Technical Memorandum

Anacostia Tributary Streambank Erosion Pilot Study

Phase I

Upper Beaverdam Creek Subwatershed

Prepared for:
Maryland Department of the Environment

Prepared by:
Department of Environmental Programs
Metropolitan Washington Council of Governments

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Phong Trieu, John Galli, Kate Levendosky and Christine Vatovec

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Executive Summary

In partnership with the U.S. Department of Agriculture's Beltsville Agricultural Research Center (BARC) and with funding support from the Maryland Department of the Environment (MDE), the Metropolitan Washington Council of Governments (COG) through its Anacostia Watershed Restoration Program was contracted in January 2004 to: 1) evaluate current general streambank erosion conditions in the BARC portion of the Upper Beaverdam Creek subwatershed, 2) perform limited mainstem and tributary streambank soil chemistry characterization analyses and 3) develop representative permanent channel cross-sections for the surveyed portions of Upper Beaverdam Creek. The five month-long baseline condition survey described herein consisted of five parts:

- Employment of COG's Rapid Stream Assessment Technique (RSAT) to evaluate a total of 13.6 stream miles;
- Streambank soil texture and chemistry characterization (upper, middle and lower bank portions) for six representative mainstem and six tributary stream areas, respectively;
- The establishment of 39 permanent, geo-referenced channel cross-sections;
- One time, mainstem baseflow and stormflow water chemistry grab sampling (EPA priority pollutant scan, plus sediment, nutrients and bacteria); and
- Mainstem streambed sediment chemistry characterization (EPA priority pollutant scan) from the lower portion of the Upper Beaverdam Creek mainstem.

Results from this baseline study confirmed that, with few exceptions, the 5.7-mile-long Upper Beaverdam Creek mainstem streambank network is relatively stable. While also generally stable, the tributary system (vis-a-vis the mainstem) exhibited far more channel widening and downcutting.

Additional major findings and recommendations of the survey are described in the following sections.

1. Streambank Erosion

A. Mean bank stability for the mainstem (88 percent) was rated as being in the excellent range (i.e., > 80 percent = excellent). In addition, only 51 linear feet (0.01 linear feet/mile) of severe, 971 feet of moderate/severe (0.18 linear feet/mile) and 3,825 linear feet (0.72 feet/mile) of moderate streambank erosion was observed.

B. Tributary bank stability ranged from a low of 73.6 percent (good category) for the UBC-7 tributary (Entomology Tributary) to a high of 92.6 percent (excellent category) for the UBC-4 tributary (Clear Creek).

2. Stream Channel Cross-Sections

A. Cross-sectional analysis results revealed that the mean cross-sectional area of the Upper Beaverdam Creek mainstem is as follows: Upper (15.5 ft^2), Middle (66.4 ft^2) and Lower (88.4 ft^2). Bank heights for all three mainstem stream segments were well within the expected or reference condition ranges of 2-3 feet and 3-4 feet, respectively. These findings indicate that unlike most other Coastal Plain streams in the Anacostia River watershed, the Upper Beaverdam Creek mainstem has generally experienced relatively little channel widening or downcutting.

B. Tributary stream mean cross-sectional area results are as follows: UBC-1 (upper North Branch mainstem) - 30.9 ft^2, UBC-2 (lower North Branch mainstem) - 72.3 ft^2, UBC-3 (Ashcroft Tributary) - 11.5 ft^2, UBC-4 (Clear Creek) - 15.9 ft^2, UBC-5 (Beck Branch) - 46.7 ft^2, UBC-6 (Biocontrol Tributary) - 46.0 ft^2 and UBC-7 (Entomology Tributary) - 43.5 ft^2. With the exception of UBC-4 (Clear Creek), tributary channel widths and bank heights were all (for their respective drainage areas) generally wider and higher than the expected or reference condition. Specifically, mean tributary streambank heights were on the order of one to two feet higher than the expected or reference bank height ranges (i.e., 1-2 feet and 2-3 feet, respectively). Notably, the highly entrenched UBC-7 (Entomology Tributary) exhibited mean bank heights which were approximately 2.7 feet higher than expected. The preceding channel widening and downcutting conditions are reflective of long-standing uncontrolled stormwater runoff inputs.

3. Streambank Riparian Habitat Conditions

Mainstem

A. Riparian habitat condition ratings for the Upper, Middle and Lower mainstem segments were excellent, fair and good, respectively. Stream canopy coverage was rated as being in the fair (i.e., 50-59 percent) to excellent (i.e., >= 80 percent) range. In addition, the forest riparian buffer zones were generally very wide (i.e., > 195 feet) and predominantly hardwood forest. The poorest riparian habitat was observed both along an approximately 3,000 feet long Middle mainstem segment located immediately above Research Road and along the Lower mainstem segment, approximately 700 feet below Research Road. Within these reaches, because of the extensive wetland areas present, there was generally little or no canopy.

Tributaries

B. Riparian habitat condition ratings for the UBC tributary system were either good or excellent. Stream canopy coverage ranged from 60.4 to 92.1 percent (i.e., good and excellent categories). In addition, the riparian buffer zones were typically wide (i.e., > 140 feet) and comprised of hardwood forest.

4. Streambank Soil Texture and Chemistry

A. Laboratory soil texture results revealed that mainstem bank materials at the six selected sampling sites are predominantly loam-based soils (i.e., sandy loam and sandy clay loam). In contrast, tributary bank materials (also six separate sampling sites) are far more diverse, with clay, sandy clay loam, loam and silty clay soil- types present.

B. Select mainstem streambank soil chemistry results (reported as a range in mg/kg dry weight, unless otherwise noted) are as follows: 1) nitrate-nitrogen = 1.0-2.9, 2) total phosphorus = 140.44-444.58, 3) organic matter = 1.0-3.3 percent, 4) arsenic = 0.7-3.6, 5) copper = 4.17- 7.68, 6) lead = 6.99- 22.22, 7) zinc = 16.20-39.13 and 8) total PCB's = present in trace amounts (i.e., < 0.192 mg/kg) at all six streambank soil chemistry sampling sites.

C. Select tributary streambank soil chemistry results (reported as a range in mg/kg dry weight, unless otherwise noted) are as follows: 1) nitrate-nitrogen = 1.6-4.4, 2) total phosphorus = 167.00-404.42, 3) organic matter = 0.6-14.2 percent, 4) arsenic = 1.88-2.57, 5) copper = 9.17- 20.38, 6) lead = 9.19- 29.02, 7) zinc = 31.76-184.35 and 8) total PCB's = present in trace amounts (i.e., < 0.22 mg/kg) at all six streambank soil chemistry sampling sites.

D. Reported (U.S. EPA, 2003) mean Maryland soil metal background concentrations (mg/kg dry weight) for the previously-listed metals are as follows: arsenic = 3.8, copper = 20.0, lead = 22.0 and zinc = 39.0.

5. Mainstem Baseflow and Stormflow Water Chemistry Grab Sampling

A. Select laboratory (CT&E Environmental Services, Inc.) water chemistry baseflow grab sampling results (reported in mg/l, unless otherwise noted) for the Upper Beaverdam Creek mainstem (Edmonston Road area/Lower mainstem) are as follows: 1) pH = 6.75, 2) alkalinity (total, as $CaCO_3$) = 22, 3) TSS = 8, 4) turbidity = 10 NTU, 5) nitrate-nitrogen = 1.5, 6) orthophosphate = not detected, 7) total phosphorus = 0.025, 8) BOD_5 = not detected (i.e., < 2.0), 9) total organic carbon = 9.2, 10) arsenic = not detected, 11) PCB's = not detected and 12) E. coli = 4,900 MPN.

B. Select laboratory (CT&E Environmental Services, Inc.) water chemistry stormflow grab sampling results (reported in mg/l, unless otherwise noted) for the Upper Beaverdam Creek mainstem (Edmonston Road area/lower mainstem) are as follows: 1) pH = 6.62, 2) alkalinity = 29, 3) TSS = 14, 4) turbidity = 22 NTU, 5) nitrate-nitrogen = 0.73, 6) orthophosphate = 0.020, 7) total phosphorus = 0.051, 8) BOD_5 = 2.10, 9) total organic carbon = 7.6, 10) arsenic = not detected, 11) PCB's = not detected and 12) E. coli = 3,000 MPN.

C. With the exception of expected high baseflow and stormflow bacteria levels recorded in the three mainstem segments sampled, the water quality parameters tested (EPA priority pollutant scan plus sediment, nutrients and bacteria) met current MDE Use I (Water Contact, Recreation, and Protection of Aquatic Life) stream criteria. However, in COG staff's opinion, the high baseflow E. coli level (4,900 MPN) recorded in the Lower mainstem warrants additional follow-up monitoring to determine the potential source(s) of this bacterial contamination.

6. Mainstem Streambed Sediment Chemistry Characterization

A. Results from the lower mainstem EPA priority pollutant scan sediment grab sampling effort revealed that none of the major hydrocarbon analytes, PCB congeners, or pesticides were present within the detection limits of the analysis. In addition, representative metals (e.g., chromium, copper, lead and zinc) typically present in both urban runoff and at background levels in the environment were detected at relatively low levels. Based on the results of this limited, one-time, EPA priority pollutant scan it does not appear that the pollutants detected pose major environmental toxic risks to the biological community of Upper Beaverdam Creek's Lower mainstem.

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1.0 Introduction

1.1 Project Background

Streambank erosion is widely recognized as a major source of sediment and various other contaminants in fluvial systems. Recent studies (Simon and Collison, 2002) have shown that more than one-half of the total amount of sediment eroded from stream channels in the southeastern United States originates from streambanks. In addition to sediment, bank erosion is suspected of delivering large quantities of contaminants (e.g., phosphorus and nitrates) to downstream receiving bodies of water such as the Anacostia River and Chesapeake Bay.

For well over 200 years, excessive erosion and subsequent sediment deposition have been a major Anacostia River problem. Because the Anacostia River functions in many ways like a tidal lake, it is a very efficient sediment trap. It has been estimated that approximately 85 percent of the incoming sediment load remains trapped within the river (Scatena, 1987). In addition to adversely impacting navigation, reducing water clarity, degrading aquatic habitat and associated biota, sediment serves as a binding site for a broad range of urban pollutants and toxicants. These include: petroleum hydrocarbons, PCB's, pesticides, herbicides, nutrients, metals and bacteria. Sediment-related stream quality degradation in the Anacostia tributary system has been equally devastating. Related impacts include: impairment of pool and riffle habitat through deposition of finer grained sediments such as sand and silt; accelerated streambank and streambed erosion during stormflows; and high suspended solids loads which impair the biological community by obscuring the water for sight feeders and irritating exposed gills.

In an effort to both document the magnitude of current streambank erosion problems and their potential contribution of nutrients and other pollutants of interest to the Anacostia River, the Metropolitan Washington Council of Governments (COG) conducted Phase I of a comprehensive, phased, multi-year streambank erosion assessment of the Maryland portion of the Anacostia tributary system. The Upper Beaverdam Creek (UBC) subwatershed (Figure 1) was chosen for the Phase I Study due to its diverse land use/ land cover characteristics (i.e., includes both agricultural and various developed land uses).

Under Phase I, the following tasks were performed: 1) evaluation of current streambank erosion conditions, 2) documentation of stream channel cross-sectional areas, 3) evaluation of riparian forest conditions, 4) analysis of streambank soil chemical and physical properties, 5) characterization of both mainstem baseflow and stormflow water chemistry and 6) characterization of the UBC mainstem streambed sediment. The study represents the start of systematically analyzing both the overall stability of the Anacostia tributary system, as well as the potential contribution of streambank erosion to both local and downstream water quality and physical aquatic habitat problems. It is expected that the data generated from the study will be of value to MDE in its preparation of Anacostia TMDL's, as well as to BARC, AWRC and AWTA members and their various sediment and toxics monitoring, modeling and restoration initiatives. A brief description of the study area and each task is as follows.

1.2 Upper Beaverdam Creek Subwatershed

Upper Beaverdam Creek is a free-flowing, MDE Use I (Water Contact, Recreation and Protection of Aquatic Life) tributary of the Northeast Branch of the Anacostia River (Figure 1). This 14.1 square mile subwatershed is located within Prince George's County, Maryland and is wholly contained within the Coastal Plain physiographic province. Land uses in the subwatershed include forest, agricultural lands (including both pasture and row crop), institutional, garden apartment, some single family residential and various government building complexes. The majority of the subwatershed is owned by the U.S. Department of Agriculture and is operated as the Beltsville Agricultural Research Center (BARC). BARC is a long-time AWRC affiliate and has an excellent working relationship with both the AWRC and COG. Among the 14 major Anacostia subwatersheds, Upper Beaverdam Creek

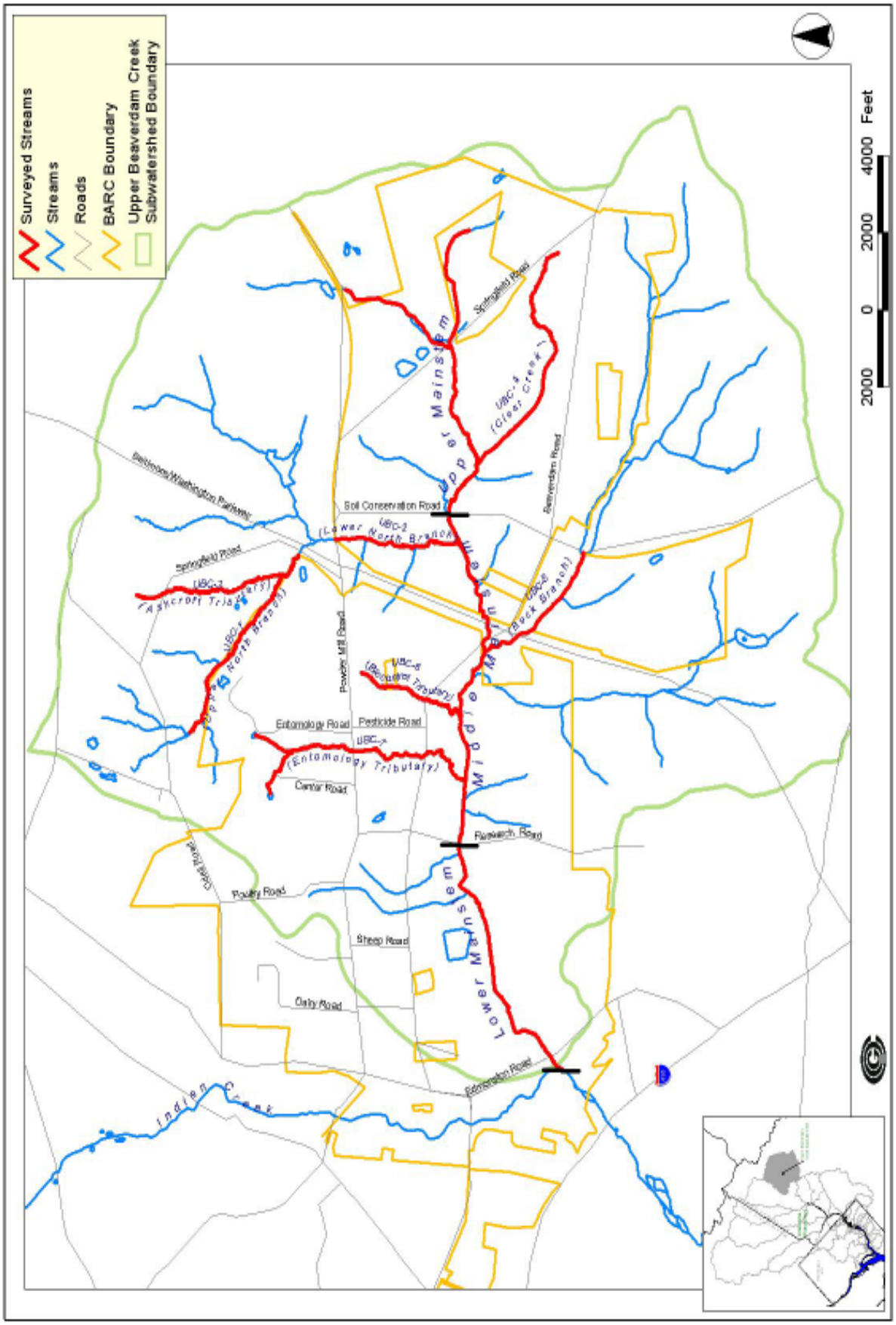

Figure 1: Upper Beaverdam Creek COG Study Area

boasts the highest percent forest cover. However, both high nutrient and high stream turbidity levels continue to plague this major tributary. Not surprisingly, casual field surveys conducted by COG staff revealed locally moderate to severe erosion problems associated with uncontrolled stormwater runoff.

