which may contribute to the low pH measurements. A mix of riffle and woody debris habitat support a poor biological community that had high taxa diversity yet a lack of both Ephemeroptera and intolerant taxa. The downstream end of the reach is deeply incised; however, armoring around a utility line has prevented the headcut from moving upstream but also backwatered the stream for a good portion of the sampling reach.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Sample dominated by midges (Diplocladius and Orthocladius), worms (Naididae), and beetles (Ancyronyx).
- Measured below COMAR standards for pH.
- Sub-optimal habitat diversity. Moderately unstable banks. Good riparian width but poor vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	6.84
Turbidity (NTU)	8.04
Temperature (°C)	19.38
pH (SU)	5.77
Specific Conductivity (µS/cm)	243.1

LPAX-18-2011 LPB Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	5
% Climbers	13.2

Calculated Metric Scores

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

Taxa	Count
Ancyronyx	14
Brillia	1
Calopteryx	4
Cheumatopsyche	1
Chironomini	1
Crangonyctidae	1
Cryptochironomus	1
Dicrotendipes	2
Diplocladius	10
Dubiraphia	1
Eukiefferiella	5
Helichus	2
Macronychus	3
Naidinae	11
Nanocladius	1
Nemata	1
Orthocladiinae	5
Orthocladius	13
Parametriocnemus	1
Polypedilum	9
Rheocricotopus	5
Simulium	4
Stenelmis	2
Stenochironomus	1
Tanytarsini	1
Tanytarsus	1
Thienemanniella	1
Tvetenia	4
TOTAL:	**106**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	3	Pool Variability	11
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	11	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	15	Sediment Deposition	15
Channel Sinuosity	10	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	9		
EPA Habitat Score			**118**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Woody Debris/Rootwads	5	58.65
Shading	95	99.94	Instream Habitat	14	87.99
Epifaunal Substrate	15	98.55	Bank Stability	6	54.77
PHI Score					**77.42**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**969.69**
Cover	**Acres**	**%Area**
Developed Land	**655.53**	**67.6**
Commercial	29.66	3.06
Industrial	0.37	0.04
Residential 1/8-acre	158.84	16.38
Residential 1/4-acre	389.28	40.15
Residential 1/2-acre	0	0
Residential 1-Acre	13.9	1.43
Residential 2-Acre	21.95	2.26
Transportation	15.13	1.56
Utility	26.38	2.72
Forest Land	**247.12**	**25.48**
Forested Wetland	0	0
Residential Woods	0	0
Woods	247.12	25.48
Open Land	**51.16**	**5.28**
Open Space	51.16	5.28
Open Wetland	0	0
Water	0	0
Agricultural Land	**15.88**	**1.64**
Pasture/Hay	15.12	1.56
Row Crops	0.75	0.08

Impervious Surface	**Acres**	**% Area**
Impervious Land	244.3	25.2

LPAX-19-2011 LPF Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0599999506 **Longitude:** -76.7310535605

This site is located on the Rogue Harbor Branch mainstem approximately 150 meters upstream of the confluence with the Little Patuxent River, just west of Piney Orchard Parkway, in the LPF subwatershed. The drainage area to this site (5,388 acres) drains a large section of Fort Meade Military Reservation and part of the Patuxent Research Refuge. The predominant land cover is split between developed and forested land (38% for each) with a large portion of open space (21%), resulting in 19.7% imperviousness. There is an good mix of stable habitat including an abundance of roots and woody debris as well as gravel riffles. Heavy bar formation in the channel indicates some overwidening, but stream banks are mostly stable. Ten EPT taxa, including 3 Ephemeroptera, and 6 scraper taxa were present in the benthic sample; however, only 6% of the sample consisted of taxa intolerant to urban stressors. Elevated levels of conductivity may be a result of the developed land cover upstream and may affect the quantity of intolerant taxa.

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Sample dominated by midges (including Polypedilum and Rheotanytarsus) and beetles (Stenelmis).
- Water quality values within COMAR standards but conductivity elevated.
- Instream habitat, epibenthic substrate, and bank stability received sub-optimal scores. Low scores for remoteness and woody debris. Good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.5
Turbidity (NTU)	7.4
Temperature (°C)	12.3
pH (SU)	7.03
Specific Conductivity (µS/cm)	425.5

LPAX-19-2011 LPF Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	29
EPT Taxa	10
Ephemeroptera Taxa	3
Intolerant Urban %	8.5
Ephemeroptera %	7.5
Scraper Taxa	6
% Climbers	15.1

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**4.14**
BIBI Narrative Rating	**Good**

Taxa	Count
Acentrella	1
Ancyronyx	2
Baetis	1
Bezzia/Palpomyia	1
Calopteryx	1
Cheumatopsyche	6
Chironomini	5
Cladotanytarsus	1
Coenagrionidae	1
Corynoneura	2
Diamesinae	1
Dubiraphia	3
Helichus	1
Hydropsyche	1
Hydropsychidae	1
Maccaffertium	6
Macronychus	2
Microcylloepus	7
Nectopsyche	1
Orthocladiinae	1
Orthocladius	5
Perlesta	1
Polycentropodidae	1
Polypedilum	9
Potthastia	1
Rheocricotopus	5
Rheotanytarsus	7
Simuliidae	1
Simulium	4
Stenelmis	14
Taeniopteryx	6
Tanytarsus	4
Triaenodes	2
Tvetenia	1
TOTAL:	**106**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	14
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	10
Channel Sinuosity	13	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	15	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	12		
EPA Habitat Score			**151**
EPA Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Woody Debris/Rootwads	12	59.94
Shading	90	91.34	Instream Habitat	15	75.98
Epifaunal Substrate	15	87.38	Bank Stability	16	89.45
PHI Score					**73.63**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 5387.58

Cover	Acres	%Area
Developed Land	**2062.63**	**38.29**
Commercial	622.23	11.55
Industrial	170.53	3.17
Residential 1/8-acre	609.19	11.31
Residential 1/4-acre	216.75	4.02
Residential 1/2-acre	28.13	0.52
Residential 1-Acre	32.69	0.61
Residential 2-Acre	30.01	0.56
Transportation	337.33	6.26
Utility	15.78	0.29
Forest Land	**2032.61**	**37.73**
Forested Wetland	7.9	0.15
Residential Woods	0	0
Woods	2024.71	37.58
Open Land	**1148.44**	**21.32**
Open Space	1096.16	20.35
Open Wetland	21.2	0.39
Water	31.07	0.58
Agricultural Land	**143.89**	**2.67**
Pasture/Hay	143.89	2.67
Row Crops	0	0

Impervious Surface	Acres	% Area
Impervious Land	1062.7	19.73

LPAX-20-2011 LPF Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0802264645 **Longitude:** -76.7259047949

Located in the Patuxent Research Refuge off of Wildlife Loop Road and immediately downstream of a culvert adjacent to a firing range, this site is on a tributary to Rouge Harbor and is part of the LPF subwatershed. The drainage area to this site (773 acres) drains a section of Fort Meade Military Reservation and part of the Patuxent Research Refuge. The predominant land cover is developed (43%), which may explain the elevated conductivity levels, followed closely by forested land (38%). Numerous riffles, while only moderate quality, as well as rootwads support a good biological community. The benthic sample for this site had high taxa diversity (31 taxa) and was dominated by an intolerant mayfly, Caenis (T.V. = 2.1), resulting in a high percentage of Ephemeroptera (24%) and percentage of taxa intolerant to urban stressors (33%).

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by Caenis(Ephemeroptera) and beetles (Stenelmis).
- Water quality values within COMAR standards but conductivity elevated.
- Bank stability scored high. Sub-optimal habitat diversity. Low scores for remoteness and woody debris. Good vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	7.22
Turbidity (NTU)	8.87
Temperature (°C)	21.37
pH (SU)	7.14
Specific Conductivity (µS/cm)	619.7

LPAX-20-2011 LPF Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	31
EPT Taxa	4
Ephemeroptera Taxa	1
Intolerant Urban %	32.7
Ephemeroptera %	23.6
Scraper Taxa	4
% Climbers	7.3

Calculated Metric Scores

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

Taxa	Count
Bezzia/Palpomyia	1
Caenis	26
Chaetocladius	4
Cheumatopsyche	3
Chironomini	1
Chironomus	2
Corynoneura	1
Diplocladius	2
Dubiraphia	1
Helichus	1
Hemerodromia	1
Hydropsychidae	1
Ironoquia	1
Ischnura	3
Micropsectra	1
Musculium	1
Naidinae	2
Nanocladius	1
Nematoda	1
Neoporus	5
Orthocladiinae	3
Parametriocnemus	3
Paratanytarsus	7
Perlesta	8
Physa	1
Polypedilum	2
Potthastia	1
Rheotanytarsus	3
Simulium	1
Sphaerium	1
Stenelmis	15
Tanytarsus	1
Thienemanniella	1
Tubificinae	4
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	13
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	13	Sediment Deposition	12
Channel Sinuosity	6	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	12		
EPA Habitat Score			**134**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Woody Debris/Rootwads	3	55.3
Shading	95	99.94	Instream Habitat	11	73.67
Epifaunal Substrate	12	82.6	Bank Stability	17	92.2
PHI Score					**73.57**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**772.69**
Cover	**Acres**	**%Area**
Developed Land	**331.97**	**42.96**
Commercial	64.81	8.39
Industrial	109.85	14.22
Residential 1/8-acre	21.37	2.77
Residential 1/4-acre	46.08	5.96
Residential 1/2-acre	5.26	0.68
Residential 1-Acre	11.67	1.51
Residential 2-Acre	1.65	0.21
Transportation	63.19	8.18
Utility	8.1	1.05
Forest Land	**296.17**	**38.33**
Forested Wetland	0	0
Residential Woods	0	0
Woods	296.17	38.33
Open Land	**84.92**	**10.99**
Open Space	77.7	10.06
Open Wetland	1.17	0.15
Water	6.05	0.78
Agricultural Land	**59.62**	**7.72**
Pasture/Hay	59.62	7.72
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	130.2	16.85

LPAX-23-2011 LP5 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0982987741 **Longitude:** -76.776099634

Located on the property of the District of Columbia Children's Center and approximately 475 meters east of the end of Forest Haven Avenue, this site is part of the LP5 subwatershed. Of the 118 acre drainage area, 62% is forested with the remaining 27% as developed and 12% as open space, resulting in 13.5% imperviousness. Located approximately 150 meters upstream of the confluence at the Little Patuxent River, the stream drains an extensive wetland network and has very little visible flow. The channel consists of all muck and detritus bottom substrate with very little stable benthic substrate. Some small emergent vegetation is present but mostly young plants. An excellent riparian buffer contributes to a partially supporting habitat. Elevated conductivity levels may be a result of the developed land cover upstream.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Bivalves (Musculium), isopods (Caecidotea), and worms (Tubificidae) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Poor habitat diversity but banks are stable. Good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	5.18
Turbidity (NTU)	25
Temperature (°C)	13.63
pH (SU)	6.68
Specific Conductivity (µS/cm)	357.4

