

National Fish and Wildlife Foundation

NFWF/Legacy Grant Project ID: 0603.11.029459

Chesapeake Bay Small Watershed Grants 2011 - Submit Final Programmatic Report (Activities)

Grantee Organization: Trout Unlimited, Inc.

Project Title: Little Tuscarora Creek Stream and Habitat Restoration Design (MD)

**Project Period** 09/01/2011 - 03/31/2013  
**Award Amount** \$26,535.54  
**Matching Contributions** \$22,347.00  
**Project Location Description (from Proposal)** Little Tuscarora Creek, northwest of intersection of Willowbrook Road and Opposumtown Pike, Frederick, MD. 39°28'14.01"N, 77°24'53.61"W. Monocacy River watershed.

**Project Summary (from Proposal)** Collaborate with the U.S. Fish and Wildlife Service to produce a restoration design for a 1,500-foot reach of Little Tuscarora Creek in Frederick, Maryland. Project will assess stream conditions and watershed characteristics, and final design plans will include realignment of the stream channel, placement of in-stream habitat structures, and riparian buffer plantings.

**Summary of Accomplishments** 100 percent stream restoration design plans are now complete, as are supporting materials including a watershed assessment, Rosgen stream classification, a construction estimate, and a near-term implementation plan. TU and FWS utilized the new Function-Based Framework for Stream Assessment and Restoration Projects in project design. This is the first use of the Function-Based Framework in the Army Corps of Engineers' Baltimore District. The Maryland Biological Stream Survey (MBSS) gathered pre-construction baseline biological data and has committed to monitoring the project post-construction.

**Lessons Learned** See report narrative for full explanation. In summary:  
 -Extra time, in the right hands, can greatly improve project outcomes.  
 -The unexpected participation of the MBSS enables this project to fill a critical gap in scientific research on stream restoration.

Conservation Activities	Stream Restoration - In-Stream Work
Progress Measures	Linear feet of streambank/shoreline stabilized
Value at Grant Completion	3000
Conservation Activities	Stream Restoration - Riparian Work
Progress Measures	Linear feet of riparian buffer restored with at least a 35-foot buffer
Value at Grant Completion	3000
Conservation Activities	Stream Restoration - Riparian Work
Progress Measures	# of participants/volunteers in project
Value at Grant Completion	35
Conservation Activities	Stream Restoration
Progress Measures	# of landowners targeted by program
Value at Grant Completion	1
Conservation Activities	Stream Restoration - Riparian Work
Progress Measures	% reduction in invasive species cover
Value at Grant Completion	33
Conservation Activities	Stream Restoration
Progress Measures	Tons of sediment reduced from entering the waterways
Value at Grant Completion	400
Conservation Activities	Design Plan Preparation
Progress Measures	Other Activity Metric (% plans complete (above metrics refer to project outcomes once implemented))
Value at Grant Completion	100



## Chesapeake Bay Stewardship Fund Final Programmatic Report Narrative

**Instructions:** Save this document on your computer and complete the narrative in the format provided. The final narrative should not exceed ten (10) pages; do not delete the text provided below. Once complete, upload this document into the on-line final programmatic report task as instructed.

### 1. Project Description.

Briefly describe your project, including a description of the problem your project is trying to address, the project's objectives and strategies, as well as the project location, and a characterization of the watershed and the relevant characteristics of the community's natural resources, population, and economy.

*This project sought to develop 100 percent stream restoration design plans for 1,500 linear feet of Little Tuscarora Creek in Frederick County, Maryland on the property of Harold Staley. Designs were needed to position Trout Unlimited (TU) and partner/consultant the U.S. Fish and Wildlife Service Chesapeake Bay Field Office (FWS) to construct the project, which would reduce sediment entering the creek from rapidly eroding stream banks and improve fish and wildlife habitat, particularly habitat for brook trout. Proposed activities included:*

- a. Assessment of project area stream conditions and watershed characteristics.*
- b. Definition of stream restoration design objectives and elements.*
- c. Preparation of conceptual, preliminary, and final stream restoration design plans.*
- d. Preparation of an implementation plan addressing construction funding and timeline.*

*Tuscarora Creek has been identified by the Eastern Brook Trout Joint Venture to have once had an intact brook trout population. That population is now considered greatly reduced and limited to the Creek's headwaters. It is a classic meadow limestone stream and one of few in Frederick County still capable of sustaining a healthy brook trout population.*

*The Little Tuscarora Creek subwatershed is part of the larger Upper Monocacy watershed. Located northwest of the City of Frederick, land is a mix of forest, suburban-residential, and agricultural uses. A Watershed Restoration Action Strategy (WRAS) was prepared for it in 2005. The WRAS set stream and riparian corridor restoration and protection and expansion of green infrastructure as priority goals for the whole watershed. Stream corridor assessments developed for the WRAS by Maryland's Department of Natural Resources indicated that 60 percent of stream miles in the Little Tuscarora watershed were inadequately buffered and 40 percent were eroded, the highest percentage of all six subwatersheds surveyed.*

*The project builds on a community outreach effort initiated by TU and the Potomac Conservancy in the Little Tuscarora Creek watershed in 2010. Since that initiative began: a brochure on habitat stewardship was prepared and disseminated to watershed residents; several schools increased tree canopy on their grounds through community tree plantings; one school started a trout-in-the-classroom program, and one stream restoration project was completed in a tributary to Little Tuscarora Creek. Additionally, TU met with the City of Frederick and a local land developer to apprise them of the effort. Both are supportive.*

### 2. Summary of Accomplishments

In four to five sentences, provide a brief summary of the project's key accomplishments and outcomes that were observed or measured.

*100 percent stream restoration design plans are now complete, as are supporting materials including a watershed assessment, Rosgen stream classification, a construction estimate, and a near-term implementation plan. TU and FWS utilized the new Function-Based Framework for Stream Assessment and Restoration Projects in project design. This is the first use of the Function-Based Framework in the Army Corps of Engineers' Baltimore District. The Maryland Biological Stream Survey (MBSS) gathered pre-construction baseline biological data and has committed to monitoring the project post-construction.*

### 3. Project Activities & Outcomes

#### Activities

- Describe and quantify (using the approved metrics referenced in your grant agreement) the primary activities conducted during this grant.
- Briefly explain discrepancies between the activities conducted during the grant and the activities agreed upon in your grant agreement.

*Major activities associated this project included: assessment of stream conditions and watershed characteristics; establishment of restoration design objectives; and preparation of preliminary and final restoration design plans. Conservation activities and metrics reported in the grant proposal referred to outcomes of the project once implemented (e.g. tons of sediment reduced), not once designed.*

*The project went according to plan, though took slightly longer to complete than anticipated. Stream restoration design plans are complete, as are all supporting materials. An excerpt of the full plan set is attached, as are the watershed assessment, construction estimate, implementation plan, and two photos. The full plan set and other project documents are available upon request.*

#### Outcomes

- Describe and quantify progress towards achieving the project outcomes described in your grant agreement. (Quantify using the approved metrics referenced in your grant agreement or by using more relevant metrics not included in the application.)
- Briefly explain discrepancies between what actually happened compared to what was anticipated to happen.
- Provide any further information (such as unexpected outcomes) important for understanding project activities and outcome results.