2.0 Study Design/Methods

2.1 Upper Beaverdam Creek Study Area

COG staff performed a modified RSAT field survey of the Upper Beaverdam Creek (UBC) subwatershed for a total of 13.6 miles of open stream channel. As part of this survey, a total of 143 stream transects (spaced on average 400 to 500 feet apart) were established for the Rapid Stream Assessment Technique (RSAT) evaluation portion of the study. For study purposes the Upper Beaverdam Creek was divided into three major mainstem segments (i.e., Upper, Middle and Lower). In addition, the RSAT survey was preformed on a total of seven tributary segments that included the UBC-1 (Upper North Branch), UBC-2 (Lower North Branch), UBC-3 (Ashcroft tributary), UBC-4 (Clear Creek), UBC-5 (Beck Branch), UBC-6 (Biocontrol tributary), and UBC-7 (Entomology tributary). General Upper Beaverdam Creek background information and RSAT stream transect locations are presented in Table 1 and Figure 2, respectively. For exact locations of transect locations, the reader is referred to Appendix A where latitude/longitude coordinates captured by a Trimble GEO-XT handheld GPS receiver have been included. Field data results tables are included as Appendix B

2.2 RSAT Survey

The Rapid Stream Assessment Technique (RSAT) was developed by COG in 1992 to provide a simple, rapid reconnaissance-level assessment of stream quality conditions. The RSAT survey includes six standard evaluation categories (i.e., 1) Bank Stability, 2) Channel Scouring/Sediment Deposition, 3) Physical Instream Habitat, 4) Water Quality, 5) Riparian Habitat Condition and 6) Biological Indicators). For this study a modified RSAT survey has been employed that included only two of the six standard RSAT survey evaluation categories; 1) Streambank Stability Conditions, and 2) Riparian Habitat Condition. In addition, as part of the study both the creation of a photo library and GIS Mapping tasks were involved. A brief overview of the types of field measurements and observations made for the preceding RSAT evaluation categories follow.

1. Streambank Stability

One of the primary assessments of channel stability is overall bank stability which is evaluated through both a visual estimation of the percentage of bank that is stable along each transect surveyed (expressed as a percentage) and a generalized approximation of the degree of erosion between transects (categorized verbally as stable, slight, slight/moderate, moderate, moderate/severe, or severe). Additional observations factored into the bank stability evaluation include the stability of stream bend areas and the number of recent, large tree falls per stream mile. The relative erodibility of the soil material comprising the bottom one-third of the bank (the area most susceptible to erosion)

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[1] Relative erodibility describes the erosion potential and is classified as low, moderate or high. Low potential denotes predominantly clay-textured soils, bedrock, saprolite and rip-rap; moderate potential characterizes non-silt or non-clay dominant soil textures; and high potential describes predominantly silt-textured soils.

[2] Mean bank heights of one to two feet for small first and second-order Coastal Plain streams and two to three feet for third-order streams approximate reference conditions. Sewer lines are typically laid three to four feet below the bottom of the streambed; therefore, their exposure offers insight into the depth of downcutting that has occurred. A nick point is an erosional feature in the streambed, marked by an abrupt drop in elevation, which is caused by stream headcutting.

Table 1: Upper Beaverdam Creek - General Study Area Information

RSAT Stream Segment	Drainage Area (mi^2)	Stream Order[1]	Stream Length		Stream Gradient (%)	No. of RSAT Transects
			Feet	Miles		
Upper Beaverdam Creek Mainstem						
1. Upper	2.86	3	6,864	2.4	0.20%	13
2. Middle	12.38	4	10,032	1.9	0.18%	22
3. Lower	14.07	4	7,392	1.4	0.16%	15
Subtotal	- -	- -	24,288	5.7	- -	50
North Branch Mainstem						
1. UBC-1 (Upper)	1.50	2	12,672	1.3	0.24%	18
2. UBC-2 (Lower)	3.27	3	4,752	0.9	0.25%	12
Subtotal	- -	- -	17,424	2.2	- -	30
Tributaries to North Branch						
3. UBC-3 (Ashcroft Tributary)	0.34	1	2,700	1.0	1.19%	12
Tributaries to Mainstem						
4. UBC-4 (Clear Creek)	0.62	1	7,392	1.4	0.60%	17
5. UBC-5 (Beck Branch)	2.50	3	4,224	0.8	0.24%	10
6. UBC-6 (Biocontrol Tributary)	0.23	1	3,696	0.7	1.62%	7
7. UBC-7 (Entomology Tributary)	0.74	2	9,504	1.8	0.78%	18
Subtotal	- -	- -	24,816	4.7	- -	52
Total	14.07	- -	69,228	13.6	- -	276

[1] Stream order determination was made using 200 foot scale maps.

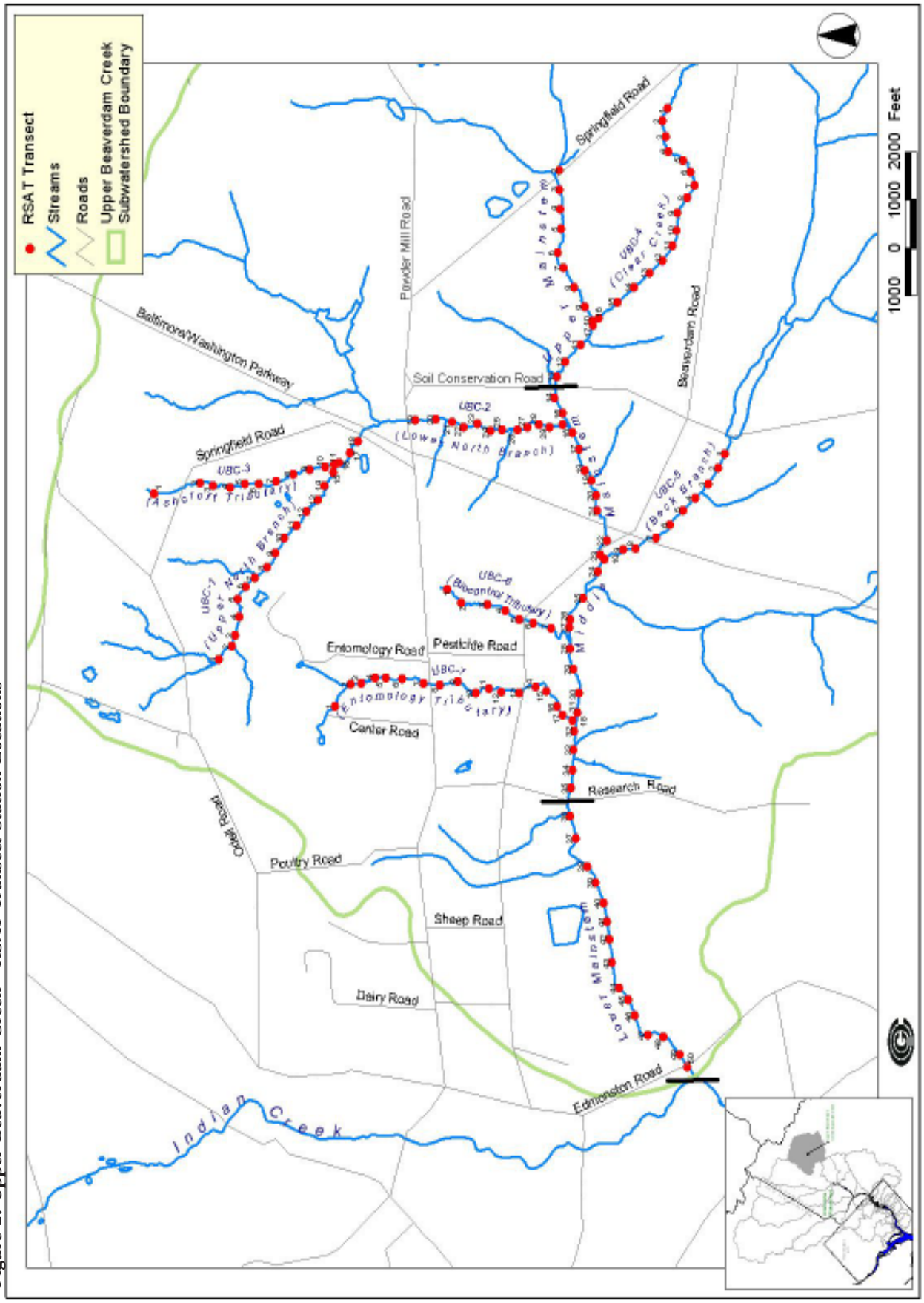


Figure 2: Upper Beaverdam Creek - RSAT Transect Station Locations

is also considered.[1] Another factor considered in assessing channel stability is the degree of channel downcutting, which is evaluated by a set of indicators that includes bank heights, exposed utility lines and nick points.[2]

2. Riparian Habitat

The quality of riparian habitat is evaluated based on 1) the width of the vegetated buffer zone on the left and right banks and the type of vegetation (a forested buffer rating highest) and 2) the percent canopy coverage (i.e., shading) over the stream.

3. Photo Library

Representative photographs were taken at each RSAT transect and at each permanent cross-section location, as well as of any notable features (including fish barriers, nick points, debris jams, etc.). The resulting photo library is a useful tool for observing high quality areas of the stream system, as well as areas of concern where additional actions may be considered. These photos have been catalogued using the geo-referenced RSAT data points, and have been included with this report as a CD-ROM. Appendix C summarizes both photo stream segment and transect locations.

4. GIS Mapping

To accurately document streambank channel conditions, COG staff employed the Trimble GEO-XT GPS receiver to register and georeference linear stream channel reaches that depicted the following streambank erosion condition: stable, slight, slight/moderate, moderate, moderate/severe and severe. Furthermore, the Trimble receiver was used to verify/correct (field truthing) the Upper Beaverdam Creek existing electronic stream channel network layer. The stream layer field truthing was conducted during the early spring 'leaf off' period. In addition, point data were also acquired for the following stream features; nick points, debris jams, fish blockages, utility line crossings, and other sites of interests. Such stream-related information were then transferred to ArcView and ArcGIS platforms for analysis and creation of illustrative maps.

2.3 Streambank Soil Collection

As part of the streambank soil sediment chemistry assessment, COG staff collected soil samples from twelve RSAT representative locations (Figure 3) within the Upper Beaverdam Creek subwatershed survey area (Note: the reader is referred to Appendix D for exact coordinate locations).

Under this task, COG staff used a stainless steel soil probe to collect the vertical streambank soil profile samples (i.e., from the upper, middle and lower portions of the streambank) for laboratory analysis. The Pennsylvania State University Soils Laboratory analyzed the samples for the following pollutants of interest: phosphorus, nitrates, arsenic, chlordane and PCB's. The laboratory also analyzed for the following metals - cadmium, chromium, copper, lead, molydenum, nickel, selenium, and zinc. In addition, they performed both percent organic content and soil textural composition analyses (i.e., percent sand, silt and clay).

2.4 Permanent Channel Cross-Sections

As part of the channel morphology characterization portion of the study, COG staff established permanent channel cross-section stations at an approximately 1,600 foot interval (i.e., every fourth RSAT transect) along the Upper Beaverdam Creek mainstem and tributaries. At each permanent cross-section, COG staff employed a LEICA Total Station (TCR110) to measure elevational differences at one-foot intervals across the stream channel. It should be noted that for consistency purposes, the LEICA total station was always positioned on the left streambank, looking downstream. Furthermore, COG staff acquired cross-section location point data using the Trimble GEO-XT handheld GPS receiver. For complete permanent channel cross-section illustrations and locations, the reader is referred to Appendix E.