LPAX-23-2011 LP5 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	16.7
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	15.7

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
Bezzia/Palpomyia	1
Bivalvia	6
Caecidotea	16
Chaoboridae	1
Chironomini	2
Chironomus	10
Chrysops	1
Crangonyx	4
Dixidae	2
Fossaria	11
Hydroporini	1
Lepidoptera	1
Limnephilidae	1
Musculium	20
Naidinae	1
Orthocladiinae	2
Orthocladius	2
Physa	1
Stratiomyidae	1
Tanytarsus	3
Tubificinae	14
Tvetenia	1
TOTAL:	**102**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	4
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	6	Sediment Deposition	10
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	5		
EPA Habitat Score			**117**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	20	100	Woody Debris/Rootwads	5	82.52
Shading	95	99.94	Instream Habitat	2	42.98
Epifaunal Substrate	4	48.38	Bank Stability	18	94.87
PHI Score					**78.12**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**117.75**
Cover	**Acres**	**%Area**
Developed Land	**31.65**	**26.88**
Commercial	28.18	23.93
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	3.46	2.94
Utility	0	0
Forest Land	**72.48**	**61.55**
Forested Wetland	0	0
Residential Woods	0	0
Woods	72.48	61.55
Open Land	**13.62**	**11.57**
Open Space	13.62	11.57
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	15.9	13.54

LPAX-24-2011 LPO Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0784450442 **Longitude:** -76.772900715

Located within the Patuxent Research Refuge approximately 100 meters upstream of Bald Eagle Drive near the visitor center, this site is on an unnamed tributary to the Little Patuxent River and is part of the LPO subwatershed. The 146 acre drainage area to this site is predominantly forested land (95%) with only 5% accounting for developed land. Only 1.7% of the drainage area is impervious surface. Even though there is an adequate mix of riffles and woody debris/rootwad habitat, there is a poor biological community due to few EPT taxa and the complete lack of Ephemeroptera taxa and scraper taxa in the benthic sample. Measured pH values fell below COMAR standards; however, the lack of anthropogenic disturbance suggests that it is due to naturally acidic conditions in this drainage area. Evidence of incision, overwidening, and active bank erosion indicate that the channel has not yet reach a stable form, which could also explain why the benthic community is not meeting expectations.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Black flies (Simulium and Stegopterna) dominated the sample.
- Measured below COMAR standards for pH.
- Most habitat variables received sub-optimal scores. Scored high for woody debris. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.93
Turbidity (NTU)	3.89
Temperature (°C)	10
pH (SU)	4.89
Specific Conductivity (µS/cm)	49.6

LPAX-24-2011 LPO Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	41.2
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	3.9

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
Bezzia/Palpomyia	2
Calopteryx	1
Chironomini	1
Cricotopus	1
Enchytraeidae	3
Eukiefferiella	5
Hydroporini	1
Ironoquia	1
Leuctra	2
Lumbricina	4
Naidinae	1
Nemouridae	2
Orthocladiinae	4
Orthocladius	1
Paramerina	1
Parametriocnemus	4
Polypedilum	3
Rheocricotopus	4
Simuliidae	5
Simulium	14
Stegopterna	35
Thienemannimyia group	4
Wormaldia	1
TOTAL:	**102**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	10
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	13	Sediment Deposition	11
Channel Sinuosity	15	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	11		
EPA Habitat Score			**144**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Woody Debris/Rootwads	8	88.94
Shading	90	91.34	Instream Habitat	11	90.7
Epifaunal Substrate	13	99.26	Bank Stability	15	86.61
PHI Score					**86.01**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) **146.29**

Cover	Acres	%Area
Developed Land	**7.3**	**4.99**
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	7.3	4.99
Utility	0	0
Forest Land	**137.79**	**94.19**
Forested Wetland	0	0
Residential Woods	0	0
Woods	137.79	94.19
Open Land	**1.21**	**0.83**
Open Space	1.21	0.83
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	2.5	1.73

LPAX-25-2011 LPO Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0783628833 **Longitude:** -76.7796143343

This site is located within the Patuxent Research Refuge approximately 0.4 miles west of the visitor center on an unnamed tributary that drains to the Little Patuxent River in the LPO subwatershed. The 208 acre drainage area to this site is predominantly forested land (86%) with 13% accounting for open space. Only 0.6% of the drainage area is impervious surface. This site has an optimal mix of stable habitat types with numerous riffles and rootwads providing adequate habitat for a healthy and diverse benthic community. High taxa diversity (35 taxa) including 8 EPT taxa, 2 Ephemeroptera taxa, and 6 scraper taxa were present in this sample. Moderate bar formation and some minor bank erosion is present, but the stream appears to be evolving to a more stable stream type from a previously disturbed and incised state. Measured pH values fell below COMAR standards; however, the lack of anthropogenic disturbance suggests that it is due to naturally acidic conditions in this drainage area.

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Various midges and the Trichoptera genus, Diplectrona, dominated the sample.
- Measured below COMAR standards for pH.
- Most habitat variables received sub-optimal to optimal scores. Scored very high for woody debris. Good riparian width and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.73
Turbidity (NTU)	3.96
Temperature (°C)	10.07
pH (SU)	5.82
Specific Conductivity (µS/cm)	51.7

LPAX-25-2011 LPO Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	35
EPT Taxa	8
Ephemeroptera Taxa	2
Intolerant Urban %	26.8
Ephemeroptera %	6.3
Scraper Taxa	6
% Climbers	18.8

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**4.43**
BIBI Narrative Rating	**Good**

Taxa	Count
Ablabesmyia	2
Amphinemura	1
Anchytarsus	4
Ancyronyx	1
Bezzia/Palpomyia	1
Calopteryx	1
Chironomini	1
Corynoneura	1
Diamesinae	1
Dineutus	1
Diplectrona	13
Eccoptura	1
Enchytraeidae	1
Eurylophella	5
Habrophlebia	1
Helichus	1
Hydroporini	1
Lepidoptera	2
Leptophlebiidae	1
Leuctra	8
Nigronia	1
Orthocladiinae	1
Oulimnius	1
Parametriocnemus	18
Phaenopsectra	1
Polypedilum	8
Pseudolimnophila	1
Psilotreta	1
Pycnopsyche	1
Simulium	1
Stegopterna	1
Stempellinella	5
Stenelmis	2
Tanytarsus	7
Thienemannimyia group	5
Tipula	1
Tipulidae	1
Tvetenia	3
Zavrelimyia	5
TOTAL:	**112**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	13
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	12
Channel Sinuosity	13	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	15	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	13		
EPA Habitat Score			**154**
EPA Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	19	100	Woody Debris/Rootwads	12	96.77
Shading	95	99.94	Instream Habitat	14	100
Epifaunal Substrate	16	100	Bank Stability	16	89.45
PHI Score					**97.69**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**208.29**
Cover	**Acres**	**%Area**
Developed Land	**1.72**	**0.83**
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	1.72	0.83
Utility	0	0
Forest Land	**179.96**	**86.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	179.96	86.4
Open Land	**26.6**	**12.77**
Open Space	26.6	12.77
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	1.3	0.6

LPAX-26-2011 LPO Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0754986306 **Longitude:** -76.7779495874

Located within the Patuxent Research Refuge just off of Switchboard Road, this site is on an unnamed tributary that drains to the Little Patuxent River and is part of the LPO subwatershed. The 101 acre drainage area to this site consists largely of forested land (94%) with only 5% accounting for developed land, only 1.4% which of is impervious surface. This reach consisted of a series of stagnant, backwatered pools caused by leaf/woody debris jams throughout the reach and exhibited virtually no visible flow. While there were only a few poor quality riffles present, instream woody debris and leaf packs provided habitat to the benthic community. A high percentage of intolerants (50%) and climbers (8%) in the sample led to a fair biological condition rating. Low dissolved oxygen levels measured at this site are largely attributed to the stream being backwatered with little mixing occurring in the water column and the abundance of detrital decomposition. Measured pH values fell below COMAR standards; however, the lack of anthropogenic disturbance suggests that it is due to naturally acidic conditions in this drainage area. Furthermore, the lack of flow and small drainage area suggest that this reach may be intermittent in nature.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea), worms (Lumbricina and Enchytraeidae), and midges dominated the sample.
- Measured below COMAR standards for pH and dissolved oxygen.
- Marginal habitat diversity and banks are moderately stable. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	4.85
Turbidity (NTU)	4.52
Temperature (°C)	10.4
pH (SU)	5.2
Specific Conductivity (µS/cm)	41

LPAX-26-2011 LPO Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	50
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	8

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
Aedes	1
Caecidotea	21
Chironomidae	1
Curculionidae	1
Enchytraeidae	11
Eukiefferiella	1
Hydrobaenus	1
Hydroporini	1
Ironoquia	2
Libellulidae	1
Lumbricina	9
Orthocladiinae	1
Paraphaenocladius	2
Podmosta	8
Pseudorthocladius	2
Stegopterna	21
Tanytarsus	8
Tvetenia	8
TOTAL:	**100**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	7
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	11	Sediment Deposition	11
Channel Sinuosity	12	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	6		
EPA Habitat Score			**120**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Woody Debris/Rootwads	2	75.33
Shading	95	99.94	Instream Habitat	7	72.25
Epifaunal Substrate	7	66.78	Bank Stability	11	74.16
PHI Score					**71.92**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**101.45**
Cover	**Acres**	**%Area**
Developed Land	**5.17**	**5.1**
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	0	0
Residential 2-Acre	0	0
Transportation	5.17	5.1
Utility	0	0
Forest Land	**95.06**	**93.71**
Forested Wetland	0	0
Residential Woods	0	0
Woods	95.06	93.71
Open Land	**1.21**	**1.19**
Open Space	1.21	1.19
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	1.4	1.4

LPAX-28-2011 LP5 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1048558768 **Longitude:** -76.7806478164

Located south of Oak Hill Drive on a tributary to the Little Patuxent River, this site is part of the LP5 subwatershed. Over half of the 407 acre drainage area is developed land (56%) and includes part of the Fort Meade Military Reservation. The channel is incised and overwidened with some heavily eroded banks and extensive bar formation. Gravel dominated riffles of moderate quality provide limited habitat for a very poor biological community. Only 11 taxa were present in the benthic sample which completely lacked EPT, Ephemeroptera, scraper, and intolerant taxa. Because habitat is partially supporting and biological condition is very poor, there are likely water quality issues, such as elevated conductivity, impacting the biological community.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Most habitat variables received sub-optimal scores. Moderately unstable banks. Refuse present in moderate amounts.

