Water Resources Research Institute

of The University of North Carolina

ANNUAL PROGRAM

CURRENT RESEARCH JULY 1, 2003, TO JUNE 30, 2004

Box 7912, N.C. State University
Raleigh, NC 27695-7912
Phone: (919) 515-2815
Fax: (919) 515-2839
www2.ncsu.edu/ncsu/CIL/WRRI

The Water Resources Research Institute is a unit of The University of North Carolina system headquartered in Jordan Hall on the North Carolina State University campus.

It is one of 54 state water institutes authorized by the Water Resources Research Act of 1964 to administer and promote federal/state partnerships in research and information transfer on water-related issues.

The mission of WRRI is threefold: to identify the state's ever-changing research needs, to motivate and support research by qualified scientists, and to provide for technology transfer.

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New research

Reckhow leads design team for prototype hydrologic observatory based on Neuse River

Under a grant from the Consortium of Universities for the Advancement of Hydrologic Science (CUAHSI), WRRI Director Dr. Kenneth H. Reckhow is leading a team of scientists in designing a Hydrologic Observatory (HO) in the Neuse River watershed. The design for the Neuse HO will serve as a paper prototype for hydrologic observatories to be developed with planning grants from CUAHSI. CUAHSI's initiative to advance the understanding of the hydrosphere and its interactions with the atmosphere, geosphere, and biosphere is being funded by grants from the National Science Foundation.

The concept of a hydrologic observatory is that of a river-basin-scale field laboratory that collects, analyzes, and synthesizes long-term data across multiple media (including streams, groundwater and atmosphere) and spatial scales (such as field plots and watersheds). It is CUAHSI's goal to establish and maintain a network of HOs where interdisciplinary research can be conducted on pressing hydrologic problems, such as the effects of climate change and human activities on water resources.

Observatories at this spatial scale and degree of complexity have never before been attempted by hydrologic scientists. Therefore, a prototype will be developed to test the concept and its feasibility in a real world setting. The Neuse River Basin is well suited for the conceptual design of a hydrologic observatory because it has the appropriate size and diversity of physiography and land cover to provide a meaningful test of the concept, and because a great deal of hydrologic data has been and continues to be collected in the basin.

The network of HOs envisioned by CUAHSI will address consistent objectives aimed at solving problems related to the land-surface/atmosphere interface, the land-surface/groundwater interface, the groundwater/surface water interface, and hydrologic extremes. The Neuse River prototype will be designed to produce answers to four questions which represent a distillation of the CUASHI science agenda and are sufficiently specific to serve as the basis of an experimental design:

Land-surface/atmosphere interface: Does water cycling within the basin contribute significantly to the precipitation that falls in the basin, and do these feedbacks intensify wet and dry periods?

Land-surface/groundwater interface: How do atmospheric and surficial processes control groundwater recharge and how can this knowledge be used to develop quantitative estimates of recharge at the scale of thousands of square kilometers?

Groundwater/surface water interface: How can the exchange of water between the regional aquifer, alluvial aquifer, and surface water be quantified and its residence time in each domain estimated, as these properties control many biogeochemical properties and influence aquatic ecosystems.

Hydrologic extremes: How do human modifications of the local hydrologic system (both directly and indirectly by changing the land surface) influence the likelihood and intensity of drought and floods relative to global climatic phenomenon such as ENSO?

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WRRI BOARD OF DIRECTORS

Members of the Board of Directors of the Water Resources Research Institute are appointed by the President of The University of North Carolina system. The Board establishes Institute policy, and the Chairman of the Board makes appointments to the Technical Committee.

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WRRI ADVISORY COMMITTEE

The Advisory Committee of the Water Resources Research Institute is composed of representatives from state and federal programs, local government, industry, environmental organizations, private consultants, water and wastewater treatment plants, the university research community and others. The committee advises the Institute on the need for water-related research in North Carolina, the region, and the nation.

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Kenneth H. Reckhow, Director, WRRI (Ex-Officio)

2003 - 2004 INSTITUTE RESEARCH PRIORITIES

At its meeting in May 2002, the WRRI Advisory Committee selected the following topics as priority water-related research needs in North Carolina

1. Determination of the sources and impacts of sediment and evaluation of sediment control technologies

2. Examination of the relative effectiveness of enforcement, incentives, and training for reducing sediment impacts on water resources.

3. Identification of the range and trade-offs among natural functions that can be restored in stream and wetland systems impacted by man.

4. Evaluation of the water quality impacts of phosphorous-based nutrient management (e.g. PLAT) for land application of animal waste and wastewater treatment biosolids.

5. Examination of the fate of pharmaceuticals, endocrine disrupters, and regulated drinking water contaminants discharged in wastewater.

6. Examination of the administrative, institutional, legal, regulatory and health-related constraints on reuse of wastewater.

7. Quantification of the avoided costs (for example, forgone advanced treatment costs) of source water protection and the long-term cost and benefits of maintaining high-quality water resources.

8. Determination of how the economic relationships between the price of water and the demand for water can be most efficiently incorporated in water rates.

9. Identification and quantification of mass loadings and evaluation of the pollution reduction effectiveness of best management practices for pasture land.

New research

Jennings evaluating fine bedload sediment removal technologies

Fine sediment washed into mountain streams from past logging operations smothers aquatic insects and covers gravely stream bottoms, reducing food for adult trout and driving out oxygen that trout hatchlings need to survive. Across the North Carolina mountains, logging has destroyed untold miles of trout habitat, including many miles of streams on the Balsam Mountain Preserve in Jackson County. Balsam Mountain Preserve is a 4,400-acre residential development that markets itself as a "human settlement within a park" but suffers a legacy of sediment-impacted streams and faces the potential of more sedimentation from golf course and home construction. In an effort to restore and protect its trout streams, Balsam Mountain Preserve is cooperating with NCSU researchers and the N.C. Department of Environment and Natural Resources (NCDENR) to demonstrate and evaluate new erosion and sediment control technologies as well as technologies designed to reverse the effects of historic stream sedimentation. At two streams on the Balsam Mountain Preserve, WRRI Associate Director Greg Jennings and graduate student Mike Shaffer are testing the effectiveness of equipment designed to measure and remove fine bedload sediments moving downstream and to remove sand and silt covering stream substrate.

Under a Clean Water Act Section 319 grant from NCDENR, Jennings and Shaffer are deploying sediment collectors manufactured by Streamside Systems, LLC* in Sugarloaf Creek below a golf course construction site. The collectors are expected to protect the stream from possible sedimentation from the golf course site and improve the stream by removing previously deposited fine bedload sediments. In addition, the collectors—one of which sorts sediments into three sizes—are designed to allow researchers to quantify the materials transported as bedload. The focus of the project is on evaluating the ability of the collectors to remove bedload sediments, but the researchers hope that sediment measurements from the collectors, along with data from concurrently deployed Helley-Smith samplers, will provide basic information on sediment budgets that will be useful for restoring many additional miles of trout streams degraded by historic sedimentation.

The researchers will also test the effectiveness of a "sand wand" in removing sands and silts but leaving stones and gravel to rehabilitate stream substrate. Macroinvertebrates will be sampled and substrate characteristics will be recorded upstream and downstream and before and after the operation. On successive 100 to 300-foot reaches of Cashie Branch, the investigators will use the sand wand to project jets of water to flush areas of the stream bottom where fine sediments have settled and are not being moved as bedload. In theory, this process will mimic natural flushing that would take decades or centuries and will remove finer particles to allow more oxygen to penetrate into the stream substrate. Collectors will be deployed above the restoration reaches to prevent sedimentation from upstream sources. Again, the quantity of material removed will be measured and the manpower expended per length of reach cleaned will be recorded so that costs of restoration and economic returns to the landowner can be estimated.

Sediment Removal Demonstration and Evaluation for Mountain Streams (50330)
Gregory D. Jennings, WRRI
February 27, 2003, to December 31, 2004
Funded by the U.S. EPA and the N.C. Department of Environment and Natural Resources with matching support provided by Streamside Systems, LLC, and Balsam Mountain Trust.

** Mention of products does not constitute endorsement.*

Neuse Hydrologic Observatory Prototype *continued*

The design team is composed of scientists from within the Neuse Basin and beyond the basin who are experts in each of the hydrologic subdisciplines as well as in the necessary assisting specialities such as information systems and measurement technology. The design exercise will last 8 months and will be an iterative process to develop a design for the study of each of the design questions as well as two questions of regional interest.

