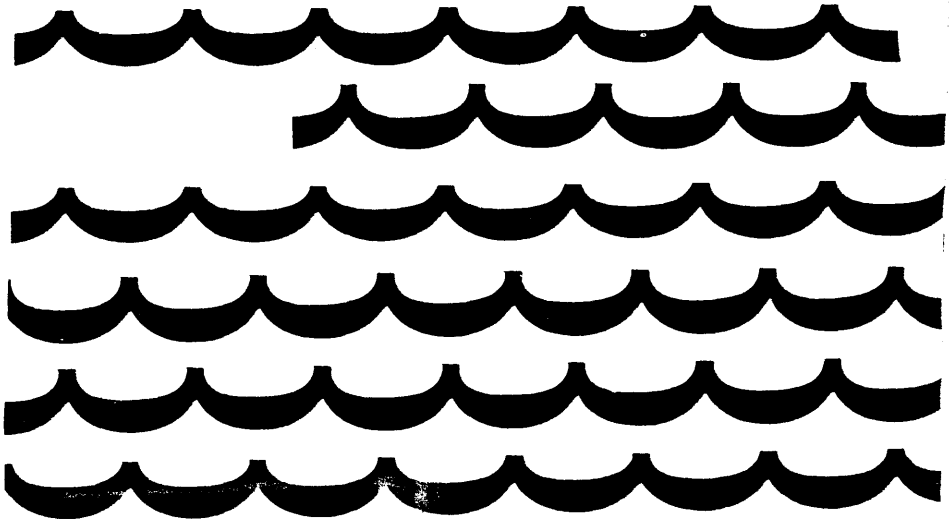
1990-1991 Program

Water Resources Research Institute of The University of North Carolina



INSTITUTE STAFF:

David H. Moreau
Director

Robert E. Holman
Associate Director

Jeri Gray
Technology Transfer Specialist

Linda Lambert
Administrative Officer

Eva W. Tew
Secretary

Frances P. Yeargan
Accounting Clerk

The Institute

The Mission: To identify research needs, to motivate and facilitate research, and to provide for the dissemination of new knowledge and transfer of technology

The University of North Carolina Water Resources Research Institute was established in 1964. A unit of The University of North Carolina 16-member System, the Institute is located in Jordan Hall at North Carolina State University.

The mission of the Institute 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.

Findings from research funded by the Institute help local, state, and federal agencies make better decisions in managing water resources.

To formulate a research program responsive to state water resources problems, the Institute works closely with the North Carolina Department of Environment, Health, and Natural Resources and other agencies.

An Advisory Committee representing state and federal agencies, industry, agriculture, the public at large, and local government provides program guidance and review. A Technical Committee of university faculty representing many disciplines also lends professional expertise to Institute programs and activities, particularly in research.

North Carolina's Water Resources

Increases in demand for water-based services, increases in waste generation, and land-use changes all affect the characteristics of North Carolina's water resources.

While agriculture and forestry continue to be major enterprises in North Carolina and continue to have major impacts on water quality, the urbanization of the state continues apace. The recruitment of each new industry or business and the development of each new resort area brings an increase in the use of water and water-based services, an increase in the generation of waste products, and changes in land use that affect the characteristics of the state's natural resources.

The problem is not just one of increasing magnitude. New technology spawns new kinds of threats to public health and the environment, and advances in science are making those threats more apparent. Moreover, the mix of agricultural, industrial, and urban activities is affecting the state's water resources in ways that have not been sufficiently explored.

It is all too easy to overstate the impacts of these changes and to suggest that the state faces a crisis in water management. That is not the case. However, it is fair to say that the state faces an unprecedented demand on its resource base, and events such as the droughts of 1986/1988 and the declining quality of the state's valuable estuarine areas are reminders of the critical importance of the water resource to the economy and environment of North Carolina.

Just as the state faces unprecedented demand for water, it enjoys unprecedented public support for protection of water resources.

Just as the state faces unprecedented demand for water, it also enjoys unprecedented public support for regulations, local government agreements, and technologies to protect that resource. Recently the North Carolina General Assembly has devoted much attention to environmental issues, and a number of important laws aimed at protecting water resources have been passed. Public pressure for solution of a

variety of environmental problems is growing, as are friction among water resource users and the frustration level among regulators and resource managers trying to mediate among users.

While a water management crisis may not exist in North Carolina, demand has never been greater for research findings that assist and support legal, regulatory, and management decision making.

Priorities

With these circumstances in mind, the Institute Advisory Committee set priorities for Institute research for the current year. Those priorities are grouped under the three broad categories of urban water management, surface water, and groundwater.

Urban Water Management

Within the general category of urban water management are several topics of special concern to North Carolina: watershed protection, treatment of drinking water and wastewater, management of urban stormwater, management of small systems, and regional management of supplies.

Surface Water

Although many of the priorities under the category of urban water management are related to surface waters, the set of concerns about surface water transcends that category. There are three problems related to surface waters in need of special attention from the research community. They are (1) the fate of toxic substances in streams and estuaries and their impacts on aquatic life; (2) evaluation of the impacts of building and operating impoundments on the aquatic life of small streams and evaluation of policies for maintaining or augmenting low flows in those streams; and (3) the potential effects of climate change on the availability of surface water.

Groundwater

Among the most important groundwater research priorities are developing methods for predicting the potential for groundwater contamination by pesticides, developing cost-effective methods for cleaning up contamination from leaking underground storage tanks, formulating siting criteria and cost-effective containment methods to prevent pollution of groundwater by sanitary landfills, and assessing the potential for contamination of groundwater by substances in wastewater treatment plant sludges applied to land.

