





An environmental focus has been at the center of a broad expanse of programs in the Department of Soil Science for more than 40 years. During this time, research and extension activities related to water and air quality have become an increasingly important dimension of the core mission in our department. Starting in the 1970s, water quality issues in particular have led to a greater understanding of the role of soils in sustaining critical ecosystem services that are essential to our everyday lives.

Faculty contributions to the water quality arena have added to our knowledge base and led to practices that promote sound stewardship of our vital soils resource; with these contributions spanning basic to applied research across the landscape continuum. Moreover, these efforts have benefitted from strong partnerships with state and federal agencies as well as other departments at North Carolina State University. In this issue of *Soil Science Solutions*, we highlight some of our faculty who have developed innovative programs addressing a broad array of water quality issues of import in North Carolina and around the world.

Beginning at an international level, you'll discover how Dr. Matt Polizzotto is using his background in soil hydrogeochemistry to address the pervasive and serious environmental problem of arsenic contamination in shallow groundwater of Southeast Asia. Returning to North Carolina, and with sediment and turbidity emanating from stormwater runoff considered a principal water quality problem in many watersheds, you'll learn how Dr. Richard McLaughlin is developing practical ways to reduce the water quality impacts of construction site runoff. Also note the extension and research efforts in on-site treatment of residential wastewaters and their disposal through surface and subsurface systems. In North Carolina, approximately 50 percent of homes rely on septic systems to safely treat and dispose of wastewaters produced in the home. Dr. Michael Hoover -- in addition to teaching short courses for site evaluators, designers, operators, and regulators in North Carolina and throughout the United States -- is exploring the water reuse potential from decentralized water and wastewater systems. In this same realm of on-site wastewater treatment, follow the research of Dr. Alexandria Graves, a soil microbiologist evaluating the environmental impacts of failing septic systems using microbial source tracking tools.

Finally, a historical and current perspective spanning four decades will provide a broader understanding of how numerous faculty have worked at the interface of nutrient management and water quality from an agricultural viewpoint.

Collectively, these articles illustrate that effective management of our water resources requires a focus on all of the land in an entire watershed, since water pollution in our lakes, streams and groundwater is the result of cumulative impact across river basins. Research and extension programs in the Department of Soil Science will continue to be at the fore in expanding our understanding of and providing solutions for water quality issues impacting citizens of North Carolina and humankind around the world.

A handwritten signature in black ink that reads "Michael Waggoner".

## SOIL SCIENCE SOLUTIONS

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*News from the Department of Soil Science  
at North Carolina State University*

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*Matt Polizzotto works in Cambodia to understand threats to well water quality.*



*Ethan Lineberger, a student in the Polizzotto lab, collects an irrigation water sample in a Bangladesh rice field. Across the region, arsenic in irrigation water is building up in soils and entering rice plants, causing yields to decrease and threatening human health.*

and *Water Resources Research*. Last year he taught an undergraduate honors seminar titled “Global Drinking Water and Contamination: Current Trends and Future Needs.”

Matt likes to tackle these cutting-edge international research topics and global policy issues that are essential to create a sustainable future for the people of the world. He believes that his endeavors are even more exciting than scaling our highest mountain peaks.



*Audrey Matteson, a researcher in the Polizzotto lab, tests well water quality with a colleague in Cambodia. High concentrations of arsenic and manganese are making well water throughout Southern Asia unsafe to drink.*

# McLaughlin's Work Influences State and National Policy

By Barrett L. Kays

Dr. Richard McLaughlin is a professor who specializes in erosion, sediment and turbidity control. He was featured in an article, "A Water Quality Sharp Shooter," in the 2009 issue of *Soil Science Solutions*. Since that time, his team has continued to provide extension courses in a variety of practical ways to reduce the water quality impacts of construction site runoff across North Carolina and the United States. He developed the Sediment and Erosion Control Research and Education Facility (SECREF) in Raleigh, where he teaches a number of workshops. Several years ago, the North Carolina Sedimentation Pollution Control Commission adopted his advanced baffled sediment basin as the standard for all construction projects.

Last year the United States Environmental Protection Agency published its new turbidity stormwater standards for construction sites and recommended Rich's flocculation methods using polyacrylamide (PAMs) chemicals to control turbidity on construction projects across the country to meet planned numeric limits. EPA published information on Rich's methodology in the Federal Register, and he has received a significant amount of interest throughout the United States. He also received the Applied Research Award from the Soil Science Society of America and the Educational Achievement Award from the International Erosion Control Association.