The hydrologic observatory prototype is expected to be presented in a special session at the Fall 2003 meeting of the American Geophysical Union. A call for proposals for planning grants for hydrologic observatories is expected to be issued in January 2004.

Members of the design team are:

Dr. Chris Duffy, Penn State (hydroclimatology)
Dr. Jay Famiglietti, UC-Irvine (atmosphere-land interactions)
Dr. David Genereux, NCSU (groundwater-surface water interaction)
Dr. John Helly, UC-San Diego (information systems)
Dr. Witold Krajewski, Iowa (hydrometeorology)
Dr. Dianne McKnight, Colorado-Boulder (bigeochemistry)
Dr. Bridget Scanlon, Texas Bureau of Economic Geology (infiltration/vadose zone hydrology)
Dr. Len Shabman, Resources for the Future (economics/social science)

Development of a Prototype Long Term Hydrologic Observatory (HO) for the Neuse Watershed (50332)
Kenneth H. Reckhow, Water Resources Research Institute (Ken_Reckhow @ncsu.edu)
April 1, 2003, to March 31, 2004
Funded by the Consortium of Universities for the Advancement of Hydrologic Science (CUAHSI)

New research

NCSU engineer aims to force more water out of wastewater sludge

Thirty to fifty percent of the cost of treating wastewater goes to managing the treatment residue—sometimes called biosolids but more often called sludge. Wastewater sludge is made up of solids (primarily bacteria, protozoa, viruses and other microorganisms) and water. Usually, sludge is 85% water, so dewatering—or removing water from sludge—can cut the volume and weight of sludge that has to be disposed and therefore the cost of disposal.

Water in sludge is basically two kinds: free and bound. Free water moves freely between individual sludge particles, is not adsorbed or bound to the particles, and is not influenced by capillary forces. Free water is easily removed by traditional dewatering processes, such as centrifuging or belt filter pressing. However, traditional processes do not remove bound water and leave a still-watery sludge that may be only 10% to 15% solids.

In this project, Dr. Francis de los Reyes of the NCSU Department of Civil, Construction, and Environmental Engineering will use his hypothesis about the mechanisms that bind water in sludge to discover a way to free bound water so that it can be removed by conventional dewatering processes.

Dr. de los Reyes thinks that cells in sludge behave like gels—attracting water molecules that layer themselves near both inside and outside cell walls (structured water)—and that well-known phenomena can be borrowed from gel science to remove bound water from sludge. His project has two objectives: (1) to confirm that various types of sludges have different levels of free water and that dewaterability is dictated by free water and (2) to find a way (or ways) of pretreating sludge that will break apart cells (cell lysis) and/or disrupt structured water to convert bound water to free water that can be removed by conventional processes.

To accomplish the first task, the investigator will collect sludge samples from a number of Piedmont area municipal wastewater treatment plants. The inherent dewaterability of sludge samples will be determined using an established centrifuge test that the investigator intends to refine. Levels of free and bound water in the samples will be quantified. The investigator will develop statistical correlations that are expected to support his concept of moisture distribution. Results will be related to results of other studies to provide a broader understanding of sludge dewaterability.

To accomplish the second task, the investigator will apply a variety of physical (sonication, heating) and chemical treatments (addition of oxidants, acids, bases, polymers, cations) and combinations or physical and chemical treatments to sludge samples. These treatments will be aimed at (1) breaking apart cells, (2) forcing a phase transition, and (3) both cell lysing and phase transition. The ultimate aim is to find simple triggers that will improve dewaterability of sludge at a reasonable cost.

Improving Dewatering of Wastewater Biosolids Using Innovative Approaches (70205)
Francis de los Reyes III
(fldelosr@eos.ncsu.edu)
Department of Civil, Construction and Environmental Engineering, NC State University
June 1, 2003, to May 31, 2004
Funded by WRRI

Multi-institutional team will evaluate use of nutrient criteria for water quality standards

State water quality standards are intended to protect designated uses of waterbodies. However, standards are not enforced through direct assessment of the designated uses but through a measurable criterion that serves as an indicator of use attainment. It appears that most states have used best scientific judgment to select water quality criteria associated with designated uses but have not undertaken modeling and/or statistical analysis to rigorously assess the relationship between a criterion and use. Therefore, the reliability of water quality criteria as indicators of use attainment is questionable. If water quality criteria are poor indicators of designated use attainment, then the belief that water quality standards are protecting designated uses is mistaken and millions of dollars devoted to developing total maximum daily loads (TMDLs) for waterbodies in violation of state standards may be wasted.

There is no doubt that nitrogen and phosphorus enrichment of surface waters is a precursor to undesirable events that affect designated uses—including nuisance algal blooms, species changes, and fishkills. However, questions remain concerning the specific levels of nitrogen and phosphorus that lead to undesirable outcomes and whether other criteria, such as chlorophyll a, might be more appropriate for certain situations/waterbodies. In this project, a team of investigators will evaluate the scientific basis for nutrient criteria as indicators of designated use associated with eutrophication in waterbodies.

Drs. Robert Wetzel of UNC-Chapel Hill, Dr. Hans Paerl, of the UNC-CH Institute of Marine Sciences, and Dr. Curtis Richardson of Duke University will assist Dr. Kenneth Reckhow of WRRI in identifying and acquiring water quality data sets covering waterbodies in several ecoregions (represented by the Neuse River Estuary, Chesapeake Bay, Lake Okeechobee and Cayuga Lake) that will allow examination of nutrient –phytoplankton relationships. The trio of aquatic scientists will provide hypotheses on functional relationships that will be expressed as graphical models and tested using statistical modeling procedures. Relationships within a single waterbody over time and among waterbodies will be examined. Models

continued

New research

WCU geologist will use lead isotopes to trace orchard pesticide in creek ecosystem

In the late 1980s, most of a former apple orchard in Haywood County in western North Carolina was sold for residential development. By the late 1990s it was evident that extensive use of pesticides more than 80 years had contaminated the site with lead, arsenic and organochlorines (from lead arsenate, DDT, DDE, and benzene hydrochlorides). The U.S. EPA excavated soils near the most contaminated homes under emergency measures, and in 2001 placed the site on the National Priorities List for Uncontrolled Hazardous Waste Sites under the Superfund Program. However, much of the original site remains contaminated.

In 2001, Dr. Jerry Miller of the Department of Geosciences and Natural Resources Management at Western Carolina University, oversaw an investigation using lead isotopic fingerprinting techniques to determine if lead attached to soil particles was moving offsite and into one of three tributaries of Richland Creek that drain the site. Sampling of steam bed sediments revealed a range of isotopic values and suggested that introduction of lead from contaminated soils to the channel bed sediments of Richland Creek was minimal. However, whole fish sampling showed that three species had lead contamination with the isotopic signature of lead arsenate. All species showed about the same level of lead arsenate contamination, but within species, the variation of isotopic ratios was significant. Additional analysis of rainbow trout taking separate samples from tissue, organs and bone showed that only bone exhibited the lead isotopic signature consistent with lead arsenate.

From this research, Miller and his colleagues hypothesized that fish in Richland Creek are exposed to pulses of lead arsenate contamination when rain washes contaminated soil into tributaries and then fish ingest or absorb lead arsenate during these brief periods of exposure. However, he thinks that lead arsenate is cleared from soft tissue by excretion fairly quickly while it bioaccumulates in bone over the life of the fish. If this can be shown to be the case, then fish bone can serve as a biomarker of long term lead contamination in ecosystems.

To test his hypothesis, Miller's research team will collect samples of creek water during low, moderate and high runoff events and have suspended sediments analyzed to determine if systematic changes in lead concentrations and isotopic values occur. Isotopic values will be compared to isotopic composition of known lead sources in the area (natural and contaminant sources) to determine the cause for the changes in isotopic values.

There is some evidence that lead from human-produced products binds less tightly to soil particles than lead from natural sources and is, therefore, more bioavailable. To test this possibility, Miller will perform sequential extraction on samples of both contaminated and "clean" sediments from the research site and surrounding area to assess the relative percentage of lead that is bioavailable.

