CRABTREE SWAMP STREAM RESTORATION IN HORRY COUNTY, SOUTH CAROLINA

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REFERENCE: *Proceedings of the 2010 South Carolina Water Resources Conference,* held October 13-14, 2010 at the Columbia Metropolitan Convention Center.

Abstract. Conceived in April 2007 during development of a watershed management plan, the Crabtree Swamp Restoration Initiative in Conway, South Carolina is a locally-driven collaborative that seeks to restore a highly-modified stream. The Initiative's mission is to restore Crabtree Swamp to a more natural state that adheres to or exceeds state and federal water quality standards, minimizes flood damage to people and their property, and provides suitable wildlife habitat.

Originally a low-gradient coastal plain stream, Crabtree Swamp was channelized and now exhibits a trapezoidal shape that disconnects the channel from its floodplain. Recent urbanization has caused stress symptoms such as bank failure, erosive channel velocities, periodic flooding, water quality impairments, invasive species infestation, and poor wildlife habitat quality. In January 2008, key local partners signed a Memorandum of Understanding (MOU) that outlines goals and an overall strategy, which allows the collaborative to complete discrete projects such as a restoration demonstration project.

Constructed in spring 2009, the demonstration project uses a two-stage design to reconnect the channel with the remnant bottomland hardwood floodplain via a gently sloping riparian bench along one-half mile of stream. Planted with native vegetation, the bench is inundated during moderate and high rainfall events. The new channel configuration provides flood storage and bank stabilization, improves water quality and provides habitat for aquatic and terrestrial species. Site assessment, topographic surveys, hydrodynamic modeling, and expert technical advice informed the project design.

Partners learned important lessons, such as the need for: 1) strong partner commitment; 2) overall coordination; 3) maintenance guidelines; 4) project assessment and sharing results; and 5) enabling natural processes. Future restoration work is needed to address continuing erosion and water quality problems in unrestored stream reaches.

INTRODUCTION

In 2007, a multi-partner collaborative set out to restore a highly-impacted coastal plain stream system in northeastern South Carolina. While stream and wetland restoration efforts have been pursued for decades across the state and nation, this effort is unique in that it originated at the local level and was derived from the cooperation of adjoining localities permitted by the state under the National Pollutant Discharge Elimination System (NPDES) Phase II stormwater program. This initiative may serve as a model for other communities in South Carolina that are permitted under the NPDES Phase II stormwater program as small municipal separate storm sewer systems (SMS4s).

BACKGROUND

The Crabtree Restoration Initiative was conceived in April 2007 as a locally-driven, multi-organizational effort to restore Crabtree Swamp, a highly-modified urban stream in Conway in Horry County, South Carolina. Building upon a successful U.S. Environmental Protection Agency (USEPA) Section 319 Nonpoint Source grant from S.C. Department of Health and Environmental Control to Coastal Carolina University's Waccamaw Watershed Academy (CCU) to characterize pollution sources in the Kingston Lake Watershed, watershed planning was conducted for the watershed through a grant from the U.S. Environmental Protection Agency's Region IV. Coordinated by CCU, the watershed planning process emphasized stakeholder input and information sharing. The Restoration Initiative began after Horry County's stormwater manager and Conway's Water Quality and Drainage Commission identified the restoration of Crabtree Swamp as a high priority.

A key step in the watershed planning process was to inform stakeholders of the stream system's history, current

Figure 1. Pre-restoration channel configuration.

conditions, outstanding problems, and management challenges. While Crabtree Swamp was originally a low-gradient coastal plain tributary to the Waccamaw River, the stream system was significantly modified by channelization projects in the 1960s (U.S. Army Corps of Engineers) and the 1980s (U.S. Department of Agriculture (USDA)). These efforts, spearheaded by the formation of the Crabtree Swamp Watershed Conservation District, aimed to improve drainage for agricultural lands. The outcome was a deep, trapezoidal channel known as Crabtree Canal (**Figure 1**). This shape has effectively disconnected the channel from its former floodplain. In the past 20 years, more intense urban land uses have replaced agricultural uses and increased stormwater runoff. Crabtree Canal now exhibits symptoms of stress such as bank failure (**Figure 2**), erosive channel velocities, high sediment loads during rain events, episodic flooding, federal 303(d)-listed water quality impairments for dissolved oxygen and fecal coliform, invasive vegetation (e.g. johnsongrass), and poor wildlife habitat quality.