Support

In 1989-90, support for the Institute came from the U.S. Geological Survey through the Water Resources Institute Program (WRIP) and individual matching grants and support from the State of North Carolina through The University of North Carolina System. This was supplemented by the Urban Water Consortium, contracts with New Hanover County, the Solid Waste Section of the North Carolina Department of Human Resources, the Divisions of Land Resources and Environmental Management of the North Carolina Department of Environment, Health, and Natural Resources, the U.S. Department of Agriculture's Soil Conservation Service, and the U.S. Environmental Protection Agency.

1990-91 PROJECTS

New Research

Evaluation of Long-Term Institutional and Financial Approaches for Maintaining Stormwater Management Systems (70110)

While many of the engineering and design problems related to urban stormwater management are adequately understood, a number of questions concerning implementation and the long-term functional integrity of stormwater management systems need to be addressed. Answering these questions is of critical importance because the U.S. EPA is scheduled to promulgate urban stormwater management regulations in 1990 and because the Federal Emergency Management Agency will soon be encouraging community stormwater management as part of the National Flood Insurance Program.

In this project, investigators will survey local governments and consultants in North Carolina and will conduct technical literature analyses to answer the following questions: (1) How does stormwater facility design relate to the cost and ease of long-term maintenance? (2) What are the most frequent and important causes of stormwater facilities failure and what can be done to mitigate those causes? (3) Have effective policies been developed to deal with disposal of material dredged from detention and retention ponds? (4) How often must maintenance procedures be performed and what is the cost of maintenance for various stormwater facilities? (5) What are the advantages and disadvantages of "preventive" versus "as-needed" approaches to stormwater management system maintenance? (6) What is the appropriate division of responsibility between the public and private sectors for maintenance of components of an urban stormwater management system? (7) What are the most cost-effective methods of providing stable, long-term financing of the maintenance of stormwater management systems?

PRINCIPAL INVESTIGATORS: Drs. Raymond J. Burby and Edward J. Kaiser, Department of City and Regional Planning, University of North Carolina at Chapel Hill
STARTING DATE: January 1, 1991
COMPLETION DATE: December 31, 1991

Sediment and Phosphorus Loading: Predicting Water Quality in an Urban Piedmont Reservoir (70109)

Although it is widely recognized that population growth and development are increasing nutrient and sediment loadings to water supply reservoirs in Piedmont North Carolina, the ability to predict the effects of increased loadings on water quality and biological resources remains limited.

In this project, investigators will develop an innovative multidisciplinary approach to predicting water and biological resource quality of Piedmont reservoirs undergoing urban development. A limnologist/algal ecologist will join forces with an environmental engineer to examine the response of aquatic communities to imposed gradients of sediment and phosphorus loading. Field and laboratory experiments will be employed in this phase of the research. In another phase, the investigators will

inventory and evaluate models currently used to predict reservoir water quality and will select the model most suitable for use in Piedmont reservoirs. Experimental data will be used to test improved mathematical formulations that describe the dynamics of water and biological quality in reservoirs and to provide a base for selecting and modifying chemical and biological parameters for the process-based model. The project will strengthen the ability of reservoir managers and regulatory agencies to predict impacts of variable sediment and nutrient loadings on reservoir systems.

PRINCIPAL INVESTIGATORS: Dr. JoAnn M. Burkholder, Department of Botany, and Dr. John E. Parsons, Department of Biological and Agricultural Engineering, North Carolina State University
STARTING DATE: July 1, 1990
COMPLETION DATE: June 30, 1991

Economic Impacts of Pesticide Regulations to Protect Groundwater (20159)

In December 1988, the Environmental Protection Agency reported detections of 74 pesticides in the groundwater of 38 states, raising the possibility of widespread, serious pesticide contamination of groundwater supplies. Assessments of the potential for pesticide contamination of groundwater have, however, been controversial. Such assessments have been done without relevant local or regional input and without consideration of several critical hydrogeologic factors, including the characteristics of pesticides and site-specific soil characteristics. Moreover, local officials responsible for selecting policies to protect groundwater from pesticide contamination rarely have information about how well various policies protect groundwater or how the policies affect consumers and agricultural producers economically.

This research will provide missing information that policy makers need to assess pesticide contamination threat and select the most efficient policies to protect groundwater resources. An improved, more comprehensive pesticide use database will be developed, and missing hydrogeologic facts will be incorporated into a model to estimate contamination potential for selected pesticides in areas of the Southeast Coastal Plain. Once the contamination potential information is available, estimation of the economic impacts of alternative policies designed to reduce the contamination potential will be analyzed using producer and consumer economic impact models.

This project is being funded by a two-year matching grant to the Water Resources Research Institute by the U.S. Geological Survey.

PRINCIPAL INVESTIGATORS: Drs. Leon E. Danielson and Gerald A. Carlson, Department of Economics and Business, and Dr. Jerome B. Weber, Department of Crop Science, North Carolina Sate University
STARTING DATE: July 15, 1990
COMPLETION DATE: July 14, 1992

Biomarkers for Redox-Active Genotoxins in Contaminated Sediments: A Mechanistic Approach (20158)

It has been shown that persistent contaminants in rivers, lakes, and estuaries frequently collect in bottom soils or sediments, and recent studies have revealed elevated rates of tumors in bottom- dwelling fish taken from contaminated environments. These observations have generated considerable concern about the direct impacts of contaminants on aquatic ecosystems and indirect impacts of contaminants on human users. There is, therefore, an important need for methods for assessing the hazards which contaminated sediments pose to aquatic systems and people who use them.