To test the hypothesis that lead is cleared from soft tissue but bio-accumulates in bone of fish, Miller and fisheries biologist Peter Galbreath will conduct experiments to determine tissue-specific rates of lead uptake and detoxification. In one experiment, they will expose fingerling rainbow trout to a constant low concentration of lead. In the other, they will expose the fish to pulsed high concentrations of lead to provide a total exposure level that is about equal to the constant exposure test. In the constant-exposure experiment, the dorsal muscle, liver and vertebral column of fish will be sampled and analyzed for lead isotopic values periodically over a 4-week exposure period to determine the rate of uptake. Then, the lead contaminated water will be replaced with clean water, and the remaining fish will be periodically sampled to determine the rate of detoxification. In the pulsed-exposure test, fish will be sampled after each of 8 six-hour contaminant pulses for 4 weeks to determine uptake. Then, pulses will be discontinued and periodic sampling will be done to determine detoxification.

The results of this study will be important for fingerprinting of lead arsenate and lead contaminants in general and could help to provide a long-term biomarker of lead loadings to aquatic systems.

The Role of Flood Flows on the Lead Isotopic Composition of Stream Waters, Suspended Sediments, and Rainbow Trout Downstream of Lead Contaminated Soils in Barber's Orchard (70201)
Jerry R. Miller (jmiller@wcu.edu) Department of Geosciences and Natural Resources Management, and Peter F. Galbreath, Director of the Mountain Aquaculture Research Center, Western Carolina University
March 1, 2003 to February 29, 2004
Funded by WRRI and the U.S. Geological Survey

Water Quality Standards *continued*

will be constructed and statistical procedures selected by Dr. Reckhow and Dr. Sandra McBride of Duke University. Statistical analyses will be conducted by students at N.C. Central University under the direction of Dr. Russell Gosnell

A follow-on study will then be designed either to replicate results from the first phase in other locations or, if the first phase cannot be completed because of insufficient data, to address data gaps. A third phase in which pilot field studies will be used to evaluate phase two designs is anticipated but not included in this project.

Water Quality Indicators: Nutrient Impacts on Chlorophyll or Algae Species Composition (50341)
Kenneth H. Reckhow, WRRI
June 1, 2003, to May 31, 2005
Funded by the Water Environment Research Foundation

New research

UNC-Greensboro biologists will study nitrogen retention in restored urban streams

There is a strong effort across the country to restore water quality by restoring degraded streams. Most often stream restoration projects are aimed at stabilizing the stream channel, improving the functioning of the floodplain, establishing forested riparian buffers, and improving stream corridor aesthetics. However, to be useful for improving water quality, stream restoration projects should also be aimed at restoring ecological functioning of streams.

North Buffalo Creek in Lindley Park, Greensboro. The stream was restored by the NC Department of Transportation in 2000. Photo courtesy of graduate student Erin C. Lynam, who samples the site.

Among the most important ecological services of streams is nutrient processing. Recent research has shown that small streams incorporate nitrogen into biota more quickly (that is in a shorter distance from point of discharge) than large streams. This discovery implies that efforts to improve water quality should focus on restoring the functioning of small, low order streams such as those draining urban areas. Restoring nutrient processing in such streams, however, may require addressing storm flows and sedimentation.

In this project, Dr. Anne Hershey and Dr. Paul Mou of UNC-Greensboro will conduct a set of studies to evaluate the extent to which a typical stream restoration project has renewed the nutrient processing capability of an urban stream in Greensboro, NC.

Building on their experience in using the stable nitrogen isotope 15N to trace anthropogenic nitrogen through the food web of an urban stream, the investigators will trace and compare nitrogen uptake in restored urban streams, non-restored urban streams, and forested streams in the Greensboro area.

The researchers will begin the project by sampling macroinvertebrates and water quality in three streams of each type. Then, in one stream of each type, they will measure uptake length for ammonium. Uptake length is the distance traveled along a stream reach by a nitrogen molecule in solution before it is incorporated into algae or bacteria. At a given discharge, the shorter the uptake length, the greater the biological demand for nitrogen. If restoration is effective in renewing nutrient processing in a stream, the uptake length should decrease. Comparing the uptake lengths of the three stream types will reveal the extent to which the restored stream has recovered nutrient processing function.

To learn how nutrients are processed in the three stream types—and assess the importance of storm flows and sedimentation in dampening processing—the investigators will conduct 15N tracer addition experiments. These experiments will allow them to quantify the uptake of ammonium, movement of algal-derived nitrogen into the dominant primary consumers in the food web, and release of ammonium and nitrate from the streambed through mineralization and nitrification.

The results of this research will provide information for managers of restoration programs on the success of current stream restoration projects in restoring ecological functioning, and will help identify needs for planning future projects.

Evaluation of Ecological Function in Restored Urban Streams (70202)
Anne E. Hershey (Anne_Hershey @uncg.edu) and Paul P. Mou, Department of Biology, UNC-Greensboro
June 1, 2003, to May 31, 2004
Funded by WRRI

New research

NCSU hydrogeologist will investigate groundwater age and flow and inter-aquifer exchange in Black Creek and Upper Cape Fear Aquifers

The Black Creek and Upper Cape Fear confined aquifers stretch across large portions of North Carolina's Central Coastal Plain. Clear evidence of over-withdrawals of groundwater from these aquifers —with consequent land subsidence, permanent lost of aquifer capacity, and salt water intrusion— led the N.C. Environmental Management Commission to approve rules creating the Central Coastal Plain Capacity Use Area (CCPCUA) in 2002. The rules provide for possible reductions in withdrawals of up to 75 percent over the next 16 years.

The basic hydrogeologic features of the Black Creek and Upper Cape Fear aquifers are reasonably well known. It is also known that, under pre-development conditions, groundwater in the aquifers flowed from the major recharge areas in the western Coastal Plain toward the coast but that the coastward pattern has been strongly disrupted by pumping. However, because other important aspects of groundwater flow (e.g. rate) and age in these aquifers are unknown, there is no firm basis for quantitatively predicting hydraulic responses of the aquifer to recovery of water levels achieved by the CCPCUA. In this pilot study, Dr. David Genereux of NC State University will provide some of the flow and age data needed to construct models of the aquifers that can predict responses to recovery. At the same time, the study will advance the science of age-dating tracers for use in aquifers.

Genereux will use established ^{14}C tracer methodology to date groundwater in the aquifers. Ages determined by ^{14}C dating will be compared to ages that have been estimated using physical characteristics (pre-development head gradients and hydraulic conductivity values from pumping tests) to evaluate the physically based understanding of flow in the aquifers. This comparison will be useful for calibrating future groundwater models. Groundwater age measurements based on ^{14}C will also serve as a point of comparison for future age measurements. Changes in groundwater age over relatively short periods can help assess transient hydraulic effects associated with pumping and inter-aquifer exchange.

Simultaneously with ^{14}C dating, Genereux will measure the concentration of ^{4}He in groundwaters. If a well-defined relationship between the two can be established, then ^{4}He could be a simpler, less expensive method for age dating groundwater in these aquifers.

Finally, Genereux will analyze samples for tritium (^{3}H) to look for evidence of relatively young groundwater (less than 40 years) at depths where groundwaters are expected to be hundreds to thousands of years old. Presence of tritium would indicate possible rapid downward leakage across upper confining layers caused by increased head gradients.

This study will also help fill an important gap in knowledge of deep Atlantic Coastal Plain aquifers, providing a bridge between tracer work in states to the south and north.