Rich also has developed an innovative research program – funded by North Carolina Clean Water Management Trust Fund – to study methods to enhance infiltration on compacted soils on construction sites. Enhanced infiltration may be a soil-based approach for stormwater retention and treatment using the urban soilscapes to effectively meet stormwater discharge standards. This approach can significantly reduce runoff volume and prevent nutrients and suspended solids from reaching our streams.

Rich's research has been published in a variety of periodicals including *Transactions of American Society of Agricultural and Biological Engineers*, *Soil Science Society of America Journal*, *Journal of American Water Research Association*, *Journal of Soil and Water Conservation*, *Water Environment Research*, and *Journal of Environmental Quality*.

Rich's new approaches to turbidity control and enhanced infiltration are exciting new water quality tools for construction sites in North Carolina and across the United States. These innovative practices are applicable to both new development sites and for the reclamation of disturbed lands in urban and rural areas.



Rich McLaughlin explains the function of a porous baffle to workshop participants at the SECREF.



## DEPARTMENT WELCOMES NEW FACULTY MEMBER

Dr. Alan Franzluebbers joined the Department as a special faculty member at the rank of USDA professor. Alan serves as research ecologist at the Plant Science Research Unit in Raleigh, N.C. His research projects range in scope from those that address a specific and isolated part of the soil ecosystem to those that address broad aspects of soil-plant-animal-water-atmospheric systems within fields and watersheds.

The overarching goal of his research is to produce a quantitative understanding of how soil organisms, plants and animals interact to impact a wide range of biogeochemical processes that affect soil carbon sequestration, greenhouse gas emissions, nutrient storage and turnover, plant productivity and biophysical manipulation to improve soil functioning.

## Water Reuse is Central to Hoover's International Work

*By Barrett L. Kays*

Dr. Michael Hoover is a professor who specializes in soils, wastewater and water systems. Mike developed the North Carolina Soils and On-Site Wastewater Training Academy fifteen years ago, and his team has taught more than 50 extension courses to more than 3,000 attendees last year at 18 locations across the state.

Three years ago he was instrumental in establishing the "International Decentralized Water/Wastewater Think Tank" with partners from Australia, Canada, England, India, Ireland, Nepal, Thailand and the United States. This group is helping Mike with his greatest challenge: to promote sustainable decentralized water and wastewater systems as the 21st-century solution for both cities and rural areas in every country around the globe. Mike promotes the fact that decentralized water and wastewater systems are both substantially more economical and environmentally-friendly solutions than centralized approaches that are the norm in most of the world's metropolitan areas.

In order to accomplish this global initiative, he has partnered with United States Environmental Protection Agency, Centers for Disease Control and Prevention, the United States Bureau of Reclamation, National Sanitation Foundation and similar governmental and non-governmental organizations in other countries.

Mike's international initiative also is focused on promoting water reuse. Climate change projections throughout the 21st century are leading experts to support new innovations in water conservation and reuse. If water reuse is taken seriously, it will totally change how society values and allocates water and wastewater.

One challenging goal is to eliminate the distinction between drinking water, wastewater and stormwater, and to treat all of these sources of water to a common quality standard. This will allow decentralized systems to handle and reuse all three types of water, thus further lowering the costs. Does it really make a difference which source of water you drink if it meets the appropriate sanitation standards?

Mike serves as chair of the National Sanitation Foundation International Wastewater Technology Joint Committee, National Sanitation Foundation International Council of Public Health Consultants, and Centers for Disease Control International Expert Panel for Healthy Housing. He is currently coordinating the first national study of decentralized water/wastewater reuse for the Centers for Disease Control.



# Graves Tracks “Needle in a Haystack” Through Microbiology Research

By Barrett L. Kays



*A beautiful source of fecal pollution relaxing in the North River, Carteret County, N.C.*

Dr. Alexandria Graves recently received tenure as an associate professor and specializes in soil and environmental microbiology. Alex grew up in North Carolina, but learned at an early age that soil and medicine are interconnected during a summer program at the National University of Singapore. This led her into soil microbiology with graduate studies at Virginia Tech University and post-doc studies at Texas A&M University.

Alex joined the NC State faculty in 2005 and has focused her research on bacterial contamination of soils, water and food, with emphasis on fecal coliform bacteria, antibiotic resistance of bacteria and microbiologic tracking of bacteria. You could say she is an “expert microbiological sleuth.”

In North Carolina, she has worked on soil and groundwater contamination caused by swine waste and closure of the North River in Carteret County due to high concentrations of fecal coliform organisms. Alex is an expert at bacterial source tracking techniques, and that became essential in tracing the flow of pathogens from swine wastewater lagoons and spray irrigation systems. Alex has determined the best bacteria indicators of swine sewage -- along with the scientifically valid methods to use for regulatory compliance investigations -- since the application of her methods is used by both the plaintiff and defendant in litigation cases.