*Project period outcomes were met. TU and FWS now have actionable design plans to be used for implementation. A local partnership is willing to implement the project.*

*The project was being completed as the new Environmental Protection Agency publication A Function-Based Framework for Stream Assessment and Restoration Projects was being finalized. The project's principal design consultant, FWS staffer Rich Starr, is a lead author of this publication. Another publication author, Will Harmon, reviewed and commented on draft designs. According to Starr, this project represents the first application of the Function-Based Framework to a stream restoration project in Maryland and the Baltimore District of the Army Corps of Engineers.*

*Additionally, two positive unexpected outcomes of this project include:*

- a. Participation of the Maryland Biological Stream Survey (MBSS) as an independent evaluator of the biological outcomes of the project. Evidence of the biological impacts of stream restoration is sought by both FWS and MBSS. MBSS completed two rounds of pre-construction data collection, and summarized their findings in a PowerPoint presentation for the project team. This presentation is available upon request. MBSS committed to collect post-construction biological data for several years.*
- b. Engagement of upstream landowner Clover Ridge LLC. Securing approval from Clover Ridge LLC to have MBSS collect data on their property, which serves as a control site, may spur interest in completing stream restoration projects on their lands or in nearby watersheds.*

### 4. Challenges and Lessons Learned

Describe any specific challenges that have arisen during the course of the project and how they have been addressed. Also describe the key lessons learned from this project, such as the least and most effective conservation practices or notable aspects of the project's methods, monitoring, or results. How could other conservation organizations adapt their projects to build upon some of these key lessons about what worked best and what did not?

*As stated, the project went according to plan but required an extension. FWS was easy to work with, as was the site's landowner. Multiple on-site meetings and periodic phone calls with FWS staff ensured that the project went smoothly and*

*that both TU and the landowner were pleased with the plans. The extra time required to complete the project ultimately improved it—plans are now in place that utilize the new Function-Based Framework, and MBSS is now lending their expertise to the project. This would be the project’s greatest lesson learned and serve as advice to others: extra time—in the right hands—can greatly improve project outcomes.*

*The largest challenge to future progress will be securing implementation funding. An implementation plan has been prepared by the project team, and having finished plans and a solid construction estimate should entice prospective funders. However, the total cost (~\$195,000) is significant, and, as was necessary with project design, multiple contributions from several grantors and/or breaking the project into phases may be necessary.*

*TU’s greatest success in this project was securing assistance from MBSS. Their involvement enables this project to function as an experiment in stream restoration—one that connects physical outcomes (e.g. floodplain connectivity, lateral stability) with biological outcomes (e.g. macroinvertebrate communities). In other words, MBSS’s participation enables this project to fill a critical gap in the scientific research on stream restoration.*

## **5. Dissemination**

Briefly identify any dissemination of lessons learned or other project results to external audiences, such as the public or other conservation organizations.

*Being a design project on private property, this project did not have much public involvement. Public involvement will be solicited during implementation via volunteer riparian buffer plantings. Also, after construction, TU and FWS intend to use this site for demonstration purposes. The landowner has already agreed to this.*

*Seven volunteers did provide key assistance on the project. Cumulatively, it is assumed that these seven contributed at least 32 hours to the project, with five of the seven contributing professional services as engineers and hydrologists.*

*A workshop is tentatively planned for June at which TU and FWS will discuss the project with the Seneca Valley chapter of TU.*

*TU fully expects that the results of this project will be used by others. As stated, it is the first application of the new Function-Based Framework, which is expected to inform the stream and wetland mitigation process from this point forward. As the project goes through permitting, design elements will be contextualized in this new framework, giving regulators an opportunity to test it in action.*

*Also, the site will be used for demonstration purposes after construction. FWS has already discussed this with the Maryland State Highways Administration, which may be able to provide some funding for construction because of the project’s demonstration value. Additionally, this project will be discussed by TU and FWS staff in numerous presentations to other professionals and the general public.*

## **6. Project Documents**

Include in your final programmatic report, via the Uploads section of this task, the following:

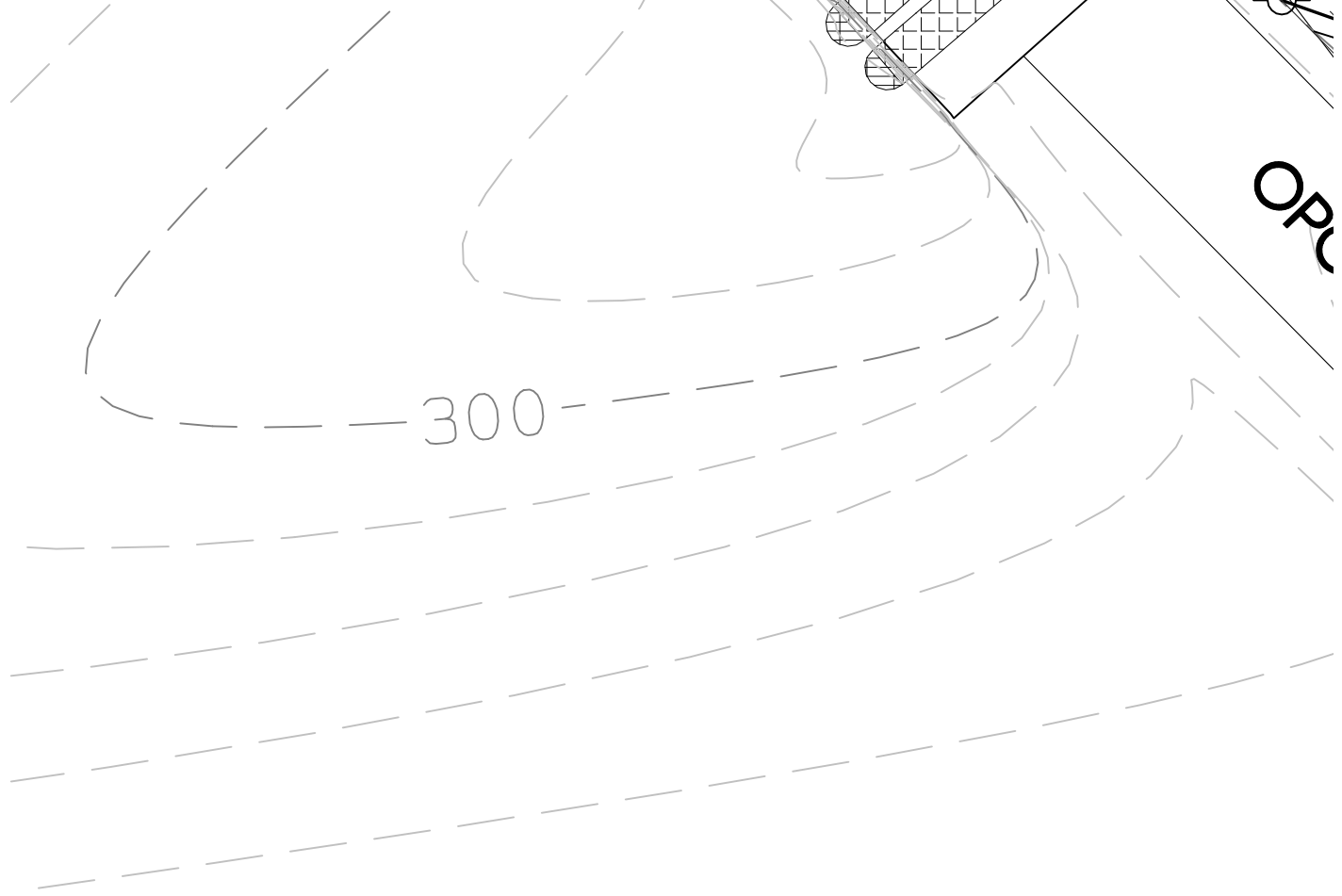
- 2-10 representative photos from the project. Photos need to have a minimum resolution of 300 dpi;
- report publications, GIS data, brochures, videos, outreach tools, press releases, media coverage;
- any project deliverables per the terms of your grant agreement.