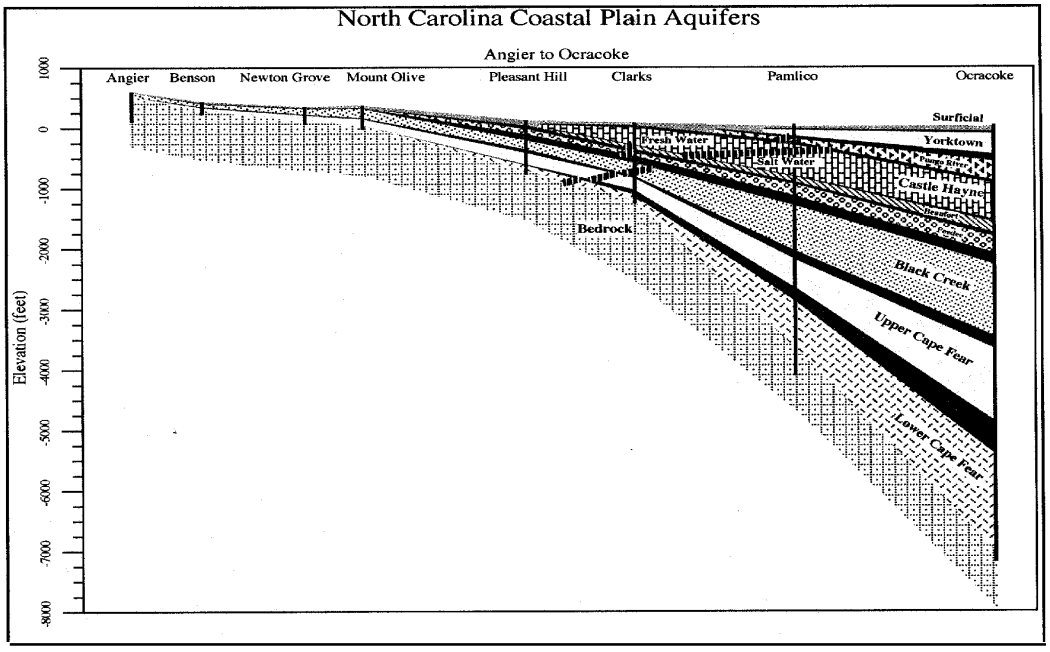

Figure from Central Coastal Plain Capacity Use Investigation Report. N.C. Division of Water Resources, November 1998.

Pilot Project on Groundwater Dating in Confined Aquifers of the North Carolina Coastal Plain (70203)

David Genereux
(genereux@ncsu.edu), Department of Marine, Earth, and Atmospheric Sciences,
NC State University

May 10, 2003 to May 9, 2004

Funded by WRRI

New research

Duke economist will plumb landowner decision-making about restoring wetlands

In an effort to recover the ecological functions of lost wetlands, a number of government programs are providing incentives for landowners to restore converted wetlands on their property. In North Carolina, the programs include the U.S. Department of Agriculture's Wetland Reserve Program, the North Carolina Wetlands Restoration Program, and the Conservation Reserve Enhancement Program, a combined state and federal program available in select areas of the state. Besides being administered by different agencies, these programs have different goals and differ in the variety of options they offer to participating landowners in terms of the payments, the types of contracts, the length of contracts, and allowed uses of enrolled lands. If the program managers had insight into how individual landowners make decisions about participating in the programs, they could configure their programs to reach landowners whose decisions will be most compatible with a specific program's goals. However, there is currently little understanding of how the various terms of the wetlands restoration programs appeal to individual landowners.

In this project, Dr. Randall A. Kramer of the Duke University Nicholas School of the Environment will develop models that predict how individual landowners with specific characteristics weigh the options of various programs to make decisions about program participation. He will then use these models to perform policy analysis that will determine the most efficient configuration of program attributes for wetland restoration programs with various goals and objectives.

Using a data set collected from landowners in several watersheds in North Carolina, Kramer will utilize Hierarchical Bayes (HB) analysis to investigate how individual landowner characteristics (age, education, farm size, farm type, etc) interact with wetland restoration program attributes (lease length, payment level, allowable land use, etc.) to determine the choices made by potential program participants. HB statistical analysis enables the estimation of individual-level models and more accurate targeting of individuals for various purposes. It is widely applied in today's highly segmented marketing environment as a method to predict individual consumer choices and to design new products. This study will be the first application of HB analysis to predicting landowner behavior in the context of natural resource management.

After developing individual models of landowner decision-making, Kramer will construct an econometric policy simulation model and perform policy simulations that predict potential enrollment in different kinds of wetland restoration programs. For the policy simulations, the individual-level parameters estimated in the HB analysis will be used to divide the data into segments based on the differing characteristics of the landowners. These segments will identify clusters of landowners with similar attitudes, preferences or socio-economic characteristics. These clusters can then be used for the targeting of different permutations of restoration programs. The simulations will also be capable of determining the program payments necessary to achieve a target number of acres enrolled in programs with a specified mix of attributes.

Designing Programs to Improve Water Quality through Wetlands Restoration
(70204)
Randall A. Kramer (kramer@duke.edu),
Nicholas School of the Environment,
Duke University
April 1, 2003 – March 31, 2004
Funded by WRRI

UNC-Chapel Hill investigator will monitor campus construction to support better practices

As a result of voter approval of a $3 billion bond, construction is gearing up on campuses throughout the University of North Carolina system. At UNC Chapel Hill, officials have adopted a policy to minimize the impacts of stormwater on campus streams during and after construction. To this end, they have developed a plan that specifies a set of BMPs to be used to control runoff from construction sites as well as BMPs to control post-construction runoff. Dr. Lawrence Band, Voit Gilmore Professor of Geography, as well as other professors and a number of graduate and undergraduate students will use construction/reconstruction of the Chapel Hill central campus as a laboratory to examine how sources of sediment and nutrients vary over the pre-construction, construction, and post-construction periods and how they are affected by soil moisture and groundwater levels in areas of different cover and activities. Parts of central campus date to the 1790s and the existing drainage and sanitary infrastructure are in need of major upgrading. The area is drained by Meeting of the Waters Creek, a tributary of Morgan Creek, which flows in to Jordan Lake, an important regional water supply. The creek is listed as impaired. Band and his students will investigate the possible contribution of aging sewer lines to water quality impairment and will conduct monitoring and analysis to supplement that being done by the UNC Facilities Management. They will also examine stream denitrification rates, stream channel morphology, and sediment dynamics. They will also conduct sampling to develop spatial patterns of soil moisture over the year for correlation with runoff sources. Activities in the first year will establish a baseline dataset for tracking water quality and quantity

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WRRI Continuing Research

Hydrological and Biogeochemical Investigations of Riparian Buffers in the Piedmont and Blue Ridge Regions of North Carolina (70194) *Craig J. Allan, Department of Geography and Earth Sciences, and Jy S. Wu, Department of Civil Engineering, UNC-Charlotte. (Mar 1, 2002, to June 30, 2004) Funded by WRRI and the U.S. Geological Survey.* The investigators have received a second year of funding to continue assessing the effectiveness of vegetated riparian buffers in controlling the export of nitrogen, phosphorus, suspended sediment, and fecal coliform bacteria from agricultural operations to surface waters in the western Piedmont and Blue Ridge regions of North Carolina.

A Systematic Evaluation of Polyacrylamide for Sediment and Turbidity Control (70196) *Richard A. McLaughlin, Department of Soil Science, NC State University (Mar 1, 2002, to Feb 29, 2004) Funded by WRRI and the U.S. Geological Survey.* The investigator has received a second year of funding to continue to investigate practices that will aid polyacrylamide (PAM) in accomplishing under field conditions the same turbidity reduction it has accomplished under highly controlled experimental conditions. During this year, he plans to test additional brands of PAM logs, to test other forms of PAM as well as a possible system to deliver PAM to basins, and to test a filter bag that may have the potential to replace small sediment traps.

Reduced Cost Strategies for Regional Integration of Surface and Ground-water Use (70195) *Gregory W. Characklis, Department of Environmental Sciences and Engineering, UNC-Chapel Hill. (Mar 1, 2002, to Feb 29, 2004) Funded by WRRI and the U.S. Geological Survey.* The investigator has received a second year of funding to continue constructing a model that reflects all the costs of conjunctive use of surface and ground water in the N.C. Central Coastal Plain Capacity Use Area, to calibrate and verify the model for selected test areas, to evaluate minimum costs of water supply for individual communities, and to generate minimum regional cost scenarios.

Detention and Export of Phosphorus and Sediment in Vegetated Piedmont Filter Zones Bordering Agricultural Fields (70198) E. Carlyle Franklin and Dennis W. Hazel, Department of Forestry, and Wayne P. Robarge, Department of Soil Science, NC State University. June 1, 2002, to December 31, 2003. Investigators continue research to discover how vegetated filter zones trap and cycle phosphorus. They are also demonstrating a phosphorus fractionation procedure that can be applied successfully across nearly all soils within North Carolina and used to characterize soils and runoff sediments for designing forest buffer zones.