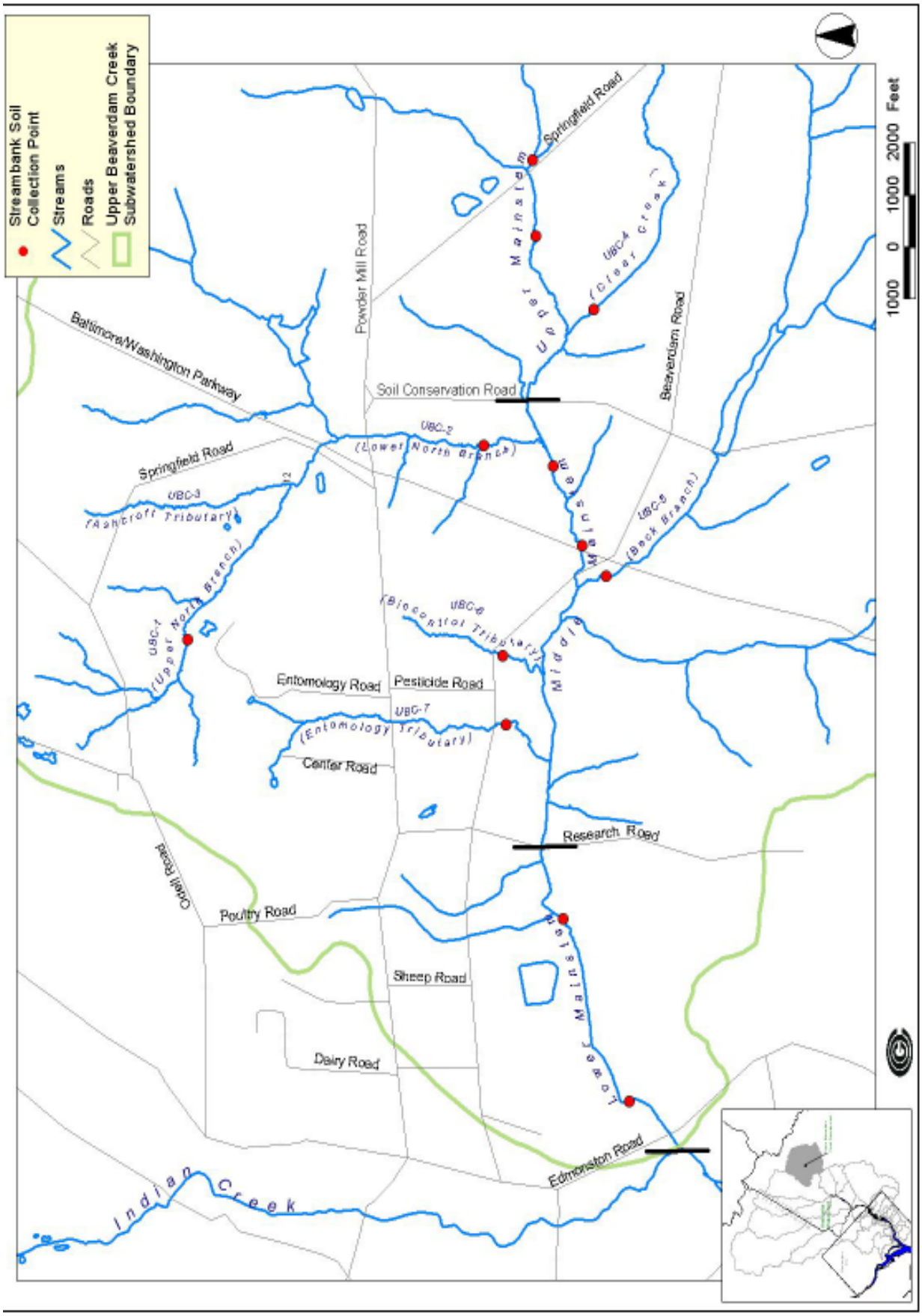


Figure 3: Upper Beaverdam Creek - Streambank Soil Collection Locations

2.5 Mainstem Baseflow and Stormflow Grab Sampling

One baseflow (June 17, 2004) and one stormflow (April 26, 2004) water chemistry grab sample was collected for the purpose of conducting EPA priority pollutant scans. Both baseflow and stormflow water-grab samples were collected at the following three locations: Springfield Road (Upper Mainstem), Beaverdam Creek Road (Middle Mainstem), and Edmonston Road (Lower Mainstem). Each water sample included 13 separate collection containers, each containing their respective preservative.

The stormflow grab sample was collected during a storm event that produced 0.70 inches of rainfall (BWI Airport 24-hour rainfall data). During this storm, the sample was collected by completely submerging the collection containers into a pool to collect the initial runoff associated with the rising limb of the hydrograph (i.e., first flush). The baseflow water grab sample was similarly collected, but from an undisturbed pool. Both baseflow and stormflow water samples were iced and transferred to CT&E Environmental Services, Incorporated (located in Charleston, West Virginia) within six hours.

2.6 Mainstem Streambed Sediment Chemistry

One composite streambed sediment grab sample was collected from a total of ten Lower mainstem pool sites located above Edmonston Road. In order to have enough material to perform an EPA priority pollutant scan, a total of 32 ounces of fine sediment was collected using a long-handled, polyethylene dipper (which featured a 500 ml bowl set at a 45° angle). The composite was homogenized in a large porcelain mixing bowl, transferred into eight sterilized four ounce glass sample containers, appropriately labeled and placed in an ice cooler. The cooled sample was then delivered to the CT&E Environmental Services, Incorporated laboratory within six hours for analysis.

3.0 Results

3.1 Upper Beaverdam Creek - Upper, Middle and Lower Mainstem Areas

3.1.1 Stream Channel Erosion

Background

Under the RSAT system, the following channel morphology-related data were collected at each riffle transect: top channel width, bottom channel width, average right and left bank height, general right and left bank material type and right and left bank stability. In addition, between each transect station, COG staff noted and recorded both the general level of bank stability in the channel network and the presence of recent tree falls, exposed utility lines, perched road culverts or other tell-tale signs of lateral stream channel erosion and degradation. Bank stability conditions between transect stations were visually rated and placed into one of the following six categories:

1) Stable - Over 90 percent of bank network is stable, with no signs of major lateral bank erosion problems present;

2) Slight - 81 to 90 percent of bank network is stable and signs of major lateral bank erosion problems are rarely observed;

3) Slight/Moderate - 71 to 80 percent of bank network is stable and signs of major lateral bank erosion problems are uncommon to common;

4) Moderate – 61 to 70 percent of bank network is stable and signs of lateral bank erosion problems are common;

5) Moderate/Severe – 50 to 60 percent of bank network is stable and signs of lateral bank erosion problems are very common;

6) Severe – Less than 50 percent of bank network is stable and major portions of banks are unraveling.

The preceding information was digitized, in the field, into an Upper Beaverdam Creek GIS-based database using a Trimble Geo-XT handheld GPS receiver and mapping unit. Additional bank condition information was logged on field survey forms and subsequently entered into a Microsoft Excel spreadsheet database for further analysis. Photographs were taken to document stream channel erosion conditions.

Mainstem

Streambank stability results are summarized in Table 2 and Figure 4. Also, representative photographs depicting bank conditions for the mainstem areas are shown in Figures 5 through 16. Mean streambank stability for the Upper, Middle and Lower mainstem (i.e., 88.0, 73.3 and 70.8 percent, respectively) were rated as being excellent to good. Mean streambank stability results suggest a general decreasing trend heading downstream.

RSAT Upper Beaverdam Creek mainstem streambank erosion results and totals are as follows: 51.0 linear feet of severe bank erosion (<1.0 percent of the total length) was documented only in the Lower mainstem and at a very minor localized pocket, 970.8 linear feet of moderate/severe streambank erosion (3.2 percent of the total length) and 3,824.5 linear feet of moderate erosion (12.8 percent

of the total length). However, it should be noted that more than 90 percent of the Upper mainstem stream segement bank network generally fell between the stable to slight/moderate categories, with very small localized areas of moderate/severe conditions that totaled 129.9 linear feet (<1.0 percent of the total mainstem length).

RSAT streambank soil texture survey results for the Upper Beaverdam Creek mainstem (Figure 17) indicated that the bank materials present are, in order of dominance, moderate (i.e., generally loam-textured soils), high (i.e., generally sand/silt-textured soils) and low (i.e., generally clay-textured soils) erodible potential soil types, respectively.

Table 2: Summary: Upper Beaverdam Creek - Mainstem Streambank Erosion Condition[1]

RSAT Stream Segment	Approx. Stream Segment Length (mi.)	Streambank Erosion Length (Feet)			No. of Recent Tree Falls[2]		No. of Ersional Log Jams	Mean Bank Stability (%)[3]
		Severe	Moderate/ Severe	Moderate	No.	No./mi		
Upper Beaverdam Creek (UBC)								
1) Upper	2.4	0	130	0	5	2.1	0	88.0
2) Middle	1.9	0	564	1,738	7	3.7	1	73.3
3) Lower	1.4	51	277	2,086	10	7.1	1	70.8
Total	5.7	**51**	**971**	**3,824**	22			

[1] Moderate – 61 to 70 percent of bank network is stable and signs of lateral bank erosion problems are common; Moderate/Severe – 50 to 60 percent of bank network is stable and signs of lateral bank erosion problems are very common; Severe – Less than 50 percent of bank network is stable and major portions of banks are unraveling.

[2] Tree fall interpretation: 0-1/mi. = Excellent, 2-3/mi. = Good, 4-5/mi = Fair, ≥6/mi. = Poor.

[3] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

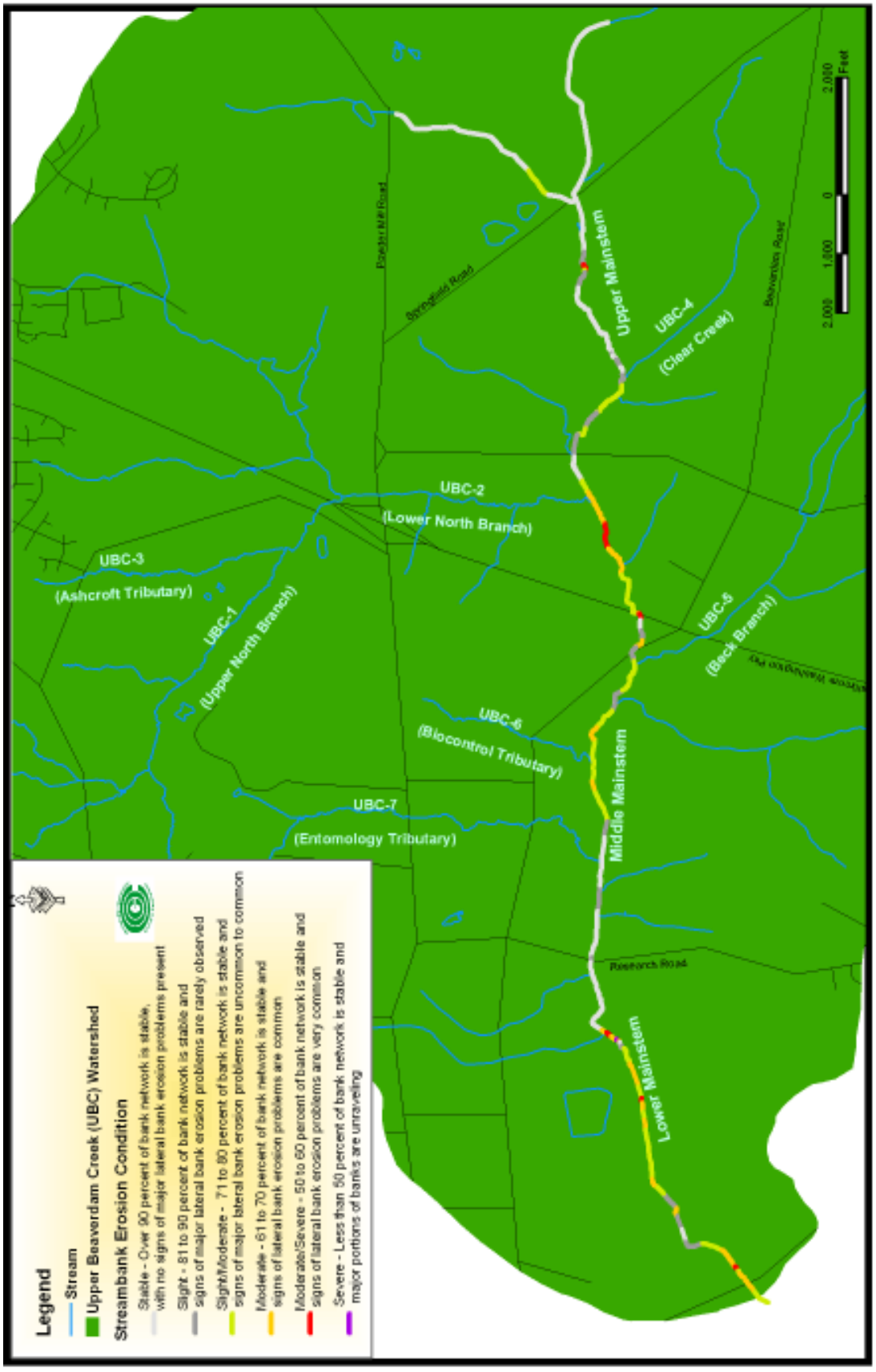


Figure 4: Summary: Upper Beaverdam Creek Mainstem Streambank Erosion Condition

Figure 5: Location - Approximately 500 Feet Upstream of Springfield Road (X-1): Stable Streambank

Figure 6: Location - Approximately 1,100 feet Downstream of Springfield Road (Near X-5): Moderate/Severe Streambank Erosion

Figure 7: Location : Approximately 2,400 feet Downstream of Springfield Road (X-8): Stable Streambank

Figure 8: Location: Approximately 100 Feet Upstream of Soil Conservation Road (Near X-13): Slight Streambank Erosion

Middle Mainstem

Figure 9: Location: Approximately 1,300 Feet Downstream of Soil Conservation Road (X-17): Moderate/Severe Streambank Erosion

Figure 10: Location: Approximately 800 Feet Upstream of Baltimore Washington Parkway (X-20): Slight/Moderate Streambank Erosion

Figure 11: Location: Approximately 1,700 Feet Downstream of Beaverdam Road (X-26): Slight/Moderate Streambank Erosion

Figure 12: Location: Approximately 900 Feet Upstream of Research Road (X-34): Slight Streambank Erosion