**POSTING OF FINAL REPORT:** *This report and attached project documents may be shared by the Foundation and any Funding Source for the Project via their respective websites. In the event that the Recipient intends to claim that its final report or project documents contains material that does not have to be posted on such websites because it is protected from disclosure by statutory or regulatory provisions, the Recipient shall clearly mark all such potentially protected materials as “PROTECTED” and provide an explanation and complete citation to the statutory or regulatory source for such protection.*





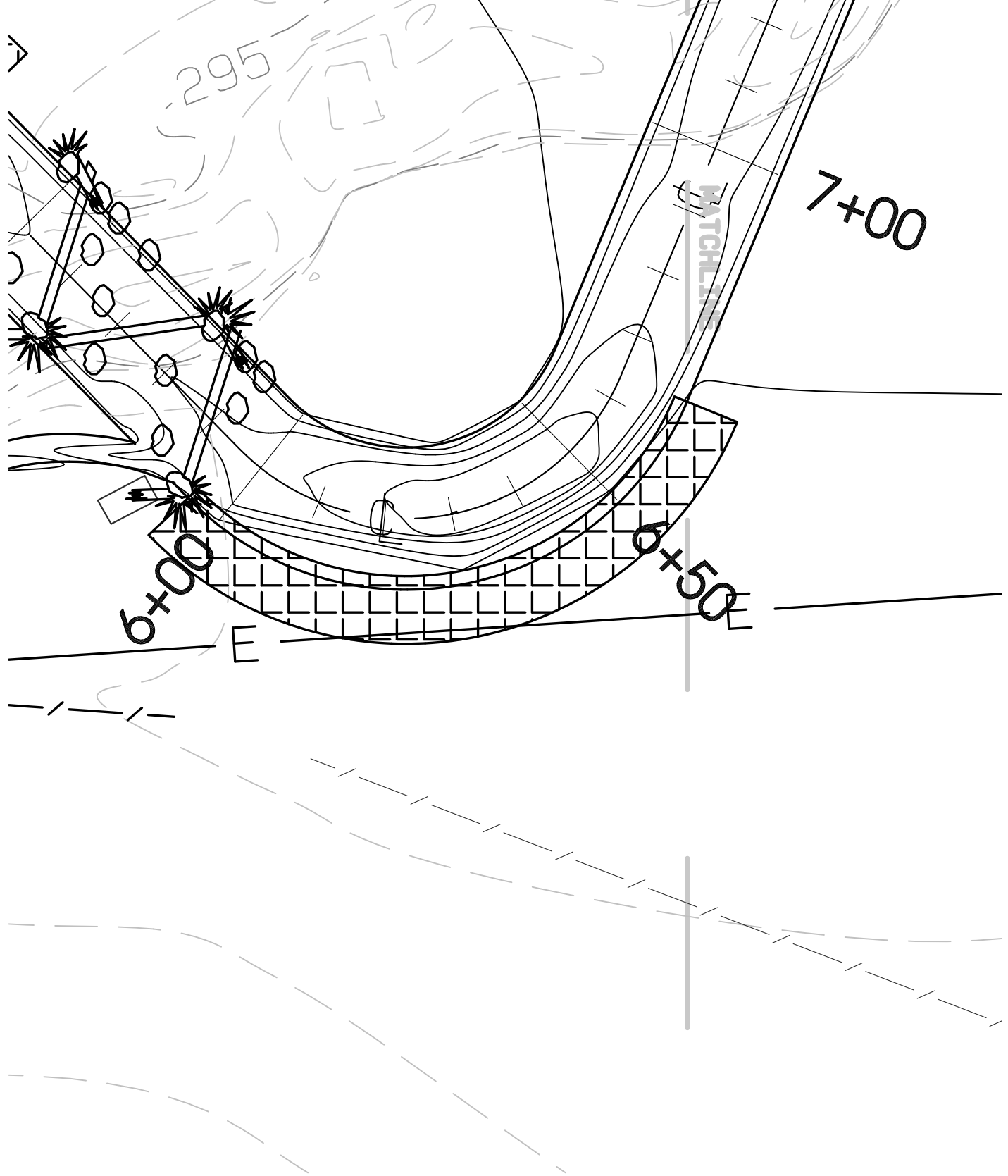




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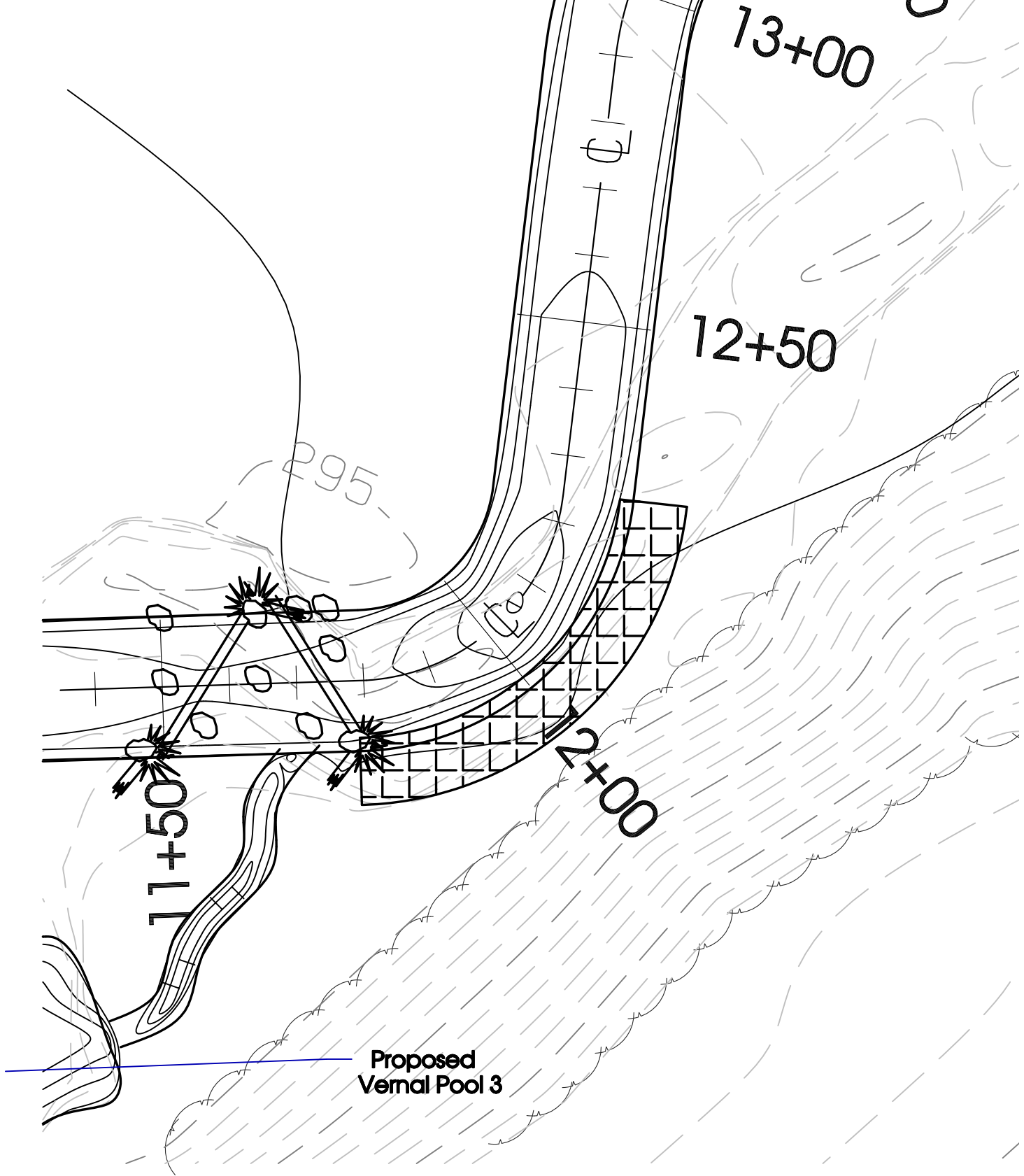




