Mitigation Programs and Bioengineering Help Communities in Souther Utah Achieve Vision for Flood Control

For centuries, the problems of sandy, easily erodible soils have plagued the Utah communities of St. George and Santa Clara along the banks of the Virgin and Santa Clara Rivers. In 1862, settlers were forced to relocate homes and farms along the Santa Clara as a result of an extreme flood. Ever since, river flooding and lateral erosion along the riverbanks has caused significant damage to these areas.

A major flood in 2005 ravaged the communities, resulting in the loss of 27 homes and triggering a federally declared disaster. Rock riprap, the layering of rocks along the riverbank to counteract erosion, was the primary mitigation technique used following the 2005 flood to rapidly stabilize river banks and protect vital infrastructure and homes from additional damage. Although effective in preventing erosion, the City of St. George recognized the drawbacks to riprap such as increasing the speed of water flow along a length of river causing potential downstream impacts; impeding the natural functions of a riverbank that interface between land and rivers or streams; and, the effect on wildlife, specifically fish. Riprap reduces areas for vegetation or riverbank diversity in which fish seek refuge during high water events and often results in their being washed out of the area during flooding. Riprap also can leave riverbanks with an unappealing man-made look.

The city was introduced to alternative bioengineering solutions by the late Tom Moody, the principal engineer with Natural Channel Design and the primary author of the Santa Clara and Virgin River master plans. Bioengineering uses a variety of nature-inspired and environmentally conscious techniques to stabilize riverbanks from erosion. Mr. Moody's master plans provided the community with a road map for reconstruction, management and long-term maintenance of the river corridors that incorporates bioengineering.

St. George was hit with two more significant floods in 2010 and 2011. During the rebuilding process, the city has used some form of bioengineering techniques on 100 percent of their bank stabilization projects as outlined in their master plans.

Rick Rosenberg, of Rosenberg Associates, was selected as the City of St. George's project manager for the bank stabilization efforts. According to Rosenberg, "Bioengineering provides a much more natural method to improve bank stability and protection from lateral erosion. In the long run, it is better for the environment, it is more aesthetically pleasing, and it allows us to extend limited river bank stabilization funds. In many cases, the planting stock is readily available from the river and it greatly simplifies the environmental permitting process."

The most recent bioengineering method used on the Santa Clara River consists of embedding root wads and horizontal logs spaced at 90-degree angles into the river bank supplemented by rock riprap toe protection. This technique, adopted from the Natural Resources Conservation Service (NRCS), adds stability to the river bank using native cottonwood and willow tree pole plantings and root wads. Some rock is used in addition to the -bioengineering to help stabilize and protect the highly erosive river bank soils until the vegetation becomes established.

A bioengineering system cannot totally replace a rock riprap system for critical erosion protection in arid sand bed environments like Southern Utah. However, supplementing the rock rip-rap with bioengineering techniques can simplify the environmental permitting process for a project as well as

improve the overall long-term stability of the river. The costs to include bioengineering have been affordable, ranging between 1 and 5 percent of the total project costs, depending on the type of bioengineering used. Pole plantings have been very affordable (less than 2-percent); root wads are slightly higher (up to 5-percent).

Initial Bioengineering Efforts and Success

While rock riprap was the primary technique used after the 2005 floods, the city conducted some initial bioengineering efforts that included willow and cottonwood plantings. During the 2010-2011 floods on the Santa Clara River, about 60-percent of that re-vegetation was successful and resisted damage. In many cases, the vegetation held and trapped sediment and debris, preventing lateral erosion damage to the adjacent stream bank.

The rate of vegetation growth is critical for the success of bioengineering efforts and is influenced mainly by water quality and quantity. After the 2005 floods, willow and cottonwood plantings also were placed in the Virgin River. However, due to the presence of an invasive species, poorer water quality, and insufficient flows during the summer months, the rate of re-vegetation that survived the 2010-2011 floods was much lower than that of Santa Clara River. We found the following lessons learned from this experience:

- Water-quality testing to determine the salinity of the project site is critically important prior to plant selection for bioengineering work.
- Efforts should be made to measure the lowest groundwater levels throughout the year at the work sites to determine the required bury depth for plantings. Most of the failures of the early Virgin River projects are due to inadequate bury depth during construction.
- Consideration should be given to historic river erosion patterns when selecting bioengineering sites. Sites that are highly susceptible to routine lateral erosion damage (such as the outside of sharp bends) should be avoided.
- It is critically important to follow NRCS guidelines regarding cutting, storage, and presoaking of plant materials prior to planting.

Recent Bank Stabilization Projects

Due to the significant impacts of the 2010 and 2011 floods, Utah received presidential disaster declarations for both events (DR-1955 and DR-4011, respectively). With these declarations came access to FEMA's Public Assistance Section 406 Mitigation grant funding and Section 404 Hazard Mitigation Grant Programs (HMGP). Section 406 provides funding for mitigation measures in conjunction with approved FEMA Public Assistance (PA) projects to repair infrastructure damaged during the declared disaster. Section 404 HMGP funding allows the state to identify mitigation projects that do not need to be directly related to the impacts of the declared disaster.

"The city has been able to effectively use the HMGP to fill in critical gaps in the erosion protection repair projects funded by PA and the NRCS Emergency Water Protection (EWP) programs along the Santa Clara and Virgin rivers to provide a more complete solution for bank stabilization," Rick Rosenberg noted.

In early 2013, St. George used FEMA Mitigation funding to repair and install erosion protection along the banks of the Virgin River to protect critical public infrastructure, the Millcreek Electric Generation Facility, a $64 million gas-fired power plant and substation. By working with FEMA, state officials and environmental regulators, the city was able to expand the scope of the total project to combine FEMA's two mitigation grant programs (Sections 404 and 406), and constructed a longer, continuous section of rock riprap bank stabilization, including bioengineering.

In early 2014, St. George completed a HMGP-funded bank stabilization project using bioengineering techniques just downstream of a PA mitigation repair project to replace a maintenance road crossing with a reinforced low-water crossing. These two projects work together to provide additional erosion protection for residents in the Monterey and River's Edge subdivisions, in addition to the city-owned Sunbrook Golf Course.

Also in 2014, 160 linear feet of riverbank at two locations along the Virgin River was repaired under the DR-1955 PA program. The DR-4011 HMGP program was used to extend and join the two completed sections under the PA program using a combination of rock and bioengineering providing an additional 650 feet of bank protection.

The city's vision for river-bank stabilization in the valley is beginning to take shape. Using FEMA's two mitigation grant programs and incorporating bioengineering, St. George has been able to leverage local flood-control funds and dramatically improve erosion protection along the Santa Clara and Virgin rivers. "The end result will be a more effective system to mitigate the risks of lateral bank erosion," stated Rick Rosenberg, "In time, the vegetation will become established and the rivers will again provide the much-needed habitat for birds, fish, wildlife and people as they always have."

The Santa Clara River bioengineering-pole plantings to supplement riprap the city's overall vision for bank stabilization.

Toe rock bioengineering

Project to protect critical public infrastructure

Completed project