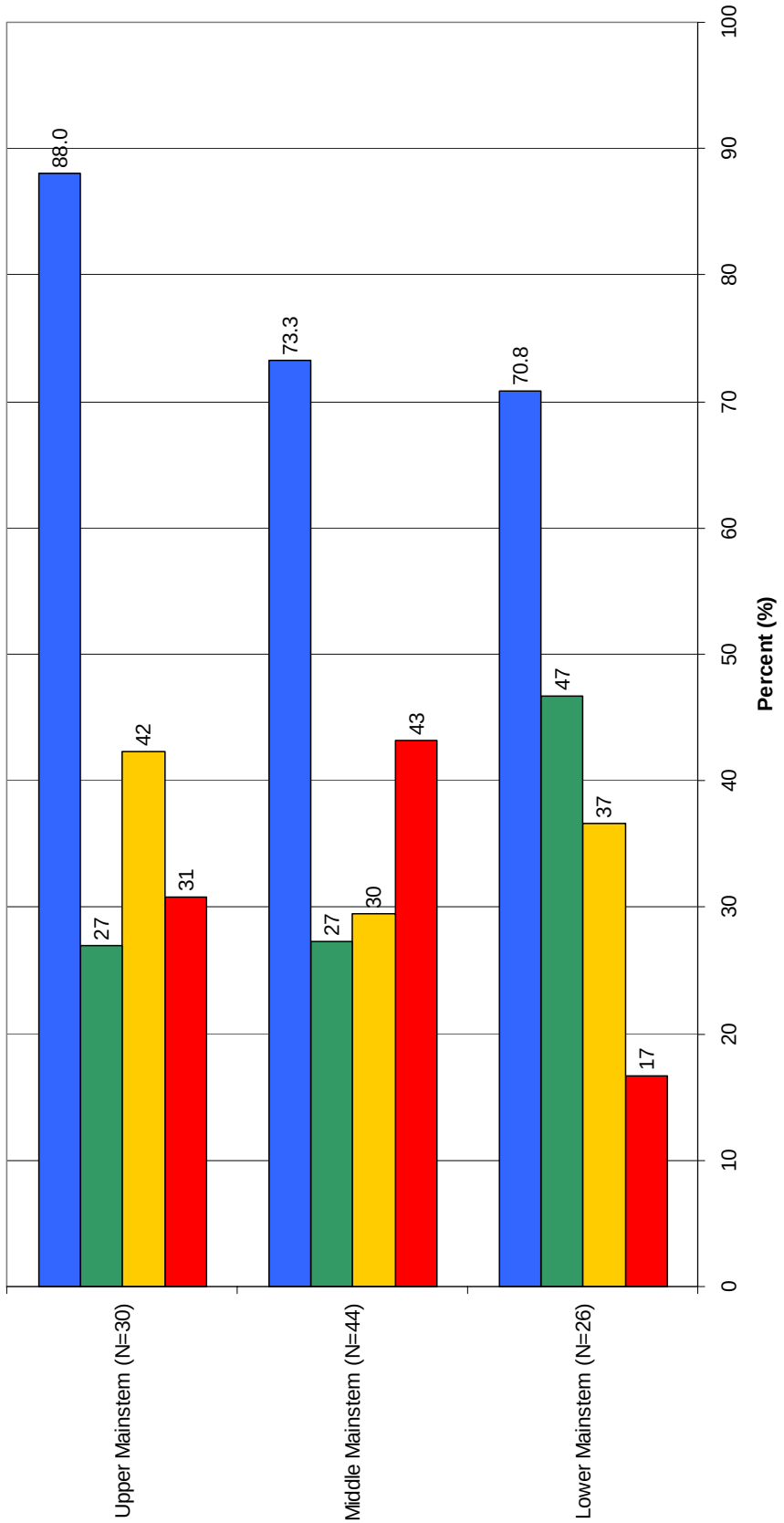
Figure 13: Location: Approximately 1,500 Feet Downstream of Research Road (X-38): Severe Streambank Erosion

Figure 14: Location: Approximately 3,000 Feet Downstream of Research Road (X-42): Moderate Streambank Erosion

Figure 15: Location: Approximately 2,000 Feet Upstream of Edmonston Road (X-46): Slight Streambank Erosion

Figure 16: Location: Approximately 150 Feet Upstream of Edmonston Road (X-50): Moderate Streambank Erosion

Figure 17: Upper Beaverdam Creek Mainstem Mean Streambank Stability[1] and Relative Erodibility (%)[2]



[1] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

[2] Total number of observations to determine average bank stability and relative erodibility appear in parentheses.

Tributaries

Streambank stability results are summarized in Table 3 and Figure 18. Also, representative photographs depicting bank conditions for the tributary areas are presented in Figures 19 through 38. Mean streambank stability for the Upper and Lower North Branch, Ashcroft tributary, Clear Creek, Beck Branch, and Biocontrol and Entomology tributaries (i.e., 78.0, 76.5, 87.5, 92.6, 75.8, 81.6, and 73.6 percent, respectively) were rated as being good to excellent.

RSAT Upper Beaverdam Creek tributary streambank erosion results and totals are as follows: 502.3 linear feet of severe streambank erosion (2.9 percent of the total length), 502.9 linear feet of moderate/severe erosion (2.9 percent of the total length) and 5,962.7 of moderate streambank erosion (33.8 percent of the total length). It should be noted that over 90 percent of the Clear Creek tributary generally fell within the stable to slight streambank erosion category; with a short isolated area of moderate erosion present that totaled 406.1 linear feet (5.5 percent of the total stream length).

RSAT streambank soil texture survey results for tributary system (Figure 39) revealed that the bank material present is predominantly moderately erodible soil types (i.e., generally loam-textured soils).

Table 3: Summary: Upper Beaverdam Creek - Tributary Streambank Erosion Condition[1]

RSAT Stream Segment	Approx. Stream Segment Length (mi.)	Streambank Erosion Length (Feet)			No. of Recent Tree Falls[2]		No. of Erosional Log Jams	Mean Bank Stability (%)[3]
		Severe	Moderate/ Severe	Moderate	No.	No./mi		
North Branch Mainstem								
1. UBC-1 (Upper)	1.3	223.7	158.7	474.7	4	3.1	2	78.0
2. UBC-2 (Lower)	0.9	0.0	0.0	373.4	0	0.0	1	76.5
Tributaries to North Branch								
3. UBC-3 (Ashcroft Tributary)	1.0	15.3	0.0	433.9	4	4.0	0	87.5
Tributaries to Mainstem								
4. UBC-4 (Clear Creek)	1.4	0.0	0.0	406.1	1	0.7	0	92.6
5. UBC-5 (Beck Branch)	0.8	0.0	121.4	66.2	0	0.0	1	75.8
6. UBC-6 (Biocontrol Tributary)	0.7	263.4	83.3	645.9	6	8.3	2	81.6
7. UBC-7 (Entomology Tributary)	1.8	0.0	139.5	3,562.4	4	2.2	1	73.6
Total	**7.9**	**502.3**	**502.9**	**5,962.7**	**19**		**7**	

[1] Moderate – 61 to 70 percent of bank network is stable and signs of lateral bank erosion problems are common; Moderate/Severe – 50 to 60 percent of bank network is stable and signs of lateral bank erosion problems are very common; Severe – Less than 50 percent of bank network is stable and major portions of banks are unraveling.

[2] Tree fall interpretation: 0-1/mi. = Excellent, 2-3/mi. = Good, 4-5/mi = Fair, ≥6/mi. = Poor.

[3] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

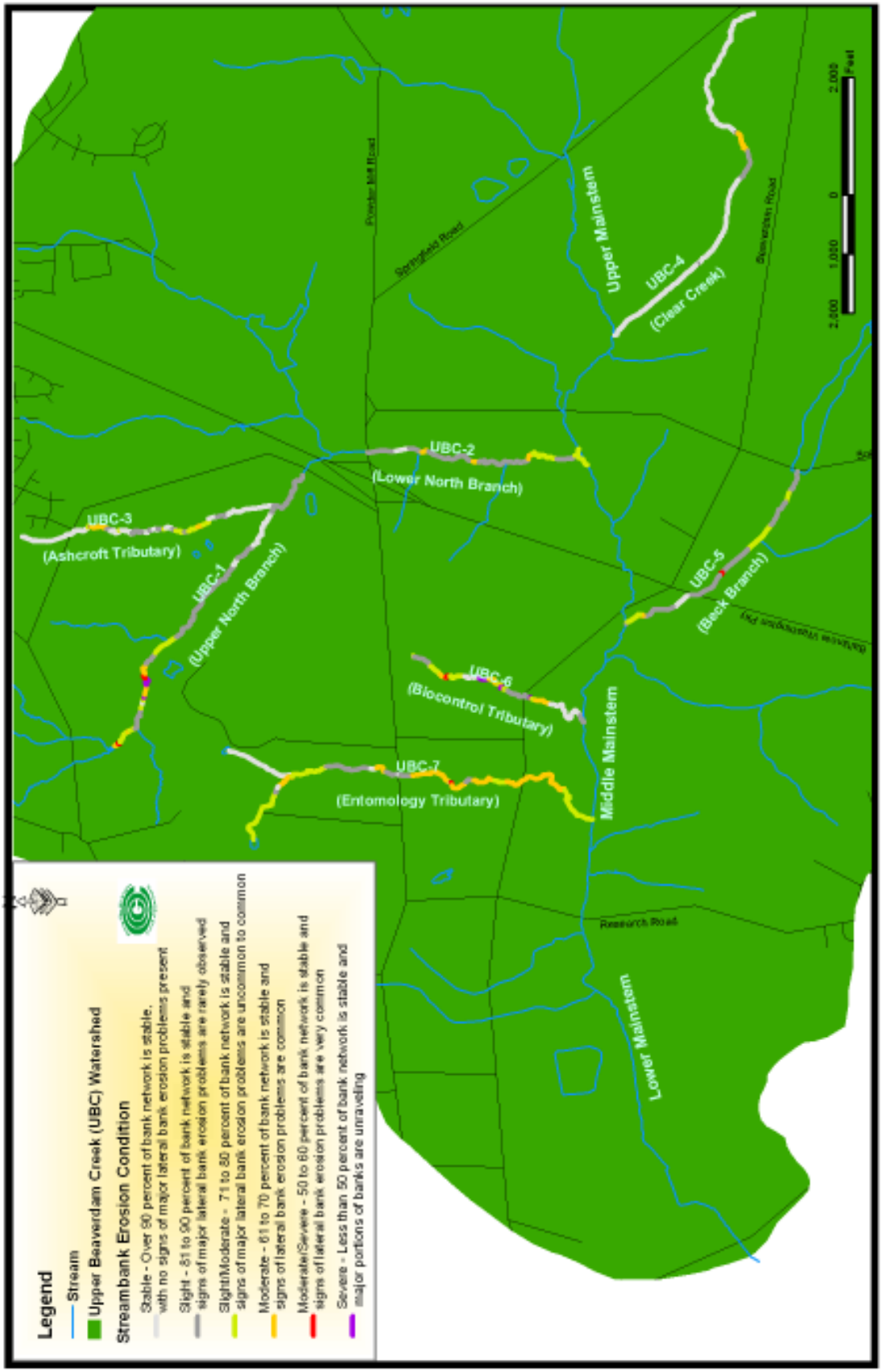


Figure 18: Summary: Upper Beaverdam Creek Tributary Streambank Erosion Condition

UBC-1 (Upper North Branch)

Figure 19: Location: Approximately 5,500 Feet Upstream of Springfield Road (X-2): Moderate Streambank Erosion

Figure 20: Location: Approximately 4,500 Feet Upstream of Springfield Road (X-4): Moderate Streambank Erosion

Figure 21: Location: Approximately 4,000 Feet Upstream of Springfield Road (Upstream X-5): Severe Streambank Erosion

Figure 22: Location: Approximately 400 Feet Upstream of Springfield Road (X-17): Slight Streambank Erosion

UBC-2 (Lower North Branch)

Figure 23: Location: Approximately 1,200 Feet Downstream of Powder Mill Road (X-22): Slight Streambank Erosion

Figure 24: Location: Approximately 3,500 Feet Downstream of Powder Mill Road (X-30): Slight/Moderate Streambank Erosion

UBC-3 (Tributary to North Branch UBC - Ashcroft Tributary)

Figure 25: Location: Approximately 300 Feet Downstream of Springfield Road (X-2): Moderate Streambank Erosion

Figure 26: Location: Approximately 3,200 Feet Downstream of Springfield Road (X-10): Stable Streambank

UBC-4 (Clear Creek)

Figure 27: Location: Approximately 5,500 Feet Upstream of UBC Mainstem (X-2): Stable Streambank

Figure 28: Location: Approximately 4,225 Feet Upstream of UBC Mainstem (X-6): Moderate Streambank Erosion

Figure 29: Location: Approximately 2,830 Feet Upstream of UBC Mainstem (X-10): Stable Streambank

Figure 30: Location: Approximately 243 Feet Upstream of UBC Mainstem (X-16): Stable Streambank

UBC-5 (Beck Branch)

Figure 31: Location: Approximately 1,460 Feet Downstream of Soil Conservation Road (X-4): Slight/Moderate Streambank Erosion

Figure 32: Location: Approximately 900 Feet Downstream of Baltimore/ Washington Parkway (X-10): Slight/Moderate Streambank Erosion

UBC-6 (Biocontrol Tributary)

Figure 33: Location: Approximately 750 Feet Upstream of Beaverdam Road (Upstream of X-4): Severe Streambank Erosion

Figure 34: Location: Approximately 560 Feet Downstream of Beaverdam Road (X-7): Stable Streambank

UBC-7 (Entomology Tributary)

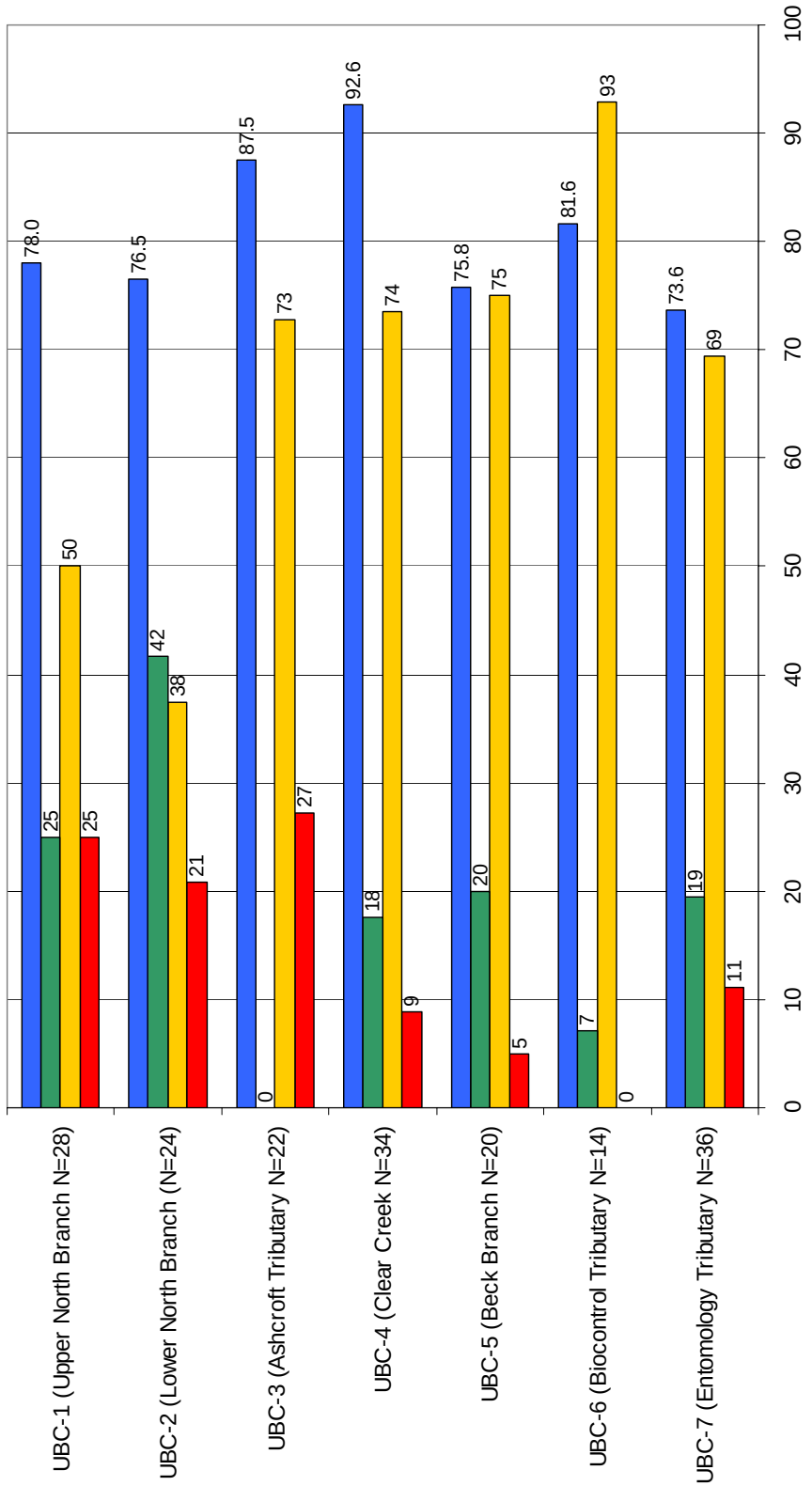
Figure 35: Location: Approximately 2,500 Feet Upstream of Powder Mill Road (X-1): Slight/Moderate Streambank Erosion

