Up the Creek

North Carolina project improves water quality, flood control in creek basin

By John Moll

The town of Highlands, N.C., applied for and won a grant from the Clean Water Management Trust Fund that helped fund a major drainage improvement project on a portion of Mill Creek adjacent to the downtown area. There were two main goals for the project, which entailed drainage system improvements, some underground storage and water quality treatment with a hydrodynamic separator.

The first project goal was to relieve frequent flooding in the immediate project area. An underground storage facility constructed of modular cubes provided good structural support for the landscaped area above, but also provided storage space to help attenuate the historic flooding that had occurred in this area. The second goal was to improve the quality of the water exiting the basin.

The 14.6-acre basin that was upstream of these new structures is about 50% highly developed downtown shopping area (almost all impervious) and 50% natural forest. The impervious areas have developed over time, and have led to higher peak flows in the project drainage corridor. The natural stream bed had a small and steady standing flow, and had an existing low-capacity piped storm drainage system that helped direct high flows around the natural corridor.

Highlands has about 90 in. of annual rainfall, and high-intensity storms could easily overcome the capacity of the existing combination of pipes and the small stream bed. In this climate, storm water runoff is an issue. McGill Associates, P.A., in a cooperative effort with town of Highlands engineer Lamar Nix, provided the design expertise and managed the results of an effort to improve both water quality and flood control in this basin.

Project Specs

The project specification required providing a hydrodynamic separator that could withstand a maximum flow of 25 cu ft per second (cfs), while removing 85% of total suspended solids (TSS), using the small-particle-oriented SM-2540-D analysis method—formerly EPA 160.2—and 35% of total phosphorus, using EPA 365.1 analysis. A CrystalStream Model 2056 hydrodynamic vault was selected to improve water quality.

The town of Highlands in the Blue Ridge Mountains sits at an elevation of 4,118 ft above sea level and straddles the Eastern Continental Divide.

The small particle analysis method was used because two diversion weirs above the project acted to remove the larger sand particles from the influent to the two systems. A small weir upstream diverted the low-standing watershed flow through the picturesque small stream corridor when there was no rainfall. When storm events occurred, higher flows were diverted through a high-capacity pipe system that protected the small stream.

A second weir was placed in the high-capacity pipe system to divert the first 25 cfs of high flows through both the CrystalStream water quality vault and the underground storage system located just downstream of the vault. The water quality peak flow for the basin was calculated at 7.48 cfs, and the 10-year, 24-hour peak flow was calculated at 60.2 cfs. The result of this configuration followed that for flows up to 25 cfs, all the water passes through the water quality vault, into the underground storage area and then downstream. For catastrophic storm events, the first 25 cfs is still treated, but excess flows pass over the secondary weir and through the bypass pipes to proceed downstream without treatment. Twenty storm events were sampled that met the test criteria. Each storm had to be at least 0.5 in. in depth, and had to be preceded by three consecutive days of less than 0.2 in. of rainfall. In addition to TSS and total phosphorus removal, other water quality parameters were examined.

Sampling & Analysis

The CrystalStream Model 2056 CrystalClean Separator employs two 10-ft-by-5-ft vaults in series. The first vault is composed of a trash basket and two perforated baffles. The second vault comprises a third baffle, a spill containment/hydrocarbon reservoir and a coconut fiber filter for final treatment. The water quality treatment flow capacity of the vault system typically is 5.8 cfs. This water quality flow rate is based on a hydraulic loading rate of 26 gal per minute (gpm) per sq ft for the vault. In this test, however, the water quality flow of 7.48 cfs produced a hydraulic loading rate of 33.57 gpm per sq ft. The actual results for the CrystalStream Separator were that 96% of the TSS was removed along with 74% of the total phosphorus and 74% of the total nitrogen. This performance met the goals of the project, but there is more to the story.