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# **LITTLE TUSCARORA CREEK WATERSHED AND GEOMORPHIC ASSESSMENT**

This section presents a brief summary of the methods used by the Service to conduct a limited watershed and stream assessment, develop restoration objectives, and conduct a restoration design.

## **A. Watershed Assessment**

The limited watershed assessment involved two levels of assessment: stream-based assessment and land-based assessment. The stream-based assessment involved a visual assessment of stream character and stability condition upstream and downstream of the project area. The fluvial geomorphic conditions observed included channel dimensions, pattern, profile, and substrate material, vertical and lateral stability, sediment supply potential, Rosgen stream type, and channel evolution. The land-based assessment analyzed land use/land cover patterns, soils, geology, hydrology, valley type, existing water quality and biological data, and watershed development. The assessment was predominantly an office exercise with field verification.

### **1. Geology and Soils**

The Little Tuscarora Creek watershed is located in the Lowland section of the Piedmont Plateau province, which lies in between the Blue Ridge and Coastal Plain provinces. The Piedmont Plateau Province is composed of hard, crystalline igneous and metamorphic rocks and extends from the inner edge of the Coastal Plain westward to Catoctin Mountain, the eastern boundary of the Blue Ridge Province. Bedrock in the eastern part of the Piedmont consists of schist, gneiss, gabbro, and other highly metamorphosed sedimentary and igneous rocks of probable volcanic origin. In several places these rocks have been intruded by granitic plutons and pegmatites. Deep drilling has revealed that similar metamorphic and igneous rocks underlie the sedimentary rocks of the Coastal Plain. Several domal uplifts of Precambrian gneiss mantled with quartzite, marble, and schist are present in Baltimore County and in parts of adjacent counties. Differential erosion of these contrasting rock types has produced a distinctive topography in this part of the Piedmont.

The Little Tuscarora Creek project area primarily consists of two soil types (i.e., Bermudian silt loam and Birdsboro silt loam). The Bermudian silt loam consists of very deep, somewhat well drained soils and typically located in floodplains with convex, linear side slopes. Permeability is 0.60 to 6.00 in/hr throughout but is limited by capacity. Slopes range from 0 to 3 percent. Mean annual precipitation is about 37 - 48 inches, and mean annual temperature is about 45 - 55 degrees F. The Birdsboro silt loam consists of very deep, somewhat well drained soils and typically located in floodplains with convex, concave side slopes. Permeability is 0.57 to 1.98 in/hr throughout but is limited by capacity. Slopes range from 0 to 3 percent. Mean annual precipitation is about 37 - 46 inches, and mean annual temperature is about 45 - 59 degrees F.

## 2. Land use/Land cover

The Service used aerial photographs and land use/land cover maps to estimate the land use/land cover percentages for the Little Tuscarora watershed. The primary land uses in the watershed is Agricultural/Rural and Natural Resource land with some associated Low Density Residential land use. Based on the 2010 Frederick County Comprehensive Land Use Plan, the land uses of this watershed will remain mostly unchanged. Currently, the watershed consists of less than 10% impervious surface.

## 3. Hydrology

The Little Tuscarora Creek watershed is a sub-watershed of the Monocacy River, which is the largest Maryland tributary to the Potomac River. The Little Tuscarora Creek watershed is approximately 5.6 square miles (**Figure 3**) at the project location and is in the Blue Ridge hydrologic region. The valley type, as defined by Rosgen (1996) is a valley type VIII; a wide, gentle valley slope with a well developed floodplain adjacent to river terraces.

Little Tuscarora Creek exhibits a flow regime typical of streams found in rural areas. Most runoff is absorbed into the soils, recharging the water table. Since Little Tuscarora Creek is predominantly spring fed, and there is little impervious surface, Little Tuscarora Creek does not exhibit “flashy” flows commonly found in urban settings. The Service aims to increase the flood prone area within the project area and will make no significant bed elevation changes. Proposed cross sections were designed to accommodate bankfull flows that were determined by collected data, regional curve calculations and resistance equations.

## 4. Hydraulic Assessment

The Service has not yet modeled the design reach, but will upon design completion to ensure no negative impacts up or downstream of restoration reach.

## 5. Riparian Vegetation

The Little Tuscarora Creek Stream Restoration project area exists within a mixed use agricultural setting (**Figure 1**). A portion of the project area has been tilled for rotating crops and some of the adjacent land has remained in planted in grasses to be mowed for hay production. The buffer width ranges from approximately 0 to 50 feet consisting of native and non-native grasses, shrubs, understory trees, and mature canopy trees. However, the majority of the project (**Figure 2**) exists within an area that is dominated by agriculture that consists of mowed/tilled edges and little to no canopy cover.