Figure 2. Bank failure is a symptom of stress.

Once the history and challenges were communicated to stakeholders, the stakeholder brainstorming meetings elicited ideas and concepts that were distilled into a formal MOU that outlines goals and a comprehensive strategy. The Initiative's mission is to restore Crabtree Swamp to a more natural state that adheres to or exceeds state and federal water quality standards, minimizes flood damage to people and their property, and provides suitable wildlife habitat. Facilitated by CCU, the key local partners – City of Conway, Horry County, Crabtree Swamp Watershed Conservation District, and Horry Soil and Water Conservation District – finalized the agreement in January 2008. The agreement established the basis for proceeding with discrete restoration activities within the former swamp system.

DEMONSTRATION PROJECT

The first discrete project was designed as a pilot for implementing selected elements of the overall comprehensive strategy. Constructed in the spring of 2009, the demonstration project used a two-stage channel design to reconnect the channel with its remnant bottomland hardwood floodplain via a gently sloping riparian bench along one-half mile of stream. The sloping floodplain was planted with over 500 trees and shrubs of species native to coastal floodplain habitats. The new channel configuration results in inundation of the bench and slope during significant rainfall events. The project design strives towards greater flood storage, bank stabilization, improved water quality, and enhanced habitat for terrestrial and aquatic species.

Extensive planning and investigation was conducted during the design phase. Local partners sought the technical expertise of academic and agency advisors. Researchers from Coastal Carolina University and Clemson University conducted water quality and flow monitoring, which identified significant sediment and fecal coliform problems. Hydrodynamic modeling by Clemson also informed project design and predicted ideal bench elevation. Advice on species selection and design for planting was sought from Clemson, U.S. Fish and Wildlife Service, USDA's Natural Resources Conservation Service, and S.C. Department of Natural Resources.

Once the design phase was complete, the City of Conway and Horry County bid out and oversaw the construction phase. State and federal permit approvals for channel maintenance were acquired prior to construction. During construction, accumulated spoil material from dredging and historic channel and bank maintenance was excavated from the bank and adjacent berm and removed to a neighboring parcel. The bench elevation was designed to be inundated during the 2-year storm event as the slope rises to meet the existing grade of the former

Figure 3. Post-construction restoration design.

Figure 5. Installation of pre-rooted aquatic carpets.

floodplain (**Figure 3**) that had been isolated behind the berm. The excavated slope was stabilized for erosion control with sediment tubes and grasses.

With funding from the U.S. Fish and Wildlife Service, over 500 trees and shrubs of species native to coastal floodplains were planted in the native soils with little soil amendment. A machine auger, staff and volunteers were used to install the plants during early May 2009. Ideally, planting would occur during cooler months, but the contractual process for construction forced a later start. Plantings were arrayed to allow limited equipment access to the bench and to the channel for maintenance (**Figure 4**). Experimental aquatic coir-fiber mats with pre-rooted wetland plants (**Figure 5**) were secured to the bank edge in hopes of re-establishing native aquatic and wetland species. When mature, the floodplain and aquatic plantings will offer suitable wildlife habitat. Wildlife activity has been observed at the site.

Figure 4. Native plantings on restored floodplain.

SITE ASSESSMENT AND MAINTENANCE

A key part of the restoration demonstration project is to assess success in achieving objectives. One of the challenges in site assessment is that funding is often limited. Partners must be resourceful in implementing a monitoring program. CCU has arranged for undergraduate and graduate students to conduct monitoring with oversight by their advisers. One of the strengths of a robust monitoring and assessment program is the ability to report progress when seeking additional funding from granting agencies. Furthermore, sharing results with colleagues and contacts generates sustained interest in the project and attracts new technical expertise that may resolve issues or conduct research.