Water Chemistry:

Dissolved Oxygen (mg/L)	11.03
Turbidity (NTU)	9.1
Temperature (°C)	14.33
pH (SU)	7.9
Specific Conductivity (µS/cm)	613.8

LPAX-28-2011 LP5 Subwatershed

Biological Assessment

Raw Metric Values

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

Calculated Metric Scores

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

Taxa	Count
Argia	1
Ceratopogonidae	2
Chaetocladius	1
Chironomidae	1
Cricotopus	2
Ephydridae	1
Hydrobaenus	2
Limnophyes	1
Muscidae	1
Nematoda	3
Orthocladiinae	4
Orthocladius	98
Stenelmis	2
TOTAL:	**119**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	9
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	14	Sediment Deposition	7
Channel Sinuosity	10	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	11		
EPA Habitat Score			**114**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Woody Debris/Rootwads	3	62.55
Shading	90	91.34	Instream Habitat	11	80.22
Epifaunal Substrate	12	86.78	Bank Stability	8	63.25
PHI Score					**76.59**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**407.26**
Cover	**Acres**	**%Area**
Developed Land	**229.3**	**56.3**
Commercial	105.15	25.82
Industrial	0	0
Residential 1/8-acre	94.51	23.21
Residential 1/4-acre	1.46	0.36
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	28.17	6.92
Utility	0	0
Forest Land	**143.2**	**35.16**
Forested Wetland	0	0
Residential Woods	0	0
Woods	143.2	35.16
Open Land	**34.77**	**8.54**
Open Space	34.27	8.42
Open Wetland	0	0
Water	0.5	0.12
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	147.3	36.18

LPAX-29-2011 LPN Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0903630658 **Longitude:** -76.7636466722

This site is located between Patuxent Freeway (Rt. 32) and General Aviation Drive, this site is on an unnamed tributary to the Little Patuxent River and is part of the LPN subwatershed. Close to half of the 124 acre drainage area to this site is developed land (49%), which includes part of the Fort Meade Military Reservation. Forested and open space account for the remaining 32% and 20% of the drainage area, respectively. Over a third of the drainage area (37%) is impervious surface, which includes several large parking lots and a large stretch of Rt. 32. This site is located on an incised channel with little observed flow. The stream appears to have been historically channelized but is creating meanders and increasing sinuosity, which is leading to actively eroding and undercutting banks. Less than 80 organisms were identified in the entire benthic sample, which indicates a poor biological community likely resulting from the degraded habitat conditions. Elevated levels of conductivity, possibly due to the high imperviousness in the drainage area, may also be impacting biota.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- This sample only contained 64 organisms, the majority of which were midges (Diplocladius) and bivalves (Musculium and Pisidiidae).
- Water quality values within COMAR standards but conductivity elevated.
- Instream habitat and epibenthic substrate received marginal scores. Moderately unstable banks. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	7.09
Turbidity (NTU)	7.72
Temperature (°C)	11.57
pH (SU)	6.55
Specific Conductivity (µS/cm)	709.4

LPAX-29-2011 LPN Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	7.8
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	3.1

Calculated Metric Scores

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

Taxa	Count
Caecidotea	2
Chaetocladius	1
Chironomus	1
Cordulegaster	2
Crangonyx	2
Diplocladius	13
Enchytraeidae	1
Fossaria	1
Hydrobaenus	4
Ironoquia	5
Lepidoptera	2
Musculium	6
Orthocladiinae	4
Orthocladius	3
Physa	1
Pisidiidae	9
Rheocricotopus	1
Sialis	1
Tubificinae	5
TOTAL:	**64**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	7
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	13	Sediment Deposition	11
Channel Sinuosity	12	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	7		
EPA Habitat Score			**125**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Woody Debris/Rootwads	6	84.87
Shading	95	99.94	Instream Habitat	6	64.63
Epifaunal Substrate	7	65.47	Bank Stability	12	77.46
PHI Score					**77.96**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**124.19**
Cover	**Acres**	**%Area**
Developed Land	**60.29**	**48.55**
Commercial	26.48	21.32
Industrial	8.78	7.07
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	18.99	15.29
Utility	6.03	4.85
Forest Land	**39.48**	**31.79**
Forested Wetland	1.1	0.88
Residential Woods	0	0
Woods	38.39	30.91
Open Land	**24.42**	**19.66**
Open Space	24.42	19.66
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	46.5	37.46

LPAX-30-2011 LPN Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0963491529 **Longitude:** -76.7578387815

Located near the intersection of O'Brien Road and Mapes Road immediately downstream of the Fort Meade Golf Course, this site is on an unnamed tributary and is part of the LPN subwatershed. Of the 123 acre drainage area to this site, open space accounts for 41%, developed land accounts for 36%, and forested land accounts for the remaining 24%. Close to one-quarter of the drainage area (22%) is impervious surface. Half of the drainage area to this site drains the Fort Meade Golf Course while the other half drains developed parcels on the Fort Meade Military Reservation. Riparian vegetation along the left bank is mostly cleared due to a utility corridor. Because habitat is supporting and biological condition is poor, there may be problems with water quality in this drainage area that cannot be measured through in situ analysis only. Measured pH values fell below COMAR standards, but it is unclear whether it is due to naturally acidic conditions or anthropogenic disturbance.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Midges, black flies (Simulium), and worms (Naididae and Tubificidae) dominated the sample.
- Measured below COMAR standards for pH.
- Poor remoteness score and marginal habitat diversity.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.75
Turbidity (NTU)	3.84
Temperature (°C)	12.97
pH (SU)	6.44
Specific Conductivity (µS/cm)	236.3

LPAX-30-2011 LPN Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	33
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	13.2
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	0.9

Calculated Metric Scores

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

Taxa	Count
Agabus	1
Amphinemura	1
Bezzia/Palpomyia	2
Chaetocladius	5
Corynoneura	1
Crangonyx	3
Cricotopus	4
Cryptochironomus	1
Culicoides	1
Curculionidae	1
Dicranota	2
Diplectrona	3
Enchytraeidae	1
Eukiefferiella	2
Heterotrissocladius	3
Lepidostoma	1
Microvelia	1
Naidinae	4
Neoporus	1
Nigronia	1
Orthocladiinae	6
Orthocladius	6
Oulimnius	1
Parametriocnemus	1
Pisidiidae	4
Polycentropus	2
Prodiamesa	2
Prostoma	5
Rheocricotopus	9
Simulium	17
Thienemanniella	2
Thienemannimyia group	1
Tubificinae	10
Zavrelimyia	1
TOTAL:	**106**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	10
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	6
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	16	Sediment Deposition	10
Channel Sinuosity	8	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	13		
EPA Habitat Score			**127**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	3	16.16	Woody Debris/Rootwads	2	73.13
Shading	75	73.32	Instream Habitat	8	75.81
Epifaunal Substrate	9	77.14	Bank Stability	16	89.45
PHI Score					**67.5**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres) 123.22

Cover	Acres	%Area
Developed Land	**43.79**	**35.54**
Commercial	37.72	30.62
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	6.06	4.92
Utility	0	0
Forest Land	**29.27**	**23.75**
Forested Wetland	0	0
Residential Woods	0	0
Woods	29.27	23.75
Open Land	**50.16**	**40.71**
Open Space	50.16	40.71
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	27.4	22.21

LPAX-31-2011 LPE Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0911964223 **Longitude:** -76.7403186317

Located near the intersection of Rock Avenue and Leonard Wood Avenue, this site drains a large section of Fort Meade Military Reservation to Rogue Harbor and is part of the LPE subwatershed. An abundance of rootwads and gravel riffles provide stable habitat for a fair biological habitat. There are some areas of active erosion, but the banks are mostly stable. Forty percent of the 1,905 acre drainage area to this site is developed land, with 32% as forested and 25% as open space. One fifth of the drainage area is impervious surface, which may explain the elevated conductivity measured at this site.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by midges (Orthocladius, Polypedilum, and Tanytarsus) and black flies (Stenelmis).
- Water quality values within COMAR standards but conductivity elevated.
- Remoteness scored poorly with sub-optimal scores for most of the remaining habitat variables. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.06
Turbidity (NTU)	16.4
Temperature (°C)	11.3
pH (SU)	6.93
Specific Conductivity (µS/cm)	335.2

LPAX-31-2011 LPE Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	27
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	8
Ephemeroptera %	0
Scraper Taxa	7
% Climbers	29

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	1
Ancyronyx	2
Antocha	1
Calopteryx	6
Cheumatopsyche	3
Chironomini	1
Cricotopus	4
Cryptochironomus	1
Dubiraphia	6
Hemerodromia	3
Hydrobaenus	2
Hydroptila	1
Limnocharidae	1
Macronychus	1
Micropsectra	7
Optioservus	1
Orconectes	1
Orthocladiinae	6
Orthocladius	10
Polypedilum	8
Rheocricotopus	1
Rheotanytarsus	6
Simulium	3
Sphaerium	1
Stenelmis	9
Tanytarsus	8
Thienemanniella	1
Thienemannimyia group	3
Tvetenia	2
TOTAL:	**100**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	12
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	18	Sediment Deposition	13
Channel Sinuosity	6	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	13		
EPA Habitat Score			**135**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Woody Debris/Rootwads	9	62.83
Shading	70	68.32	Instream Habitat	14	81.07
Epifaunal Substrate	14	88.34	Bank Stability	12	77.46
PHI Score					**69.29**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1905.35**
Cover	**Acres**	**%Area**
Developed Land	**764**	**40.1**
Commercial	209.37	10.99
Industrial	2.17	0.11
Residential 1/8-acre	338.33	17.76
Residential 1/4-acre	92.02	4.83
Residential 1/2-acre	0	0
Residential 1-Acre	19.93	1.05
Residential 2-Acre	12.75	0.67
Transportation	89.44	4.69
Utility	0	0
Forest Land	**626.33**	**32.87**
Forested Wetland	0	0
Residential Woods	0	0
Woods	626.33	32.87
Open Land	**470.87**	**24.71**
Open Space	467.94	24.56
Open Wetland	0	0
Water	2.93	0.15
Agricultural Land	**44.15**	**2.32**
Pasture/Hay	44.15	2.32
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	382.7	20.08

LPAX-32-2011 LPE Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1061492851 **Longitude:** -76.7485572877