Geochemical Tracers of Water Movement between the Castle Hayne Aquifer, Associated Shallow Aquifers, and Surface Waters in Brunswick and New Hanover Counties, North Carolina (70192) *Terri L. Woods, Department of Geology, East Carolina University. (Mar 1, 2001, to Dec 31, 2003) Funded by WRRI.* The investigator continues evaluating the chemical evolution, vertical movement, and horizontal flow of groundwater in the Castle Hayne and Peedee aquifers and the potential for nutrient flux from groundwater into coastal surface water.

One-Meter Resolution Mapping and Monitoring of Stream Riparian Buffer Zones and Adjacent Land Use and Land Cover (70197) *Dr. Siamak Khorram, Center for Earth Observation, and Dr. James D. Gregory, Department of Forestry, NC State University. (Mar 1, 2002, to Aug 31, 2003) Funded by WRRI.* The investigators continue the effort to develop procedures to characterize and map stream riparian buffer zones and provide highly detailed classification and mapping of land use and land cover in adjacent areas based on one-meter resolution satellite data.

Water Quality and Quantity Impacts of Urban Form: A Comparative Analysis of Compact and Low-Density Developments (70200) *Philip R. Berke, Rhonda Marie Ryznar, and Joseph A. MacDonald, Department of City and Regional Planning, UNC-Chapel Hill and Daniel E. Line, Nancy M. White, Michael V. Holmes, and Kat Oury, NC State University. (May 1, 2002, to Dec 31, 2003) Funded by WRRI.* In the first year of this project, the investigators collected data on how 100 compact and low-density developments in the Southeast addressed sensitive open space protection and restoration, riparian buffer protection, techniques for reducing impervious cover, treatment of stormwater runoff through landscaping, and treatment of stormwater runoff through best management practices, as well as the capacity and commitment of local agencies to monitor and enforce development regulations. They are now completing the second phase of the study, aimed at designing development scenarios (based on information collected in the survey), applying the scenarios to a demonstration sub-basin threatened by urbanization, and comparing the results.

Influence of Nutrient Reduction on Phytoplankton Primary Production, Standing Stock, and Community Composition in the Lower Neuse River (70199) *Stephen C. Whalen, Department of Environmental Sciences and Engineering, UNC-Chapel Hill. (Jun 1, 2002, to Feb 29, 2004) Funded by WRRI and the Lower Neuse Basin Association.* The investigator continues the effort to use nutrient dilution bioassays to investigate whether a 30% reduction in nitrogen might trigger blooms of blue-green algae in freshwater portions of the Neuse River.

North Carolina Water Quality Workgroup

In 1999, the N.C. General Assembly established the North Carolina Water Quality Workgroup to select and recommend collaborative studies between the N.C. Department of Environment and Natural Resources and constituent institutions of The University of North Carolina that "collectively close knowledge policy gaps with regard to the State's water quality." Funds in the amount of $183,350 were appropriated to fund research projects recommended by the Water Quality Workgroup for the current year. WRRI is providing administrative support for the Water Quality Work-group, facilitating the call for proposals, proposal review, and contract administration. New research funded by the Water Quality Workgroup is described on pages 10 and 11. Continuing projects are listed on page 12.

Erosion and Sedimentation Control Research

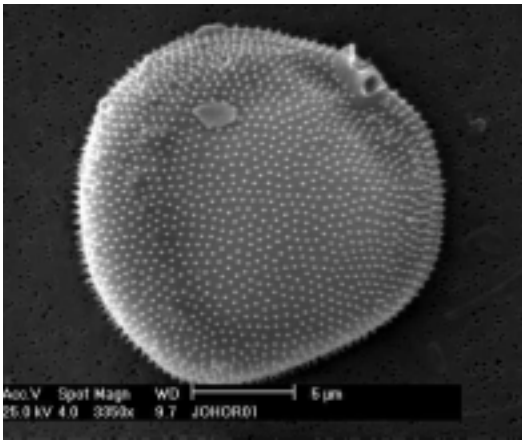
In its 1999-2001 biennial budget for State government, the N.C. General Assembly provided a one-time appropriation of $260,000 to fund research aimed at evaluating and improving erosion and sedimentation control technology and application. The N.C. Sedimentation Control Commission (SCC) was charged with selecting projects to be funded.

In 1999, the SCC voted to provide about $136,000 to fund start up of the Sediment and Erosion Control Research and Education Facility (SECREF) at NC State University's Lake Wheeler Road Field Laboratory and contracted with WRRI to administer the remainder of the funds for individual research projects to be selected by the SCC. The final project funded by this special appropriation is concluding this fiscal year. Dr. Richard A. McLaughlin of NCSU will complete project 50325 ***Evaluation of Temporary and Permanent Ground Cover Establishment Methods for Erosion Control***.

New research

UNC-Wilmington biologist continues surveillance for toxic algae in New River

In a previous investigation funded by the Water Quality Workgroup, Dr. Carmelo Tomas of UNC Wilmington—working with the N.C. Division of Water Quality (DWQ)—found 18 species of harmful or potentially harmful algae in the New River. All of these species can produce blooms (rapid and massive buildup that discolors water), and a number were found to be toxic to fish. With three species, a sensitive ELISA assay confirmed the presence of the potent neurotoxin brevetoxin, formerly considered to be produced only by the "red tide" organism (*Karenia brevis*). There have been no indications that any of the species have caused problems related to human health or natural resources, but their presence may indicate deteriorating water quality and suggests the potential for economic damages to fishing and recreation



In the New River a sequence of harmful algal blooms began in January with the dinoflagellate Prorocentrum minimum. Elevated abundances persisted until March in an area from Wilson Bay through Morgan Bay. The investigator found no evidence of harmful effects of P. minimum in the New River, although it is a known toxic species that caused distress to hundreds of persons in Japan and was found toxic at bloom proportions in Europe. Photo courtesy Dr. Carmelo Tomas.

In the current project, Tomas will again work with DWQ to conduct more focused monthly sampling to confirm previous identifications and investigate the source of the organisms. Since the earlier study showed that species recur in similar areas, Tomas will examine sediments as potential sources. If sediments are found to harbor resting stages of algal species, then "hatching" studies will be conducted to provide an estimate of their persistence in the sediment. The resting stages will also be photographed to use in the series of plankton identification sheets that Tomas is producing.

Tomas will also conduct a nutrient bioassay with water from Wilson Bay to examine the role of nutrients in stimulating the natural algal populations in the New River. Nitrogen, phosphorus, silica, vitamins and trace metals will be tested separately and in combinations for their ability to stimulate blooms. Species composition of blooms will be determined to provide some indication of the selective effect of the different nutrients.

Harmful Algal Species from the New River – Composition and Dynamics
(50337)
Carmelo R. Tomas (tomasc@uncwil.edu), UNC-Wilmington.
July 1, 2003, to June 30, 2004.
Funded by the N.C. Water Quality Workgroup

Other New Water Quality Workgroup Research

Impact of Microbial-Particle Interaction on Microbial Fate and Transport in Stormwater (50335) *Gregory W. Characklis (charack@email.unc.edu), Mark D. Sobsey, and Otto D. Simmons, II, Department of Environmental Sciences and Engineering, UNC-Chapel Hill, July 1, 2003, to June 30, 2004. Funded by the N.C. Water Quality Workgroup*

Stormwater runoff has been identified as a major source of microbial contamination of surface waters. In order to develop effective strategies or BMPs to reduce microbial contamination from runoff, it is necessary to understand partitioning of microorganisms between the particulate and "free" phases in the water column. Microbes associated with particles potentially settle out more quickly, while those in the free phase generally travel much greater distances. In addition, particle-associated organisms tend to remain viable and infectious for much longer than their free-phase counterparts. The objective of this project is to characterize microbial partitioning in urban stormwater runoff. Multiple stormwater samples taken throughout the progression of at least three storms will be collected from sites characteristic of residential, commercial, and industrial land use in the Upper Neuse and Cape Fear watersheds. Samples will be filtered into aliquots of three particle size fractions: > 100 um, 100 to 10 um and <10 um. Each size fraction will be analyzed for particulate mass and a suite of bacterial, viral, and protozoan parasite indicator organisms. Survival rates for each microbial indicator organism will be evaluated within each size fraction. Data on survival, size, and density of particle/microbial pairings will provide a basis for modeling microbial transport and fate. Modeling will allow for more accurate estimates of the distance over which upstream sources can impact downstream water quality, as well as evaluations of the effectiveness of current stormwater treatment measures.