Additional sampling and analysis were performed. In addition to testing the water quality above and below the device, the sediments trapped and the filter fiber also were analyzed for pollutant content, and a particle size distribution also was determined.

When the sediments taken from the device were analyzed, the particle size distribution was found to be 57% sand, 35.5% silt and 7.5% clay. This distribution compares well with the particle size distribution used in most test protocols, even though the device contained more clay than most protocols demand. It also is important to remember that this distribution was not material fed into the device during a test, but was material actually caught in real storm events.

Clay particles in suspension simply cannot be caught by a hydrodynamic separator, but the presence of clay in the trapped sediments shows that clay usually is not suspended freely in nature. Most clay particles normally are attached to other, larger particles. When the sediments are examined under a microscope, small silt- and clay-sized particles are found extensively on the surface of other sediments and vegetative materials. In the laboratory, when sediment samples are analyzed for particle size distribution, it sometimes is necessary to add an anti-flocculant to prevent clay-sized particles from clumping together, and steps are taken to dislodge the clay particles from the surface of other, larger particles. Processing native soils is fairly straightforward, although there may be some organic content in the sample, but processing sediments from a storm water vault is much more difficult because there typically is a large quantity of organics mixed in with the sediments. Based on the high TSS removal rate recorded in the water samples, and the high percentage of clay in the sediments, it is likely that very little "free" clay was present in the water coming into the device.

In addition to analyzing the particle size distribution, the sediments also were analyzed for metals and nutrients.

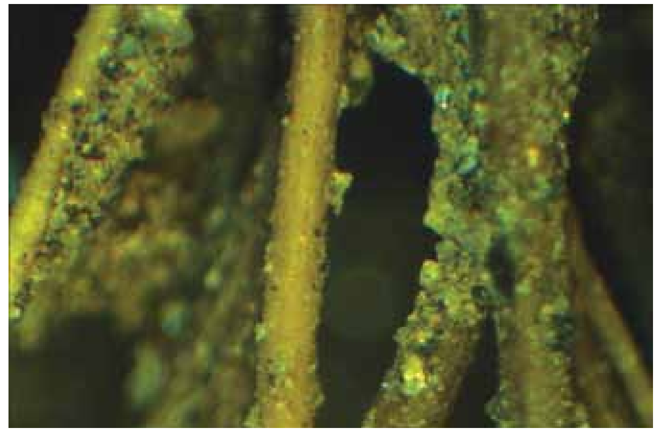
The pollutants found in the sediments were not all of the materials caught by the CrystalStream device.

While most pure separators would have been limited to capturing just the sediments, this vault added the extra step of filtration to the process.

Summary of Findings

The study analyzed the water above and below the device, sampled and analyzed the sediments, and analyzed the fiber filter. The types and amounts of materials removed by the CrystalStream vault were impressive, but there was one more measurement that is perhaps just as important.

When the vault was cleaned out, the weight of the sediments and the debris caught in the trash basket also were measured. The study found that, in addition to the 10,293 lb of sediments, 1,072 lb of trash, debris and vegetative materials were removed. A large percentage of the materials in the trash basket were organic, which adds to the nutrient removal rate, and the materials found there also had small particles attached to their surfaces. It is not known how much additional sediment and dissolved metal constituents were contained in that area of the device, but it certainly added to the overall efficiency of the device.



Used fiber filter coated with particles

When looking at the results contained in the data from this study, it is important to understand that this is not a typical separator that settles sediments, or one that allows trash, debris and vegetative materials to float and decompose. This device screens gross material and keeps it dry, settles out sediments, and then filters the relatively clean water prior to release.

This hybrid device helped to deliver high-quality water back to Mill Creek based on system design, an effective manufactured BMP, and the town's dedication to proper maintenance and cleaning. But, in the end, water quality is not a product—it is a process. SWS

John Moll is CEO of CrystalStream Technologies. Moll can be reached at johnmoll@crystalstream.com.

For more information, write in 807 on this issue's reader service form on page 49.