Located on the Fort Meade Golf Course directly off of Kenyon Loop, this site drains a large section of Fort Meade Military Reservation to Rogue Harbor and is part of the LPE subwatershed. The riparian buffer is severely lacking due to the golf course and active bank erosion is present throughout the site. Numerous pipe outfalls were observed along the right bank, which likely contributed to the elevated conductivity measured at this site. A relatively high taxa diversity (22 taxa), number of scraper taxa, and a high percentage of climbers present in the benthic sample resulted in a fair biological condition rating. Forty percent of the 1,381 acre drainage area to this site is developed land, with 39% as forested and 17% as open space, resulting in 18% impervious cover.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Severely Degraded"*
- Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Very low woody debris, percent shading, and remoteness scores. Marginal habitat diversity, riparian width, and vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.09
Turbidity (NTU)	13.6
Temperature (°C)	12.9
pH (SU)	6.71
Specific Conductivity (µS/cm)	305.3

LPAX-32-2011 LPE Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	22
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	1.9
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	15.2

Calculated Metric Scores

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

Taxa	Count
Bezzia/Palpomyia	1
Boyeria	1
Calopteryx	2
Ceratopsyche	2
Chelifera	1
Cheumatopsyche	2
Chironomidae	2
Chironomini	2
Coenagrionidae	1
Cricotopus	1
Dubiraphia	2
Eukiefferiella	2
Hemerodromia	2
Hydrobaenus	2
Orthocladiinae	2
Orthocladius	51
Paratendipes	1
Polypedilum	8
Potthastia	2
Rheocricotopus	1
Simulium	5
Stenelmis	4
Tanytarsus	4
Tubificinae	1
Tvetenia	3
TOTAL:	**105**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	11
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	2
Channel Flow Status	18	Sediment Deposition	10
Channel Sinuosity	5	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	11		
EPA Habitat Score			**103**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	5	26.93	Woody Debris/Rootwads	1	42.81
Shading	20	21.22	Instream Habitat	9	56.63
Epifaunal Substrate	10	67.2	Bank Stability	9	67.08
PHI Score					**46.98**
PHI Narrative Rating					**Severely Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1380.66**
Cover	**Acres**	**%Area**
Developed Land	**555.57**	**40.24**
Commercial	86.63	6.27
Industrial	0.15	0.01
Residential 1/8-acre	295.53	21.4
Residential 1/4-acre	92.02	6.66
Residential 1/2-acre	0	0
Residential 1-Acre	19.93	1.44
Residential 2-Acre	12.75	0.92
Transportation	48.57	3.52
Utility	0	0
Forest Land	**542.64**	**39.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	542.64	39.3
Open Land	**238.3**	**17.26**
Open Space	238.3	17.26
Open Wetland	0	0
Water	0	0
Agricultural Land	**44.15**	**3.2**
Pasture/Hay	44.15	3.2
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	249.1	18.04

LPAX-33-2011 LPG Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0937869212 **Longitude:** -76.7386858015

This site is located immediately upstream of Redwood Road and drains to Rogue Harbor in the LPG subwatershed. The entire drainage area of this site (1,082 acres) is within the Fort Meade Military Reservation and consists of 42% developed land, 38% open space, and 19% forested land. Nearly one-quarter of the drainage area (24%) is impervious surface. Elevated levels of conductivity may be a result of the developed land cover upstream. This site is backwatered due to a debris jam at the culvert which is located at the downstream portion of the site. A wet retention pond is located 230 meters upstream from the site and may be altering flow. Despite the poor physical habitat quality, a fair biological community attributed to high taxa diversity (26 taxa), number of scraper taxa, and a high percentage of climbers (46%) present in the benthic sample, as well as the presence of Caenis, an intolerant mayfly.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Severely Degraded"*
- Polypedilum (midge) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Very low woody debris, percent shading, and remoteness scores. Marginal habitat diversity.

Water Chemistry:

Dissolved Oxygen (mg/L)	8.27
Turbidity (NTU)	28.9
Temperature (°C)	15
pH (SU)	7.15
Specific Conductivity (µS/cm)	429.7

LPAX-33-2011 LPG Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	2.6
Ephemeroptera %	1.8
Scraper Taxa	3
% Climbers	46.5

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	3
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.57**
BIBI Narrative Rating	**Fair**

Taxa	Count
Caenis	2
Chaetocladius	2
Cheumatopsyche	1
Chironomidae	1
Chironomini	7
Chironomus	1
Clinotanypus	1
Coenagrionidae	1
Crangonyx	3
Dicrotendipes	2
Enchytraeidae	1
Glyptotendipes	8
Hirudinea	1
Hydrobaenus	1
Ironoquia	1
Ischnura	1
Limnophyes	1
Menetus	1
Naidinae	2
Orthocladiinae	1
Orthocladius	6
Paratanytarsus	1
Physa	1
Polypedilum	49
Potthastia	1
Rheotanytarsus	2
Simulium	8
Tanypodinae	1
Thienemanniella	1
Thienemannimyia group	5
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	10
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	12	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	18	Sediment Deposition	14
Channel Sinuosity	4	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	13		
EPA Habitat Score			**122**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	1	5.39	Woody Debris/Rootwads	1	45.57
Shading	35	36.34	Instream Habitat	9	59.12
Epifaunal Substrate	8	57.17	Bank Stability	18	94.87
PHI Score					**49.74**
PHI Narrative Rating					**Severely Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1082.53**
Cover	**Acres**	**%Area**
Developed Land	**459.22**	**42.42**
Commercial	262.78	24.27
Industrial	0	0
Residential 1/8-acre	90.49	8.36
Residential 1/4-acre	27.69	2.56
Residential 1/2-acre	4.6	0.42
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	73.66	6.8
Utility	0	0
Forest Land	**209.59**	**19.36**
Forested Wetland	0	0
Residential Woods	0	0
Woods	209.59	19.36
Open Land	**413.73**	**38.22**
Open Space	405.31	37.44
Open Wetland	0	0
Water	8.42	0.78
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	259.6	23.98

LPAX-34-2011 LPG Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0992103206 **Longitude:** -76.7315979907

Located immediately upstream of Llewellyn Avenue, this site drains to Rogue Harbor and is part of the LPG subwatershed. The entire drainage area of this site (790 acres) is within the Fort Meade Military Reservation and consists largely of developed and open space (39% for both) with 23% as forested land. Impervious surface accounts for 22% of the drainage area. This site is backwatered a good distance due to a culvert just downstream of the sampling reach and possible beaver activity. Because habitat is supporting and biological condition is poor, there may be problems with water quality in this drainage system that cannot be measured through in situ analysis only. The depressed biological community may be a result of the backwatered condition in the sampling reach.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Midges (Orthocladius, Polypedilum, and Tanytarsus) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Bank stability scored high but habitat diversity received marginal scores. Very poor remoteness score.

Water Chemistry:

Dissolved Oxygen (mg/L)	7.81
Turbidity (NTU)	28
Temperature (°C)	12.87
pH (SU)	6.8
Specific Conductivity (µS/cm)	322.4

LPAX-34-2011 LPG Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	2.7
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	35.1

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	1
Argia	6
Calopteryx	2
Chironomidae	2
Chironomini	1
Dicrotendipes	1
Diplocladius	1
Dubiraphia	1
Enallagma	1
Enchytraeidae	1
Eukiefferiella	2
Hydrobaenus	3
Hydroporini	2
Ironoquia	1
Ischnura	1
Micropsectra	3
Orthocladiinae	2
Orthocladius	28
Parametriocnemus	4
Paratanytarsus	1
Paratendipes	1
Physa	1
Polypedilum	16
Rheotanytarsus	1
Simulium	4
Sphaerium	2
Stictochironomus	1
Tanypodinae	2
Tanytarsus	15
Thienemannimyia group	4
TOTAL:	**111**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	12
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	18	Sediment Deposition	11
Channel Sinuosity	8	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	12		
EPA Habitat Score			**131**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	2	10.77	Woody Debris/Rootwads	5	60.97
Shading	60	58.94	Instream Habitat	9	62.35
Epifaunal Substrate	10	70.84	Bank Stability	18	94.87
PHI Score					**59.79**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**789.64**
Cover	**Acres**	**%Area**
Developed Land	**305.45**	**38.68**
Commercial	167.4	21.2
Industrial	0	0
Residential 1/8-acre	74.69	9.46
Residential 1/4-acre	5.89	0.75
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	57.47	7.28
Utility	0	0
Forest Land	**178.26**	**22.58**
Forested Wetland	0	0
Residential Woods	0	0
Woods	178.26	22.58
Open Land	**305.93**	**38.74**
Open Space	305.23	38.65
Open Wetland	0	0
Water	0.7	0.09
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	173.3	21.95

LPAX-35-2011 LP6 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1096682415 **Longitude:** -76.7980677411

This site is located approximately 150 meters downstream of Russett Green West and approximately 100 meters upstream of the confluence with the Little Patuxent River in the LP6 subwatershed. Of the 413 acre drainage area, 78% is developed land, the majority of which is high density residential. The remaining 21% of the drainage area is forested land. Nearly one-half of the drainage area (47%) is impervious surface. The site is deeply incised and overwidened with severe erosion on both banks and heavy sediment deposition, likely due to the altered flow regime. Woody debris is abundant but primarily dewatered due to low flow in the channel. Riffle habitat is also present but poor quality. A complete lack of EPT, Ephemeroptera, and taxa intolerant to urban stressors characterize a very poor biological community. Elevated conductivity levels are likely the result of a highly-developed, highly-impervious drainage area, and are potentially indicative of water quality impairment.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Sample dominated by midges (Chironomus, Cricotopus, and Orthocladius) and worms of the Tubificidae family.
- Water quality values within COMAR standards but conductivity elevated.
- Refuse present in moderate amounts. Poor bank stability with marginal habitat diversity. Good riparian width but poor vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	6.67
Turbidity (NTU)	4.54
Temperature (°C)	14.97
pH (SU)	7.15
Specific Conductivity (µS/cm)	700.4

LPAX-35-2011 LP6 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	3.8

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
Ancyronyx	4
Chironomidae	1
Chironomus	15
Cricotopus	34
Dicrotendipes	1
Enchytraeidae	2
Eukiefferiella	1
Lumbriculidae	1
Naidinae	3
Nemata	2
Orthocladius	10
Paratanytarsus	1
Polypedilum	4
Thienemanniella	1
Tubificinae	24
TOTAL:	**104**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	1	Pool Variability	10
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	9	Sediment Deposition	6
Channel Sinuosity	10	Vegetative Protection - Left Bank	2
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	6		
EPA Habitat Score			**94**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	10	83.11
Shading	95	99.94	Instream Habitat	6	52.34
Epifaunal Substrate	8	63.45	Bank Stability	4	44.72
PHI Score					**66.23**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**412.79**
Cover	**Acres**	**%Area**
Developed Land	**323.11**	**78.28**
Commercial	77.68	18.82
Industrial	0	0
Residential 1/8-acre	191.92	46.49
Residential 1/4-acre	24.82	6.01
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	28.7	6.95
Utility	0	0
Forest Land	**87.94**	**21.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	87.94	21.3
Open Land	**1.74**	**0.42**
Open Space	1.74	0.42
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	192.3	46.58