Hydrologic, Biologic, And Geomorphic Character of Headwaters Streams in North Carolina (50334) *James D. Gregory (jim_gregory@ncsu.edu), Department of Forestry, NC State University. July 1, 2003, to June 30, 2004. Funded by the N.C. Water Quality Workgroup*

Headwaters streams play a key role in the hydrologic and water quality functions of watersheds. In the Piedmont, headwaters streams drain up to 85% of the area of small watersheds. They carry most of the surface and subsurface runoff to perennial streams and, therefore, most of the sediments, dissolved constituents, and organic carbon input to the stream network. In spite of their importance, headwaters streams in North Carolina have not been extensively studied. This project will address the dearth of knowledge about the characteristics and ecological functions of small, headwaters streams in the state. Stable forested watersheds in the three physiographic regions of the state will be studied (as resources permit) to determine the geomorphic characteristics of drainage basins and of the channels and hyporheic zones of ephemeral and intermittent streams, to determine the character of riparian zones adjacent to headwaters streams, to compare the flow regimes of intermittent streams to perennial streams, to compare the structure of the benthic macroinvertebrate populations of ephemeral and intermittent streams to that of the perennial streams to which they discharge, to test the NC Division of Water Quality (NCDWQ) stream classification methodology to determine if all indicators contribute to stream origin determinations and to test the use of high resolution remotely sensed data to improve the mapping of headwaters streams. The results will help NCDWQ improve maps and develop desktop applications for determining locations of headwaters streams, assist in developing standards for mitigating losses of headwaters streams, and contribute to developing an interconnected network of protected land and water that maintains natural ecological processes and supports native species.

Ferry Mon: Ferry-based Monitoring and Assessment of Water Quality for North Carolina's Pamlico Sound (50336) *Hans W. Paerl (hpaerl@email.unc.edu), UNC-CH Institute of Marine Sciences. July 1, 2003, to June 30, 2004. Funded by the N.C. Water Quality Workgroup*

Despite its importance as an essential fisheries habitat, North Carolina's Pamlico Sound has not been monitored as intensively or extensively for changes in water quality as its tributary estuaries or the Chesapeake Bay, and there are many significant gaps in knowledge base about Pamlico Sound. Monitoring following hurricanes Dennis and Floyd in 1999 showed chlorophyll concentrations of 30 µg/L, approaching the 40 µg/L indicative of cultural nutrient enrichment. Monitoring the following year showed concentrations had dropped to 5-15 µg/L. However, these are isolated monitoring results, and the absence of a long-term systematic monitoring program makes it difficult to ascertain the long-term impacts of flooding or other events on the sound. Following the 1999 hurricanes, the UNC Institute of Marine Sciences, Duke University, the N.C. Department of Environment and Natural Resources, and the N.C. Department of Transportation began developing an innovative, automated water quality monitoring system aboard ferries that traverse the Pamlico Sound. The system tracks surface water quality status and trends by recording data across temporal and spatial scales. In this project, the investigator will use the ferry-based system to (1) calibrate in situ estimates of chlorophyll a with in vitro measurements, (2) help identify and fill existing data voids regarding the Pamlico Sound, and (3) incorporate existing and future ferry-based data into a geo-database and generate summary information for the dissemination of the results. The primary thrust of the project is the use of chlorophyll a as a reliable environmental indicator that can be linked to aerial spectral surveys and associated watershed, estuarine, and oceanic studies.

In 1985, WRRI in cooperation with several of North Carolina's larger cities established the North Carolina Urban Water Consortium to provide a program of research and development and technology transfer on water problems that urban areas share. In 1998, several members of the partnership formed a special group to sponsor research and technology transfer on issues related to urban stormwater management. Through these partnerships, WRRI helps individual facilities and regions solve problems related to local environmental or regulatory circumstances. The N.C. Urban Water Consortium (http://www2.ncsu.edu/ncsu/CIL/WRRI/uwc/) and Stormwater Group (http://www2.ncsu.edu/ncsu/CIL/WRRI/stormwater/) are administered by WRRI. Participants support the program through annual dues and enhancement funds and guide the program through representation on an advisory board, selection of research topics, participation in design of requests for proposals, and review of proposals. Current Consortium members are the Cities of Burlington, Charlotte, Durham, Fayetteville, Greensboro, Greenville, High Point, Raleigh, Wilmington, and Winston-Salem and the Orange Water and Sewer Authority. Members of the Stormwater Group are the cities of Charlotte, Durham, Fayetteville, Greensboro, High Point, Raleigh, Wilmington and Winston-Salem. Current research projects sponsored by these partnerships are described on the following pages.

Continuing Research Funded by the NC Water Quality Workgroup

- Method Development to Determine Fecal Contaminant Source Information for TMDL Assessments (50300) *Helene A. Hilger, UNC-Charlotte. Ending Dec 31, 2003.*
- Urbanization and Decline in Water Quality: Do Statistically Identifiable Thresholds Exist? (50316) *James F. Gilliam, NC State University. Ending Dec 31, 2003.*
- Determining the Effectiveness of Shrub Buffers to Reduce Nitrate-Nitrogen from Agricultural Fields in a Coastal Plain Setting (50318) *Deanna Osmond, David Hardy, J. Wendell Gilliam, and Robert O. Evans, NC State University. Ending Dec 31, 2003.*
- Application of DRAINMOD-Based Nitrogen Loading Models to Lower Coastal Plain Watersheds (50321) *George M. Chescheir, Glenn P. Fernandez, and Devendra M. Amatya, NC State University. Ending March 31, 2004.*
- Effect of Riparian Buffer Zones on Water Quality and Biodiversity in Piedmont Urban Streams (50319) *Anne E. Hershey and Paul P. Mou, UNC-Greensboro. Ending April 30, 2004.*

UNC-CH researcher will model UWC members' expected compliance with Stage 2 DBP rule

In 2002 public water systems that use surface water and serve more than 10,000 people began monitoring water in their distribution systems for compliance with the Safe Drinking Water Act's Stage 1 Disinfectants and Disinfection Byproducts Rule. Disinfection byproducts (DBPs) are compounds formed when water containing organic matter is treated with chlorine to kill bacteria and other microorganisms. High concentrations of DBPs have been linked to bladder, rectal and colon cancer as well as reproductive and developmental adverse health effects. The Stage 1 DBP rule determines compliance with DBP limits by calculating the running annual averages of samples from all monitoring locations across a drinking water distribution system. However, levels of DBPs in drinking water can vary significantly from one point in a distribution system to another, and national survey data suggest that some drinking water customers are receiving water with high levels of DBPs even when their systems as a whole are in compliance with the Stage 1 rule. Therefore, EPA has proposed to improve control of DBPs in drinking water systems. A new Stage 2 DBP rule has been proposed that, when promulgated, will require that

compliance with maximum contaminant levels for two groups of DBPs (total trihalomethanes and haloacetic acids) be calculated for each monitoring location in the distribution system rather than as a systemwide average as in the Stage 1 rule. Drinking water systems that use a disinfectant will be required to conduct an evaluation of their distribution systems to identify locations with high DBP concentrations, and these locations will be used as sampling sites for Stage 2 compliance monitoring. The monitoring approach under Stage 2 is referred to as the locational running average (LRAA).

In this project, Dr. Philip C. Singer, Director of the Drinking Water Research Center in the School of Public Health at UNC-Chapel Hill, will use empirical DBP models and existing data to predict what LRAAs at points identified by distribution system evaluations are likely to be for each member of the Urban Water Consortium. The models were developed as part of the regulatory negotiation process for the Stage 2 rule and contain temperature and residence times as variables. These variables can be used to predict DBP concentrations at different seasons during the year and at distant locations. Information from the models will give consortium members an idea of the degree of compliance with Stage 2 rules that they can expect. The investigator will also recommend a sampling program to verify results of the models and will recommend individual potential treatment strategies to achieve compliance.