This project focuses on genotoxins that have been associated with tumors in fish and on the role played by free radicals in genotoxic sequelae and their implications for biomonitoring. The goal is to develop a sensitive, mechanistically based approach for monitoring DNA damage and associated indices of oxidative stress and contaminant metabolism in benthic fish exposed to contaminated sediments. Laboratory in vivo studies will employ intact sediments from two streams in the Niagara River system. These experiments will serve to quantify relationships between exposures to sediments and responses indicative of genotoxicity, oxidative stress, and hydrocarbon metabolism. Initial in vitro studies will assess the abilities of representative model compounds to redox cycle and generate free radicals and to select one compound for detailed investigation of free radical-mediated mechanisms of DNA change.

In the second year of the project, field studies employing both wild and caged fish will be conducted in Niagara River systems streams that will closely parallel the in vivo laboratory studies. Collectively, these integrated laboratory and field studies will provide for creation of a sensitive and practical methodology for assessing the bioavailability and genotoxic impacts of compounds widely occurring in sediments of contaminated aquatic ecosystems. The methodology will have very practical uses for evaluating contaminated systems, prioritizing areas for clean-up efforts, and determining the success of clean-up efforts.

This project is being funded by a two-year matching grant to the Water Resources Research Institute by the U.S. Geological Survey.

PRINCIPAL INVESTIGATORS: Drs. Richard T. Di Giulio, David Watson, and Philip Darby, School of Forestry and Environmental Studies, Duke University
STARTING DATE: July 15, 1990
COMPLETION DATE: July 14, 1992

Determining the Role of Nitrogen-Enriched Acid Rain in Estuarine Eutrophication: The Neuse River Estuary, NC (20157)

Acid rain and associated dry deposition constitute a significant, yet frequently overlooked and unassessed source of biologically available nitrogen in shallow East Coast estuaries. According to some preliminary estimates, atmospheric nitrogen inputs to major East Coast estuaries may contribute from 20 to 40 percent of the total nitrogen loading. The increasing frequency of nuisance algae blooms and the resulting water quality degradation in these waters suggest that the role of atmospheric nitrogen loading in estuarine eutrophication should be quantified.

This research will examine productive and trophic impacts of atmospheric nitrogen deposition on the Neuse River Estuary. The research team will measure nutrients and physical and biotic features of the river area being studied bimonthly. They will analyze wet and dry deposition inputs, evaluate other point and nonpoint nutrient input sources, and assess the relative importance of atmospheric deposition

through short-term in situ bioassay and longer-term mesocosm studies. The studies will help determine which constituents of acid rain stimulate or inhibit phytoplankton growth; if acid rain events can be linked spatially and temporally to phytoplankton production or community composition; if acid rain plays a specific role in estuarine eutrophication and nuisance bloom dynamics; and how acid rain affects the trophic transfer between phytoplankton and zooplankton.

This project is being funded by a three-year matching grant to the Water Resources Research Institute by the U.S. Geological Survey.

PRINCIPAL INVESTIGATOR: Dr. Hans W. Paerl, Institute of Marine Sciences, University of North Carolina at Chapel Hill
STARTING DATE: July 15, 1990
COMPLETION DATE: July 14, 1993

Effects of Drainage and Water Table Control on Groundwater and Surface Water Quality (20160)

Poorly drained agricultural soils account for 40 percent of North Carolina's total cropland. Nationwide, 25 percent of agricultural cropland is composed of poorly drained soils. Because poorly drained areas lie near creeks, rivers, and estuaries, nonpoint source pollution from such areas used for agriculture pose a significant potential threat to surface waters. Moreover, agricultural nonpoint source pollution may also threaten groundwater.

Research has shown that drainage and water table control practices can affect the rate and pathway of water draining from agricultural lands. This knowledge has led to development of controlled drainage methods which are now being used as best management practices (BMPs) on thousands of acres in North Carolina and other Atlantic coast states. However, present methods for predicting effects of water management and cultural practices on pollutant loading are limited. Current methods cannot predict the effects of changing fertilizer rates or the time of fertilizer application or determine the best way to manage controlled drainage systems to minimize pollutant loading. Little research has been done on the effects of water table management on pesticide movement and fate in the groundwater and surface water of poorly drained soils.

This study will determine the effects of drainage and related water table control practices on groundwater and surface water quality, with particular focus on the movement and fate of pesticides and nutrients. Data on water quality effects of BMPs will be collected through well-instrumented, precisely controlled field experiments. The data will then be used to test the reliability of simulation models for predicting the fate of pollutants in ground and surface waters. The most promising of these models will be further developed to improve their reliability for shallow water table conditions. The results will be useful to state and federal agencies, consultants, and farmers who are developing, evaluating, and applying methods for reducing nonpoint source pollution.

This project is being funded by a three-year matching grant to the Water Resources Research Institute by the U.S. Geological Survey.

PRINCIPAL INVESTIGATORS: Drs. R. Wayne Skaggs, Robert O. Evans, and John E. Parsons, Department of Biological and Agricultural Engineering; Dr. J. Wendell Gilliam, Department of Soil Science; and Dr. T. Jackson Sheets, Departments of Entomology, Crop Science, and Horticultural Science; North Carolina State University
STARTING DATE: July 15, 1990
COMPLETION DATE: July 14, 1993

A Study of Nitrate Movement to Groundwater at the Neuse River Wastewater Treatment Plant Facility (50167)

A previous study at the Neuse River Wastewater Treatment Plant sludge application site has shown nitrate contamination of groundwater at some fields, suggesting the need for more detailed studies to determine possible various routes of nitrate movement into groundwater and to surface water.

