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StREAM Lab at Virginia Tech

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Improving engineering design is difficult when the final product requires years or even decades to complete and evaluate; thus, a major challenge for ecological design is the time required to assess design performance. To address this issue, as well as other water-quality management challenges, faculty in the department of biological systems engineering (BSE) at Virginia Tech developed the Stream Research, Education, and Management (StREAM) Laboratory. During 2008-2010, 2.1 km (1.5 mi.) of Stroubles Creek and an unnamed tributary were restored. The main stem of Stroubles Creek was divided into sections to evaluate the effectiveness of three levels of stream restoration. The stream and associated floodplain were also instrumented to provide continuous, real-time data for use in research, teaching, and extension on stream restoration, water quality, and stream management. Located just downstream of the town of Blacksburg and the Virginia Tech campus (fig. 1), the StREAM Lab is used by faculty from multiple disciplines to address hydrologic, geomorphic, biogeochemical, and ecological questions related to the restoration and management of stream systems.

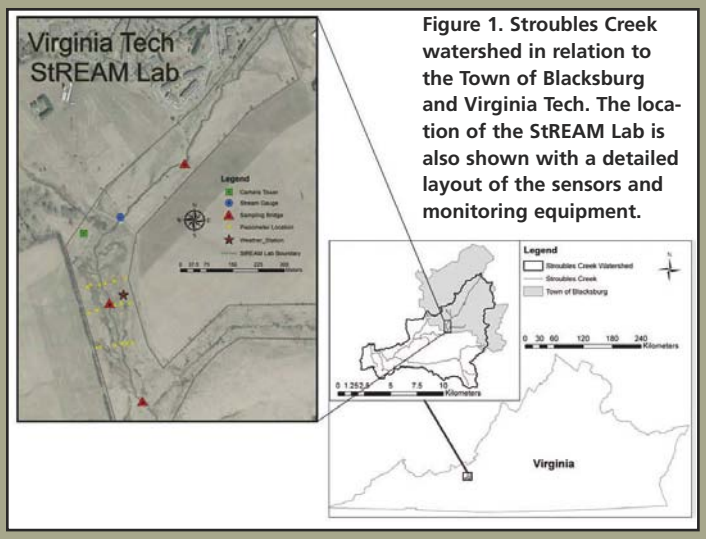

Figure 1. Stroubles Creek watershed in relation to the Town of Blacksburg and Virginia Tech. The location of the StREAM Lab is also shown with a detailed layout of the sensors and monitoring equipment.

Faculty and graduate students in the BSE department developed the restoration plan. The first step was to fence cattle out of the stream. Following livestock exclusion, three restoration and reforestation techniques were used along the creek: natural re-vegetation, bank reshaping to a 3:1 slope with replanting, and bank grading to construct 3:1 slopes and an inset floodplain within the main channel to reduce in-stream velocities during runoff events (fig. 2a/b).

The final design was developed based on multiple methodologies and existing site constraints. Because the stream sinuosity was similar to a reference reach, the existing stream slope and baseflow channel width were maintained. Thus, the main dimensions for the channel design were the elevation and width of the inset floodplain. The elevation of the inset floodplain was determined based on the shear stress required to transport sand and cobbles on the streambed. The width of the inset floodplain was based on site constraints. Extensive floodplain wetlands along the creek are maintained by small natural levees. To minimize impact to these wetlands, the inset floodplain was limited to a width that would not completely remove the levee and drain the floodplain wetlands.

A labor of love

While a private contractor was hired for the excavation work, BSE faculty and students provided oversight of the contractor and volunteer labor. More than 260 volunteers worked for over 1,200 hours to install erosion control materials and plant wetland vegetation along the stream, while learning firsthand about nonpoint-source pollution and water quality (fig. 3). These volunteers were members of more than 40 different organizations ranging from middle school service courses to Virginia Tech students, as well as local and university-based clubs.

Following the completion of stream restoration in May 2009, the site was equipped with high-resolution monitoring capabilities that provide Virginia Tech faculty with a unique opportunity to concurrently conduct physical, chemical, and biological research as well as education and outreach activities. The StREAM Lab currently has three sampling bridges with water-quality datasondes that continuously measure dissolved oxygen, specific conductance, turbidity, pH, and temperature. Three groundwater well transects with nested piezometers use pressure transducers to continuously monitor groundwater elevations in the floodplain to evaluate interactions between the stream and the local groundwater. These data are transmitted wirelessly to campus, where they are displayed on the StREAM Lab website (https://sites.google.com/site/troublescreek/home) and stored. In addition to a full weather station, an onsite tower is equipped with two weatherproof cameras that take hourly pictures of the site.

Figure 2a. Eroding streambanks were a significant sediment source to Stroubles Creek before ...

Figure 2b. ... and two years after restoration.

Making a difference

The StREAM Lab will continue to have local and national impacts. The project is located adjacent to a local bike path, which makes it highly visible to the community (fig. 4). Currently, more than 14 classes across four colleges use the StREAM Lab for laboratory exercises and projects. The lab is also used for continuing professional education, including stream restoration workshops for professional engineers and tours for groups ranging from high school students to international researchers. Nationally, the laboratory is featured through Virginia Tech's Center for Watershed Studies (www.cws.bse.vt.edu) and conference presentations.

While the educational and outreach opportunities at the StREAM Lab are extensive, another significant contribution of the facility to the field of watershed management is the potential to develop an extensive long-term water-quality dataset for a small, mixed-landuse watershed. Due to the variability of environmental data, decades-long data are needed to improve our understanding of fundamental processes and to develop and test models. Since research funding is typically available to monitor only a limited number of parameters over short periods, comprehensive, long-term hydrologic and water quality data are rare. Through the development of such a comprehensive and long-term dataset, the StREAM lab will serve to increase our understanding of water and pollutant transport through watersheds and to educate the next generation of water quality professionals.

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Figure 3. Volunteers plant seedlings into coir fiber erosion control fabric along a recently graded streambank.

Figure 4. A highly visible outreach sign along the Huckleberry Trail describes the project.