Figure 36: Location: Approximately 235 Feet Downstream of Powder Mill Road (X-8): Slight/Moderate Streambank Erosion

Figure 37: Location: Approximately 250 Feet Upstream of Beaverdam Road (X-13): Moderate Streambank Erosion

Figure 38: Location: Approximately 1,110 Feet Downstream of Beaverdam Road (X-16): Slight/Moderate Streambank Erosion

Figure 39: Upper Beaverdam Creek Tributary Mean Streambank Stability[1] and Relative Erodibility[2] (%)



[1] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

[2] Total number of observations to determine average bank stability and relative erodibility appear in parentheses.

3.1.2 Stream Channel Downcutting

Mainstem

Stream channel downcutting results (Table 4) revealed that both the Upper and Middle mainstem areas fell within the expected or reference condition bank height range of two to three feet. In addition, Lower mainstem mean bank heights fell within the expected or reference condition bank height range of three to four feet.

Table 4: Summary: Upper Beaverdam Creek - Mainstem Stream Channel Downcutting

RSAT Stream Segment	Drainage Area (mi^2)	Approx. Stream Segment Length (mi.)	Mean Bank Height Right[1] (ft)	Mean Bank Height Left[2] (ft)	Mean Bank Height L and R (ft)	Expected Bank Height Range (ft)	Number of Nick Points	Number of Exposed Utility Lines Within Stream Channel
Upper Beaverdam Creek (UBC)								
1) Upper	2.86	2.4	1.6	1.6	1.6	2-3	4	0
2) Middle	12.38	1.9	2.6	2.7	2.7	2-3	5	0
3) Lower	14.07	1.4	2.8	3.0	2.9	3-4	4	2
Total	**14.07**	**5.7**					**13**	**2**

Tributaries

Except for Clear Creek, stream channel downcutting results (Table 5) revealed that the tributary mean streambank heights were approximately one to two feet higher than the expected or reference condition bank height range. Most notably, Entomology tributary mean streambank heights were on the order of 2.7 feet higher than the expected or reference condition bank height range. Such existing conditions suggest that a moderate degree of channel downcutting has taken place within the surveyed areas.

Table 5: Summary: Upper Beaverdam Creek - Tributary Stream Channel Downcutting

RSAT Stream Segment	Drainage Area (mi^2)	Approx. Stream Segment Length (mi.)	Mean Bank Height Right[1] (ft)	Mean Bank Height Left[2] (ft)	Mean Bank Height L and R (ft)	Expected Bank Height Range (ft)	Number of Nick Points	Number of Exposed Utility Lines Within Stream Channel
North Branch Mainstem								
1. UBC-1 (Upper)	1.50	1.3	2.9	3.0	2.9	1-2	2	0
2. UBC-2 (Lower)	3.27	0.9	3.8	3.8	3.8	2-3	0	0
Tributaries to North Branch								
3. UBC-3 (Ashcroft Tributary)	0.34	1.0	1.8	1.8	1.8	1-2	1	0
Tributaries to Mainstem								
4. UBC-4 (Clear Creek)	0.62	1.4	1.7	2.0	1.9	1-2	1	0
5. UBC-5 (Beck Branch)	2.50	0.8	3.4	3.4	3.4	1-2	1	1
6. UBC-6 (Biocontrol Tributary)	0.23	0.7	3.5	3.9	3.7	1-2	3	0
7. UBC-7 (Entomology Tributary)	0.74	1.8	4.7	4.6	4.7	1-2	1	1
Total	**9.20**	**7.9**					**9**	**2**

[1] Right bank looking downstream.
[2] Left bank looking downstream.

3.1.3 Stream Channel Cross-sections

Mainstem

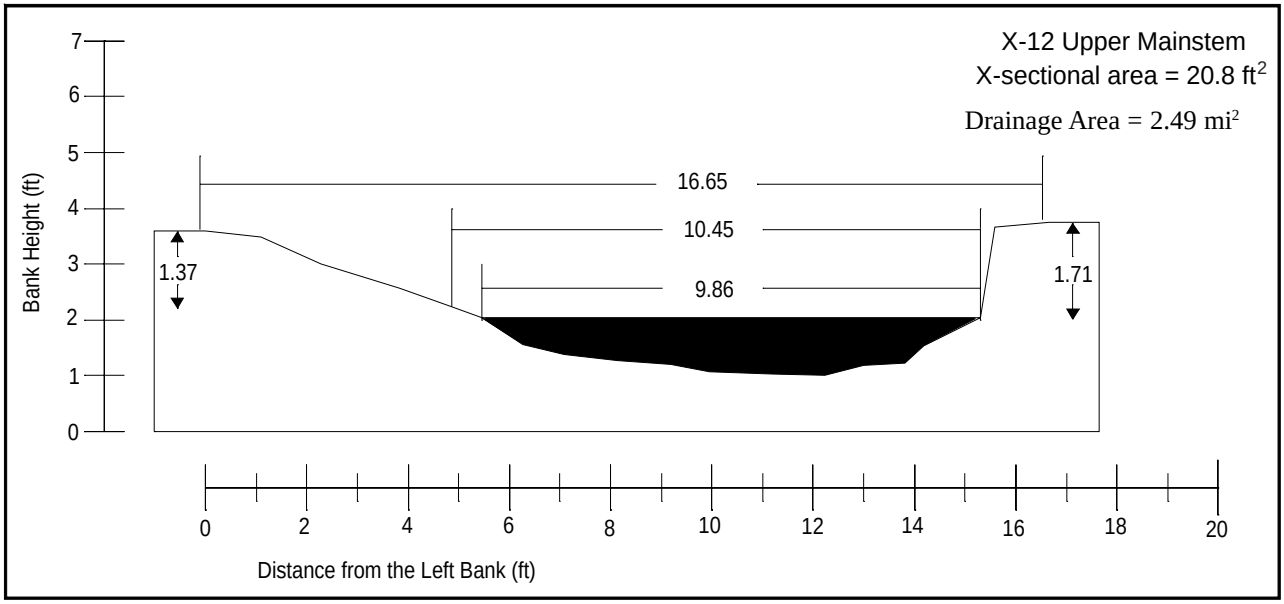
Cross-sectional analysis results revealed that the mean cross-sectional area of the Upper Beaverdam Creek mainstem is as follows: Upper (15.5 ft^2), Middle (66.4 ft^2) and Lower (88.4 ft^2). Bank heights for all three mainstem stream segments were well within the expected or reference condition ranges of 2-3 feet and 3-4 feet, respectively. These findings indicate that unlike most other Coastal Plain streams in the Anacostia River watershed, the Upper Beaverdam Creek mainstem has generally experienced relatively little channel widening or downcutting. Figures 40 through 42 illustrate selected mainstem cross-sections.

Tributaries

Tributary stream mean cross-sectional area results are as follows: UBC-1 (upper North Branch mainstem) = 30.9 ft^2, UBC-2 (lower North Branch mainstem) = 72.3 ft^2, UBC-3 (Ashcroft tributary) = 11.5 ft^2, UBC-4 (Clear Creek) = 15.9 ft^2, UBC-5 (Beck Branch) = 46.7 ft^2, UBC-6 (Biocontrol tributary) = 46.0 ft^2 and UBC-7 (Entomology tributary) = 43.5 ft^2. With the exception of UBC-4 (Clear Creek), tributary channel widths and bank heights were all (for their respective drainage areas) generally wider and higher than the expected or reference condition. Specifically, mean tributary streambank heights were on the order of one to two feet higher than the expected or reference bank height ranges (i.e., 1-2 feet and 2-3 feet, respectively). Notably, the highly entrenched UBC-7 (Entomology tributary) exhibited mean bank heights which were approximately 2.7 feet higher than expected. The preceding channel widening and downcutting conditions are reflective of long-standing uncontrolled stormwater runoff inputs. Figures 43 through 48 illustrate selected mainstem cross-sections.

Figure 40: Representative Cross Section and Photograph for Upper Beaverdam Creek Upper Mainstem[1]

Location: Approximately 690 feet above Soil Conservation Road[2]

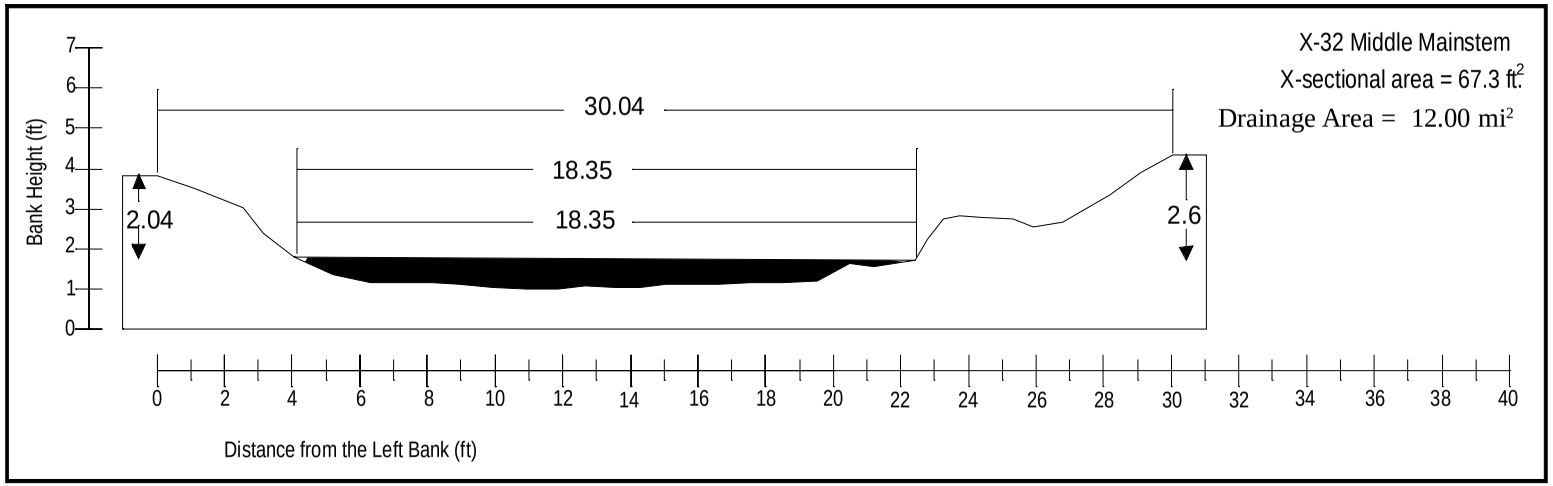


[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking downstream (i.e., the left bank is on the left side).

Figure 41: Representative Cross Section and Photograph for Upper Beaverdam Creek Middle Mainstem[1]

Location: Approximately 1,500 feet above Research Road[2]

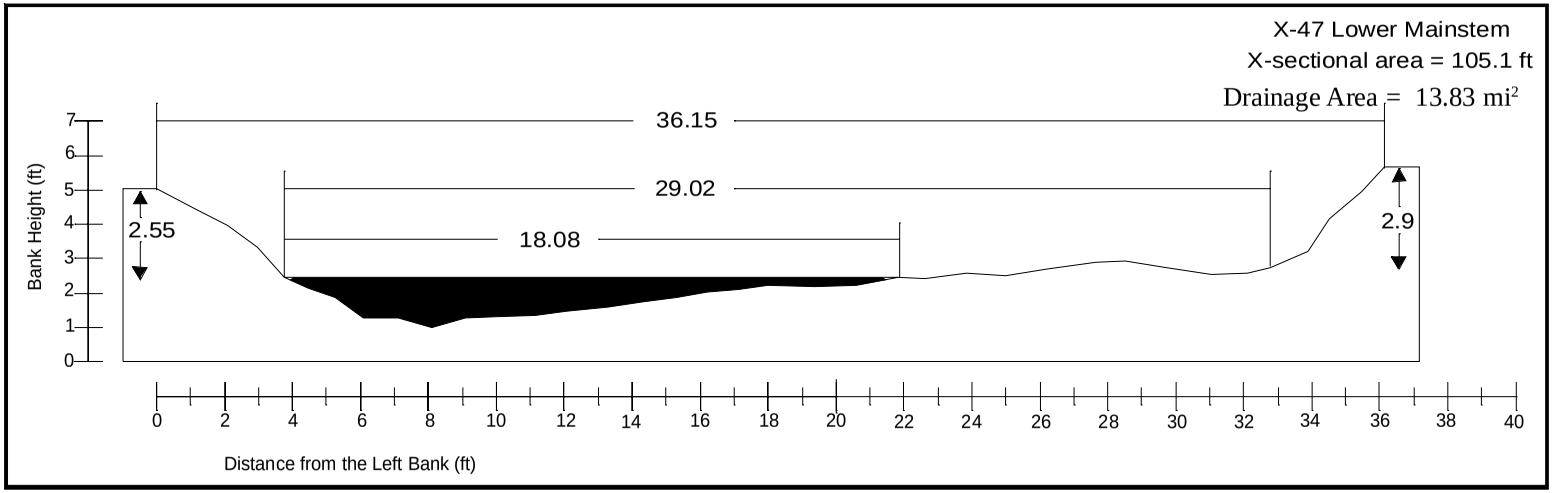


[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking downstream (i.e., the left bank is on the left side).