This research will utilize three test sites at the Neuse River Wastewater Treatment Plant facility. At Site 1, a field which borders a stream and which has not yet been used for sludge application, background information about groundwater and surface water quality will be gathered first. Then, as sludge is applied, the effects on the groundwater and surface water system will be studied. At Site 2, a field where sludge has been applied for several years, sampling of a number of monitoring wells will be conducted weekly for specific conductance, pH, and water level; monthly for chloride, nitrate, sodium, potassium and calcium; and quarterly for more complete analyses. These data will provide insight into the actual movement of nitrate through the vados zone into the saturated zone and then toward stream discharge areas as well as an understanding of the potential for contamination of a bedrock well by nitrate originating in sludge. At Site 3, located on NCSU's Randleigh Dairy Farm, four wells will provide information on nitrate movement to the shallow groundwater for three different potential sources of nitrate: commercial fertilizer applications to a grain field, dairy barns and feedlots, and a wastewater holding pond. Data from this site will allow the investigator to compare the potential for groundwater nitrate contamination at a sludge application site to the contamination potential at a dairy farm.

Collectively, the results of the study will supply new information about how nitrate moves through a working sludge application site.

This study is being funded by the City of Raleigh through the Urban Water Consortium.

PRINCIPAL INVESTIGATOR: Dr. Charles W. Welby, Department of Marine, Earth and Atmospheric Sciences, North Carolina State University
STARTING DATE: August 1, 1990
COMPLETION DATE: July 31, 1993

A Study of Baseline Water Quality in Lake Raleigh (50165)

Lake Raleigh is a small urban reservoir located on NCSU's Centennial Campus. It is anticipated that the chemistry and morphometry of the lake may be modified by construction activities in its drainage basin. It is, therefore, desirable to document present conditions as a reference point for comparison with future changes in reservoir water quality.

In this project, a bathymetry map will be developed for the lake, and three stations for monthly sampling will be established to include the near-inflow area, midregion, and near-outflow of the lake. Water clarity, light, temperature, turbidity, dissolved oxygen, pH, conductivity, and suspended solids will be determined. A nutrient analysis will be performed, as will monthly analyses for fecal coliform bacteria and quarterly analyses for heavy metals. Biological parameters other than fecal coliforms in the a baseline assessment of water quality in Lake Raleigh will include monthly chlorophyll samples and late-summer assessment of the taxonomic composition and abundance of the phytoplankton community.

This study is being funded by the NCSU Centennial Campus

PRINCIPAL INVESTIGATOR: Dr. JoAnn M. Burkholder, Department of Botany, North Carolina State University
STARTING DATE: July 1, 1990
COMPLETION DATE: June 30, 1991

Continuing Research

Treatability Assessment of Jordan Lake Water (70098)

The suitability of Jordan Lake water for public consumption has been extensively debated. Questions of synthetic organic chemicals (SOCs) which may be carcinogenic to man, disinfection by-products, and disinfection efficiency are of interest to local water supply practitioners. The goal of this project is to evaluate the potential health hazards arising from the use of Jordan Lake as a source of drinking water.

This project will explore three different potable water treatment scenarios for Jordan Lake water. A conventional surface water treatment scheme using coagulation, sedimentation, filtration, and chlorination will be compared with two advanced treatment schemes, one using granular activated carbon adsorption, the other using ozonation and chloramination in place of chlorine for disinfection. Treatment effectiveness will be evaluated using conventional water quality characteristics (e.g. turbidity, color, total organic carbon, trihalomethanes) and the Ames mutagenicity bioassay.

PRINCIPAL INVESTIGATORS: Drs. Philip C. Singer, Louise Ball, and Francis DiGiano, Department of Environmental Sciences and Engineering, University of North Carolina, Chapel Hill
STARTING DATE: June 1, 1989
COMPLETION DATE: June 30, 1991

Movement and Dissipation of Pesticides and Water in Soils (20155-56)

The major limitation in predicting groundwater contamination is the lack of understanding of the interactions among the processes involved in the dissipation of organic solutes in soil under natural conditions. Pesticides are an important source of such potential contaminants. Pesticide behavior in soil is effected typically by the processes of advection, hydrodynamic dispersion, evapotranspiration, volatilization, sorption/desorption, and degradation. While much work has been done in the area of pesticide process reactions, few studies have examined all of the operative processes for a given system.

This project will add new information about the interaction of processes that affect the fate and transport of common organic solutes in the unsaturated soil zone. The expected results will also include new information about the feasibility of using polymers to limit the mobility of potential groundwater contaminants.

The research includes controlled field studies, laboratory process studies, and mathematical modeling of field and laboratory studies.

PRINCIPAL INVESTIGATORS: Dr. Jerome B. Weber, Department of Crop Science, North Carolina State University, and Dr. Cass T. Miller, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill
STARTING DATE: June 1, 1989
COMPLETION DATE: May 31, 1992

This three-year project is funded by a matching grant to the UNC Water Resources Research Institute from the U.S. Geological Survey.

A Mound/Constructed Wetland System for On-Site Wastewater Treatment (70101)

As development continues in the coastal zone of North Carolina, the need for effective treatment of wastewater becomes more critical. Incomplete treatment of wastewater leads to pollution of groundwater, streams and estuaries. Because of the high cost of municipal wastewater treatment plants and the rural nature of most of the area, on-site treatment is usually the only alternative. This poses a dilemma since much of the land within the coastal zone is unsuitable for effective wastewater treatment using conventional septic tanks and associated absorption fields. Soil limitations are perched or seasonal high water tables, slowly permeable clays, or coarse textured sands which offer very little treatment potential.

An alternative treatment system, the pressure dosed septic system, has been successfully used to overcome some soil problems; however, this system does not effectively treat wastewater during periods of seasonal high water tables or when installed in massive clays.

This research will determine the ability of a combination mound and constructed wetland system to improve the quality of wastewater passed through it via subsurface flow from a septic tank serving a single family dwelling. Constructed wetlands may be used to upgrade existing systems or to build new systems. The principal benefit of the results will be an improved method of wastewater treatment that will reduce the risk of pollution by nutrients, suspended solids, and disease organisms.