Compliance with Stage 2 DBP Rules for Urban Water Consortium Utilities (50345)
Philip C. Singer (phil_singer@unc.edu), UNC-Chapel Hill
Sept 1, 2003, to Dec 31, 2004
Funded by the N.C. Urban Water Consortium

City of Charlotte partners with NCSU researchers on study of effectiveness, efficiency, and maintenance needs of stormwater BMPs

As part of its stormwater management efforts under the NPDES Phase I Stormwater Program, the City of Charlotte continually monitors the performance of various stormwater BMPs within various land uses. To produce scientifically defensible monitoring results useful in research and suitable for publication and submittal to the USEPA/ASCE National BMP Database, Charlotte Stormwater Services has teamed up with NCSU researchers Bill Hunt and Jonathan Smith on a three-year BMP monitoring and study project. From field screening of public and private stormwater BMPs in Charlotte and Mecklenburg County, the investigators will select up to 12 of various types of BMPs deployed in various land uses for study. They will develop a general BMP monitoring protocol for the city, a two-year monitoring/study plan for the project, and a specific monitoring plan for each BMP in the study to ensure results suitable for determining BMP cost-benefit, efficiency and maintenance requirements. The investigators will provide direction for acquiring and on-site management of installation of monitoring equipment and will train Charlotte Stormwater Services personnel on monitoring protocols. When monitoring results are in, they will analyze the data and prepare a paper documenting the study for publication, national discussion, and submittal to the USEPA/ASCE National BMP Database. Using information from literature and other similar studies in North Carolina, the researchers will develop maintenance plans for each BMP monitored in the study and a general maintenance document for various BMP types. Study results will be available in 2006.

Monitoring Study and Maintenance Plan Development for 12 Stormwater BMPs for the City of Charlotte (50344)
William Hunt (Bill_Hunt@ncsu.edu) and Jonathan T. Smith, NC State University
June 27, 2003, to December 30, 2006
Funded by the City of Charlotte

Study of membranes to treat wastewater for reuse enters Phase II

In an earlier project, Drs Francis A. DiGiano and Michael D. Aitken of the UNC-CH Department of Environmental Sciences and Engineering reviewed literature and surveyed wastewater treatment facilities to determine the state-of-the-art of membrane applications for wastewater treatment, with particular emphasis on reuse applications. Based on the results of this earlier project, the investigators will now install pilot plant equipment and evaluate factors critical to further development of membrane processes for wastewater treatment. The pilot plant evaluation will compare side-by-side performance of two dual or integrated membrane systems on the same secondary effluent. One pilot plan will use microfiltration pretreatment for reverse osmosis (RO); the second pilot plant will use ultrafiltration pretreatment for RO. The evaluation will determine the ability of the processes to achieve water quality required for specific reuse applications.

Membrane Treatment of Secondary Effluent for Subsequent Use, Phase II (50346)
Francis A. DiGiano (fran_digiano@unc.edu) and Michael D. Aitken, UNC-Chapel Hill
Sept 1, 2003, to Oct 31, 2004
Funded by the N.C. Urban Water Consortium and the Water Environment Research Foundation

NCSU investigators will evaluate "realistic yield expectation" for wastewater biosolids

Matching nutrient application rates—from fertilizers or animal waste or wastewater biosolids— to yield potential can help reduce the risk of excessive environmental loading of plant nutrients. Most crop nutrient recommendations and regulation of nutrient application are based upon the "realistic yield expectation (RYE)" for the specific crop. Because many variables contribute to yield, RYE is best determined from field records of

Continued page 14

Urban Water Consortium

"Realistic yield expectation" continued

yields over several years. However, if field records are not available, RYE is determined by consulting tables that are prepared by State Land Grant Universities giving RYE for crops grown on specific soil types. Municipalities are questioning whether these estimates, developed from studies of the behavior of chemical fertilizers and animal waste in soils, are valid for wastewater biosolids, which are generated by various treatment processes that affect their chemical makeup and nutrient content.

In this project, Drs Noah Ranells, James Green and Wei Shi of the NCSU Department of Crop Science will focus on verification of RYE for biosolids through field and laboratory studies. The investigators will summarize available literature on differences between biosolids and other sources of plant nutrients, determine characteristics of biosolids produced by each member of the Consortium, evaluate soil resources available to Consortium members, and evaluate soil quality dynamics related to historical biosolids application and the effects of constituents on plant growth soil parameters.

Biosolids and Realistic Yield Expectations (50338)
Noah N. Ranells, James T. Green, Jr. and Wei Shi, NC State University
March 15, 2003, to December 31, 2003
Funded by the Urban Water Consortium

Urban Water Consortium Continuing Research

- Investigation of the Occurrence of Residual Antibiotics and their Metabolites in Drinking Water (50307) Howard Weinberg, Department of Environmental Sciences and Engineering, UNC-Chapel Hill, and Michael T. Meyer, U.S. Geological Survey. Sept 1, 2001 to Nov 30, 2003.
- Further Evaluation of Pesticide Residue Levels in the Water Supply Watersheds of the City of Winston-Salem (50311). Ross B. Leidy, Department of Toxicology, NC State University. July 1, 2001, to Dec 31, 2003.
- A Feasibility Study for Developing Real-Time Flood Forecast Systems (50315) Jy S. Wu, Department of Civil Engineering, UNC-Charlotte. May 1, 2001, to Oct 31, 2003.
- RIVERNET Monitoring (50328). William J. Showers, Department of Marine, Earth, and Atmospheric Sciences, NC State University. Jan 1, 2003, to Dec 31, 2003. Funded by the City of Raleigh.

UNC-Chapel Hill campus construction monitoring *continued*

changes and will identify processes and conditions responsible for runoff and for retention. The results will provide knowledge about variable sources of nutrients and sediments as well as the local factors and mechanisms controlling the production of runoff and the cycling and transport of nutrients to streams. This knowledge will be useful for designing watershed restoration practices aimed at promoting nutrient retention and reducing downstream sedimentation.

Sources, transport and fate of sediment and nutrients from a redeveloping watershed: Hydrology of the central UNC campus (70206)
Lawrence E. Band, UNC-Chapel Hill
June 1, 2003, to May 31, 2004
Funded by WRRI

TECHNOLOGY TRANSFER

WRRI disseminates information and promotes adoption of new technology and practices through publication of newsletters and technical completion reports on its projects, support of a World Wide Web site and an email list serve, and sponsorship and cosponsorship of conferences, workshops and seminars. The Institute also conducts technology transfer projects under grants from other organizations.

WRRI reports are distributed to libraries, and summaries of reports are published in the WRRI newsletter, and distributed to interested research faculty, other state water institutes, and relevant government agencies. Single copies of publications are available to North Carolina residents at a cost of $4 per copy prepaid ($6 per copy if billed) and to nonresidents at a cost of $8 per copy prepaid ($10 per copy if billed). A listing of all WRRI technical reports is available on the website or by calling WRRI. Summaries of more than 100 WRRI technical reports are available on the Institute's website at http://www2.ncsu.edu/ncsu/CIL/WRRI/reports/index.html. During the past year the following peer-reviewed technical completion reports were published:

- **Using Natural and Landscaped Buffers to Reduce Pollutant Loading from Agricultural Runoff.** Report 340. December 2002. Richard A. McLaughlin and J. Wendell Gilliam, NCSU

- **Seeking Science-based Nutrient Standards for Coastal Blackwater Stream Systems**. Report 341. August 2002. Michael A. Mallin, Lawrence B. Cahoon, Matthew R. McIver, and Scott H. Ensign, UNC-Wilmington.

- **Predicting Long-Term Wetland Hydrology from Hydric Soil Field Indicators.** Report 342. August 2002.

Michael J. Vepraskas, Xiaoxia He, David L. Lindbo, and R. Wayne Skaggs, NCSU.

■ **The Economics of Structural Stormwater BMPs in North Carolina.** Report 344. May 2003. Ada Wossink and Bill Hunt, NCSU.

■ **Assessment of Changing Land-Use Practices on Basin Sediment Yields and Provenance in Western North Carolina Using Multivariate Finger Printing Techniques.** Report 345. July 2003. Jerry Miller, Lawrence Kolenbrander, Mark Lord and Steven Yurkovich, Western Carolina University.

■ **Sedimentation and Water Quality in Lake Jeanette, Greensboro, NC.** Report SRS-22. November 2002. Craig A. Stow, James W. Wintergreen, and Rebecca D. Cason, Duke University.