Figure 42: Representative Cross Section and Photograph for Upper Beaverdam Creek Lower Mainstem[1]

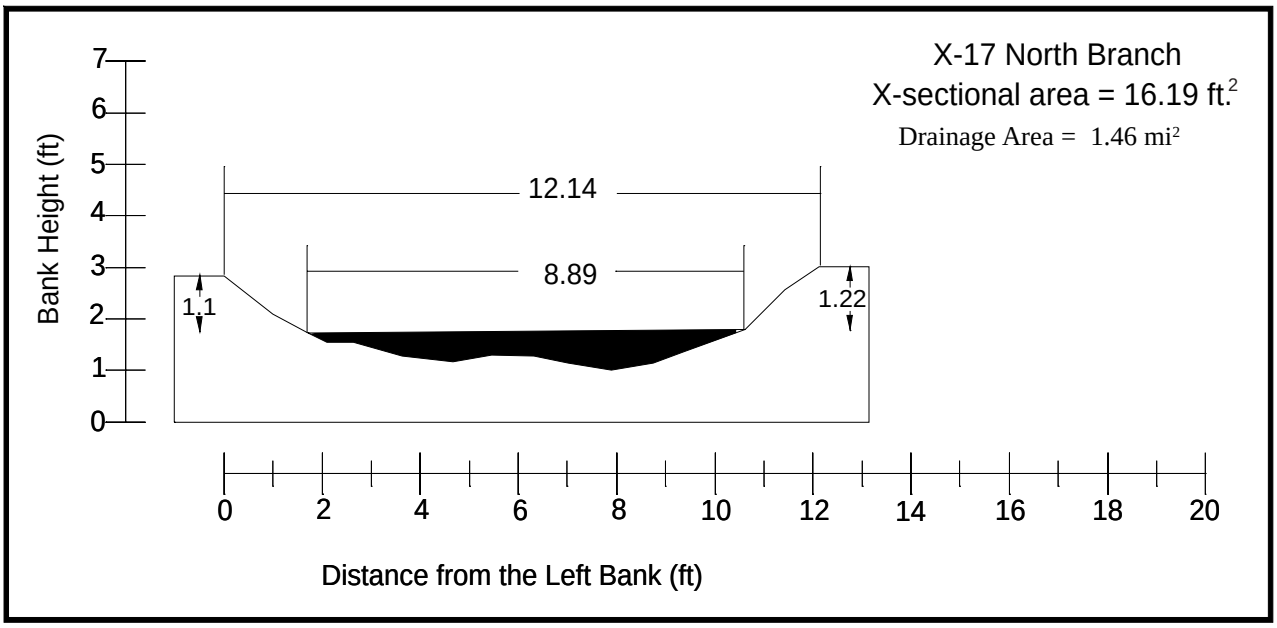
Location: Approximately 1,150 feet above Edmonston Road[2]



[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.
[2] Photograph orientation is looking downstream (i.e., the left bank is on the left side).

Figure 43: Representative Cross Section and Photograph for UBC-1 (Upper North Branch)[1]

Location: Approximately 760 feet above B/W Parkway; looking upstream [2]

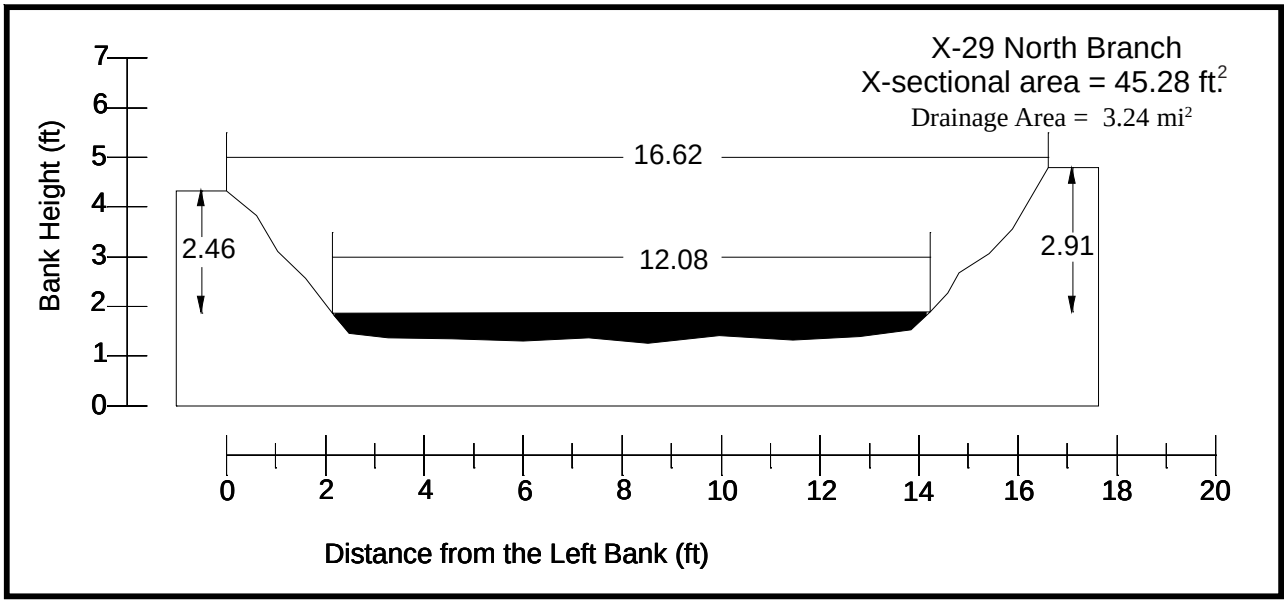


[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking upstream (i.e., the left bank is on the right side).

Figure 44: Representative Cross Section and Photograph for UBC-2 (Lower North Branch)[1]

Location: Approximately 690 feet above Upper Beaverdam Creek Mainstem; looking upstream [2]

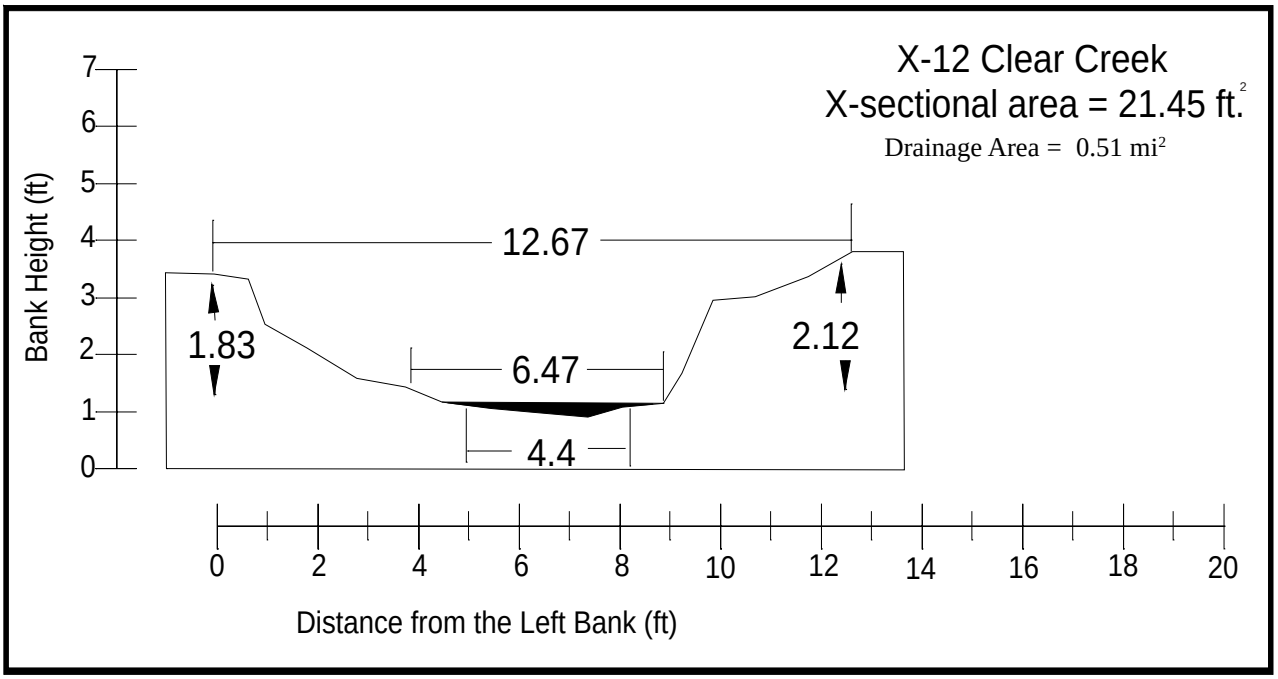


[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking upstream (i.e., the left bank is on the right side).

Figure 45: Representative Cross Section and Photograph for UBC-4 (Clear Creek)[1]

Location: Approximately 2,000 feet above Upper Beaverdam Creek Mainstem; looking upstream[2]

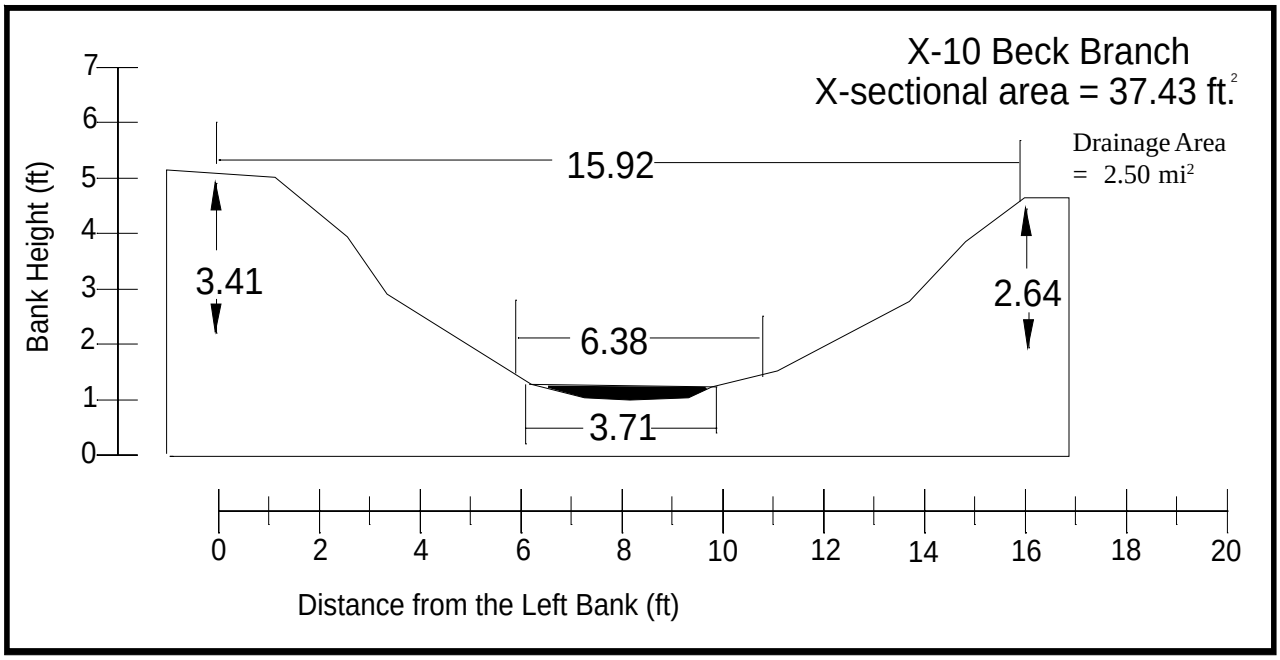


[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking upstream (i.e., the left bank is on the right side).

Figure 46: Representative Cross Section and Photograph for UBC-5 (Beck Branch)[1]

Location: Approximately 220 feet above Upper Beaverdam Creek Mainstem; looking upstream [2]

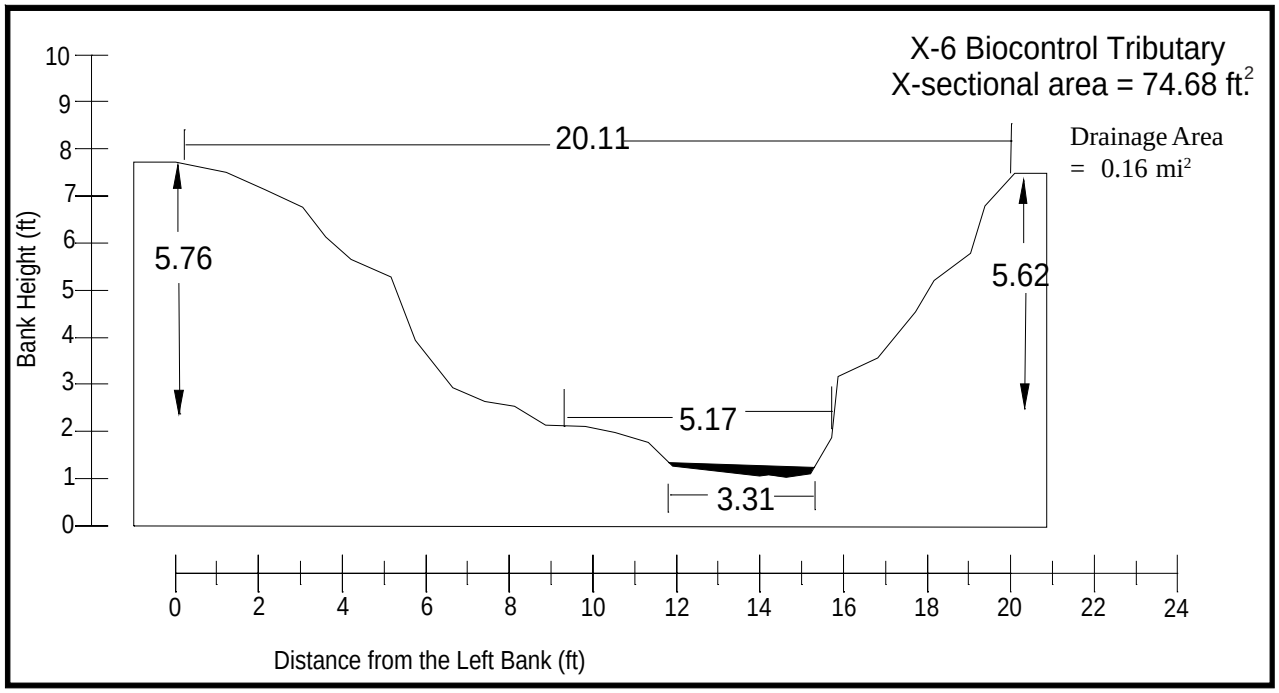


[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking upstream (i.e., the left bank is on the right side).

