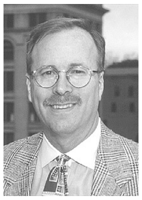
Turbidity

in Construction Runoff



By Barrett L. Kays, Ph. D., ASLA

In June 1997 The Raleigh News & Observer reported:

"Wake Runoff Muddies Neuse to New Bern." "Rick Dove, the Neuse Riverkeeper, sounded the alarm when a giant reddish plume of clay appeared in the Neuse River in New Bern. Dove and Chris Roessler of DENR flew up the river and traced the plume about 180-miles upstream to Crabtree Creek. Hundreds of construction sites were found to be fueling the massive mud slick."

Again, in April 1998 the News & Observer followed up:

"Silt Cops Dig for Dirt on Muddied Waters". "The inspections had all the intrigue of a police raid: an early-morning rendezvous at Raleigh-Durham International Airport, a list of targeted sites and government agents fanning out on a secret mission. Instead of breaking up drug rings or liquor stills, however, the inspectors hit construction sites to ensure they weren't spilling mud into Crabtree Creek..."

Excessive levels of turbidity in our streams and waters cause a host of problems. First, turbidity significantly reduces the amount of biological activity by restricting light penetration. Second, the suspended particles causing turbidity are chemically active and typically contain high levels of phosphorus, metals, and organic chemicals. Third, when the particles do settle, they can destroy biotic habitats by accumulations of mud. And, lastly, excessive turbidity is frequently the unsightly condition that the public sees and frequently responds to in complaints. Landscape architects are involved in many aspects of runoff management, through design, implementation and construction management of land disturbing activities. We are part of the problem, but we can also be part of the solution this pervasive water quality pollution.

North Carolina's Turbidity Control Program

North Carolina's response to sediment pollution was the establishment of best management practices (BMP's) and turbidity standards associated with the Sedimentation Pollution Control Act of 1973. But, the BMP's don't work, at least in the official opinion of Judge Beecher R. Gray of the North Carolina Office of Administrative Hearings. On March 30, 2000 Judge Gray ruled that the North Carolina turbidity standard in 15A NCAC 2B .0211(3) (k), as interpreted and applied in the case Wallace Burt, Jr. et al v. DENR and Highlands Cove, 99 HER 0980,0989,1084 was void because it allowed the numerical state water quality standard for turbidity to be violated if best management practices for erosion and sedimentation control were being followed. The North Carolina turbidity standard provides for a numerical limit of 10 NTU's (Nephelometric Turbidity Units) for the subject stream, which in this case is a designated NC Trout Water.

On October 12, 2000, the Environmental Management Commission (EMC) ruled that turbidity levels in a stream may not exceed the specified numerical water quality standard for that stream even if best management practices are being followed. At the December 14, 2000 meeting of the EMC's Water Quality Committee, staff of the Divisions of Water Quality, Land Resources, Soil and Water Conservation, and Forest Resources, said that as many as 90% of the land disturbing activities that are currently reviewed by these various divisions might not meet the numerical turbidity standard despite compliance with BMP's. Since that time, the staffs have been directed to study the relationship between turbidity standards and best management practices. And, the Sedimentation Control Commission has been studying various ways to implement turbidity standards on all land disturbing activities. The Technical Advisory Committee of the Sedimentation Control Commission will be meeting this year to determine if the "state of the science" will allow for achieving 10, 25, and 50 NTU's on construction sites.

New Technology Addresses Murky Problem

"Our program is not designed to create crystal-clear water," said John L. Holley Jr., regional engineer for the state land resources division. "There's not but so much that conventional sediment control practices can do."

Why Do Normal Sediment Controls Simply Not Work?

Traditional soil erosion controls on construction sites can remove sand and larger silt particles from stormwater, but cannot effectively remove smaller silt particles, clay, and organic particles. These fine particles of clay are referred to as "colloidal particles", because they function at something like a molecular level in water. They are extremely tiny (diameter of 2 microns or less), have an immense surface area for their weight and carry negative electrical charges that attract and bond with cations (positively charged ions) in the stormwater. The negative charges and large surface area means that these particles are chemically active and likely to remain suspended indefinitely.