LPAX-36-2011 LP6 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1185223756 **Longitude:** -76.8099706349

Located approximately 100 meters upstream of the confluence with the Little Patuxent River, this site is northwest of the Marsh Crossing Drive and Big Pool Road intersection and adjacent to the Oxbow Natural Area in the LP6 subwatershed. Of the 375 acre drainage area to this site, the majority of the land cover is forested (75%) with the remaining 17% and 9% consisting of open space and developed land, respectively. Only 2% of the drainage area is impervious surface. In spite of the heavily forested drainage area, the channel is incised and overwidened with very little flow and a very poor biological community. It appears that the channel has either been historically channelized or is a relic of the abandoned oxbow channel. The benthic sample completely lacked EPT, Ephemeroptera, scraper, and climber taxa; however, half of the taxa were intolerant to urban stressors.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Caecidotea (isopod) and Chironomus (midge) dominated the sample.
- Measured below COMAR standards for dissolved oxygen.
- Poor instream habitat with marginal epibenthic substrate. Banks are stable with abundant woody debris. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	2.43
Turbidity (NTU)	36
Temperature (°C)	15.57
pH (SU)	6.68
Specific Conductivity (µS/cm)	169.1

LPAX-36-2011 LP6 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	7
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	49.5
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
Amphipoda	5
Bivalvia	3
Caecidotea	55
Chironomus	27
Crangonyx	7
Parachironomus	1
Phaenopsectra	1
Pisidium	11
Psectrotanypus	1
TOTAL:	**111**

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	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	7	Sediment Deposition	9
Channel Sinuosity	9	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	7		
EPA Habitat Score			**114**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Woody Debris/Rootwads	10	84.21
Shading	90	91.34	Instream Habitat	4	42.23
Epifaunal Substrate	6	52.46	Bank Stability	16	89.45
PHI Score					**71.62**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**374.68**
Cover	**Acres**	**%Area**
Developed Land	**33.46**	**8.93**
Commercial	0.7	0.19
Industrial	0	0
Residential 1/8-acre	4.91	1.31
Residential 1/4-acre	0	0
Residential 1/2-acre	14.73	3.93
Residential 1-Acre	2.77	0.74
Residential 2-Acre	6.49	1.73
Transportation	3.81	1.02
Utility	0.05	0.01
Forest Land	**279.16**	**74.51**
Forested Wetland	28.02	7.48
Residential Woods	0	0
Woods	251.14	67.03
Open Land	**62.05**	**16.56**
Open Space	4.45	1.19
Open Wetland	53.77	14.35
Water	3.83	1.02
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	7.4	1.98

LPAX-37-2011 LPI Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1076948539 **Longitude:** -76.7876171728

This site is located on the mainstem of Dorsey Run, approximately 100 meters upstream of the confluence with the Little Patuxent River, just off of the eastbound Route 32 ramp to southbound Baltimore-Washington Parkway (Rt. 295) in the LPI subwatershed. Of the 8,054 acre drainage area to this site, 1,704 acres drains from Howard County. Over one-half of the total drainage area is developed land (56%) with 32% as forested and 11% as open space. More than one-quarter of the drainage area is impervious surface (27%). This site is located on a large, wide channel with a good mix of velocity/depth and stable habitat for benthos; however, large bar formation and active bank erosion is evident, suggesting an unstable stream reach. Gravel riffles of moderate quality and abundant woody debris support a good biological community. The benthic sample for this site had high taxa diversity (31 taxa), 7 EPT, 2 Ephemeroptera, and 7 scraper taxa; but, only 6% of the sample consisted of taxa intolerant to urban stressors. Elevated levels of conductivity, likely resulting from the heavily developed land cover upstream, may be influencing the quantity of intolerant taxa.

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Snails (Amnicola) and bivavles (Musculium) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Percent shading, remoteness, and woody debris received low scores. Moderately unstable banks with sub-optimal habitat diversity. Good riparian width.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.31
Turbidity (NTU)	4.69
Temperature (°C)	20.8
pH (SU)	7.36
Specific Conductivity (µS/cm)	540.3

LPAX-37-2011 LPI Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	31
EPT Taxa	7
Ephemeroptera Taxa	2
Intolerant Urban %	5.7
Ephemeroptera %	2.8
Scraper Taxa	7
% Climbers	21.7

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**4.14**
BIBI Narrative Rating	**Good**

Taxa	Count
Acentrella	1
Amnicola	21
Amphipoda	4
Ancyronyx	2
Argia	1
Boyeria	1
Brillia	1
Caecidotea	1
Chelifera	1
Cheumatopsyche	2
Chironomidae	1
Cricotopus	4
Curculionidae	1
Heptageniidae	2
Hydrobaenus	1
Hydropsyche	4
Hydropsychidae	1
Lumbriculidae	1
Macronychus	3
Musculium	27
Naidinae	3
Orthocladiinae	1
Orthocladius	6
Perlesta	1
Physa	1
Pisidiidae	5
Polycentropodidae	1
Potthastia	1
Rheotanytarsus	1
Staphylinidae	1
Stenelmis	2
Taeniopteryx	1
Thienemannimyia group	1
Tvetenia	1
TOTAL:	**106**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	15
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	12
Channel Sinuosity	10	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	15	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	14		
EPA Habitat Score			**138**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Woody Debris/Rootwads	9	46.51
Shading	65	63.55	Instream Habitat	14	66.32
Epifaunal Substrate	15	84.76	Bank Stability	10	70.71
PHI Score					**64.28**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

*For individual land cover categories only Anne Arundel County land use data is presented below; however, total acreage and percent area land cover values (listed in bold) and impervious land include both Anne Arundel County and Howard County data.

Total Drainage Area (acres) 8053.52

Cover	Acres	%Area
Developed Land	**2236.5**	**56.27**
Commercial	508.94	6.32
Industrial	64.88	0.81
Residential 1/8-acre	11.13	0.14
Residential 1/4-acre	35.82	0.44
Residential 1/2-acre	104.48	1.3
Residential 1-Acre	71.22	0.88
Residential 2-Acre	119.39	1.48
Transportation	175.73	2.18
Utility	13.98	0.17
Forest Land	**888.15**	**31.54**
Forested Wetland	0	0
Residential Woods	0	0
Woods	1434.99	17.82
Open Land	**445.3**	**11.48**
Open Space	453.19	5.63
Open Wetland	11.43	0.14
Water	21.8	0.27
Agricultural Land	**676.96**	**0.54**
Pasture/Hay	19.17	0.24
Row Crops	0	0

Impervious Surface	Acres	% Area
Impervious Land	2194.2	27.24

LPAX-38-2011 LPI Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1172534438 **Longitude:** -76.7832578219

Located on the Dorsey Run mainstem, just prior of the exit at eastbound Route 32 to southbound Baltimore-Washington Parkway (Rt. 295), this site is part of the LPI subwatershed. Of the 7,562 acre drainage area to this site, 1,704 acres drains from Howard County. Over half of the total drainage area is developed land (58%) with 31% as forested and 10% as open space. More than one-quarter of the drainage area is impervious surface (28%). This site is located on a deep, wide channel with extensive bar formation and heavy bank erosion on the outer meanders, likely due to altered flow regimes caused by high imperviousness. Several very deep pools were observed throughout this site. An abundance of woody debris and rootwads provides adequate habitat for a fair biological community. Elevated levels of conductivity may be a result of the developed land cover upstream and may be influencing the quantity of intolerant taxa--only 5% of the benthic sample consisted of taxa intolerant to urban stressors.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Worms (Naididae) and midges dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Most habitat variables received sub-optimal scores. Good riparian width with suboptimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.77
Turbidity (NTU)	6.32
Temperature (°C)	21.1
pH (SU)	7.34
Specific Conductivity (µS/cm)	550.3

LPAX-38-2011 LPI Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	4.9
Ephemeroptera %	2.9
Scraper Taxa	6
% Climbers	7.8

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	3
BIBI Score	**3.86**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amnicola	3
Ancyronyx	5
Argia	2
Baetis	1
Brillia	6
Caecidotea	2
Caenis	1
Cheumatopsyche	3
Chironomidae	1
Chironomini	1
Chironomus	4
Cricotopus	8
Enchytraeidae	1
Hagenius	1
Hydropsyche	5
Lumbriculidae	1
Maccaffertium	1
Macronychus	6
Naidinae	28
Orthocladiinae	1
Orthocladius	9
Physa	4
Polypedilum	1
Simulium	3
Stenelmis	1
Thienemanniella	1
Tubificinae	2
Xylotopus	1
TOTAL:	**103**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	16
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	9
Channel Sinuosity	12	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	13		
EPA Habitat Score			**144**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Woody Debris/Rootwads	12	56.1
Shading	50	49.95	Instream Habitat	14	66.96
Epifaunal Substrate	14	79.36	Bank Stability	13	80.63
PHI Score					**68.96**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

*For individual land cover categories only Anne Arundel County land use data is presented below; however, total acreage and percent area land cover values (listed in bold) and impervious land include both Anne Arundel County and Howard County data.