Figure 47: Representative Cross Section and Photograph for UBC-6 (Biocontrol Tributary)[1]

Location: Approximately 1,250 feet above Upper Beaverdam Creek Mainstem; looking upstream [2]

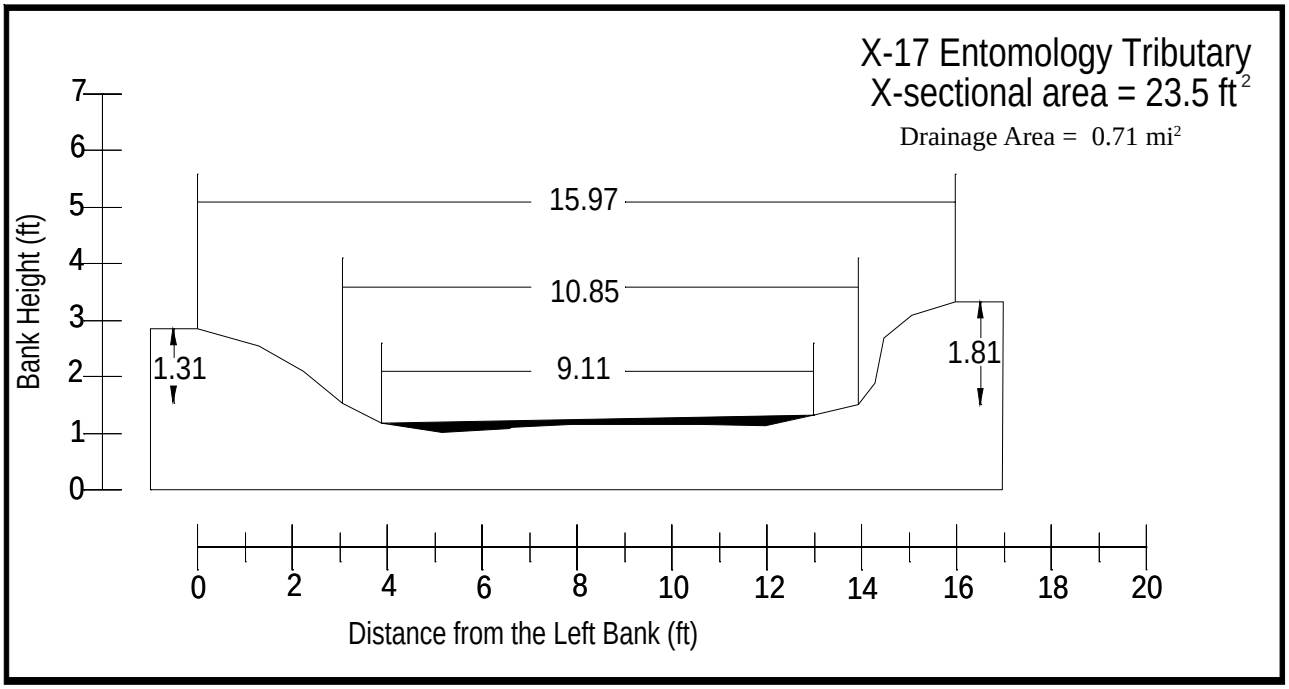


[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking upstream (i.e., the left bank is on the right side).

Figure 48: Representative Cross Section and Photograph for UBC -7 (Entomology Tributary)[1]

Location: Approximately 360 feet above Upper Beaverdam Creek Mainstem; looking upstream [2]



[1] Measurements of top channel, bottom channel, wetted perimeter and bank heights are shown. Wetted perimeter is depicted as a blackened area.

[2] Photograph orientation is looking upstream (i.e., the left bank is on the right side).

3.1.4 Riparian Habitat Conditions

Mainstem

Riparian habitat conditions (Table 6) for the Upper (Figure 49), Middle and Lower mainstem segments were rated as being excellent, fair and good, respectively. Stream canopy coverage was rated as being in the fair (i.e., 50-59 percent) to excellent (i.e., >= 80 percent) range. In addition, the forest riparian buffer zones were generally very wide (i.e., > 200 feet) and predominantly, hardwood forest. It should be noted that the poorest riparian habitat condition was observed both along an approximately 3,000 feet long Middle mainstem reach located immediately above Research Road (Figure 50) and along the Lower mainstem, approximately 700 feet below Research Road (Figure 51). Within these reaches, because of the extensive wetland areas present, there was generally little or no canopy.

Table 6: Summary: Upper Beaverdam Creek - Mainstem Riparian Habitat Condition

RSAT Stream Segment	Segment Length (mi.)	Number of Observations	Mean Buffer Width Right (ft)	Mean Buffer Width Left (ft)	Mean Canopy Coverage (%) [1]	Riparian Habitat Condition Verbal Ranking
Upper Beaverdam Creek (UBC)						
1) Upper	2.4	28	190	195	85.4	Excellent
2) Middle	1.9	51	200	200	51.4	Fair
3) Lower	1.4	34	200	200	63.9	Good
Total	5.7	113	--	--	--	--

Figure 49: Location - Upper Mainstem Immediately Downstream of Springfield Road: Excellent Stream Canopy Coverage

[1] Mean canopy coverage interpretation: ≥ 80% = Excellent, 60-79% = Good, 50-59% = Fair, <50% = Poor.

Figure 50: Location - Middle Mainstem Immediately Upstream of Research Road: Poor Stream Canopy Coverage (wetland area)

Figure 51: Location - Lower Mainstem Approximately 700 Feet Downstream of Research Road: Poor Stream Canopy Coverage (wetland area)

Tributaries

Riparian habitat condition ratings (Table 7) for the UBC tributary RSAT system were either good or excellent. Generally, stream canopy coverage percentages ranged from 60.4 to 92.1 falling into the good or excellent categories. In addition, the forest riparian buffer zones were typically wide (i.e., > 140 feet) and comprised of hardwood forest. Figures 52 through 54 depict representative riparian habitat conditions for select RSAT tributary stream areas.

Table 7: Summary: Upper Beaverdam Creek - Tributary Riparian Habitat Condition

RSAT Stream Segment	Segment Length (mi.)	Number of Observations	Mean Buffer Width Right (ft)	Mean Buffer Width Left (ft)	Mean Canopy Coverage (%) [1]	Riparian Habitat Condition Verbal Ranking
North Branch Mainstem						
1. UBC-1 (Upper)	1.3	23	200	200	72.8	Good
2. UBC-2 (Lower)	0.9	22	200	193	67.7	Good
Tributaries to North Branch						
3. UBC-3 (Ashcroft Tributary)	1.0	12	187	190	92.1	Excellent
Tributaries to Upper Beaverdam Creek (UBC)						
4. UBC-4 (Clear Creek)	1.4	29	185	193	70.3	Good
5. UBC-5 (Beck Branch)	0.8	19	143	171	67.4	Good
6. UBC-6 (Biocontrol Tributary)	0.7	11	140	155	80.2	Excellent
7. UBC-7 (Entomology Tributary)	1.8	30	200	179	79.4	Good
Total	**7.9**	**259**				

Figure 52: Location - UBC-2 (Lower North Branch) Mainstem Below Powder Mill Road: Excellent Stream Canopy Coverage

[1] Mean canopy coverage interpretation: ≥ 80% = Excellent, 60-79% = Good, 50-59% = Fair, <50% = Poor.

Figure 53: Location - UBC-4 (Clear Creek) Downstream of Soil Conservation Road: Excellent Stream Canopy Coverage

Figure 54: Location - UBC-5 (Entomology Tributary) Downstream of Powder Mill Road: Excellent Stream Canopy Coverage

3.3 Streambank Soil Texture and Chemistry Analysis

3.3.1 Streambank Soil Texture

As shown in Table 8, soil texture results revealed that mainstem bank materials at the six selected sampling sites are predominantly loam-based soils (i.e., sandy loam and sandy clay loam). In contrast, tributary bank materials (also six separate sampling sites) are far more diverse, with clay, sandy clay loam, loam and silty clay soil-types present.

3.3.2 Streambank Soil Chemistry Analysis

Table 9 summarizes the mainstem streambank soil chemistry analysis results. Select mainstem streambank soil chemistry results (reported as a range in mg/kg dry weight, unless otherwise noted) are as follows: 1) nitrate-nitrogen = 1.0-2.9, 2) total phosphorus = 140.44-444.58, 3) organic matter = 1.0-3.3 percent, 4) arsenic = 0.7-3.6, 5) copper = 4.17-7.68, 6) lead = 6.99-22.22, 7) zinc = 16.20-39.13 and 8) total PCB's = present in trace amounts (i.e., < 0.192 mg/kg) at all six streambank soil chemistry sampling sites.

Table 10 summarizes the UBC tributary streambank soil chemistry analysis results. Select tributary streambank soil chemistry results (reported as a range in mg/kg dry weight, unless otherwise noted) are as follows: 1) nitrate-nitrogen = 1.6-4.4, 2) total phosphorus = 167.00-404.42, 3) organic matter = 0.6-14.2 percent, 4) arsenic = 1.88-2.57, 5) copper = 9.17-20.38, 6) lead = 9.19-29.02, 7) zinc = 31.76-184.35 and 8) total PCB's = present in trace amounts (i.e., < 0.22 mg/kg) at all six streambank soil chemistry sampling sites. It should be noted that mean Maryland soil metal background concentrations (mg/kg dry weight) for the above-listed metals are as follows: arsenic = 3.8, copper = 20.0, lead = 22.0 and zinc = 39.0 (U.S. EPA, 2003).

Table 8: Upper Beaverdam Creek - Mainstem and Tributary Streambank Soil Particle Size[1, 2]

Sampling Site	% Sand	% Silt	% Clay	Soil Texture Class
Mainstem				
1. Upper				
~200' above Springfield Road	67.5	16.9	15.6	Sandy Loam
~2100' below Springfield Road	69.7	13.1	17.1	Sandy Loam
2. Middle				
~2200' below Soil Conservation Road	50.1	19.8	30.1	Sandy Clay Loam
~200' below BW Pkwy	52.6	22.5	24.9	Sandy Clay Loam
3. Lower				
~2100' below Research Road	52.8	21.0	26.3	Sandy Clay Loam
~2300' above Edmonston Road	54.6	22.9	22.5	Sandy Clay Loam

Sampling Site	% Sand	% Silt	% Clay	Soil Texture Class
Tributaries				
Upper North Branch (UBC-1)				
~8000' above Springfield Road	31.4	26.5	42.1	Clay
Lower North Branch (UBC-2)				
~4000' below Powder Mill Road	48.6	27.5	23.9	Sandy Clay Loam
Clear Creek (UBC-4)				
~2000' above confluence to Mainstem	49.1	29.7	21.3	Loam
Beck Branch (UBC-5)				
~500' above confluence with Mainstem	17.6	40.3	42.1	Silty Clay
Biocontrol Tributary (UBC-6)				
~100' below Beaverdam Road	46.5	32.1	21.5	Loam
Entomology Tributary (UBC-7)				
~100' below Beaverdam Road	33.4	42.0	24.6	Loam

Note: Soil sample not collected for Ashcroft Tributary (UBC-3)

[1] COG staff used a stainless steel soil probe to collect the vertical streambank soil profile samples (i.e., from the upper, middle and lower portions of the streambank) from represenative erosional and depositional stream areas.
[2] Particle size analysis performed by Agricultural Analytical Services Laboratory, Pennsylvania State University.

Table 9: Summary: Upper Beaverdam Creek - Mainstem Streambank Soil Chemistry Results[1]

Parameters	Unit	Detection Limit	1. Upper		2. Middle		3. Lower	
			~200' above Springfield Road	~2100' below Springfield Road	~2200' below Soil Conservation Road	~200' below BW Parkway	~2100' below Research Road	~2300' above Edmonston Road
1. pH	--	--	5.0	5.5	4.5	5.5	4.6	4.5
2. Total Nitrogen	%	--	0.13	0.11	0.09	0.1	0.04	0.04
3. Nitrate Nitrogen	mg/kg	1	1.3	1.9	2.4	2.9	1.4	1.0
4. Total Carbon	%	--	2.26	1.73	2.14	1.92	0.73	0.60
5. Total Phosphorus	mg/kg	0.06	444.58	296.77	140.44	222.89	140.03	187.25
6. Organic Matter	%	--	3.3	2.8	2.4	2.5	1.0	1.1
7. Cation Exchange Capacity	meq/100g	--	10.2	6.6	13.1	7.0	5.4	5.3
Metals[2]								
8. Arsenic	mg/kg	0.5	3.6	3.4	0.7	2.1	1.02	3.37
9. Cadmium	mg/kg	0.004	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
8. Chromium	mg/kg	0.005	9.14	7.58	8.58	9.36	8.47	12.49
10. Copper	mg/kg	0.002	7.58	7.68	4.17	6.97	4.39	6.22
11. Lead	mg/kg	0.025	12.15	11.9	7.16	22.22	6.99	8.27
12. Molybdenum	mg/kg	0.005	<0.25	<0.25	<0.25	<0.25	<0.25	0.59
13. Nickel	mg/kg	0.01	6.7	8.05	7.73	12.64	6.44	7.88
14. Selenium	mg/kg	0.3	0.42	0.42	0.39	0.39	<0.25	0.25
15. Zinc	mg/kg	0.004	18.83	33.7	18.38	39.13	16.2	20.22
16. Total PCB's[3]	mg/kg	--	<0.191	<0.183	<0.173	<0.192	<0.143	<0.127

[1] Mainstem soil analysis samples were collected on May 7, 2004. Chemical analysis performed by Agricultural Analytical Services Laboratory, Pennsylvania State University.

[2] EPA mean reported soil metal background concentrations (mg/kg dry weight) for Maryland are as follows; Arsenic = 3.8, Cadmium = not reported; Chromium = 47.9, Copper = 20; Lead = 22, Nickel = 13, Selenium = 0.2, and Zinc = 39 (2003, USEPA).

[3] PCB results indicate the maximum possible value detectable by analyzer.

Table 10: Summary: Upper Beaverdam Creek - Tributary Streambank Soil Chemisry Results[1]

[1] Tributary soil analysis samples were collected on June 3, 2004. Chemical analysis performed by Agricultural Analytical Services Laboratory, Pennsylvania State University.