**Figure 1. Project area (Looking downstream)**



**Figure 2. Project area (Looking downstream)**

# Little Tuscarora Creek Project Location Map

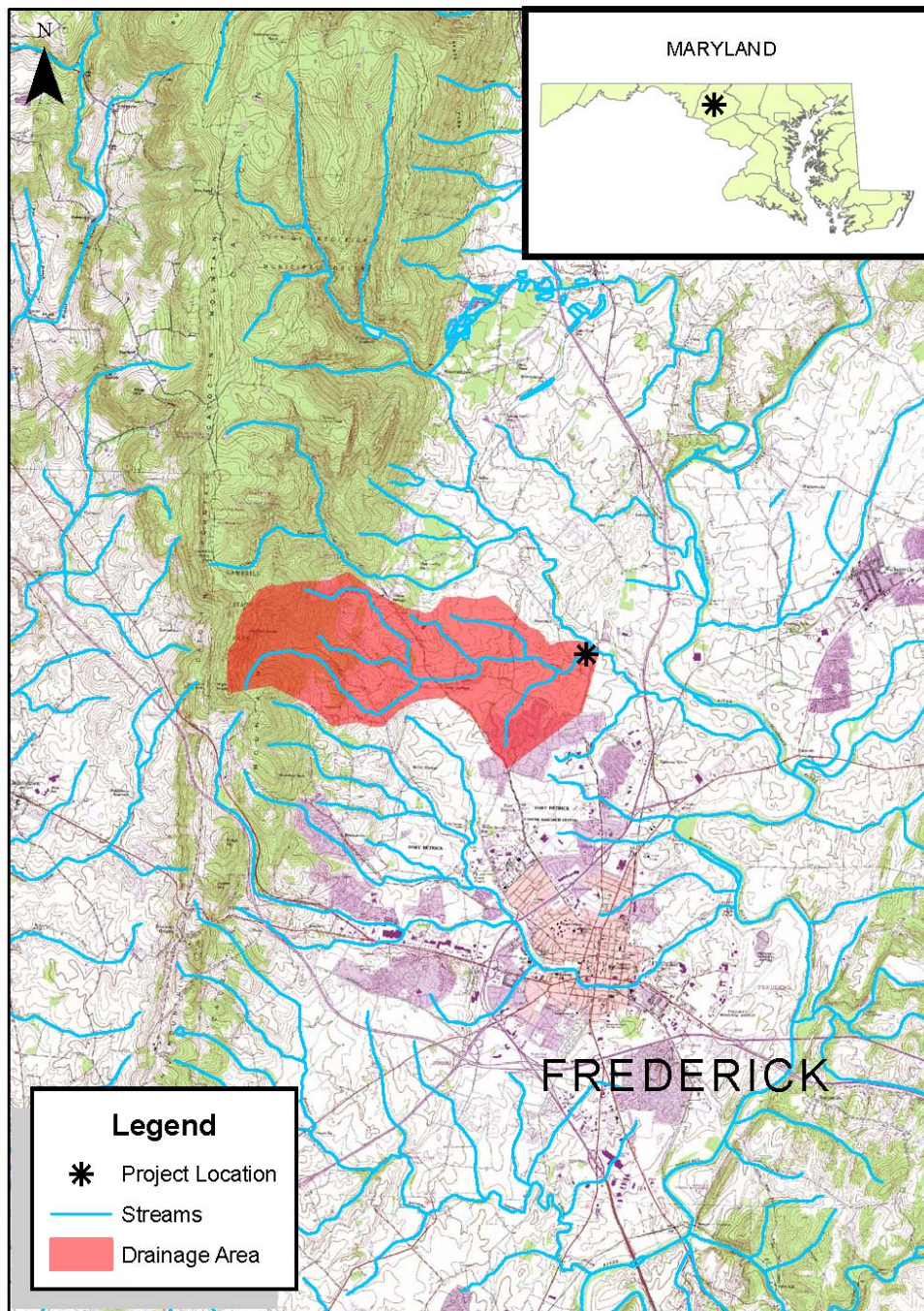


Figure 3. Little Tuscarora Creek Watershed

## B. Base Mapping

The Service conducted a baseline survey and produced 1-foot ground survey information to accurately map and represent the project area. This Service used this information to assess base line conditions and to develop and illustrate a restoration design plan. Plan form, longitudinal profile, and topographic information is represented.

## C. Project Reach Geomorphic Assessment

The Service conducted a visual Rosgen Level II assessment to assess the portion restoration reach portion of Little Tuscarora Creek. The Rosgen Level II assessment describes the existing morphological character of the stream and classifies the stream using the Rosgen stream classification system (Rosgen 1994). The Rosgen stream classification system uses physical features of a stream such as width, depth, pattern, and bed material, to group streams into a “type” denoted by alphanumeric codes.

The 1,800 linear foot project area shows indices of an unstable Rosgen F4 channel with poorly defined characteristics and widespread instability (**Figure 4**). However, the width-to-depth ratio and entrenchment ratio are within acceptable ranges for a Rosgen C channel and particle distributions are consistent with the Rosgen C4/1 channel type as well. Post restoration the stream is expected to function as a stable C4 channel with increased floodplain interaction.

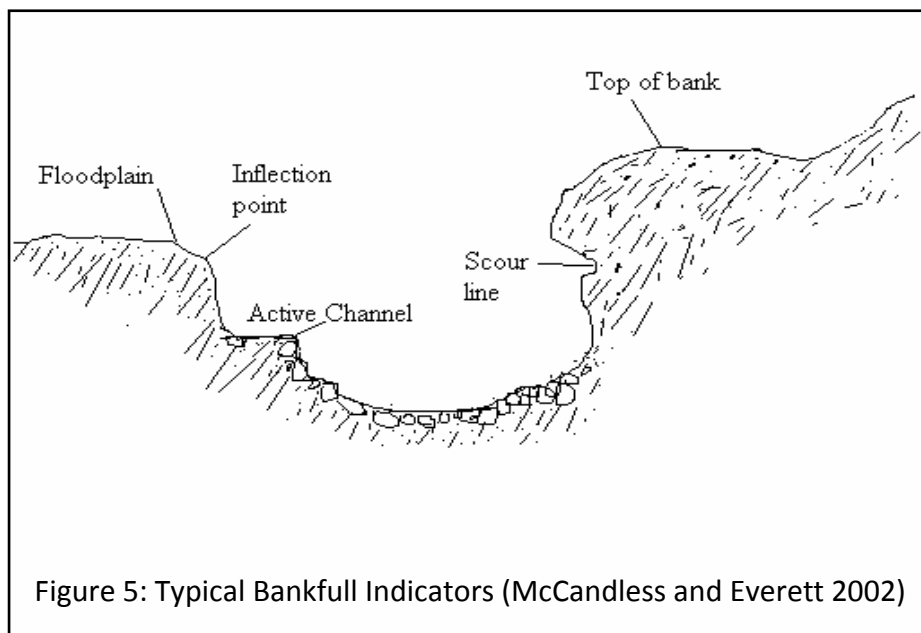


**Figure 4. Lateral instability**

## D. Bankfull Verification

Bankfull discharge characterizes the range of discharges that is effective in shaping and maintaining a stream. Over time, geomorphic processes adjust the stream capacity and shape to accommodate the bankfull discharge within the stream. Bankfull discharge is strongly correlated to many important stream morphological features (*e.g.*, bankfull width, drainage area, etc.) and is the critical parameter used by the Service in assessing Little Tuscarora Creek. Bankfull discharge is also used in natural channel design procedures as a scale factor to convert morphological parameters from a stable reach of one size to a disturbed reach of another size.

During the Little Tuscarora Creek assessment, the Service identified bankfull stage using physical indicators of bankfull stage described by McCandless and Everett (2002). **Figure 5** depicts significant geomorphic indicators typically found in the Mid-Atlantic. Based on these indicators, the Service identified a consistent geomorphic feature at Little Tuscarora Creek. This geomorphic indicator was typically a significant slope break or back of bench found throughout the project area.



The Service compared representative cross section dimension to the regional relationships of the same parameters developed for the Maryland Piedmont (McCandless and Everett 2002) physiographic regions for verification (**Table 1**). The representative cross section dimensions were collected approximately 150 feet downstream of the start of the project area. The Service determined that the existing condition measurements were not sufficient for developing design criteria and instead used reference data from similar watersheds and regional curve information.