Total Drainage Area (acres) 7561.83

Cover	Acres	%Area
Developed Land	**635.63**	**58.45**
Commercial	470.73	6.23
Industrial	52.24	0.69
Residential 1/8-acre	11.13	0.15
Residential 1/4-acre	31.55	0.42
Residential 1/2-acre	104.48	1.38
Residential 1-Acre	71.22	0.94
Residential 2-Acre	119.39	1.58
Transportation	132.85	1.76
Utility	0	0
Forest Land	**246.44**	**31.21**
Forested Wetland	0	0
Residential Woods	0	0
Woods	1255.3	16.6
Open Land	**49.16**	**9.58**
Open Space	266.44	3.52
Open Wetland	11.43	0.15
Water	8.57	0.11
Agricultural Land	**15.03**	**0.57**
Pasture/Hay	19.17	0.25
Row Crops	0	0

Impervious Surface	Acres	% Area
Impervious Land	2136.3	28.25

LPAX-39-2011 LPJ Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1235897278 **Longitude:** -76.7804216847

Located approximately 100 meters upstream from the confluence with Dorsey Run, just off of the exit of Guilford Road to National Business Parkway, this site is part of the LPJ subwatershed. Over half of the 873 acre drainage area to this site is forested land with 26% as developed land with 12% as impervious surface. The stream channel is overwidened and incised with multiple bars throughout, likely due to altered flow regimes caused by development upstream. Both banks are actively eroding. An abundance of woody debris and rootwads, but poor quality riffle habitat, supports a fair biological community. Elevated levels of conductivity may be a result of the developed land cover upstream and may be influencing the quantity of intolerant taxa--only 6% of the benthic sample consisted of taxa intolerant to urban stressors.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Midges (Hydrobaenus, Orthocladius, and Parametriocnemus) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Most habitat variables received sub-optimal scores. Moderately unstable banks. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.33
Turbidity (NTU)	14.6
Temperature (°C)	11.33
pH (SU)	7.16
Specific Conductivity (µS/cm)	428.5

LPAX-39-2011 LPJ Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	6.1
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	13.1

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	5
Amphinemura	1
Brillia	1
Cheumatopsyche	2
Chironomidae	1
Chironomini	1
Cricotopus	1
Eukiefferiella	3
Gastropoda	1
Helichus	1
Hydrobaenus	16
Ironoquia	1
Microtendipes	3
Orthocladiinae	6
Orthocladius	10
Parametriocnemus	17
Paratanytarsus	1
Paratendipes	1
Polypedilum	9
Rheotanytarsus	1
Simulium	4
Stegopterna	5
Tanytarsus	3
Thienemannimyia group	1
Tipula	1
Tvetenia	2
Xylotopus	1
TOTAL:	**99**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	12
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	7
Channel Sinuosity	13	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	12		
EPA Habitat Score			**128**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Woody Debris/Rootwads	6	62.8
Shading	90	91.34	Instream Habitat	12	77.97
Epifaunal Substrate	12	81.81	Bank Stability	9	67.08
PHI Score					**75.17**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**872.95**
Cover	**Acres**	**%Area**
Developed Land	**229.57**	**26.3**
Commercial	114.98	13.17
Industrial	0	0
Residential 1/8-acre	11.13	1.28
Residential 1/4-acre	31.55	3.61
Residential 1/2-acre	3.41	0.39
Residential 1-Acre	2.47	0.28
Residential 2-Acre	28.89	3.31
Transportation	37.13	4.25
Utility	0	0
Forest Land	**557.07**	**63.81**
Forested Wetland	0	0
Residential Woods	0	0
Woods	557.07	63.81
Open Land	**79.01**	**9.05**
Open Space	79.01	9.05
Open Wetland	0	0
Water	0	0
Agricultural Land	**7.3**	**0.84**
Pasture/Hay	7.3	0.84
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	103.8	11.89

LPAX-40-2011 LPJ Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1298022137 **Longitude:** -76.7676944484

Located behind the National Business Park located off of the Baltimore Washington Parkway, this site is part of the LPJ subwatershed and drains to Dorsey Run. Of the 535 acre drainage area to this site, over half of the area is forested land (61%) with 24% as developed and 14% as open space. Eleven percent of the drainage area is impervious surface. A trail runs approximately 2 meters from the left bank and multiple bars were observed throughout the site. Good woody debris and rootwad habitat along with some gravel riffles support a fair biological community. Elevated levels of conductivity may be a result of the developed land cover upstream and may be influencing the quantity of intolerant taxa--only 5% of the benthic sample consisted of taxa intolerant to urban stressors.

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Sample dominated by Parametriocnemus (midge).
- Water quality values within COMAR standards but conductivity elevated.
- Most habitat variables received sub-optimal scores. Good riparian width with suboptimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.69
Turbidity (NTU)	4.87
Temperature (°C)	13.87
pH (SU)	7.15
Specific Conductivity (µS/cm)	363.2

LPAX-40-2011 LPJ Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	4
Ephemeroptera Taxa	1
Intolerant Urban %	5.1
Ephemeroptera %	0.9
Scraper Taxa	3
% Climbers	10.3

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	3
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.57**
BIBI Narrative Rating	**Fair**

Taxa	Count
Ablabesmyia	1
Amphinemura	1
Baetidae	1
Bezzia/Palpomyia	1
Brillia	2
Chironomini	3
Corynoneura	1
Cricotopus	1
Eriopterini	1
Hydrobaenus	3
Ironoquia	1
Lepidoptera	1
Lepidostoma	1
Microtendipes	7
Neoporus	2
Nigronia	1
Orthocladiinae	1
Orthocladius	1
Oulimnius	1
Parametriocnemus	63
Polypedilum	9
Pseudolimnophila	1
Stenelmis	1
Stenochironomus	1
Tanytarsus	2
Thienemanniella	1
Thienemannimyia group	3
Tvetenia	5
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	11
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	7
Channel Sinuosity	10	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	12		
EPA Habitat Score			**134**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Woody Debris/Rootwads	8	74.25
Shading	90	91.34	Instream Habitat	13	88.52
Epifaunal Substrate	13	90.81	Bank Stability	13	80.63
PHI Score					**81.7**
PHI Narrative Rating					**Minimally Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**535.05**
Cover	**Acres**	**%Area**
Developed Land	**130.1**	**24.32**
Commercial	33.7	6.3
Industrial	0	0
Residential 1/8-acre	11.13	2.08
Residential 1/4-acre	27.92	5.22
Residential 1/2-acre	3.41	0.64
Residential 1-Acre	2.47	0.46
Residential 2-Acre	16.86	3.15
Transportation	34.61	6.47
Utility	0	0
Forest Land	**324.23**	**60.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	324.23	60.6
Open Land	**74.29**	**13.89**
Open Space	74.29	13.89
Open Wetland	0	0
Water	0	0
Agricultural Land	**6.42**	**1.2**
Pasture/Hay	6.42	1.2
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	58.7	10.98

LPAX-41-2011 LPH Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1242488469 **Longitude:** -76.7814099186

Located on the Dorsey Run mainstem, just off of the exit of Guilford Road to National Business Parkway, this site is part of the LPH subwatershed. Of the 6,321 acre drainage area to this site, 1,704 acres drains from Howard County. Over half of the total drainage area is developed land (64%) with 26% as forested and 10% as open space. Almost one-third of the drainage area is impervious surface (30%). This channel is overwidened with large mid-channel and point bars, likely due to altered flow regimes caused by high imperviousness. Several deep pools with cover provide good habitat for fish. A good mix of gravel riffles, rootwads, and wood provide diverse habitat for benthic macroinvertebrates. However, the biological community was poor due to the complete lack of Ephemeroptera taxa and taxa intolerant to urban stressors. Elevated levels of conductivity may be a result of the highly-developed land cover upstream and are likely influencing the quantity of intolerant taxa. Because habitat is supporting and biological condition is poor, there may be additional water quality impairments, other than elevated conductivity, in this drainage area that cannot be measured through in situ analysis only.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Most habitat variables received sub-optimal scores. Refuse present in moderate amounts. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	12.86
Turbidity (NTU)	4.38
Temperature (°C)	12.93
pH (SU)	7.63
Specific Conductivity (µS/cm)	651.1

LPAX-41-2011 LPH Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	4.5

Calculated Metric Scores

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

Taxa	Count
Ancyronyx	2
Ceratopsyche	1
Cheumatopsyche	5
Chironomidae	2
Cricotopus	2
Hydrobaenus	2
Naidinae	2
Orthocladius	78
Parametriocnemus	1
Paratanytarsus	1
Pisidiidae	1
Polypedilum	3
Rheotanytarsus	2
Stenelmis	3
Tanytarsus	2
Tubificinae	3
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	15
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	9
Channel Sinuosity	10	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	13		
EPA Habitat Score			**138**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Woody Debris/Rootwads	12	58.13
Shading	70	68.32	Instream Habitat	14	68.8
Epifaunal Substrate	14	80.53	Bank Stability	13	80.63
PHI Score					**71.97**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

*For individual land cover categories only Anne Arundel County land use data is presented below; however, total acreage and percent area land cover values (listed in bold) and impervious land include both Anne Arundel County and Howard County data.

Total Drainage Area (acres) 6320.59

Cover	Acres	%Area
Developed Land	**5.17**	**63.59**
Commercial	224.8	3.56
Industrial	51.93	0.82
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	101.07	1.6
Residential 1-Acre	68.75	1.09
Residential 2-Acre	88.91	1.41
Transportation	57.65	0.91
Utility	0	0
Forest Land	**127.81**	**25.79**
Forested Wetland	0	0
Residential Woods	0	0
Woods	525.06	8.31
Open Land	**1.21**	**9.83**
Open Space	163.84	2.59
Open Wetland	11.43	0.18
Water	7.94	0.13
Agricultural Land	**0**	**0.57**
Pasture/Hay	11.88	0.19
Row Crops	0	0

Impervious Surface	Acres	% Area
Impervious Land	1925	30.46

LPAX-42-2011 LPH Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1298028977 **Longitude:** -76.7818087904

Located on the mainstem of Dorsey Run just off of Brock Bridge Road, this site is part of the LPH subwatershed. Of the 5,994 acre drainage area to this site, 1,632 acres drains from Howard County. Over half of the total drainage area is developed land (63%) with 26% as forested and 10% as open space. Nearly one-third of the drainage area is impervious surface (30%). This site is a large, overwidened channel with many mid-channel and point bars, likely due to altered flow regimes caused by high imperviousness. There is a good mix of velocity/depth and an abundance of large woody debris in deep pools provides good habitat for fish. The presence of moderate quality gravel riffles provides some stable habitat for a poor biological community. Elevated conductivity levels may be a result of the highly-developed land cover upstream, much of which is industrial/commercial development, and may be influencing the quantity of intolerant taxa--only 5% of the benthic sample consisted of taxa intolerant to urban stressors. Because habitat is supporting and biological condition is poor, there may be problems with water quality in this drainage system, as indicated by the elevated conductivity readings, which are impacting the biota.

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Worms of the Naididae family dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Most habitat variables received sub-optimal scores. Good riparian width with suboptimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.34
Turbidity (NTU)	6.97
Temperature (°C)	21.5
pH (SU)	7.39
Specific Conductivity (µS/cm)	603

LPAX-42-2011 LPH Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5.2
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1

Calculated Metric Scores

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

Taxa	Count
Acentrella	1
Brillia	9
Caecidotea	2
Chaetocladius	1
Cheumatopsyche	2
Corbicula	1
Cricotopus	4
Enchytraeidae	1
Hagenius	1
Hydrobaenus	1
Naidinae	61
Orthocladius	6
Polycentropodidae	2
Polypedilum	1
Tubificinae	4
TOTAL:	**97**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	15
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	8
Channel Sinuosity	11	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	13		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Woody Debris/Rootwads	11	55.77
Shading	55	54.42	Instream Habitat	14	69.34
Epifaunal Substrate	13	75.07	Bank Stability	13	80.63
PHI Score					**67.54**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

*For individual land cover categories only Anne Arundel County land use data is presented below; however, total acreage and percent area land cover values (listed in bold) and impervious land include both Anne Arundel County and Howard County data.