[2] EPA mean reported soil metal background concentrations (mg/kg dry weight) for Maryland are as follows; Arsenic = 3.8, Cadmium = not reported; Chromium = 47.9, Copper = 20; Lead = 22, Nickel = 13, Selenium = 0.2, and Zinc = 39 (2003, USEPA).

[3] PCB results indicate the maximum possible value detectable by analyzer.

3.4 Mainstem Baseflow and Stormflow Water Chemistry Grab Sampling

As previously stated, one baseflow (June 17, 2004) and one stormflow (April 26, 2004) water chemistry grab sample was collected for the purpose of conducting EPA priority pollutant scans. Both baseflow and stormflow water-grab samples were collected at the following three mainstem locations: Edmonston Road (Lower), Beaverdam Creek Road (Middle), and Springfield Road (Upper). Each water sample included 13 separate collection containers, each containing their respective preservative. The stormflow grab samples were collected during a storm event (Figure 50) that produced 0.70 inches of rainfall (BWI Airport 24-hour rainfall data).

Table 11 summarizes baseflow chemistry results. Select laboratory (CT&E Environmental Services, Inc.) water chemistry baseflow grab sampling results (reported in mg/l, unless otherwise noted) for the Upper Beaverdam Creek mainstem (Edmonston Road area/lower mainstem) are as follows: 1) pH = 6.75, 2) alkalinity (total, as $CaCO^3$) = 22, 3) TSS = 8, 4) turbidity = 10 NTU, 5) nitrate-nitrogen = 1.5, 6) orthophosphate = not detected, 7) total phosphorus = 0.025, 8) BOD_5 = not detected (i.e., < 2.0), 9) total organic carbon = 9.2, 10) arsenic = not detected, 11) PCB's = not detected and 12) E. coli = 4,900 MPN.

Table 12 summarizes stormflow chemistry results. Select laboratory (CT&E Environmental Services, Inc.) water chemistry stormflow grab sampling results (reported in mg/l, unless otherwise noted) for the Upper Beaverdam Creek mainstem (Edmonston Road area/lower mainstem) are as follows: 1) pH = 6.62, 2) alkalinity = 29, 3) TSS = 14, 4) turbidity = 22 NTU, 5) nitrate-nitrogen =0.73, 6) orthophosphate = 0.020, 7) total phosphorus = 0.051, 8) BOD_5 = 2.10, 9) total organic carbon = 7.6, 10) arsenic = not detected, 11) PCB's = not detected and 12) E. coli = 3,000 MPN.

With the exception of expected high baseflow and stormflow bacteria levels recorded in the three mainstem segments sampled, the water quality parameters tested (EPA priority pollutant scan plus sediment, nutrients and bacteria) met current MDE Use I (Water Contact, Recreation, and Protection of Aquatic Life) stream criteria. However, a high baseflow E. coli level (4,900 MPN) was recorded in the lower mainstem.

Figure 55: Location - Upper Beaverdam Creek - Lower Mainstem Below Edmonston Road - April 26, 2004 stormflow (BWI 24-hour rainfall = 0.70 inches)

Table 11: Summary: Upper Beaverdam Creek - Mainstem Baseflow Water Chemistry Grab Sample Results

	Unit	Detection Limit	Upper	Middle	Lower
1. Alkalinity, Total (as Ca Co3)	mg/L	2	14	37	22
2. Hardness (total)	mg/L	5	62	62	62
3. PH	--	--	6.37	6.93	6.75
4. Specific Conductance	mmhos/cm	1	140	230	190
6. Total Suspended Solids	mg/L	5	14	9.0	8.0
7. Turbidity	NTU	0.50	12	11	10
8. Nitrate Nitrogen	mg/L	0.05	3.1	0.90	1.5
9. Ortho Phosphate	mg/L	0.02	ND	0.60	ND
10. Total Phosphorous	mg/L	0.02	0.044	0.60	0.025
11. Total Organic Carbon	mg/L	5	9.7	8.9	9.2
12. Biochemical Oxygen Demand – 5 Day	mg/L	2	ND	ND	ND
13. Arsenic	mg/L	0.0050	ND	ND	ND
14. Cadmium	mg/L	0.0010	0.0015	0.0013	ND
15. Chromium	mg/L	0.0050	ND	ND	ND
16. Copper	mg/L	0.0050	0.0068	0.0080	0.0062
17. Iron	mg/L	0.05	2.7	1.9	1.5
18. Lead	mg/L	0.0050	ND	ND	ND
19. Nickel	mg/L	0.0050	0.011	0.0081	0.0077
20. Selenium	mg/L	0.0050	0.007	0.0062	ND
21. Zinc	mg/L	0.020	0.024	ND	ND
PCB Congeners					
22. Aroclor-1016	mg/kg	0.045	ND	ND	ND
23. Aroclor-1221	mg/kg	0.045	ND	ND	ND
24. Aroclor-1232	mg/kg	0.045	ND	ND	ND
25. Aroclor-1242	mg/kg	0.045	ND	ND	ND
26. Aroclor-1248	mg/kg	0.045	ND	ND	ND
27. Aroclor-1254	mg/kg	0.045	ND	ND	ND
28. Aroclor-1260	mg/kg	0.045	ND	ND	ND
29. Total Petroleum Hydrocarbons	mg/L	1	ND	ND	ND
30. Surfactants (MBAS)	mg/L	0.03	0.038	0.050	0.032
31. Fecal Coliform	MPN	c/100	330	220	4900
32. Total Coliform	MPN	c/100	3500	3500	7900
33. E. coli	MPN	c/100	330	220	4900

Note: Baseflow sample collected on 6/17/2004.

[1] Chemical analysis performed by CT&E Environmental Services Inc.

Table 12: Summary: Upper Beaverdam Creek - Mainstem Stormflow Water Chemistry Grab Sample Results

	Unit	Detection Limit	Upper Beaverdam Creek Mainstem		
			1.Upper	2.Middle	3.Lower
1. Alkalinity, Total (as Ca Co3)	mg/L	2	13	20	29
2. Hardness (total)	mg/L	5	36	46	48
3. pH	--	--	6.09	6.41	6.62
4. Specific Conductance	mmhos/cm	1	120	180	210
6. Total Suspended Solids	mg/L	5	14	12	14
7. Turbidity	NTU	0.50	15	14	22
8. Nitrate Nitrogen	mg/L	0.05	1.40	0.91	0.73
9. Ortho Phosphate	mg/L	0.02	ND	NC	0.020
10. Total Phosphorus	mg/L	0.02	0.06	0.06	0.051
11. Total Organic Carbon	mg/L	5	13	11	7.60
12. Biochemical Oxygen Demand – 5 Day	mg/L	2	2.70	ND	2.10
13. Arsenic	mg/L	0.0050	ND	ND	ND
14. Cadmium	ug/L	1	ND	ND	ND
15. Chromium	mg/L	0.0050	ND	ND	ND
16. Copper	ug/L	5	ND	ND	ND
17. Iron	mg/L	0.05	5	1.80	2
18. Lead	mg/L	0.0050	ND	ND	ND
19. Nickel	mg/L	0.0050	0.0062	0.0074	0.0073
20. Selenium	mg/L	0.0050	ND	ND	ND
21. Zinc	mg/L	0.020	ND	0.023	ND
PCB's Congeners					
22. Aroclor-1016	mg/kg	0.045	ND	ND	ND
23. Aroclor-1221	mg/kg	0.045	ND	ND	ND
24. Aroclor-1232	mg/kg	0.045	ND	ND	ND
25. Aroclor-1242	mg/kg	0.045	ND	ND	ND
26. Aroclor-1248	mg/kg	0.045	ND	ND	ND
27. Aroclor-1254	mg/kg	0.045	ND	ND	ND
28. Aroclor-1260	mg/kg	0.045	ND	ND	ND
29. Total Petroleum Hydrocarbons	mg/L	1	ND	ND	1.60
30. Surfactants (MBAS)	mg/L	0.03	ND	ND	ND
31. Fecal Coliform	MPN	2.0	1,700	300	3,000
32. Total Coliform	MPN	2.0	3,000	5,000	17,000
33. E. coli	MPN	2.0	1,700	300	3,000

Note: Stormflow sample collected on 4/26/2004. Twenty-four hour precipitation data for the BWI Airport = 0.70 inches of rainfall.
ND = Not detected; NC = Not collected (sample jar broke during delivery)

[1] Chemical analysis performed by CT&E Environmental Services Inc.

3.5 Mainstem Streambed Sediment Chemistry Characterization

Results from the lower mainstem EPA priority pollutant scan sediment grab sampling effort revealed that none of the major hydrocarbon analytes, PCB congeners, or pesticides were present within the detection limits of the analysis. In addition, representative metals (e.g., chromium, copper, lead and zinc) typically present in both urban runoff and at background levels in the environment were detected at relatively low levels. Based on the results of this limited, one–time, EPA priority pollutant scan, it does not appear that the pollutants detected pose major environmental toxic risks to the biological community of Upper Beaverdam Creek's Lower mainstem.

Table 13: Summary: Upper Beaverdam Creek - Mainstem Composite Sediment Chemistry Sample Results[1]

[1] Chemical analysis performed by CT&E Environmental Services Inc.
[2] ND indicates not detected.
[3] Detected and reported as the sum of Benzo(b)flouranthene and Benzo(k)flouranthenes.

4.0 Study Recommendations

1) Because of the inaccurate nature of current GIS stream channel network data layers for the Upper Beaverdam Creek subwatershed (i.e., Prince George's County, BARC, USGS, COG and others), it is recommended that future studies (as the first order of business) include a field-generated stream channel mapping task. Furthermore, the study should build upon the Anacostia 'area of interest' (i.e., nick points, debris jams, fish barriers, stormdrain outfalls, utility line stream crossings, etc.) database (Figure 56). Note: In performing its RSAT survey it was necessary for COG staff to create (via the employment of a sub-one-meter GPS unit) a new data layer for all stream areas surveyed.

Figure 56: Location - Upper Beaverdam Creek - Lower Mainstem Above Edmonston Road - COG Staff Collecting The Utility Line Coordinate Location

2) Conduct additional and similar RSAT-type surveys, so as to provide a comprehensive stream channel erosion, streambank chemistry and water quality picture of all remaining major BARC Upper Beaverdam Creek tributaries (i.e., a Phase 2 Study). In addition, if at all possible, the BARC mainstem portions of Indian Creek, Little Paint Branch and Paint Branch should be surveyed, as well.

3) Based on RSAT survey results, the UBC-4 tributary (Clear Creek) is potentially an excellent reference stream for the entire BARC-wide tributary system, as well as the Coastal Plain portion of the Anacostia River watershed. Similarly, the Upper Beaverdam Creek mainstem represents an excellent mainstem reference stream area for the Anacostia watershed. As such, additional long-term monitoring (i.e., water temperature regime, water chemistry and biological community) should be seriously considered.

4) As part of a larger BARC, facility-wide stormwater management planning effort, it is recommended that potential stormwater retrofitting focus first on those tributary area catchments exhibiting significant amounts of 'moderate' streambank erosion levels or higher. These include both the Biocontrol (UBC-6) and Entomology (UBC-7) tributaries. In addition, large uncontrolled on-site and off-site impervious surfaces (such as large building areas, parking lots and major roadways) which generate significant amounts of stormwater runoff should be similarly evaluated. In COG staff's opinion, BARC's Animal Husbandry, Poultry Management and aerobic manure digester complexes, the National Park Service's Baltimore Washington Parkway, NASA's Goddard Space Flight Center, and the U.S. Department of Health, Education and Welfare's facility are all additional candidate retrofit areas that are currently contributing large volumes of uncontrolled runoff to the Upper Beaverdam Creek system.

5) Based on both the level of current streambank erosion and degree of channel downcutting, Rosgen-based stream channel restoration studies should be initiated for the following tributaries: UBC-6 (Biocontrol), UBC-7 (Entomology) and the U.S. Department of Health, Education and Welfare portion of UBC-1 (Upper North Branch).

6) The relatively small, isolated pockets of Upper Beaverdam Creek mainstem 'moderate/severe' (Figure 57) and 'severe' streambank erosion should (where feasible) be stabilized using bioengineering techniques similar to those recently employed at both the BARC Spray Irrigation and Sleepy Creek tributaries (i.e., bank slope regrading, stabilization with bio-logs, erosion matting , live fascines and native plant materials).

Figure 57: Location - Upper Beaverdam Creek - Lower Mainstem Above Edmonston Road - Moderate/Severe Streambank Erosion

7) At a minimum, a thorough structural integrity evaluation of the Beaverdam Road culvert over the UBC-7 tributary (Entomology) should be performed by a certified structural engineer as soon as possible. It should be noted that COG staff's visual inspection revealed the presence of several large cracks and exposed and rusted rebar in the culvert's concrete deck and superstructure.

Figure 58: Location - UBC-7 (Entomology Tributary) - Below Beaverdam Road - Fish Barrrier

8) While several tributary fish blockages were observed during the RSAT survey, the perched Beaverdam Road culvert (UBC-7, Entomology tributary, Figure 58) should be a leading candidate for either removal or modification. The employment of a riffle-grade control structure for this medium-sized tributary is further recommended. Note: Given that the current road culvert is serving as a defacto stream grade control structure, its modification/removal must be done in a way that does not cause or aggravate upstream headcutting problems.

9) The high, lower mainstem baseflow E. coli level (4,900 MPN) observed in the vicinity of Edmonston Road (MD Rte 201), warrants additional follow-up monitoring to determine the potential source(s) of this bacterial contamination.

10) The high total nitrogen, phosphorus and organic carbon streambank levels (0.51 mg/kg, 404.4 mg/kg, and 11.39 percent, respectively) observed at UBC-4 (Clear Creek tributary) are unusual, and warrant further investigation.

11) As a companion piece to both the RSAT survey and PGDER's recent macroinvertebrate sampling, a comprehensive electrofishing survey of the Upper Beaverdam Creek mainstem and tributary system should be performed. This would provide additional and valuable information on both the current biological health of this stream system, as well as fish community changes over the past 14-15 years.

12) Given their ecological significance, a comprehensive Upper Beaverdam Creek subwatershed riparian corridor analysis (which at a minimum examines buffer widths and vegetation types) should be made a high priority.

13) Results from this study should be integrated into both BARC's stormwater management and Facility-Wide Baseline Ecological Risk Assessment initiatives, as well as into broader Anacostia water quality monitoring, modeling and TMDL development efforts. In addition, a joint meeting between MDE, BARC, COG and other interested stakeholders to go over study findings and coordinate next steps is recommended.

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