<b>Table 1. Little Tuscarora Creek Design and Regional Curve Bankfull Characteristics</b>			
<b>Bankfull Characteristics</b>	<b>Existing Representative Cross Section</b>	<b>Design Cross Section</b>	<b>USGS Carbonate Regional Curve</b>
Area (ft <sup>2</sup> )	31.16	34.00	30.53
Width (ft)	20.52	20.00	21.31
Depth (ft)	1.52	1.70	1.46
Velocity (ft/s)	3.23	3.08	4.32
Discharge (cfs)	100.65	105.00	132.03
1. Maryland Stream Survey: Bankfull Discharge and Channel Characteristics of Streams in the Piedmont Hydrologic Region (McCandless and Everett 2002)			

**Worksheet 5-3.** Field form for Level II stream classification (Rosgen, 1996; Rosgen and Silvey, 2005).

Stream: <b>Little Tuscarora Creek, Reach - Staley Property</b>	
Basin: <b>Tuscarora Creek</b>	Drainage Area: <b>3584</b> acres <b>5.6</b> mi <sup>2</sup>
Location: <b>Frederick County, MD</b>	
Twp.&Rge: ;	Sec.&Qtr.: ;
Cross-Section Monuments (Lat./Long.): <b>39.46942 Lat / 77.41714 Long</b> Date: <b>02/23/12</b>	
Observers: <b>BH, MS, CB</b>	Valley Type: VIII

<b>Bankfull WIDTH (<math>W_{bkf}</math>)</b> WIDTH of the stream channel at bankfull stage elevation, in a riffle section.	<b>20.52</b> ft
<b>Bankfull DEPTH (<math>d_{bkf}</math>)</b> Mean DEPTH of the stream channel cross-section, at bankfull stage elevation, in a riffle section ( $d_{bkf} = A / W_{bkf}$ ).	<b>1.52</b> ft
<b>Bankfull X-Section AREA (<math>A_{bkf}</math>)</b> AREA of the stream channel cross-section, at bankfull stage elevation, in a riffle section.	<b>31.16</b> ft <sup>2</sup>
<b>Width/Depth Ratio (<math>W_{bkf} / d_{bkf}</math>)</b> Bankfull WIDTH divided by bankfull mean DEPTH, in a riffle section.	<b>13.5</b> ft/ft
<b>Maximum DEPTH (<math>d_{mbkf}</math>)</b> Maximum depth of the bankfull channel cross-section, or distance between the bankfull stage and Thalweg elevations, in a riffle section.	<b>1.87</b> ft
<b>WIDTH of Flood-Prone Area (<math>W_{fpa}</math>)</b> Twice maximum DEPTH, or ( $2 \times d_{mbkf}$ ) = the stage/elevation at which flood-prone area WIDTH is determined in a riffle section.	<b>50.88</b> ft
<b>Entrenchment Ratio (ER)</b> The ratio of flood-prone area WIDTH divided by bankfull channel WIDTH ( $W_{fpa} / W_{bkf}$ ) (riffle section).	<b>2.48</b> ft/ft
<b>Channel Materials (Particle Size Index ) <math>D_{50}</math></b> The $D_{50}$ particle size index represents the mean diameter of channel materials, as sampled from the channel surface, between the bankfull stage and Thalweg elevations.	<b>29.49</b> mm
<b>Water Surface SLOPE (S)</b> Channel slope = "rise over run" for a reach approximately 20–30 bankfull channel widths in length, with the "riffle-to-riffle" water surface slope representing the gradient at bankfull stage.	<b>0.00381</b> ft/ft
<b>Channel SINUOSITY (k)</b> Sinuosity is an index of channel pattern, determined from a ratio of stream length divided by valley length (SL / VL); or estimated from a ratio of valley slope divided by channel slope (VS / S).	<b>1.24</b>

<b>Stream Type</b>	<b>C 4/1</b>	<b>(See Figure 2-14)</b>
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**Worksheet 5-4.** Morphological relations, including dimensionless ratios of river reach sites (Rosgen and Silvey, 2005).