PRINCIPAL INVESTIGATOR: Drs. Stephen W. Broome and Michael T. Hoover, Department of Soil Science, North Carolina State University
STARTING DATE: July 1, 1989
COMPLETION DATE: June 30, 1991

Evaluation of Saprolite in the Piedmont and Mountain Regions for On-Site Wastewater Disposal (20154)

Over 50 percent of North Carolinians rely on septic tank systems for managing household wastewater. The soils in the N.C. Piedmont and Mountain regions (occupying 55 percent of the state) are characterized by the presence of saprolite at or near the surface. N.C. rules governing septic tank systems are being changed to reclassify some saprolite for direct wastewater application.

Because of the presence of cracks, foliations, natural dikes, and various pores in saprolite it is suspected that direct application of wastewater to saprolite will result in the rapid movement of pollutants into the groundwater. There currently is not enough information to determine if any saprolite is suitable for wastewater disposal or to define procedures by which suitable material could be recognized .

This research is aimed at identifying properties of various saprolites associated with the major soils and rock types in the two regions, and developing procedures to identify suitable saprolites for septic tank systems. The information obtained in this study will help the regulatory agencies to develop rules and regulations regarding use of saprolite for wastewater disposal in Piedmont and Mountain regions. This information will also be important for assessing groundwater recharge and movement of other inorganic chemicals in waste materials such as sludge or landfill leachate throughout the soils of the two regions.

This project is being funded by a three-year matching grant to the Water Resources Research Institute by the U.S. Geological Survey.

PRINCIPAL INVESTIGATORS: Drs. Aziz Amoozegar, M.T. Hoover and H. J. Kleiss, Department of Soil Science, North Carolina State University
STARTING DATE: September 1, 1988
COMPLETION DATE: August 31, 1991

An Evaluation of An Approach for Determining the Cause of Chronic Toxicity in the Effluent from Municipal Wastewater Treatment Plants (70103)

This project is being funded by the Urban Water Consortium.

Many wastewater treatment plants in North Carolina are currently required to meet chronic toxicity limits as a condition of the National Pollutant Discharge Elimination System (NPDES) Permit. Many of these plants are having difficulty meeting this permit limit. Unlike acute toxicity, there currently are no accepted methods to trace the source of chronic toxicity so that this might be eliminated either at the source or by treatment. This research will test a relatively simple technique which wastewater treatment plant personnel may utilize for identifying the source of chronic toxicity.

The research proposes to test the precision of the chronic toxicity test in identifying factors which might contribute to chronic toxicity of effluents that have no obvious source of toxic influent.

The results of this research will identify whether a relatively straight-forward but labor intensive, evaluation system has utility for identifying the source of chronic toxicity in the effluent of wastewater treatment plants. In addition, the results of this research will be beneficial in evaluating the nature of the *Ceriodaphnia* chronic toxicity bioassay test in systems which have a very high regulatory, instream waste concentration. Such information may lead to modifications of the bioassay testing procedure.

PRINCIPAL INVESTIGATORS: Drs. Donald E. Francisco, and Francis A. DiGiano, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill
STARTING DATE: July 1, 1989
COMPLETION DATE: June 30, 1990

Effectiveness of Vegetative Filter Strips in Removing Sediments, Nitrogen, and Phosphorus from Agricultural Drainage (70105)

This project is being jointly funded by the U.S. Environmental Protection Agency, the USDA Soil Conservation Service, and WRRI.

Vegetative filter strips (VFS) between agricultural fields and surface waters are being promoted by the U.S. Department of Agriculture and the U.S. Environmental Protection Agency as techniques to remove sediment and nutrients from surface drainage water before it enters surface waters.

This project is aimed at providing data for answering questions about the effectiveness of VFS for water quality purposes. The project consists of experimental studies for acquiring data and a modeling effort to allow extension of the data collected to different climatic, soil and geomorphic conditions.

The results will be useful both technically, in establishing design criteria for filter strips, and in the policy area, by providing analysis criteria for stream buffer requirements and other regulations.

PRINCIPAL INVESTIGATORS: Drs. J.W. Gilliam and Raymond B. Daniels, Department of Soil Science, North Carolina State University
STARTING DATE: July 1, 1989
COMPLETION DATE: June 30, 1991

Suspended Sediment Yield Model for North Carolina Rural Watersheds (70097)

Suspended and deposited sediment are particularly widespread water quality problems, and tremendous expenditures are required to combat their effects on water resources.

Reduction of sediment yield from nonpoint sources can be enhanced with management tools to aid in the determination of critical watersheds and in the evaluation of program effects. A suspended sediment yield model applicable to a wide range of watersheds is one such tool that is not available for North Carolina.

This research is directed toward the development and testing of a model to predict suspended sediment yields from gaged and ungaged rural drainage basins in North Carolina. The project will identify and quantify drainage basin characteristics that are the most important influences on sediment yield in the various regions of the state to which the model will apply.

PRINCIPAL INVESTIGATOR: Dr. James D. Gregory, Department of Forestry, North Carolina State University
STARTING DATE: April 1, 1989
COMPLETION DATE: December 31, 1990

Cloud Point Extraction and Pre-concentration Procedures for Organics and Related Pollutants (70108)

Monitoring and control studies desired in many areas of water resources research are dependent upon the ability to extract/concentrate organic pollutants from large masses of water or desorb such organic materials from sludge or solid (soil) matrices prior to further fractionation and/or quantitation of the desired constituent(s). Another problem is how to deal with the adsorbents (such as activated carbon or charcoal) which were utilized to remove organic materials (or other materials such as radon) from aqueous industrial or related effluents.