Total Drainage Area (acres) **5994.41**

Cover	Acres	%Area
Developed Land	**33.46**	**63.22**
Commercial	206.08	3.44
Industrial	16.74	0.28
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	101.07	1.69
Residential 1-Acre	68.75	1.15
Residential 2-Acre	88.91	1.48
Transportation	46.68	0.78
Utility	0	0
Forest Land	**276.82**	**25.95**
Forested Wetland	0	0
Residential Woods	0	0
Woods	450.44	7.51
Open Land	**62.05**	**10.14**
Open Space	151.86	2.53
Open Wetland	11.43	0.19
Water	6.23	0.1
Agricultural Land	**0**	**0.6**
Pasture/Hay	11.88	0.2
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	1811.2	30.21

LPAX-43-2011 LPK Subwatershed

Upstream View:

Downstream View:

Latitude: 39.1440169295 **Longitude:** -76.7581064463

Located just off of Race Road between Citrus Avenue and Sellner Road, this site is part of the LPK subwatershed. This site is deeply incised most likely due to a road culvert located just upstream. A 2 foot drop below the culvert is causing a severe fish blockage. The reach is overwidened leading to mid-channel bars and areas of active bank erosion, indicating an unstable stream type. Shallow, poor quality riffles provide inadequate habitat leading to a very poor biological community with low taxa diversity. There was a complete lack of Ephemeroptera taxa and climber taxa in the benthic sample; however over half of the sample (59%) consisted of taxa intolerant to urban stressors. The small drainage area to this site (89 acres) is largely forested land (79%) with 17% as developed land. Only 9% of the drainage area is impervious surface. Conductivity levels were elevated considerably, possibly due to highway runoff from Baltimore-Washington Parkway (Rt. 295) and Jessup Road (Rt. 175) or from the corrugated metal culvert pipe immediately upstream of the sampling reach.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Midges (Hydrobaenus) and black flies (Stegopterna) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Moderately unstable banks, poor instream habitat, and marginal epibenthic substrate. Refuse present in moderate amounts.

Water Chemistry:

Dissolved Oxygen (mg/L)	10.21
Turbidity (NTU)	7.79
Temperature (°C)	8.47
pH (SU)	7.26
Specific Conductivity (µS/cm)	758

LPAX-43-2011 LPK Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	58.6
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
Diamesa	2
Heterotanytarsus	2
Hybomitra	1
Hydrobaenus	30
Nemouridae	1
Neoporus	3
Orthocladius	9
Podmosta	1
Stegopterna	65
Thienemannimyia group	1
Zavrelimyia	1
TOTAL:	**116**

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	8
Channel Alteration	10	Riparian Vegetative Zone Width- Right Bank	4
Channel Flow Status	7	Sediment Deposition	7
Channel Sinuosity	9	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	7		
EPA Habitat Score			**84**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	2	10.77	Woody Debris/Rootwads	4	82.69
Shading	75	73.32	Instream Habitat	5	62.46
Epifaunal Substrate	6	61.8	Bank Stability	8	63.25
PHI Score					**59.05**
PHI Narrative Rating					**Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**89.3**
Cover	**Acres**	**%Area**
Developed Land	**15.38**	**17.22**
Commercial	3.37	3.77
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.17	0.19
Residential 1-Acre	0.88	0.98
Residential 2-Acre	3.23	3.61
Transportation	7.74	8.67
Utility	0	0
Forest Land	**70.65**	**79.11**
Forested Wetland	0	0
Residential Woods	0	0
Woods	70.65	79.11
Open Land	**3.27**	**3.67**
Open Space	3.27	3.67
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	7.9	8.82

LPAX-46-2011 LP4 Subwatershed

Upstream View:

Downstream View:

Latitude: 39.0608370599 **Longitude:** -76.7392940294

Located in the Patuxent Research Refuge just west of Wildlife Loop Road, this site is part of the LP4 subwatershed. The majority of the 596 acre drainage area to this site is forested land (94%) with 6% as open space. Less than 1% of the entire drainage area is impervious surface (0.2%). This site is a low gradient stream on the floodplain of the Little Patuxent River with reduced flow due to debris jams just upstream. With an entirely silt/sand bottom, there is very little stable habitat and an abundance of fine particulate organic matter. A complete lack of EPT, Ephemeroptera, and scraper taxa resulted in a very poor biological community. Although habitat is partially supporting, instream habitat and epifaunal substrate were rated in the poor categories, limiting the streams ability to support a diverse biological community. Furthermore, the acidic pH values (below COMAR standards), which appear to be naturally influenced by the surrounding wetland system draining to the site, may further limit the biological potential of this stream.

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Crangonyx) and bivalves (Musculium) dominated the sample.
- Measured below COMAR standards for pH.
- Poor habitat diversity but banks are stable. Very little woody debris present. Good riparian width with sub-optimal vegetative protection.

Water Chemistry:

Dissolved Oxygen (mg/L)	5.09
Turbidity (NTU)	9.09
Temperature (°C)	21
pH (SU)	5.96
Specific Conductivity (µS/cm)	54.4

LPAX-46-2011 LP4 Subwatershed

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	15
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	1.8

Calculated Metric Scores

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

Taxa	Count
Bezzia/Palpomyia	1
Bivalvia	2
Caecidotea	17
Chironomus	3
Crangonyx	40
Dicrotendipes	1
Diplocladius	1
Lepidoptera	1
Lumbricina	2
Musculium	37
Paratendipes	1
Polypedilum	1
Simulium	1
Tanytarsus	1
Thienemanniella	1
Thienemannimyia group	2
Zavrelimyia	1
TOTAL:	**113**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	3
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	14
Channel Sinuosity	6	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	8		
EPA Habitat Score			**111**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Woody Debris/Rootwads	1	52.33
Shading	95	99.94	Instream Habitat	5	43.04
Epifaunal Substrate	5	43.63	Bank Stability	16	89.45
PHI Score					**67.3**
PHI Narrative Rating					**Partially Degraded**

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**595.52**
Cover	**Acres**	**%Area**
Developed Land	**0.37**	**0.06**
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	0.37	0.06
Utility	0	0
Forest Land	**557.86**	**93.68**
Forested Wetland	7.59	1.27
Residential Woods	0	0
Woods	550.27	92.4
Open Land	**37.28**	**6.26**
Open Space	32.96	5.54
Open Wetland	0	0
Water	4.32	0.73
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	1	0.17

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 Little Patuxent Watershed Targeted Biological Assessment following the methods described by Hill and Pieper (2011b). 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. 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. All *in situ* parameters were measured with a multi-parameter sonde (YSI Professional Plus series or YSI 560 series) except turbidity which was measured with a Hach 2100 Turbidimeter. 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.

Sample buckets contained both internal and external labels. All chain-of-custody procedures were followed for transfer of the samples between the field and the identification lab.

Replicate (duplicate) samples were taken at ten percent of the overall sites (four sites), one within each sampling unit. 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	0.96	22

[1]Values derived from Hill and Pieper, 2011b

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	% Climbers	BIBI	Rating
LPAX-05-2011	14	0	0.0	0	0.0	2	8.7	2.43	Poor
LPAX-05-2011-QC	15	0	0.0	0	2.0	4	6.9	2.14	Poor
LPAX-18-2011	25	1	0.0	0	0.0	5	13.2	2.71	Poor
LPAX-18-2011-QC	24	0	0.0	0	0.0	5	13.0	2.71	Poor
LPAX-24-2011	20	4	0.0	0	41.2	0	3.9	2.43	Poor
LPAX-24-2011-QC	17	3	0.0	0	49.2	0	0.0	2.14	Poor
LPAX-36-2011	7	0	0.0	0	49.5	0	0.0	1.57	Very Poor
LPAX-36-2011-QC	6	0	0.0	0	85.0	0	0.0	1.57	Very Poor
Median RPD	11.1	14.3	0.0	0.0	35.17	0.0	12.47	6.25	-
RMSE	1.99	0.58	0.00	0.00	7.59	**1.10**	2.01	0.20	-
CV	12.4	**57.7**	0.0	0.0	26.77	54.9	35.20	9.12	-

Both metric values and index scores were compared to MQOs to determine exceedances. One metric, EPT Taxa, exceeded the MQO for CV, but did not exceed the MQO for mRPD or RMSE. The high CV was due to the low occurrence of EPT Taxa in all samples (mostly zero) except LPAX-24-2011, which skewed the CV upward. Another metric, Scraper Taxa, exceeded the MQO for RMSE, but passed mRPD. This was primarily due to one outlier sample pair (LPAX-18-2011), which had a large proportion of Scraper Taxa relative to the other samples. All other values were within acceptable ranges.

Laboratory Sorting and Subsampling

Bias

All sorting was completed following the SOPs described in the QAPP. For these samples, approximately 59 percent (26 samples) underwent quality control procedures for sorting, above the ten percent requirement. Average percent sorting efficiency was 95.9% (n= 26). All samples sorted by laboratory personnel in training (i.e., not consistently achieving >90% sorting efficiency) were checked, while ten percent of samples sorted by experienced laboratory personnel were also checked. 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

Four samples (LPAX-02-2011, LPAX-06-2011, LPAX-26-2011, and LPAX-33-2011) were randomly selected for QC identification and enumeration by an independent lab. Original identification was completed by Environmental Services and Consulting, LLC[1] (ESC). 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 taxonomic 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 four samples are found in Tables 3-7.

The PDE was below the MQO value of 5% for all verification samples. Following re-identification by the secondary laboratory, the initial PTD of one sample (LPAX-26) exceeded the acceptable

[1] Address: 101 Professional Park Drive, STE 303, Blacksburg, VA
[2] Address: 545 Cathy Jo Circle, Nashville, TN

MQO value of 15%. There was a minor discrepancy between laboratories concerning two genera of Orthocladiinae (Midges), *Eukiefferiella* and *Tvetenia,* partially due to some specimens being mounted on their side where key distinguishing features were obscured. The secondary laboratory took a second look at the specimens under oil and verified that the individuals in question had the characteristics of *Tvetenia,* which agreed with the primary identification. There was another minor discrepancy between laboratories concerning two genera of Nemouridae (Stoneflies), *Podmosta* and *Paranemoura,* which was resolved when the secondary taxonomist concurred with the primary identification of *Podmosta.* There was also a hierarchical disagreement between five Simuliidae (Blackfly) pupae, where the primary taxonomist was able to key them to genus, while the secondary taxonomist left them at family level. Upon closer inspection by the secondary laboratory, the five specimens were keyed out to genus level as *Stegopterna,* resulting in a full agreement for those specimens. As a result, there were enough agreements to reduce the PTD for sample LPAX-26 to an acceptable value of 14%.