Alex approaches all of these problems as an expert environmental detective painstakingly tracing the bacterial contamination up main stem rivers, up countless small tributaries, and across the land to the sources of pollution. It’s like finding a microscopic needle in a watershed-sized haystack.

Alex’s research has been published in a variety of scientific journals including *Journal of Environmental Quality*, *Journal of Environmental Engineering*, *Microbiological Research*, *Water Science Technology*, *Environmental Research Journal*, *Journal of Applied Microbiology*, and *Livestock Science*.

Alex also is interested in solving some very intractable problems, such as bacterial contamination in low income communities and new, innovative low-cost ways to repair failing septic systems on severely limiting soils in our rural areas.

# Interface of Nutrient Management and Water Quality

By Deanna Osmond

The Department of Soil Science at North Carolina State University has worked at the interface of nutrient management and water quality for more than 40 years, beginning with Dr. Wendell Gilliam measuring nutrient losses from fertilized and non-fertilized agricultural fields in the mountains of North Carolina. He was one of the first researchers in the United States to measure the ability of riparian buffers to reduce nitrogen contributions from fields into streams.

Researchers have continued to document riparian buffer effectiveness and provide nitrogen reduction values to the N.C. Department of Environment and Natural Resources. Our Department was instrumental in the mid-1990s in developing the nutrient management training required for animal waste operators. During this time, Dr. David Crouse helped develop the training module and worked with producers during certification and afterward to ensure extension materials were provided for continued certification of these farmers. By virtue of these training efforts, nutrients from animal waste used to grow crops are now applied at the appropriate rates, thereby protecting water quality.

As the poultry and swine industries have changed management practices and feed ingredients that directly affect the nutrient content and mineralization potential of animal waste, research and extension programs have continued to ensure that we have a better understanding of the nutrients available in these materials. Given the relatively high phosphorus content in animal waste, especially from poultry, phosphorus losses to surface waters can be a concern as elevated phosphorus concentrations can result in water quality problems in phosphorus-sensitive rivers and streams. Faculty from the Department of Soil Science, along with the NC State Department of Biological and Agricultural Engineering, were responsible for developing the North Carolina Phosphorus Loss Assessment Tool (PLAT) required by the USDA Natural Resources Conservation Service. This index is considered one of the most defensible in the U.S. because it is based on extensive and long-term research developed by researchers in our department.

With Neuse River Basin regulations requiring all sectors, point source and non-point source, to reduce nitrogen coming into the river by 30 percent, Dr. Deanna Osmond led a team that developed the required Nitrogen Loss Estimation Worksheet (NLEW) and later the phosphorus accounting tool (PTAC) for



*Protecting water quality through exclusion fencing and nutrient management, Chatham County, N.C.*

the Tar-Pamlico River Basin. In conjunction with this effort, and working with former soil science faculty member Dr. Steve Hodges, the team developed a farmer nutrient management program to be delivered in regulated river basins by local extension agents. More than 5,000 farmers in North Carolina's regulated river basins (Neuse, Tar-Pamlico and Jordan) have been trained in nutrient management.

At the national level, Osmond led a team of nine scientists in recently reviewing 13 federally funded projects that tried to relate water quality change to conservation practice implementation. This project, known as the National Institute of Food and Agriculture Conservation Effects Assessment Project (NIFA CEAP), identified key lessons that could increase the effectiveness of conservation planning and implementation relative to water quality protection so that resources are used more judiciously. These lessons have been presented in a recently published book, fact sheets and webinars, as well as through conversations with conservation planning organizations.

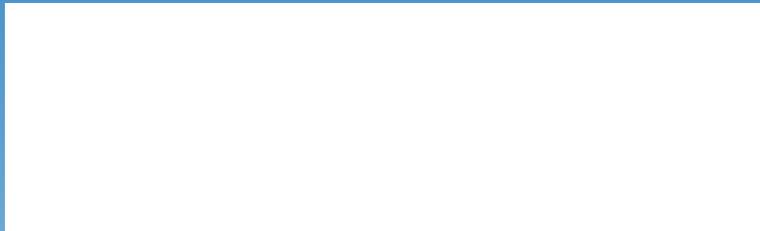
Collectively, the efforts described above illustrate why the Department of Soil Science has been a recognized leader for more than four decades in understanding the relationship between water quality and nutrient management while providing solutions to farmers and state and federal agencies.



## SOIL SCIENCE SOLUTIONS

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- expand research programs
- augment professional training programs
- foster the development of partnerships with industry, business and government organizations

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