This research addresses both of these important areas and outlines a means by which one can extract and pre-concentrate organic species from water samples or remove such species from solids such as soils and activated carbon. The general technique will facilitate not only the monitoring of organic pollutants (such as pesticides, haloalkanes, phenols, phthalate esters, etc.) in North Carolina waters but will also be applicable to the regeneration of activated carbon now employed to remove pollutants from industrial or other effluents.

PRINCIPAL INVESTIGATOR: Dr. Willie L. Hinze, Department of Chemistry, Wake Forest University
STARTING DATE: January 1, 1990
COMPLETION DATE: December 31, 1990

Identification of Organic Nitrogen Chlorination By-Products in North Carolina Surface Waters (70104)

North Carolina's surface water supplies, especially in the eastern part of the state, contain natural and anthropogenic forms of organic carbon. Chlorine disinfection of these waters produces hundreds of organic by-products, a number of which have been shown to be toxic. The trihalomethane class of by-products is currently regulated by EPA at 100 µg/l, and this level is likely to be lowered further.

Organic compounds also react quickly and completely with chlorine to form N-chloramine compounds. These by-products may also be toxic and can interfere with the analytical methods for measuring free chlorine residuals. The interference of chloramines makes it difficult to determine if disinfection has occurred and can hinder compliance with EPA regulations.

This research will develop an analytical method for identifying the chlorine by-products from nitrogen bases, and the methodology will be applied to analysis of chlorinated water from Jordan Lake near Durham and High Rock Lake near Winston-Salem.

PRINCIPAL INVESTIGATOR: Dr. J. Donald Johnson, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill
STARTING DATE: July 1, 1989
COMPLETION DATE: August 31, 1990

Movement of Multiple Pollutants in Groundwater (20152)

Groundwater resources in many areas of the United States have been contaminated by a variety of organic pollutants. Devising economical and effective clean-up methods requires an understanding of how contaminants move through groundwater systems and of what ultimately becomes of pollutants in the subsurface environment. This project will examine one of the most important processes operative in subsurface systems—the sorption-desorption process. It will describe and model mathematically the physical and chemical mechanisms by which certain common organic pollutants collect on or in substances in specific aquifer soils and the mechanisms by which these organics are released from the soil phase into groundwater. Importantly, the project will also examine how the sorption-desorption process may be affected by the simultaneous presence of several different organic pollutants.

The practical benefit of the investigation will be knowledge that will lead to more accurate assessments of risks from contamination and more effective design of remedial aquifer renovation measures.

The project is being funded by a matching grant to the Water Resources Research Institute from the U.S. Geological Survey.

PRINCIPAL INVESTIGATOR: Dr. Cass T. Miller, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill
STARTING DATE: August 1, 1987
COMPLETION DATE: October 31, 1990

Precipitation Regime Changes Resulting from Climatic Changes (20153)

It is becoming increasingly clear that climatic changes have the potential to create dramatic changes in the precipitation regime and hence the water resources of a region. Climate scenarios based on general circulation models indicate the potential changes but do not provide adequate detail for impact assessments. Analogue scenarios, using historical records, provide much greater detail but cannot incorporate the effects of the processes creating future climates. The objective of this project is to combine the strengths of the two approaches and develop climate scenarios for the southeastern United States directly applicable to assessments of the impact of climatic changes on water resources.

The results, given in terms of precipitation event frequency distributions, can be used both as input to hydrologic models and as estimates of seasonal precipitation by water managers.

This project is being funded by a two-year matching grant to the Water Resources Research Institute by the U.S. Geological Survey.

PRINCIPAL INVESTIGATORS: Drs. Peter J. Robinson and Stephen J. Walsh, Department of Geography, University of North Carolina at Chapel Hill
STARTING DATE: September 1, 1988
COMPLETION DATE: February 29, 1991

Assessment of Municipal Sludge Management Practices in North Carolina (70102)

Development of feasible municipal sludge management programs in North Carolina is hampered by lack of information regarding the quantity and quality of sludge produced by municipalities, as well as insufficient analyses of the effectiveness of existing alternative sludge management practices.

This study will provide improved information on sludge management practices in North Carolina. Data will be collected addressing the quality of sludge generated in the state and the quantity of sludge applied to lands in North Carolina. Several other sludge management alternatives will be examined. Those alternatives include: composting, incineration, and potential storage.

PRINCIPAL INVESTIGATORS: Dr. A. Robert Rubin, Department of Biological and Agricultural Engineering, and Dr. Joe Zublena, Department of Soil Science, North Carolina State University
STARTING DATE: July 1, 1989
COMPLETION DATE: March 31, 1991

Preliminary Investigation of the Uranium Isotope in the Groundwaters of Northeastern North Carolina (70100)

The "ages" of water in the various aquifers underlying the northeast region of North Carolina could provide some evidence about the movement of groundwater in that area. By knowing how long the water has been resident in different layers, scientists may be able to gain insight into the velocities of flow and mixing between aquifers. The purpose of this project is to measure the isotopic signatures for several aquifers in the study area using the U234/U238 activity ratio.

PRINCIPAL INVESTIGATOR: Dr. Francisco C. San Juan, Department of Geosciences, Elizabeth City State University
STARTING DATE: June 1, 1989
COMPLETION DATE: December 31, 1990

Prediction of Pollutant Movement from Poorly Drained Soils (70088)

Aquatic biologists and fishermen believe that agricultural drainage of Coastal Plain land has been detrimental to the productivity of estuarine nursery areas.

The purpose of this research project is to develop and test methods for predicting the effects of agricultural water management and cultural practices on pollutant movement from poorly drained soils. Specifically, this project is designed to combine DRAINMOD, a model for water movement in poorly drained soils for different water management systems, with CREAMS and/or GLEAMS, models for evaluating sediment and nutrient movement from different agricultural management systems, and test the validity of the resulting combination. The combination model is expected to provide a method for evaluating the effect of water management, fertility, pesticide and cultural practices on pollutant loading from poorly drained agricultural fields.