For this project, the partners decided to assess the key elements of wetland systems – hydrology, soils, and vegetation. CCU students maintain and monitor Global™ water loggers both immediately upstream and downstream of the restoration site to assess the frequency of site inundation. They also monitor rain gauges arrayed throughout the watershed. The students conduct annual soil accumulation profiling with a laser level on permanent transects to track the shape of the floodplain over time. Finally, students perform a quarterly inventory of the plantings (**Figure 6**) using a Global Positioning System (GPS) to assess their condition and survival. The data is maintained in a GIS system so that individual and species plant survival and success can be easily tracked. After one year, plantings achieved a 70% survival rate. Some species (e.g. ti-ti, persimmon, green ash, and sycamore) exhibited exceptional survival, while others (e.g. tulip poplar, eastern red cedar, and southern red oak) struggled to survive. Future monitoring may include groundwater monitoring and hydrogeomorphic wetland assessment.

Figure 6. Students perform inventory of plantings.

LESSONS LEARNED

As the area's first stream restoration of its kind, the project yielded lessons that will help to improve future projects. First, strong partner commitment is critical from the outset, as is sustaining that commitment over time. In the Crabtree Swamp Restoration Initiative, the Memorandum of Understanding was crucial in solidifying partner support for the collaborative's principles. The document also communicated the Initiative's goals to potential partner and funding agencies.

Overall coordination is important to sustaining project momentum. The Crabtree Restoration Initiative was initially coordinated by Coastal Carolina University during early implementation of the watershed management plan. Later, coordination was transferred to Horry County's Stormwater Department. Establishing a single point of contact improves coordination of activities and resources among partners. A single point of contact also offers project stability and consistency.

Site maintenance is an ongoing responsibility. Identifying guidelines for maintenance activities and responsibilities is important to the restoration process. With multiple partners responsible for various maintenance and assessment activities, it became necessary to agree upon a set of guidelines that specify proper procedures. Since maintenance at the restoration site requires a different approach than routine maintenance activities at other public facilities, the partners met with maintenance supervisors to determine what procedures would be reasonable and feasible.

As time has passed, the partners have been able to assess site success and share results. The results have attracted new partners, such as those interested in coastal plain fish habitat. The results have also brought additional technical resources to the table from partner agencies and organizations. In addition, officials and decision-makers are interested in the project and the partners have used the site as a vehicle to educate them about innovative ways to treat and control stormwater pollution and runoff.

Finally, it is important to recognize and communicate that the restoration site is part of a natural system and the partners must allow some flexibility for natural processes to occur. For instance, once plantings are firmly established, the area will be managed more as a natural area than a park-like setting. Also, minor erosion and scour may occur in some places, while accretion and deposition may occur in others. Allowing this natural process to introduce variability to the site will ultimately result in a more natural and functional floodplain.

RECOMMENDATIONS

The project partners have carried out a successful and rewarding floodplain restoration project. Positive results have sustained and broadened partner interest for future restoration phases within the Crabtree Swamp watershed. Partners intend to pursue additional phases of restoration, which will incorporate the restoration of fish habitat functions. Indeed, funding has already been secured from the U.S. Fish and Wildlife Service's Southeast Aquatic Resources Partnership to restore the floodplain on the opposite bank from the current demonstration site.

The demonstration site, however, remains vulnerable to water quality and quantity problems that originate upstream. Therefore, it is imperative that problems in the upper reaches of the watershed be addressed. Based on a detailed elevation survey, plans are underway to achieve grade stabilization in the upper watershed, where severe channel incision and bank erosion continues.

Finally, ongoing and sustained assessment work will be important during the life of the project. Significant results are likelier to be found as the restoration site matures and exhibits more of the functions found on natural floodplains.

ACKNOWLEDGEMENTS

Horry County Stormwater provides personnel and funding for construction and chemical maintenance. The City of Conway provides personnel and maintenance equipment. The U.S. Fish and Wildlife Service's Coastal Program provided funding for planting. Watershed planning was enabled by USEPA Wetland Program Development Grant #CD-96416209-0 to Coastal Carolina University. The nonpoint source pollution study was funded by USEPA 319 Grant #C9994639-99 to CCU. CCU students, staff and faculty provided project and planting coordination and continues to monitor and assess the project site. Clemson University provided hydrodynamic modeling and water quality monitoring through a grant from the S.C. Water Resources Center.