Certain cations, notably phosphorus ions, will create a diffused suspension making it even more difficult to settle the particles from the water. In fact, every time you run your dishwasher you creating such a suspension to keep your glasses from spotting. The can be reversed when other chemicals such as calcium are used to over power the chemical bonds causing the suspension. Calcium ions will cause the clay particles to come together and form soft aggregates that act as larger particles and begin to settle out of the water. This process is called "flocculation" and is used in water treatment and wastewater treatment plants to clarify water. However, flocculation can take 12 to 24 hours, which means that all the runoff on a construction site would need to be impounded without any discharge, treated, and held in a stilling basin until the settling process is complete. Then the stormwater must be carefully drained avoiding agitation and re-suspension of the particles.

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Turbidity from construction runoff in Crabtree Creek near Raleigh. Note the normally clear water in the side stream. Photo courtesy of Rick Dove, Neuse River Riverkeeper.

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The North Carolina Arboretum used this flocculation process during the construction of the Fredrick Law Olmstead Parkway near Asheville, NC. O'Brien Atkins & Associates and the North Carolina Arboretum wanted to enhance the environmental protection of Bent Creek, a Mountain Trout Water running parallel to the parkway. Through the use of calcium in finely ground dolomitic limestone to power the flocculation process, the turbidity of the stormwater flow leaving the construction site was significantly reduced. The project received a design Honor Award from NCASLA in 2000.

New Technologies Emerge

Now new modern polymer techniques are available that will revolutionize how we conduct site design, manage runoff, and protect the water quality of the receiving streams. The new techniques will allow us to treat, flocculate, and trap the colloidal particles in less than one minute. All of this is possible because of the use of polyacrylamides (PAM's). The PAM's are extremely powerful flocculating agents. They are commercially available from a number of distributors. The most useful approach is to purchase PAM embedded into "polymer gel block". Some of the trade names are "Floc Log" by Applied Polymer Systems, Inc. (*http://www.realpagessites.com/siltstop/page12a.html*); and "Gel-Floc" by Natural Site Solutions, Inc. (*http://www.naturalsitesolutions.com/Gel-Floc.html*). The polymer blocks are then installed in the stormwater pipes just upstream of the settling basin. The flowing water activates, mixes, and reacts with the PAM before the stormwater flows into the settling basin.

Applied Polymer Systems carries about 40 different types of Floc Logs. They select the best type of Floc Log for your particular soils and water chemistry. They prefer to do this on a project-by-project basis and ask the contractor to send in a sample of the soil and stormwater.

Dr. Richard McLaughlin of NCSU Department of Soil Science has been conducting research on soils in North Carolina using PAM's (*http://www.soil.ncsu.edu/lockers2/McLaughlin_R/index.html*).

McLaughlin has used elongated sediment basins with multiple filter fence baffles crossing the basins. Beyond the baffles, a floating shimmer is used to allow only the water near the top of the pool to discharge from the basin. The discharge from the basin then runs through a dense grass buffer prior to collection and discharge. This approach has provided the best results for the removal of colloidal particles. If properly done it can produce a very clear discharge. The results will vary depending upon the type of clay minerals present, site and climatic characteristics, facility design, and degree of maintenance. This approach should be used after traditional sediment control has already removed the sand and larger silt particles.

NCSU has periodically provided continued education courses on Sediment & Erosion Control. These workshops include presentation of Dr. Richard McLaughlin's research; for more information, visit *http://www.soil.ncsu.edu/training*.

Implications for Landscape Architects

North Carolina will likely decide to require some phased approach to achieve reductions in turbidity in stormwater leaving a construction sites. This will require a whole new level of design and management of construction sites. It may mean that water quality samples will need to be collected from rainfall events that discharge stormwater from the construction site. The State is allowed to assess fines up to $10,000 per day for water quality violations. EPA treats every local notice of violation of the erosion and sedimentation control program as a violation of the federal stormwater laws and can levy fines of up to $27,500 per day. EPA has recently cited a developer in Fairfax County, VA alleging damages due to observed plumes of turbid waters in a lake ¾-mile downstream of a new residential subdivision, despite the fact that stormwater from the project had passed through a wet detention facility that had effectively removed 85% of the sediment in the stormwater, and was constructed according to local regulations. The County has also sued and is seeking monetary damages of up to $2,400,000 to fund corrective actions.

Implementation of these new technologies will be required in order to make progress in achieving the current water quality standards in North Carolina. It will not be easy. Countless changes in construction management, many unpopular, will be required. The design of the techniques will need to be carefully fitted to each site, since no two sites will be the same. Landscape architects already embrace this level of sensitivity, but they must also now master the new scientific technologies and become promoters of the proper implementation of non-point source water quality management on construction sites.

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