PRINCIPAL INVESTIGATORS: Drs. R.W. Skaggs, J.E. Parsons, and R.O. Evans, Department of Biological and Agricultural Engineering, and Dr. T. J. Sheets, Departments of Entomology, Crop Science, and Horticultural Science, North Carolina State University
STARTING DATE: May 1, 1988
COMPLETION DATE: September 30, 1990

An Improved Viral Indicator of Fecal Contamination and Treatment Process Efficiency to Meet New EPA Drinking Water Regulations (70107)

Proposed EPA regulations to control microbial contaminants in drinking water will require better source water quality and improved water treatment practices. However, in order to adequately control viruses and other microbial contaminants in both source and treated waters, an improved microbial indicator of fecal contamination that reliably indicates viruses is needed.

This project will evaluate and apply a new indicator of fecal contamination that indicates the presence of human viruses as well as bacteria. This system will be used to determine the quality of surface and groundwater sources, to determine the comparative reductions of the new indicator as well as important viral pathogens by biological and non-biological granular activated carbon (GAC) treatment in laboratory bench-scale columns, and to determine the reductions of indicator viruses and bacteria by conventional water treatment processes. Water treatment plants having fecally contaminated source waters and inadequate treatment relative to EPA's proposed treatment regulations will receive particular attention.

This research is partly funded by the American Water Works Association Research Foundation (AWWARF).

PRINCIPAL INVESTIGATOR: Dr. Mark D. Sobsey, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill
STARTING DATE: January 1, 1990
COMPLETION DATE: December 31, 1990

Implications for Disposal of Activated Carbon Used to Remove Radon from Drinking Water (70099)

It has been found that some individual drinking water wells in North Carolina may have high levels of radon. To protect the health of people using this water, the radon must be removed.

Two principal methods have been proposed for removing radon from drinking water—aeration and adsorption on granular activated carbon (GAC). Because aeration is expensive and requires maintenance, it is expected that GAC removal may be better suited for individual wells. However, questions about radiation exposure resulting from build-up of radioactivity on the GAC and disposal of GAC have not been addressed. This project will address these questions with emphasis on the disposal issue. If the study indicates that the GAC must be considered low-level radioactive waste, limitations , alternatives, and costs of disposal will be studied. A determination will also be made of lead build-up on the GAC and an assessment made of whether the GAC might be classified as hazardous waste.

PRINCIPAL INVESTIGATOR: Dr. James E. Watson, Jr., Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill
STARTING DATE: June 1, 1989
COMPLETION DATE: September 30, 1990

Urban Water Consortium

In 1985, the Institute, in cooperation with several of North Carolina's larger cities, established the Urban Water Consortium. The Consortium is designed to provide a program of research, development and technology transfer on the many water problems that urban areas share.

The Consortium program is administered by the Institute. Participating cities support and guide the program through annual dues, which are matched by state funds, and representation on an advisory board. Membership in the Consortium is open to all cities and special districts in North Carolina. The program initially received support from the N.C. Department of Natural Resources and Community Development and appropriations from the N.C. General Assembly.

Support for Consortium projects during 1989-90 was provided by the Orange Water and Sewer Authority; the cities of Raleigh, Durham, High Point, Winston-Salem, and Burlington; the U.S. Environmental Protection Agency; and WRRI.

Information Dissemination and Technology Transfer

The Institute disseminates information and promotes the adoption of new technology through publication of newsletters and of technical completion reports on its projects and through conferences, workshops and seminars.

Technical Reports

Eight completion reports were published in 1989-90. Each report received peer review as required by Institute publication policy, and the availability of the reports was publicized by review in the Institute newsletter and by special mailings to members of the research and regulatory communities. Reports published were:

Report 244	Historical Account of Public Water Supplies in North Carolina
Report 245	Tentative Identification or Organic Compounds at the Westside Wastewater Treatment Plant (High Point, NC) and Implications for Aquatic Toxicity
Report 246	Modeling Organic Contaminant Sorption Impacts on Aquifer Restoration
Report 247	Proceedings of Workshop on Management of Aquatic Weeds and Mosquitoes in Impoundments
Report 248	Evaluation of Detention Basin Performance in the Piedmont Region of North Carolina
Report 249	Movement of Water and Chemical Pollutants from Wastewater Disposal Systems through the Soil and Saprolite of Piedmont Landscapes
Report 250	Managing Public Water Supplies during Droughts (Experiences in the United States in 1986 and 1988)
Report 251	Nutrient Processing and Water Quality in a Piedmont Bottomland Receiving Urban Wastewater
Report 252	Agricultural Pesticides and Groundwater in North Carolina: Identification of the Most Vulnerable Areas

If you would like a complete listing of reports and proceedings published by the Institute, please call (919) 737-2815 and request the Institute Publications List.

Newsletters

The Institute *NEWS*, a 10-16 page newsletter, was distributed bimonthly to more than 2,400 federal and state agencies, university personnel, multi-county planning regions, city and local officials, and consultants. The *NEWS* regularly includes a wide range of water-related articles from current federal and state legislation and regulatory activities to new research findings and listings of water-related publications. The *Urban Water Consortium News*, a 6-10 page newsletter, is published periodically and distributed to members of the Urban Water Consortium who use the newsletter to keep their constituencies (city councils, county commissions, etc.) informed about the activities of the consortium and about water-related issues affecting municipalities. The newsletter carries descriptions of research funded through the consortium as well as news about water-related projects undertaken independently by members, and state and federal programs and legislation.