Stream: <b>Little Tuscarora Creek, Reach - Staley Prop</b>		Location: <b>Frederick County, MD</b>							
Observers: <b>BH, MS, CB</b>		Date: <b>02/23/12</b>	Valley Type: <b>VIII</b>						
		Stream Type: <b>C 4/1</b>							
<b>River Reach Summary Data</b>									
<b>Channel Dimension</b>	Mean Riffle Depth ( $d_{bktf}$ )	<b>1.16</b> ft	Riffle Width ( $W_{bktf}$ )	<b>19.33</b> ft	Riffle Area ( $A_{bktf}$ )	<b>31.16</b> ft <sup>2</sup>			
	Mean Pool Depth ( $d_{bktfp}$ )	<b>1.96</b> ft	Pool Width ( $W_{bktfp}$ )	<b>27.37</b> ft	Pool Area ( $A_{bktfp}$ )	<b>53.03</b> ft <sup>2</sup>			
	Mean Pool Depth/Mean Riffle Depth	<b>1.69</b> $\frac{d_{bktfp}}{d_{bktf}}$	Pool Width/Riffle Width	<b>1.42</b> $\frac{W_{bktfp}}{W_{bktf}}$	Pool Area / Riffle Area	<b>2.33</b> $\frac{A_{bktfp}}{A_{bktf}}$			
	Max Riffle Depth ( $d_{maxrif}$ )	<b>1.76</b> ft	Max Pool Depth ( $d_{maxp}$ )	<b>3.09</b> ft	Max Riffle Depth/Mean Riffle Depth	<b>1.517</b>			
	Max Pool Depth/Mean Riffle Depth	<b>2.664</b>	Point Bar Slope	<b>0</b> ft/ft	Inner Berm Width ( $W_{ib}$ )	<b>0</b> ft			
	Inner Berm Depth ( $d_{ib}$ )	<b>0</b> ft	Inner Berm Width/Depth Ratio	<b>0</b>	$W_{ib}/d_{ib}$	Inner Berm Area ( $A_{ib}$ )	<b>0</b> ft <sup>2</sup>		
	Streamflow: Estimated Mean Velocity at Bankfull Stage ( $u_{bktf}$ )	<b>3.23</b> ft/s	Estimation Method	<b>Liminero's</b>					
	Streamflow: Estimated Discharge at Bankfull Stage ( $Q_{bktf}$ )	<b>100.65</b> cfs	Drainage Area	<b>5.6</b> mi <sup>2</sup>					
<b>Channel Pattern</b>	<b>Geometry</b>			<b>Dimensionless Geometry Ratios</b>					
	Mean	Min	Max	Mean	Min	Max			
	Meander Wavelength ( $L_m$ )	<b>120</b>	<b>68.6</b>	<b>189</b> ft	Meander Length Ratio ( $L_m/W_{bktf}$ )	<b>6.21</b>	<b>3.55</b>	<b>9.76</b>	
	Radius of Curvature ( $R_c$ )	<b>37.3</b>	<b>19.4</b>	<b>164</b> ft	Radius of Curvature/Riffle Width ( $R_c/W_{bktf}$ )	<b>1.93</b>	<b>1.00</b>	<b>8.46</b>	
	Belt Width ( $W_{bit}$ )	<b>76.4</b>	<b>12</b>	<b>107</b> ft	Meander Width Ratio ( $W_{bit}/W_{bktf}$ )	<b>3.95</b>	<b>0.62</b>	<b>5.52</b>	
	Individual Pool Length	<b>70.7</b>	<b>30.7</b>	<b>143</b> ft	Pool Length/Riffle Width	<b>3.66</b>	<b>1.59</b>	<b>7.39</b>	
	Pool to Pool Spacing	<b>109</b>	<b>44.1</b>	<b>224</b> ft	Pool to Pool Spacing/Riffle Width	<b>5.63</b>	<b>2.28</b>	<b>11.61</b>	
Riffle Length	<b>48.4</b>	<b>30.7</b>	<b>80.6</b> ft	Riffle Length/Riffle Width	<b>2.51</b>	<b>1.59</b>	<b>4.17</b>		
<b>Channel Profile</b>	Valley Slope (VS)	<b>0.006</b> ft/ft	Average Water Surface Slope (S)	<b>0.00381</b> ft/ft	Sinuosity (VS/S)	<b>1.24</b>			
	Stream Length (SL)	<b>1482</b> ft	Valley Length (VL)	<b>1043</b> ft	Sinuosity (SL/VL)	<b>1.42</b>			
	Low Bank Height (LBH)	start: <b>1.41</b> ft end: <b>2.19</b> ft	Max Riffle Depth	start: <b>1.36</b> ft end: <b>1.2</b> ft	Bank-Height Ratio (BHR) (LBH/Max Riffle Depth)	start: <b>1.04</b> end: <b>1.83</b>			
	<b>Facet Slopes</b>			<b>Dimensionless Slope Ratios</b>					
	Mean	Min	Max	Mean	Min	Max			
	Riffle Slope ( $S_{rif}$ )	<b>0.016</b>	<b>0.010</b>	<b>0.023</b> ft/ft	Riffle Slope/Average Water Surface Slope ( $S_{rif}/S$ )	<b>4.157</b>	<b>2.675</b>	<b>6.010</b>	
	Run Slope ( $S_{run}$ )	<b>0.019</b>	<b>0.014</b>	<b>0.025</b> ft/ft	Run Slope/Average Water Surface Slope ( $S_{run}/S$ )	<b>4.921</b>	<b>3.617</b>	<b>6.480</b>	
	Pool Slope ( $S_p$ )	<b>0.001</b>	<b>0.000</b>	<b>0.002</b> ft/ft	Pool Slope/Average Water Surface Slope ( $S_p/S$ )	<b>0.228</b>	<b>0.076</b>	<b>0.394</b>	
	Glide Slope ( $S_g$ )	<b>0.001</b>	<b>0.000</b>	<b>0.002</b> ft/ft	Glide Slope/Average Water Surface Slope ( $S_g/S$ )	<b>0.197</b>	<b>0.055</b>	<b>0.412</b>	
	<b>Feature Midpoint<sup>a</sup></b>			<b>Dimensionless Depth Ratios</b>					
	Mean	Min	Max	Mean	Min	Max			
	Max Riffle Depth ( $d_{maxrif}$ )	<b>1.76</b>	<b>1.5</b>	<b>1.96</b> ft	Max Riffle Depth/Mean Riffle Depth ( $d_{maxrif}/d_{bktf}$ )	<b>1.52</b>	<b>1.29</b>	<b>1.69</b>	
	Max Run Depth ( $d_{maxrun}$ )	<b>0</b>	<b>0</b>	<b>0.00</b> ft	Max Run Depth/Mean Riffle Depth ( $d_{maxrun}/d_{bktf}$ )	<b>0</b>	<b>0</b>	<b>0.00</b>	
Max Pool Depth ( $d_{maxp}$ )	<b>3.09</b>	<b>2.85</b>	<b>3.33</b> ft	Max Pool Depth/Mean Riffle Depth ( $d_{maxp}/d_{bktf}$ )	<b>2.66</b>	<b>2.46</b>	<b>2.87</b>		
Max Glide Depth ( $d_{maxg}$ )	<b>2.03</b>	<b>2.03</b>	<b>2.03</b> ft	Max Glide Depth/Mean Riffle Depth ( $d_{maxg}/d_{bktf}$ )	<b>1.75</b>	<b>1.75</b>	<b>1.75</b>		
<b>Channel Materials</b>	<b>Reach<sup>b</sup></b>			<b>Bar</b>			<b>Protrusion Height<sup>d</sup></b>		
	% Silt/Clay	<b>0</b>	<b>0</b>	<b>0</b>	$D_{16}$	<b>12.6</b>	<b>12.6</b>	<b>11.38</b>	<b>0</b> mm
	% Sand	<b>0</b>	<b>0</b>	<b>0</b>	$D_{35}$	<b>20.71</b>	<b>20.71</b>	<b>29.98</b>	<b>0</b> mm
	% Gravel	<b>82.35</b>	<b>82.35</b>	<b>59.88</b>	$D_{50}$	<b>29.49</b>	<b>29.49</b>	<b>50.46</b>	<b>0</b> mm
	% Cobble	<b>17.65</b>	<b>17.65</b>	<b>40.12</b>	$D_{84}$	<b>68.86</b>	<b>68.86</b>	<b>103.86</b>	<b>0</b> mm
	% Boulder	<b>0</b>	<b>0</b>	<b>0</b>	$D_{95}$	<b>111.16</b>	<b>111.16</b>	<b>121.83</b>	<b>0</b> mm
% Bedrock	<b>0</b>	<b>0</b>	<b>0</b>	$D_{100}$	<b>180</b>	<b>180</b>	<b>130</b>	<b>0</b> mm	

<sup>a</sup> Min, max, mean depths are ave. mid-point values except pools: taken at deepest part of pool.

<sup>b</sup> Composite sample of riffles and pools within the designated reach.

<sup>c</sup> Active bed of a riffle.

<sup>d</sup> Height of roughness feature above bed.

**Worksheet 5-10.** Summary form of annual streambank erosion estimates for various study reaches.

Stream: <b>Little Tuscarora Creek, Reach - Staley Pr</b>		Location: <b>Frederick County, MD</b>					
Graph Used:			Total Bank Length (ft): <b>1482</b>			Date: <b>2/23/2012</b>	
Observers: <b>BH, MS, CB</b>		Valley Type: <b>VIII</b>			Stream Type: <b>C 4/1</b>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Station (ft)	BEHI rating (Worksheet 5-8) (adjective)	NBS rating (Worksheet 5-9) (adjective)	Bank erosion rate (Figure 5-38 or 5-39) (ft/yr)	Length of bank (ft)	Study bank height (ft)	Erosion subtotal [(4)×(5)×(6)] (ft <sup>3</sup> /yr)	Erosion Rate (tons/yr/ft) $\{[(7)/27] \times 1.3 / (5)\}$
1. Bank #1	High	Moderate	0.2999148	264	4	316.71	0.06
2. Bank #2	High	Moderate	0.3	378	4	453.6	0.06
3. Bank #3	High	High	0.500241	83	4.5	186.84	0.11
4. Bank #4	Low	Moderate	0.0701874	122	3.5	29.97	0.01
5. Bank #5	Low	Moderate	0.0698901	117	3.5	28.62	0.01
6. Bank #6	Very High	High	0.4999612	368	3.5	643.95	0.08
7. Bank #7	High	Moderate	0.3000857	100	3.5	105.03	0.05
8. Bank #8	High	Very High	0.8001099	78	3.5	218.43	0.13
9. Bank #9	High	High	0.5	297	3.5	519.75	0.08
10. Bank #10	High	Moderate	0.2998509	230	3.5	241.38	0.05
11. Bank #11	Very High	Very High	0.7998288	146	4	467.1	0.15
12. Bank #12	High	Moderate	0.2999012	347	3.5	364.23	0.05
13. Bank #13	High	Moderate	0.3001263	190	3.75	213.84	0.05
14. Bank #14	High	Very High	0.7997838	111	3.75	332.91	0.14
15. Bank #15	Very Low	Low	0	100	3	0	0.00
16. Bank #16	Very Low	Low	0	100	3	0	0.00
17.							
18.							
19.							
20.							
21.							