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	2011 Results
Field Sampling	Precision	mRPD (BIBI)	<20	6.25
		RMSE (BIBI)	<0.6	0.2
Laboratory Sorting/Subsampling	Bias	PSE	>90	95.9
Taxonomic Identification	Precision	PDE	<5	1.1
		PTD	<15	10.2
Site Assessment	Sensitivity	90% CI (BIBI)	≤0.96	0.33

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

Table 4 - Taxonomic Identification and Enumeration Results: LPAX-02-2011

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Ceratopogonidae	-	-	Ceratopogonidae	1	1	1
	Chironomidae	-	-	Chironomidae	1	0	0
	Chironomidae	Chironominae	Chironomini	Microtendipes	4	4	2
	Chironomidae	Chironominae	Chironomini	Polypedilum	2	2	2
	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	2	2	2
	Chironomidae	Chironominae	Tanytarsini	Rheotanytarsus	6	6	6
	Chironomidae	Orthocladiinae	-	Corynoneura	1	1	1
	Chironomidae	Orthocladiinae	-	Eukiefferiella	3	3	3
	Chironomidae	Orthocladiinae	-	Limnophyes	1	1	1
	Chironomidae	Orthocladiinae	-	Orthocladius	13	0	13
	Chironomidae	Orthocladiinae		Cricotopus/Orthocladius	0	13	0
	Chironomidae	Orthocladiinae	-	Parametriocnemus	1	1	1
	Chironomidae	Orthocladiinae	-	Thienemanniella	4	5	4
	Chironomidae	Orthocladiinae	-	Tvetenia	5	5	5
	Chironomidae	Tanypodinae	-	Tanypodinae	1	1	1
	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	1	1	1
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia group	1	1	1
	Chironomidae			Dicrotendipes	4	4	4
	Chironomidae			Potthastia	1	1	1
	Simuliidae	-	-	Simuliidae	2	2	2
	Simuliidae	-	-	Simulium	5	5	5
	Tipulidae	-	-	Tipula	1	1	1
Coleoptera	Elmidae	-	-	Stenelmis	22	22	22
	Elmidae			Dubiraphia	0	1	0
Ephemeroptera	Baetidae	-	-	Acentrella	1	0	0
	Baetidae	-	-	Baetis	1	0	0
	Baetidae	-	-	Baetidae	0	1	0
	Baetidae	-	-	Plauditas	0	1	0
Haplotaxida	Naididae	-	-	Naididae	14	0	14

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
	Naididae	-	-	Nais	0	14	0
	Tubificidae	-	-	Tubificidae	5	1	5
	Tubificidae	-	-	Limnodrilus	0	1	0
	Tubificidae	-	-	Bothrioneurum	0	1	0
	Tubificidae	-	-	Aulodrilus	0	1	0
	Tubificidae	-	-	Spirosperma	0	1	0
Odonata	Coenagrionidae	-	-	Argia	1	1	1
	Coenagrionidae	-	-	Enallagma	1	1	1
Trichoptera	Limnephilidae	-	-	Ironoquia	1	1	1
Bivalvia	Pisidiidae	-	-	Pisidiidae	3	3	3
				Total	109	110	104
				PDE			0.46
				PTD			5.45

Table 5 - Taxonomic Identification and Enumeration Results: LPAX-06-2011

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Chironomidae	-	-	Chironomidae	2	0	0
	Chironomidae	Chironominae	Chironomini	Chironomus	1	1	1
	Chironomidae	Chironominae	Chironomini	Chironomini	3	0	0
	Chironomidae	Chironominae	Chironomini	Polypedilum	0	3	0
	Chironomidae	Diamesinae	-	Potthastia	1	1	1
	Chironomidae	Orthocladiinae	-	Brillia	2	2	2
	Chironomidae	Orthocladiinae	-	Chaetocladius	1	0	0
	Chironomidae	Orthocladiinae	-	Cricotopus	7	0	0
	Chironomidae	Orthocladiinae	-	Orthocladius	75	0	0
	Chironomidae	Orthocladiinae	-	Cricotopus/Orthocladius	0	79	79
	Chironomidae	Orthocladiinae	-	Orthocladiinae	2	5	2

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
	Chironomidae	Orthocladiinae	-	Eukiefferiella	0	1	0
	Chironomidae	Orthocladiinae	-	Hydrobaenus	0	1	0
	Chironomidae	Orthocladiinae	-	Zalutschia	0	1	0
	Chironomidae	Orthocladiinae	-	Parakiefferiella	1	1	1
	Chironomidae	Orthocladiinae	-	Thienemanniella	1	0	0
	Chironomidae	Orthocladiinae	-	Tvetenia	2	2	2
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia group	1	1	1
Coleoptera	Elmidae	-	-	Macronychus	1	1	1
	Elmidae	-	-	Stenelmis	1	1	1
Ephemeroptera	Baetidae	-	-	Acentrella	1	0	0
	Baetidae	-	-	Baetidae	2	3	2
Haplotaxida	Naididae	Naidinae	-	Naidinae	8	0	8
	Naididae	-	-	Nais	0	8	0
Odonata	Aeshnidae	-	-	Boyeria	1	1	1
				Total	113	112	102
				PDE			0.44
				PTD			8.93

B Table 6 - Taxonomic Identification and Enumeration Results: LPAX-26-2011

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Chironomidae	-	-	Chironomidae	1	0	0
	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	8	8	8
	Chironomidae	Orthocladiinae	-	Eukiefferiella	1	1	1
	Chironomidae	Orthocladiinae	-	Parakiefferiella	0	1	0
	Chironomidae	Orthocladiinae	-	Hydrobaenus	1	0	0
	Chironomidae	Orthocladiinae	-	Orthocladiinae	1	1	1
	Chironomidae	Orthocladiinae	-	Paraphaenocladius	2	2	2

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
	Chironomidae	Orthocladiinae	-	Pseudorthocladius	2	2	2
	Chironomidae	Orthocladiinae	-	Tvetenia	8	8	8
	Culicidae	-	-	Aedes	1	0	0
	Simuliidae	Simuliinae	Prosimuliini	Stegopterna	16	18	16
	Simuliidae	Simuliinae	Prosimuliini	Stegopterna	5	5	5
Coleoptera	Curculionidae	-	-	Curculionidae	1	0	0
	Dytiscidae	Hydroporinae	Hydroporini	Hydroporini	1	0	1
	Dytiscidae	Hydroporinae	Hydroporini	Hydroporinae	0	1	0
Haplotaxida	Enchytraeidae	-	-	Enchytraeidae	11	20	11
	not identified	-	-	Lumbricina	9	0	0
	Tubificidae	-	-	Tubificidae	0	1	0
Isopoda	Asellidae	-	-	Caecidotea	21	20	20
Odonata	Libellulidae	-	-	Libellulidae	1		0
	Corduliidae	Corduliinae	-	Corduliinae		1	0
Plecoptera	Nemouridae	-	-	Podmosta	8	8	8
Trichoptera	Limnephilidae	-	-	Ironoquia	2	2	2
				Total	110	99	85
				PDE			0.50
				PTD			14.14

Table 7 - Taxonomic Identification and Enumeration Results: LPAX-33-2011

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Diptera	Chironomidae	-	-	Chironomidae	1	0	0
	Chironomidae	Chironominae	Chironomini	Chironomini	4	0	0
	Chironomidae	Chironominae	Chironomini	Chironomini	3	3	3
	Chironomidae	Chironominae	Chironomini	Chironomus	1	1	1
	Chironomidae	Chironominae	Chironomini	Dicrotendipes	2	0	0

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
	Chironomidae	Chironominae	Chironomini	Glyptotendipes	8	8	8
	Chironomidae	Chironominae	Chironomini	Phaenopsectra	0	2	0
	Chironomidae	Chironominae	Chironomini	Polypedilum	49	51	49
	Chironomidae	Chironominae	Chironomini	Stictochironomus	0	2	0
	Chironomidae	Chironominae	Chironomini	Tribelos	0	1	0
	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	1	1	1
	Chironomidae	Chironominae	Tanytarsini	Rheotanytarsus	2	2	2
	Chironomidae	Diamesinae	-	Potthastia	1	1	1
	Chironomidae	Orthocladiinae	-	Chaetocladius	2	2	2
	Chironomidae	Orthocladiinae	-	Hydrobaenus	1	0	0
	Chironomidae	Orthocladiinae	-	Limnophyes	1	1	1
	Chironomidae	Orthocladiinae	-	Parakiefferiella	0	1	0
	Chironomidae	Orthocladiinae	-	Orthocladiinae	1	0	0
	Chironomidae	Orthocladiinae	-	Orthocladius	5	0	0
	Chironomidae	Orthocladiinae	-	Orthocladius	1	0	0
	Chironomidae	-	-	Cricotopus/Orthocladius	0	7	6
	Chironomidae	Orthocladiinae	-	Thienemanniella	1	2	1
	Chironomidae	Tanypodinae	-	Tanypodinae	1	0	0
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia group	5	6	5
	Chironomidae	Tanypodinae	Tanypodini	Clinotanypus	1	1	1
	Simuliidae	-	-	Simulium	8	1	1
Ephemeroptera	Caenidae	-	-	Caenis	2	1	1
Haplotaxida	Enchytraeidae	-	-	Enchytraeidae	1	1	1
	Naididae	-	-	Naididae	2	1	1
	not identified	-	-	Hirudinea	1	1	1
Odonata	Coenagrionidae	-	-	Coenagrionidae	1	0	0
	Coenagrionidae	-	-	Enallagma	0	1	0
	Coenagrionidae	-	-	Ischnura	1	1	1
Trichoptera	Hydropsychidae	-	-	Cheumatopsyche	1	1	1
	Limnephilidae	-	-	Ironoquia	1	1	1
Amphipoda	Crangonyctidae	-	-	Crangonyx	3	3	3

Order	Family	Subfamily	Tribe	Final ID	Primary Taxonomist	Secondary Taxonomist	# of agreements
Basommatophora	Physidae	-	-	Physa	1	1	1
	Planorbidae	-	-	Gyraulus	0	1	0
	Planorbidae	-	-	Menetus	1	1	1
				Total	114	107	94
				PDE			3.17
				PTD			12.15