Other Publications

Institute staff also participated in the development and editing of several non-Institute publications. *Proceedings of the Workshop on Management of Aquatic Weeds and Mosquitoes in Impoundments*, which the Institute had co-sponsored last year, were edited by the Institute during 1989-90. In addition, the Institute editor was co-editor of the *Preliminary Status and Trends Report for the Albemarle-Pamlico Estuarine Study (APES)* and co-writer/editor of the APES Preliminary Status and Trends summary document.

Conferences, Workshops, and Seminars

During 1989-90 the Institute sponsored and helped plan and execute three workshops and conferences on key water-related issues. Following is a brief description of them.

A Workshop on Siting, Design, and Permitting of Solid Waste Landfills. In September, WRRI joined the N.C. Solid Waste Management Section, the N.C. Association of County Commissioners, the N.C. League of Municipalities, the County Managers Association, the Governmental Refuse Collection and Disposal Association, and the N.C. Chapter of the American Public Works Association in presenting a workshop to provide regulatory and technical information to facilitate implementation of new solid waste landfill performance standards.

Erosion and Sediment Control Workshop for Local Programs. In December, WRRI, the N.C. Sedimentation Control Commission, and the N.C. Land Quality Section presented a workshop to update local technicians and administrators on changes in the state's erosion and sediment control program.

Erosion and Sediment Control Workshop. In January, the same sponsors presented a workshop to introduce changes in the state's erosion and sediment control program to private engineers, architects, surveyors and other practicing professionals.

WATER RESOURCES RESEARCH INSTITUTE

Board of Directors

Dr. James K. Ferrell, Dean of College of Engineering, North Carolina State University (Chairman)

Dr. Durward F. Bateman, Dean of College of Agriculture and Life Sciences, North Carolina State University

Dr. Russell F. Christman, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

Dr. Franklin D. Hart, Vice Chancellor for Research, North Carolina State University

Professor Milton S. Heath, Jr., Associate Director Institute of Government University of North Carolina

Dr. David H. Moreau, Director Water Resources Research Institute (Secretary)

Advisory Committee

Mrs. Edythe McKinney Assistant Secretary for Environmental Protection, N.C. Department of Environment, Health and Natural Resources (Chairman)

Mr. Charles L. Baker, Chairman, N.C. Environmental Management Commission

Mr. Dempsey E. Benton, Jr., City Manager, City of Raleigh

Mr. Bruce A. Brye, Environmental Engineer, Water Resources, Tennessee Valley Authority

Mr. Richard G. Catlin, Richard Catlin and Associates

Mr. Michael R. Corcoran, Executive Vice President, N.C. Wildlife Federation

Mr. Charles H. Gardner, Director, Division of Land Resources, N.C. Department of Environment, Health, and Natural Resources

Dr. George T. Everett, Director, Division of Environmental Management, N.C. Department of Environment, Health, and Natural Resources

Mr. John Garrett, Assistant State Conservationist, USDA Soil Conservation Service

Mr. Edward A. Holland, Planning & Resource Administrator, Orange Water & Sewer Authority

Dr. Ronald H. Levine,State Health Director, N.C. Department of Environment, Health, and Natural Resources

Mr. Steven J. Levitas, N.C. Environmental Defense Fund

Mr. William J. McCabe, Design Engineering Department, Duke Power Company

Mr. John N. Morris, Jr., Director, Division of Water Resources, N.C. Department of Environment, Health and Natural Resources

Dr. George J. Oliver, Manager, Environmental Services, Carolina Power and Light Company

Mr. Edmund P. Regan, Fiscal Analyst, N.C. Association of County Commissioners

Mr. David E. Reynolds, Executive Director, N.C. League of Municipalities

Mr. A. Terry Rolan, Director, Department of Water Resources, City of Durham

Mr. William Schimming, Manager, Environmental Affairs, Texasgulf Chemicals

Mr. David Sides, Director Division of Soil and Water Resources N.C. Department of Environment, Health and Natural Resources

Mr. James L. Stokoe, Director, Environmental and Energy Programs, Land-of-Sky Regional Council

Mr. James F. Turner, District Chief, Geological Survey, U.S. Department of Interior

Lt. Col. Thomas C. Suermann, District Engineer, Corps of Engineers, U.S. Department of the Army

Mr. R. Paul Wilms, N.C. Homebuilders Association

Technical Committee

Dr. David H. Moreau, Director Water Resources Research Institute (Chairman)

Mr. Michael D. Aitken, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

Dr. Stephen W. Broome, Department of Soil Science, North Carolina State University

Dr. Robert C. Borden, Department of Civil Engineering, North Carolina State University

Dr. C.Q. Brown, Chairman, Department of Geology, East Carolina University

Dr. Raymond J. Burby, Department of City and Regional Planning, University of North Carolina at Chapel Hill

Dr. B.J. Copeland, Director, UNC Sea Grant College Program, The University of North Carolina

Prof. Richard D. Ducker, Institute of Government, The University of North Carolina

Dr. Godfrey A. Gayle, Department of Plant Science and Technology, North Carolina Agricultural and Technical State University

Dr. Robert E. Holman, Associate Directoor, Water Resources Research Institute

Dr. Edward J. Kaiser, Department of City and Regional Planning, University of North Carolina at Chapel Hill

Dr. George J. Kriz, Associate Director, Agricultural Research Service, North Carolina State University

Dr. Nelson R. Nunnally, Department of Geography and Earth Sciences, University of North Carolina at Charlotte

Dr. Frederic K. Pfaender Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

Dr. Philip C. Singer, Department of Environmental Sciences and Engineering, University of North Carolina at Chapel Hill

Dr. Donald W. Stanley, Institute for Coastal and Marine Resources, East Carolina University

Dr. Philip W. Westerman, Department of Biological and Agricultural Engineering, North Carolina State University