## Implementation Plan

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### *Little Tuscarora Creek – Staley Property*

Trout Unlimited (TU) and contractor the U.S. Fish and Wildlife Service – Chesapeake Bay Field Office (Service) recently completed a stream restoration plan for 1,800 linear feet of Little Tuscarora Creek on the property of Harold Staley in Frederick County, Maryland. The design follows Natural Channel Design methodology and is the first stream restoration design to utilize a new function-based framework for stream assessment and restoration.<sup>1</sup> A rigorous monitoring plan has been established by the Maryland Biological Stream Survey (MBSS) to assess the physicochemical and biological “lifts” provided by the project, once constructed. MBSS has already gathered pre-construction data, and has agreed to carry out post-construction monitoring for several years.

The Service’s estimated cost for construction is approximately \$195,000, including permitting, construction, and construction management.<sup>2</sup> TU, the Service, and Mr. Staley are eager to move forward with construction, with Mr. Staley’s only condition being that he is not willing to enter into any long-term agreements governing his use of the property (e.g. conservation easements). He is, however, willing to maintain the riparian buffer planting and plan his agricultural activities around the project (portions of the project area are currently planted in corn).

Funding for construction will need to be secured through public and private grants, as neither TU nor Mr. Staley have cash available to pay for construction. Three requests for project funding have been submitted and declined to date. Two applications were submitted to the American Rivers – EPA Potomac Highlands Implementation Grant Program. Both were declined and the program is no longer accepting applications. A third request was made to the Chesapeake Bay Trust, a design-phase funder. That was also declined, though the Chesapeake Bay Trust remains a strong prospect if additional funding can be secured as match.

Two requests for funding are pending consideration with Maryland state government. These and other near-term funding prospects are presented in the table on the following page.

To meet certain eligibility criteria, it may be necessary to break implementation into phases, with an obvious division being in-stream work and riparian buffer establishment. Only once a first attempt is made to secure all implementation phase funding will TU consider scaling back the project and lowering its overall request for financial support.

Based on the above information and current funding landscape, in the near-term TU intends to pursue:

1. The National Fish and Wildlife Foundation’s Chesapeake Bay Stewardship Fund in spring 2013 for approximately \$150,000.
2. The Chesapeake Bay Trust’s Restoration Grant Program in summer 2013 for approximately \$45,000.

These requests may not be necessary or may be modified if pending requests are awarded.

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<sup>1</sup> [http://water.epa.gov/lawsregs/guidance/wetlands/upload/A\\_Function-Based\\_Framework-2.pdf](http://water.epa.gov/lawsregs/guidance/wetlands/upload/A_Function-Based_Framework-2.pdf)

<sup>2</sup> A complete construction cost estimate was provided to TU by the Service on March 27, 2013.

**Table 1. Implementation Funding Prospects, Little Tuscarora Creek - Staley Property, March 28, 2013**

<b>Funder</b>	<b>Program</b>	<b>Max. Award</b>	<b>Deadline</b>	<b>Notes</b>
Nat'l Fish and Wildlife Foundation	Chesapeake Bay Stewardship Fund	\$200,000	May-13	Strong prospect given previous investment in desi
Chesapeake Bay Trust	Restoration Grant Program	\$50,000	Jun-13	Strong prospect given previous investment in desi
<i>MD Dept. of Natural Resources</i>	<i>Watershed Restoration Division</i>	<i>NA</i>	<i>NA</i>	<i>Request for \$213,590 submitted to K. Smith. To be</i>
<i>MD State Highways Adm.</i>	<i>NA</i>	<i>NA</i>	<i>NA</i>	<i>R. Starr coordinating possible funding. SHA may cc</i>
USFWS-CBFO	In-Kind Services	~\$18,000	NA	In-kind services provided by design team for const
MD Dept. of Natural Resources	Stream Restoration Challenge	Varies	May-13	Could be used for volunteer tree plantings after in
Chesapeake Bay Trust	Mini Grant Program	\$5,000	Rolling	Could be used for volunteer tree plantings after in

*Italics indicate requests are pending*

**LITTLE TUSCARORA CONSTRUCTION ESTIMATE TABLE**

1	2	3	4	5	6	7
<b>Item</b>	<b>Commodity</b>	<b>Unit of Measure</b>	<b>Contingent (C)</b>	<b>Estimated Quantity</b>	<b>Unit Price</b>	<b>Total Price (Col 5 x Col 6)</b>
1	Mobilization	Lump sum		1	\$5,000.00	\$10,000.00
2	Construction stakeout	Lump sum		1	\$5,000.00	\$5,000.00
3	Erosion & Sediment control	Lump sum		1	\$5,000.00	\$10,000.00
-	Silt Fence	Linear Feet		-	Include in item 3	n/a
4	Clearing and Grubbing	Lump Sum		1	\$3,000.00	\$3,000.00
5	Toe Wood Installation	Linear Feet		585	\$20.00	\$11,700.00
6	Excavation (other)	Cubic Yard		4,012	\$4.00	\$16,048.00
7	Rock/Log in stream structures	Linear Feet		104	\$55.00	\$5,720.00
8	Stacked Rock Wall	Linear Feet		68	\$30.00	\$2,040.00
9	Log Roller Riffle	Linear Feet		65	\$20.00	\$1,300.00
10	Utility Crossing	Lump Sum		1	\$5,000.00	\$5,000.00
11	Temporary stream diversion(s)	Lump sum		1	\$30,000	\$30,000.00
12	Material Haul-off	Cubic Yard	C	940	\$10.00	\$9,400.00
13	Soil stabilization matting & stakes	Square Yard		2000	\$5.00	\$10,000.00
14	Temporary Seeding	Square Yard		14,868	\$0.30	\$4,460.40
15	Riparian Seeding	Square Yard		14,868	\$0.65	\$9,664.20
16	Riparian Shrubs	Each		492	\$15.00	\$7,380.00
17	Riparian Trees	Each		615	\$25.00	\$15,375.00
18	Livestakes	Each		3000	\$4.00	\$12,000.00
19	Fence (woven)	Linear Feet		665	\$3.50	\$2,327.50
20	Power Line Relocate	Each		2	\$4,000.00	\$8,000.00
<b>TOTAL BASE BID:</b> Sum of Column 7 (including contingent items)						\$178,415.10