■ **Establishing Spatial and Temporal Trends of Atmospheric Nitrogen Deposition in Eastern North Carolina.** Report SRS-23. December 2002. David R. Whitall and Hans W. Paerl, UNC-CH Institute of Marine Sciences.

New Publication Policy. Effective March 2003, WRRI instituted a new policy regarding publication of technical completion reports. To fulfill the obligation of providing a final project completion report the Principal Investigator may submit a refereed journal publication. A refereed publication that meets all of the following criteria will be accepted in fulfillment of the final project completion report obligation:

(a) the refereed journal article must be from a journal generally recognized in the field;

(b) the article must report the work done under the WRRI grant;

(c) 25 reprints of the article must be provided along with clear evidence that the journal will allow WRRI to distribute the reprints to interested individuals and institutions without payment of any fees or royalties to the journal or its publisher.

(d) WRRI is acknowledged as a/the source of funding, and the WRRI report number is listed (in the final, accepted version).

Under this new policy, WRRI accepted two journal articles in fulfillment of completion report obligation during FY 2002-2003:

■ **Optimizing ferric sulfate coagulation of algae with streaming current measurements.** David S. Briley, CH2M Hill, and Detlef R.U. Knappe, NCSU. Published in *Journal AWWA* 94(2): 80-90. Accepted as final report on WRRI projects 50215 and 50217, *Optimization of Treatment to Mitigate Impacts of Algae and Algae Control on Finished Water Quality* by Detlef Knappe, Sarah Liehr and JoAnn Burkholder, NCSU. Report WRRI-2003-JA1.

■ **Tracing Nitrate Transport and Environmental Impact from Intensive Swine Farming Using Delta Nitrogen-15.** Jonathan D. Karr, Duke University; William J. Showers and J. Wendell Gilliam, NC State University; and A. Scott Andres, University of Delaware. Published in *Journal of Environmental Quality* 30 (4):1163-1175. Accepted as final report on WRRI project 70157, *Stable Nitrogen Isotopic Tracer ($\delta^{15}N$) of Nitrogen Sources to Surface and Groundwaters near Animal Production Facilities*. William J. Showers, NC State University. Report WRRI-2003-JA2.

Newsletters: WRRI produces two newsletters. The ***WRRI NEWS*** is published every other month and sent to nearly 4,200 federal and state agencies, university personnel, multi-county planning regions, city and local officials, environmental groups, consultants, businesses and individuals. The *NEWS* regularly covers a wide range of water-related topics from current federal and state legislation and regulatory activities to new research findings. The *WRRI NEWS* is available free to residents of North Carolina. To be added to the mailing list, call or write WRRI.

Access to the web version of the newsletter and other announcements is provided through the WRRI-News listserve.

The Institute also produces a quarterly newsletter, ***Sediments***, published by the N.C. Sedimentation Control Commission to provide information and assistance to the regulated community and to facilitate communication among personnel of state and local erosion and sediment control programs. Current circulation is about 5,700. This newsletter is free. To be added to the mailing list contact WRRI.

WRRI's Internet homepage (http://www2.ncsu.edu/ncsu/CIL/WRRI) provides on-line access to the *WRRI News*; the WRRI Annual Program; technical report summaries; the Water Resources Research Seminar Series schedule; a water resources research expertise directory; information on workshops, conferences, calls for papers, and public hearings; and the Neuse River Homepage, a gateway to information on the web about the Neuse River at **http://www2.ncsu.edu/ncsu/CIL/WRRI/neuse.html.**

WRRI-News list serve. WRRI also operates an email list serve that has become an important communications vehicle for the water community in North Carolina. The list serve provides almost daily information on conferences, workshops, calls for papers, grant opportunities, job opportunities, public hearings, public meetings, and recently posted material on the WRRI website, including the WRRI News. Currently there are nearly 450 subscribers to the listserve. To be added to the list serve, send an email message to mj2@lists.ncsu.edu. Put nothing in the subject line. In the body of the message say only and exactly:

subscribe WRRI-News

2003 - 2004 Water Resources Research Seminar Series

Seminars will be presented at 11 am on Fridays. Seminars will be presented on the NCSU Campus, on the UNC-Chapel Hill campus, on the Duke University campus, or in the Archdale Building in downtown Raleigh. Updates on specific locations of seminars at Chapel Hill and Duke will be made to the WRRI website and will be included in email announcements. Email announcements will be sent to the WRRI-News list serve about 4 weeks prior to each seminar and a reminder will be sent about 1 week before each seminar. Professional Engineers and Land Surveyors can receive one Professional Development Hour for attendance. Questions regarding location or other logistics should be directed to Julie_Mason@ncsu.edu. Questions about seminar content should be directed to Greg_Jennings@ncsu.edu.

September 19, 2003
1132 Jordan Hall, NCSU campus
Dr. Helene Hilger, UNC-Charlotte
"Water Reuse in North Carolina"

October 10, 2003
Room 1301, McGavran-Greenberg Hall, UNC-Chapel Hill
Dr. Bill Hunt, NC State University
"Innovative Stormwater Best Management Practice Evaluations"

November 7, 2003
1132 Jordan Hall, NCSU campus
Dr. Jerry Miller, Western Carolina University
"Sediment Sources and Impacts on Water Quality in the North Carolina Mountains"

January 23, 2004
1132 Jordan Hall, NCSU campus
Dr. Greg Characklis, UNC-Chapel Hill
"Regional Water Supply Management in North Carolina"

February 13, 2004, Ground Floor Hearing Room, Archdale Bldg, Downtown Raleigh
Dr. Bob Rubin, NC State University
"Land Application of Municipal Biosolids"

March 5, 2004,
1132 Jordan Hall, NCSU campus
Dr. Craig Allan, UNC-Charlotte
"Hydrology and Water Quality Associated with Restored Riparian Forests in the Piedmont and Blue Ridge of North Carolina"

April 23, 2004
TBA, Duke University campus
Dr. Larry Band, UNC-Chapel Hill
"Land Use & Water Quality"

STUDENT INTERNSHIPS

WRRI coordinates internship programs which provide college students opportunities to work with the following government agencies to gain practical experience in various areas of environmental protection:

- N.C. Division of Pollution Prevention and Environmental Assistance
- N.C. Division of Land Resources, Land Quality Section
- U.S. Geological Survey
- N.C. Division of Soil and Water Conservation

2003 - 2004 WORKSHOPS AND CONFERENCES

Land Use and Water Quality Interactions Using GIS. Sept 8, 2003, College of Textiles Bldg, NCSU Centennial Campus. With the N.C. Water Resources Association (NCWRA).

Erosion and Sediment Control Basic Planning and Design Workshop. Oct 15-16, 2003, Hickory, NC. With N.C. Sedimentation Control Commission (SCC) and N.C. Land Quality Section (LQS), Division of Land Resources.

Erosion and Sediment Control Basic Planning and Design Workshop. Oct 29-30, 2003, New Bern, NC. With SCC and LQS.

The Neuse River Basin: Five Years of Progress. Nov 19-20, 2003, New Bern, NC. With NCSU, Neuse River Education Team, NC Assoc. of Environmental Professionals, and Soil Science Society of NC.

Water Reuse. Dec 1, 2003, College of Textiles Building, NCSU Centennial Campus. With the NCWRA.

Morgan Creek and Little Creeks Local Planning Initiative. Feb 2, 2004. With the NCWRA.

Advanced Erosion and Sediment Control Planning and Design Workshop. Wilmington, NC. Feb 2004. (Location and dates TBA). With the SCC and LQS.

Southeast Erosion and Sediment Control Workshop. March 18-19, 2004. Charlotte, NC. With the International Erosion Control Association Southeast Chapter, the NCSU Dept. Soil Science, the SCC and NC LQS.

Annual Water Resources Research Conference, Mar 30 - 31, 2004. McKimmon Center, Raleigh.

Stormwater: Emerging Issues for Local Communities. April 19-21, 2004. Asheville, NC. With USEPA, NCSU, and N.C. Department of Environment and Natural Resources.

Southeastern Regional Conference on Stream Restoration. June 21-24, 2004, Winston-Salem, NC. With the NC Stream Restoration Institute.